Evaluation of Forest Trees and Shrubs in Nun River Forest, Nigeria: Ornamental perspective

Abstract

The protection of ornamental plants is greater than that of their wild counterparts, and they continue to serve as symbols of ownership, prohibiting all forms of trespass. In addition, the immense benefits of the trees mean that they cannot be arbitrarily cut down or removed. Forest trees are not afforded such protection, especially in most third-world nations where forest protection laws are not enforceable. Therefore, identifying, selecting, and cultivating indigenous forest plants for ornamentals and urban plantings may be the most practical means of achieving a greener future. This study aims to identify and select ornamental native forest trees and shrubs in the Nun River Forest. Four randomly selected 50x10 m transects were helpful in the identification of trees and shrubs in the Nun River forest. In addition, four out of ten forest communities were randomly selected and classified as native or exotic species. The result was the identification of 1,127 trees and shrubs, of which 821 (72.85%) were exotic, and 306 (27.15%) were native. The diversity indices revealed a similarity in human activities impacting the composition of trees and shrubs in the study area. The study shows planting more trees and shrubs as ornamentals than indigenous in the five communities. Rural communities must be aware of the vast plant resources available in our forests yet unidentified as ornamentals.

Keywords: Forest resources, Human activities, Nun River Forest, Ornamental plants

Introduction

The forest constitutes a significant portion of the world's natural capital, essential for human survival. Nevertheless, the free ecosystem services provided by the world's forests cannot be fully accounted for and quantified monetarily. According to the World Wild Fund for Nature [1], over 2 billion people depend on forests, including 60 million indigenous people, and over 13 million people worldwide live on jobs provided by forests.

Food and Agriocultural Organization and the United Nations Environment Program World Conservation Monitoring Centre estimated that 420 million hectares of forest had been converted to other land uses since 1990, including more than 80 million hectares of primary forest[2]. Various scientists estimate that between 260 000 and 450,000 plant species have been discovered and identified, with approximately 21%–33% of these species threatened with extinction [3, 4]. These revelations necessitate immediate conservation programs, particularly for endangered plant species.

Robert [5] ascribed the origin of ornamental plants to peasant farmers' selection and cultivation of crop plants and prehistoric domestication of food plants by humans. According to the study, the later development of ornamental plants for homes and gardens was motivated by the need to restore the equilibrium between man and his disturbed environment. Given the high landscaping

price with exotic tree species, everyone should be encouraged to identify, select, and cultivate native trees and shrubs as ornamental plants. The scientific basis for selecting wild plants for cultivation or domestication may include ecological factors, compatibility with locally preferred food crops, local customs, tree product use, availability of planting stock, and markets [6].

Ornamental trees are aesthetically pleasing and enhance life quality [7], According to the UNUP [8], ornamental trees and shrubs can affect wind speed, temperature, and evaporation to alter the local environment. They also prevent soil erosion, river pollution, and dam siltation by stabilizing the soil. In addition, they absorb air pollutants, release oxygen, and reduce noise. Indigenous trees and shrubs can provide all of these qualities and functions. Though these benefits are afforded both by exotic and indigenous plants, there are several other benefits peculiar to the use of native plants as ornamentals.

Indigenous trees and shrubs, in this context, are those plants native to the tropical region occuring naturally [9]. Native trees and shrubs are the opposite of exotic ones introduced in non-native areas [10]. The use of indigenous or native plants as ornamental has been encouraged for several reasons, spanning through ecological, ethnobotanical, and economic benefits. Economically, native trees are less expensive to cultivate and maintain because they are better adapted to the environment, more suited to infertile soils and theirfore require little watering and reduces input of chemicals like pesticides and inorganic fertilizers. They are more resistant to pests and diseases [9, 11, 12]. Ecologically, native plants support native birds and insects as they provide essential nutrients in their food. Some wildlife including birds, butterflies, pollinators evolved with the plants in their environment and can only feed on such plants. Moreover, many native insects can only draw nectar from exotic plants, but cannot lay eggs and their larvae cannot feed on those plants. this limitations essentially puts such insects on the fast lane to extinction. Native plants as ornamentals surely promotes biodiversity of organisms in the environment [11,13]. Furthermore, non-native plant species are known to be more invasive than native species as they lack or at least have limited natural deterrents to their survival, reproduction and spread such as pests, diseases and competotors [11]. Invasive plants are so successful because of their rapid growth, maturity, reproduction and dispersal ability with enormous environmental and economic impacts like degraded watersheds, decreased biodiversity, poisonous plants to livestock, cost of control [12, 14].

However, despite these benefits, there is a preference for exotic plant species over the indigenous species as ornamental plants. The critical factor to consider is that while these indigenous trees and shrubs are neglected by those who should conserve them, the natural forest is constantly lost as a result of natural effects such as flooding [15], human activities such as fuel wood collection and charcoal production, chainsaw milling, commercial logging, agricultural expansion and road construction referred to as drivers of deforestation and forest degradation [16,17].

The result of all these will be the rapid destruction of indigenous trees in the wild due to alternative land uses, failure to conserve indigenous species as ornamentals, and the accelerated decrease in ethnobotanical knowledge of indigenous trees and shrubs. In addition, building modern cities, or urbanization, drives men away from directly interacting with nature. This loss of contact with nature significantly decreases specific taxonomic knowledge [18,19].

Consequently, indigenous trees need more attention in research, development, and utilization than exotic species.

In the Niger Delta region of Nigeria, forest resources are essential sources of animal protein, commonly known as bush meat [20-23]; medicinal plants used in the treatment of several diseases, particularly those caused by microorganisms [24-35]. Also, it can be used in the control of vectors, particularly mosquitoes [36-30]. In addition, many forests are designated protected areas throughout the region, including in Bayelsa State, Nigeria.

Nun River Forest is one of the most important forests in Nigeria's Bayelsa State [40]. The Nun River Forest is a tropical woodland rainforest threatened by sextinction. This forest is vital to the survival of the surrounding communities. It provides the communities with essential food, shelter, fuel, spices, medicine, and industrial raw materials [42]. Moreover, the Nun River forest has numerous fruit trees with nutritional, dietary, ethnobotanical, and economic significance. The majority of trees in the region are ornamental and edible. Therefore, this study assessed the ornamental value of trees and shrubs in the Nun Forest.

Materials and Methods

Study Area

The study was at the proposed Nun River Forest Reserve (NRFR) of the old Rivers State, now located in Bayelsa State, with an approximate area of 97.15 km2 [43, 44]. The forest extends into portions of the Sagbama, Southern Ijaw, Kolokuma/Opokuma, and Yenagoa Local Government Areas. This proposed forest reserve, rich in biodiversity at its designation as a forest reserve, is rapidly becoming a relic due to the massive negative impact of human activities such as oil exploration and exploitation, hunting, logging, agriculture, and other environmental factors. As one who was born and raised in a community on the fringe of the Nun River Forest, we have seen renowned hunters who took pride and celebrated killing seven bush pigs (Potamochoerus larvatus) in one night, killing elephants (Loxondonta africana) and killing African buffalos (Syncerus coffa), at different hunting expeditions, and having the skulls or tusks of these animals displayed in purpose-built sheds.

According to reports, certain animals have been unspotted in this forest for over thirty years [45]. Similarly, the fascinating sights of balls of white cotton wool from giant cotton trees (Ceiba pentandra) scattered across the sky by winds became historical as greedy and thoughtless loggers cut them down for planks. Authors frequently discuss biodiversity depletion and loss caused by deforestation, bush burning, migrant farmers, industrialization, and urbanization in the study area [44,46].

Field Procedure

The research team visited a selection of communities on Wilberforce Island, all dependent on wood from the Nun River forest, and collected samples there. Four transects or plots (1, 2, 3 and 4), each measuring 50 meters in length and 10 meters in width (and spaced out by 50 meters), were divided into five 10 m x 10 m sub-plots, randomly labeled A, B, C, D, and E to achieve

more manageable sizes and detailed identification. With the help of trained foresters and identification guides by Hutchinson and Dalziel [47], Keay [48], and Nyananyo [49], we were able to correctly name all trees and shrubs in each sub-plot that were greater than or equal to 1 meter (1 m) in height. The communities are: Amassoma (community A), Otuan (community B), Bumoundi (community C), and Igbedi (community D), randomly selected due to their proximity to the forest reserve. An in-depth evaluation via interviews and field observations on each community's ornamental trees and shrubs using standardized criteria to catalog and explain native and exotic species was conducted.

Statistical analysis

The diversity indices were carried out using Hammer et al.'s Paleontological statistics software package [50].

Results and Discussion

Species identification in forest plots

The distribution and density of species in the forest sample area are presented in Table 1. 296 trees and shrubs were identified in the four 50 m x 10 m plots in the Nun River forest belonging to 30 genera and 19 families.

Table 1: Distribution of species in forest plots and Richness Index Table

S/N	Species	Plot 1	Plot 2	Plot 3	Plot 4	Total	Density Per Hectare
1	*Alchornea cordifolia* (Schum. & Thonn.) Müll.-Arg	**2**	**2**	**3**	**0**	**7**	**35**
2	*Anthocleista djalonensis* A Chev.	**3**	**9**	**1**	**6**	**19**	**95**
3	*Barteria nigritana* Hook.f	**2**	**1**	**0**	**3**	**6**	**30**
4	*Carpolobia lutea* (G. Don)	**7**	**0**	**0**	**0**	**7**	**35**
5	*Cleistopholis patens* (Benth.)	**1**	**2**	**3**	**3**	**9**	**45**
6	*Coelocaryon preussi* Warb.	**3**	**3**	**10**	**4**	**20**	**100**
7	*Ctenolophon englerianus*	**2**	**1**	**1**	**2**	**6**	**30**
8	*Elaeis guineensis* Jacq	**11**	**2**	**8**	**13**	**34**	**170**
9	*Fagara macrophylla* (Oliv.)	**2**	**2**	**3**	**1**	**8**	**40**
10	*Ficus exasperata* Vahl	**2**	**1**	**0**	**1**	**4**	**20**
11	*Funtumia africana* (Benth.) Stapf	**2**	**3**	**1**	**0**	**6**	**30**
12	*Harungana madagascariensis*	**0**	**1**	**0**	**0**	**1**	**5**
13	*Hexalobus crispiflorus* A. Rich	**1**	**0**	**1**	**0**	**2**	**10**
14	*Homalium alnifolium* Hutch. & Dalziel	**3**	**1**	**2**	**0**	**6**	**30**
15	*Irvingia gabonensis*	**1**	**3**	**1**	**5**	**10**	**50**
16	*Klainedoxa gabonensis* Pierre	**0**	**0**	**0**	**1**	**1**	**5**

	ex Engl						
17	*Lophira alata* Banks ex P.Gaertn	**0**	**0**	**1**	**0**	**1**	**5**
18	*Macaranga* sp	**1**	**1**	**0**	**1**	**3**	**15**
19	*Mammea africana* Sab	**0**	**0**	**1**	**0**	**1**	**5**
20	*Massularia acuminata* (G Don) Bullock	**5**	**0**	**0**	**0**	**5**	**25**
21	*Mitragyna ciliata* (MYTA)	**0**	**1**	**0**	**0**	**1**	**5**
22	*Musanga cecropioides* R.Br.	**7**	**16**	**14**	**4**	**41**	**205**
23	*Nauclea diderrichii* (De Wild. &T.Durand) Merr	**0**	**0**	**0**	**1**	**1**	**5**
24	*Pycnanthus angolensis* (Welw.)	**1**	**0**	**3**	**3**	**7**	**35**
25	*Raphia vinifera* P.Beauv.	**3**	**0**	**0**	**4**	**7**	**35**
26	*Rauvolfia vomitoria* Afzel	**13**	**15**	**16**	**2**	**46**	**230**
27	*Spondianthus preussii* Engl	**0**	**0**	**0**	**1**	**1**	**5**
28	*Theobroma cacao* L.	**1**	**0**	**0**	**0**	**1**	**5**
29	*Uapaca heudelotii* Baill	**3**	**2**	**9**	**5**	**19**	**95**
30	*Vitex grandifolia* Gürke	**8**	**5**	**2**	**1**	**16**	**80**
	TOTAL					**296**	

Table 2 presents the diversity indices of trees and shrubs in Nun River Forest, Bayelsa State, Nigeria. In Plots 1, 2, 3, and 4, the number of tree and shrub species counted was 23, 19, 18, and 19, respectively. The individuals were in the following order: Plot 4; Plot 2; Plot 3; and Plot 1. The total number of taxa and individuals were 30 and 296, respectively.

In plots 1, 2, 3, and 4, diversity indices were 0.078, 0.127, 0.11,7, and 0.093, respectively (dominance),0.922, 0.873, 0.8,83 and 0.907 respectively (Simpson), 2.806, 2.437, 2.423 and 2.644, respectively (Shannon Wiener index), 0.720, 0.602, 0.627 and 0.740, respectively (Evenness), 2.510, 2.255, 2.012 and 2.433, respectively (Menhinick), 4.965, 4.223, 3.879 and 4.379, respectively (Margalef), and 00.895, 0.828, 0.838 and 0.898, respectively (Equitability).

The dominance value indicates that there are just a few species in the various plots [45]. Pollution levels were moderate, according to the Wiener index for Shannon [51,52]. According to the Shannon Wiener index, humans have impacted the nun forest's diversity of trees and plants. The diversity and uniformity of the vegetation revealed that many plant species were shared among the various plots. A high Simpson index suggests the plot's sustained tree and shrub community. This suggests that human behaviors across the plots under study are similar. According to the Margalef index, the species makeup of the various plots is similar. According to Menhinick's index, the species richness in the various plots is comparable. The equitability index was close to 1, indicating that the plots' frequency was similar [51,52].

Table 2: Diversity indices of trees and shrubs in the studied plots

Diversity indices	Plot 1	Plot 2	Plot 3	Plot 4	Total

Taxa_S	23.000	19.000	18.000	19.000	30.000
Individuals	84.000	71.000	80.000	61.000	296.000
Dominance	0.078	0.127	0.117	0.093	0.080
Simpson index	0.922	0.873	0.883	0.907	0.920
Shannon Wiener index	2.806	2.437	2.423	2.644	2.854
Evenness	0.720	0.602	0.627	0.740	0.578
Menhinick	2.510	2.255	2.012	2.433	1.744
Margalef	4.965	4.223	3.879	4.379	5.096
Equitability	0.895	0.828	0.838	0.898	0.839

Ornamental trees and shrubs planted in the selected communities were studied. The various species, life forms, origins (i.e., whether they are indigenous or exotic), and their principal uses are presented in Table 3. A total of 1,127 trees and shrubs were identified in the communities. Of these, 821 (72.85%, representing 28 species) were exotic, while 306 (27.15% representing 14 species) were indigenous. The result is a clear indication of the fact that exotic ornamentals were preferred to indigenous ones. This observation aligns with that of Okafor [9] that fruit trees and other plants of ethnobotanical importance whose numbers in the natural forests are limited are ignored while their conventional counterparts have been given greater attention in research and development. This neglect results in the paucity of accurate information on indigenous fruit trees – their identification, distribution, nutritional value, phenology, and propagation methods.

Table 3: Cultivated Ornamental Plants in the five Communities surveyed

S/N	Species	Life Form	Total Number	Origin	Principal Use
1.	*Senna hirsuta* (L.) H.S. Irwin & Barneby	Shrub	2	Exotic	Anti-snake
2.	*Caesalpinia pulcherrima* (L.) Sw.	Shrub	21	Exotic	Beautification
3.	*Hibiscus rosa-sinensis* L.	Shrub	1	Exotic	Beautification
4.	*Ixora coccinea* L.	Shrub	11	Exotic	Beautification
5.	*Plumeria rubra* L.	Shrub	3	Exotic	Beautification
6.	*Breynia disticha* J.R. Forst. & G. Forst.	Shrub	7	Exotic	Beautification
7.	*Delonix regia* (Bojer ex Hook.) Raf.	Tree	2	Exotic	Beautification
8.	*Polyalthia longifolia* (Sonn.) Thwaites	Tree	7	Exotic	Beautification
9.	*Roystonia regia* (Kunth) O.F. Cook.	Tree	1	Exotic	Beautification
10.	*Annona murica* L.	Tree	25	Exotic	Food

11.	*Citrus sinensis* (L.)Osbeck.	Tree	257	Exotic	Food
12.	*Citrus reticulata* Blanco.	Tree	4	Exotic	Food
13.	*Citrus paradisi* Macfad.	Tree	4	Exotic	Food
14.	*Carica papya* L.	Tree	153	Exotic	Food
15.	*Cocos nucifera* L.	Tree	20	Exotic	Food
16.	*Mangifera indica* L.	Tree	103	Exotic	Food
17.	*Psidium guajava* L.	Tree	58	Exotic	Food
18.	*Persia americana* Mill.	Tree	15	Exotic	Food
19.	*Arthocarpus altilis* (Parkinson) Fosberg	Tree	1	Exotic	Food
20.	*Prunus domestica* L.	Tree	5	Exotic	Food
21.	*Theobroma cacao* L.	Tree	44	Exotic	Food - soup thickener
22.	*Hevea brasiliensis* (Willd. Ex Adr de Juss.) Muell. et. Arg.	Tree	2	Exotic	Rubber production
23.	*Gmelina arborea* Roxb.	Tree	6	Exotic	Shade Tree
24.	*Eugenia uniflora* L.	Tree	30	Exotic	Shade Tree
25.	*Terminalia catapa* L.	Tree	24	Exotic	Shade Tree
26.	*Hura crepitans* L.	Tree	1	Exotic	Shade Tree
27.	*Eucalyptus sp*	Tree	1	Exotic	Thunder protection
28.	*Citrus aurantifolia* (Christm.) Swingle	Shrub	13	Exotic	Treatment of malaria
29.	*Alchonea cordifolia (Schum. & Thonn.) Müll.-Arg*	Shrub	2	Indigenous	Stops bleeding of wounds
30.	*Senna alata* (L.) Roxb.	Shrub	9	Indigenous	Eczema treatment
31.	*Massularia acuminata* (G. Don) Bullock ex Hoyl	Shrub	1	Indigenous	Chewing sticks
32.	*Chrysophyllum albidum* G. Don	Tree	1	Indigenous	Food
33.	*Dacryodes edulis* (G. Don) H.J. Lam	Tree	49	Indigenous	Food
34.	*Elaeis guineensis* Jacq	Tree	14	Indigenous	Food
35.	*Irvingia gabonensis* (Aubry-Lecomte ex O'Rorke) Baill.	Tree	13	Indigenous	Food
36.	*Monodora myristica* (Gaertn.) Dunal.	Tree	1	Indigenous	Food
37.	*Newbouldia laevis* (P.Beauv.) Seem.	Tree	31	Indigenous	Boundary Tree
38.	*Spondias mombin* L.	Tree	102	Indigenous	Boundary Tree
39.	*Millettia aboensis* (Hook.f.) Baker.	Tree	24	Indigenous	Medicinal - purgative
40.	*Glyphaea brevis* (Spreng)Monachino	Tree	44	Indigenous	Planted in shrines
41.	*Napoleona vogelii* Hook. and Planch	Tree	2	Indigenous	Planted in shrines/Blood tonic

42.	*Cola Pachycarpa* K. Schum.	Tree	13	Indigenous	Food
	TOTAL		**1,127**		

According to this study, six main factors influenced the selection and cultivation of ornamentals to varying degrees. Food, aesthetics, shelter, security, health, and spirituality were identified as the primary motivation for plant selection and domestication. Furthermore, it was not surprising that the provision of food was the most critical factor (49%) influencing the selection and cultivation of ornamental plants in the communities surveyed [5].

There are several indigenous fruit and food trees (such as *Spondias mombin*, *Hexalobus crispiflorus*, *Monodora myristica*, *Irvingia gabonensis*, *and Chrysophyllum albidum*) that can be selected, improved, and cultivated around homes and in gardens to provide food or spices and also promote the knowledge of these plants. Aesthetic appeal or beautification of the environment ranked second (18%) in the factors influencing the selection of ornamentals. A report showed that a well-wooded, beautiful environment helps build stronger bonds in relationships and reduces crime [53]. The Nun River forest has enormous potentials for the selection, development, and cultivation of indigenous trees and shrubs as ornamental plants. Species such as *Spathodea campanulata*, *Senna alata*, *Alstonia boonei, and Alchornea cordifolia* encountered in this study are good candidates for ornamental use.

Conclusion

Trees and shrubs in the Nun River forest serve many purposes, including provision of food, decoration, protection, shade, and even religious significance. These plants, however, are ignored in favor of exotic ones. As a result, trees in the wild are cut arbitrarily at an alarming rate because of competing uses of the land, which undermines conservation efforts. In addition to disrupting our cultural diets, this trend threatens our ethnobotanical knowledge of native trees. Therefore, research into the selection, cultivation, and deployment of native species as ornamentals is desperately needed.

Authors Contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

References

1. WWF. Importance of forests. 2020. Available from: https://wwf.panda.org/ discover/our_focus/forests_ practice/importance_forests/
2. FAO and UNEP. The State of the World's Forests 2020. Forests, biodiversity and people. Rome. 2020. https://doi.org/10.4060/ca8642en
3. Pimm SL, Joppa LN. How many plant species are there, where are they, and at what rate are they going extinct? Annals of the Missouri Botanical Garden, 2015; 100: 170–176
4. Morelle R. Kew report makes new tally for number of world's plants. BBC. 2016. Available from: https://www.bbc.com/news/science-environment-36230858
5. Roberts WS. Ornamental Plants and economic Botany" (in) Swaminathan M.S. and Kochhar, S.L. (Eds) Plants and Society. Macmillan Publishers: London, 1989.
6. Peace Corps. Reforestation in the Pacific Islands. 1990. Available from: http://www.nzdl.org. [Accessed: May 5, 2021].
7. Herbert LE. The Natural History of trees. Weidenfeld and Nicolson: London. 1976.
8. UNUP. Obstacles to tree planting in arid semi-arid lands. United Nations University Programmes . 1982.
9. Okafor JC. Indigenous fruits production and utilization in Nigeria". Paper presented at the National Workshop on fruit production in Nigeria, 14th – 16th March, 1985, at FACU, Ibadan.
10. Smith DM. The Practice of Silviculture. John Wiley and Sons: USA. 1986.
11. Slattery BE, Kathryn R, Susan MZ. *Native Plants for Wildlife Habitat and Conservation Landscaping: Chesapeake Bay Watershed*. U.S. Fish & Wildlife Service, Chesapeake Bay Field Office, Annapolis, MD. 2003.
12. Abbey TM. *Alternatives for Invasive Ornamental Plant Species*. The Connecticut Agricultural Experiment Station for the Connecticut Invasive Plant Working Group. 2004.
13. PennState Extension. Why Use Native Plants? College of agricultural Sciences, Pennsylvania State University. 2019. https://extension.psu.edu/ why-use-native-plants
14. Blossey B. Invasive Plants Facts and Figures. Cornell. 2002. www3.ncrn.cornell.edu.
15. Ohimain EI, Izah SC, Otobotekere D. Selective impacts of the 2012 water floods on the vegetation and wildlife of Wilberforce Island, Nigeria. International Journal of Environmental Monitoring Analysis, 2014; 2: 73 – 85.
16. Goll II, Nick B, Li Jianhua, McKay Jr, John S. Analysis on the Causes of Deforestation and Forest Degradation in Liberia:Application of the DPSIR Framework. Research Journal of Agriculture and Forestry Sciences, 2014; 2(3): 20-30.
17. Wildlife Conservation Society. Report on the Assessment of Drivers of Deforestation and Forest Degradation in Houaphan Province (Draft Report v4.0). 2015.
18. Harrison KD. When languages die: The extinction of the world's languages and the erosion of human knowledge. Oxford University Press; 2007.
19. Ross NJ. "What's That Called?" Folk Taxonomy and Connecting Students to the Human-Nature Interface. In C. L. Quave (ed.), *Innovative Strategies for Teaching in the Plant Sciences*. New York: Springer Science+Business Media, 2014. DOI 10.1007/978-1-4939-0422-8_8.

20. Izah SC, Seiyaboh EI. Challenges of wildlife with therapeutic properties in Nigeria; a conservation perspective. International Journal of Avian & Wildlife Biology, 2018; 3(4):259–264.
21. Izah SC, Aigberua AO, Nduka JO. Factors affecting the population trend of biodiversity in the Niger Delta region of Nigeria, International Journal of Avian and Wildlife Biology, 2018; 3(3):206–214.
22. Izah SC, Angaye CN, Aigberua AO, Nduka JO. Uncontrolled bush burning in the Niger Delta region of Nigeria: potential causes and impacts on biodiversity, International Journal of Molecular Ecology and Conservation, 2017; 7(1): 1-15.
23. Izah SC. Ecosystem of the Niger Delta region of Nigeria: Potentials and Threats. Biodiversity International Journal, 2018; 2(4):338–345.
24. Enaregha EB, Izah SC, Okiriya Q. Antibacterial Properties of *Tetrapleura tetraptera* pod against some pathogens. Research and Review Insights, 2021; 5:1-5. doi: 10.15761/RRI.1000165.
25. Epidi JO, Izah SC, Ohimain EI, Epidi TT. Phytochemical, antibacterial and synergistic potency of tissues of *Vitex grandifolia*. Biotechnological Research, 2016; 2(2): 69-76.
26. Epidi JO, Izah SC, Ohimain EI. Antibacterial and Synergistic Efficacy of Extracts of *Alstonia boonei* Tissues. British Journal of Applied Research, 2016; 1(1), 0021-0026.
27. Izah SC, Chandel SS, Etim NG, Epidi JO, Venkatachalam T, Devaliya R. Potency of Unripe and Ripe Express Extracts of Long Pepper (Capsicum frutescens var. baccatum) Against Some Common Pathogens. International Journal of Pharmaceutical and Phytopharmacological Research, 2019; 9(2), 56-70.
28. Izah SC, Etim NG, Ilerhunmwuwa IA, Silas G. Evaluation of crude and ethanolic extracts of Capsicum frutescens var. minima fruit against some common bacterial pathogens. International Journal of Complementary and Alternative Medicine, 2019; 12(3):105–108.
29. Izah SC, Etim NG, Ilerhunmwuwa IA, Ibibo TD, Udumo JJ. Activities of Express Extracts of Costus afer Ker–Gawl. [Family COSTACEAE] Against Selected Bacterial Isolates", International Journal of Pharmaceutical and Phytopharmacological Research, 2019; 9(4): 39-44.
30. Izah SC, Uhunmwangho EJ, Dunga KE. Studies on the synergistic effectiveness of methanolic extract of leaves and roots of Carica papaya L. (papaya) against some bacteria pathogens. International Journal of Complementary and Alternative Medicine, 2018; 11(6):375–378.
31. Izah SC, Uhunmwangho EJ, Etim NG. Antibacterial and synergistic potency of methanolic leaf extracts of Vernonia amygdalina L. and Ocimum gratissimum L. Journal of Basic Pharmacology and Toxicology, 2018; 2(1):8-12
32. Izah SC, Uhunmwangho EJ, Eledo BO. Medicinal potentials of Buchholzia coriacea (wonderful kola), Medicinal Plant Research, 2018; 8(5): 27-43
33. Izah SC, Zige DV, Alagoa KJ, Uhunmwangho EJ, Iyamu AO. Antibacterial Efficacy of Aqueous Extract of Myristica fragrans (Common Nutmeg). EC Pharmacology and Toxicology, 2018; 6(4): 291-295.
34. Kigigha LT, Izah SC, Uhunmwangho EJ. Assessment of hot water and ethanolic leaf extracts of Cymbopogon citratus Stapf (Lemon grass) against selected bacteria pathogens. Annals of Microbiology and Infectious Diseases, 2018; 1(3): 1- 5.

35. Kigigha LT, Selekere RE, Izah SC. Antibacterial and synergistic efficacy of acetone extracts of Garcinia kola (Bitter kola) and Buchholzia coriacea (Wonderful kola). Journal of Basic Pharmacology and Toxicology, 2018; 2(1):13-17.
36. Bassey SE, Izah SC. Nigerian plants with insecticidal potentials against various stages of mosquito development. ASIO Journal of Medical and Health Sciences Research, 2017; 2(1): 07-18
37. Seiyaboh EI, Seiyaboh Z, Izah SC. Environmental Control of Mosquitoes: A Case Study of the Effect of Mangifera Indica Root-Bark Extracts (Family Anacardiaceae) on the Larvae of Anopheles gambiae. Annals of Ecology and Environmental Science, 2020; 4(1), 33-38.
38. Seiyaboh EI, Odubo TC, Izah SC. Larvicidal Activity of *Tetrapleura tetraptera* (Schum and Thonn) Taubert (Mimosaceae) extracts against *Anopheles gambiae.* International Journal of Advanced Research in Microbiology and Immunology, 2020; 2(1): 20-25.
39. Izah SC. Activities of Crude, Acetone and Ethanolic Extracts of Capsicum frutescens var. minima Fruit Against Larvae of Anopheles gambiae. Journal of Environmental Treatment Techniques, 2019; 7(2):196-200.
40. Izah SC, Chandel SS, Epidi JO, Venkatachalam T, Devaliya R. Biocontrol of Anopheles gambiae larvae using fresh ripe and unripe fruit extracts of Capsicum frutescens var. baccatum. International Journal of Green Pharmacy, 2019; 13 (4) | 338 – 342.
41. Izah SC, Seiyaboh EI. Changes in the protected areas of Bayelsa state, Nigeria, International Journal of Molecular Evolution and Biodiversity,2018; 8(1): 1-11
42. NARESCON. Natural Resources Conservation Action Plan. Final Report, Volume 1, Okiki-Olu Printers: Ibadan, 1992.
43. Hamadina MK, Otobotekere D, Anyanwu DI. Impact Assessment and Biodiversity Considerations in Nigeria: A Case study of Niger Delta University campus project on wildlife in Nun River Forest Reserve. Management of Environmental Quality, 2007; *18*(2): 179-197
44. Kayode J, Ihinmikaiye SO, Arewosegbe S, Oyedeji AA. Checklist and Ethnobotanical Knowledge of Timber Species in Bayelsa State. Insights of Forest Research, 2019; 3(1): 91 – 98.
45. Youkparigha FO, Patani DE. Application of Diversity Indices in the Study of Trees and Shrubs of the Nun River Forest, Nigeria. International Journal of Research Studies in Biosciences, 2019; 7(11): 1-9.
46. Obute GC, Ebiare E. Ethnobotanical Applications of some Floral Species in Bayelsa State, Nigeria. Ethnobotanical Leaflets, 2008; 12: 713-718.
47. Hutchinson J, Dalziel JM. Flora of West Tropical Africa. Vol. 1, Part 1. Flora of West Tropical Africa. Vol. 1, Part 1.. 1954.
48. Keay RW. Trees of Nigeria. Clarendon Press; 1989.
49. Nyananyo BL. Plants from the Niger Delta. Onyoma Research Publication. 2006.
50. Hammer Ø, Harper DAT, Ryan PD. PAST: Paleontological statistics software package for education and data analysis. Palaeontologia Electronica, 2001 4(1): 9pp.

51. Ogamba EN, Charles EE, Izah SC. Phytoplankton Community of Taylor Creek in the Niger Delta Using Diversity Indices. Journal of Plant and Animal Ecology, 2019; 1(3): 1 – 12.

52. Ogamba EN, Charles EE, Izah SC. Application of Diversity Indices in the Study Zooplankton Community of Taylor Creek in the Niger Delta, Nigeria. Sumerianz Journal of Biotechnology, 2019; 2(6): 35-41

53. Sullivan WC. Do trees strengthen urban communities, reduce domestic violence?. Northeastern Area State and Private Forestry, Urban Forestry Center for the Midwestern States; 1996.