

# Assessment of Invasive and Noninvasive Plant Species Composition and Diversity in Mangrove Ecosystem, Ibeno, Akwa Ibom, Nigeria

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## Abstract

*Invasive Alien Species are currently considered as the second leading cause of extinctions of documented species and the third threat coming for species at risk of extinction. The study assessed the invasive and non-invasive plant species composition and diversity in Mangrove Ecosystem, Ibeno LGA, Akwa Ibom State, Nigeria. Two 10m x 10m transects were laid within the invasive and non-invasive stations for the evaluation of species abundance using a random sampling technique. The data acquired from the composition of plants was used to compute the abundance, diversity and evenness of plants in the study area using standard methods. Results showed that 7 different plant species: *Rhizophora racemose*, *Rhizophora mangle*, *Acrostichum aureum*, *Cyperus janicus*, *Nypa fruticans*, *Avicennia germane* and *Paspalum vaginatum* were found belonging to 6 families: *Rhizophoraceae*, *Avicenniaceae*, *Pteridaceae*, *Cyperaceae*, *Poaceae* and *Arecaceae* in which *Rhizophoraceae* was the highest (42.9%). Invasive plant discovered was *Nypa fruticans* in mangrove ecosystem. Non-invasive plants had the highest diversity (2.12) and evenness (0.360). The study concluded that both invasive and non-invasive plant species are found in the study area, but the invasive species was mainly dominated by *Nypa fruticans* which is gradually taking over the entirety of Mangrove Ecosystem in Ibeno LGA, Akwa Ibom, Nigeria. *Nypa fruticans* is monotypic and have negative impact on environment, biodiversity and economic of the people living in the community. It is therefore recommended among others that awareness and community participation must be established to combat the expansion of the alien species in Ibeno, LGA.*

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## **Introduction**

A large proportion of the world's biodiversity is contained in the tropical ecosystems (Barlow 2018) and extensive exploitation of the natural resources has subjected the region to severe pressure from rapid and widespread habitat destruction, thereby posing a constant threat to local biota (Marcogliese, 2023). Globally, the modification of the ecosystem by human actions has also been a major threatened to biodiversity (Prakash, 2022). In Africa, deforestation is a major problem destroying natural habitats (e.g. lowland rainforest) is destroyed at a relative rate that is higher than those of other tropical regions (Archad et al., 2020). Furthermore, there is a prediction that an unabated, continuation of the tropical forest destruction will result in the loss of about three-quarters of original forest cover by the turn of the next century (Archad et al., 2020).

According to Sheppard et al., 2019 IUCN defined invasive alien species as any animal, plant or other creature that is brought into a location beyond its natural range with the intention of destroying the native biodiversity, ecosystem services or human well-being. Noba et al., (2017) reported that invasive species are recognized as one of the main causes of erosion of global biodiversity as they represent one of the major environmental challenges of the 21st century and the second cause of biodiversity loss, just after habitat destruction. There has been scanty information on invasive plant species in Nigeria as affirmed in Borokini (2011); and as a result, the Convention on Biological Diversity came up with a policy to include the issue of invasive plants among its main sectorial themes with a strong objective of preventing and managing their introduction and propagation. Biological invasions by alien species are now considered one of the main factors responsible for biodiver-

sity loss and endangered species listings worldwide (Borokini, 2011), and almost certainly the worst one on islands (Cayot et al., 2021). The reason is that the natural obstructions of oceans, mountains, rivers and deserts, which used to provide the isolation essential for unique species and ecosystems to evolve, have lost their effectiveness, due to the increase in economic globalization and development. This has resulted in an exponential increase in the movement of organisms from one part of the world to another through trade, transport, travel, and tourism, in some cases causing tremendous damage to the natural ecosystems of their new habitats (Hulme 2021). Invasive alien species are found in all taxonomic groups, and they include introduced viruses, fungi, algae, mosses, ferns, higher plants, invertebrates, fish, amphibians, reptiles, birds, and mammals (Borokini, 2011). They have invaded and affected native biota in virtually every ecosystem type, in all regions (Buckley & Catford 2021). In protected areas, as elsewhere, impacts from invasive alien species take the form of impacts on ecosystem function, structure, and species communities or habitats as well as at the level of species. Invasive alien species directly or indirectly impact on livelihoods and poverty alleviation, affecting ecosystem services and through impinging on cultural heritage values. Virtually all countries in Africa are affected by Invasive Alien Species. However, very little is known about invasive alien species in Nigeria, with most technical reports and literatures reporting fewer than 10 invasive plants in the country. Aside from plant invaders, *Rattus rattus* and Avian influenza virus were also considered invasive alien species in Nigeria (Izah et al 2022). The initial entry of invasive alien species into Nigeria was mainly through exotic plant introductions by the colonial rulers either for forest tree plantations or for ornamental purposes (Borokini, 2011). The entry of exotic plants into Nigeria during the post-independence era was favoured by increasing economic activity, commencement of commercial oil explorations, introduction

through ships, and introduction of ornamental plants by commercial floriculturists (Borokini2011).

From previous studies on some of the invasive species identified in Nigeria and some other African countries, it was discovered that some of these species have remarkable significance in biofuel production, organic farming, medicinal plant research and herbal therapy, cover cropping, source of food and fodder. Therefore, if the potentials of these invasive are harnessed, they can change from being an ‘enemy crop’ to an economically friendly crop (Borokini and Babalola, 2012). It has been reported that *Chromolaena odorata* have been reported to be very effective in the production of biogas and also for carbon storage (sink), in addition to the fact that it is also processed to treat malaria and wound disinfection in Southwest Nigeria. One extensively studied aquatic exotic weed is water hyacinth; the plant has been utilized for various purposes such in the production of biogas, vermicompost, gibberlic acid, paper and insulation board and in the treatment of sewage and industrial effluents (Rezania et al., 2015). Water fern has been studied extensively and was discovered to be used as compost, mulch, paper pulp, livestock fodder supplement and for the treatment of sewage and effluent (Rosdi 2022).

Invasive Nipa palm (*Nypa fruticans*) is a major threat to mangroves and coastal systems in the Niger Delta region in Nigeria, apart from oil and gas exploration (Numbere, 2019). The palms were first introduced as foreign species to curb coastal erosion over a century ago (i.e. 1906). From Akpan et al.,2021 Land use land use cover *Nypa fruticans* became invasive and started multiplying in Ibeno Community since 1989. The palms have acclimatized to the coastal environment by developing superior root system, which they use to tap available nutrients. They also have tough and buoyant seeds, which aid in their wide dispersal. These qualities of the palms had made them to have an edge over the mangroves (Van et al., 2019). Numbere (2019) further re-

ported that Nipa palms change the pedology, hydrology and landscape architecture of the coastal environment once they are established. A threat to the mangroves is a threat to the entire coastal system, which benefits from the ecosystem services provided by the mangroves. It is believed that mangroves may disappear completely from the Niger Delta in the next 50 years if the encroachment of the palms continues unabated. Studies relating to knowing and assessing the composition of invasive species and non-invasive species have been very rare in the literature and the available ones concentrated on the general invasive fauna and flora, with no comparative analysis between invasive and non-invasive plants; and while the scope of those that are available are unable to cover much of the Niger Delta especially in Ibeno LGA. Therefore, the present studies focused on the assessment of invasive and non-invasive plant species composition and diversity in Ibeno LGA, Akwa Ibom, Nigeria.

## **Methodology**

### **The Study area**

This study was carried out in Ibeno local government area (LGA), a riverine community in Akwa Ibom State. It is bounded to the West by Eastern Obolo LGA, to the North by Onna, Esit Eket and Mbo LGAs and to the south by the Atlantic Ocean (Figure 1). Ibeno LGA has latitudinal extent between 4°30' N and 4°45'N; and longitudinal extent between 7°50'E and 8°15'E. It has a population of 74,840 inhabitants (Ekwerre, 2016). Ibeno occupies the largest coastline of more than 129km in Akwa Ibom State. Located in the mangrove swamp forest; much of the area is not habitable. Mean annual rainfall for this coastal region ranges from 2,000mm to 2,500mm. The mean minimum and maximum temperature are 26°C and 30.5°C respectively while the mean relative humidity of the area is about 83% (Werre, 2001). The prime occupation of the people is fishing; however petty trading and minimal farming are also

carried out by the people. The women are actively involved in fish smoking.

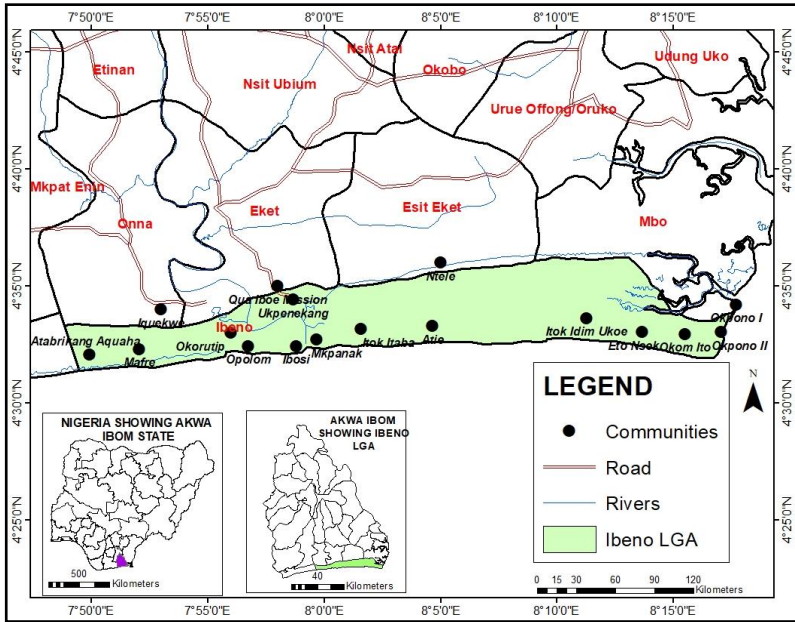


Fig. 1: Ibeno LGA showing communities

## Field data collect and measurement methodology

### Vegetation Inventory

The random sampling approach was used to conduct the vegetation inventory whereby two 10m x 10m transects were laid within the invasive and non-invasive stations for the evaluation of species abundance.

Species abundance was determined according to Tigabu (2024).

$$Abundance = \frac{\text{Total Number of individual species in all sample units}}{\text{Total number of sampling units in which the species occurred}}$$

Station with very high abundance were denoted with +++++ and classed as very highly invasive, whereas the station with very low abundance were denoted with + and classed as non-invasive.

### Species Diversity of Trees

The species diversity index of the invasive and non-invasive plants was computed using Shannon-Wiener's Diversity Index (Equ.1).

$$H = \sum[(pi) \times \ln(pi)] \dots\dots\dots \text{Equ. 1}$$

- pi = proportion of total sample represented by species i
- Divide no. of individuals of species i by total number of samples
- S= number of species, = species richness
- Hmax=ln(S) = Maximum diversity possible
- Where: n= number of individuals of each species

### Species Evenness

Species evenness (the distribution of individuals among the species) was calculated using Simpson's evenness method (Das, 2021). Evenness is a measure of the relative abundance of the different species making up the richness of an area. The Simpson's evenness formula is given as:

$$E' = D'/S$$

- where — D' is the Simpson's diversity index and S is the number of species.
- E' is constrained between 0 and 1. The less variation in communities between the species, the higher E' is.

### Method of Data Analyses

Descriptive statistics in form of the use of frequencies and percentages and qualitative assessment was used for the data analyses indicating +++++ Very high abundance;++++ High abundance;+++ Moderate Abundance;++ Low abundance;+ Very low abundance. This involved the use of frequencies and percentages. Also, qualitative assessment of abundance of the level of invasive and non-invasive plants was done in some locations within the entire LGA through observation and on the spot assessment.

## Results and Discussion

### Plant species composition of the study sites

The result of species composition as shown in Table 1 revealed that the study sites are generally low in species content as only *Nypa fruticans* was recorded in the invasive site while a total of 9 species (*Rhizophora racemosa*, *Rhizophora mangle*, *Rhizophora harrisonii*, *Acrostichum aureum*, *Cyperus janicus*, *Laguncularia racemosa*, *Avicennia germane* and *Paspalum vaginatum*) were found in the non-invasive site. This shows that 11.1% of the plant species were invasive while 89.9% were non-invasive. This value agreed with Numbere & Camilo, 2016 and Akpan et al., (2021) that *Nypa fruticans* forms monocious strands in the ecosystem, low leaf falls and have negative influence on native species wiping them out of existence. Akpan et al., (2021) studied people's perception of *Nypa fruticans* in Ibeno and 80% of people interviewed affirmed Nipa palm to have negative effect on the ecosystem, biodiversity and livelihood of the people living in the area. The result of the invasive site indicates that the invasive species has colonized the entire invasive site. Its presence in the non-invasive site means that in the nearest future, they may likely colonize there. Seven different families were found in the study area in which 42.9% which was the highest were Rhizophoraceae. Furthermore, 66.7% of the plants were trees while 22.2% were herbs and 11.1% were shrub.

**Table 1: Species content and diversity of invasive and noninvasive sites**

	Family	Species	Habit	Invasive	Non-invasive
1.	Rhizophoraceae	<i>Rhizophora racemose</i>	Tree	-	+
2.	Rhizophoraceae	<i>Rhizophora mangle</i>	Tree	-	+
3.	Pteridaceae	<i>Acrostichum aureum</i>	Shrub	-	+
4.	Cyperaceae	<i>Cyperus janicus</i>	Herb	-	+
5.	Arecaceae	<i>Nypa fruticans</i>	Tree	+	+
6.	Aviciniaceae	<i>Avicennia germane</i>	Tree	-	+
7.	Poaceae	<i>Paspalum vaginatum</i>	Herb	-	+

### Species Diversity, Evenness and Abundance

The result of species diversity and evenness as presented in Table 2 shows that the non-invasive site has greater species diversity and evenness. The species diversity was 2.12 and species evenness was 0.360, compared to the invasive site with diversity and evenness recording zero (0) respectively. This also shows the aggressive invasive capacity ability of *Nypa fruticans*.

For the abundance in Table 3, qualitative analysis through observation reveals that locations like Mkpanak (8<sup>o</sup> 00.148'E and 4<sup>o</sup> 32.280'N) and Upenekang (7<sup>o</sup>57.140'E and 4<sup>o</sup>33.822'N). are found to be very high abundant of *Nypa fruticans* while locations like Ibeno Beach, Ntaikang and Akod-Utip had lower abundance of *Nypa fruticans*.

**Table 2: Species diversity and evenness of invasive and noninvasive site**

	Sites	Species diversity	Species evenness
1	Invasive	0	0
2	Non-invasive	2.12	0.360

**Table 3: Location of *Nypa fruticans* invasiveness within Ibeno**

	Location	Longitude	Latitude	Abundance
1	Mkpanak	8°00.148'	4°32.280'	+++++
2	Mkpanak	7°59.701'	4°33.830'	++++
3	Mkpanak	8°00.075'	4°33.793'	+++
4	Ibeno Beach	8°00.132'	4°34.700'	++
5	Ntaikang	8°01.543'	4°32.719'	+
6	Upenekang	7°57.140'	4°33.822'	+++++
7	Akod-Utip	7°55.585'	4°33.013'	+

+++++ *Very high abundance*; ++++ *Very abundance*; +++ *Abundance*; ++ *Low abundance*; + *Very low abundance*

*Nypa fruticans* was the only species recorded in the invasive site while a total

of 7 species (*Rhizophora racemosa*, *Rhizophora mangle*, *Acrostichum aureum*, *Cyperus janicus*, *Avicennia germane* and *Paspalum vaginatum*) were found in the non-invasive site. The invasive plants can easily lead to the reduction of mangroves in the study area. Noba et al., (2017) reported that invasive alien species are currently considered as the second leading cause of extinctions of documented species and potential third threat coming for species at risk of extinction. Native mangrove vegetation consist of trees, shrubs and herbs mostly *Rhizophora mangle* with prop and *Avicennia germinans* while *Nypa fruticans* is monospecific. Native mangrove vegetations are economic benefit for population of other organisms. The spread of *Nypa fruticans* in study area threatens the native mangrove vegetations by outcompeting and displacing the native species, lowering biodiversity as well as affecting people's livelihoods through reduced fish catch and reduced collection of shellfish. Akpan et al., 2021 examined the soil properties associated with the invasive *Nypa fruticans* (INF) and native mangrove plants (NMP) in Ibeno LGA, Akwa Ibom, Nigeria; concluded that the presence of invasive species (*Nypa fruticans*) alters the soil properties of a mangrove ecosystem.

*Nypa fruticans* has negative impact on the environment, biodiversity and livelihoods (Akpan et al., 2021) and disrupting prevailing vegetation dynamics and nutrient cycling.

### **Conclusion**

The study concluded that both invasive and non-invasive plant species are found in the study area, but the invasive species was mainly *Nypa fruticans* which is gradually taking over the entirety of Ibeno LGA, Akwa Ibom, Nigeria. Based on the findings, the following recommendations are suggested.

1. Both federal and state governments must swing into action to identify and understand the biology and ecology of the invasive alien species in the study area.
2. Awareness and community participation must be established to combat

the expansion of the alien species in Ibeno, LGA.

3. Both governmental and non-governmental organizations should promote scientific research to prepare and understand the basic data of species, their biology, ecology, impact assessment and management guidelines
4. The presence of *Nypa fruticans* as the main invasive alien species in Ibeno LGA should be catalogued and widely circulated even beyond the LGA; but also to the State and Federal Government. Their distribution, rates of invasion, population dynamics and indigenous management practices should be established, catalogued and circulated also.

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