

**RIVERS STATE UNIVERSITY,  
PORT HARCOURT**



**“WILDLIFE AND BIODIVERSITY  
CONSERVATION-AN INDISPENSIBLE  
STRATEGY FOR  
SUSTAINABLE DEVELOPMENT”**

**AN INAUGURAL LECTURE**

By

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**Professor of Wildlife and Biodiversity Conservation**

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currently championing wildlife and biodiversity conservation awareness campaign in Nigeria, through series of symposia organized on World Wildlife Day and Environment Day programmes and articles contributed in Nigerian daily Newspapers.

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***An  
Inaugural Lecture  
by***

**PROFESSOR**

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## *Biodiversity Quotes*

"From time immemorial, nature has fed us, cured us, and protected us. But today the roles have switched. We need to feed nature, we need to cure it and protect it if we want to secure a healthy and prosperous future for our children."

"Nature do not need people; people need nature" ....  
Conservation International (CI).

"The Cheetah, *Aonyx jubatus* the fastest sprinter on earth is not outrunning extinction."

"The easiest way to command nature is to obey her laws"  
-Francis Bacon.

"One million of earth's species are threatened with extinction because of human activities that cause habitat loss, pollution and climate change. Nature's vital contributions to human life are being eroded, which can affect our access to food, medicine, energy and clear water and air. Despite these dire warnings, there is still time to slow down and even reverse the erosion to our resources and the extinction of species, but it will take significant, transformative change" ..... United Nations (2019).

## CITATION

Godfrey Chukwuma Akani, B.Ed Hon. (Zoology) Ibadan, M.Phil (Marine Biology), Ph.D (Environmental Biology) RSUST, is a Professor of Wildlife and Biodiversity Conservation and Head of Department, Applied and Environmental Biology, Rivers State University, Port Harcourt (2015 -2017). He is a versatile and passionate Ecologist and conservationist with an amazing wealth of research experience, corporate company experience and has published extensively in reputable local and international journals on the wildlife and biodiversity of the Niger Delta. In fact, he is one the most published African Ecologists with H-index of over 35. Prof. Akani, was Nigeria's Chairman for the international Declining Amphibian Population Task Force (DAPTF) between 2001 and 2005. As shown in list of publications, Professor Akani created a niche for himself in the study of one the most dreaded animals – Snakes; What is known today about the snakes of Niger Delta and Nigeria is due to Professor Akani and his Italian counterpart, Professor Luca Luiselli. Thus, in Rivers State University of Science and Technology, the name Akani is synonymous with snakes. During his sabbatical in Shell, Port Harcourt, Akani produced a guideline on how to manage/ curtail snakes incidence. Presently, his research has delved into the possibility of producing snake repellents from local herbs from Nigeria, instead of the toxic fumigant often used. He believes that such environmentally friendly snake-away extracts will help conserve snakes, which check rodent populations in our farms. He also assisted the company in drawing up modalities for the conservation of forests where endangered species like Chimpanzees, elephants and Red Colobus monkeys occur in Rivers State and Bayelsa States.

Professor Akani is Fellow of Institute of Vertebrate Zoology (FIZV) of Italy, Fellow Civilian Institute of Democratic Administration (FCIDA), Ghana; Member, International Society of Zoological Science (MISZS) China, and Member, Nigerian Environmental Society (MNES) and a member of Nigeria Conservation Foundation (NCF). He is

## **SOME GENERAL CRITERIA TO IDENTIFY WHETHER AN ENCOUNTERED SNAKE IS VENOMOUS OR NOT:**

**No simple way is available, but there are some general rules that may be useful:**

1. Any snake with conspicuous longitudinal stripes along the body is not venomous.
2. Any snake very big (over 2 m long) is probably dangerous.
3. Any green, green-grey, olive-green snake longer than 1.2 m is probably dangerous.
4. Any snake that spreads its hood or flattens its neck is certainly dangerous.
5. Any snake with conspicuous bars, cross-bands, rings, and V-marks on the heads may be dangerous.
6. Any very fat snake, very slow moving, with spectacular geometric patterned coloration is certainly highly dangerous.
7. Any small burrowing (worm-like) snake, with no obvious head and with a spine on the tail, dark coloured, is dangerous.
8. Any snake that does not have anything of these characteristics is probably harmless.

## ***Dedication***

**In loving Memory of my late Father, Chief  
Benson Enyindah Akani,**

**My late Elder sister, Lady Justina Chikenwo Omodu,**

**My late cousin, His Royal Highness Michael  
Badumerum Onwuna Oriebe, B.Sc (Ife),  
Nyenwe-Ali Akpor IX.**

**&**

**Late Charles Bruce Powell (Biodiversity Unit, IPS.,  
RSU., PH) – A Canadian known as the father of  
Wildlife and Biodiversity Research of the Niger Delta.**



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*but more vividly coloured*). Rare in southern Nigeria, where it is found only in forest sites, often around streams, rocky places, and rivers. It seems common north of Calabar (Oban Hills), but very rare in Niger Delta.

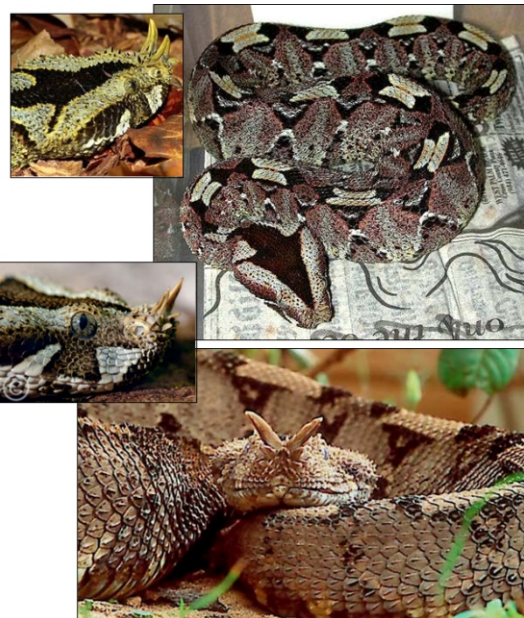
### *Causus maculatus* (Night Adder) (DANGEROUS)

Up to 70 cm long (normally 40-60 cm). A small stout viper with a fairly short head slightly distinct from the neck, a rounded snout and a medium-size eye with a round pupil, the top of the head covered with nine large scales. *On the head there is usually a characteristic V-shape mark, solidly black in juveniles or dark-brown in adults*. Usually some shade of brown on the back of the body, occasionally greyish, olive or light green. There are a number of dark brown or blackish patches all along the back. Very common in Nigeria, especially in Port Harcourt area. It is found in forest- plantation mosaics, altered bush, secondary forests, and suburbs as well.



Easily recognizable by its appearance. Up to 160 cm long (normally 100-120 cm), it has a very broad head with a pair of small horn-like knobs on the top of the snout. The body is extremely stout, and the tail is very short. The body is coloured in an attractive geometric pattern: the head is whitish with a central dark line and two black triangles above the angle of the jaw and under the eye. The body has a series of elongate, yellow to light buff, rectangular markings linked to hourglass-shaped velvety-brown

interspaces down the middle of the back. The flanks have a complex triangular pattern of buff, purple, brown and pinkish. The belly is yellowish to cream with dark spots. Common in forests, forest clearings, forest edges, and in the forest-plantation mosaic. Locally abundant (especially in the Niger Delta), has a typical "lumped" distribution in the territory.



*Bitis nasicornis*  
(Rhinoceros Viper)  
(LETHAL)

Up to 120 cm long (normally 80-90 cm), it is a stout, large viper, quite similar to the Gaboon viper. The main differences with the above-mentioned species are: *the presence of prominent small horn-like knobs on the top of the snout, the coloration of the head (blue or green with a vivid black arrow mark), and the spectacular body coloration (patterned in a similar way to the Gaboon,*

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It is a big (to 300 cm long, normally 140-220 cm), slender tree snake with **very long narrow head, small eye with round pupil**, long and thin tail, smooth scales. Dorsal coloration is **dull green, with a yellow tail with tail scales black-edged, giving a net effect**. Common in Nigeria, in mangroves, rainforests, forest- plantation mosaics, bush, and even suburbs. Captured inside PH.

### ***Atheris squamiger* (Green Bush Viper) (VERY DANGEROUS)**

Up to 78 cm long (normally 40-55 cm), is a typical viper with a broad and flat head, and slender body. **The scales of both head and body are strongly keeled (giving the impression of spines)**. The coloration is variable, but is normally green or yellowish-green, sometimes with darker blotches. Belly is yellowish, and



tip of the tail is whitish. It is an expert climber. Locally abundant in Nigeria (e.g. Oguta forests), it seems uncommon or even rare elsewhere. It was observed in forest clearings, forest edges, and altered bush. Doesn't occur in suburbs.

### **Family VIPERIDAE**

#### ***Bitis gabonica* (Gaboon Viper) (LETHAL)**





**black bars on the underside of the neck.** The black is less bright than that of the forest cobra, and gives the snake an appearance of a ROUGHLY SCALED snake. The juveniles are **grey, with a black head.** It is extremely common in southern Nigeria, where is found mainly in altered habitats, suburbs, plantations, and forest-plantation mosaics. In Calabar it is, together with *Grayia smythii*, the most common snakes.

***Pseudohaje goldii* (Gold's Tree Cobra) (LETHAL)**

Big (up to 300 cm long, normally 150 to 200 cm), shiny, thin-bodied snake. **It has a very short head and a HUGE dark eye with a round pupil (hard to see!).** Scales are smooth and very glossy. **Dorsal coloration is glossy black, with the scales of head, chin, and throat being yellow edged with black. Ventral coloration is yellow.** It is a rare snake, found only in high forest, often around water bodies, It was captured by us in Akampka and in Niger Delta.



***Dendroaspis jamesoni* (Green Mamba) (LETHAL)**



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### *Naja melanoleuca* (Black Forest Cobra) (LETHAL)

A big (to 330 cm long, normally 180-240 cm), thick-bodied cobra, with a big head and a large dark eye with a round pupil. Scales are smooth and glossy. Dorsal coloration of southern Nigerian specimens is ***glossy black (very bright!), with chin, throat, and anterior part of the belly cream or white, with broad black cross-bars and blotches. The sides of the head are strikingly marked with black and white, giving the impression of vertical black and white bars on the lips.*** It is found in undisturbed forest sites, in the forest-plantation mosaic, often in the vicinity of streams, rivers, and water bodies. It is one of the most handsome snakes of our forests, where it is still relatively widespread.



### *Naja nigricollis* (Spitting Cobra) (LETHAL)

A typical cobra, up to 200 cm long (normally 80-120 cm). In southern Nigeria, it is easily recognizable by the coloration: above is ***black or dark-grey, with a series of vivid pink or reddish bands interspersed with***

4. Anal plate divided - (6)
5. Anal plate undivided - (7)
6. *TRACTASPIS IRREGULARIS* (213-244 ventral scales; 24-32 subcaudals, all of them divided; to 60 cm total length; dark or black in coloration, more rarely brownish)
7. *TRACTASPIS ATERRIMA* (244-300 ventral scales; 18-26 subcaudals, most of them undivided; to 70 cm total length; dark-brown or bluish in coloration).



### **Family ELAPIDAE**

#### ***Boulengerina annulata* (Water Cobra) (LETHAL)**

Up to 270 cm long, normally 120-180 cm. It is a big, heavy-bodied snake, with broad flat head, cylindrical body and long tail. The dorsal scales are smooth and glossy, and organized in 21-23 rows at mid-body. **Coloration is yellow to light brown, banded along the whole body with broad jet-black bands that go all the way around the body.** Water cobras are astonishingly similar to *Grayia smythii*. In life, at least in southern Nigeria, the main difference is that water cobras appear to have a clearly "banded coloration", whereas *Grayia smythii* has a "confused pattern" where bands are less visible and more confused. When dead, the water cobra is easily recognized by the presence of two big fangs in the anterior part of the mouth and for the absence of the loreal scale. Water cobras can inflate the body, but do not spread hoods. Found in Nigeria only in big rivers with undisturbed forest along the banks. Not recorded around human settlements, but *probably more widespread than what is currently known*. It is entirely aquatic.

### **PROTOCOL**

The Vice Chancellor,  
Deputy Vice-Chancellor,  
Registrar and other Principal Officers,  
Provost of College of Medicine; Dean of Post graduate School and Deans of Faculties,  
Distinguished Professors and Emeritus Scholars,  
Directors of Institutes and Heads of Departments,  
Fellow Members of Senate,  
Distinguished Guests,  
Staff and Students of Rivers State University,  
Ladies and Gentlemen.

### **INTRODUCTION**

Let me begin by appreciating God Almighty for His special grace and favour on my life, and making it possible for me to stand here to deliver this 64<sup>th</sup> inaugural lecture, All I am today is by Him. He is the KING of GLORY (Psalm 24: 10) and To Him I give all the glory.

I would also like to thank our amiable Vice Chancellor, Professor Blessing Chimezie Didia and the chairman, Senate Lectures Committee, Prof. I.K.E. Ekweozor for giving me the opportunity to deliver this inaugural lecture, four years after I became Professor. I am particularly excited as this is the first inaugural lecture addressing Biodiversity conservation issues, by the first Professor of Wildlife and Biodiversity Conservation in RSU and Nigeria. It is also heart-warming to have been given the opportunity to justify my well deserved promotion to this rank and to present an overview of my research career so far, update colleagues on current and future research plans, and introduce my research to a wider audience.



I am also thankful to God that I am one of the products of Rivers State Government manpower development dreams of the 1970s for which this great University was created in 1980. Because of the dire manpower needs of Rivers State then, every good student of Rivers State origin who gained admission into College Science and Technology (which metamorphosed into the present day RSU) or any University was given automatic scholarship, irrespective of whether he/she was from the home of the "haves" or "have-nots." Brilliance, hardwork and merit were all that were needed for admission. Thus, I sincerely raise my cap for the then Military Governor of Rivers State, Commander, Alfred Diette-Spiff, (Rtd) for his good heart and visionary leadership to uplift the common man.

Vice chancellor Sir, ladies and gentlemen, permit me to use this platform to intimate you, a bit, of my background and academic trajectory.

My academic journey to this level was not rosy. It all started at St Philips Catholic (Primary) School, Creek Road, Port Harcourt. It was indeed a humble beginning, as my late father was a Water Supply Superintendent in Ministry of works, Moscow Road, Port Harcourt and my mother a petty trader. Our "yard" was 207 Victoria Street, P-H, where I was born and bred. Electricity Corporation of Nigeria (ECN) was supplying light steadily, and the dogged Sanitary inspectors of the time would not spare any culprit of improper waste management. Proximity of our home then to my school, enabled the excited pupil I was to go to school early.

This was the period when Our Lady of Lourdes Catholic Church, Creek road, was built and Rev Father Stigular was the Parish Priest, supported by others like Fr. Daisy, Fr. Fraser, Fr. Gilbright, and Bishop Godfrey Okoye was the Catholic Bishop of Port Harcourt Diocese. As a mass server, I enjoyed the goodwill and support of these catholic missionaries whose influence impacted my life up till date. Even my baptismal name, Godfrey (meaning the peace of God), was taken after late Bishop Godfrey Okoye. My early interaction with catholic priests taught me a lot of pleasant lessons. First, is punctuality; I turn out to be an early riser because, every morning I would go to church at 5.00am to start my day with morning mass. I was conscious of mortal and

### ***Psammophis phillipsi* (Forest Sand Snake)**

Up to 180 cm (normally 90-120 cm), is a typical racer. The head is elongated and clearly distinct from the body, tail is relatively long, dorsal scales are smooth, ventral scales number 151-185, and the anal plate is undivided. Dorsal coloration is grey-brown with two longitudinal stripes brown, often irregularly shaped in adults. The ventral coloration is whitish to green. It is a species of the forest plantation mosaic, diurnal, very common in suburbs (e.g. in Calabar, Eket, Uyo, Aba, PH).



### **Family *TRACTASPIDIDAE***

#### **Genus *TRACTASPIS* (Stiletto or Mole Snakes) (VERY DANGEROUS)**

These unusual snakes have a small head that is not distinct from the neck and is covered with symmetrical head shields. The eyes are very small, with round pupils. Body is cylindrical, with smooth, shiny scales in 17-37 rows. The anal is undivided. The tail is short, with paired or single subcaudals, and a terminal spine. Although they are locally common in rainforest and in forest-plantation mosaics, they are hardly found due to their burrowing habits.

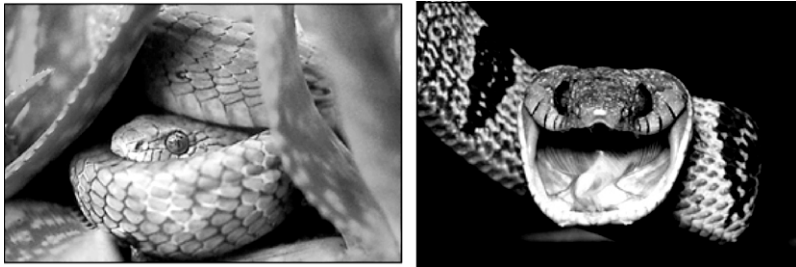
#### **Identification Key:**

1. Less than 210 Ventral scales - (3)
2. More than 210 Ventral scales - (4)
3. *TRACTASPIS CORPULENTA* (178-208 ventral scales; 22-28 subcaudal scales, most of them undivided; to 58 cm total length; dark-brown in color, with **a white tail or white tip on the tail**)

in juveniles. The ventral coloration is yellow. Two species occur in Nigeria, one very common (*T. blandingii*) and one very rare (*T. pulverulenta*). The typical habitat is mangrove forest, but is common in every habitat type, including suburbs.

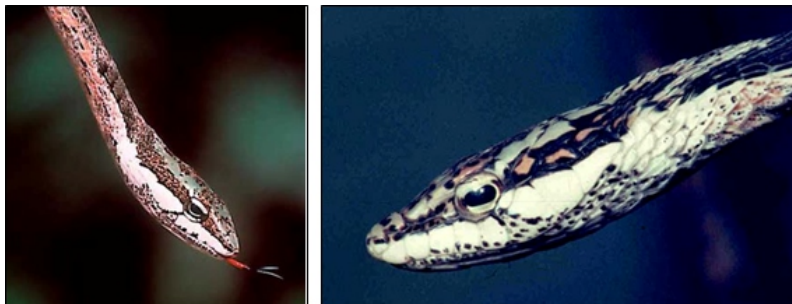
Captured in the towns of Port Harcourt and Calabar.

1. 19 ranges of dorsal scales at mid body - *Toxicodryas blandingii*  
21-25 ranges of dorsal scales at mid-body - *Toxicodryas pulverulenta*



***Thelotornis kirtlandii* (Forest Vine Snake) (DANGEROUS!)**

No other forest snake resembles this species. It is a long, very thin tree snake (up to 160 cm long, normally 90-100 cm), **with a long arrow-shaped head and large pale eyes with horizontal keyhole-shaped pupils.** A narrow groove runs from each eye to the tip of the snout. **The tongue is brightly red with a black tip.** The head is green above, lips and chin are white, with black spots. The body is grey-brown above, heavily speckled with darker grey or black. Very common in mangrove forests, but also locally abundant in rainforest patches. Not aggressive, but highly dangerous.



penitential sins, and I would stand still at 12.00 noon and 6.00pm, everyday to observe the "*Angelus*" no matter where I heard the bell of angelus. At my tender age, I could read and translate Latin very well. Little did I know that I was being prepared to understand Latin names in taxonomy (and English language), which enhances knowledge of Biodiversity, which I am destined for.

I attended two Category I secondary schools in Rivers State; first was St. Pius X College, Bodo-Ogoni, when Rev Fr. James Masterson was Principal, and Fr Murphy, Fr. Sean Allen, etc were support staff, with whom I served morning mass at St. Patrick's Catholic Church, Bodo (now a Cathedral) and Sunday mass at St. Bernard, Biara, Regina Caeli, Bori; and Marian High School, Bane. Thus, I was made Sachristian and librarian during the period. And to be a functionary in this school then, you must be among the top five in your class, and also be of exemplary character. The motto of this school "*In humilitate et Scientia*" intrigued me a lot, connoting that one needs humility to acquire knowledge, because it require a lot of "dos" and don'ts", which you must adhere to religiously. My schooling in SPC was however, interrupted by the Civil war which broke out in 1967. For security reasons, I had to relocate to County Grammar School, when Chief C. E. Okpara (late), was Principal and Venerable Kingsley Amadi (late) was Vice Principal. By their administrative prowess these two disciplinarians placed the school on high pedestal, that for many years the school recorded 100% success, in WAEC. Here the motto of the school is "*Par Adua ad Astra*" meaning Hardwork leads to the sky (any height). I benefited from this school also which tutelage enabled me to clear all my papers in WAEC and GCE, London each in one sitting.

With hard work during my sixth form (in Higher School Certificate HSC program) while in College of Science & Technology CST, I gained admission into Nigeria's Premier University- University of Ibadan, in 1975. In fact, it was a lot easier then, if you have sponsor(s), to gain admission into oversea Universities than the few Nigerian Universities. That year, out of the thousands of candidates that sat for the entrance examination in Baptist High School, Port Harcourt, only three candidates were given admission from Rivers State; namely, Late Barr.



Gilbert Obior, Late Mr. Benneth Ayonoadu, and my humble self . To God be the glory!

### WHY WILDLIFE AND BIODIVERSITY RESEARCH ?

Vice Chancellor, sir, my interest in wildlife and biodiversity conservation research was stimulated right from my undergraduate programme in University of Ibadan, when our Ecology lecturers like Prof. S. O. Fagade, Prof. Austin Egborge (Late), Prof Pius Anadu (late) who annually, took us to Yankari Game Reserve (now Yankari National Park, Bauchi) for practical ecological studies of wild animals in a savanna habitat. As somebody who loves adventure and tourism, it was a great fun, as we saw many herbivores and carnivores roaming and interacting in the ecosystem. The biological names of any one we sighted was immediately given to us, as well as their ecological niches because we would at the end submit a report of each trip. With our cameras and binoculars we could get good images of the animals and their habitat.

When I returned to my State and got absorbed in RSUST, I could not continue with wildlife and biodiversity, but I switched to Marine biological research and worked on fish ecology and macro invertebrate diversity, in relation to environmental pollution in the Upper Bonny estuary. Although, I obtained my second degree (M.Phil), I had awful experiences working in the marine environment. There was a lot of logistic hiccups; for each trip, I had to hire boat at cut-throat price, pay field assistants and buy reagents for water quality analysis, etc, all from my lean purse. Thus, for my Ph.D I had to revert back to terrestrial wildlife and biodiversity research.

My interest in terrestrial wildlife and biodiversity conservation research was fully rekindled when I worked with a consortium of foreign wildlife and biodiversity experts invited by TSKJ Nig Ltd., to undertake a two year Environmental Impact Assessment (EIA) of LNG Transmission pipeline from Kreigani to Bonny. With this exposure I was encouraged to publish my findings in reputable international journals for the first time. The only Nigerian scientists in the team was Late Dr. E. N. U.Okpon (for flora), Prof. B. A. Ekeke (forestry) and my humble self (for fauna).

### *Crotaphopeltis hotamboeia*

Easily recognizable species, 40-60 cm long, with a **flat and large head with big eyes with vertical pupils, and strongly keeled dorsal scales**. Ventral scales number 140-182, and the subcaudal scales are doubled and number 27 to 57. **Dorsal coloration is**



**olive-green to brown, with many whitish dots irregularly spread; ventral coloration is uniformly whitish.** The species is common in wet forest sites, but enters into suburbs and towns. Common in Calabar town.

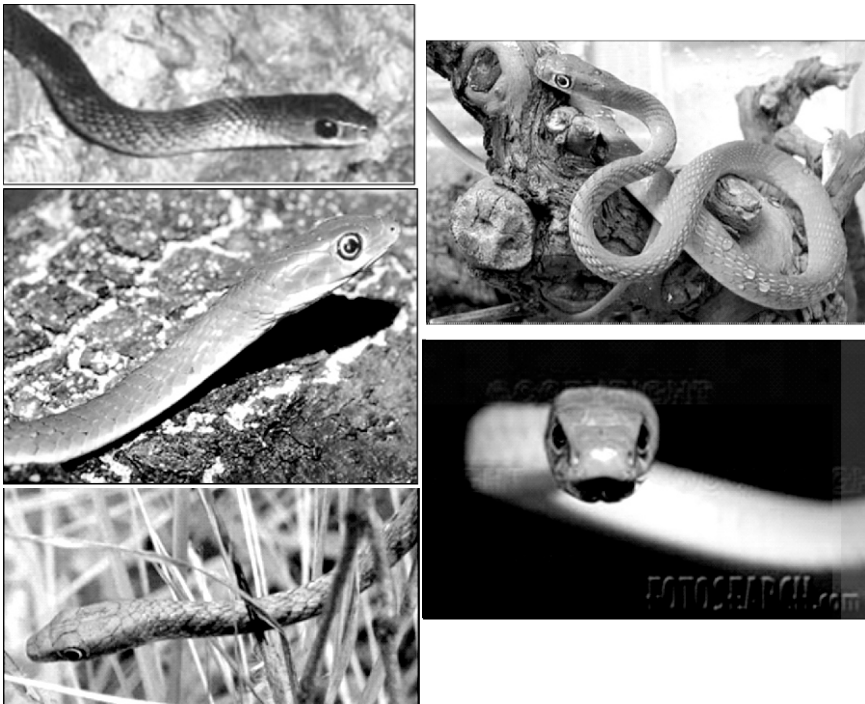


### Genus *TOXICODRYAS (BOIGA)* (DANGEROUS!)

They are very big tree snakes (up to 280 cm long, normally 160-200 cm), easily recognizable by **large and flat head with eyes with vertical pupils, triangular in shape, thin neck, elongated body clearly triangular in section and rubbery in texture**, smooth dorsal scales, and long and thin tail. The dorsal coloration is variable, but normally glossy black in adult males and brown with dark blotches crossing the body in the females and

### Genus *PHILOTHAMNUS* (Green Tree Snakes)

It is the most problematic genus of African snakes, and it is nearly impossible to identify the various species if not after careful examination of dead specimens. Thus, here we limit our identification key to the genus level. They are 50-80 cm long (in rare case over 100 cm), with elongated body and very long and thin tail. The head is long, thin, and not clearly distinct from the body. The *dorsal scales are smooth, the dorsal coloration is olive-green, often with dark-green blotches in the anterior part of the body*. They are very common in secondary forests and plantations, and often occur also in suburbs. Found in both Calabar and Eket towns.



Besides, there are also many practical justifications for which I delved into Wildlife and biodiversity studies. It is more or less the pillar - the natural resources on which the human race depends, for continuous sustenance of life. Our food, our health and industrial raw material supplies are all linked to them. Several occupations exist today because of support from wildlife and biodiversity products. For instance, drum makers depend on certain wildlife skin; our woolen materials are products of furs from wildlife species; canoes carvers need specific types of wood; Xylophone makers need an array of wood for its production. Ambergris from the gut of whales is needed for producing the best perfume (which is highly aromatic with long shelf lives). A lot of art work depends on availability of wildlife and biodiversity products. Fish oil, fish manure, fish meal, etc are derived from fish and the making of kilns, and fishing nets are sustained by availability of fish. Most concoctions used today in trado-medicine and orthodox medicine are derivatives of wildlife and biodiversity parts. In orthodox medicine, wild animals such as primates, rats, hamsters, etc that have relatively similar anatomy and physiology as human, are used to test new drugs, as nobody would like to offer himself as a "guinea pig" or test animal. Furthermore, the ontogeny of human social behavior has been traced to primate social behavior in the wild. In all, wildlife and biodiversity are known to have commercial, industrial, aesthetic, scientific, recreational and ethical values. It suffices to say that if we do not check the extinction rate of wildlife and biodiversity their values will equally be lost, which may culminate in the collapse of some occupations.

## BASIC CONCEPTS OF WILDLIFE AND BIODIVERSITY CONSERVATION

Vice Chancellor sir, ladies and gentlemen, I would, at this juncture, like to throw some light on some of the registers commonly used in wildlife and biodiversity research, for clarity, and a better comprehension of this lecture. All too often students ask questions about their meaning.

### Definitions

**Wildlife** is a collective term used to describe all living things which are not under human control. This includes both terrestrial and aquatic plants, animals, and microorganisms in the wild. Unlike livestock which are controlled by their caretaker or owner, these wild organisms are in their natural habitat, roaming freely and feeding for themselves. Although the wildlife most people are conversant with and which we have lavished interest on (because of their considerable economic importance to man) are fish and shellfish, amphibians, reptiles, birds, mammals, economic trees, and weeds. A lot of invertebrate wildlife and wild plants (microscopic or macroscopic) which have hardly been explored are also wildlife.

### Biodiversity

The term biodiversity - which has become a buzzword that has permeated into various disciplines today - is an acronym for biological diversity, first used by an Ecologist, E.O. Wilson in 1985. Biodiversity is defined simply as the number, variety and variability of genes, species and ecosystems in a place. (World Bank, 1995; Barnes 1996). A more elaborate definition of this abstract concept is provided in Article 2 of the Earth Summit, Convention for Biodiversity of 1992 which refers to biodiversity as "The variability among living organisms from all sources including *inter alia*, terrestrial, marine, and other aquatic ecosystems and the biological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (Barnes, 1996). In other words, biodiversity encompasses different types of ecosystems, different species of organisms with the whole range of their variants and genes adapted to different climates, environments along with their interactions and processes.

### *Gastropyxis smaragdina* (Emerald Snake)

Up to 110 cm long (normally 60-80 cm), it is the most common forest green tree snake in southern Nigeria. Extremely fast moving, nevertheless it is easily recognizable when examined after capture. The dorsal coloration is **uniformly green-emerald**, and the same is true for the ventral coloration. There is a black line on the sides of the head, back to the eyes. The dorsal scales are **strongly keeled**, and the same is true for



the ventral scales. The **tail is extremely long**; the head is long and clearly distinct from the body; the ventral scales are 150-172; the anal plate is divided; the subcaudal scales are doubled and keeled, and number 129 to 172. Found everywhere in forest, clearings, forest edges, and even plantations and suburbia.



### *Hapsidophrys lineatus* (Green-lined Tree Snake)

Typical tree snake, with elongated body and longtail, to 120 cm long (normally 60-80 cm). It has long head, dorsal scales clearly keeled, ventral scales keeled in numbers of 156 to 176, the anal plate is single, and the subcaudal scales are doubled and number 90-158. It is most readily recognizable by its dorsal coloration: **black with green longitudinal stripes**, and the ventral coloration is **uniformly green**. Common in Nigerian rainforests, usually in mature and undisturbed sites.



### ***Rhamnophis aethiopissa***

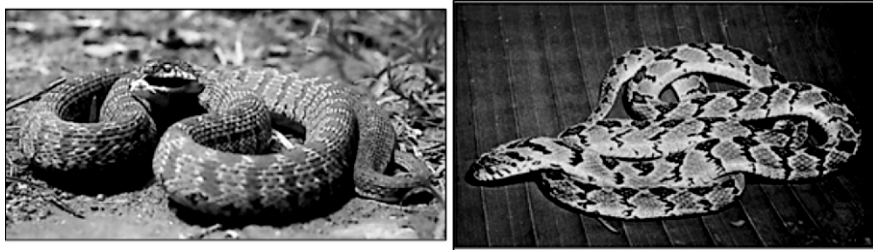
Very similar to both *Thrasops* and *Dispholidus* spp. (this latter is dangerous!) So, although harmless, they should be handled with care before correct identification. The **head is conspicuously short, with very big eyes** with round pupils. The **dorsal scales along the vertebral line are clearly enlarged in comparison with the other dorsal scales**. The tail is long, and the body is elongated. Dorsal coloration variable from green with



yellow, black and dark dots, to almost black with green marks, often arranged in transverse bands. Up to 150 cm long. Found in forest, often riverine. Common in Port Harcourt and Bayelsa, but never recorded in Akwa-Ibom and Cross River States, where, nevertheless it should be expected.

### ***Dasypeltis fasciata* (Forest Egg-Eater)**

Up to 100 cm long (normally 60-70 cm), it is easily recognizable by **strongly keeled dorsal scales, vertical pupil**, with a dorsal coloration olive-green to reddish with transverse yellowish and brown patches. Ventral coloration is uniformly grey. The head is small and not clearly distinct from the body, and the tail is relatively short. They are common in forest and around human settlements situated inside forest sites. **Images are of *Dasypeltis scabra*.**



Biodiversity includes the genetic variability (for which different varieties of species have appeared in the course of evolution) and diversity of life forms such as plants, animals, microbes, etc. living in a wide range of ecosystems.

The diversity may be intraspecific (within species) interspecific (in between species) but these are well supported by the ecosystem. It is seen that the diverse living forms of the ecosystem are modulated with the global environmental changes.

For brevity, the layman can see biodiversity as the variety of biological resources endowed to a place by nature.

### **Levels of biodiversity**

There are three interrelated hierarchical levels of biodiversity namely, genetic diversity, species diversity, and community or ecosystem diversity.

#### **i. Genetic Diversity:**

It describes the variation in the number and types of genes as well as chromosomes present in different species. The magnitude of variation in genes of a species increases with increase in size and environmental parameters of the habitat.

The genetic variation arises by gene and chromosome mutation in individuals and in sexually reproducing organisms and it is spread in the population by recombination of genetic materials during cell division after sexual reproduction.

Genetic diversity has the following importance:

- i. It helps in speciation or evolution of new species;
- ii. It is useful in adaptation to changes in environmental conditions;
- iii. It is important for agricultural productivity and development;

**ii. Species diversity:**

It describes the variety in the number and richness of the species within a region. The species richness may be defined as the number of species per unit area. The richness of a species portray the extent of biodiversity of a site and provides a means of comparing different sites.

The species richness depends largely on climatic conditions. The number of individuals of different species within a region represents species evenness or species equitability. The product of species richness and species evenness gives the species diversity of a region. When a species is confined entirely to a particular area, it is termed as endemic species.

**iii. Ecosystem diversity:**

This refers to the assemblage and interaction of species living together and the physical environment in a given area. It relates varieties of habitats, biotic communities, ecological processes in the biosphere. It also includes the diversity within the ecosystem. It is also referred to as land escape diversity because it includes placement and size of various ecosystems. For instance, landscapes like wetlands, forests, grasslands, deserts, mountains, etc., show ecosystem diversity. Ecosystem diversity is due to variety of niches, trophic levels and ecological processes like nutrient cycling, food webs, energy flow, role of dominant species and various related biotic interactions. Such type of diversity can generate more productive and stable ecosystems or communities capable of tolerating various types of stress e.g. drought, flood, etc.

**IS THERE ANY DIFFERENCE BETWEEN WILDLIFE AND BIODIVERSITY?**

One of the commonest questions students ask is "What is the difference between Wildlife and biodiversity?" The foregoing definitions make the answer clear. Although there is no sharp line between them, the fact remains that wildlife is a subset of Biodiversity. While wildlife refers to all living organisms in the wild, biodiversity includes both wildlife and

- 1. Anal plate undivided - *Natriciteres fuliginoides*  
(uniformly brown, but lighter in the abdomen)
- Anal plate divided - 2
- 2. 19 ranges of dorsal scale at mid-body, - *Natriciteres olivacea*  
absence of light neck collar
- 15 ranges of dorsal scale at mid-body, - *Natriciteres variegata*  
light yellowish neck collar

**Genus THRASOPS (Black Tree Snakes)**

Large tree snakes (to nearly 180 cm long, but always no more than 120 cm), with dark brown to black coloration. Normally, the head is a little lighter than the body (yellowish to brownish), at least on the throat. **The head is conspicuously short and clearly distinct from the body**, the dorsal scales are smooth, and give to the snake **a typical oily appearance**, that is not found in other forest species. The anal plate is divided, and



the subcaudal scales are doubled. Found in forest, they are common around Calabar, and apparently less common in the Niger Delta. Two species are found in the forest region of Nigeria. They are very similar, and can be differentiated only by the following key:

- 1. < 188 ventral scales - *Thrasops occidentalis*
- 2. > 188 ventral scales - *Thrasops flavigularis*

*These snakes can be confused with tree cobras (see keys), and so SHOULD BE HANDLED WITH CARE before correct identification.*



### *Grayia smythii* (Smith's Banded Water Snake)

100-180 cm long (occasionally over 200 cm), is the commonest water snake of the forest region, including wet areas in suburbs.

Robust snake, with big head, cylindrical body shape, and stout tail. Dorsal scales smooth. Dorsal coloration is brownish, with several transverse bars dark to black. Ventral coloration is whitish-yellow, and in Nigeria several specimens have a clearly white throat, and others a brightly yellow throat.



### *Afronatrix anoscopus* (Brown Water Snake)

Up to 80 cm long, normally 40-50 cm. Easily recognized by: keeled dorsal scales, and eyes placed in a very anterior position relatively to the head length; ***There is a line of small scales between the labial scales and the eye.*** Dorsal coloration is brown-reddish, with small darker dots; ventral coloration is yellowish to orange, with small black dots. Common along streams and small rivers, especially with stony or rocky banks



### Genus *NATRICITERES* (Marsh Snakes)

Very small snakes (20-40 cm long), with autonomic tail (as lizards). Any very small, elongated, and dark-brown coloured specimen captured in or around ponds and water bodies can be suspected to be one of such snakes. Definitely, they can be identified by the following:

livestock, and deals particularly with the number and variety of genes, species, ecosystems and ecosystem services available in a place. The latter gives a clue as to whether there is ecosystem stability or not.

### Sustainability

This is another terminology that has become central theme in present day environmental science and resource use. Although it means different things to different persons, the central concept is that we should use resources (anything that is useful for creating wealth or improving our lives) in ways that do not diminish them (Cunningham and Cunningham, 2004), so that they continue to be available for future generations. With the soaring human populations and great demands placed on resources, as well as the degradation of the environment in the course of resource exploitation, there are doubts in some quarters whether sustainability can actually be achieved. Research has made it abundantly clear that it is achievable through collective effort of all and sundry to avoid waste or over-exploitation of natural resources and protect our environment against agents of degradation. This explains why there is a vigorous campaign throughout the globe, today, for people to take biodiversity and ecological conservation serious, for posterity.

### SUSTAINABLE DEVELOPMENT

– is any development that meets the needs and aspirations of the present and future generation. Among the major needs of man is biodiversity. Thus, such development or actions that enhances the biodiversity of a place and the environment in which the biota survives are deemed to be sustainable development, since they culminate in the improvement of human welfare; example- afforestation/reforestation, habitat restoration, bioremediation, erosion control, pollution control, judicious land use, aquaculture, horticulture, game-farming, Legal protection of habitats, Laws controlling exploitation of natural resources, etc. All the activities that are carried out during Environmental Impact Assessments (EIA) are geared towards sustainable development, as the whole process ensures that the proposed development project does not jeopardize the life of the



people. A sustainable development should have the aim of achieving balance/ harmony between environment sustainability, economic sustainability and social sustainability.

Because sustainable development means different things to different people, there are over hundred definitions of sustainable development. According to Deswal and Deswal (2009), some of them are as follows:

- ❖ Environmental care 'married' to development
- ❖ Improving the quality of human life while living within the carrying capacity of the supporting systems.
- ❖ Development based on the principle of inter-generational, inter species and inter-group equity (that is bequeathing the same inherited or improved resources to future generations.)
- ❖ Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
- ❖ An environmental 'handrail' to guide development
- ❖ A change in consumption pattern towards more benign products, and a shift in investment towards augmenting environmental capital.

However, the most frequently quoted or popular definition is that given by Brundtland Report, '*Our Common Future*' (WCED, 1987), which upholds Sustainable development as "the development that meets the needs of the present without compromising (lowering) the ability of future generations to meet their own needs". Central in these definitions are two key concepts:

- (i) Prioritization and judicious management of basic human needs for all – e.g. biodiversity
- (ii) Ensuring that technological development does not undermine environmental integrity.

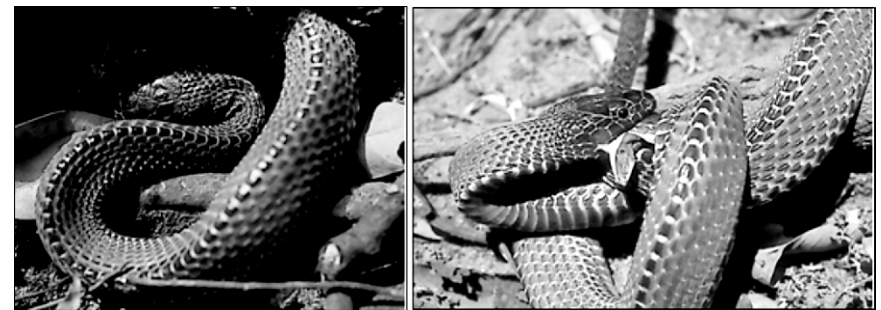
Although there are several bottlenecks faced in the bid to achieve sustainable development, it is widely accepted that achieving sustainable development requires balance between the economy, environment and society, as illustrated in the model below (fig 1)

### *Homonotus modestus* (Uganda House Snake)

60-80 cm long, with a **totally flat head, triangular and clearly separated from the body**. The tail is long. **Ventral scales are rough** ("karynated"), in numbers of 221-244. The dorsal coloration is grey-brown without marks, and the ventral coloration is grey to yellowish. Found in forests. It has never been found by me in the wild, but it is present in west Cameroun and should be expected to occur even in Nigeria.

### Genus *MEHELYA* (File Snakes)

Easily recognizable by other snakes of the same regions. They are characterized by rough scales (strongly keeled and almost conical), **subtriangular body shape**, interstitial skin between scales clearly exposed, and **broad flat head** very distinct from the neck, and small **eyes with vertical pupils**. Five species are found in Nigeria, but only three in the forest region. They are **uniformly brown to dark-grey in the dorsal parts, and light brown to yellow in the ventral side**. File snakes are found in every habitat, including mature forests and suburbs as well.

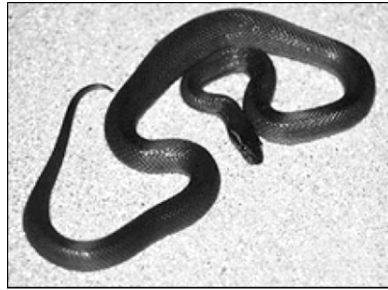


They can be discriminated only by following this key:

1. 17 ranges of dorsal scales at mid-body - *Mehelya crossii*  
More than 17 ranges of dorsal scales at mid-body- 2
2. More than 80 subcaudals - *Mehelya poensis*  
Less than 80 subcaudals - 3
3. More than 235 ventral scales - *Mehelya guirali*

**Genus LAMPROPHIS  
(House Snakes)**

A relatively problematic genus. They can be recognized by the long and flat head, and by the eyes with a vertical pupil. They are often found around human houses and compounds. They have small size (60-70 cm), and feed on rodents. Four species can be found in south-eastern Nigeria, but they can be discriminated only by following this key:



1. Subcaudal scales are **simple**...*Lamprophis olivaceus*  
..... **Divided**..... 2
2. The head is grey-dark with two parallel lines (yellow to white) on each side - *Lamprophis*  
The head is grey-brown, without any lightline - 3
3. 23 to 25 dorsal scale ranges at mid body - *Lamprophis virgatus*  
25 to 35 dorsal scale ranges at mid body - *Lamprophis fuliginosus*

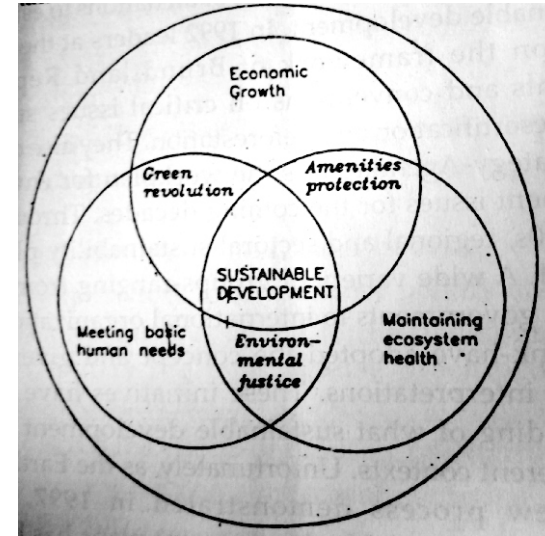


Fig 1. A model for integrating human needs, ecosystem health and sustainable economic growth (After Deswal and Deswal, 2009)

**Sustainable Development Goals.**

The sustainable development goals, also known as the 2030 Agenda for sustainable development are set of 17 achievable goals set aside in the year 2015 by leaders from 193 countries of the world to ensure a safe and healthy world to live. The goals amidst others seek to eradicate poverty and hunger and ensure safety from the worst effects of climate change. Acknowledging the role protected areas play is inevitable in achieving the SDGs. However, some of these goals (astericked) are direct to the environment and the natural resources (wildlife and biodiversity). They includes;

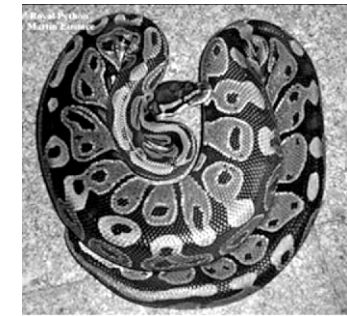
- GOAL1:** End Poverty in All its Forms Everywhere
- GOAL2:** End Hunger, Achieve Food Security and Improved Nutrition and Promote Sustainable Agriculture
- GOAL3:** Ensure Healthy Lives and Promote Well-being for All at All Ages
- GOAL4:** Ensure Inclusive and Equitable Quality Education and Promote Lifelong Learning Opportunities for All



- GOAL 5:** Achieve Gender Equality and Empower All Women and Girls.
- GOAL 6:** Ensure the Availability and Sustainable Management of Water and Sanitation for All
- GOAL 7:** Ensure Access To Affordable. Reliable, Sustainable And Modern Energy For All
- GOAL 8:** Promote Sustained, Inclusive and Sustainable Economic Growth, Full and Productive Employment and Decent Work For All.
- GOAL 9:** Build Resilient Infrastructure, Promote Inclusive and Sustainable Industrialization And Foster Innovation
- GOAL 10:** Reduce Inequality Within and Among Countries.
- GOAL 11:** Sustainable cities and communities: Make cities and human settlements inclusive, safe, resilient and sustainable.
- GOAL 12:** Ensure Sustainable Consumption and Production Patterns.
- GOAL 13:** Climate action: Take urgent action to combat climate change and its impacts.
- GOAL 14:** Life below water: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
- GOAL 15:** Life on land: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse degradation and halt biodiversity loss.
- GOAL 16:** Promote Peaceful and Inclusive Societies for Sustainable Development, Provide Access to Justice For All and build Effective and Accountable and Inclusive Institutions at All Levels.
- GOAL 17:** Strengthen the Means of Implementation and Revitalize the Global Partnership for Sustainable Development.

***Python regius* (Royal or Ball Python)**

Typical python, with solid and stout body, not longer than 150 cm. The dorsal coloration is very bright: yellow to light brown, with large black blotches of irregular shape. The head has black marks. The ventral coloration is whitish with little black spots. Common in plantations, suburbia, and altered forest.



***Family COLUBRIDAE***

***Bothrophthalmus lineatus*  
(Red Lined Snake)**

Small to medium sized species, up to 100 cm long, but usually smaller (60-70 cm). Easily identified by the coloration: **dorsally black with three red to pink longitudinal stripes, and uniformly red to pink on the back.** The head is long and

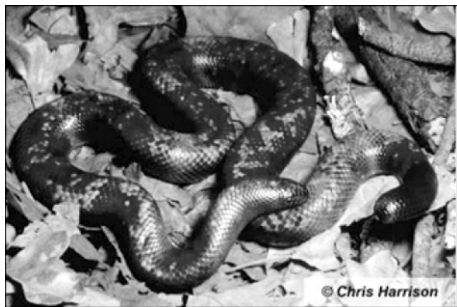


triangular, brownish with many black marks irregularly distributed. Found in rainforest, but seems rare in Nigeria. Recorded in Orashi River forests, Otari, and Taylor Creek Reserve.

## **Family BOIDAE**

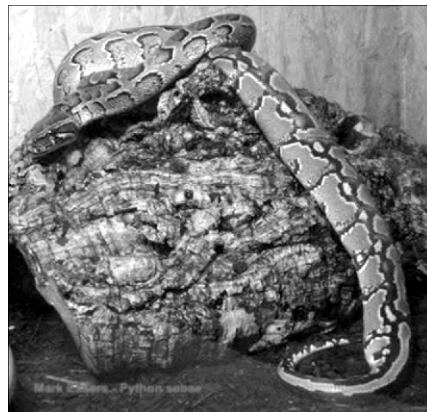
### ***Calabaria reinhardtii* (Calabar Burrowing Python)**

50-100 cm long, with short head not clearly distinct from the body, and very short tail. The tail is apparently of similar shape to the head, and the body is perfectly cylindrical. Coloration is dorsally brown to reddish, with irregular whitish and dark spots. Ventral coloration is similar, but with some tendency to be more yellowish. Common in swamp forests, and also found in plantations. Records in Ahoada, Port Harcourt, Eket, Uyo, Calabar, Akampka.



### ***Python sebae* (Giant Python)**

Any python longer than 2m is surely one such specimens. Maximum size: 980 cm (Freetown, Sierra Leone), but much smaller in Nigeria (to about 5m). The body is solid, stout, and has very small smooth scales. The head is triangular, with a large dark spearhead mark on the crown. Body coloration is grey-green or grey-brown, with dark brown bands that may form isolated blotches on the flanks.



Present in every habitat type, often around rivers and water bodies

## **BIODIVERSITY " HOT SPOTS"**

These are regions of the world richly endowed with amazing variety and abundance of biodiversity and many endemic species (i.e species exclusively native to a place). These areas of high endemics happen to occur in undeveloped and developing countries within the tropics with soaring human population and most of them are forests. Great demands are now placed on biodiversity in the hot spots by the poor, rural communities, who eke much of their living exclusively from the forest and aquatic systems. A graphic example of a biodiversity hotspots is Brazil's Atlantic Forest, which holds over 20,000 plant species, 1,350 vertebrates and millions of invertebrates. Other hotspots are the equatorial rain forests of west and central Africa, Seychelles, South-East Asian Islands of (Borneo, Sumatra, Java, Papua New Guinea, etc. Unfortunately, there is high exploitation or extraction of biodiversity in these hot spot areas especially by the natives, without replacement. Also known for its spectacular biodiversity is the Island of Madagascar (Africa's largest island), with unique deciduous forests and lowland rain forests. It is believed that since the island separated from mainland Africa 65 million years ago many species and ecosystems evolved independently, hence the diversity. Similar island speciations must have taken place in the other Indian ocean islands. The term biodiversity Hotspots was first identified by Dr. Norman Meyer who used it in two articles in the scientific journal, *The Environmentalist* (issue of 1988 and 1990).

**Table 1: Global Biodiversity Hotspots**

Hotspots	Plant species	Endemic plants	% of Global plants	Vertebrate species	Endemic vertebrates	% of Global vertebrate
1. Tropical Andes	45000	20000	6.7	3389	1567	5.7
2. Mesoamerican forests	24000	5000	1.7	2859	1159	4.2
3. Caribbean	12000	7000	2.3	1518	779	2.9
4. Brazil's Atlantic Forest	20000	8000	2.7	1361	567	2.1
5. Choc/Darien of Panama Western Ecuador	9000	2250	0.8	1625	418	1.5
6. Brazil's Cerrado	10000	4400	1.5	1268	117	0.4
7. Central Chile	3429	1605	0.5	335	61	0.2
8. California Floristic Province	4426	2125	0.7	584	71	0.3
9. Madagascar	12000	9704	3.2	987	771	2.8
10. Eastern Arc and Central Forest of Tanzania/Kenya	4000	1500	0.5	1019	121	0.4
11. Western African Forests	9000	2250	0.8	1320	270	1.0
12. Cape Floristic Province	8200	5682	31.9	562	53	0.2
13. Succulent Karoo	4849	1940	0.6	472	45	0.2
14. Mediterranean Basin	25000	13000	4.3	770	235	0.9
15. Caucasus	6300	1600	0.5	632	59	0.2
16. Sundaland	25000	15000	5.0	1800	701	2.6
17. Wallacea	10000	1500	0.5	1142	529	1.9
18. Philippines	7620	5832	1.9	1093	518	1.9
19. Indo-Burma Eastern Himalayas	13500	7000	2.3	2185	528	1.9
20. South-Central China	12000	5300	1.2	1141	178	0.7
21. Western Ghats-Sri Lanka	4780	2180	0.7	1073	355	1.3
22. South-western Australia	5469	4331	1.4	456	100	0.4
23. New Caledonia	3332	2551	0.9	190	84	0.3
24. New Zealand	2300	1865	0.6	217	136	0.5
25. Polynesia/Micronesia	6557	3334	1.1	342	223	0.8
Total	-	133,149	44.4	-	9645	35.3

Source Myers *et al.*, 2000

## APPENDIX

### SNAKES OF SOUTH-EASTERN NIGERIA IDENTIFICATION GUIDE

#### TO IDENTIFY THE FAMILY

1. Body entirely covered with scales of identical shape both dorsally and ventrally - 2
- Presence of large ventral scales - 3
2. FAMILY TYPHLOPIDAE and LEPTOTYPHLOPIDAE (earthworm-snakes)
3. Ventral scales centrally occupying approximately half of the ventral side - BOIDAE
- Ventral scales occupying the whole of the ventral side - 4
4. Head scales very small - VIPERIDAE
- Head scales with large plates - 5
5. Big fangs in the mouth - ELAPIDAE
- No fangs in the mouth, but just the presence of very small teeth - COLUBRIDAE

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## West African Biodiversity

The Guinean Forests of West Africa are another recognized biodiversity hotspot. It is home to an estimated 9,000 vascular plant species, about 20% (1,800 species) of which 20% are thought to be endemic. The floristic composition is closely related to that of central Africa, and most genera are widespread throughout both regions. But the endemism at the species level is apparently higher. Conservation areas such as Tai National Park in Cote d'Ivoire, Mount Nimba on the Liberia, Guinea and Cote d'Ivoire border, as well as Cross River National Park in Nigeria and Mount Cameroon are known to support significant assemblages of endemic plant species (Conservation International, 2006). In Mount Cameroon area alone, nearly 2,500 species have been recorded. Because of their relative isolation from the hinterland, the Gulf of Guinea islands also support highly endemic flora; approximately 185 species are endemic to these islands. Among the many economic trees species that constitute flagship species are the Oil palm, *Elaeis guineensis*, which is widely planted throughout the tropics for palm oil production, and timber producing species like – the African ebony, *Diospyros gracilis*, two genera of African Mahogany,- *Entandophragma sp* and *Khaya sp*- and the Iroko, *Milicia excelsa*, which are widely exploited.

**Table 2:** Guinean Forests of West Africa – Diversity and Endemism

Taxonomic Group	Species	Endemic species	Percent Endemism
Plants	9,000	1,800	20.0
Mammals	320	67	20.9
Birds	785	75	9.6
Reptiles	210	52	24.8
Amphibians	221	85	38.5
Freshwater Fishes	512	143	27.9

**Source:** Conservation International (2006)



## BIODIVERSITY CRISIS

The accelerated loss or extinction of plants and animals and their habitats caused by human activities is referred to as biodiversity crisis.

The escalating extinction crisis shows that the diversity of nature cannot support the current pressure that humanity is placing on the planet. Every day biodiversity is being lost at up to 1,000 times the natural rate. The extinction of individual species, but also habitat destruction, land conversion for agriculture and development, climate change, pollution and the spread of invasive species are only some of the threats responsible for today's crisis. With the current biodiversity loss, we are witnessing the greatest extinction crisis since dinosaurs disappeared from our planet 65 million years ago. Not only are these extinctions irreversible, but they also pose a serious threat to our health and wellbeing.

### Evidence of Biodiversity Crisis :

Recent biodiversity assessment in various parts of the world reveal that:

- 70% Coral reefs which provide food, storm protection, jobs recreation and other income sources for more than 500 million people worldwide are threaten or destroyed. 17,936 species out of 52,017 assessed so far are threaten with extinction
- Of the world's 5,490 mammals, 78 are extinct or extinct in the wild, with 118 Critically Endangered, 450 Endangered and 492 Vulnerable
- 1,895 of the planet's 6,285 amphibians are at the brink of extinction, making them one of the most threatened groups of species known to date. The abundance of species has declined by 40% between 1970 and 2000. Species that inhabit rivers, lakes, and wetlands/marshlands have declined by 50%.
- In the North Atlantic, fish have declined by 66% in the last 50%.
- Since 2000, a total of 6million hectares of primary forest have been lost annually.

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- In the Caribbean region, hard coral cover has declined from 50% to 10% in the last three decades.
- 35% of mangroves have been lost in just 20 years.

## NATURAL RESOURCES

Natural resources are materials, substances, or any wealth endowed to us by nature, on which we depend for continuous sustenance of life. They are materials useful to man and other organisms, and include the air we breathe, the water we drink, the plants, and animals we eat, the soil we farm on, as well as mineral deposits in the earth. Natural resources occur in the environment, free of charge, for anybody who has the technology to harness for manufacturing process, utilization, etc. Atmospheric resources, for instance, are varied; and include oxygen, nitrogen, carbon dioxide, utilized by plants for photosynthesis, rain that waters our crops, solar radiation that dries our wet articles, and electromagnetic waves that link mobile phone discussions anywhere in the world. Air planes can fly because they are air-borne. Countries all over the world are endowed with varying quantities and qualities of natural resources. Natural resources fall into two major categories; **Renewable and Non-renewable resources.**

**Renewable resources** - include such resources which can be replenished by good management when its quantity diminishes - such as fish, forest, wildlife, soil, water, air, etc.

**Non-renewable resources** on the other hand are exhaustible and cannot be replenished. They occur in fixed amount in reservoirs or deposits. This includes the mineral resources – such as Gold, silver, Iron, aluminium, copper, diamond, tin, etc and fossil fuels- crude oil, natural gas and coal.

A third category of resources termed '**Intangible resources**' or **Abstract resources**, include such valuables as open space, information, diversity, peace, satisfaction, serenity, and beauty. Intangible resources can be both exhaustible and inexhaustible; they have no upper limits and can easily be destroyed. For instance, there is no upper limit to the amount of knowledge, information or beauty, one can have; but an hour of noise or small thrash in the classroom can distort information flow and beauty of the classroom respectively. It is worth

knowing that the two most powerful and largest industry of the world today – tourism and information management – are based on intangible resources. Tourism thrives in an atmosphere of peace and friendliness as seen in Dubai. In the warring neighboring countries, tourism cannot flourish.

### Conservation of Natural Resources.

It is the judicious or wise use of natural resources, without jeopardizing their availability for use by future generation or compromising the environment that sustains them. It entails, reservation, preservation, restoration, protection, regeneration, and saving of all species and genes, ecosystems endowed to a place by nature. The word is derived from the Latin word "conservare" meaning to keep or save. Every species irrespective of whether they are harmful or harmless deserves conservation, because in ecosystems in which they thrive, they play unique roles which contribute to stability of the ecosystem. Thus, the loss of a species can cause a drastic disruption of the ecosystem with time, especially, where they are keystone species.

### DRIVERS OF BIODIVERSITY LOSS & UNSUSTAINABILITY

The rapid rate at which species are getting endangered or extinct since the past 150 years has been attributed to a myriad of anthropogenically-induced factors. Among the drivers of biodiversity loss, which continues to damage our environment, are:

- **Habitat Destruction** – as observed in places where several hectares of forest, grassland and woodland have been converted to farmland, pastureland, estates and cities, and where wetlands are reclaimed for residential accommodations, ; regularly dredged rivers, and areas consumed by wildfire. Most biomes of the world, today, have lost their species and integrity to extensive habitat destruction in the course of development projects.
- **Habitat Fragmentation** – This is the splitting or reduction of habitat into smaller and smaller scattered blocks or fragments; as in places where a network of roads is constructed; in areas of seismic operation; and where pipeline Right-of-Way crisscrosses a region, etc. Such fragmentation culminates in biodiver-

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sity reduction because, many tree and shrub species are lost in the process, large-sized animals like the big cats, elephants, antelopes, buffaloes, etc require large continuous territories to subsist. There are other species such as forest interior birds which reproduce successfully only in the serene deep forest far from the habitat edges and human settlement.

Fragmentation separates populations into isolated small groups, which may not have the normal sex ratio and age ratio of the original population. Very small populations may not have enough breeding adults which invariably will affect the rate of recruitment into the population, by birth. In the event of any single catastrophic episode such as stormy weather, disease epidemic or wildfire the isolated population may be wiped out.

Besides, fragmentation create success for nearby communities to further exploit forests, and fishing grounds which hitherto were inaccessible.

- **Chronic Environmental pollution:** this is the frequent release of substances or energy into the environment by man to levels where they are harmful or deleterious to living things or undermine amenities and quality of the environment. The introduction of thousands of chemicals including pesticides, herbicides, hydrocarbons (Petroleum), radio nuclides, etc., have killed many animals and plants. Perhaps the worst form of pollution is Latent (hidden, or unnoticeable) pollution such as the release of colorless chemicals and radioactive radiation into the environment which continues to decimate populations or cause health problems for a long term without detection. A case in point is the Minamata episode in Japan, which gave impetus to heavy metal pollution research.
- Introduction of exotic species. Exotic species are **Invasive/ Alien/ non-native species** that establish and spread outside their normal distribution. Some of the most threatening invasive species include cats and rats, green crabs, zebra mussels, the African tulip tree and the brown tree snake. Introductions of alien species can happen deliberately or unintentionally, for example,



by organisms "hitch-hiking" in containers, ships, cars or soil. They may flourish in the new ecosystem and upset it, through competition with some native species, and infecting them with their parasite, etc. e.g Nypa palm, Water hyacinth, weeds, etc.

- Unbridled exploitation / over-exploitation of wildlife resources without replacement considerations, as in areas of open access fishing and hunting without closures or gear control.
- **Unorthodox methods of hunting and fishing:** - The use of toxic chemical like Gammalin-20 and poisonous herbs to kill fish, and alcohol to immobilize monkeys are some of the unorthodox methods that kill wildlife, *en masse*.
- **Traditional/Cultural Practices:** Hunting /Provision of Fetic materials for trado-medicine and spiritual healing.
- Lax policies and apathy of some Governments to enforce conservation and environmental laws.
- **Oil and Gas Industry activities (Akani, 2008) :** – Seismic operations, Gas flaring, Pipeline construction /operation, Refinery, Dredging, etc.
- **Global warming / Climate change** – has enormous impact on biodiversity. Large volumes of literature have accumulated in recent times indicating that climate change originate from the global emission of heat trapping (greenhouse) gases produced by vehicles, power plants, industrial processes, Gas flaring, bush-burning, etc. As these greenhouse gases accumulate, they act like a big blanket, disallowing the deflected radiant heat from the earth surface from getting into outer space. Thus, the heat remains below the troposphere and overheating the planet, what is referred to as global warming. Today, the world has become hotter than any time during the past 1000 years. Predictions of climate models reveal that global warming will continue if emission of heat-trapping gases continues to be in ascendancy. Since biological processes are optimal at certain temperature ranges, global warming / climate change will upset the processes and ecosystems, and lead to;

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- ❖ changes in distribution of plants and animals; population sizes; growth rates, timing of plant flowering, and timing of animal migration, etc.
- ❖ changes in intensity and frequency of storms, flood, drought, and fires, (which is already ravaging various regions of the world, e. g the US.)
- ❖ melting of ice at the polar region, and rise in sea level. Low-lying coastal cities and wetlands will be flooded.
- ❖ Protected habitats and their wildlife, may no longer have the right climate that supported them, and ecosystems will be jeopardized as the food webs get disrupted.
- ❖ Saltwater intrusion into the hinterland (due to rise in sea level) will disrupt freshwater ecosystems killing several freshwater plant species and oligohaline fishes.
- ❖ Elevated global temperature would affect sea turtles immensely. This is because the sex of sea turtle hatchlings is temperature-dependent. At higher temperatures the hatchlings are predominantly males. What this means is that with global warming, more and more male turtles will be hatched and female will continue to diminish and will eventually go extinct. Thus, the extinction of the females will spell reproductive failure for the turtle population and turtles will go extinct.

## HISTORY AND PHILOSOPHY OF ENVIRONMENTAL CONSERVATION

Vice chancellor sir, permit me at this juncture, to throw some light on the antecedents of environmental conservation.

The degradation of natural environment from human misuse was first recognized by the great philosopher, Plato in the 4<sup>th</sup> century B.C., when he lamented that Greece once blessed with fertile soil and vested with abundant forests of fine trees had lost its trees to building and ship construction projects. The heavy rains that followed had washed the soil into the sea, leaving only rocky landscapes like “skeleton of a body

wasted by diseases"(Cunningham *et al*, 2005). This aptly demonstrated that at this time deforestation had been identified to be an agent that could aggravate soil erosion and other problems. Later Stephen Hales, a pioneering British plant physiologist, came up with the concept that conserving green plants could preserve rainfall. Hale's ideas were put into practice in 1764 on the Caribbean island of Tobago, where about 20% of the land was first cultivated with plants to modify the climate. This practice has been on in many places, even in the desert region of UAE, around Abu Dhabi and Dubai, where drought resistant plants (like the neem) are progressively modifying the arid climate. Cunningham (2005) also reported that Pierre Poivre, an early French governor of Mauritius, was the first to express displeasure at the environmental and social devastation caused by unbridled and indiscriminate destruction of wildlife such as the flightless Dodo, and the felling of Ebony forest by early European settlers. This ugly development prompted the governor to order a reforestation of 25% of the island, particularly areas of steep mountain slopes and areas along waterways in 1769.

The interesting thing about these early conservation proponents was that although they were administrators, they were very much interested in nature and gave priority to the aesthetics and serenity of areas under their jurisdiction.

Natural resources conservation received dramatic impetus following the publication of the book, *Man and Nature* by a North American Geographer, lawyer, and diplomat, George Perkins Marsh, in 1864. During his diplomatic missions in the Mediterranean region and Turkey, Marsh observed the overgrazing by goats and sheep, and deforestation problems of this region and noticed the same in North America. This prompted him to write the book warning about the ecological consequences of misuse of these resources. Consequently, in 1873 National Forest Reserves were established in the US to protect the depleting timber resources in the country.

By 1873 the Yellowstone National Park was established to protect a particularly valuable natural environment (Toole and Toole, 1998; Dasmann, 1964). Among those who sensed reason with Marsh's warning were Theodore Roosevelt and his chief conservation advisor,

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Gifford Pinchot, who established the frame work of US national forest, park and wildlife refuge systems and promulgated game protection laws and theories, thereby giving resource management the first touch in American history in 1908. Pinchot organized and chaired the White House conference on natural resources, perhaps the most prestigious and orchestrated environmental meeting ever held in the United States (Cunningham *et al* 2005).

### Utilitarian Conservation.

Roosevelt and Pinchot conservation policy was, rather a pragmatic, utilitarian type. They contended that the forest should be saved "not because they are beautiful or because they shelter wild creatures of the wilderness, but only to provide homes and jobs for people"; that conservation means nothing but saving natural resources for future generations.

### Biocentric conservation

The utilitarian conservation of Roosevelt and Pinchot was contested by John Muir, who argued that nature deserves to exist for its own sake, regardless of its usefulness to man. Believe that aesthetic and spiritual values should be the focus of nature conservation. This concept referred to as biocentric preservation, emphasizes the fundamental right of other organisms to exist and to pursue their own interests. Nature created them for the happiness provided by each of them, and so should be allowed to exist as entities not to be destroyed by man, who is also a unit of creation. Muir, also fought hard for the creation of Yosemite and Kings Canyon National parks of USA.

Shortly after, other countries began to show interest in the conservation of nature. For instance, preservation of National Parks and game reserves commenced in Australia by 1886, and in New Zealand by 1894. It was not until 1949 that the first British national park was established, but prior to that many societies such as the Royal society for protection of birds (1889) and the national trust (1895) had been set up to promote conservation (Toole & Toole, 1998). Today, a large number of agencies has sprung up which promote wildlife and biodiversity conservation either by funding conservation research, or

by direct involvement in park management, captive breeding of endangered species, or in capacity building.

### List of some International Organizations which promote Biodiversity and Wildlife Conservation

1. International Union for Conservation of Nature and National Resources (IUCN) The world conservation union.
2. The world conservation Fund Monitoring Centre (WCMC)
3. Worldwide Fund for Nature (WWF)
4. International Chelonian Organization
5. Birdlife International
6. Man and Biosphere (MAB)
7. African Conservation of Nature and Natural Resources
8. Conservation International (CI)
9. Wetland International
- 10 Wildlife Conservation Society (WCS)

There are several instances in which wildlife conservation efforts have saved some animals from extinction. For instance, the American buffalo, *Bison bison*, owes its survival to the legal protection given to it by the American government. By the late 1800s, hunters had killed all but about 550 of these animals. Today, over 10,000 buffaloes live in the western United State (World encyclopedia, 1975). It is also on record that some notable animals such as Arabian Oryx, Californian condor, black-footed ferret, red wolf and Mauritius kestrel which were once on the brink of extinction, were saved by captive breeding and returning them to the wild (Lafferty and Rowe 2001). The cheetah population in Namibia which had dropped from 10,000 in the early 1980s to 700 in the early 1990s, was saved by the concerted efforts of IUCN. Others in the list which have attracted the attention of IUCN and United Nations are the Elephants, the Big cats, - Lion, leopard, Tiger, Cheetah, and the Black and White Rhinoceroses. Another animal of conservation concern is the wild horses in Namibia, which population has been plummeting rapidly due to frequent attacks by hyena parks.

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The protection of wildlife in Nigeria, began with her creation, soon after the amalgamation of the Northern and Southern protectorates in 1914. Regional game laws were enacted, initially by eastern Nigeria in 1916 and later by the western and northern regions in 1928 and 1963 respectively (IUCN, 1992). Ever since then, More laws have been promulgated to enhance conservation of the country's wildlife resources, while the legislations in table 6 are geared towards protecting the environment from hydrocarbon emission by oil companies. A series of National parks, game reserves and sanctuaries totaling over thirty have been established to enhance *in situ* conservation.

Unfortunately, the distribution of these delineated conservation areas favored the savanna region where the big games occur. In the forest region of the south, only the Cross River National Park preserves the forest wildlife. In the Niger Delta, which harbor some notable endemic and endangered species appears to have been overlooked. This is indeed a big lapse in the conservation strategy of Nigeria.

## **RATIONALE BEHIND WILDLIFE AND BIODIVERSITY CONSERVATION**

The reasons for bothering about biodiversity conservation lies in myriads of benefits biodiversity confers to the continuous sustenance of life and ecosystems. Once we loose any species to extinction we loose its values and its functions in the ecosystem, forever. Large volumes of literature have accumulated in recent times (Millenium Ecosystem Assessment 2005; Isbell *et al* 2009; Cardinale *et al*, 2002, Udoh 1999) highlighting the benefits of biodiversity, which include:

- (1) Livelihood support - provision of food, medicine, and pharmaceuticals for humans, livestock and wildlife populations.
- (2) Functioning and stability of ecosystems.
- (3) Indicators of environmental change.
- (4) Sources of industrial raw materials: -High forests are usually sources of special materials for handicraft, woodwork, building construction, etc. Among them are various qualities of wood

used for roofing, carving, Xylophone, cane for cane chair and baskets, ropes, and substances like oil, waxes, resin, tannin, and raffia for masquerading, etc. Shells of molluscs (periwinkle, whelks, bivalves) are important sources of calcium carbonate and a resource for fine arts and decorations. The availability of the materials presently sustains the various industries that help people to eke a living. It is a matter of conjecture what will happen to these sectors, if the raw materials are nudged to extinction.

Ecosystem services and sustainable livelihood: Ecosystem services define the direct and indirect contributions of spatial unit of the natural environment to human well-being and sustainable livelihoods. Biodiversity is critically linked to human well-being and life; it directly or indirectly supports our survival and quality of life. This explains why conservationist bother a lot about wildlife and biodiversity conservation. Their values to mankind, ecosystem functions and ecosystem services, as listed below. When a species goes extinct the values and services they provide are lost forever and future generations are denied these benefits. Biodiversity is involved in / provides :

- Food – vegetable, nuts, fruits,
- Water; regulates water flow and water purification
- Industrial raw materials- Fuels and fibres, wood, leather, paper, rope, wax, dye, etc.
- Genetic materials /resources
- Medicine, Cosmetics, and biochemical resources (testing new drugs)
- Ornamental resources
- Air quality regulation
- Carbon sequestration
- Climate regulation
- Erosion prevention
- Maintenance of soil quality
- Pollination services

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- Biological control
- Maintenance of life cycles of migratory species
- Cultural materials/ services; aesthetic information, opportunities for recreation and tourism, inspiration for culture, art and design, spiritual experience, information for cognitive development, etc.

The Millennium Ecosystem Assessment (MA, 2005) defined Ecosystem services as “ the benefits people derive from ecosystems”. Besides provisioning services or goods like food, wood, medicine, nutrient cycling and other raw materials; plants, animals and microorganisms by their respective life style provide essential regulating services such as pollination of crops /tall trees (by butterflies, birds, bats, snakes,etc); prevention of soil erosion and water purification (by plants); and a vast array of cultural services, like recreation , landmark species, etc. The global Millennium Ecosystem Assessment (MA,2005) methodology classified ecosystem services into four broad categories, namely – those that cover the material or provisioning services; those that cover the way ecosystems regulate other environmental media or processes; those related to the cultural or spiritual needs of the people; and finally the supporting services that underpin these other three types.

**Table 3:** Showing Ecosystem Services and Benefits

Provisioning services	Regulating services	Supporting services	Cultural services
The products obtained from ecosystems	The benefits obtained from the regulation of ecosystem processes	Ecosystem services that are necessary for the production of all other ecosystem services.	The non-material benefits people obtain from ecosystems.
❖ Food ❖ Fibre ❖ Freshwater ❖ Genetic resources	❖ Climate regulation ❖ Hazard regulation ❖ Noise regulation ❖ Pollination ❖ Disease and pest regulation ❖ Regulation of water, air and soil quality	❖ Soil formation ❖ Nutrient cycling ❖ Water cycling ❖ Primary production	❖ Spiritual or religious enrichment ❖ Cultural heritage ❖ Recreation and tourism ❖ Aesthetic experience.

Source : Kremen (2005)



**Provisioning services** – refer to the products obtained from ecosystems such as food, freshwater, timber, fuelwood, fiber, honey, bushmeat, palm wine, raphia, snail, wax, nuts, rope, rattan cane, forest vegetable, fruits and seeds, mushroom, spices, genetic resources and medicine. These major services are provided by tropical rainforest (as we have in the Niger Delta), and the life of the rural people, their livelihoods and local economy are highly dependent on the forest. While exploitation of the Non-timber Forest products NTFPs, is carried out mainly by women, the timber products are exclusively exploited by men.

**Regulating Services** – are the benefits obtained from the regulation of ecosystem processes such as climate regulation, natural hazard regulation, water purification, waste management, pollination, or pest control. Climate regulation is one of the prime benefits of ecosystem services of forests both globally and on a local scale as terrestrial ecosystems represent a major medium of carbon sink from human generated emissions of carbon (EASAC, 2009).

**Habitat services** – Highlight the importance of ecosystems to provide habitat for migratory species and to maintain the viability of gene-pools. The tall growing emergent, which coppice well provide habitats for epiphytes, arboreal animals like monkeys, squirrel, pangolins and snakes. Other services include the provision of food storage and nesting sites in hollows on the bore of the tall trees (for breeding birds, squirrels and tree frogs).

**Cultural services** – Include non-material benefits that people obtain from ecosystems such as spiritual enrichment (as shrines, sacred lakes, forest grooves etc.) knowledge system and intellectual development (use of medicinal herbs, ornamental plants, taboos, totems etc.) recreation and aesthetic values and sense of place. The elderly men in the rural communities developed very rich wealth of knowledge given their many years of interaction with the forest in terms of medicinal provisions, burial rites, marriage rites and traditional festivals.

In spite of the ecological, regulatory, cultural, aesthetic and economic importance of these services, the ecosystems and biodiversity that strengthens the ecosystem are under constant degradation with resultant loss and threat on species at an extraordinary scale. This is because the

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inhabitants of the forest area whose lives revolve around the ecosystem functions, do not fully appreciate the value (importance) of ecosystems to their welfare in their everyday planning and decision-making. Similarly, massive deforestation for plantation agriculture and subsistence farming, oil spills, pollution, overfishing, lumbering activities and other unsustainable use of natural resources of the area exert a cost on ecosystem services at the expense of the poor and future generations.

**Agricultural values** -Other reasons for biodiversity conservation lie in its importance in the Agricultural sector. Most crops such as wheat, corn. Cowpea, groundnut and rice were formally wild plants, and have been modified by agricultural practices to be high producers (Mader, 2001). More food crops are yet to be discovered; biological resources need to be saved because there is no knowing which weed, herb, tree, insects, etc will turn to become food in future. It might surprise you to know that processed cockroach is food in some countries, today! e.g in Thailand, where it is steam-roasted and eaten ,and in China where it is fried and eaten.

### **Adaptation to disease eruption.**

The significance of biological resources in medical and scientific research, provides another utilitarian justification for biodiversity conservation. Wild animals such as monkeys, gorilla and chimpanzees are often used to test new drugs, as no human would offer himself as a test organism for such experiment. Availability of considerable biodiversity makes it possible for mankind to adapt to changing needs and health problems in our environment. As our planet earth ages, man is more often than not plagued with disease epidemics that puzzle science. For instance, sometime ago, it was influenza, yaws, gonorrhoea, syphilis, chicken pox, tuberculosis, jaundice, and recently HIV/AIDS, SARS, Ebola, Zika. The scientific world is looking forth to the extraction or synthesis of drugs from biological resources for the control or cure of these dreaded diseases. If by chance a potent drug is extracted from an endangered species, then humanity will be confronted with the problem of generating a very high population of that species for commercial production of the novel drug. For this

singular reason therefore, there is every justification for mankind to embark on biodiversity conservation, since no one knows the plant or animal species that would be the source of the antedotes for diseases that might erupt now and in future (Akani, 2008).

Further reasons for wildlife and biodiversity conservation include:

- ❖ Enhancement of ecotourism.
- ❖ Economic values.
- ❖ Ethical values
- ❖ Erosion control
- ❖ Continuance of evolutionary processes.

## **INSTITUTIONAL AND REGULATORY FRAMEWORKS.**

In Nigeria, a number of institutional and regulatory frameworks exist to manage and conserve biodiversity at the local, state, national and international levels. These are listed here as follows:

### ***Ministry of Agriculture and Natural Resources of Rivers State.***

The Ministry of Agriculture and Natural Resources of Rivers State oversees the effective management of the forest reserves in the state through its Forestry Department. Dedicated staff were appointed to manage the FRs in line with the laws of the state.

### ***Ministry of Environment of Rivers State.***

The Ministry of Environment of Rivers State is charged with the policing and management of the environment together with the sustainable management of biodiversity. The ministry ensures that development projects do not have adverse impact on the environment including the biodiversity of Rivers State.

### ***National Conservation Strategy (1988)***

The National Conservation Strategy (NCS) focuses on conservation of Nigeria's renewable resources, including vegetation, forgae, water, fisheries and other marine resources, wild animals and soil. The overall objective of the NCS is to provide development planning with a long-term, strategic approach to the management of natural resources and

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their uses. The NCS attempts to commit agencies at different levels to integrate conservation and development plan and for ecological impact studies at the conceptual stage of development project.

### ***Convention on Biodiversity(CBD; 1992).***

This is the principal global policy instrument for the conservation of biological diversity which was adopted at the United Nations Conference on Environment and Development in 1992. The objectives of CBD are the conservation of biodiversity, sustainable use of biological resources and equitable sharing of the benefits of sustainable use of biological resources. Occasioned by the rapid rates of species extinction and endangerment (Biodiversity Crisis) throughout the globe, the Convention on Biodiversity during the Earth Summit of 1992 in Rio-de-Janeiro, Brazil, made a clarion call to all 108 member nations, of which Nigeria is one, to take drastic steps towards conserving their biodiversity.

### ***Forestry Act (1963)***

This Act of 1958 provides for the preservation of forests and the setting up of forest reserves. It is an offence, punishable with up to 6 months imprisonment, to cut down trees over 1m in girth at breast height or to set fire to the forest except under special circumstances. The overall objectives of forest policy are to prevent further deforestation and to recreate forest cover, either for productive purposes, on already deforested fragile land.

### ***Millennium Ecosystem Assessment (MA; 2005)***

From 2001 to 2005, the MA assessed the consequences of ecosystem changes on human well-being. Published in 2005, the MA outcomes provided the first state-of-the-art scientific appraisal of the condition and trends in the world's ecosystems and the services they provide, as well as the scientific basis for action to conserve and use them sustainably. In 2006, the eighth meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD COP) in Curitiba, Brazil, adopted a decision on the MA's implications for the work of the CBD, in which it encourages parties, *inter alia*, to use the MA framework for sub-global and national assessment.

**The Ramsar Convention (1971)**

This is a convention on wetlands of internal importance especially as waterfowl habitat. It is an intergovernmental treaty that provides the framework for national action and international co-operation for the conservation and wise use of wetlands and their resources. Table 4 shows Ramsar Wetland sites in Nigeria.

**Table 4.** Ramsar Wetland Sites in Nigeria

Ramsar Site	Location (State)	Area (ha)
Apoi Creek Forests	Bayelsa	29,213
Baturiya	Kano	101,095
Dagona Sanctuary Lake	Yobe	344
Foge Islnds	Niger	4,229
Lake Chad Wetlands in Nigeria	Borno	609, 354
Lower Kaduna-Middle Niger Floodplain	Niger	229,054
Maladumba Lake	Bauchi	
Nguru Lake (and Marma Channel) Complex	Yorbe	58,100
Oguta Lake	Imo	572
Pandam and Wase Lakes	Nasarawa	19,742
Upper Orashi Forest	Rivers	25,165

**The World Heritage Convention (WHC; 1972)**

This convention seeks to encourage the identification, protection and preservation of cultural and natural heritage around the world considered to be of outstanding value to humanity. Natural heritage refers to outstanding physical, biological, and geological formations, habitats of threatened species of animals and plants and areas with scientific, conservation or aesthetic value.

**The Convention on the Conservation of Migratory Species (CMS; 1979).**

The convention seeks to conserve terrestrial, marine and avian migratory species throughout their range. Concerned with the conversation of wildlife and habitats on a global scale, the convention distinguishes between migratory species threatened with extinction and migratory species that need or would significantly benefit from international co-operation.

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## ***The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES; 1975).***

CITES aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. The trade is diverse, levels of exploitation of some animals and plant species are high and capable of depleting their populations and even bringing some species into extinction. Although many wildlife species may not be endangered, the existence of an international agreement to ensure the sustainability of the trade is important in order to safeguard these resources for the future.

## ***The 20 Aichi Targets.***

This is a strategic plan comprising of a shared vision, a mission, strategic goals and 20 ambitious yet achievable targets, collectively known as Aichi Targets. The strategic plan serves as a flexible framework for the establishment of national and regional targets and it promotes the coherent and effective implementation of the three objectives of the Convention on Biological Diversity.

## ***The Satoyama Initiative.***

The satoyama initiative targets complex rural ecosystems formed by long period of interactions between human lifestyles and the natural world. The initiative strives to create a vision for resource management and the land use that balances the twin needs of biodiversity conservation and sustainable utilization. UNEP adopted this initiative and encourages nations to adapt it as a model for sustainable natural resource management according to environmental capacity and natural resilience. In other words, the Satoyama initiative enhances the sustainable use of biodiversity based on the benefits of living in harmony with nature.

## ***The Endangered Species (Control of Intentional Trade and Traffic) Decree No. 11 1985.***

The decree is an off-shoot of the CITES signed by Nigeria which requires that national governments promulgate national legislation to enforce the provision of the convention. The Decree stipulated that as from April 20, 1985 the hunting, capture of, or trade in 59 animal



species specified in its schedule 1, had been absolutely prohibited while those 35 in schedule 2 are animals to which international trade may be conducted under licence.

#### ***National Biodiversity Strategy and Action Plan (NBSAP), (2009).***

The goal of the NBSAP is to develop appropriate framework and programme instruments for the conservation of Nigeria's Biological Diversity and enhance its sustainable use by integrating biodiversity consideration into national planning, policy and decision-making processes. Nigeria has since the ratification of the NBSAP undertaken surveys and inventories of its biodiversity, which form the bases for setting the National Strategy for Conservation and Sustainable Use of Biodiversity. The strategy is now part of our national commitments under the Convention and a testimony to our responsibilities to our future generations.

#### ***National Forestry Action Programme (1996)***

The National Forestry Action Programme (NFAP) is geared towards ensuring sustainable forest management, promoting participatory process of development, facilitating private sector-forestry development and adopting an integrated approach of forestry development.

### **CONSERVATION STATUS OF SPECIES**

The conservation status of a species reflects its state in terms of abundance or ecological significance in a place. The status in terms of abundance or scarcity is usually determined and published by IUCN/ Red-List.

**Satisfactory species:** refers to species whose number is high enough and does not cause conservation concern. Such species are commonly found around, e.g lizards, skinks, rats, oil palm tree, etc. IUCN Red-list describes this category as Least Concern (LC).

**Vulnerable species:** Are those species which are unprotected by their way of life and so are prone to becoming rare due to frequent exploitation.

- All the Local Government Areas of Rivers, Akwa Ibom, Bayelsa and Delta state should endeavor to delineate at least two large forest reserves to protect the rapidly depleting biodiversity in their areas, arising from logging, urban development and agricultural land take.
- Government should include biodiversity Conservation in High school curriculum, and encourage the development of Biodiversity Conservation Societies.
- Finally, FEDERAL GOVERNMENT/ TETFUND should build a CENTRAL RESEARCH LABORATORY WITH AUTOMATED EQUIPMENT&TRAINED OPERATORS IN EVERY NIGERIAN UNIVERSITY, to stop the "conduct of research with tears" experienced by Nigerian Scientists. Because of lack of such facilities, Nigerian Scientists are grossly underused.

reserves, researchers/tourist camps, trails, and mounting warning signs against poaching, policing the forest with well trained and well paid rangers properly equipped uniform and forest-guarding gadgets.

- Government should not allow anybody, O&G and /or agency to tranverseor construct any road across a forest reserve or National Park.
- Law enforcement agents should be given special training on enforcement of biodiversity and environmental laws. Defaulters (poachers) should be paraded on TV and taken to court for legal action. Any confiscated live animal should be handed over to the nearest zoo.
- People should be sensitized to know that handling, buying and selling endangered species or their parts anywhere in the world are unlawful. CITES frawns at it. So when people are shopping overseas they should ensure that the product they are buying is not made from an endangered species. They should also be educated on the role of Convention on International Trade on Endangered Species (CITES). Government should enact a law to ban trade on endangered species products. e.g. skin of iconic animals like lion, elephant tusks, Antelopes, Eagle feather, parrots, python, crocodiles, etc.
- Government should establish and fund a breeding zoo in each of the states to encourage the propagation of endangered species. Every zoo should be equipped with dart-guns charged with sedatives to bring down any carnivore that jumps the cage. Zoos should be equipped to have an animal farm from which animals will be sourced to feed the carnivores. Sheep which produces sizeable litter, is a promising candidate for feeding carnivores like lions and leopard in zoos.
- Government should establish grasscutter farms to provide the bushmeat cherished by the people. With the grasscutter breeding venture, animals in the wild will be let alone to survive (Mensah, 1991).

**Endangered species:** are animals and plants categorized by IUCN Red list, as likely to become extinct in no distant time, if the cause of endangerment or depletion is not checked. The number has dropped so low that they are rare to come by. Invariably their range also have contracted. Rarity of such species is a signal that it is about to vanish from the earth and therefore deserves urgent conservation attention.

**Critically endangered species:** Are species which are very seriously threatened with extinction. Such species are at verge of extinction and may disappear if no conservation steps are taken to reverse the trend.

**Threatened species:** Are species whose number is obviously depleting, but the status is not clear; whether it is vulnerable, endangered, critically endangered or extinct.

**Extinct species:** Are species which have disappeared from the surface of the earth; examples are the Kiwi, Dodo, Passenger Pigeon, dinosaurs, etc. Among the extinct fishes are the Bacaccio Rock fish, European eel, Goliath Grouper, Maltese Ray and Blue Tuna (Sikoki Pers. Comm). Extinction is the worst status for any species, because its loss is forever, and is irreversible. Once gone, it is gone for good.

In recent times, however, it has been observed that some species which were deemed to have gone extinct, are rediscovered. This has necessitated a redefinition of extinct species, to mean; species that have not been found in the wild for 50 years.

**Extant species:** are currently existing species.

**Games species:** are any hunted species.

**Totem species:** A totem is a species of cultural or traditional importance to certain families, clans which have taboo against killing or eating (Powell 1998; Akani and Luiselli, 2000). Totems are known in most African communities. For instance, some Ijaw and Kalabari communities in the southerly part of the Niger Delta, especially, Nembe Brass, Kula, etc., deify or worship pythons and therefore would not kill or eat its meat. At Toru-egbene and Angalabiri in Bayelsa State of Nigeria tortoises are venerated and therefore spared. Because the people protect them by not killing them, there number tends to increase.

The same is true of crocodiles in Oguta and Tungbo in Bayelsa State.

**Indicators species:** This is a species whose presence, absence or relative well-being in a given environment is a sign of the overall health of its ecosystem (AHSD, 2002). An indicator species is a plant or animal that is very sensitive to environmental changes in its environment. An ideal indicator species is affected almost immediately by damage to the ecosystem and can give early warning that a habitat is suffering. Damages from external influences such as water pollution, air pollution or climate change first appears in indicator species. By monitoring condition and behavior of an indicator species ecologists can determine how changes in the environment are likely to affect other species that are more difficult to study. Indicator species abound which tell us the state of an ecosystem. The abundance of lichen on trees is an indicator of air pollution; mosses are indicators of acid soils, while Tubifex worms are indicators of oxygen-deficient stagnant water that is unfit for human consumption; the polychaete, *Capitellacapitata* is an indicator of marine pollution while *Sternaspsis* sp is an indicator of dredged marine water (Day, 1981). Also the presence of chironomid and chaoborus larvae are indicators of organically polluted freshwater; and freshwater looking like "green soup" due to bloom of blue-green algae is an indicator of eutrophication (enrichment of a water body by plant nutrients). The abundance of species such as *Musangacecropoides*, *Irvingiagabonensis*, *Raphia*, *Cyrtospermasenegalense*, *Triumphetta* sp and *Clappertonia* sp is an indicator of a healthy seasonal freshwater habitat.

**Endemic species:** These are species native or indigenous to a place and found nowhere else, or have restricted geographical distribution. They are restricted to a region because of the peculiar ecology of where they flourish. Thus, survival elsewhere is not likely. What this means is that endemic species could be nudged to extinction, if the habitat in which it thrives is not conserved or managed. Earlier work by scholars such as Happold (1987), Powell (1998) and Werre (2001) identified the existence of Sclater's guenon, *Cercopithecus sclateri*, an endemic species of the Niger Delta, with a geographical range between the Niger River and Cross River. The Pigmy Hippo, is another endemic species

- O & G operators develop aquaculture systems at convenient sites and annually generate fingerlings and to release them at appropriate times, as compensation or replacement for mass fish kill during oil spills. Native species should be used and this should be done in collaboration with fisheries and aquaculture department in the nearest university.
- Burning of Oiled forests and habitat (due to oil spillage) should no longer be allowed as more damage is done to the ecosystem than when nature is allowed mop up the oil.
- Troupe hunting and trapping with wire-nooze and fence, should be prohibited by law as these two techniques are the major causes of wildlife depletion in the Niger Delta region.
- Washing of motor vehicles and bikes on the shores of rivers and streams, which introduce fuel and grease and other petroleum hydrocarbons into habitats of amphibians and fish, should be prohibited by law, as the freshwater ecosystems and services are disrupted.
- We must stop giving titles to killers or hunters of charismatic species like elephant, lion, leopard, gorilla, chimpanzee, monkeys, manatee, buffalo, crocodile, python, etc. Such titles as "Ogbuenyi", "Ogbuagu", "Ebube-dike", etc, empowers the hunters to get more at all cost.

Government should establish a functional **NIGER DELTA NATIONAL PARK** and more forest reserves to protect the vanishing populations of elephant, chimpanzee, Sclater guenon, Red colobus monkey, in the Niger Delta region (Powell 1998, Werre, 2001; Akani 2008). It is indeed an oversight, if not a lapse, that the fragile Niger Delta ecosystem with its rare and endemic species, and diverse wildlife habitat and wetland has no National Park. Such a park is necessary to safeguard the huge genetic diversity and ensure continuing evolutionary processes.

- For effective conservation, government support is key: Government presence should be manifested in the forest reserves – through building administration blocks at the entrance of the



routine check on trawlers in our territorial waters to stall trapping of these herps., and defaulters to book.

- O & G operators should strengthen sea turtle conservation, if sea turtle breeds in their area of influence. For instance, AGIP should support Sea turtle conservation in Akassa and Brass where sea turtle are known to breed (Akani and Luiselli, 2011), while SPDC and LNG take the responsibility in Bonny, and Exxon Mobil does the same in Ibeano.
- There should be regular patrol by the navy to ensure that trawlers operating in our territorial waters (around Akassa, Brass, Idama, Bonny, Andoni, Oron, etc, use Turtle Exclusion Device (TED) to protect sea turtles arriving our coast to spawn (Fretey 2001 and Akani and Luiselli, 2011).
- Ensure regular removal and incineration of solid wastes (plastic containers, nets, textile, wood, bottles, etc) along the coasts. Some of the lost fishing nets in water continue to trap fish and entangle sea turtles. Sometimes sea turtles mistake floating "pure water bags" for jellyfish (their food). They get choked by the plastic bag, and eventually starve to death (Castro and Huber, 2005).
- O & G operators should brace up to their responsibility, to implement to the letter, mitigation measures recommended by EIA studies in the areas of influence.
- Whenever an oil spill occurs along the coast, a biodiversity rescue team from the affected O&G company should be drafted (in a flying boat) to patrol and rescues any suffocating or moribund birds, reptile or mammal and take them to a Marine Research laboratory for rehabilitation / resuscitation.
- O & G operators should establish a forest reserve near their major footprint or operational area to serve as refuge for displaced wildlife due to their facility e.g. Gbaran FLT of SPDC in Bayelsa and Finima Nature Park (FNP) managed by NLNG, in Bonny Island. Such protected areas should be properly guarded against poachers from the neighborhood.

known only in Liberia and Niger Delta, (specifically around Nun R. forests of Bayelsa State between Amasomma and Otusega).

**Flagship species:** is a species which is the main reason for the conservation of an ecosystem or protected area. Such number one species, which is usually "charismatic" is chosen because of its vulnerability, uniqueness or attractiveness to gather more support and acknowledgment from the public for its conservation. Invariably, every National Park or forest reserve has its own flagship species. The flagship species concept holds that by giving publicity to a few key species, the support given to the species will successfully leverage conservation of the entire ecosystem and all species resident therein. As a rule a candidate to be declared a flagship species must be an endangered or endemic species. According to WWF, flagship species are iconic animals that provide a focus for raising awareness and stimulating action and funding for broader conservation efforts. There are about a score of popular flagship species the world over, namely – Bonobo, Chimpanzee, Freshwater and marine Dolphins, Crocodiles, Elephants, Giraffe, Giant Panda, Gorilla, Leopard, Marine turtles, Orang-utang, Polar bear, White and Black Rhinoceroses, Rock wallaby, Tree Kangaroo, Whales, etc. Others are lion, Tiger, Cheetah, Buffalo, Oryx, etc.

### **Extinction – prone species**

Some categories of wildlife are more susceptible to going extinct, than others because of their features or habits. Among them are:

- ❖ **Massively built vertebrate species.** – are easily attracted to hunters and other predators. e.g Elephant, Rhinoceros, Gorilla, Manatee, whales, Dolphins, etc
- ❖ **Species having valuable parts** - such as ivory, beautiful pelt, horns, hoof, as well as plants with medicinal bark, stem, roots, leaves, flower, fruit and seeds.
- ❖ **Long-lived species with low reproductive rates and long generation time** recovers slowly from lowered population levels (Botkin and Keller 1998). They do not breed until a relatively advanced age is attained and they produce few young.

- ❖ **Species requiring special habitats or diet** ; e.g endemic species, Pigmy hippo, Sclater guenon, etc.
- ❖ **Species at the higher tiers of the food chain**, viz; big carnivores such as - lions, leopard, Tiger, Cheetah, etc .Naturally, their number is lower than species at the lower tiers, and their characteristic low litter size plus their cannibalistic behavior to young - when stay a long time without catching a prey-predispose them to extinction.
- ❖ **Species with cluster distribution and breed in colonies.** Because they aggregate, many are killed in the event of danger e.g disease epidemic, wildfire, pollution, flood, and natural disasters.
- ❖ **Animals that exhibit altruism** – These are animals that mete out selfless care or sacrifice (if necessary of life itself) to other related individuals or their offspring, so that they may survive. Altruistic species show empathy to a down-trodden member of their population. As they gather to grieve over the fallen mates or flockmates, they are easily killed themselves. Refusal to abandon their wounded or distressed fellow will therefore hasten their extinction. Endangered species like elephants, zebra, wolves, gorillas, and whales have this altruistic trait.
- ❖ **Slow-moving animals**; as they are helpless in the face of hunting pressure, human and non-human predators and in times of danger, bushfire, war, e.g. Tortoises, chameleon, snails. Flightless birds like the Great Auk, Great Elephant Bird, Dodo, etc

### Exotic species

These are non-native or non-indigenous plants or animals that have been introduced (mostly by human activities) into an area where they do not naturally occur. They represent all phyla from microscopic to macroscopic plants and animals, whether terrestrial or aquatic. Sometimes referred to as alien, introduced, foreign, or invasive species, etc, most exotic species are introduced either intentionally or unintentionally by man.

### RECOMMENDATIONS

In view of the foregoing findings of the survey, we submit that mainstreaming of biodiversity conservation in the O & G operations for **sustainability** will be achievable, if the following recommendations are implemented:

- All the Ministries of Environment, Departments of Forestry and Fisheries need to be revived; empowered with manpower and equipment to effectively mainstream biodiversity. Nurseries and hatcheries with sufficient number of trained technicians and labour are key to the functioning of the forestry and fisheries departments. To this end, adequate funding should be allotted to biodiversity conservation in government budgets.
- There should be a vigorous tree-planting exercise (afforestation and re-forestation) in their OML areas, and de-reserved forest reserves in collaboration with the State Forestry Departments of every state for at least a decade.
- On decommissioning from a seismic operation site, the O&G company should ensure that they undertake a re-vegetation exercise/project along the seismic lines and the base camps, using native tree species from the neighborhood.
- Tree-planting, using native species, should also be carried out by O&G operators along the edges of the pipeline Right-of-Way, to check erosion and compensate for the numerous trees lost during the construction phase.
- A Marine Biological Research Station should be established by O&G operators along the coastal zone to continuously monitor the dynamics of marine biodiversity – plankton, crustaceans, molluscs fish, as well as the mangrove ecosystems. They should do so in collaboration with the Marine Biology / Hydrobiology Departments in the nearest University.
- Governments should ensure that fish and shrimp trawlers on our coastal or territorial waters have Turtle Exclusion Device (TED) fixed to their boat to protect sea turtles arriving at the coast to breed. Our Naval force or Marine Police may be drafted to do a

indispensable in determining accurately the species richness and diversity of a given community.

In most departments and ministries vital equipment for biodiversity assessment work are poorly supplied or lacking, consequently they frequently depend on consultants to accomplish most tasks which they should do themselves. There are no laboratories in these ministries and working equipment / apparatus like camera trapper, binoculars, mist net, ekman grab, secchi disc, echo-sounder, GPS, plankton net, water quality analysis kit, air quality analysis kit, Salinometer, turbidometer, Colorimeter, AAS, GC Analyzer, soil auger, etc are often lacking. You cannot tie someone hands and legs and expect him to run fast. Our counterparts overseas are running faster than us in research simply because they are far better equipped and motivated. They should be properly equipped and motivated to function.

The investigation observed that several unbridled traditional practices contribute to undermine Biodiversity Conservation in the Niger Delta, which government should address. Among them are: overfishing, logging, fuelwood gathering, troop-hunting, use of wire nooze and Drift-fence traps, bush burning hunting, and the culture of giving titles to hunters of iconic / endangered species such as elephants, lion, chimpanzees, gorilla, etc. Other biodiversity depressant practices include washing of motor vehicles and bikes on the shores of rivers and streams, which introduce fuel and grease and other petroleum hydrocarbons into habitats of amphibians and fish, should stop forthwith. Burrow-pit excavation for (road) construction, sand-mining, improper disposal of industrial and domestic wastes and vehicular rides on coastal beaches, lead to biodiversity loss.

The oil and gas industry on the other hand undermine biodiversity at various phases of the oil prospecting through seismic operation, exploration drilling, flowstation development, gas flaring, pipe-line construction and operation.etc. and should collaborate with the host communities to make conservation efforts effective.

**Advertent / Intentional introductions** - are usually accomplished for a purpose; such as in biological control ; checking pest population attacking crops, or fish in an aquaculture system; in medicine (e.g in mosquito or tse-tse fly control and control of other vectors) or as ornamental plants.

### **Inadvertent Introductions**

Exotic species can also arrive in a new place, inadvertently by hitching a ride on an airplane, on board a ship, or in a car. For microscopic organisms mere contamination can be a means of transportation (road, water or air). This is why laws that govern agricultural commerce, enforce quarantines to prevent the accidental spread of disease organisms, insect pest and weed seeds, during the importation of biological resources.

On arrival in a new place, the exotic species may survive, reproduce and establish themselves. Their survival and proliferation in the new location is traceable to the fact that

- (i) removing a species from its native environment frees it from natural predators, parasites, pathogens and competitors that limits its number, and
- (ii) the abiotic or physical environment of the new place is favorable,
- (iii) the native species are defenseless against the new source of predator attacks or succumb in the competition for food, space, and other biological resources with the alien species. Sometimes an alien species can become overwhelmingly successful, and consequently cause ecological and economic damages. In such instances they are referred to as invasive species. Some authorities define invasive species as alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.



## Aquatic Introductions

### *How are species introduced to a new aquatic habitat?*

There are numerous ways in which exotic marine and freshwater species are introduced, generally associated with human activity. Two major routes of aquatic introduction of exotic species is through **aquaculture**, and **ocean-liners** which may transport encrusting organisms on them from one continent to the other.

Intentional introductions are also possible through **ballast** water.

### **Ballast Water**

All cargo ships contain huge ballast tanks. These tanks are filled at ports to help steady cargo-less ships as they travel and emptied once cargo is loaded. Each tank can hold millions of gallons of water containing any and all of the aquatic life found at a port; everything from bacteria and algae to worms and fish have been found in ballast water. As ships travel faster and world trade grows, species are better able to survive the journey, and the threat of invasive species from ballast water increases. The US alone receives at least 21 billion gallons of ballast water each year from around the world, leading to problems like that of the well-known **zebramussels**.

Another example of an exotic species which has invaded an area after introduction via ballast-water is the American comb jelly, *Mnemiopsis leidyi*. A comb-jelly is a small, marine invertebrate superficially resembling a jellyfish. It is carnivorous, and preys on tiny aquatic animals, such as plankton. Transported in ballast possibly from New England, the American comb jelly invaded the Black and Azov Seas in Europe. The rapidly expanding population preyed so heavily on plankton that its biomass declined by as much as 90percent. Anchovies, which feed on plankton, sharply declined as well, causing local fisheries to suffer. Ballast tanks are filled and emptied off the coastline, in estuaries and bays where freshwater and salt water meet.

Thus species picked up during a filling are able to survive when emptied back into conditions similar to their native community. If, instead, ballast was emptied in the ocean and filled with marine water, species would be much less likely to survive in the foreign location.

## CONCLUSION

*Vice Chancellor Sir,*

*I have in the course of this lecture tried to highlight the significance of Wildlife and Biodiversity conservation as a means of ensuring continuous sustenance of life, not only for the present generation but also for posterity. Basic concepts of Wildlife and biodiversity conservation have been elucidated in more or less layman language with less scientific registers. The lecture has also brought to focus the concepts of sustainable developments and global efforts to alleviate the suffering of the human race.*

*The multiple factors that lead to to unsustainability have been addressed with particular reference to the Niger Delta and Nigerian Scenario. Nigeria is signatory to many conservation and environmental conventions but the legislation is weak in terms of enforcement of the law.*

*The lecture has exposed the yawning gap in conservation and what we need to do to close the gap. Predictions have also been made of what the situation will be, if we continue to show apathy to conservation of our natural resources.*

Vice Chancellor Sir, this lecture further reveals that mainstreaming biodiversity in government and O & G operations / policy and decisions has become necessary considering the multiple pressures on biodiversity of these states. Biodiversity conservation could be strengthened by collaboration of both government, the oil concessionaires and communities. There should be accelerated and concerted effort to train enthusiasts and increase biodiversity conservation awareness. In virtually all the states, biodiversity activities are low and research in biodiversity is abysmal due to lack of fund and research facilities. There is also scarcity of professionals in various aspects of biodiversity studies: of particular note is the lack of taxonomists, invertebrate biologists, parasitologists, entomologists, algologists, herpetologists, ornithologists, mammalogists, ecotoxicologists, geneticists, molecular biologists, and mycologists, who are

6. Many animals that dive into produced water in savor pits in flow stations- such as anurans, birds, and dragon flies died immediately or later, because of the toxic nature of the water.
7. The preponderance of evidence of wildlife presence such as footprints, fecal droppings, sloughed skin, along the pipelines provided evidence that the ROW was used by many as route for foraging wildlife at night. This indicates that the phenomenon of edge effect develops along the ROWs.

### **Aquaculture**

Aquaculture, as defined in the USDA National Aquaculture Development Plan, is the "manipulation of marine or freshwater organisms and/or their environment before eventual release, harvest, or capture; the controlled cultivation and harvest of aquatic animals and plants". In order to control the cultivation of fish or other aquatic species, one of two different methods are generally used. The species are either released freely into regional water, or else they are contained in a closed or open circulation pen. In the latter case, reproduction, food, growth, and spread can be controlled, but any resulting changes in the conditions of the environment cannot. If released freely, a species can affect the ecosystem in the ways already mentioned, such as competing or breeding with the indigenous species.

Proponents of aquaculture, however, cite many reasons why it is the next market that should be expanded and explored.

Throughout the world, the demand for fish and all seafood is increasing as consumption increases. However, the supply of fish from the wild has declined as they are over-exploited, and their habitats polluted and destroyed. Thus, supporters maintain that now is the time to encourage aquaculture. Because "fish [and other aquatic species] have certain advantages over land animals in their suitability for farming", aquaculture is more efficient and profitable than agriculture.

They are more efficient at converting food to flesh because they do not have to maintain their body temperature (they are cold-blooded), nor do they have to support their weight. Because the farms where these species are raised have the added dimension of depth, there are greater yields per acre when raising a species in water as opposed to on land. If regulated strictly, it is believed that aquaculture could provide food and profit without negative effects. While the support for aquaculture is growing, some, like Jim Carlton, professor of marine science at Williams College, feel that introducing exotic species for any purpose is too great a risk. "Whenever we introduce a new species, it's an ecological roulette with nature. We'd rather not play that game."

### Impacts of Exotic species

Ecologists are usually not enthusiastic about the introduction of a species into a new ecosystem. This is because of the impacts they leave in the new place. Two types of impacts are known to be exhibited by exotic species, namely ecological and economic impacts.

#### Ecological impacts

On arrival in a new ecosystem, an exotic species may turn to be a better predator or grazer than the native species in the same trophic level leading to alteration of food chains. It can out – compete the native species for resources such as food, nesting site and territorial space and consequently nudge them to extinction. Such a loss in biodiversity, generates a cascading effect in the food-web which jeopardizes the entire ecosystem. Overgrazing by an invasive species can lead to considerable disturbance of soil, loss of habitat, soil erosion, and alteration of nutrient levels in soils. Sometimes species intentionally introduced to prey on a pest population, rather than face the pest, finds another species in the ecosystem more palatable and easier to capture and so feasts on them, causing another problem in the ecosystem. The exotic species may also come along with a disease parasite to which the native species are not resistant. For these reasons, wildlife ecologists are usually not too comfortable or optimistic in introducing a foreign species into a Park or game reserve. Thus, any introduction must be done with caution, after sufficient research on the habitat requirements of the species in question. Although, there is the tendency for people to assume that introduced species have negative ecological impacts, it is not always so. For instance, the dung beetle (a potential scavenger) which was introduced to Australia, a couple of years ago, is now helping to reduce the problem of excessive cow dung on ranches.

As noted by Bhaskar and Pederson (2010), exotic species can help an ecosystem by providing a missing link in a food chain. Some scientists believe that introductions can also be beneficial by preserving species in cases where they are endangered or threaten in their natural habitats. Sometimes introducing them in a different habitat enables them to survive, and thus preserve biodiversity.

### Other Findings on Biodiversity of the Niger Delta Region

1. Most invertebrate fauna which are very sensitive to low humidity (earthworms, snails, insects, etc) tended to show avoidance reaction to gas flare stacks zones, while raptors are attracted to them instinctively to hunt for offal and warm themselves in cold weather. In the same vein snakes were attracted to the zone to bask.
2. Birds such as the weaver have the drive to weave their nest around gas flare stack as the heat enhances hatchability of their eggs.
3. In the course of my research on the wildlife and biodiversity of the Niger Delta, I recorded the occurrence of one endangered mammalian species, namely the Flying squirrel, *Idiurus sp* in Arayah, Delta State. I also recorded the occurrence of rare lizards, namely *Mochlusfernandi* in Brass, Bayelsa State; and in Bonny, Rivers State in 2008. Interestingly, also I spotted the presence of the rare Green Gecko, *Lygodactylusconrauii* in Shell Residential Area, Port Harcourt in 2011 and in Tabaa in Khana LGA of Rivers State in 2016.
4. During my decades of work in Bayelsa State, I observed that the Oil palm trees, *Elaeisguineensis* in the hydric environment of Yenagoa, grew much taller and lankier than those of Rivers State. While the average height and thickness of the Yenagoa oil palm was 20.4 m and 28.8cm respectively, those of Rivers State had average height and breadth of 14m and 35cm respectively.
5. My work also created the awareness that virtually all the forest reserves established since 1975 is increasingly being dereserved, by the landlord communities, in the Niger Delta as government after government has shown apathy to establishing their presence in the reserves. Consequently, my work has severally highlighted the need for creation of the NIGER DELTA NATIONAL PARK and ANDONI FOREST RESERVE to protect the diminishing wildlife population in the fragile ecosystem.



- **Imposing closure-** Periodic restriction of fishing in some swamps and streams.
- **Prohibition of trade on ( or taking) totemic species as bushmeat.** Most of the totem species are covered in the work of Powell, (1995) as well as Akani and Luiselli (2002). Among the totemic animals of some Niger Delta communities are pythons, crocodiles, Nile monitor, tortoise, snail, etc

### **Implication Of Apathy Towards Biodiversity Conservation**

Vice Chancellor, Sir, my studies have also revealed that apathy towards biodiversity conservation would have negative consequences in due course, as :

1. It may lead to future generation importing a lot of wood for their construction project.
2. It will lead to scarcity of finfish and shell fish and their importation.
3. Common indigenous Non-timber products such as canes, ropes, waxes, nuts, snails, forest vegetables, tannins, spices, and industrial raw materials and recipes for pharmaceuticals and cosmetics may become rare and thereby affecting productivity in most sectors.
4. Businesses and industries supported by availability of some forest and marine biodiversity will fold up, if the conservation of these resources fail.
5. Improper or planless land use whereby we continue to build roads and other infrastructure on fertile soil may lead to painful scarcity of arable land. Then the big question is...WILL FUTURE GENERATIONS FARM ON CONCRETE? All these will be the outcome of unsustainability, which calls for judicious land use.

### **Economic impacts**

A major economic impact precipitated by exotic species is the widespread damage done by rapidly invading and taking over an area and displacing economically profitable native species. Moreover, it can cost any responsible government or organization a lot of money to research into and eradicate this pestering species and restore indigenous species.

Besides, an exotic species, according to Bhaskar and Pederson (2010), may cause economic damage by (i) hybridizing with valuable species and producing worthless crossbreeds (ii) carrying or supporting harmful pests, and (iii) constituting nuisance and reducing the aesthetic quality and recreational prospects in an area. (iv) Hybridization, with time may lead to loss or extinction of the pure breed. Apart from importing diseases that affect related species, they may be poisonous, serve as vectors of human diseases that have social and human consequences, which may involve a lot of cost to eradicate.

Furthermore, invasive species may also breed with native species, resulting in potentially dangerous or poisonous hybrids which humans may inadvertently consume. Again, cures and preventions of the health problem may be very expensive.

### **Examples of exotic species**

There are several note-able examples of exotic species worldwide. Among them is the Eurasian Zebra mussel, *Dreissenapolyomorpha* (Pallas), introduced from Europe into the Great lakes, when a ship discharged its ballast water into one of the lakes, in the mid-80s. Favored by the environment, the mussel, has now spread throughout most freshwaters of the northeastern and Midwestern United States, including the Mississippi and Hudson Rivers. The mussel now constitutes a nuisance in some places as it clogs intake valves for pumping stations, power plants, and industrial facilities, and cause obstructions in boating and sports fishing. Moreover, it has caused declines of some native freshwater species thereby upsetting local ecosystems.

Through ballast water also an American comb jelly, *Mnemiopsis leidyi*, was transported from New England to the Black and Azov Seas in Europe, where its population exploded and preyed so heavily on plankton that the plankton biomass declined abruptly by as much as 90%. This ugly development affected the anchovies which feed on them. Thus, there followed a sharp decline in the anchovies, causing the local fisheries to suffer.

Pough et al (2001) report that in 1872, mongooses were introduced to Jamaica (West Indies) from India to kill rat populations pestering the sugarcane plantations. The mongooses which were diurnal and unspecialized to deal with the nocturnal rats, switched over its predation heavily on reptiles and birds. The result was a drastic reduction of several lizard species, including the iguanid, *Cycuracollei* and the colubrid snake *Alsophisater*.

The Nypa palm, *Nypa fruticans*, native of southeast Asia, is another exotic plant of Nigeria. Its seeds were introduced into Calabar from Singapore in 1906 (Keay et al, 1964) during the colonial era. It was specifically planted along the Idua Oron beach in 1912 to check erosion of the beach by tidal waves of the Atlantic ocean through the Cross River estuary (NCF, 2000a; Udofia and Udo, 2005). Favored by the environment, the plant has become invasive and has spread to other coastal towns of the country upto Ondo and Lagos states in the west. Nipa palm flourishes in soft mud and slow-moving tidal and river waters that bring in nutrients. Hence, it forms dense colonies on estuarine or brackish mud, as seen in Khono Waterside and Opobo channel, Andoni and around Kidney Island, Port Harcourt, all in Rivers State. Its rapid spread is attributed to the prostrate underground stem (NCF, 2000b) that ramifies in any mangrove mud it establishes. Only the feathery leaves and flower stalk grow upwards, usually up to 9m high, and the shade provided, coupled with the ramifying stem, suppress the growth of other mangrove plants. Nipa palm in the Niger Delta is disliked and seen to constitute a menace because of its adverse ecological impacts on waterways and marine lives. Its spread has blocked

- Fishing with poisonous chemicals / herbs
- Demand for endangered species parts for spiritual healing by native doctors (eg. demand for lion teeth and hair, eagle feather, vulture egg, etc) (Tunde, 2017)
- Use of endangered species parts (skin, horns, skulls, etc) for decoration of wrestlers, palaces, shrines, etc.
- Overharvesting of medicinal plants (or their parts) instead of planting more of them.
- Keeping of endangered species like monkeys, crocodiles, tortoise, Otter, parrot, eagle, etc as pets.
- Sand mining

Sand mining is a lucrative business in communities around rivers and creeks of these states, driven by the great demand by builders and construction companies. On regular basis, several tippers arrive at the shoreline to load the sand. It is evidentially clear in communities around Orashi, R, Nun R., Forcados R, Otamiri R., Imo R, and Qua Iboe R. In these river systems, sand mining not only disrupts the habitat, but smoothers the benthic organisms as the river beds are scooped, interferes with spawning sites and alters the migration pattern of fishes.

### **Ethical practices in rural communities that promote biodiversity conservation**

Vice chancellor Sir, in the course of my decades of field research in the Niger Delta, I also identified some positive cultural practices that tend to enhance biodiversity conservation in the area under survey:

These include;

- **Sacred grooves** – small chunks of forest where shrines are located. Because of limited access to people, most animals that have lost their habitat find refuge in these grooves.
- **Control of exploitation** of certain tree products (e.g *Irvingagabonensis*, Iroko, *Miliciaexelca* and Iron wood, *Lophira alata* in Abua –Odua, etc).



**Plate 22:** A hunting troop of seven, with their game - an antelope, recorded in Rivers State

### Traditional Practices

From our interactions with communities we observed a number of traditional practices that contribute to biodiversity loss.

- Annual hunting ceremony by youth as proof of maturity. A typical case in point is in Agba Ndele (Ikwerre LGA of Rivers State). On a fixed date for the ceremony all youth who think they are mature get into the bush early in the morning to hunt. At the peak of the event in the evening every participant comes to the arena to display his bounties at the ceremonial arena. Unlucky ones would not show up (because of shame) but wait till the following season. The implication of the failure is that he will always be silenced by his peer in social gatherings, as he could not maneuver even a rat. Such cultural practice tells much on the wildlife of the place, as many animals are caught that day, because of the competition. Among the cultural practices that hasten biodiversity loss in these state also include:
- Honouring hunters of endangered / charismatic species with titles.

waterways and therefore hinders navigation of small channels which hitherto, were used for fish-trapping and periwinkle picking canoes (Udofia and Udo, 2005; Ecolink, 2002). It is rapidly displacing the slow-growing but more useful and cherished *Rhizophora* and *Avicennia* spp which provide the creek dwellers good fuelwood for smoking their fish, termite-resistant hardwood for scaffolding, construction of piers and bridges, poles, source of tannin. Moreover, they are rapidly loosing the suitable mangrove environment that offers good sites for rice cultivation as well as nurseries and breeding grounds for fish, crustaceans, oysters and clams (Owonubi *etal* 2001; Etukudo 2001; Udofia and Udo, 2005), In its provenance, South east Asia, Nipa leaves are traditionally used for thatching, while the sap is useful for production of alcoholic drink, sugar, sweet, syrup, as well as vinegar, The young seed is eaten raw, and the plant parts are used in traditional medicine.

However, Udofia and Udo, (2005) investigating the indigenous use of Nipa palm, found that in parts of Akwa Ibom State the Nypa palm has recently been locally utilized for the manufacture of a number of items, namely – roofing mats, broom, hat, basketry, bags and dye (Ukpong, 2014).

The Water hyacinth, *Eichhornia crassipes* (Mart.) Solmes - a free floating aquatic weed - is another example of invasive species in Nigeria. The floating macrophyte is a bulbous plant of the lily family: Pontederiaceae, was originally native of the Amazon River Basin and in recent times has spread to more than 50 countries in five continents. Water hyacinth has been reported in water bodies of several West African countries including Ghana, Benin, Togo, Cote d'voire, Cameroon and Nigeria. Akinyemiju and Imevbore (1990) reported that the weed entered Nigeria's lagoon system in 1984, and its incursion into Nigerian coastal waters has been traced to the Porto Novo creek in Benin Republic through which it gained entry into Badagry Creek in Nigeria which connects the two neighboring countries (Akinyemiji, 1987; Epelle and Farri, 1993). Ever since, the weed has invaded nearly all water bodies in the southern part of the



low salinity lagoons in Lagos State to freshwater streams and creeks along the coastal areas of Ogun, Ondo, Edo, Delta, Bayelsa, Rivers, Akwa Ibom and Cross River States. It is estimated that the weed has invaded over 60% Nigeria's fresh and brackish coastal waters (Epelle and Farri, 1993).

The sporadic spread of this weed in Nigeria has been attributed to a number of factors: (i) the intricate interconnectivity of our creeks and streams, driven by tidal current, wind, etc (ii) dispersal by rivercrafts, timber and fishing activities. (iii) its excellent buoyancy (as both roots and shoots are filled with numerous air spaces) which facilitates its transportation (iv) It is highly adaptable to both brackish and freshwater habitats (v) It has an unusual reproductive vigor ; being able to reproduce both sexually and vegetatively, and more of the latter ; a single plant under ideal conditions can reproduce 3,000 others in 50 days and also cover an area of 600m<sup>2</sup> in a year (vi) the maximum fruiting environment of 90% humidity and 22.5 – 35oC (Gopal,1987) required by the weed is met in Nigeria (vii) Nutrient –rich water in which the roots float.

Dense mats of *Eichhornia crassipes* constitute a menace in various waterways; they have been observed to hinder navigation, fishing activities of the artisanal fisheries sector and alter the ecological balance of affected areas (Balogun *etal*, 1997). Such clusters are unsightly and thereby reduce the aesthetic and recreational values of the rivers and negatively impact on the socio-economic activities of communities around as it interferes with the use of waterways for transportation, washing, swimming, food fermentation, etc. Mats of water hyacinth are capable of causing accidents when their stolons hook on the propeller of a racing speed boat. They also interfere with irrigation by greatly reducing flow rate of water to irrigation equipment, thereby increasing pumping times and costs. As the flow rate gets to zero, the water becomes a fertile ground for mosquitoes.

There have been several efforts geared towards the control and management of water hyacinth.

extinction. The extinction of an apex predator (a predator at the top of a food chain) can result in catastrophic consequences for ecosystems. In these states, four types of hunting/trapping were observed to be prevalent, namely (i) troop hunting, (ii) Wire snare and drift fence trap (WNDF) (iii), snap trap. (iv) Others are occasional use of subterranean trap and machet blows. Of these methods troop hunting and WNDF methods record higher success than other methods (See plate 5). They are therefore the most devastating cropping method for wildlife of the area.



**Plate 21:** A Wire Snare and Drift Fence trap (WSDF) commonly used by trappers in the Niger Delta



crabs and shrimps gain entry into these containers and get killed in the toxic content. Abandoned or lost plastic nets continue to trap fish and even sea turtles at the coastal fringes.

The oil and gas sector, overtime, has created unlined saver - pits into which miscellany of toxic wastes namely – drill, cuttings, cement slurry/dust, condemned pipes, and filters are dumped throughout the delta. These pits are open, and result in the direct mortality of thousands of insects, anurans and birds that venture into them annually. Sometimes these pits overflow occasionally during the rainy season and the toxic wastes spread through the wetlands, destroying biodiversity, *en masse*.

### 3.7 Urban Development

In the past decade, the Niger Delta States have had amazing crave for urban development to accommodate many rural to city migrants, tourists and job-seekers in oil and gas industry. Consequently, there are today several social amenities and infrastructure all over the states such as roads, stadia, airport, housing estates, University campuses, Army barracks, etc which have gulped large expanse of forest and wildlife habitats, and in some places they have caused habitat fragmentation and its attendant problems to ecosystem functioning. This is particularly the case in Bayelsa, Rivers State, and Akwa Ibom where there is a lot of wetland reclamation.

### 3.8 Over hunting and trapping

Hunting for bushmeat is a major source of wildlife loss in the coastal states of Delta, Bayelsa, Rivers and Akwa Ibom. The hunters include amateur teenagers while adolescents and adults constitute the professional hunters group. There are designated bushmeat markets where consumers buy the fresh and dried forms. Among the markets are Omagwa, Obigbo market and Akabuka in Rivers State; Swali market in Yenagoa, Bayelsa State, and Adeje, Mosoga and Ologbo market in Delta State; and Uyo and Itu-bridge markets in Akwa Ibom State. Along the highways of Ikot Abasi – Eket are also a good number of bushmeat markets that regularly provide meat to highway restaurants and bars. The indiscriminate hunting of wildlife (both in forest reserves and non-protected areas) irrespective of their size for profit, increase the risk of

Useful aspects of water hyacinth (National Academy of Sciences, NAS, 1987)

- ❖ Wastewater treatment
- ❖ In the Philippines water hyacinth petioles (leaf stalks) are dried and woven into baskets and purses. The dried petioles make tough, resilient products that are soft to the touch.
- ❖ In Indonesia, water hyacinth is harvested for feeding pigs. One animal may consume about 1.5-2kg of fresh plants per day (NAS,1987)
- ❖ An aquatic weed's composition nonetheless mirrors the chemical composition of its waterway (NAS, 1987) and Water hyacinth at the downstream of a river or stream can be used as an indicator to detect discharge of toxic substances into the water.

The Pineapple, *Ananascomosus*, one of the sweetest fruits cherished by many, is also exotic. It is reported to have originated in the Verdont lowlands of Paraguay, South America. It was conveyed aboard the 15th and 16th century trade ships, and now flourishes as far away as Mexico, Australia, Nigeria, China, and India. Christopher Columbus is said to have brought pineapple home from his travels in the “New World” and they soon became gourmet delight savored across Europe <http://www.doleplantation.com>. It is particularly favored in well illuminated lowland areas with at least 1100mm of rain, well drained sandy loam soil, having high organic matter, with a pH of 4.5.

The **Whistling** pine, *Casuarina equisetifolia* (=littoralis), commonly planted as ornamental tree or avenue plant around streets, homes and school premises is exotic in Nigeria and other tropical countries. It is native of Australia and has become invasive in southern Florida, Hawaiian islands and Bermuda, where it grows both on the seashore in dry salty, calcareous soils. The wood is used for shingles, fencing and is known to make hot-burning fuelwood. The plant is quite tolerant of windswept

locations, and as wind rushes between the slender leaves and twigs the plants produce a thrilling wispy or whistling sound, hence the name.

The Siam weed, *Chromolaenaodorata* (L.) KingandRobinson. This weed is widespread in West Africa. In some parts of Nigeria it is locally known as "Awolowo weed". It is another good example of exotic species.

**Endemic species** – refer to species that are restricted to a particular geographic region. Because the species is adequately adapted to the environmental conditions there, survival in other places is difficult. E.g the kangaroo, monotremes, of Australia and New Zealand, Anambra Waxbill (a bird), Pigmy hippo of Liberia and Niger Delta, and the Sclater guenon of Niger Delta, the Indian Elephant, etc

**Foot-print impacted species.** This refers to species whose populations are primarily threatened because of unsustainable or unbridled exploitation e.g. through hunting, logging, fishing and other land-use activities. Table...shows the list of some well known foot-print impacted species, worldwide.

**List of foot-print impacted species.**

- ❖ African Teak (*Tectonagrandis*)
- ❖ Alaskan Pollock
- ❖ Albatross – Southern Ocean
- ❖ Antelope – Saiga
- ❖ Antelope – Tibetan
- ❖ Argali (Wild sheep)
- ❖ Cacti (A succulent plant of warm deserts)
- ❖ Cichlids - East African
- ❖ Cod
- ❖ Coral
- ❖ Cork Oak
- ❖ Ginseng
- ❖ Humphead wrasse



Plate 19. A sample of freshwater fishes caught in R.Nun, in Bayelsa Freshwater zone



Plate 20: *Heterotis niloticus*, known in the freshwater zone is getting depleted due to overfishing

### 3.6 Improper waste disposal

Large volumes of municipal wastes have built up very high of the Niger Delta states as great number of people fluck in these oil- producing zones. Both domestic and industrial sewage are usually not pretreated before discharging them into the aquatic environment. Here they cause objectionable odour, oxygen depletion, and mass kill of aquatic lives, after causing eutrophication of the water. Solid wastes such paper, plastics, wood, cans, etc are transported into the rivers and streams by runoff and gutter water. Some of the containers have remnants of pharmaceuticals, cosmetics, and poisonous chemicals. Fish, mollusca,

### 3.4 Gathering of Non-Timber Forest products (NTFPs)

The Niger Delta forests provide a wide variety of non-timber products (for medicine, food, industrial raw materials, etc) which invariably attract the rural communities to gather them both for subsistence and/or commercial reasons. Among them are snails, forest vegetables, ropes, honey, wax, resin, oil, nuts, cane, chewing stick, venier, poles, bamboos, etc (NDES,1998) and there is always open access allowing great thoroughfare. Among the varieties of NTFPs of great economic uses are the African giant snail, *Archachatina archachatina*, *A. maginata*, the canes- *Calamus deeratus* and *Lacosperma secundiflorum*,-thechewing stick, *Garcinia manii*, Indian Bamboo, *Bambusa vulgaris* and food wrapping leaves such as *Thaumatococcus danielli* which also produces fruits that are sweeter than sugar (Amoru, 2015). The current economic downturn and inflationary trends have led to excessive harvesting of non-timber forest products, to the extent that some species such as *Hymenocardiaacida*, *Kigelia africana* (African sausage tree) and *Cassia nigricans* are threatened.

### 3.5 Overfishing.

Fishing is another important economic base of the Niger Delta coastal states. Virtually every dweller resident near the sea, rivers streams and lakes fish either for subsistence or for commercial purpose. There is no control over the type of gears used or fishing effort. Thus, the aquatic systems are grossly overfished, because of the high frequency of fishing in the same water, with net of small mesh sizes. With such practice both the gravid females and fries are caught, and the juveniles are not returned to the river, irrespective of their size. In some localities they depend on imported "Iced fish" to prepare their dishes, even when the rivers are under their nose. Large scale artisanal fishing without control in the coastal states of the Niger Delta has culminated in great loss of fish species previously known in the area. Plates 3 and 4 show some common fishes caught in the freshwater zone of Bayelsa, Delta and Rivers States.

- ❖ Korean Cedar Pine
- ❖ Mahogany –Bigleaf
- ❖ Paddle fish
- ❖ Ramin
- ❖ Salmon European & Pacific
- ❖ Sharks - pelagic
- ❖ Sharks – Coral reef
- ❖ Sturgeon
- ❖ Swordfish & other billfish
- ❖ Tortoises & Freshwater turtles (terrapins) – Asian
- ❖ Tuna

### Keystone species

Scientists understand that living communities of plants and animals depend keenly on one another for survival. Plants provide essential nutrients and energy to browsing and grazing animals and, ultimately, to the carnivores that feed on these herbivores. When plants and animals die, fungi, microbes and other organisms mine the nutrients from the dead tissues and return these chemicals to the soil. Newly enriched, the soil is ready to support yet another generation of plants and animals. As vital as these connections are, they are not the only ties that link animals and plants together. Plants and animals interrelate on many levels and in almost infinite ways. Various plant species, for example, rely on animals—insects, bats, rodents or others—to carry pollen and fertilize seeds. And, various animals count on plants for shelter—branches for nesting sites or tall grasses to hide from predators or ambush prey. By the same token, roots hold soils steady against erosion, keeping silt out of streams and water clean for fish and other organisms. And, so it goes. All living things are connected, and maintaining these connections promotes the health of species, populations, communities, habitats and ecosystems.



Within a habitat, each species connects to and depends on other species, and each species contributes to the overall integrity of the habitat. But, while each species contributes to habitat functioning, some species apparently do more than others in the overall scheme of things. Some species provide essential services that are also unique. Without the work of these key species, the habitat changes significantly. Scientists call these pivotal players keystone species. When a keystone species disappears from its habitat, that habitat changes dramatically. The keystone's disappearance triggers the loss of other resident species, and the intricate connections among the remaining residents begin to unravel. In a "domino effect," species losses cascade through the habitat, as the loss of one species prompts the loss of still others. As resident species vanish, other species move in or become more abundant. The altered mix of species changes the habitat's appearance and character. The "new" habitat looks different from the original one, and it houses a new mix of plants and animals. Often, the new habitat supports fewer species and works less efficiently than the original one: nutrients and energy turn over more slowly and less efficiently, biological diversity dwindles and the landscape begins to change.

## CONSERVATION STATUS OF WILDLIFE AND BIODIVERSITY ISSUES OF THE NIGER DELTA REGION

Vice Chancellor, sir, ladies and gentlemen, permit me to bring to focus some conservation issues as it relate to the Niger Delta, where I did extensive research, over the years.

When I began work in the Niger Delta States, I observed that Ecological data on the wildlife and biodiversity of the Niger Delta basin had been few, until the early 1980s. The earliest wildlife reports were on some terrestrial form of the northerly lowland forest and freshwater areas such as Sapele, Benin, Asaba, Owerri, Aba, and Port Harcourt, where the earlier, visiting and resident naturalists were based (Heslops, 1935a, 1935b; Cozens and Merchant, 1951, Romer, 1953). In his elaborate studies of Rhacophorids (tree frogs) of west Africa, Schioltz (1969) discussed specimens collected in the Niger Delta. Dunger's

markets. These trees are usually felled towards by late dry season and stacked near the river banks. By wet season, the dry floating logs are pooled (aided by water current) in great chains to the market. The diversity of trees logged in these states are recorded in earlier works (Werre 1990; Keay 1999; Etukudo 2003; Ubom, 2010,).



**Plate 18:** Stacked logs being transported via the waterways to cities like Port Harcourt and Lagos, where they are highly priced.

After Yann Arthus Bertrand ([www.gettyimages.pt/fotos/timber-raft](http://www.gettyimages.pt/fotos/timber-raft))  
Date of retrieval – 6<sup>th</sup> Nov.,2017

### 3.3 Fuelwood gathering

The majority of the rural-poor categories in the Niger Delta states depend exclusively on fuelwood to cook. With a higher population that the higher class the annual fuel-wood extraction is very high. Sometimes the fuel wood is collected to eke a living. In the Mangrove zone communities such as Burutu, Warri, Nembe, Kula, Okrika, etc., the mangroves are cut mainly for cooking and smoking fish. The red and white mangroves are also extracted for other purposes namely; in the construction of piers, buildings, canoes, paddles, and cooking utensils and also as a source of tannin.





**Plate 17:** A typical case of Bush burning in the Niger delta prior to farming.

### 3.2 Unbridled logging.

The uncontrolled logging in the Niger Delta states is contributing enormously to deforestation due to the slash and burn method of farming. Many forests have lost their 2 or 3-layer stratification due to this unwholesome practice. The twilight condition even at midday characteristic of the forests are virtually gone, and more sunlight is admitted into the forest, to the disadvantage of shade-loving organisms. Most times as the trees are felled many young saplings are killed as the logs fall on them, leading to further loss; and it takes many many years for a timber-producing species to produce timber. The high-pitch sound generated by the sawing machines scare wildlife and keeping them jittery for a long time. Where the noise becomes persistent they are compelled to migrate, sometimes to alien habitats in which they are less likely to survive. Because of the incessant logging, tree species for which places like Sapele (in Delta State) Abua and Mbiama in Rivers State were popularly known are now critically endangered. Among them are, *Nauclea diderrichii* (Opepe), *Milicia excelsa* (Iroko), the Mahoganies, Ebony, *Mansonia*, *Triplochiton sceleroxylon* (Obeche), *Terminalia superba* (White Afara) and *Terminalia ivorensis* (Black Afara), *Lophira alata* (Iron wood), and others known in international

preliminary studies of Nigerian lizards and snakes also covered those of the Niger Delta.

Happold's (1987) detailed work on mammals of Nigeria included 20 Niger Delta species, out of 274 recorded throughout the country. Earlier workers, as well as Happold, did not recognize the delta as a fauna unit, but emphasized on the differences in the forest fauna on the western part of the Niger. Current estimates of the possible faunal speciation on the both flanks plus those of the derived savanna, show that the terrestrial vertebrates of the Niger Delta consist of about 119 species; made up of the 38 chiroptera, 33 rodents, 12 primates, 12 Artriodactyla, 9 carnivore, 9 shrew species and few others (NDES, 1998).

Data accruing on Niger Delta wildlife and biodiversity since 1985, revealed the occurrence of endangered monkeys in the upper Delta and the floodplain of the lower Niger (Anadu & Oates 1980, Oates 1989, were 1991; Oates *et al* 1992). Powell (1993) discovered the Red Colobus monkeys, previously unknown in Nigeria and indicated that the population is restricted to parts of southern Ijaw Local Government Area of Bayelsa State. In subsequent surveys, Powell (1993- 1995) working in the eastern and central segments of the Delta identified deficiencies in our knowledge of large mammals and eventually delineated unrecognized faunal zones that characterize the entire region (flood forest, marsh forest, Eastern flank zone). Powell also showed that those zones harbor 15 mammalian species of conservation interest; five of which were new to Nigeria, plus relict populations of chimpanzee, elephants, and hippopotamus known to the indigenes, but overlooked in standard scientific and conservation records. Among the newly reported species within the Niger Delta were – the Sclater guenon, *Cercopethicus sclateri*, Tantalus monkey, *Cercopethicus tantalus*, Cape clawless otter, *Aonyx capensis*, Speckle-throated otter, *Lutra maculicollis*, large spotted genet, *Genetta rubiginosa* and the Egyptian mongoose, *Herpestes ichneumon*. Those entirely new to Nigeria (Powell, 1997) included the Delta Red Colobus, *Procolobus affpennantii*, Pygmy flying squirrel, *Idiurus macrotis*, small green squirrel, *Paraxerus poensis*, Black tree squirrel, *Funisciurus* sp., and the Black-fronted duiker, *Cephalophus nigrifrons*. Powell's (1997) records also highlighted the

four species new to Nigeria, which were restricted to the west of Cross river, namely – Talbot's tree squirrel, *Funiscuiruspyrrhopustalboti*; Crested genet, *Genettacristata*. Long-nosed mongoose, *Xenogalenaso* and the Ogilby's Duiker, *Cephalophusogilbyi*. Considerable information on the wildlife of the Niger Delta have also been presented in the work of Ojonugwa (1986) and some Italian zoologists (Politano, 1985; AA.VV. 1998; and Angelici *et al*, 1998, 1999, 2005) especially on smaller mammals- shrew, bats, and rodents as well as birds along the central axis of the Niger delta.

Werre (1991), reported on the biodiversity and mammals, particularly, primates of the Taylor Creek area. He also has rich data on the ecology and conservation of the Niger Delta Red Colobus, vis-à-vis the socio-economic and oil exploration related activities in 18 communities in the marsh zone of Bayelsa State, where they are restricted. He observed that the Red colobus distribution was limited to only a small triangular area of 2,000km<sup>2</sup>, bordered by the Forcados River in the west, and Sagbama, Osiana and Apoi creek in the east, while the triangle is closed by the mangrove zone boundary and Ogbotobo coastal barrier island, which limits the monkey to the south. His report shows that in NAOC OML 60, 61, 62 and 63 areas the monkey co-exists in the forest with 11 primates, 10 rodents, 9 carnivora, 1 sirenia, 1 hyracoidea and 6 artiodactyla species. Unfortunately, these species are under threat due to anthropogenic activities- logging, fishing and farming, with the first being the overriding factor.

A more elaborate and holistic study of Niger Delta wildlife and biodiversity was conducted by NDES (1998). The commission observed that a considerable number of the region's wildlife have been classified as threatened globally (IUCN 1994/1996 Red list) or nationally endangered (Act 11 of 1985). Among them are 7 primates, 4 carnivores (the Leopard, *Pantherapardus*, Cape clawless otter, *Aonyxcapensis*, speckle-throated otter, *Lutramaculicollis*, and the crested Genet, *Genettacristata*) and two cetaceans, namely- The Atlantic Humpbacked Dolphin, *Souseteuszii* and Manatee, *Trichaechus senegalensis*. Others are the African Elephant, *Loxodontaafricana*, various antelopes, Pangolins, (*Manis* spp) and large reptiles such as Crocodiles, Nile monitor and sea turtles.

of industrial and domestic wastes and vehicular rides on coastal beaches.

The oil and gas industry on the other hand undermine biodiversity at various phases of the oil prospecting through seismic operation, exploration drilling, flowstation development, gas flaring, pipe-line construction and operation,, etc. and should collaborate with the host communities to make conservation efforts effective.

### **Anthropogenic Activities That Threaten Biodiversity Conservation In The Coastal Niger Delta States** Akani et al (2014)

In this section we assessed the human activities in the states that compromise biodiversity conservation. This range from individual habits, cultural ventures, to non-oil industrial activities.

#### **3.1 Slash-and-burn method of preparing farmlands.**

In the rural Niger Delta communities farming is a major economic base of most families. Annually, several hectares of riparian forests, secondary forests, bush fallows, are slashed and burnt in preparation for farming. With the soaring human population and hardship, more farmlands are cultivated to feed their families, this thereby impact significantly on biodiversity of the states. The bush burning destroys a lot of ground-dwelling and burrowing animals including snails, earthworm, insects, millipedes, skinks, lizards, rats, etc, while the very motile forms are scared away to a strange habitat, where they may not survive. During the slashing phase of the land preparation, most arboreal animals like birds, monkeys, genets, snakes, squirrels, chameleons, etc are also displaced from their habitats. In effect, there is complete destabilization of the ecosystem, with the massive loss of biodiversity to the slashing and burning of forest and usually just a few species of crops is cultivated, compared to the number of wild plants destroyed.

## Conclusion

The study reveals that mainstreaming biodiversity in government and O & G operations / policy and decisions has become necessary considering the multiple pressures on biodiversity of these states. Biodiversity conservation could be strengthened by collaboration of both government, the oil concessionaires and communities. There should be accelerated and concerted effort to train enthusiasts and increase biodiversity conservation awareness. In virtually all the states, biodiversity activities are low and research in biodiversity is abysmal due to lack of fund and research facilities. There is also scarcity of professionals in various aspects of biodiversity studies: of particular note is the lack of taxonomists, wildlife ecologists, invertebrate biologists, parasitologists, entomologists, algologists, herpetologists, ornithologists, mammalogists, ecotoxicologists, geneticists, molecular biologists, and mycologists, who are indispensable in determining accurately the species richness and diversity of a given community.

In most departments and ministries vital equipment for biodiversity assessment work are poorly supplied or lacking, consequently they frequently depend on consultants to accomplish most tasks which they should do themselves. There are no laboratories in these ministries and working equipment / apparatus like camera trapper, binoculars, mist net, ekman grab, secchi disc, echo-sounder, GPS, plankton net, water quality analysis kit, air quality analysis kit, soil auger, etc are often lacking. You cannot tie someone hands and legs and expect him to run fast. They should be properly equipped and motivated to function.

The investigation observed that several unbridled traditional practices contribute to undermine Biodiversity Conservation in the Niger Delta, which government should address. Among them are: overfishing, logging, fuelwood gathering, troop hunting, use of wire nooze and Drift-fence traps, bush burning hunting, giving titles to hunters of iconic / endangered species such as elephants, lion, chimpanzees, gorilla, etc. Other biodiversity depressant practices are; washing of motor vehicles and bikes on the shores of rivers and streams, which introduce fuel and grease into habitats of amphibians and fish, burrow-pit excavation for (road) construction, sand mining, improper disposal

The Niger Delta is also known to harbor one of Nigeria's two endemic and endangered birds, the Anambra Waxbill, *Estrildapoliopareia* recorded at Asaba and Forcados areas. Various EIA studies have recorded as common, birds like hawks, kites, pied crow, Allied hornbill, vultures, egrets, swifts, kingfishers, weavers, sunbirds, etc (AA.VV 1997, 1998; CORDEC,1994). Elgood *et al* (1994) observed that movements of European migrants along the Niger Delta coast are poorly known, as are some freshwater swamp forest species group like Rails and Ibises. (NDES, 1998) report that the region as important for the parrot and eagles (*Palmnut* vulture) feathers and illicit trade in life parrot is rampant. In some localities, some birds particularly the Hammerkop, *Scopusumbretta*, the Hooded vulture, *Necrosyrtesmonachus*, the Red-eyed Dove, *Streptopeliasemitorquata*, the Pied kingfisher, *Cerylerudis*, the Blue plantain eater, *Corytheolacristata*, and the Senegal coucal, *Centropussenegalensis* receive traditional protection as totems.

On invertebrate wildlife, it is also known that Powell in the early 1980s worked extensively on the shrimps of the Niger Delta, during which he discovered seven crustaceans new to science. These included three shrimps, *Desmocaribislineata* (Powell, 1977); *Euryrynchinaedingtonae* (Powell, 1976) and *Potamapheopspylorus* (Powell, 1979); two crabs, namely *Telmatothrixpowelli* (Manning & Holthius 1981) and *Acheauspowelli* (Manning, 1982); and two Isopods (*Metastenaselluspowelli* (Magniez, 1979) and *Munnapowelli* (Kensley, 1986)).

Several studies since the 1960s to the present (NEDECO, 1961; NDES 1998) point to the fact the Niger Delta, being a biodiversity hotspot, has an amazing wealth of biodiversity (like the Amazon which separated from it during the pre-historic continental drift). There are myriads of habitats and microhabitats associated with the region, such as primary rainforests, secondary forests, riparian forests, bush fallows, oil palm bush, farmlands, derived savanna, ponds, streams, rivers, brackish water, marine or oceanic water, etc as well as ecotones between these habitats. Each of the habitats has its characteristics flora and fauna, and environmental conditions.



## THE ROLE OF CITES

Vice Chancellor sir, permit to deliberate a bit on CITES as discussion on wildlife and biodiversity conservation will be incomplete without mention of the role of this important organization. CITES is the Convention on International Trade in Endangered Species of Wild Animals and Plants – an international agreement or treaty signed on March 3 1973 to regulate trade on critically endangered species of plants and animals, their parts, and products made from them. The convention which came into force on July 1, 1975 has been endorsed by 135 member nations, including Nigeria.

In its Article VII, CITES specifically provides for the promulgation of national legislations to enforce the provisions of the convention. This treaty prompted the passing of Nigeria's endangered species Decree (ESD) (No. 11 of April 20, 1985). The decree, which is today known as Act 11 of 1985, is the legal instrument of CITES in Nigeria. The Act has two schedules:

Schedule I – has a list of animal species threatened with extinction, which are absolutely prohibited from hunting, capture, trading or handling.

Schedule II – includes a list of animals which are not necessarily threatened with extinction, but may become so in no distant time, if trade on them is not controlled. It stipulates that no person shall hunt, capture, trade in or otherwise deal with an animal species belonging to Schedule II, unless he is in possession of a license issued under this act and complies with the following provisions:

- ❖ He has obtained an export permit granted by the Minister.
- ❖ The Minister is satisfied that such export will not be detrimental to the survival of the animal in question.
- ❖ The Minister is satisfied that; where the species is to be exported alive, it will be so prepared and transported as to minimize the risk of injury, damage to health, cruel treatment or death of the animal.

and automated equipment for water analysis are often lacking. Project vehicles are too few, and often lack maintenance.

There is consensus of opinion in all the states that the fund allocated for biodiversity research is grossly inadequate. This issue needs to be properly addressed by including it, as part of annual budget for biodiversity mainstreaming to be a reality.

For government to succeed in mainstreaming biodiversity in her policy and plans and in Oil & gas industry, there should be vigorous awareness campaign, poverty alleviation through empowering the youth with alternative livelihood support, that will make them less dependent on the forests and rivers; collaboration with of the communities, and implementation of the environmental and conservation laws to the letter.

Capacity building for mainstreaming biodiversity has been designed to be by lecture-cum- practical for two categories of personnel; (i) Basic training - for Forest guards, rangers, zookeepers, nursery attendants, aquaculture attendants, plant breeders, secondary school leavers, volunteers, and Law enforcement agents , namely the police, Immigration and customs officers. (ii) Advanced training – for graduates, practitioners, etc. Course outline for the categories has been proffered, and relevant textbooks for the advance category are listed.

A total of 25 implementable recommendations has been suggested including establishment of forest reserve near the footprint of any O&G industry and making it mandatory for every local government area in Akwa Ibom, Bayelsa, Delta and River States to establish at least 3 large forest reserves  $\geq 50$  hectares each, and embark on 10 year tree-planting programme, to compensate for the rapid depletion of biodiversity observed in these states.



## Ground-truthing

For a better understanding of the biodiversity conservation issues, we had course to do some ground-trotting visits at some sites, such as farmlands, logging sites, hunting sites, bushmeat markets, etc, in some communities, from where photographic documentations were carried out, when necessary.

## Our finding

We observed that the biodiversity of the Niger Delta coastal states is depleting due to multiple pressure from two major sources – anthropogenic factors and Oil & gas industry. The most devastating human factors are over-exploitation of the forests, troop-hunting and use of wire nooze and drift fence trap and overfishing. Others are excessive land take for infrastructural development in the States. The oil and gas sector undermine biodiversity primarily through seismic operation, pipeline construction and oil spills via mechanical failures and pipeline vandalism . The impacts of refineries and LNG are localized.

The Ministry of Environment in the States in conjunction with the Department of Forestry are identified to be capable of mainstreaming biodiversity, but for efficiency, there should be considerable increase in employment of professionals in the diverse areas of biodiversity, coupled with technical staff nursery attendants, unskilled labour for maintenance works.

The agency has the capacity in terms of manpower, to carry out Environmental Impact assessment (EIA) but the method of execution need to be improved. Highly experienced professionals should be posted out as regulators, and not mediocre. It is unethical that most mitigation measures proffered by consultants on biodiversity issues during EIAs are not implemented.

There is gross inadequacy in the material/tools for mainstreaming biodiversity. Consequently, the Ministries of Environment often contract out the job which they ought to do themselves, to consultants or contractors. They lack scientific laboratories; equipment such as camera trapper, mist net, binoculars, altimeters, tents, swamp boogey,

- ❖ The Act further stipulates that any person who contravenes its provisions by trading in, being in possession of, or otherwise deals with, a specimen specified in its control list will be guilty of an offence, and be liable on conviction to a fine, for a first offence, and for a second or subsequent offence, to imprisonment for a specified term, without the option of a fine. And where any person is convicted of an offence under this law, the court may order a forfeiture of the specimen in question, including the upkeep of live specimens at the expense of the convicted person.

## Aims and Activities of CITES

The principal aims of CITES include to:

- (i) Achieve rational and sustainable utilization of earth's living resources for human benefit – conservation of biological resources.
- (ii) Assist countries fulfill the economic potential of properly regulated wildlife trade.
- (iii) Protect over 35,000 species endangered by international trade, through international co-operation, i.e by exerting tight controls on the multi-billion dollar world trade in endangered species.

To achieve these goals CITES relies on a system of permits to regulate trade in wildlife. With its secretariat in Geneva, Switzerland, CITES operates a network with parties in other parts of the world and provides assistance where required, checks the authenticity of permits, and alerts national and international agencies when breaches of the convention seem likely to occur.

At the national level CITES requires each member nation to create two bodies to assist in the implementation of the convention, namely:

- (i) A National Management Authority, charged with the duty of issuing permits (export), import or re-export.
- (ii) A National Scientific Authority – to advise the National Management Authority on species conservation status.

Looking at the Nigerian scenario, the defunct FEPA which today has given way to the Federal Ministry of Environment, played the role of the National Management Authority, while the National Scientific Authority includes – the National Parks Services (NPS), the Ornithological Society of Nigeria, the Nigerian Institute of Oceanography and Marine Research (NIOMR), Forestry Research Institute of Nigeria (FRIN), Nigerian Conservation Foundation (NCF), Departments of Forestry, Federal Ministry of Agriculture, Water Resources and Rural Development.

CITES also provides valuable information on the quantities of different species legally traded each year, who exports them; and who re-exports them. Usually, the permit applications are collected and submitted for processing at the Ministry of Environment. The specimen to be exported are inspected by officials of the Ministry (who are zoologists/ Veterinary medicine practitioners, ecologists, etc). The permit applicant pays a processing fees which is a percentage of the total value of the export; this permit is valid for six months from the date of issuance.

### **WHY WE NEED TO CONSERVE THE TOP PREDATORS (BIG CATS)?**

Vice Chancellor Sir, many laymen have wondered why we bother about conserving dangerous animals like the big cats.

#### **Ecological role**

From ecological standpoint, we understand that every species occupies its own niche performing its own role which other species cannot perform. They are not only iconic but keystone species in ecosystems in which they are found. The big cats as predators at the top tiers of the food web, contribute in ensuring ecological balance in their ecosystem. How? They put the herbivore populations in check, so that the herbivore populations do not soar to levels where the herbs and grasses become insufficient. Overgrazing as we know leads to soil erosion. Thus, by checking the herbivore population, the top predators are checking overpopulation of herbivores and indirectly checking soil

departments, Corporate organizations (O & G) and agencies. The questionnaire (appendix.1) was developed in tandem with the project TOR, and included 20 questions that were either open form (allowing respondents to express their views in their own words), or a combination of open and closed form multiple choice, but with the opportunity to add comments or additional categories.

- (h) Survey questions were aimed at gathering information as to how effective they have been in mainstreaming biodiversity in their business, taking into consideration the strategies, capacity, equipment used, coverage, experts, etc.
- (i) Enough time was given to the respondents to submit their comments the following day. Interview responses were compiled and summarized as relative percentages of types of response for each question.
- (j) University and research institutes, libraries in the four states were assiduously searched for biodiversity data, since from 1990s to the present.
- (k) The area under survey fall into four ecological zones – coastal barrier Is, Mangrove swamp zone freshwater zone and Lowland forest (Powell, 1998). To evaluate sources of biodiversity loss and biodiversity enhancement, oral interviews were conducted with hunters and natives in the rural areas who could communicate well, in the way of Akani (2008), (see appendix1). Similar interviews were extended to bushmeat dealers, herbalists and dealers of fetish materials in the markets. From such exercises we gathered useful data on the hunting techniques, hunting success of each method, as well as the ethnobotany and ethnozoology in the area, which drive biodiversity consumption or utilization. Our investigation also considered how oil and gas operations in these states impact on biodiversity, as to come up with meaningful conclusions and recommendations for biodiversity conservation mainstreaming.

## **Mainstreaming Biodiversity Conservation In Government And Oil & Gas Operations And Policies in the Niger Delta. Akani, G. C. and Darah, G.g. (2018).**

Vice Chancellor Sir,

Between 2017-2018, we under the auspices of UNDP/GEF, we investigated the extent and role of mainstreaming of biodiversity conservation in Government and oil & gas operations in the coastal states of the Niger Delta, namely- Akwa Ibom, Bayelsa, Delta and Rivers State. These coastal states encompass an area of 46,420 km<sup>2</sup> (Okali 2014). The oil and Gas Industry facilities here altogether cover an area of 600 km<sup>2</sup> or 1.3% of the region. The study entailed:

- (a) Identification of the government agencies that have responsibility for mainstreaming biodiversity into the oil and gas production landscape of Niger Delta States of Akwa Ibom, Bayelsa, Delta and Rivers.
- (b) Assessment of the capacity of the responsible agencies to mainstream biodiversity management policies into state government policies and plans.
- (c) Assessment of capacity of the agencies to meet the regulatory and oversight functions with respect to the Niger Delta's oil and gas (O&G) sector.
- (d) Assessment of the Agencies' educational and skill sets of staff in employment, capable of carrying out the tasks of mainstreaming biodiversity into government policies and plans
- (e) Assessment the agencies capacity for undertaking Environmental Impact Assessment (EIA) as it relates to Biodiversity issues in oil and gas sector.
- (f) Assessments of the agencies' capacity in terms of availability of specialized appliances and equipment, specialized tools, implements, vehicles and apparatus.
- (g) In all the four designated Niger Delta coastal states, of Akwa Ibom, Bayelsa, Delta and Rivers (fig 1), structured questionnaires were administered in biodiversity-related ministries,

erosion in a pastureland. As they hunt, they also contribute to dispersal of grass seeds which cling on to their furs. Furthermore,

- (i) The BIG Cats are boosters of wildlife tourism. E.g in countries like Kenya, where wildlife tourism is the mainstay of their economy
- (ii) Biocentric reasons – they are part of creation and deserve the right to survive, irrespective of whether they are harmful or not. Parts of animals have been useful for preparation of drugs e.g. the snake venom. Nobody knows if the antidote for HIV/AIDs will come from dangerous animals, like the BIG CATS.

According to Panthera President and CEO, Fred Launay, the hope for the conservation of Big Cats can only be possible by:

- (i) Increased law enforcement and persecutions for wildlife criminals
- (ii) Crossborder cooperation

## **"ENDANGERED SPECIES OF NIGERIA: HOW CAN WE SAVE THEM ?"**

### **The Role of CITES**

CITES is an international agreement or treaty signed on 3rd March 1973, to regulate trade in critically endangered species of plants and animals, their parts and derivatives / products and any articles made from them. The convention which came into force on July 1, 1975 has been endorsed by over 135 member nations including Nigeria. In its Article VII, CITES specifically provides for the promulgation of national legislation to enforce the provision of the convention. This treaty prompted the passing of Nigeria's Endangered Species (ESD) (No. 11 of April, 1985). Invariably, this decree now known as Act 11 of 1985, is the legal instrument of CITES in Nigeria. The Act has two schedules:

- (a) Schedules I - has a list of animal species threatened with extinction and which are absolutely prohibited from hunting, capture or trading.

(b) Schedule II – includes animals which are not necessarily threatened with extinction, but may become so, if trade on them is not controlled. It stipulates that no person shall hunt, capture, trade in or otherwise deal with an animal species belonging to schedule II, unless he is in possession of a license issued under this Act and complies with the following provisions:

- ❖ He has obtained an export permit granted by the Minister.
- ❖ The Minister is satisfied that such export will not be detrimental to the survival of the animal in question.
- ❖ The Minister is satisfied that where the species is to be exported alive, it will be so prepared and transported as to minimize the risk of injury, damage to health, cruel treatment or death of the animal.

The Act also stipulates that any person who contravenes its provisions by trading in, being in possession of, or otherwise deals with a specimen specified in its control list will be guilty of an offence, and be liable on conviction to a fine, for a first offence, and for a second or subsequent offences to imprisonment for a specified term without the option of a fine.

The Act goes further to explain that where any person is convicted of an offence under this law, the court may order a forfeiture of the specimen in question, including the upkeep of live specimens at the expenses of the convicted person.

Among the strongly prohibited animals and parts in international trade are-

- ❖ Live lizards (e.g. Nile monitors, chameleon)
- ❖ Live snakes
- ❖ Live primates (monkeys, chimpanzees, Gorilla, mangabey, Drill, baboon, etc)
- ❖ Live parrots
- ❖ Lizard skin
- ❖ Crocodile skin

Throughout the period the cane rat, *Thryonomyswinderianus* dominated in all stations, except in Omagwa where the Mongoose, *Corssarchus* sp dominated. Among the very occasional landings in the markets were – Bush pig, Mona monkey, Genets, Civet cats, antelope (*Philatombamaxwelli*,) crocodile, tortoises and python. This rarity was an indicator of their threatened status in the wild. We observed that hunters landed more carcasses in the markets when the moon was out of phase, while the number of landings decreased progressively from full moon to waning moon. Species diversity however varied with the moon phases, while sex ratios were relatively constant at 1:1 for almost of the species. Following Nigerian Endangered species List (Act 11 of 1985) six endangered species were traded in the markets.

**Table 23:** Showing Study Stations and their Coordinates

Location of Bushmeat market	Local Government Area	Coordinate
Chokocho	Etche	4 <sup>0</sup> 59'22"N; 7 <sup>0</sup> 03'15"E
Petrochemical Junction	Eleme	4 <sup>0</sup> 49'44"N; 7 <sup>0</sup> 6'10" E
Imo River Bridge	Oyigbo	4 <sup>0</sup> 52'41"N; 7 <sup>0</sup> 7'42"E
Omagwa	Ikwerre	4.98 <sup>0</sup> N; 6.91 <sup>0</sup> E



gathering/harvesting, handicrafts, are paralyzed, and some whose nets and other gears were soaked with oil have to struggle to clear them of oil or replace them. The oil spill may be so severe to cause some fishers to search and relocate to new fishing ports at great costs. Others who lack the wherewithal to relocate, begin to think of the option of changing their means of livelihood, because there is no catch immediately after a major oil spill, and income dwindle to a sorry state over the years, and frustration sets in. Some who cannot bear the situation may take to alcoholism and drugging as a means of escape from reality. Even a change of their means of livelihood is not easy, because unlike fishing and farming, which they learnt from childhood, a new skill will require training fee, and start off fund. Most times the affected oil company comes up with compensation, but what the people get is next to nothing compared to the plight the oil spill has precipitated in the community.

There are also instances when shrines located along the shorelines are claimed to be desecrated by the oil spill, and the priest/worshippers would demand huge sums of money from the “Polluter company” to enable them relocate the shrines and appease their “gods”. Otherwise, they would record more deaths from the wraths of the Gods.

#### **Effects of Lunar cycle on the abundance and diversity of rainforest wildlife based on carcasses in selected Bushmeat markets of Rivers State, Nigeria. Godfrey C. Akani, and Ebenezer Lekue(2016)**

Investigations into how the moon phases affect the abundance and diversity of wildlife in bushmeat in selected bushmeat markets of Rivers State was conducted between dry and wet season months of 2015 and dry season months of 2016., by taking inventories of carcasses at each visit plus structured questionnaire administered to 50 literate bushmeat dealers in the markets. The sampling protocol was once a week, and before each trip the phase of the moon, the night before was recorded. The questionnaire required from the respondents information such as the hunting techniques, season of high hunting success, and provenance of their bounty, and judgement concerning availability of each species in the area. Results revealed the occurrence of 12 mammalian and 4 reptilian species in the markets.

- ❖ Wildcat skins – those of leopard, cheetah, tiger, hyena, civet, etc.
- ❖ Elephant tusks / ivory
- ❖ Rhinoceros horn
- ❖ Tortoise and terrapins
- ❖ Sea turtles
- ❖ Eagle feather

#### **List of Endangered fauna and flora of Nigeria.**

In Nigeria we have a myriad of wild animal species threatened with extinction, and begging for protection, namely – Elephants, Gorilla, chimpanzees, Monkeys, lion, leopard, Cheetah, Zebra, Antelopes, Manatees, Dolphins, Crocodiles, Pythons, Sea turtles, etc. The same is true for such trees as the Iroko (*Milicia excelsa*), Mahogany (*Khayaivorensis* and *Khaya grandifolia*), Sapele wood (*Entandrophragma cylindricum*), Teak (*Tectonagrandis*) and False balsam (*Daniellaoliveri*). Others are Obeche, Ebony, Ironwood, Rain-tree, and Mansoni, etc.

Powell (1998) reported that the Niger Delta contained more species of global concern (12 or more 'Vulnerable' or 'Endangered' on the IUCN Red List) than any part of Nigeria; and it contained all the 3-4 larger mammals more or less endemic to Nigeria (Powell, 1998, Blench 2007).. There is no known 'Red-Listed' bird (but the tiny and little-known Anambra Waxbill could be present). The only Red-Listed reptiles present are the Slender-snouted Crocodile and an undetermined number of marine turtles which nest on beaches.

According to Bruce Powell, the species most in need of conservation attention are, Nigerian or Heslop's Pygmy Hippo - found solely in SPDC (E) area, virtually extinct; the Delta Red Colobus monkey - new to science and occurring in Apoi-Ekeremor area and the relic populations of Chimpanzee, Elephant and Hippopotamus and the Red-tailed or Sclater's guenon - national endemic, between Niger and Cross Rivers (Blench, 2007, Baker 2005).

### What steps do we take to save Nigerian Endangered species?

All the 774 local Government Areas of Nigeria should endeavour to delineate for conservation, at least two or more forest reserves in areas harboring the remaining endangered species. All degraded forest reserves of the Old Rivers State (table 1) (some of which are now in Bayelsa State (e.g. Edumanom, Apoi, Egbedi, Nun R, Taylor Creek, etc) should be revived through vigorous reforestation / revegetation programme. The same applies to all protected areas (Strict Nature Reserves, Forest/ Game reserves) throughout the federation that have been de-reserved by anthropogenic activities – subsistence and commercial farming, illegal grazing, unbridled bushfire, infrastructural development, oil exploration, etc.

- ❖ Andoni Forest Reserve which harbours the remaining forest elephants and hippos in Rivers State, should be given accelerated conservation attention.

**Table 5:** Proposed Forest Reserves of Old Rivers State (before the creation of Bayelsa State in 1996).

Name of Proposed forest Reserve (FR)	Size (sq.km)	Situation/ location	Present State of location
1. Lower Orashi FR	47.67	Abua/Odual and Kalabari	Rivers
2. Upper Orashi FR	89.90	Abua/ Odual	Rivers
3. Sombreiro FR	193.60	Ikwerre / Ahoada	Rivers
4. Otamiri FR	150.44	Ikwerre / Etche	Rivers
5. Upper Imo River FR	115.28	Etche	Rivers
6. Daen or Lower Imo River FR	55.70	Khana	Rivers
7. Taylor Creek FR	218.91	Yenagoa and Ogba/Egbema	Rivers and Bayelsa boundary
8. Nun River FR	97.15	Yenagoa /Oporoma	Bayelsa
9. Ikebiri Creek FR	191.71	Koluama and Oporoma	Bayelsa
10. Apoi Creek FR	64.77	Koluama	Bayelsa
11. Egbedi Creek FR	66.32	Yenagoa/ Oporoma	Bayelsa
12. Edumanom	86.76	Ogbia/Brass	Bayelsa



**Plate 16:** Dead victims of fire outbreak from pipeline vandalism

### Effect of oil Spill on oil-bearing communities of the Niger Delta

Aside from these tragic events that follow oil spill, oil bearing communities are prone to various degrees of hardship, when oil spill occurs. Akani (2008) observed that the Niger Delta region is endowed with a great variety of ecosystem, ranging from marine ecosystem in the south to coastal barrier island, Mangrove swamp, freshwater/flood zone, seasonal freshwater swamps, lakes, streams, gallopy forests, dry secondary forests, etc in the north. In the event of oil spill all the natural resources and ecosystem services provided by them are undermined and because the communities depend on them for continuous sustenance of life, the communities suffer untold misery and begin to seek relief from government and charity organizations.

The pungent smell of the air and thick oil in water deprive the people from cultural use of these ecosystems. Fermentation of food like breadfruit and cassava along the shorelines stops immediately. Collection of water for domestic use and recreational swimming at the waterfronts or jetties are also suspended, as the water become unsightly and repulsive. Children who defile the oil slick, and continue to swim, end up having rashes that cause them a lot of scratching. Economic activities like farming, Palm wine tapping, fishing, shellfish



Plate 14: Youth scooping spilled oil from vandalized pipeline



Plate 15: A lucky/surviving victim of fire from pipeline explosion with high degree of burns.

For effective conservation of these protected areas, government support is key. Adequate government presence should be shown in each place – through building administration blocks for the reserves; research / tourist camps, long trails, and mounting warning signs against poachers and intruders; policing the forest; training and employing native and non-native youth around the area as rangers. Such rangers should be paid well and properly equipped with uniform, boots and forest-guarding gadgets.

- We must fight Wildlife crime; namely (i) poaching (illegal hunting, logging, fuel wood extraction, etc) (ii) trading on endangered species parts- meat, ivory, pelt, horn, hoof,(iii) degradation or fragmentation wildlife habitats, and ensure the enforcement of conservation laws.
- We must stop giving titles to killers or hunters of charismatic species like elephants, lions, leopard, cheetah, gorilla, chimpanzees, monkeys, buffalo, zebra, manatees, crocodile, python, etc Such titles as "Ogbuagu", "Ogbu-nyi", "ebube-dike", empowers the hunters to get more at all cost. etc.
- Conservation societies should be encouraged in secondary schools and taught conservation principles. Such societies should be engaged in annual planting of endangered tree saplings in collaboration with the nearest forestry department.
- Ensure that EIA laws are followed to the letter, to protect endangered species habitats and corridors.
- Ban the trapping of wildlife with wire- snare and- fence trap, as this trap catches over 95% of forest animals readily.
- Establish a functional **Niger Delta National Park** and more forest reserves to protect the vanishing populations of elephants, chimpanzees and Sclater guenon, Red Colobus, Pygmy hippo , manatees, etc., in the Niger Delta region (Powell, 1998; Akani 2008). It is indeed a big lapse that the Niger Delta with its wealth of endangered species,

endemic species, and diverse wildlife habitat and wetland has no National park.

- Establish and fund breeding zoos to encourage the propagation of endangered species.
- Establish Cane rat ("grasscutter") farms to provide the bushmeat often cherished by Nigerians. With this grasscutter breeding, animals in the wild will be let alone to survive (Mensah, 1991).
- Establish rehabilitation Clinic or zoo for orphaned primates, antelopes, and aquatic animals- birds, otter, manatees, sea turtles, dolphins, etc tainted by oil pollution. After rehabilitation in such clinics, the victim is returned back to its habitat type.
- Ensure that trawlers operating in our territorial waters (around Akassa, Brass, Bonny, Andoni, Oron, Calabar .etc, use Turtle Exclusion Devices (TED) to protect sea turtles arriving to our coast to spawn (Fretey 2001; Akani and Luiselli, 2011).
- Ensure regular removal and incineration of wastes along the coasts. Some of the lost fishing nets entangle sea turtle. Sometimes sea turtles mistake floating "pure water bags" for jelly-fish (their food). They get choked by the plastic bag and starve to death.
- Arrest and prosecute fishers killing fish with Gammalin - 20 and other chemicals, as well as fishers who catch and sell fish below table size.
- Arrest and prosecute pipeline vandals who pollute our rivers and creeks with crude oil and petroleum products, thereby killing a great variety of aquatic life.

### Consequences of oil spill from pipeline vandalism

In Nigeria pipeline vandalism precipitates myriads of problems as shown in the reports of environmentalists. These include huge economic losses from pipeline and plant shutdown, environmental pollution, biodiversity losses, fire outbreak usually resulting in loss of lives and properties, increase in emergency cases in nearby hospitals, and psychological trauma on families of dead victims and people whose properties were gutted by fire (Akani, 2008; Udofia, *et al* 2012). ***Figs...***Show a graphic incidence/ site of oil spill in the Niger Delta. Some who are ignorant of the chemistry of petroleum product, see a spill as a windfall, and are attracted, in their numbers, to scoop oil for sale and personal use. Thus, at the slightest spark of fire, many of them are incinerated to death. Survivors with varying degrees of burn may not go to the hospital for fear of arrest, and questions of what happened, by doctors. So they often go for self- medication and patronizing quacks.

Tampering with government properties such as oil pipelines, water pipelines and electricity lines has been promulgated as unlawful since the 1990s. In spite of this prohibition, pipeline vandalism and oil bunkering have remained a lifestyle for hardened criminals. Each time the multinational company affected incurs heavy losses as several barrels of oil are lost. The company is therefore compelled to shut down, to avoid further losses. Disheartening however, the pipe must be clamped, within the shortest possible time, and the environment cleaned of oil by the same company that has lost its oil.

In 2003, the then adviser to the president on Petroleum and Energy, Dr.Rilwanu Lukman, stated that the Nigerian oil industry which accounts for 40% of Gross Domestic Product (GPD) provides 80% of government revenue and 95% of foreign exchange earning, is so sensitive and central to the Nigerian economy, and the pipeline vandalism and illegal bunkering which are now in ascendancy constitute a major economic and social hazard to the country. As at 2003, it was estimated that about 386,000 barrels of crude oil were lost daily to the activities of the vandals.



**(A) Complacent attitudes of some pipeline operators:**

**Aged and exposed pipelines:**

There is extensive network of old pipelines between oilfields, as well as numerous small networks of flowlines, all over the country, especially in the Niger Delta. Most segments of the onshore pipelines are exposed by erosion or laid above the ground, thereby making them available for vandalism. Graphic examples are found in Kolo Creek in Bayelsa, Adibawa in Joinkrama, Ubie, Korokoro-tei and K-Dere in Rivers State and Olomoro flowstation in Delta State. According to Etekpe and Okolo (2010) the management of SPDC had promised in SPDC (1995), *Nigeria Brief* that it had designed programmes to replace and upgrade aging facilities and pipelines, improve the way it operates, maintain facilities and respond much quicker to oil spills as well as work more closely with host communities. But none of these came to pass. It is contended that the multinational oil companies overlook replacement of the old pipelines because of the huge cost involved (Esptein and Selbel, 2002).

**Inadequate checks and patrol on the pipeline routes.**

There is hardly sufficient surveillance of pipelines by the operators. Thus, the miscreants cash in on the lax security. Sometimes the fuel theft goes on for about six months or more, without intervention by patrol or security men.

**Economic status and emotional state of host communities:**

**This include;**

- Poverty, Ignorance, Greed and covetousness
- Unemployment, Neglect of host communities
- Incessant fuel scarcity
- Toothless / ineffective laws : corruption
- Patronage of vandal's stolen products

**Table 6.** List of major conservation legislations of Nigeria

S/N	Legislation
1.	The Forestry Ordinance 1937 (Chapter 75)
2.	The Eastern Region Forest Law 1955
3.	The Forestry Ordinance with Ammendments; Northern Nigeria
4.	The Forestry Law (Eastern States) (Caps.38)
5.	The Forestry Amendment Edict; Western State 1969
6.	The Forestry Amendment Edict; Western State 1973
7.	The Wild Animals Preservation Law (Cap.132)
8.	The Sea Fisheries Decree (Act) 1971
9.	Sea Fisheries Decree 1971
10	Exclusion Economic Zone Decree, 1978
11	The Wild Animals Preservation Law (Western Nigeria) 1959
12	The Wild Animals Law (Northern Nigeria) 1963
13	The Wild Animals Law (Eastern Nigeria) 1965
14	The Wild Animals Laws Preservation Law (Lagos State) 1972
15	The Wild Animals Law Amendment Edict (North-eastern State)1975
16	The Wild Animals Laws Amendment Edict (Kano State) 1978
17	The Kainji Lake National Park Decree 1979
18	The Endangered Species Decree /Act 11, 1985
19	The Natural Resources Conservation Council Decree 1989
20	Natural Resources Conservation Council Act, Cap286, LFN 1990

**CONTRIBUTIONS TO KNOWLEDGE (Akani, G.C (2008)**

**Methods of Studying Wildlife and Biodiversity**

My research engagement on wildlife studies has been mostly to provide a checklist of the wildlife of the Niger Delta (their conservation status inclusive), which before this time, had suffered neglect due to lack of experts in taxonomy (except for Powell 1997, 1998, NDES 1998) and apathy of governments to sponsor such research. In the tropical rainforest of the Niger Delta, sampling wildlife is quite a herculean task as the animals are very secretive, and there is virtually no intervisibility in the forest. Thus, it can take weeks and months to arrive at a comprehensive checklist of wildlife in an area of study. The method of sampling must be correct or the result will not be accepted by any well

meaning journal. Conventional methods used are provided in the work of Sutherland (2002), Davies (2000) Dasmann (1964) and include:

- Visual Encounter Survey (VES) along transects/ footpaths using binoculars, video camera and GPS.
- Use of pit-fall traps with drift fence. (Fig...)
- Use of camera trappers set overnight on trees branches.
- Use of Mist nets for birds and bats.
- Indirect method – using evidence of animal presence, namely; faecal droppings/scats, footprints/tracks, sloughed skin, skeleton, food remains, playground, vocalization/calls, road-kills, etc.
- Morphometric measurement was often done with flexible field tapes and weights of animals were taken with spring balance. In the process the sex of the animal was determined.
- Photographic documentation was done for each animal and its habitat and the animals were released as soon as possible in consonance with the tenets of wildlife conservation.
- Examination of wildlife carcasses in bushmeat markets.
- Interview of hunters/bushmeat dealers in conjunction with wildlife field guides such as Kingdon (1998) and Happold (1987) for mammals; Boomey (2002) for birds; Branch (1988) for reptiles; and Rodel (2012) for amphibians.



**Plate 1.** Pit fall method of trapping forest floor animal.

When oil spill occurs in terrestrial habitats such as a forest, the pungent volatile components of the oil fill the air, and the highly mobile animals like birds, antelopes, monkeys, etc simply avoid the polluted area, for good. Those often trapped by the oil include ; (i) slow-moving species like tortoises, snails, earthworms, millipedes, apterygote insects, (ii) burrowing species – which are overtaken, (iii) crawling species that exhibit cluster distribution such as the Gaboon viper, *Bitis gabonica*, and the Pythons; *Python sebae* and *Python regius*. (iv) species that have narrow home ranges, high site fidelity, or reliance on specific nesting sites. Sometimes the oiled forest is set on fire by natives. This action exacerbates the already disrupted ecosystem, as the case of an Odual forest (Rivers State), and Tebidaba forest (Bayelsa State) in 2008 (*See fig...*). Where both ground and crown fire occur, many animals; cursorial, or arboreal are either killed, or prompted to migrate to safer habitats. With the ecosystem jeopardized, the survivors may be faced with increased intra- and interspecific competition in the new habitat. For example, Luiselli *et al* (2006) reported that a West African black turtle species (*Pelusios niger*) which changed its habitat use consequent upon an oil spill in the Niger Delta, experienced increased competition with a congener (*Pelusioscastaneus*) already resident in the new habitat.

Other ecological effects of such spill include : decrease in availability of preferred diet or prey, thereby compelling them to forage on low quality alternatives. The changes in trophic interactions may reduce growth, survival and reproductive success in some species.

### **Effect of Oil Spill from Pipeline Vandalism on Host Communities**

Pipeline vandalism – is the willful or deliberate act of damaging petroleum pipeline with the sole aim of stealing crude oil and associated petroleum products (Udofia *et al*, 2012). It is an act of sabotage. This criminal act has resulted in fouling of Niger Delta marine and fresh waters with petroleum, culminating in heavy loss of biodiversity. Most environmentalists and activists trace the causes of pipeline vandalism to :

- the degradation by oil spill and other environmental stressors lead to habitat fragmentation and separation of populations.
- Such habitat degradation and fragmentation is capable of altering the sex ratio and age ratio of wildlife species which invariably impact on the recruitment of new individuals into the population, by birth.
- In most cases when oil spill occurs, if flows into the waterway and eventually reaches the intertidal areas, and depending on the topography of the supratidal or backwater mangroves may be less affected than the intertidal mangroves. The oil seeps into the soil, the rate of seepage depends on the textural properties of the soil, abundance of burrows created by fossorial animals like Ocypod crabs, polychaetes, bivalves, etc. Thus, the bulk of the infauna die *en masse*.
- Death of mangrove trees occur slowly; first yellowing of leaves, defoliation, drying of branches and stems, and falling on the ground as logs. As the mangrove logs and stumps decay, juveniles ocypod crabs and tubicolous polychaetes burrow into them to hide, leading to further breakdown of the logs.
- When mangrove roots and stems are oiled, encrusting invertebrate fauna on them such as barnacles, oysters, whelk, *Littorina* sp., bryozoans, etc, are smothered and they die off. Shell fish which hitherto was common within the creeks have grossly been depleted by the incessant oil spillage. This is seriously affecting the local economy as many depend on finfish and shellfish business to eke a living.

### Effects of Oil Spill on Terrestrial Biodiversity

For terrestrial biodiversity the effect of oil spill depends on a number of factors. First, let us consider terrestrial plants. The flora may be affected directly by oil tainting the shoots or the oil permeating the soil, root system to the shoot. Within a short time interval, the leaves turn yellow, red to brown, and defoliation follows, signaling the death of the plants. The magnitude of the effect usually depends on the size of the area affected by the spill and the depth to which the oil permeated the soil.

### Ecological Impacts of Petroleum Industry activities on Wildlife and Biodiversity of the Niger Delta.

#### (a) Effects of Seismic operation on wildlife, biodiversity and host communities Akani, G.C. (2008)

This study took a close look at the exactness of the impact of industry activities from a scientific perspective between 2005 and 2008 and did not rely on overstatement from aggrieved individuals. The study established that the greatest biodiversity loss via oil industry footprints are during (i) seismic activity when several hectares of forest are deforested to create base camp, location road, and seismic lines. The repeated earthquake-like vibrations (of more than 80dB) for several months deafen people, especially the elderly, disturb their sleep and aggravates cardiovascular problems.

#### Impact of onshore seismic exploration

- The seismic lines ramify the entire prospect areas, traversing various habitats - farmlands, orchards, fishing ponds, shorelines, forests, shrines, farm roads, water fronts, recreational grounds, etc to the discomfort of the neighboring communities. Most natives are compelled to avoid the seismic operation sites, which is tantamount to deprivation of their cultural use of their land. The cutting of these seismic shooting lines culminate in biodiversity loss, habitat fragmentation, and disruption of the ecosystem as the seismic workers continue to disturb the ecosystem for several months. The cost of deprivation of cultural use of their farmland, fishing ports, recreational grounds, etc for months could run into several millions of naira per affected community. Peasants in the area convert the seismic lines to access routes to further exploit the forest resources which hitherto were not accessible. Regrowth of seismic lines created in mangrove swamp is known to be very slow.
- The earthquake-like vibration, is usually unnerving and impairs hearing in people especially of elderly people; Interferes with discussion, siesta (afternoon sleep,) and disturbs the reading population, etc.

- Foundations of houses close to seismic site are compromised by the persistent earthquake like vibrations for months. Such vibrations can hasten the cracking down of weak buildings and bakeries.
- The noise generated keeps both livestock and wildlife jittery as their heart rate increase each time there is detonation. Akani (2008) observed that wildlife response to seismic detonations was; general increase in vocalization, avoidance motility, nervousness, footprint and fecal droppings. Sometimes agitated wild animals like antelopes, bushpig, grasscutter, porcupines, mongoose, snakes, are dislodged from their habitat, are killed by the seismic workers, as these agitated animals try to avoid the disturbed area. As many of as 75 animals may be killed in this way during such terrestrial seismic survey.

**1. INCIDENTS AND FREQUENCY OF PIPELINE VANDALISM IN NIGERIA: causes and consequences , Akani et al, (2010).**

In recent times, pipeline vandalism has become a major causative factor of oil spill and holocaust in Nigeria. Oil spill records in Nigeria according to Abowei and Sikoki (2005), showed that out of the 399 pipeline leaks recorded between 1991- 1995; 221 or 55.4% was due to sabotage and 47,446 bbls were lost to the environment. (Akani 2008) observed that many of the vandalized pipelines in the Niger Delta (between 1993-1997) belong to SPDC, NAOC, etc and over 85% of them were onshore pipeline. Among the pipeline of chronic vandalism in the Niger Delta and their percentage frequency of all the 82 pipeline leaks during this period were Okordia- Rumuekpe (33%); Nun River to Kolo creek (10%); Ubie (10%); Etelebou flowline (5%); Mininta – Rumuekpe (5%) and Adibawa (4%). Nevertheless, none of these cases lost more fuel than the vandalism of 24 inch Ogada – Brass pipeline into which a 10mm hole was reportedly drilled on 5<sup>th</sup> October, 1983 letting out 15,000 bbl of oil into the environment.

Discussing the problem of pipeline vandalism in Nigeria's oil industry, Dambatta (2003) reported that a recent government fact sheet showed that between 1995 and 1998, there was total of 131 cases of pipeline and

The mechanism of toxicity is often by physical suffocation and physiological impacts, as the pneumatophores and lenticels, located in the same intertidal portions are often coated by oil. Coating can also interfere with the usual salt exchange, the leaves and submerged roots of the mangrove responsible for mediation of salts. Sessile animals attached to them cannot escape but get smothered. Semi-sessile forms like crabs, periwinkle and hermit crabs manage to survive helped by the shell covering them. They can minimize activities in response to the stress condition.

Mangrove-associated invertebrates and plants recover more quickly from oiling than do the mangroves themselves, because of the longer time for mangroves to attain maturity. The result of long-term research reveals that mangrove recovery after an oil spill takes a long time as shown by Lewis(1983).

**Table 22:** Generalized responses of mangrove forests to oil spill.(Lewis,1983).

Stage	Observed Impact
Acute	
0 - 15 days	❖ Death of birds, fish, invertebrates
15 - 30 days	❖ Defoliation and death of small (<1m) mangroves.
	❖ Loss of aerial root community
Chronic	
30day - 1 year	❖ Death of medium (<3m) mangrove. ❖ Tissue damage to aerial roots.
1yr - 5 years	❖ Death of larger (>3m) mangroves. ❖ Loss aerial of aerial roots ❖ Regrowth of roots(sometime deformed) ❖ Recolonization of oiled areas by new seedlings.
1yr - 10 years ?	❖ Reduction in litter fall. ❖ Reduced reproduction ❖ Reduced seedling survival ❖ Death or reduced growth of recolonizing trees. ❖ Increased insect damage
10 - 50 years ?	❖ Complete recovery.

- The bulk of the findings on the effect of Okolo oil spill on the mangrove of the Andoni-Bonny river system is in conformity with the observations of Ekweozor (2014) on oil spill effects on the mangroves of the Niger Delta. He opined that:



observed that the tiny but highly numerous fiddler crab, *Ucatangeri*, were prominent at the high tide mark of sandy shores in the area.

Here in Bonny and Andoni mangroves, additional ocy pod crabs recorded are the *Sesarma huzardii*, *S. alberti*, and *S. elegans*. The flat limbs of these crabs enable them to climb upto the stem of mangrove plant during high tide. Other climbers are the gastropods such as *Littorina* and *Neritina* spp. We observed that the climbing propensity of these macrofauna equally enables them to avoid oiled water.

Generally at the Peterside shorelines the impact of the oil had disappeared at the time of the survey. Hence, most of the stations had no trace of oil. The wave action and volume of water that baths the shore are enormous and must have absorbed and dispersed the oil to insignificant concentrations. Thus, discoloration, defoliation or other effects of oil on the flora was not observed in this shoreline. All the shell fish recorded in this study, especially around the Bonny and Peterside axes, were also observed in earlier studies by ENL (1993).

In all, it is appropriate to submit that the Okolo Launch was a major spill, considering the volume that was lost to the environment for about three weeks before the outfall pipe was clamped. The bulk of the observation in this study conformed with the findings of earlier workers in other parts of the globe, (e.g Florida, Persian Gulf, etc) except for a few departures due to geographical difference, the volume spilled, as well as weather and oceanographic conditions at the time of the spill. Hoff (2002) highlighted the effects of oil toxicity on mangrove. Mangroves are highly susceptible to oil exposure; oil may kill them within a few weeks to several months as observed in the Okolo launch case. Lighter oils are more acutely toxic to mangroves than are heavier oils; increasing weathering generally lowers oil toxicity. The increased dispersal may have been the reason why much of the oil impact was not noticed at the Bonny-Peterside axis. The physiognomic change observed at the Andoni area such as curling of leaf, yellowed or browning leaves, defoliation and tree death are usual oil effects. But more subtle responses included; branching of pneumatophores, germination failure, decreased canopy cover and increased sensitivity to other stresses.

other oil facility vandalism throughout the country. But in 1999 alone, 497 cases or more than threefold of the cases in the four years to 1998 were recorded. In the year 2000, the Federation of Nigeria regrettably recorded a high of 909 cases of this malaise. In the following years 2001 and 2002 the records showed 461 and 507 cases respectively, and between 1999 and year 2002 the incidence reached a total of 2,374.

It was however surprising that the causes of pipeline vandalism escalated despite measures taken by government and operators to alleviate the sufferings of the Niger Delta. Eyo-Essien (2008) reported that in 2006 alone Shell Nigeria recorded 241 spills incidents. Of this number, sabotage / vandalism accounted for 165 (69%), while 50 (20%) were controllable incidents (resulting from equipment failure, corrosion or human error; the remaining 26 (11%) could not be classified due to inaccessibility arising from atmosphere of insecurity in the affected communities.

Among the frequently vandalized trans-regional pipelines is the Escravos –Lagos trunklines that supplies gasoline and other petroleum products to the west. Vandalism on the western and northern trunklines has for two years paralyzed production in Warri and Kaduna refineries, thereby placing uncommonly greater demands on Port Harcourt refinery.

### **Vandals operational techniques and devices**

We gathered that pipeline vandals sever the pipeline either by sawing, drilling, and or application of corrosive chemicals, and sometimes with explosives, when the pipeline is not in use; that is when the product is not pumped. Sometimes they take advantage of an already leaking pipe. Later when the pump station is in action, large quantities of oil may ooze from the severed pipe, sometimes for weeks. In some instances the oil is siphoned into motor tankers and carted away to their hide-out, where the product is sold at a relatively cheaper rate. Since the perpetrators of this heinous acts are sufficiently competent to determine precisely when there is no product flowing and hence safe to cut or sever the pipeline (Awobajo, 1981), askance is being looked at some renegade oil workers or some insiders to be accomplices in this crime. Considering the sophisticated technology required to sever pipelines,

it is not an act that could be executed by poor, inexperienced youth alone; there are likely to be some rich barons behind the criminality, who have the technical know-how and equipment, and who knows where the valves and manifold are positioned. The operation time of the perpetrators, according to respondents, range from 10.00pm to 6.00am Nigerian time, during which is rechargeable lanterns and torch-lights are used. It was also gathered that most of the vandalistic act took place in between the last quarter of the year and the first quarter of the following year. Which include the festive periods of Christmas, new year and Easter celebrations. The oil thieves also make brisk business, when there is fuel scarcity in the cuties. In some areas the nefarious activities occurred in rapid successions, cashing in on the lax security along the pipeline.

**Table 7:** Incidents of pipeline vandalism in Nigeria and associated fire disaster(1998-2008).

S/N	Date	Location/site Of vandalism	State	Estimated Death toll	Consequences
1	17 <sup>th</sup> Oct.1998	Jesse	Delta	1,500	Damage to farmlands/ loss of bioduversity
2	22 <sup>nd</sup> April 1999	Bayama (an Ijaw community)	Delta	10	Damage to farmland, environmental pollution.
3	10 <sup>th</sup> July, 2000	Near jesse	Delta	250	
4	16 <sup>th</sup> July,2000	Warri	Delta	100	
5	30 <sup>th</sup> November,2000	Fishing village near Ebute, lagos	Lagos	60	Environmental pollution
6	19 <sup>th</sup> June, 2003	Isiukwuato, Umuahia	Abia	125	
7	3 <sup>rd</sup> June, 1999	Akute-Odo	Ogun	15	
8	13 <sup>th</sup> October, 1999	Ekikpanire	Delta		Damage of farmland, flora and fauna destroyed.
9	14 <sup>th</sup> January, 2000	Gana	Delta	12	
10	7 <sup>th</sup> February, 2000	Ogwe	Abia	15	Damage of farmland and pollution of nearby stream.
11	14 <sup>th</sup> March, 2000	Umuagbede	Abia	50	
12	22nd April, 2000	Uzo- Uwani	Enugu	6	Damage of farmland.

Extensive impacts on mangroves similar to the case of Okolo launch are well documented elsewhere (Hoff et al, 2000). But the essential facts remain that the mud on which mangrove grows is anoxic and for breathing, the roots form a mat on the soil surface and are wetted by tides. When the roots are oiled, the effects are often devastating and large tracts of mangroves are killed as the roots are shunted from oxygen supply. Sessile organisms for which mangrove root provide the essential hard substrate for attachment, namely oysters, barnacles, hydroids, tunicates, were smothered. Semi-sessiles forms like polychaetes, amphipods and tanaids attached to the mangrove roots were equally smothered.

Studies on effect of oil pollution on living organisms near the outfall, indicate that there is usually high tissue levels of induced enzyme activity (e.g mixed function oxidase) in mollusks, reduced growth in sea grass, behavioral change and recruitment failure in crabs, and successional changes in small benthic crustaceans (GESAMP 1990). At the region towards the sea around Oyorokoto, Ikworki and Ataba some sessile or semi- sessile organisms like oysters and barnacles were found still alive. This is attributed to the survival strategy adopted by them, which is to close their operculum or valves (Ekweozor and Snowden, 1985) hermetically, and therefore lower tissue metabolism during the tidal or seasonal periods when environmental conditions are unfavorable (Vannucci,2000). Mudskippers in these stations may have survived by skipping several times to avoid toxic mud or water. Such avoidance reaction is expected since the body is naked (scaleless) and the peripherally positioned eyes would easily be tainted by oil. It is also possible that the relatively higher survival of fauna at the region towards the sea, was due to regular wave action washing off oil from them.

The macroinvertebrates or receptors recorded in this study are similar to those encountered by Badejo (1995) in south Forcados area of the Niger Delta. Both studies revealed the abundance of mollusks and crabs. He observed that about 29% of the collected shells of *Thais* harbored the hermit crab, *Clibanarius* sp which unlike most free living crabs has a characteristically soft body which is symmetrical and modified to fit within the spiral chamber of gastropod shells. He further

flat predisposes it to trapping plenty of the current-dispersing oil. At curves where the current slows down, the nipa palms there trapped more oil and died *en masse*.



**Plate 13:** Showing a segment of Nypa-dominated mangrove swamp turned reddish brown as the mud was deeply oiled in Okolo .

Ecologically, however, the Nipa vegetation provides a microclimate and serene environment that can attract spawning fishes and make an excellent hide-out for avian, reptilian and mammalian species. There is a consensus of opinion among our interviewees that, it harbors Antelopes like, Bush-buck, (*Tragelaphus scriptus*), Sitatunga (*Tragelaphus spekei*), Short-nose crocodile, (*Osteolaemustetraspsis*), Nile Monitor (*Varanus niloticus*), and snakes such as Spitting Cobra (*Naja nigricollis*), Forest cobra, *Naja melanoleuca* Green mamba (*Dendroapsis jamesonii*), Bird-eating snake, *Theletornis kirtlandii*, and *Python* sp. These wildlife have been recorded elsewhere in this zone of the Niger Delta (AA. VV., 1997, 1998).

Areas closer to the outfall were more drastically devastated than more distant areas. This is expected, because as tidal water dispersed the oil, the toxicity to organisms is likely to have been reduced. In the vicinity of the outfall, there was massive kill of intertidal organisms by both the toxic and coating properties of the crude oil. Oil trapped in crab holes did not allow the crabs to return as they are tainted, to even their eyes and gills.

S/N	Date	Location/site Of vandalism	State	Estimated Death toll	Consequences
13	3 <sup>rd</sup> June, 2000	Adeje	Delta		Damage to forest, plus electric poles.
14	20 June, 2000	Okuedjeba	Delta		Damage to farmland.
15	10 <sup>th</sup> July, 2000	Oviri court	Delta	300	Damage to farmland and environmental pollution
16	March, 2000	Osisioma, Aba	Abia	50	Pollution of forest and nearby stream.
17	3 <sup>rd</sup> November, 2001	Umudike	Abia	3	Several bicycles burnt, 17 persons injured.
18	2001	Tarkwa Bay atlas cove	Lagos	500	Environmental pollution.
19	15 <sup>th</sup> June, 2003	Onicha- Amiyi-Uhu	Abia	125	Damage to farmland; dozens of people injured.
20	6 <sup>th</sup> January, 2004	Elikpokwuodu	Rivers		About 200 hectares of farmland oiled plus properties worth millions of naira destroyed.
21	30 <sup>th</sup> July, 2004	Agbani	Enugu	7	Several people injured.
22	16 <sup>th</sup> Sept, 2004	Ijgun	Lagos	60	Water pollution.
23	Dec, 2004	Imore	Lagos	60	Environmental pollution.
24	30 <sup>th</sup> May, 2005	Akinfo	Oyo	16	34 persons injured.
25	13 <sup>th</sup> Jan, 2006	Iyeke	Edo	7	6 persons injured; damage to farmland.
26	12 <sup>th</sup> May, 2006	Inagbe village	Lagos	150	Water pollution plus incineration of bush within 20m radius; dozens of people injured.
27	October, 2006	Awawa kwali	Abuja	-	Damage to farmland.
28	2 <sup>nd</sup> Dec, 2006	Ijeododo	Lagos	1	Damage to farmland.
29	24 <sup>th</sup> Dec, 2006	Egbula/Egba Agege	Lagos	500	Incineration of 40 vehicles, a dozen homes, including a mosque and two churches, and many business houses. Many families mourned.

S/N	Date	Location/site Of vandalism	State	Estimated Death toll	Consequences
30	26 <sup>th</sup> Dec, 2006	Agba-Okwan Asarama, Andoni	Rivers		Water pollution.
31	16 <sup>th</sup> May, 2008	Ijegun, Ikotun	Lagos	16	
32	26 <sup>th</sup> May, 2008	Gbaga village near	Ogun	-	-

A critical analysis of pipeline and explosion incidents during the period indicates that the percentage frequency of vandal's attack in the states was in the following order : Delta State> Lagos State> Abia State> Enugu State > Ogun State > Rivers State > Oyo State > Edo State> FCT. This data reveal that the frequently vandalized networks are *System 2B*, *System 2E* and *System 2A* which convey very volatile petroleum products, leading to gruesome disasters and heavy mortality.

### Causes of Pipeline vandalism and explosion in Nigeria

Results of interview with elites of affected communities and sympathizers reveal that there are a myriad of underlying causes responsible for pipeline vandalism in Nigeria. Virtually all sectors of the society are culpable.

#### A. Complacent attitude of some pipeline operators.

- (i). Aged and exposed Pipelines. In the country, there is an extensive network of old pipelines between the oilfields, as well as numerous small networks of flowlines – the narrow diameter pipes that convey oil from wellheads to flowstations – thereby increasing the chances for leaks. In onshore areas, most pipelines and flowlines are exposed by erosion or laid above ground and the pipeline operators do not see the urgent need to cover them. In this conditions the pipelines are ready for vandalism. Besides, such exposed pipes are prone to corrosion and when there are leaks they are not detected in time till vandals start scooping oil from them. In the process, an explosion might follow. It is contended that the multinational oil companies overlook replacement of the old pipes, because of the huge cost involved (Esptein and Selbel, 2002).

of the shoot (*Fig.*). Around Amansan and “Freetown fishing port”, the bulk of the *Rhizophora* and *Avicennia* sp were defoliated, as there were oil sheens and black oil with obvious smell here.

The generality of the intertidal zone was gentle sloping mudflats, and were green to brown in color due to abundant epipellic algae. At the Peterside and Bonny axis, the intertidal zone was also gentle slope, except that the substrate was predominantly sandy.

Fishing activities were still going on in the area by artisanal fishermen who use fishing fences, long-lines, gillnet, around Oyorokoto, Shebiekiri, Otokolomabie in Andoni and Ayimanga, Oruanga fishing settlements near Peterside. In some creeks around Asaramatoru, women folk were engaged in periwinkle collection by low tide. Towards the high pressure pipeline opposite BOP-28, beach seine fishing and hand-trawling was going on around the sandy shore. Inspection of some of their catches revealed the occurrence of Sciaenids, Polynemids, Cynoglossids, Muglid, clupeid and Monodactylid, during the period.

Sessile organisms for which mangrove root provide the essential hard substrate for attachment, namely oysters, barnacles, hydroids, tunicates, were smothered. Semi-sessiles forms like polychaetes, amphipods and tanaids attached to the mangrove roots were equally smothered.

However, living receptors such as Ocypod crabs, mudskippers, hermit crabs, oysters, periwinkles, Whelk, *Littorina* sp, *Anadara* sp., etc were recorded in varying densities away from shorelines, distant from the outfall, such as Asaramatoru; higher densities were recorded on muddy flats.

Avifauna activity was high in these sites during low tide, but not around the outfall. The birds commonly found were herons / egrets, stork, hammerkop, whistling duck, and sand hoppers. Kites were only found on a sandy substrate near Peterside axis.

The Nipa palm was found to be the most impacted mangrove due to the Okolo spill. This is because it is the most abundant species in the area, and its morphology of underground stem/root which ramify the mud



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The Nipa palm was found to be the most impacted mangrove due to the Okolo spill. This is because it is the most abundant species in the area, and its morphology of underground stem/root which ramify the mud flat predisposes it to trapping plenty of the current-dispersing oil. At curves where the current slows down, the nipa palms there trapped more oil, and died *en masse*.

Following the oil spill classification in Nigeria (Adekunle and Foster 1985; Ekweozor and Snowden, 1985), the Okolo incident is a major spill, since over 2500 barrels of oil was lost into the environment. According to them, this classification is generally used by all oil companies operating in Nigeria.

Results show that the most impacted zone was close to the outfall around Amansan, "Freetown", Asaramatoru, and Melanie Cruise House boat. Oil sheens and small lumps were sighted around the mangrove roots in this zone. From here the tidal current dispersed the oil towards other Andoni communities of Ibotuosor, "Ajegule" fishing port, Ikworiki, upto Oyorokoto close to the ocean. In the Andoni axis, the dominant and invasive *Nypa fruticans* was the most affected. In some segments the Nipa palm trapped a lot of oil especially in areas where tidal current slowed down at bends. Some crab holes also trapped oil. The roots were oiled up to a height of 1-1.5m thus causing browning

(ii). Inadequate checks or patrol on the pipeline routes. There is consensus of opinion by the respondents that there is hardly sufficient patrol by the pipeline operators. Sometimes the fuel theft can go for about six or more months and no security or patrol man intervenes.

**(B) Economic status and emotional state of host communities.**

**Poverty**

The root cause of the increasing rate of pipeline vandalism could be traced to abject poverty facing the youth. Poverty, especially in the Niger Delta region, is widespread, and discontents among a people that have suffered a long history of neglect, marginalization and repression by virtually every government, cannot be ruled out. Poverty breeds insecurity, and has eaten deep into the fabrics of the nation that most youth take the risk of vandalizing the pipeline to eke a living. Even when the pipeline explosion episodes have been televised, some still don't give a damn about the life-stifling consequence. It has indeed dawn on some that they rather choose the devil's alternative of dying in an inferno instead of slowly dying of hunger. Many are aggrieved and complain that they live in the midst of plenty but are poverty-stricken. But the oil companies' staff just in their neighborhood for years sink in the luxury of their edifices with constant electricity and water, while they watch on, in their fatherland. These poor, neglected and frustrated people, in the bid to vent their anger, take to drilling or severing petroleum-conveying pipelines, that pass behind their homes and farmlands (Oghenesivbe, 2008), without minding the risk.

Many are aggrieved who say "how can we live in the midst of plenty and continue to suffer?" In spite of the wealthy status of the country, it is disheartening that over 90% of Nigerians are starving coupled with poor health care, declining standard in education, highly congested labor market. In fact, the poverty level in the country is believed to be responsible for the diverse criminal activities, including the militia experience in the Niger Delta – a region that has the more been impoverished through

incessant oil pollution of farmlands and fishing grounds (Ogenesivbe, 2008).

#### **Ignorance**

A close examination of the people involved in this clandestine activity shows that over 95% of them are illiterates, touts, unemployed youth, etc, who do not know the chemistry of the substance they are toying with, but look forth to making quick and huge profit.

#### **Greed and covetousness**

Some of the vandals take to this criminal act out of greed and covetousness. They want to have a feel of the oil wealth (like politicians, business tycoons, oil workers); drive big cars, build mansions, without making conscious effort to work. When they see some lucky ones wriggle out of it, they feel they must make it, *terra marique* (by land and by sea).

#### **Unemployment**

The teeming number of idle, unemployed youth find solace in pipeline vandalism. An idle hand, as the popular saying goes, is the devil's workshop. Every year thousands of graduates and technicians are churned out from universities and colleges and are left wallowing without jobs; some have no choice than to resort to pipeline vandalism as a fast way of getting rich.

#### **Neglect of host communities.**

Complaints by the respondents demonstrate that communities through which the pipelines pass are bitter with complete neglect by the government and the multinational companies. Although some of the respondent subscribe to the fact that oil companies helped to provide, in a number of places, schools, scholarships, roads, cottage hospitals, community halls, portable water, etc. the number of these projects are too few to serve the vast community. Some communities are completely neglected, where they remain quiet.

## **Results**

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topography of the shoreline, vegetation structure, floristic composition, and physiognomy / health status, and wildlife activity were brought to focus. High power binoculars (Fujiyama model) were used to enhance observation of the biodiversity features of each station.

Since the area had had a number of previous spills, the impacts due to the current Okolo oil spill was deciphered by assessing only mangroves having fresh oil sheen, thick oil, tar balls, etc on or around their roots, stems and leaves.

Densities of sessile and semi-sessile macrofauna considered the best receptors, and were estimated (where possible by direct count) or by means of 1m<sup>2</sup> quadrat cast 5 – 10 times, followed by photographic documentation, where necessary.

Further information about the habitat and spill history of the area was deduced from the native fishermen who are conversant with the terrain, who were engaged as escorts.

**Table 21:** Summary of sampled stations around Okolo Oil spill Area

Station No.	Nearest locality / landmark	LGA	Co-ordinate
1	Ikworiki: Zone 4.5	Andoni	004.504165N
2	Zone 4.4	Andoni	007.364501E
3	Zone 4.3	Andoni	004.504546N
4	Zone 4.2	Andoni	007.359774E
5	Zone 4.1	Andoni	
6		Andoni	
7	Amansan		
8	Freetown		004.51608N; 007.23789E
9	Asaramatoru		004.9385N; 007.27382E

Failure of companies to fulfill agreed terms in the memorandum of understanding (MOU) with communities is also among the grievances of these youths.

**Incessant fuel scarcity.**

Over the years, there have been incessant scarcity of fuel in the country. When this scenario prevail, people become desperate and become anxious to get fuel for their cars and generators, at all cost. The scarcity thus drives the vandals to severe pipelines and make brisk business. Sometimes, they get the fuel adulterated – mixing various fractions to get large volumes of fuel for sale. Cars using such fuel sometimes develop some problem after a short time interval.

**Toothless/ ineffective Laws.**

It is unfortunate and disappointing that the statutory provisions on pipeline vandalism are toothless, and have hardly caught reasonable number of culprits, even in the face of high frequency of occurrence of this criminality. There is indeed no provision in the Petroleum Act 1969 (as amended) providing for the punishment of pipeline vandals. Even the Economic Sabotage Act which has made provisions in this respect softened by making the offence of pipeline vandalism bail-able and with very lenient jail terms. Because the law has rather trivialized the matter, barons sponsoring the vandals arrange for accelerated prosecution of the case, so that the court will grant them bail as soon as possible. Upon their release, they resume their nefarious activities almost immediately.

Interviews with the sympathizers at the scene of the incidents revealed that the people involved in the act are illiterates, jobless youth, touts, some individuals retrenched from oil companies. It is glaring that the poverty level in the country is responsible for the criminal activities. In spite of the fact that these people have read in the dailies and watched on the television about the disaster this fuel stealing has caused, they still risk their lives out of poverty.

### Patronage of the vandal's bounty

The risky business is also encouraged by buyers who are ready to patronize the vandals. These buyers themselves look for ways to get fuel at cheaper rate, for their cars and generators, when there is oil scarcity in the cities. This is in conformity with the adage which says: "Society creates the crime and criminals commit it". Invariably, our society creates the crime by patronizing them. If we ignore the fake products, certainly they will not go for another.

### Consequences of the pipeline vandalism and explosion

Incidents of pipeline vandalism in Nigeria have always been disastrous, not only to the human population, but also the habitat and associated flora and fauna – biodiversity. When the nefarious act is carried out near human settlements (a rural town or city), in which case many opportunist have access to the severed pipeline, many lives are lost. Ignition of the volatile petroleum product, which vapor had filled the air for hours, could cause explosion of the pipeline, the fire spreads far and wide as more and more of the fuel is discharged from the outfall. Dark smokes engulf the area. Within a few hours there are series of outcry and wailing as many people are incinerated or charred to death, including bystanders in the vicinity (Walsh, 1998).

By the time sympathizers arrive the scene, many had died on the spot. In the Isiukwuato episode, according to respondents, victims ran helter-skelter in stampede as the fast-moving fire caught up with their fuel-soaked wears and containers. While some individual affected by the inferno often died on the spot, some were maimed and hospitalized with varying degrees of burns; others avoided the hospitals to avoid being interrogated by detectives on the cause of the incident. Thus, a lot of victims die out of hospital, so that the records of death toll are often an underestimate. Table 3 shows records of such episodes between 1998 and 2008, which reveals that at least 4,363 persons died.

Several plastic containers (20 litres – 50 litres capacity) usually lie around the deceased, indicating the magnitude of rush to benefit from the unwholesome business. Few days after the incident, the repulsive morbid odor of putrefying human bodies, which were not immediately discovered filled the air, causing allergic persons around to throw up.



Plate 12: Caudal vertebrae of a large-sized reptile - a crocodile, killed in Tebidaba oil spill and fire (Source Akani, 2008)

### Effects of Oil Spill on Mangrove Swamps:

#### A case study of Okolo Pipeline oil spill of 2014.

On 22nd November, 2014 an oil spill was reported to have occurred from an Okolo Well-head, which spread far and wide from Bonny River upto Andoni River to the east. SPDC Oil Spill Response team on 2<sup>nd</sup> December, 2014, traced the spill to sabotage and gave the volume estimate as 3802 bbl, out of which 1200 bbl or 31.6% was recovered. A total of area of 2469 ha of surface water was impacted, while the impacted riverbanks and mudflats was about 138 ha.

Biodiversity Assessment of the oil spill sites was conducted as required by Shoreline Clean Up Assessment Technique (SCAT) of NOAA (2013). This was preceded by a reconnaissance survey of the entire area impacted, which informed the strategy for the studies. Ten impacted stations were delineated for sampling by the Joint Investigation Team (JIT) as shown in table 1. All the stations were studied during the diurnal low tides of 11<sup>th</sup> to 15<sup>th</sup> December, 2014. This timing offered the widest field of view for detailed observation of the impact on biota of the intertidal zone. Incidentally, the period of the survey corresponded with the full moon phase. Virtually all the locations for vegetation studies corresponded with the soil sampling stations. In each location, the





**Plate 10:** Massive destruction of biodiversity following the Tebidabaoil spill of 2005 in a seasonal freshwater swamp (source: Akani, 2008)



**Plate 11:** Another segment showing the massive destruction of Biodiversity following the Tebidaba Oil spill and fire (Source Akani 2008)

Pipeline vandalism near human settlements has often resulted in enormous loss of property. Merchants loose billions of naira when nearby markets, buildings, workshop, vehicles, electronic stores, computer shops, etc were affected, as in the cases of Egbula-Egba, Agege, Lagos in 2006, and Ijegan, Lagos in 2008.

### **Economic Loss**

Tampering with Government properties such as oil pipelines, water pipelines and electricity have been promulgated as unlawful since the 1990s. In spite of this, pipeline vandalism and oil bunkering have remained a lifestyle for some criminals. The multinational company affected or owner of pipeline incur heavy losses as several barrels of oil are lost. Again, the vandalized pipe must be clamped, and the environment cleaned of oil by the same company that has lost its oil. In 2003, the Adviser to the President on Petroleum and Energy, Dr. Rilwanu Lukman, stated that the Nigerian oil industry which accounts for 40% of Gross Domestic Product (GDP), provides 80% of government revenue and 95% of foreign exchange earning is so sensitive and central to the Nigerian economy. Thus, the frequency of oil pipelines vandalism and illegal oil bunkering which are now in ascendancy constitute a major economic and social hazard to the country (Dambatta, 2003). As at 2003, it was estimated that about 386,000 barrels of crude were lost daily to the activities of the vandals. When calculated at a low rate of \$26 per barrel, this amounted to \$3.5 billion per annum, which is slightly more than a quarter of the country's annual budget. Analyzing the loss due to petroleum theft, Dambatta (2003) noted that "the amount was slightly more than a quarter of the country's annual budget or more than the naira equivalent of the amount received collectively by some 17 states in the Federation from the federation account, annually. The amount could also pay for the construction of more than 90 structures similar to the New Central Bank of Nigeria (CBN) headquarters, at Abuja. That huge sum of \$3.5 billion could also buy 40 brand new Boeing 747 aircraft with enough spare parts for ten years. It can finance the sinking of 116,666,666 boreholes throughout the country at N3,000,000 each to supply clean water to thirsty Nigerians. It could as well give the country a minimum of 10

modern 500,000 bpd capacity refineries that could effortlessly refine crude oil and supply products to entire continent of Africa.

It is on record that between 1999 to 2007, Nigeria lost a whopping sum of N160 billion to pipeline vandalism and the report from the Pipeline and Product Marketing Co-operation (PPMC) indicated a record of over 12,800 cases. The report states that the highest number of vandalism was 2006, with 3674 cases in which the nation lost N36,640 billion naira. The heaviest loss of N42,102 billion occurred in 2005 from 2,237 cases, while the least, N3,867 billion occurred in 2001, from 461 incidents. The trend of pipeline vandalism was apparently in ascendency between 2005 and 2007, when militant activity was also at its zenith in the Niger Delta.

**Table 8:** Trends in reported Cases of Pipeline Vandalism and Monetary Economic Loss in Nigeria (2000-2007)

Year	No. of Cases	Monetary Economic Loss in Naira
2000	984	10,121,000,000.00
2001	461	3,867,000,000.00
2002	516	7,971,000,000.00
2003	779	12,986,000,000.00
2004	895	19,660,000,000.00
2005	2,237	42,102,000,000.00
2006	3,674	36,640,000,000.00
2007	3,224	17,240,000,000.00
Total		150,587,000,000.00

Source: Dambatta (2003); Akani (2010)

aquatic insects – Gerrids, Dysticid, backswimmers, the water boatman, *Belostoma* sp,) and annelid worms.



**Plate 8:** Massive destruction of biodiversity following the Odual oil spill in a seasonal freshwater swamp (source: Akani, 2008)



**Plate 9:** Another segment showing massive destruction of biodiversity following the Odual oil spill in a seasonal freshwater swamp (source: Akani, 2008)

Comparisons of floral diversity loss by station between SIZ Vs IMZ; SIZ Vs GIZ and IMP Vs GIZ, each case showed no significant difference.

### **Wildlife Mortality in Odual oil spillage.**

Following the Odual oil spill, many species of the seasonal freshwater swamps were found dead. *Table...* is a summary of the mortality count for the affected piscean, amphibian, reptilian and avian species. In all the station, no mammalian mortality was recorded. The data shows that the GIZ had the highest faunal mortality of 336 followed by IMZ and SIZ with counts of 248 and 162 respectively. No mortality occurred in the UIZ or control site. In all, a total of 21 vertebrate species were found dead and oiled. These included 10 piscean, 4 amphibian, 5 reptilian, and 2 avian species. The bulk of the piscean victims were obligate air-breathers that frequently come to the surface to gulp air, especially *Phractolaemus ansorgei* and the Clariids. Among the amphibians, the black clawed frog, *Silurana (=Xenopus) tropicalis* were the greatest victims with a mortality of 129 individuals, while the freshwater snake, *Grayias mithyii* dominated the reptilian casualties. The two bird species that drowned in the oiled water were the Allied hornbill, *Tokus fasciatus* and the water duck *Nettapus auritus*.

Analysis of faunal diversity loss to the oil spill, was accomplished using Margalef's and Menhinick's indices, as well as Shannon-Wiener, Evenness, All the comparison of faunal diversity between stations using t-test showed no significant difference, as in all cases,  $t < (t_{cal})$  was observed. The Shannon-Wiener (H) values in all the stations (except the control) was slightly above 1, indicating that the swamp was moderately polluted. The evenness values which is a little lower than 1 suggests that many species were almost equally affected, while the low Simpson Dominance index values confirmed that no species was extraordinarily affected more than others.

Other effects on biodiversity components of the swamp were yellowing of affect plants including floating and submerged macrophytes. Myriads of aquatic arthropods associating with these plants also died in their numbers, namely shrimps such as *Desmocariss* and *Palaemonetes*,

### **Biodiversity Loss And Ecosystem Effect**

When a pipeline is vandalized in remote areas from human settlements, the inferno may not kill many people, but often destroys cultivated farmlands, forests and swamps ecosystems. In the study of Ogbodo-Isiokpo 2001 pipeline incident; Odual-Obedum-Anyim-Ekuniga-Emelego 2005 pipeline leak (in Ikwerre Local Government Area and Abua/Odual Local Government Area of Rivers State, respectively) and the Tebidaba-Igbomatoru 2008 pipeline incident in Southern Ijaw Local Government Area of Bayelsa State, Akani (2008) noted that in Ogbodo-Isiokpo several hectares of riparian forest and fresh water swamp were destroyed by the fire. Various trees such as *Raphia spp*, *Elaeis guineensis*, *Calamus deeratus*, *Hallea ledermannii*, *Terminalia superba*, *T. ivorensis*, *Albizia ferruginea*, *Cleistopholis patens*, *Symphionia globulifera* and *Alchornea cordifolia*, had the greatest frequency of occurrence among trees affected by the inferno at the three site. Among the commonly killed wildlife a few days after, were; terrapins, *Pelusios spp.*, the short-nose Crocodiles, *Osteolaemus tetrapsis*, Fresh water snakes – *Grayia smithy*, Red and black line snakes, *Bothriophyllus lineatus*. Amphibians were represented by edible anurans like *Xenopus tropicalis*, *Ptychadena spp* and *Dicroglossus occipitalis*. Among the fishes frequently killed are those that must come to the surface at intervals to take air, namely, *Clarias spp*, *Heterobranchus spp* and *Phractolaemus ansorgei*, *Hepsetus odoe*, *Malapterurus electricus*, etc.

The forest canopy and floor were all affected; all the crawling vertebrates and invertebrates and weeds are charred, leaving a bare, jeopardized and desolate ecosystem. Eyo- Essien (2007) reported that run-off from oil impacted sites may find its way into the neighboring freshwater source, used by a rural community for domestic purposes, and for fermentation of food like cassava, breadfruit, etc.

### **Psychological problems**

The series of pipeline explosions in southern Nigeria have left behind victims' families in varying degrees of psychological problems. The most excruciating pains are seen with women and children who lost their husbands/ fathers, in the inferno and vice versa. Confused and



depressed are also elderly parents who are looking up to be buried by their son who are gutted by fire. They cry ceaselessly for weeks and loose appetite. In one case in Lagos a woman carrying her baby on the back was reportedly burnt along with her baby. What a blow on the psyche of her husband! As many were incinerated beyond recognition, the victims are buried in a mass grave. People whose business premises were gutted in fire, faced a phase of depression and may end up developing hypertension, as they may have to begin from scratch.

### Legislative framework

The Federal Government of Nigeria has made concerted efforts to curb this perennial problem, but the crime appears to be taking rather new and more sophisticated dimensions. Up till date, a series of pipeline Acts have been promulgated to check the excesses of these perpetrators and of course to check the scenario, when oil companies will irresponsibly pollute the environment during production. Omorogbe (2002) defined the pipeline laws, which are meant to protect the pipelines as follows:

- (i) Oil pipelines Act Cap.338
- (ii) Petroleum Production Distribution (Anti-Sabotage) Act No. 353
- (iii) Crude Oil (transportation and shipment) regulations
- (iv) Oil and Gas Pipelines Regulations 1995.

Besides there are other legal framework that prohibits discharge of petroleum and petroleum derivatives into the environment, as a means to exercise surveillance over oil spills in Nigeria, namely:

- Oil Pipeline Act 1956 (as amended by Oil Pipeline Act 1965) which prevents pollution of land or any waters.
- Petroleum regulation 1967, which prohibits discharge or escape into waters within harbor area and make provisions for precautionary measures in the conveyance of petroleum and rules for safe operation of pipeline are.
- Oil in Navigable Waters Acts 1968 which prohibits discharge of oil or any mixture containing oil into the territorial or navigable inland waters.

killed by the oil and inferno, at four delineated zones sampled; namely Unimpacted zone (control) UIZ; Slightly Impacted zone SIZ; Impacted zone, IMZ; and Grossly Impacted zone, GIZ. Many individuals were burnt beyond recognition.

**Table 20:** Diversity and Numerical abundance of plants killed by Odual oil spill of 2005 (in 100m x 100m plots). UIZ = Unimpacted zone (Control); SIZ= Slightly Impacted zone; IMZ= Impacted zone; and GIZ= Grossly Impacted zone.

Species	Family	UIZ	SIZ	IMZ	GIZ	Total
<i>Musanga cecropoides</i>	Cecropiaceae	0	0	11	5	16
<i>Alchornea cordifolia</i>	Euphorbiaceae	0	6	8	5	19
<i>Calamus deeratus</i>	Palmae	0	3	12	19	34
<i>Raphia hookeri</i>	Palmae	0	2	16	22	40
<i>Raphia vinifera</i>	Palmae	0	0	7	19	26
<i>Anthocleista vogelii</i>	Loganiaceae	0	0	13	6	19
<i>Symphiona globerifera</i>	Guttiferae	0	0	15	20	35
<i>Uapaca staudii</i>	Euphorbiaceae	0	0	3	3	6
<i>Harungana madagascariensis</i>	Hypericiaceae	0	0	14	23	37
<i>Hallea ledermanni</i>	Rubiaceae	0	1	16	10	26
<i>Ficus exasperata</i>	Moraceae	0	0	3	0	3
<i>Pterocarpus sp</i>	Leguminosae	0	0	0	5	5
<i>Cleistopholis patens</i>	Annonaceae	0	2	8	3	13
<i>Funtima afr icana</i>	Apocynaceae	0	0	0	5	5
<i>Dracaena arborea</i>	Agavaceae	0	3	7	11	21
<i>Ouratea sp.</i>	Ochnaceae	0	1	3	0	4
<i>Sterculia tragacantha</i>	Sterculiaceae	0	0	2	5	7
<i>Rauvolfia vomitoria</i>	Apocynaceae	0	4	5	0	9
	Total no. of plants killed by oil spillage	0	22	143	161	326
	No. of species	0	8	16	15	
	Margalef index(d)	0	2.2646	3.0225	2.7551	
	Menhinick's index (d)	0	4.5503	7.1822	6.6543	
	Diversity indices					
	Shannon diversity (H')	0	1.9247	2.6155	2.4795	
	Shannon Wiener index (H)	0	0.8359	1.1359	1.0768	
	Evenness (E')	0	0.9256	0.9434	0.9156	
	Simpson's Dominance(C)	0	0.1653	0.0806	0.0980	



Results of vegetation assessment indicated that the Tebidaba oil spill, claimed a total of 97 trees in the sampled plot. Within the control zone (UIZ), no plant died throughout the period, whereas the maximum loss of 42 trees was recorded in the outfall site (GIZ), followed by the IMZ and SIZ areas. The number of tree species affected in the IMZ and GIZ were virtually the same. T-test for SIZ and IMZ plot mortalities for the trees was found to be -2.1080 and  $t_{(cal)} = 3.2905$ , and since  $t < t_{(cal)}$  it was inferred that the difference was not significant ; degree of freedom = 13269.2509. Comparing SIZ and GIZ plot mortalities, a t-values of -1.7515 was obtained implying that the difference was not significant, as  $t < t_{(cal)}$  with degree of freedom= 10425.8407. In the same vein, t-test for IMZ and GIZ mortalities yielded a value of 0.6355, revealing no significant difference in the oil kill, since  $t < t_{(cal)}$  with a degree of freedom = 85420.6004.

Estimate of stocking density in the plots showed obvious decrease from the control site to the grossly impacted zones and the percentage litter cover increased enormously in the grossly impacted zone as many plants shed their leaves in response to the stress due to the oil spill.

#### **(b) Odual Oil Spill of 2005 in Abua-Odual LGA of Rivers State.**

Another oil spill incident studied was that which occurred in Odual area of Abua/Odual LGA of Rivers State. The spill was traced to rupture, due to corrosion of SPDC pipeline along Kolo Creek-Rumuekpe route which traverses Odau seasonal freshwater swamp forests. For days the oil gushed with high pressure and spread to forests of other communities, like Obedum, Eminikpokor, Anyu, Ekunuga, Okolomade and Emelego. The company's spill contingency team, would not venture into the place (for security reasons) until the charged communities are pacified (through series of negotiations, with the chiefs and elders and other stakeholders, accompanied with relief and gifts), before clamping of the ruptured pipe can commence. This delay, also applicable to other oil spill sites, is often the cause of more oil-letting into the environment than it should have been. Shortly after the spill, the forests were set on fire by an unknown persons thereby exacerbating the damage already done to the ecosystem (*see fig..*). *Tables.20 and 21.* show some of the identified flora and fauna

As a means of beefing up pipeline security, a pipeline surveillance team, known as Federal Task Force on petroleum pipeline vandalism, Bunkering and Allied Crime (FTFPPVBAC) was created to patrol and arrest culprits. Unfortunately much could not be achieved, as vandals in no time learnt to evade them. Men of the task force were grossly inadequate; not trained for the task, and were ill-equipped, lacking relevant communication gadgets and functional patrol vehicles. They lacked binoculars, tents, boots and other basic items relevant to the surveillance assignment and the often swampy terrain the pipeline traverses. Meanwhile, to alleviate tension created by the militants in the region which has been telling in oil production in recent times, the Federal government of Nigeria in September 2008 inaugurated a 45 – man Technical Committee, (with members drawn from various states and other civil platforms by virtue of their experience) charged with the task of proffering sustainable solution to the Niger Delta crises which has degenerated to such vices as hostage taking, militancy, pipeline vandalism, as avenues of sabotaging or discrediting government of the day.

#### **Ecological And Conservation Considerations on the Reptile Fauna of the Eastern Niger Delta (Nigeria)**

**Akani *et al* (1999)**

Vice Chancellor, Sir, we were prompted to undertake this research, consequent upon our literature search, which revealed that the herpetofauna of the Niger Delta was poorly known (NDES, 1998), and was worse with the reptiles ; and moreover the quantitative studies on the functioning of these communities was at an embryonic stage (Scott 1982; Luiselli *et al*, 1998).Some Information on the amphibians and reptiles of the Niger Delta were only presented as scattered mentions in classical momographs of West African herpetofauna or specific papers of Nigerian species (e.g. Romer 1953;Schiotz, 1967,1969; Ekundayo and Otusanya, 1969; Dunger 1967a, 1967b,1967c, 1968, 1971a, 1971b, 1972a, 1972b, 1973 ; Villiers 1975; Butler and Reid 1986; Sodeinde and Kuku 1989, Sodeinde and Ogunjobi, 1994 , etc).In all this literature,

however, very little is reported on ecological distribution and ecophysiology of the various taxa.

This research paper (which has been widely cited) constitutes the first attempt to describe the composition of the reptile fauna of several Niger Delta localities in terms of quality and quantity and in relation to the variation of habitats available. The aim of the paper was to provide a contemporary checklist of the reptilian fauna, and review the reptilian zoogeography of the region and comment on the reptiles that will be grossly affected by the Gas transmission pipeline that would transect the eastern Niger Delta from Kreigani through Ndele –Rumuji – Tombia-Bakana- Alakiri- Peterside to Bonny where the NLNG was to be built.

The study area (presented in table..) is extremely heterogeneous in that water and land patchily alternate. The variation of the salinity level of water bodies (due to concomitant presence of freshwater and tidal water) is an important factor.

Various observation techniques were adopted: reptiles were searched for by walking along random routes leading through all habitat types available in the 10 transects (table..). The transects were approximately 7 km long each and were walked along only one direction and once per day to avoid multiple counts of individual per observation unit. Due to logistic problems field work was predominantly restricted to the daylight hours (08.00 to 18.00), which is of course not the best time for finding amphibians and reptiles in African rain forests, as several of these species have their above-ground activity peaks early in the morning and late in the afternoon (Branch 1988). In general, at least 40 hours were spent in the field in each study transect. Most animals encountered during our surveys were captured by hand, drift fences or pitfall traps and photographed.

To avoid unrecognized recaptures (leading to erroneous counts) lizards were marked by toe-clipping and snakes by ventral scale clipping. Crocodiles were not captured, but photographed and remained unmarked. Turtles were marked by unique sequences of notches filed into the marginal scutes.

**Table 19:** Showing the UIZ, SIZ, IMZ, GIZ

Species	Family	UIZ	SIZ	IMZ	GIZ	Total
<i>Symphiona globulifera</i>	Guttiferae	0	0	2	6	8
<i>Alstonia boonei</i>	Apocyanaceae	0	3	8	4	15
<i>Calamus deeratus</i>	Palmae	0	0	3	7	10
<i>Musanga cecropoides</i>	Cecropiaceae	0	0	3	5	8
<i>Terminalia superb</i>	Combretaceae	0	2	1	4	7
<i>Cleistopholia patens</i>	Annonaceae	0	2	5	2	9
<i>Monodora tenuifolia</i>	Annonaceae	0	3	6	6	15
<i>Spondiathus preussi</i>	Euphobiaceae	0	1	4	4	9
<i>Macaranga barteri</i>	Euphobiaceae	0	0	0	3	3
<i>Anthostema aubreyanum</i>	Euphobiaceae	0	0	3	0	3
<i>Alchornea cordifolia</i>	Euphobiaceae	0	1	3	2	6
<i>Hallea ledermanni</i>	Rubiaceae	0	1	2	0	3
<i>Syzygium guineense</i>	Myrtaceae	0	2	0	0	2
<i>Baphia nitida</i>	Leguminosae	0	1	3	2	6
	Total no. of trees killed	0	15	40	42	97
	No. of species	0	8	11	10	
	Margalef index	0	2.5849	2.7119	2.4079	
	Menhinick's index	0	4.8614	5.7272	5.1725	
	<b>Diversity Indices</b>					
	Shannon diversity (H')	0	1.9913	2.2655	2.2023	
	Shannon Wiener Index (H)	0	0.8648	0.9839	0.9564	
	Evenness index (E')	0	0.9576	0.9448	0.9564	
	Simpson's dominance index	0	0.1467	0.1163	0.1179	
	Stocking density Ind./m <sup>2</sup>	45	31	14	8	
	% litter cover	75	60	72	95	

Analysis of wildlife diversity loss in the Tebidaba oil spill, using Margalef index, Menhinick's index, Shannon-Wiener, Evenness, etc, is also included in table....The t-test for faunal mortality in SIZ and IMZ plots gave -3.8260 against  $t_{(cal)} = 3.2905$ . Thus, the difference was not significant, as  $t < t_{(cal)}$  and degree of freedom = 1134.1314. The t test for mortalities in SIZ and GIZ gave -3.5934, and since  $t < t_{(cal)}$ ; degree of freedom = 1112.7120, the difference was also not significant. The same is also true of the t-test between IMZ and GIZ which gave 0.4929 and degree of freedom= 115007.6524. The values deduced for Shannon-Wiener were, for all the stations generally less than 1, indicating that the water was heavily polluted.

Table 19: Diversity and numerical abundance of trees killed by the Tebidaba oil spill of 2005, Bayelsa State (in 100m x 100m plots).

UIZ = Unimpacted Zone (Control); SIZ = Slightly Impacted Zone; IMZ = Impacted Zone; GIZ = Grossly Impacted Zone.

## Quantitative analysis

For quantitative analysis, only reptile specimens which were clearly visible to us (i.e excluding those under cover) were counted. The hiding snakes were recorded for description of the faunal composition. Exclusion of hidden specimens was done under the assumption that the proportion of active (visible) specimens should be the same in all study transects (given that the time of surveying was the same in all cases) and because the probability to find covered animals might have been different in the various sites (e.g. because of different frequencies of objects on the ground level, etc.).

Based on the above quantitative data collected we calculated both species diversity and species dominance of each area, which are important parameters for any biodiversity analysis (Dodd, 1992). Species diversity(D) was calculated using Margalef's Diversity Index (Magurran, 1988):

$$D_{Mg} = (S-1)/\ln N$$

where  $S$  represents the number of species and  $N$  the number of individuals (sampled) in the area under study.

Species dominance ( $d$ ) was assessed using the Berger-Parker Index (Magurran, 1988) :

$$d = N_{max} / N$$

where  $N$  represents the number of individuals and  $N_{max}$  the number of individuals of the most abundant species (sampled) in the area under study.

An increase in the value of  $1/d$  (the reciprocal of the species dominance) indicates an increase in diversity and a decrease in dominance (Magurran, 1988). In order to determine whether inclusion of juveniles influenced the values of diversity and dominance, separate indices were calculated (i) with juveniles included and (ii) excluded. Since non-parametric matrix correlation Mantel tests did not show evident differences between corresponding indices (i) and (ii) in any study transect (in all cases  $P > 0.4$ ), the pertinent indices were pooled. Recaptured individuals were excluded from calculations of diversity and dominance.

Several methodological factors may have biased the result; for example vegetation and landscape characteristics permit easier localization of reptiles in secondary forests than in primary forests. Thus, the lower number of taxa detected in the latter might reflect rather field constraints than true differences.

**Statistical Analysis.**

Statistical tests were done by means of SAS® (Statistical Analysis System) and STATISTICA® PC packages. All tests were two-tailed with alpha set at 5% . Data were tested for normal distribution by Kosmogorov-Smirnov test before applying parametric statistical procedures, otherwise non-parametric statistical tests were used.

**Table 9:** Transects studied in the region of Port Harcourt (Rivers State, Nigeria) including local names and geographic coordinates of the study areas.

Transect	Name of Place	Latititude	Longitude
T1	Kreigeni	0° 17'59.2	E 006° 37'41.3
T2	Abarikpo	N 05° 08'11.9	E 006° 37'45.7
T3	Otari	N04° 53'22.3	E 006° 41'19.7
T4	Rumuji	N04° 57'19.3	E 006° 46'28.1
T5	Orubiri	N04° 42'25.6	E 007° 01'13.6
T6	Soku-Elem Sangama	N04° 40'39.8	E 006° 40'54.2
T7	Tombia Forest	N04° 46'34.9	E 006° 53'65.9
T8	Tombia Mangrove	N04° 44'50.9	E 006° 51'53.9
T9	Orashi River	N04° 44'43.1	E 006° 38'10.1
T10	Peterside(Bonny)	N04° 29'14.9	E 007° 10'04.8

**Table. 18:** Diversity and numerical abundance of wildlife and fish killed by the Tebidaba oil spill of 2005, Bayelsa State (in 100m x 100m plots).

Class	Species	Family	UIZ	SIZ	IMZ	GIZ	Total
Aves	<i>Tokus fasciatus</i>	Bucerotidae	0	0	2	5	7
	<i>Egretta sp</i>	Ardeidae	0	1	0	3	4
	<i>Halcyon malimbicus</i>	Alcedinidae	0	0	2	2	4
	<i>Unident. Spp</i>	-	0	2	1	4	7
Reptilia	<i>Varanus ornatus</i>	Varanidae	0	0	0	2	2
	<i>Grayia smithy</i>	Colubridae	0	1	3	8	12
	<i>Afronatrix anoscopus</i>	Colubridae	0	0	1	4	5
	<i>Boulengerina annulata</i>	Elapidae	0	0	0	2	2
Pisces	<i>Pelusios niger</i>	Pelomedusidae	0	0	2	0	2
	<i>Tilapia sp</i>	Cichlidae	0	5	9	37	51
	<i>Mugil sp</i>	Mugilidae	0	0	11	13	24
	<i>Ethmalosa fimbriata</i>	Clupeidae	0	0	14	23	37
	<i>Chrysichthyes sp</i>	Bagridae	0	0	5	7	12
	<i>Pseudotolithus sp.</i>	Sciaenidae	0	0	8	0	8
			Total no .of animal killed =	0	9	58	110
			Margalef index =	0	1.3654	2.4628	2.3402
			Menhinicks =	0	2.6985	5.4589	5.5349
			Diversity indices				
			Shannon diversity (H')	0	1.1491	2.0736	2.0104
			Shannon-Wiener Index (H)	0	0.4990	0.9006	0.8731
			Evenness (E')	0	0.8289	0.8648	0.8090
			Simpson's Dominance(S)	0	0.3827	0.1516	0.1866



Tebidaba axis, thick layers of the oil accumulated near the outfall, from where it was dispersed by water current and flood to Kalatoru and Isolotubo rivers (small distributaries of Sangana rivers), causing a lot of damage to the environment. For many days the environment was pungent with the volatile components of the crude in the air. In the bid to clear the oil, the affected vegetation was burnt by some unknown person, thereby worsening the biodiversity loss and the damage already done to the ecosystem. **Fig..3** shows segments of the tall economic trees and the caudal vertebrae of a crocodile killed in the jeopardized ecosystem. Following the oil spill various wildlife were found dead; some floating on the surface water and others on the shore. An inventory of wildlife mortality presented in **table 15...** shows that a total of 177 vertebrate wildlife species were killed, which consisted of three avian species and a few unidentified species, oiled beyond recognition. The reptilian fauna comprised of Daudin monitor lizard, *Varanus ornatus*, 2 colubrid and 1 elapid snake and 1 terrapin, *Pelusios niger*. No mammalian or amphibian casualties were recorded in the area. Perhaps, they were smart enough to avoid the spill and fire. The four species of fish killed were typical euryhaline fishes of Sangana estuary. Generally, wildlife mortality in the IMZ and GIZ were higher than those of SIZ six and twelve folds respectively.

**Table 10:** Main habitat types present in study transects T1 to T10 of the Port Harcourt region (Rivers State, Nigeria) NH-Number of habitat types; NI-Number of individuals; NT-Number of taxa; NTII-Number of transects in which a given habitat type was found. Data under NI and NT exclusively represent the results of the standardized sampling for the quantitative analyses.

Habitat type	T 1	T2	T3	T4	T5	T6	T7	T8	T9	T10	NTH	NI	NT
Primary dry Rainforest	-	-	X	-	-	-	-	-	-	X	2	19	7
Secondary dry forest	X	-	X	-	-	X	X	-	X	X	6	119	13
Scrubland	X	X	-	X	X	-	X	-	X	X	7	57	8
Primary Swamp forest	-	-	-	-	-	X	-	-	-	-	1	15	6
Secondary Swamp forest	-	-	X	-	-	X	X	-	-	X	4	52	13
High Mangrove	-	-	-	-	-	-	-	X	-	-	1	43	5
Low Mangrove	-	-	-	-	X	-	X	-	-	X	3	7	3
Farmland and cultivation	X	X	X	X	X	X	X	-	X	X	9	107	3
Freshwater body	X	-	X	-	-	X	-	-	X	X	5	7	3
NH	4	2	5	2	3	5	5	1	4	7			
NI	26	11	48	36	13	26	81	43	90	52			
NT	6-7	3-4	5-6	4-5	1-2	4-5	7-8	5-6	7-8	7-8			

## Results

Vice Chancellor, Sir,

On the basis of the methods applied we recorded the presence in the studied area, a total of 60 reptilian species; namely 3 Crocodilians, 7 chelonians, 13 saurians, 37 Ophidians (snakes), as presented in table.. Of the 37 snakes only 14 species(38%) are poisonous, namely- *Bitisgabonica*, *B. narsicornis*, *Causus maculatus*, *Najanigracollis*, *N. melanoleuca*, *Pseudohaje goldii*, *Dendroaspis jamesoni*, *Dispholidustypus*, *Theletornis kirtlandi*,

We observed that the 10 studied transects covered different spectra of habitat types each, and varied significantly in terms of reptile species diversity, dominance and abundance. As a rule, both dry and swampy primary and secondaryrainforests harbored a significant excess of species compared with the mangroves. Lizards were the most abundant

reptiles. Species of the compared with the mangroves. Genus *Mabuya* were numerically dominant except in cultivated lands and suburbs, where *Agamaagama* was the dominant lizard. In most localities there was a remarkable variety of snake species, but only six (*Gastropyxis smaragdina*, *Psammophis phillipsi*, *Naja nigricollis*, *Python regius* in terrestrial habitats and *Afronatrix anoscopus*, *Grayia smythii* in aquatic habitats) were regularly found.

The number of habitat types and the number of reptile species recorded per transect were positively correlated ( $p < 0.05$ ), but the general pattern was mainly due to the snakes. Dominance index of reptile species and number of habitat types registered per transect were not significantly correlated. This is a counter-intuitive result as one would expect: the higher the number of macrohabitats available, the lower the dominance of a single species. When *Mabuyas* was excluded from the analysis, the expected negative relationship between these variables was obtained ( $p < 0.05$ ).

Some negative effects of industrial gas and oil transmission and extraction activities on the biodiversity and abundance of reptiles in the Niger Delta area were projected. *Crocodylus niloticus* and *C. cataphractus* appear to be extremely rare. To avoid impoverishment of reptilian diversity, multinational oil industries should no longer lay their oil and gas transmission installations through primary and secondary rainforest patches, which house both the highest diversity of taxa and the highest densities of reptile specimens.

process, there will be weathering, and the oil concentration progressively decreases as the floating oil travels to distant places. Where the traveling oil is intercepted by barriers, however, the oil gathers again. Consequently, the concentration of oil therefore becomes unpredictable. Oil lost into most rivers and streams often collect along the shorelines or banks, where the oil sticks to floating and submerged macrophytes. Such littoral vegetation is the spawning ground of most organisms including - fish, frogs, shrimps, aquatic insects, spiders, leeches, etc., as well as fish-eating birds, reptiles and mammals. Thus, these vegetation and associated fauna are at great risk when the oil arrives the shorelines.

#### (ii) Oil spill in lentic freshwater environment

Most pipelines pass through environmentally sensitive habitats like lakes, freshwater ponds, swamps, often covered with vegetation. On rupture of the pipeline, large volume of oil may be released into such lentic or stagnant water, leading to a huge loss of biodiversity. Because lentic waters are like water in a basin, which flows to no place, it tends to incur more severe effects than lotic or running water. If the oil spill is not controlled in time, the thickness of the spilled oil builds up, and can remain there for a pretty long time. By dry season when the water level gets to the bottom of the swamp or pond, the oil infiltrates into the soil and eventually contaminates groundwater. As the water level rises again wet season, the oil slicks floats again on the water surface, killing any surviving animals and macrophytes.

#### Case studies of oil spill effects on biodiversity of freshwater ecosystem in the Niger Delta.

##### (a) Tebidaba Oil Spill of 2005 in Southern Ijaw LGA of Bayelsa State

Typical cases of the effect of oil spill on freshwater ecosystems in the Niger Delta was the Tebidaba oil spill of 2005 in southern Ijaw LGA of Bayelsa State. The spill was traced to rupture from corrosion of the Tebidaba–Brass pipeline in OML 63, which traverses series of brackish water, seasonal freshwater swamps and streams including major rivers like the Sangana and Nun. With the rupture of this pipeline at the

## General Effects of oil spill on Aquatic Organisms (including invertebrates).

Blummer (1970, 1972) summarized the potential damage to organisms consequent upon oil spill as:

- Direct kill of organisms through coating and asphyxiation
- Direct kill through contact poisoning of organisms
- Direct kill through exposure to the toxic Water Soluble Fractions (WSF) of the oil at some distance in space and time from the accident or outfall.
- Destruction of the generally more sensitive juvenile forms of organisms.
- Destruction of the food sources of higher species.
- Incorporation of sub-lethal amounts of oil and oil products into organisms, resulting in reduced resistance to infection and other stresses - the principal cause of death in birds surviving immediate exposure to oil.
- Incorporation or accumulation of the carcinogenic and potentially mutagenic chemicals in marine organism, since these substances are recalcitrant.
- Low-level or subtle effects which may interrupt events in the ecosystem such as prey location, predator avoidance, mate location or other sexual stimuli and homing behavior, all of which are necessary for the propagation of marine species and for the survival of those species higher in the marine food web.

## Effects of oil Spill on Freshwater Biodiversity

### (i) Oil spill in Lotic environment (Rivers and Streams)

The effect of oil spill has been known to vary according to the type of receiving habitat. For instance, oil discharged into running or lotic waters like the ocean, rivers, creeks, streams, will instantly, be dispersed from the outfall to other parts of the system by the current. The rate of dispersion of course will depend on the current speed, presence/absence of barriers, rapids, etc., along the route. Thus, in the

Table 11: Checklist of Reptiles of the eastern Niger Delta

Reptile taxa	Species
Crocodylia (Crocodiles)	<i>Crocodylus niloticus suchus</i> GEOFFROY, 1807
	<i>Crocodylus c. cataphratus</i> CUVIER, 1789
	<i>Osteolaemus t. tetraspis</i> COPE, 1861
Chelonia (Turtles)	<i>Pelomedusa subrufa olivacea</i> SCHWEIGGER, 1812
	<i>Pelusios castaneus</i> SCHWEIGGER, 1812
	<i>Pelusios niger</i> DUMERIL & BIBRON, 1835
	<i>Trionyx triunguis</i> FORSKAL, 1775
	<i>Kinixys bellina nogueyi</i> (LA-TASTE, 1886)
Sauria (Lizards)	<i>Kinixys erosa</i> SCHWEIGGER, 1812
	<i>Kinixyshomeana</i> BELL, 1827
	<i>Varanus ornatus</i> (DAUDIN, 1803
	<i>Chamaeleo gracilis</i> HALLOWELL, 1842
	<i>Chamaeleo oweni</i> GRAY, 1831
	<i>Agama agama</i> LINNAEUS, 1758
	<i>Hemidactylus brooki-angulatus</i> HALLOWELL, 1854
	<i>Hemidactylus fasciatus fasciatus</i> GRAY, 1845
	<i>Hemidactylus mabouia</i> (MOREAU DE JONNES, 1818)
	<i>Lygodactylus conrauiconraui</i> TORNIER, 1902
Ophidia (Snakes)	<i>Lygodactylus fischeri</i> BOULENGER, 1890
	<i>Mabuya affinis</i> (GRAY, 1839)
	<i>Mabuya maculilabris maculilabris</i> (GRAY, 1845)
	<i>Mochlus (Riopa) fernandii</i> (BURTON, 1836)
	<i>Penaspis togoensis</i> WERNER, 1902.
	<i>Calabaria reinhardtii</i> (SCHLEGEL, 1848)
	<i>Python regius</i> (SHAW, 1802)
	<i>Python sebae</i> (GMELIN, 1788)
	<i>Dispholidus typus typus</i> (SMITH, 1829)
	<i>Thelotornis kirtlandii</i> (HALLOWELL, 1844)
	<i>Rhamnophis aethiopissa</i> GÜNTHER, 1862
	<i>Grayia smythii</i> (LEACH, 1818)
	<i>Philothamnus heterodermus heterodermus</i> (HALLOWELL, 1857)

Reptile taxa	Species
	<i>Natriciteres fuliginoides</i> (GÜNTHER, 1858)
	<i>Natriciteres variegata variegata</i> (PETERS, 1861)
	<i>Afronatrix anoscopus</i> (COPE, 1861)
	<i>Mehelya crossi</i> (BOULENGER, 1895)
	<i>Mehelya guirali</i> (MOSQUARD, 1887)
	<i>Mehelya poensis</i> (SMITH, 1847)
	<i>Gastropyxis smaragdina</i> (SCHLEGEL, 1837)
	<i>Hapsidophrys lineatus</i> FISCHER, 1856
	<i>Aparallactus modestus modestus</i> (GÜNTHER, 1859)
	<i>Lamprophis virgatus</i> (HALLOWELL, 1854)
	<i>Bothrophthalmus lineatus lineatus</i> (PETERS, 1863)
	<i>Meizodon coronatus</i> (SCHLEGEL, 1837)
	<i>Toxicodryas blandingi</i> (HALLOWELL, 1844)
	<i>Toxicodryas pulverulenta</i> (FISCHER, 1856)
	<i>Dipsadoboa duchesnii</i> (BOULENGER, 1901)
	<i>Crotaphopeltis hotamboeia</i> (LAURENTI, 1768)
	<i>Psammophis phillipsi</i> (HALLOWELL, 1844)
	<i>Polemon collaris brevior</i> (WITTE & LAURENT, 1947)
	<i>Dasypeltis fasciata</i> SMITH, 1849
	<i>Dendroapsis jamesoni jamesoni</i>

- Irritation of mucous membranes (such as those in the nose, throat and eyes) leading to inflammation and infection.
- Eyes may be contaminated, either because there is oil in the sand high up on the beach at the nesting site, or because the adult turtles are oiled as they make their way across the oiled beach to the nesting site.
- Oiling of eggs may inhibit their development or cause developmental defects
- An oiled beach at the time of hatching may debar the hatchlings from making their way back to water.

### Effects of oil spill on Marine Mammals

Effects of oil on marine mammals are dependent upon species but may include:

- Hypothermia due to conductance changes in the skin, resulting in metabolic shock.
- Toxic effects and secondary organ dysfunction due to oil.
- Damages of the airways and lungs, congestion, pneumonia,
- Interstitial emphysema and even death, due to inhalation of oil droplets, oil fumes and vapor.
- Gastrointestinal ulceration and hemorrhaging due to ingestion of oil during grooming and feeding.
- Eye and skin lesions from continuous exposure to oil.
- Damage of red blood cells, and damage and failure of visceral organs like the liver.
- Damage and suppression of the immune system, sometimes predisposing them to secondary bacterial or fungal infections.
- Decreased body mass due to restricted diet and
- Stress due to oil exposure, and behavioral changes - they become too ill to hunt or breed.



their stomach. In severe cases of spill many birds, mammals and sea turtles, die as recorded in the Exxon Valdez oil spill in Alaska of 1989, Persian Gulf War spill of 1991, and the Gulf of Mexico spill of 2010.

### Effects on birds

Birds diving into oiled water soon drown as the natural repellency of the water is lost. Besides, the heavy feathers weigh them down the more and their sticky feather can no more trap enough air between them to keep them buoyant. Such incapacitated or disabled birds become easy preys, as they lose ability to flee from predators. With time hypothermia (cold condition) sets in, as the insulation and waterproofing properties of the feather are lost (Holmes and Cronshaw 1977) and the bird gives up diving and swimming for food. Ingested oil can damage the bird's adrenal tissue which interferes with the bird's ability to maintain blood pressure and concentration of fluid in its body. It can also interfere with the bird's breeding behavior such as; its sitting on eggs or by reducing the size and number, the bird normally lays.

### Effects on Marine Reptiles (Sea turtles).

All species of marine turtles are endangered, namely –Kemp's Ridley, Green turtle, Hawksbill, and leatherback. They are very graceful and long-distance swimmers. Some are known to traverse the Atlantic ocean during their breeding season to nest on the beaches of the Gulf of Guinea. Akani and Luiselli (2011) reported the annual spawning migration of some marine turtles to Akassa, in Bayelsa State and occasionally in Brass, St. Nicholas, Bonny Is, Andoni and Ibeano, to nest. Sea turtles are obligate air breathers, and if in the course of their spawning migration they encounter oil spilled water, their eyes will be affected and they usually ingest oil to the extent of blocking their airways or lungs and filling their stomach. Other effects are by intake of contaminated food supplies and by absorption through the skin. Sea turtles are also very vulnerable at beach nesting sites during the breeding season. Nesting site are typically on sandy beaches, which if oiled, can lead to the following problems:

- Digestion/ absorption of oil through food contamination or direct physical contact, leading to damage to digestive tract and accessory organs.

**Table 12:** Reptile species including numbers of specimens (n) and their proportional shares (%n) as found in the quantitative biodiversity analysis in T1 - T10

Transect	Species	N	%n
T1	<i>Agama agama</i>	2	7.69
	<i>Mabuya sp</i>	18	69.23
	<i>Mochlus fernandii</i>	2	7.69
	<i>Dendroaspis jamesoni</i>	2	7.69
	<i>Dispholidus typus</i>	1	3.84
	<i>Grayia smythii</i>	1	3.84
	Sum T1	26	100
T2	<i>Mabuya sp.</i>	6	54.54
	<i>Mochlus fernandii</i>	3	27.27
	<i>Agama agama</i>	2	18.18
	Sum T2	11	100
T3	<i>Mabuya sp.</i>	32	66.67
	<i>Mochlus fernandi</i>	1	2.08
	<i>Agama agama</i>	12	25.00
	<i>Dendroaspis jamesoni</i>	1	2.08
	<i>Naja melanoleuca</i>	2	4.16
	Sum T3	48	100
T4	<i>Mabuya sp.</i>	24	66.66
	<i>Mochlus fernandii</i>	1	2.78
	<i>Agama agama</i>	8	22.22
	<i>Gastropyxis smaragdina</i>	3	8.33
	Sum T4	36	100
T5	<i>Mabuya sp.</i>	13	100
T6	<i>Mabuya sp.</i>	21	80.76
	<i>Dendroaspis jamesoni</i>	3	11.54
	<i>Natriciteres variegatus</i>	1	3.85
	<i>Naja nigricollis</i>	1	3.83
	Sum T6	26	100
T7	<i>Agama agama</i>	38	46.91
	<i>Mabuya sp.</i>	32	39.51
	<i>Panaspis togoensis</i>	3	70
	<i>Varanus niloticus</i>	1	1.23
	<i>Thelotornis kirtlandii</i>	3	3.70
	<i>Dendroaspis jamesoni</i>	2	2.46
	<i>Natriciteres variegatus</i>	2	2.46
Sum T7	81	100	

<b>T8</b>	<i>Mabuya sp.</i>	21	48.83
	<i>Agama agama</i>	17	39.53
	<i>Varanus niloticus</i>	1	2.32
	<i>Grayia smythii</i>	2	4.65
	<i>Naja nigricollis</i>	2	4.65
	Sum T8	43	100
<b>T9</b>	<i>Mabuya sp.</i>	47	52.22
	<i>Agama agama</i>	31	34.44
	<i>Mochlus fernandii</i>	4	4.44
	<i>Psammophis phillipsi</i>	2	2.22
	<i>Gastropyxis smaragdina</i>	3	3.33
	<i>Naja nigricollis</i>	2	2.22
	<i>Python regius</i>	1	1.11
Sum T9	90	100	
<b>T10</b>	<i>Mabuya sp.</i>	40	76.92
	<i>Agama agama</i>	4	7.69
	<i>Varanus niloticus</i>	2	3.85
	<i>Gastropyxis smaragdina</i>	3	5.77
	<i>Naja melanoleuca</i>	1	1.92
	<i>Naja nigericollis</i>	1	1.92
	<i>Bitis gabonica</i>	1	1.92
Sum T10	52	100	

**Table 13:** Values of Margalef's diversity index(D) and Berger-Parker's species dominance (d) for the study transects T1 to T10

Transect	D	d
T1	1.538	0.692
T2	0.834	0.545
T3	0.465	0.667
T4	0.837	0.667
T5	0.000	1.000
T6	0.920	0.807
T7	2.733	0.469
T8	1.063	0.488
T9	4.050	0.522
T10	1.800	0.769

Additional contributions to the diversity and ecology of Niger Delta herpetofauna (Reptiles and Amphibians) are available in Akani and Luiselli. 2001, 2002; Akani *et al*, 1998, 1999b, 2001a, 2002a, 2002b, 2003, 2004, 2005; as well as in Luiseli and Akani (1998,2003, 2003a 2003b), Luiselli *et al* ( 1998, 1998b 1998c, 1999; 1999b, 2000a, 2000b, 2002, 2004b, 2005, 2006a, 2006b), etc.

escape from predators or enemies, ability to choose a habitat, recognize territory, migrate, communicate and reproduce. Patten (1977) noted that the abnormal behavior of fish exposed to hydrocarbon contamination may be in part related to anoxia since the possible mechanism leading to anoxia of such exposed fish could be central nervous system depression, loss of oxygen-carrying capacity of erythrocytes, cardiac disruption and failure.

Sandborn (1977) identified five possible ways by which oil can damage a local population of fish:

- Eggs and larvae can die in spawning or nursery areas due to coating or direct toxic effects. Even at low levels, oil can cause growth deformities and death in fish larvae.
- Adults can die or fail to reach spawning grounds in critical spawning grounds in critical, narrow, or shallow contaminated waterways.
- Local breeding populations may lose orientation or be lost due to contamination of spawning grounds or nursery areas.
- Fecundity (number of eggs produced by a female) and/ or spawning behavior may be altered.
- Local food species of the adult, juveniles, fry or larvae may be adversely affected or eliminated.

In fact, the greatest effect of oil spill on any fish population is recorded when the spill occurs during the peak of its spawning season.

### Effect of oil spill on wildlife

Oil affects wildlife by coating their bodies with a thick layer, when they dive in to swim. In the process their sense organs like eye, ears, skin, may become so affected that they lose orientation and get confused. As the oil comes in contact with the eyes and skin of the aquatic wildlife it can cause conjunctivitis and blindness, irritation or ulceration of skin, mouth or nasal passages. Hairs, in the case of mammals, and feathers of birds become heavy with oil sticking on them. Oil that sticks to furs and feather (usually crude oil) can cause many problems. Oil that gets into the digestive tract as they eat or drink can cause ulcer or bleeding in

waters, as biodegradation activities of the bacteria are slowed down by low temperature, and low oxygen concentration of water. In nutrient rich waters, biodegradation is known to be greatly enhanced.

### Effect on plankton

The first group of organisms usually affected by aquatic oil pollution is the plankton. This is predominantly the microscopic plants (phytoplankton) and animals (zooplankton) which float, and drift on water surface aided by water current. They are easily smothered by the floating oil, because they also float, and are unable to swim away, to avoid contaminated areas. The unicellular algae that make up the phytoplankton assemblage are the principal primary producers in the ocean. The zooplankton (e.g. microcrustaceans, oyster larvae, fish larvae and developmental stages of various animals in the water) are the principal herbivores and secondary consumers that form a critical link in the marine food web. The plankton float because they have one or more of the floating adaptations: small or tiny body size, conferring low density, body cavity, oil droplets, numerous bristles on their body which trap air bubbles, Thus, an oil spill affecting the plankton may have the consequences of reducing the productivity and the diversity of the community which in turn may directly impact on the food web. The ingestion of oil by these animals and the incorporation of petroleum components into tissues can be the point of entry petroleum hydrocarbons in the marine food web producing possible biomagnification at the higher trophic levels.

### Effect of oil spill on fish

In sheltered environments, such as in mangrove swamps a lot of fish are overtaken by the advancing oil to the shore, while some adults may escape by avoidance reaction (Patten, 1977) especially, subsurface swimmers. Some fish rather than keep away from oil floccules or balls, are attracted to them, as they look like floating food. Fish overtaken by oil are tainted and the gills eventually become clogged by oil and lose ability to absorb dissolved oxygen in water, the fishes die of asphyxiation. Those rendered moribund by sublethal concentrations of the oil, may lose their ability to secure food, ability to avoid injury, or

Based on the two decades of study of the snakes of the Niger Delta, a key for identification of Snakes of the South-eastern Nigeria was developed by Luca Luiselli to ease snake identification for any interested researcher in future.

### Investigations Into Avian Incursions Around Gas Flare. Akani , G.C. (2008)

Vice Chancellor, sir In the course of my Ph.D project I observed severally the relative abundance of some avian species around gas flare stacks. Driven with curiosity, I decided to investigate the activity patterns of birds in the vicinity of the stacks. In three stations, namely - the flare site of SPDC flowstation in Rumuekpe ; TotalFina Elf flowstation at Obagi; and AGIP flow station at Ebocha. Each station was visited five times in dry and five times in wet season, during which the types of birds hovering around the flare was recorded and counted for one hour, using a pair of binoculars (Fujiyama model). I observed that certain birds were habitually attracted to the flare, while others avoided the stack. Thus, the study was extended to determine the frequency of visit., and to determine the reason behind their incursion and to discuss the ecological implication.

Results on the frequency of incurs in both seasons are presented in the pie charts. (table ). This shows that the commonest visitors to the gas flare stacks were the raptors namely – the Black kites, *Milvus migrans*, Chicken Hawk, *Accipiter erythropus*, Lizzard Buzzard, *Kaupifalcomonogrammicus*, Pied Crow, *Corvus albus*, etc. The chart indicates that in all the sample stations, kites had the highest frequency of incursion both in dry and wet season, followed by hawks and Pied Crow. It was observed that these raptors dive into the black part of the flame and spiral skywards, and repeats the movement.

Another avian taxon that is associated with the gas flare stack are the Ploceidae (weavers family), particularly the Village weaver, *Ploceus cucullatus*, Spectackled weaver, *Ploceus ocularis*, and Black-headed Weaver, *Ploceus melanocephalus*. The Weaver frequency around the gas flare stack became more significant in rainy season, which corresponds with their spawning season (Serle *et al*, 1977). At Alakiri,

Nembe, Rumuekpe, and Ebocha, series of weaver nests were found in the neighbouring vegetation at distances less than 200 m. from the stack. Examination of these nests revealed the presence of at least two hatchlings in 58%, 35%, 63% and 72% of nests assessed in these Alakiri, Nembe, Rumuekpe, and Ebocha stations respectively. This suggests that the weavers select gas flare areas for spawning.

Avian incursion towards gas flare stacks recorded in this study have not been reported in any environmental studies in the Niger Delta, in spite of the several gas flaring stations which abound in the region. The Pie chart makes it abundantly clear that the raptors and weavers have strong affinity for the flare, and the kites, followed by hawks had the greatest propensity to visit gas flare stacks, in both dry and wet seasons.

Naturally, Kites and hawks are diurnal birds of prey and would always hover around burning bushes in search of offal (roasted animals like lizard, rats, snail, etc). The smoky air serves as a stimuli attracting these birds to the flare. It is not unlikely that the response is instinctive, since they repeated visit the smoky flare even as they do not find any offal. It is also possible that they are attracted because they enjoy the warmth provided by the burning gas or the smell of the gas. Hence they afforded to tolerate the noise generated as the gas rushed out of the stack nozzle

UMUEKPE WET SEASON

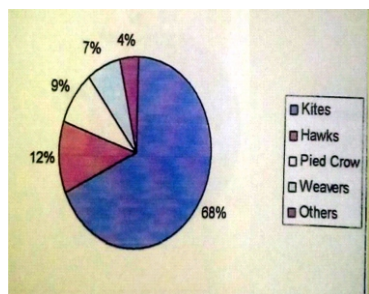


Plate 2

RUMUEKPE DRY SEASON

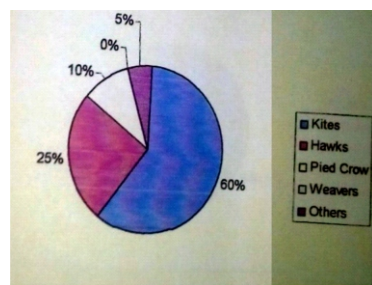


Plate 3

Percentage frequency of Avian incursion around Rumuekpe Gas flare Stack in Wet and Dry season.

### Composition and fate of spilled oil.

Crude oil and refined oil are composed of hundred of substances with widely differing physico-chemical properties. Indeed, no two crude oil from different sources have the same properties. Among the important components of the oil are:-Alkanes, Alkenes and Alkynes, the low – boiling aromatic hydrocarbons and sulphur, heavy metals. Once spilled in water, the oil floats, spreads to other parts by current, during which emulsification and weathering occurs, and the alkanes components evaporates and fills the air with their pungent smell for about 2 days or more days, depending on the severity of the spill. The Alkene and Alkyne components which are not easily degraded because of their double and triple bond content remain on the water surface and form floating tar-like globs that can be as big as tennis ball, while other chemicals sink to the ocean bottom or collect at the seashore, after several days. The Water Soluble Fractions (WSFs) such as the low-boiling aromatic hydrocarbons are the primary cause of immediate mass kills of a great variety of aquatic organisms – fish, mollusk, crustaceans, turtles, mammals, plantation, seaweed, mangrove plants etc. The fish are usually tainted and many of them die as they accumulate oil by drinking the medium. Some oil components find their way into the fatty tissues of some fish and shell fish, making the fish and shellfish unfit for human consumption because of their oily taste. Sometimes the fish accumulates sub-lethal concentrations of the petroleum hydrocarbons causing subtle changes in the organisms. For example, some lobsters and some fish may lose their abilities to locate and capture food, avoid injury, escape enemies, find a habitat, communicate, migrate and reproduce.

Floating oil reduces the natural repellency of water. As a result, buoyancy is reduced causing diving birds to drown as they dive into the water. Birds are also known to die from ingesting oil and oil-coated fish, due to the sulphur content and other components of the oil.

The disappearance of oil from water after spillage occurs naturally by biodegradation process due to indigenous bacteria aided by aeration from current and wave action. But the complete recovery of the water is very slow. It takes about 3-5 years in the warm tropical and subtropical chemicals and a much longer time in the colder arctic and Antarctic



on this categorization it is evidentially clear that the most devastating oil spill incidents in the coastal Niger Delta, (*see table.17*) fall into the Major spill category.

**Table 16:** Categorization of oil spills in terms of quantity and type of affected environment in Nigeria.

Category	Quantity	Type of Environment
Minor	Less than 25 barrels	Inland waters
	Less than 250 barrels	On land, offshore or coastal waters
Medium	Between 25 -250 barrels	Inland waters
	Between 250-2500 barrels	On land, offshore or coastal waters
Major	Over 250 barrels	Inland waters
	Over 2500 barrels	On land, offshore or coastal waters

Source: Ifeadi and Nwankwo, 1987

**Table 17:** Some of the most devastating oils spill incidents in the Niger Delta

Location of spill	Date	Barrels of oil lost	Affected IOC
Gocon's Escravos	1978	300,000	Chevron
Forcados Terminal tank failure	1978	500,000	SPDC
Apoi 20 Blowout	1980	-	Texaco
Funiwa 5 blow-out	1980	400,000	Texaco
Oyakama oil spill	1980	30,000	
Abudu Pipeline spill	1982	18,818	SPDC
Jesse fire incidence (pipeline vandalism)	1998	40,000	NNPC
Idoho	1998	40,000	MPNU
Yorla	2001	53,000	SPDC

SPDC = Shell Petroleum Development Company, NNPC; NNPC = Nigerian National Petroleum Company; MPNU=Mobil Petroleum Nigeria Unlimited.

EBOCHA WET SEASON

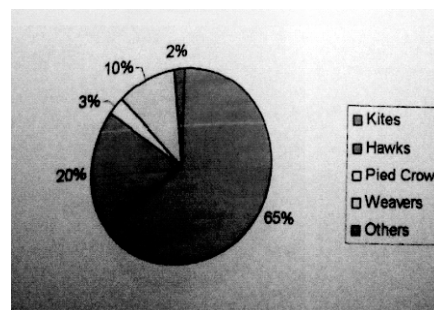


Plate 4

EBOCHA DRY SEASON

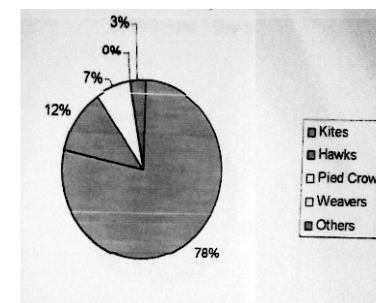


Plate 5

Percentage frequency of Avian incursion around Ebocha Gas flare Stack in Wet and Dry season.

OBAGI WET SEASON

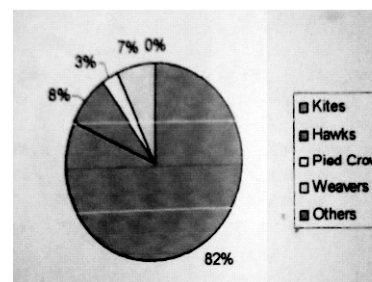


Plate 6

OBAGI DRY SEASON

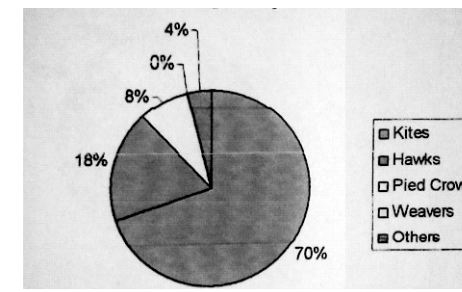


Plate 7

Percentage frequency of Avian incursion around Obagi Gas flare Stack in Wet and Dry season.

*By spiraling skywards in the gas flare smoke, the chances are high that these birds must be inhaling considerable amount of the natural gas components – SO<sub>x</sub>, CO<sub>x</sub>, NO<sub>x</sub>, and particulate matter associated with the flare. These raptors therefore stood the chance of deleterious health hazards as they inhaled a number of different products formed. Cantox Environmental (2007) reported that when natural gas was burnt, a number of different combustion products were formed, depending on the efficiency of burning. If the combustion efficiency was very high (>99%), the main products of combustion were carbon dioxide and water. However, such ideal condition was rarely met during the routine flaring of natural gas. As most*

*combustion efficiency fell within the range of 65 -95%, carbon dioxide remained the major product, accompanied by a number of minor chemicals collectively referred to as Products of Incomplete Combustion (PIC). The PICs include – unburned hydrocarbons, particulate matter (soot and ash); Volatile Organic Compounds (VOCs) such as benzene, toluene, xylene; Polycyclic Aromatic Hydrocarbons (PAHs) as well as chemicals such as aldehydes and ketones. Studies indicate that most of these minor chemicals are bound up to the particulate matter.*

It was also observed that research on the accumulation and effects of gas flare pollutants by birds are lacking. Examination of the lungs, liver, and blood parameters of such birds could be an indicator of air quality around gas flaring sites.

The selection of trees in the vicinity of gas flare stations, as nesting sites by weavers in the Nigeria was reported for the first time by Akani (2008). He opined that they are attracted by the elevated temperature of the environment due to gas flaring, which possibly enhanced hatchability of their eggs by shortening the incubation period; because 80% of all the weaver nests examined in all the stations contained some hatchlings. He also reported that the bulk of the nests were 100 – 200m away from the stack.

It is worth mentioning that since the survey was conducted during daylight, the nocturnal incursion of birds to gas flare sites might have been under-represented. Obviously nocturnal birds like the owl and nightjar were likely to avoid gas flare sites as they were usually very uncomfortable in such intensely illuminated environment. For the same reason, gas flare sites constituted an exclusion zone for nocturnal mammals like bats and shrews.

From ecological standpoint, it is not out of place to contend that avian incursions to gas flare zone tantamount to niche expansion. An animal's ecological niche is fundamentally described as its unique way of life (lifestyle) including how it utilizes habitat resources, and how it affects the environment and other organisms (Odum, 1971; Madar, 2002). Aggregation of such 'GASOPHILIC' birds around gas flare sites is considered a niche expansion because it would certainly reduce the

like USSR, Saudi Arabia, Kuwait, Iran, Iraq, Libya, Nigeria, Gabon, USA, Venezuela, Mexico, China, and Indonesia are prone to oil pollution, and the sources of oil spill are traceable to:

- Oil tanker accident – collision with other ship, explosion and ground/wrecking..
- Well blow out/ mechanical failure of oil facilities
- Pipe bursting
- Deballasting operations – washing of oil equipment and tanks
- Natural seepage from offshore installations.
- Routine loading and unloading of oil at oil terminals or jetties
- Sabotage – willful, criminal damage of oil facilities with a view to attracting compensation from the company owing the facilities. Most sabotage cases are politically motivated.

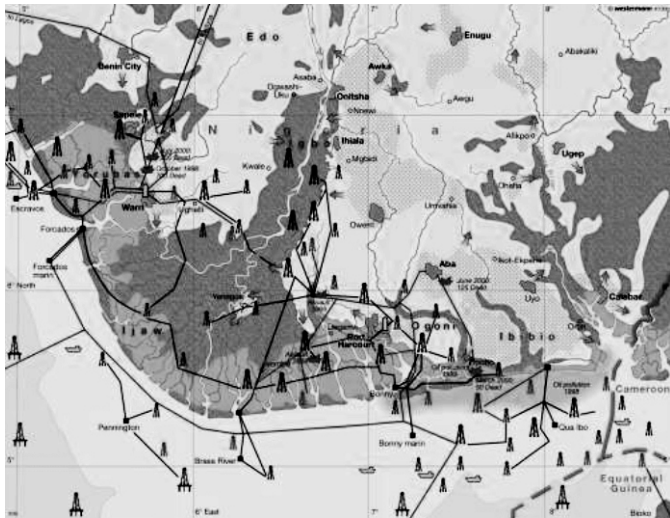
Here in the Niger delta, where over 80% of Nigeria's oil comes from several incidents of oil spill have been recorded. Many workers (Nwankwo and Irrechukwu 1981; Okoye *et al* 1987, Akani 2008 )have attributed the major spills in Nigeria to:

- (i) Pipeline leakage and rupture from corrosion.
- (ii) Tank leakages and overflows
- (iii) Sea tanker and road tanker accidents/ collision
- (iv) Equipment failure – malfunctioning of valves and pumps; including pumps at jetties or depots and hose ruptures.
- (v) Pipeline vandalism.

### **Size/ quantity of oil Spill.**

Following the incessant cases of oil spill in Nigeria, it has become necessary for accurate record-keeping and management to know the size or quantity of any oil spill, since the toxicity of oil on biodiversity has some correlation with the quantity lost to the environment. In a symposium, Ifeadi and Nwankwo (1987) presented a categorization of oil spillages in terms of quantity and type of the receiving environment, which is adopted today in the Nigerian oil industry (see table 16). Based

country, oil spill incidents have severally been traced to Corrosion, pipeline leak, equipment failure, Sabotage/vandalisms (NNPC. Ifeadi &Nwankwo , Ekweozor, IPS, Akani, 2008). Statistical records reveal that the bulk of the oil spill incidents occur onshore and inshore, while offshore cases are much fewer (Akani, 2008). This is attributed to the myriads of pipeline network located in this zone According to Eyo-Essien (2006) the causes of pipeline damage and leakage greatly varies, ranging from material defect and pipe corrosion to ground erosion, tectonic movements on the sea bottom and contact with ship anchors and bottom trawls particularly in the offshore operations, while vandalism is the major cause of onshore pipeline damage in Nigeria.



**Figure 3:** Map of the Niger Delta showing the myriad of pipeline network and location of other oil facilities which predisposes the eco-region to incessant oil spillage.

Oil spill constitutes one of the most devastating type of pollution in the marine and coastal environment. It is usually rampant in areas of oil productions, its transport route, terminal and ports and often several barrels of crude oil (and refined petroleum derivatives) are lost to water. Graphic cases of note, among the tanker accidents of the Torrey canyon and Amoco Cadiz. Invariably, the generality of oil producing countries

predation time of the raptors on their prey on daily basis, and also cause some shift in their distribution and breeding pattern.

Gas flaring also caused niche expansion for the weavers, because ordinarily the weavers in the Niger Delta show great affinity for oil palm and Mango tree and sometimes coconut tree as nesting site, but in the mangrove zone around SPDC's Alakiri and Nembe flowstations, the weavers now preferred nesting on the internodes of *Rhizophora* and *Avicennia* spp to other trees. Such nesting on the internode necessitated a slightly different weaving pattern from that weaved on the usual oil palm fronds.

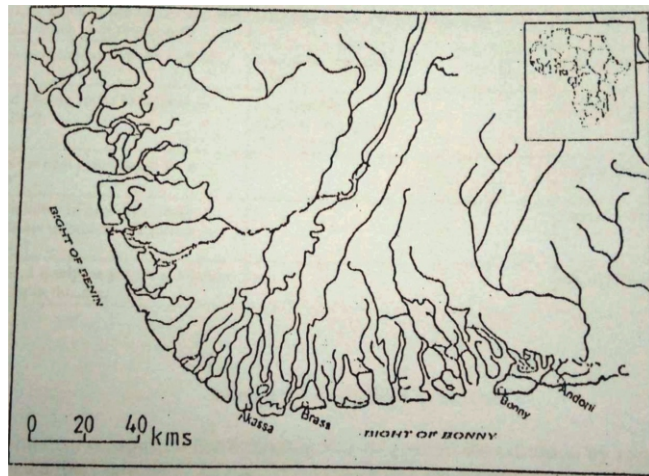
### **Diversity And Distribution Of Sea Turtles In The Niger Delta, Nigeria. Akani, G.C. and Luiselli, L (2009).**

Vice Chancellor Sir,

This work was conducted with a view to documenting the species of sea turtle that visit the coastal region the Niger Delta to spawn, as such data was almost non-existent. The site of the study was at Akassa, and Brass in Bayelsa and Bonny and Andoni in Rivers State. All sampling areas lie below latitude 4° 30' N, are characterized by broad, white, sandy beaches, ranging between 100 to 350m wide at the lowest tide, with ridges rising some 4m above the sea (NDES, 1998). The beach and sand ridge soils are composed of very coarse sand which suffer from excessive drainage and are prone to desiccation during very dry weather spells (NDES, 1998). All study sites have equatorial climatic condition, essentially warm fringing vegetation behind the sand bars and levees is often a mosaic of pockets of freshwater swamps and mangrove swamps, co-dominated by *Rhizophora sp.*, *Laguncularia sp.*, and *Pandanus candelabrum*. At intervals along the coast, especially around Bonny and Brass, little canals of 3-5m lead dark brown water from the freshwater swamps into the ocean. It is important to remark that one of our study sites, Bonny, is one of the most important coastal sites for oil and gas industry in the Niger Delta, which is the most productive oil area of the African continent (De Montelos, 1984)



## Sampling Protocol



**Figure 2:** Map of the Niger Delta showing the sampling stations

The study was based on data collected between 2005 and 2008, in the course of our herpetological surveys of the coastal barrier islands of the Niger Delta basin (Akani & Luiselli, in prep) and as part of a series of Environmental Impact Assessment (EIA) projects conducted by some oil companies and environmental/ biodiversity conservation organisations (e.g Niger Delta Wetland Centre; Fugro Consultants Nigeria Limited, Agip Oil Company Ltd., etc.). Two types of data were acquired during field surveys; (i) dealers landings (McDaniel *et al.*, 2000) and (ii) direct field search for strandings (dead turtles washed ashore, carapace) and nests. At fishing settlements of Andoni, Bonny, Brass and Akassa, we interacted with artisanal fishermen who use trawlers and long-line to fish. In the process, we examined the turtles/ carapace in their store and interviewed them on the mode of capture, site of capture, time and cultural uses of turtles in that area. These data were completed also by additional information which was acquired through 50 structured questionnaires per station (see Tab. 1) distributed to enlightened members of the society including teachers, students, traders, etc. On each trip, which lasted 4-7days, we walked 5-10km along the beaches, recording by GPS all exact sites where the

## Effects Of Oil Spill On Biodiversity - Akani, G.c. (2008).

Vice Chancellor, Sir, permit me at this juncture, to intimate the public on the effect of oil spill on biodiversity, which we depend on, for continuous sustenance of life.

As part of my doctoral and post-doctoral research, I delved into Oil spill ecology, because of the incessant oil spill that have degraded the fragile Niger Delta ecosystem, as part of my "Gown to town" research (Ekweozor, 2014) to provide clue on environmental problems that pose challenge to the society. Two approaches were involved; use of literature data and visits to oil spill sites to quantify the damages of biodiversity, since quantitative data of oil spill was virtually non-existent.

### Definition and Causes of oil spill.

An oil spill may be defined as the inadvertent release of petroleum (refined or unrefined) into the environment. In recent times however, aggrieved or disgruntled miscreants attack oil facilities to steal oil; in the process they cause oil spill - an act known as vandalism. Thus oil spill by vandalism is advertent and a criminal act. Large volumes of oil is spilled because the products are usually transported under high pressure in pipelines. Consequently, before the oil spill contingency team arrives to contain it, a lot of oil will have been lost to the environment.

### Causes of Oil Spills in the marine environment (Ocean)

The causes and deleterious effects of oil spill on ecosystems and their biota, have over the years, been the subject of great discussion by many environmentalists and activists, worldwide (GESAMP, 1977, 1990; UNEP1990; Blummer, 1970; Sandborn 1977; Baker, 1981; Cairns Jr.,1982; Nelson-Smith; Zobell, 1963 etc). Large volumes of the hard-earned oil are lost to the marine ecosystem through Tanker accidents, Well blow-out, pipeline bursting, mechanical failure, etc., while considerable quantities are also let into the system through deballasting operations, natural seepage. In Nigeria, especially in the Niger Delta eco-region, the "hub" of oil industry activities in the



**Other nesting sites.** – There are indications that turtles also visit the coastal areas of Nigeria to nest, namely the coast of Calabar and Lagos lagoon. A couple of years ago a fisherman reportedly trapped a leatherback. He was about to butcher his “bounty” for sale, when officials of Nigerian Institute of Oceanographic and marine Research (NIOMR) intervened. The turtle was bought over from the fisherman at the rate of over ₦3000 by the Institute, which eventually released it back to the Lagos Lagoon after rehabilitating it for about four days. To increase awareness of the need for conservation of sea turtles, the release was showed on television by Nigerian Television Authority (NTA) and it constituted a news item.

Overall, our data, although preliminary, showed that some species of sea turtles visit regularly the coastal beaches of southern Nigeria in order to nest, and are frequently encountered and captured by local people. Although species status and trends are still largely unknown and certainly our papers could not really help in this regard, it is clear from the high numbers of individuals seen in our surveys that coastal Nigeria may be considered an important sea turtle habitat that should be further explored. Other important sea turtle habitat have been identified along the Gulf of Guinea, including Corisco Bay, Equatorial Guinea / Gabon (Formia 1999), the Bijagos Archipelago, Guinea Bissau (Catry *et. al.*, 2002), São Tomé and Príncipe (Dontaine & Neves, 1999; Fretey, 2001; Tomas *et. al.*, 1999), hawksbill in São Tomé, Equatorial Guinea, and Cameroon (Fretey *et. al.*, 2002), whereas reproduction of *Dermochelys coriacea* in Nigeria was also confirmed before our study (Fretey *et. al.*, 2001), although the more important nesting concentration areas for this species are in Gabon (Fretey *et. al.*, 2007). The fact that *Dermochelys coriacea* were frequently observed in our surveys (they are the second most common species after *Chelonia mydas*) would suggest that the Nigerian population of this species may be important. This species was the second most important species to nest also in other areas of West Africa (e.g Ghana; Amiteye 2000; Fretey *et. al.*, 2007). Further studies are necessary to confirm the relevance of the Nigerian populations of this species for conservation purposes.

sea turtles remains (nest, shells of dead animals, etc.) were observed. In each site we also assessed on a qualitative basis the anthropogenic activities going on there.

**Table 14:** Structured questionnaire distributed at each station during the survey.

S/N	Questions	Comment / Options	Reason
1.	Have you ever sighted a sea turtle in this area before?	Yes / No	Experience of the respondent.
2.	Where precisely did you see it?	In the sea On the beach Behind the beach In the market	Habitat
3.	When did you see it or when are the sea turtles commonly seen here?	Time (morning, afternoon, evening, night) Month of the year.	Activity peak Spawning season
4.	What was it doing when you saw it?	Nesting / laying egg Crawling from beach towards the sea. Moving towards the beach.	Spawning/ post spawning return to sea. About to lay eggs.
5.	If you saw it laying eggs, how many eggs did you count?	-	Confirmation of spawning
6.	How many kinds of sea turtles can you distinguish, which visit the beach	Describe each type you have seen	Species diversity
7.	How do people here see sea turtles?	Source of tasty meat totem	Cultural value / threat factor
8.	Of what use are turtle carapaces in your locality?	Juju worship Musical instrument Town-crying	Cultural value
9.	What is the cost price range for a carapace?	-	Threat factor
10.	Do you know any organization making efforts to protect sea turtles in this locality?	-	Conservation promotion
11.	11. Comment freely on your knowledge of sea turtles in this area?	-	More information

## Results and Discussions

For practical reasons, in the following text we present data divided by study area. Overall, we observed a total sample of 89 marine turtles during the present project. This total number of individuals, divided by species and by area, is given in Table II. The sample observed showed an uneven distribution by species ( $X^2$  test,  $P < 0.05$ ), with *Chelonia mydas* being the most frequently observed species.

**Table 15:** Diversity and Numerical Abundance of Sea Turtle Recorded at Sampled Stations

Species	Andoni	Bonny	Brass	Akassa	Total
<i>Chelonia mydas</i>	11	5	14	19	49
<i>Dermochelys coriacea</i>	7	1	9	5	22
<i>Leptochelys olivacea</i>	4	-	3	8	15
<i>Eretmochelys imbricata</i>	-	-	2	-	2
<i>Caretta caretta</i>	-	1	-	-	1
<b>Total</b>	<b>22</b>	<b>7</b>	<b>28</b>	<b>32</b>	<b>89</b>

**Andoni.** – At Andoni we observed that sea turtles were caught by fishermen using long-line and drift net and gill nets. The catches were relatively common during the last year. A total of 15 dead turtles ready to be butchered and 7 carapaces were examined during the period. From this sample, it appeared that *Chelonia mydas* was dominant, followed by *Dermochelys coriacea* and *Leptochelys olivacea* (Tab II). Fishermen also reported having encountered sea turtle cultural conservation in the place.

**Bonny** – Sea turtle catch in Bonny was reported to be very occasional, compared to other stations. Only 7 specimens were found during the survey period, which consisted of three species, i.e., *Chelonia mydas*, *Dermochelys coriacea*, and *Caretta caretta* (Tab.II). This low number of individuals seen may depend on the strong industry development of this site (especially for the works of the Nigerian Liquefied Natural Gas project, LNG), and indeed fishermen indicated that before the establishment of oil and gas companies in Bonny, sea turtles and their eggs were more frequently encountered than now, along the sandy beaches. Disturbance along the beaches due to increased traffic by LNG workers and workers and working activities, producing a great lighting at night, and also gas flaring by oil and gas companies, laying of pipelines, seismic operations etc. could be the reason for the drop in turtle visit experienced in Bonny.

**Brass-** In Brass, the turtles caught as bycatch with various nets (especially those of 45cm mesh size, locally called “stroke” or 8-finger net). Most catches were taken in the Months of June/ July, and over 80% of the captured turtles were egg-laying females. The large proportion of the captured females bearing eggs at this period would suggest that this

is their spawning season. Female turtles oviposited regularly at Brass Island during the recent years: the fishers in the area captured them consecutively in 2005, 2006, 2007, and 2008. On two occasions, one of the fishers reported he had captured sea turtles with forelimb marked with stainless metallic rings with engraftment he could not interpret. He remembered that on of these rings had an inscription “78” in it. Obviously these should be marked animals from projects studying the migratory routes and biology of sea turtles. It is unfortunate that we could not get more details of these tagged specimens from the fishers. Fishermen in Brass make brisk business when they land sea turtles. The price ranges, according to size, from ₦6000 for smaller animals to ₦22000 for large animals like *Dermochelys coriacea*.

During our visits to fishing ports and beaches of Twon and Brass, we observed 6 live turtles, 3 stranded turtles and 19 carapaces around, belonging to four different species i.e. *Chelonia mydas*, *Dermochelys coriacea*, *Eretmochelys imbricate* and *Leptochelys olivacea* (Tab. II). According to local residents, major nesting sites were found at Opokunabadi, Tombibele, Deema and Okpoama beaches. According to these respondents to our questionnaires, both *Eretmochelys imbricata* and *Caretta caretta* were very occasionally located at the mouth of brackish waters of St. Nicholas, Brass, Nun, Sangana, and Fish town.

**Akassa-** A community based conservation of sea turtles is gaining momentum in Akassa. Organised by an NGO, Protanura International, conservation education has been included as part of Akassa Community Development Project. Thus, sea turtles are recognized as an essential part of the natural heritage; most nest are protected and live stranded turtles are released (Formia *et. al.*, 2003). The turtle conservation efforts started in 1998 and had been geared up by enthusiastic conservationists including Bill Night, Philip Hall, Michael Weeks, Ben Wolf, Chris Alagoa, etc. Unfortunately, the operations of this NGO have been considerably damaged by the ugly era of hostage taking by Niger Delta militants in the years 2006-2009. There are confirmed records of nesting sites on the sandy beaches of Oginibiri, Okumbiri and Fishtown. Commonly called “Abadi Ikagi”, three species of sea turtles are known in the area (TAB. II).