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Plant Species Composition, Abundance, Richness and Diversity of Disturbed and Undisturbed Forest Patches in Egbema, Rivers State, Nigeria

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ABSTRACT

Tropical forests are increasingly affected by anthropogenic disturbance, which can alter plant species composition, abundance and community structure. This study assessed plant species composition, abundance, richness and diversity in disturbed and undisturbed forest patches in Egbema, Rivers State, Nigeria. Systematic sampling was conducted in five 50 m x 50 m plots in each forest condition, giving a total sampled area of 2.5 ha. Plant species were identified and their abundance recorded. Species richness was estimated using Margalefs richness index, while Simpson's Index of Diversity was used to assess diversity. A total of 28 plant species were recorded, comprising 22 trees, three shrubs and three herbs. Nineteen species occurred in disturbed forest patches and 15 in undisturbed patches, with six species shared between the two conditions. The disturbed patches contained 355 individuals, compared with 312 individuals in the undisturbed patches. *Chromolaena odorata* was the most abundant species in the disturbed forest, with 80 individuals (22.54%), whereas *Marantochloa leucantha* was the most abundant species in the undisturbed forest, with 71 individuals (22.76%). Margalefs species richness was higher in disturbed patches (3.07) than in undisturbed patches (2.44). Simpson's Index of Diversity was nearly identical between disturbed (0.8703) and undisturbed (0.8695) patches. The results demonstrate marked differences in floristic composition and species dominance between the two forest conditions, despite their similar Simpson diversity values. The greater richness recorded in disturbed patches was associated largely with pioneer and disturbance-associated species rather than with evidence of improved forest condition. Protection of remaining relatively intact forest patches and management of disturbed areas to promote native regeneration are therefore recommended.

Keywords: Niger Delta, Forest Disturbance, Plant Diversity, Species Richness, Species Abundance, Tropical Forest, Egbema.

Introduction

Tropical forests are among the most biologically diverse ecosystems globally and provide essential ecosystem services, including carbon storage, climate regulation, soil conservation, nutrient cycling and habitat provision. They also support human livelihoods through the provision of timber, fuel wood, food, medicines and other forest products (FAO, 2020; Pan et al., 2011). Plant species composition, abundance, richness and diversity are important indicators of forest condition. Species composition describes the identity of species present in a community, whereas diversity incorporates both species richness and the distribution of individuals among species. These attributes provide complementary information for assessing vegetation structure, ecological change and forest recovery (Magurran, 2013).

Disturbance is a major driver of tropical forest dynamics. Although natural disturbances such as storms and canopy-gap formation contribute to forest regeneration, anthropogenic activities such as logging, agricultural expansion, vegetation clearing, infrastructure development and settlement can substantially modify forest communities. The ecological response to disturbance depends on its intensity, frequency, duration and spatial extent, as well as the time available for recovery (Chazdon, 2014).

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Canopy opening following disturbance can increase light availability and create conditions favourable to pioneer and disturbance-tolerant species. As a result, disturbance may alter not only the number of plant species present but also their relative abundance and dominance. Changes in species dominance are particularly important because they can influence subsequent pathways of forest succession (Chazdon, 2014).

Forest degradation and fragmentation have important implications for tropical biodiversity. Although the effects vary according to disturbance type, intensity, landscape context and taxonomic group, degraded forests generally differ substantially from primary or relatively intact forests in species composition and ecological structure (Fahrig, 2003; Gibson et al., 2011). Anthropogenic disturbance may also amplify biodiversity losses associated with forest cover reduction (Barlow et al., 2016). The Niger Delta contains important tropical forest and wetland ecosystems that have experienced extensive anthropogenic pressure. Logging, agriculture, road construction, settlement expansion and oil-related activities have contributed to the modification and fragmentation of natural vegetation. Remaining forest patches are therefore important for maintaining native plant populations and supporting ecological regeneration.

Egbema in Ogba/Egbema/Ndoni Local Government Area of Rivers State contains a mosaic of relatively intact and disturbed forest patches. However, localized information on differences in plant community composition and diversity between these forest conditions remains limited. Understanding these differences is important for evaluating the ecological consequences of disturbance and developing appropriate conservation and restoration strategies. This study specifically assessed plant species composition, abundance, richness and diversity in disturbed and undisturbed forest patches in Egbema, Rivers State, Nigeria.

Materials and Methods

Study Area

The study was conducted in Egbema, Ogba/Egbema/Ndoni Local Government Area of Rivers State, Nigeria, within the Niger Delta region. The study area lies approximately between latitudes 5°25'N and 5°45'N and longitudes 6°35'E and 6°55'E. Egbema experiences a humid tropical climate characterized by substantial annual rainfall and relatively high temperatures throughout the year. The vegetation is associated with the humid lowland rainforest zone and consists of trees, shrubs, herbs and other under-storey vegetation (NIMET, 2020).

The landscape contains forest patches subjected to varying degrees of human influence, including logging, farming, vegetation clearing, road development, settlement expansion and oil-related activities (NIMET, 2020). The occurrence of contrasting forest conditions provided an opportunity to compare plant communities in disturbed and relatively undisturbed habitats.

Site Selection and Classification

Reconnaissance surveys were conducted to identify representative disturbed and undisturbed forest patches. Disturbed patches were identified based on visible evidence of human influence, including tree stumps, canopy openings, cleared areas, agricultural encroachment and proximity to infrastructure. Undisturbed patches were characterized by relatively closed canopies, the presence of mature trees, comparatively intact under storey vegetation and limited visible evidence of recent human disturbance (Apgaua et al., 2016).

Sampling Procedure

Systematic sampling was used to assess plant species composition and abundance (Laliberte, *et al.,* 2010). Five 50m x 50m plots were established in disturbed forest patches and five equivalent plots in undisturbed forest patches, giving 10 plots in total. Each plot measured 0.25 ha, resulting in a total sampled area of 2.5 ha. Plots were separated by at least 20 m to reduce excessive spatial dependence among samples.

All identifiable plant species occurring within the plots were recorded and counted. Unfamiliar plant specimens were collected, labelled and identified using relevant botanical identification materials (Hawthrone, *et al.,* 2024) Specimens requiring confirmation were submitted to the Department of Forestry and Environment, Rivers State University.

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Species Abundance and Relative Abundance

Species abundance was determined as the number of individuals of each species recorded within each forest condition. Relative abundance was calculated as:

$P_i \frac{n_i}{N}$ (Fowler et al., 2013) Equation 1
where
P_i = relative abundance of species *i*
n_i = number of individuals of species *i*
N = total number of individuals of all species in the community

Species Richness

Species richness was estimated using Margalefs richness index:

$D_{Mg} \frac{S-1}{In\, N}$ (Margalefs 1958) Equation 2

Where

d = Margalefs species richness index
S = total number of species and
N = total number of individuals.

Species Diversity

Species diversity was assessed using Simpson's Index of Diversity:

$1 - D = 1 \sum_{i=1}^{S} p_i^2$ (Simpson, 1949) Equation 3
D = Simpson's dominance index
Pi = proportion of individuals belonging to species *i*, calculated as *ni*/N

Where

ni = number of individuals of species *i*
N = total number of individuals of all species
S = total number of species

Data Analysis

Data were summarized using species composition, abundance, relative abundance, Margalefs richness index and Simpson's Index of Diversity. Differences in species composition between forests conditions were assessed descriptively by identifying species shared between habitats and species restricted to either disturbed or undisturbed patches.

Results

The results on plant species composition of disturbed and undisturbed forest patches in Egbema, Rivers State. A total of 28 plant species were recorded across the two forest conditions. These comprised 22 tree species, three shrub species and three herbaceous species. The disturbed forest contained 19 species, whereas the undisturbed forest contained 15 species. Six species occurred in both forest conditions: *Khaya ivorensis, Aframomum melegueta, Milicia excelsa, Marantochloa leucantha, Canarium schweinfurthii* and *Piptadeniastrum africanum.*

Thirteen species were recorded only in disturbed patches, while nine species occurred only in undisturbed patches. The disturbed patches included species such as *Chromolaena odorata, Alchornea cordifolia, Costus afer* and *Musanga cecropioides*. Species recorded exclusively in the undisturbed patches included *Lophira alata, Terminalia ivorensis, Mansonia altissima, Raphia hookeri, Lasianthera africana, Celtis mildbraedii, Xylopia aethiopica, Celtis zenkeri* and *Nesogordonia papaverifera*.

The results of abundance and relative abundance of plant species are presented in Table 2. The species abundance revealed that, a total of 355 individuals belonging to 19 species were recorded in the disturbed forest, compared with 312 individuals belonging to 15 species in the undisturbed forest. In the disturbed forest, *Chromolaena odorata* was the most abundant species, with 80 individuals (22.54%), followed by *Alchornea cordifolia* with 60 individuals (16.90%), *Costus afer* with 49 individuals (13.80%) and *Musanga cecropioides* with 32 individuals (9.01%).

Among tree species in the disturbed forest, *Terminalia superba* had the highest abundance with 19 individuals (5.35%), followed by *Albizia zygia* and *Khaya ivorensis*, each with 16 individuals (4.51%). In the undisturbed forest, *Marantochloa leucantha* was the most abundant species, with 71 individuals (22.76%), followed by *Lasianthera africana* with 57 individuals (18.27%) and *Aframomum melegueta* with 42 individuals (13.46%). Among tree species in the undisturbed forest, *Raphia hookeri* was most abundant, with 29 individuals (9.29%), followed by *Khaya ivorensis* with 24 individuals (7.69%) and *Milicia excelsa* with 23 individuals (7.37%).

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Table 1: Plant species composition of disturbed and undisturbed forest patches

S/N	Scientific Names		Common Names	Family	Floral Type
	Disturbed	**Undisturbed**			
1	*Milicia excelsa*	*Milicia excelsa*	Iroko	Moraceae	Tree
2	*Nauclea diderrichii*	*Nauclea diderrichii*	Opepe	Rubiaceae	Tree
3	*Irvingia gabonensis*	*Irvingia gabonensis*	African mango	Irvingiaceae	Tree
4	*Marantochloa leucantha*	*Marantochloa leucantha*	Arrowroot plant	Marantaceae	Herbaceous
5	*Aframomum melegueta*	*Aframomum melegueta*	Alligator pepper	Zingiberaceae	Herbaceous
6	*Khaya ivorensis*	*Khaya ivorensis*	African mahogany	Meliaceae	Tree
7	*Canarium schweinfurthii*	*Canarium schweinfurthii*	Bush candle tree	Burseraceae	Tree
8	*Piptadeniastrum africanum*	*Piptadeniastrum africanum*	Dabema	Fabaceae	Tree
9	*Ricinodendron heudelotii*	*Ricinodendron heudelotii*	African oil nut tree	Euphorbiaceae	Tree
10	*Ceiba pentandra*	-	Silk cotton tree	Malvaceae	Tree
11	*Albizia zygia*	-	West African albizia	Fabaceae	Tree
12	*Terminalia superba*	-	Limba (Afara)	Combretaceae	Tree
13	*Alstonia boonei*	-	Pattern wood	Apocynaceae	Tree
14	*Pycnanthus angolensis*	-	African nutmeg	Myristicaceae	Tree
15	*Funtumia elastica*	-	African rubber tree	Apocynaceae	Tree
16	*Musanga cecropioides*	-	Umbrella tree	Urticaceae	Tree
17	*Chromolaena odorata*	-	Siam weed	Asteraceae	Shrub
18	*Alchornea cordifolia*	-	Christmas bush	Euphorbiaceae	Shrub
19	*Costus afer*	-	Bush cane	Costaceae	Herbaceous
20	-	*Lophira alata*	Ekki	Ochnaceae	Tree
21	-	*Terminalia ivorensis*	Black afara	Combretaceae	Tree
22	-	*Mansonia altissima*	African black walnut	Malvaceae	Tree
23	-	*Raphia hookeri*	Raffia palm	Arecaceae	Tree
24	-	*Lasianthera africana*	Editan	Stemonuraceae	Shrub
25	-	*Celtis mildbreadii*	African hackberry	Cannabaceae	Tree
26	-	*Xylopia aethiopica*	Ethiopian pepper	Annonaceae	Tree
27	-	*Celtis zenkeri*	African hackberry	Cannabaceae	Tree
28	-	*Nesogordonia papaverifera*	Danta	Malvaceae	Tree

Key: (-) = species not found

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Table 2: Abundance and Relative Abundance of Plant Species

S/N	Species	Disturbed Plots		Undisturbed Plots	
		Abundance	Relative Abundance (%)	Abundance	Relative Abundance (%)
1	*Ceiba pentandra*	12	3.38	0	0.00
2	*Albizia zygia*	16	4.51	0	0.00
3	*Khaya ivorensis*	16	4.51	24	7.69
4	*Terminalia superba*	19	5.35	0	0.00
5	*Terminalia ivorensis*	0	0.00	19	6.09
6	*Alstonia boonei*	4	1.13	0	0.00
7	*Pycnanthus angolensis*	3	0.85	0	0.00
8	*Funtumia elastic*	5	1.41	0	0.00
9	*Musanga cecropioides*	32	9.01	0	0.00
10	*Chromolaena odorata*	80	22.54	0	0.00
11	*Alchornea cordifolia*	60	16.90	0	0.00
12	*Costus afer*	49	13.80	0	0.00
13	*Aframomum melegueta*	12	3.38	42	13.46
14	*Milicia excels*	3	0.85	23	7.37
15	*Nauclea diderrichii*	4	1.13	0	0.00
16	*Irvingia gabonensis*	2	0.56	0	0.00
17	*Marantochloa leucantha*	13	3.66	71	22.76
18	*Canarium schweinfurthii*	2	0.56	1	0.32
19	*Piptadeniastrum africanum*	2	0.56	6	1.92
20	*Ricinodendron heudelotii*	1	0.28	0	0.00
21	*Lophira alata*	0	0.00	21	6.73
22	*Mansonia altissima*	0	0.00	3	0.96
23	*Raphia hookeri*	0	0.00	29	9.29
24	*Lasianthera Africana*	0	0.00	57	18.27
25	*Celtis mildbreadii*	0	0.00	2	0.64
26	*Xylopia aethiopica*	0	0.00	11	3.53
27	*Celtis zenkeri*	0	0.00	1	0.32
28	*Nesogordonia papaverifera*	0	0.00	2	0.64
	Total Individuals (N)	**355**	**100.00**	**312**	**100.00**
	Species Richness (S)	**19**	–	**15**	–

The results of the species richness and diversity of this study as presented in Table 3 revealed that, Margalefs species richness was higher in the disturbed forest (3.07) than in the undisturbed forest (2.44).

Simpson's Index of Diversity was 0.8703 in the disturbed forest and 0.8695 in the undisturbed forest.

The difference between the two values was only 0.0008, indicating very similar Simpson diversity between the two forest conditions.

Table 3: Species richness and diversity

Diversity Index	Disturbed Plots	Undisturbed Plots
Number of Species (S)	19	15
Number of Individuals (N)	355	312
Margalef's Species Richness (d)	3.07	2.44
Simpson's Index of Diversity (1 − D)	0.8703	0.8695

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Discussion

The findings of this study on the differences in plant species composition demonstrate clear floristic differences between disturbed and undisturbed forest patches. Although the disturbed forest contained more recorded species (19) than the undisturbed forest (15), only six species were common to both forest conditions. This indicates substantial differences in species composition despite the relatively small difference in total species richness. The occurrence of *Khaya ivorensis, Milicia excelsa, Aframomum melegueta, Marantochloa leucantha, Canarium schweinfurthii* and *Piptadeniastrum africanum* in both forest conditions suggests that these species were able to persist across the contrasting habitats sampled. In contrast, the presence of several species exclusively in the disturbed forest indicates a shift in community composition following disturbance. This is consistent with the present findings (Gibson et al., 2011).

The strong representation of *Chromolaena odorata, Alchornea cordifolia, Costus afer* and *Musanga cecropioides* in the disturbed patches is particularly notable. These species accounted for a substantial proportion of individuals in the disturbed habitat, with *Chromolaena odorata* alone contributing 22.54% of all recorded individuals. This pattern is consistent with the general ecological response of tropical vegetation to canopy opening, where increased light availability can favour pioneer and disturbance-tolerant species (Chazdon, 2014). The undisturbed forest, by contrast, contained several species that were not recorded in the disturbed plots, including *Lophira alata, Terminalia ivorensis, Mansonia altissima, Celtis mildbraedii* and *Nesogordoni apapaverifera*. The retention of species absent from disturbed patches emphasizes the conservation importance of relatively intact forest remnants. These results are consistent with evidence that forest degradation can substantially alter tropical plant communities and that relatively intact forests have high conservation value (Gibson et al., 2011). Habitat fragmentation and changes in environmental conditions can further influence the persistence and distribution of plant species within forest landscapes (Fahrig, 2003). This agreed with the research finding.

The findings on the Species Abundance, Richness and Diversity revealed that, the disturbed forest contained more individuals (355) than the undisturbed forest (312). However, this difference was strongly influenced by the high abundance of a small number of species, particularly *Chromolaena odorata, Alchornea cordifolia* and *Costus afer*. Therefore, the greater number of individuals in the disturbed forest should not be interpreted as evidence of better ecological condition. Margalefs richness was also higher in the disturbed forest (3.07) than in the undisturbed forest (2.44). This result illustrates the importance of distinguishing species richness from ecological integrity. Disturbance can create environmental conditions that allow pioneer and disturbance-associated species to coexist with surviving forest species, temporarily increasing the number of species recorded at a site.

Consequently, greater species richness does not necessarily indicate greater conservation value. The identity of species and their relative abundance must also be considered when evaluating forest condition. In this study, the higher richness of the disturbed patches was associated with a different species assemblage dominated by disturbance-associated plants. The nearly identical Simpson diversity values in the disturbed (0.8703) and undisturbed (0.8695) forests are also important. Simpson's Index incorporates the distribution of individuals among species and is sensitive to dominance. The similarity between the two values therefore indicates that the overall numerical distribution of individuals among species was broadly comparable, even though the identities and abundances of dominant species differed considerably.

The contrasting results obtained from Margalefs and Simpson's indices demonstrate the value of using multiple biodiversity measures. Margalefs index showed greater species richness in the disturbed forest, whereas Simpson's index indicated broadly similar diversity between the two forest conditions (Magurran, 2013; Simpson, 1949).

Most importantly, the results show that disturbance in Egbema appears to have changed which species dominate the vegetation rather than producing a simple reduction in the number of species or individuals. This distinction is ecologically important because changes in species dominance can influence subsequent forest regeneration and succession (Chazdon, 2014). This is consistent with the present research findings.

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Conclusion

The study demonstrated clear differences in plant species composition between disturbed and undisturbed forest patches in Egbema, Rivers State, Nigeria. A total of 28 plant species were recorded, with 19 species occurring in disturbed patches and 15 in undisturbed patches. Only six species were shared between the two forest conditions, indicating substantial compositional differentiation. The disturbed forest contained more individuals and had higher Margalef species richness than the undisturbed forest. However, Simpson's Index of Diversity was nearly identical between the two habitats. The higher richness observed in disturbed patches was largely associated with the presence and high abundance of pioneer and disturbance-associated species, particularly *Chromolaena odorata, Alchornea cordifolia, Costus afer* and *Musanga cecropioides*. The findings demonstrate that species richness alone is insufficient for evaluating forest ecological condition. Species identity, abundance and dominance are equally important. The remaining relatively undisturbed forest patches are therefore important for conserving species not represented in disturbed habitats, while disturbed areas should be managed to encourage the regeneration of native forest species.

Recommendations

Based on the findings of this study, the following measures are recommended:

1. Protection of relatively undisturbed forest patches: Remaining intact forest patches should receive priority in local conservation planning because they retain plant species absent from disturbed habitats.

2. Reduction of continued forest disturbance: Unregulated logging, agricultural encroachment, vegetation clearing and activities that promote forest fragmentation should be minimized.

3. Promotion of natural regeneration: Disturbed forest patches should be managed to facilitate regeneration of native tree and understorey species.

4. Management of disturbance-associated species: Dense populations of species such as *Chromolaena odorata* should be monitored and managed where they interfere with the establishment of native vegetation.

5. Community participation: Local communities should be incorporated into forest conservation, monitoring and restoration programmes to improve the sustainability of management interventions.

6. Long-term ecological monitoring: Permanent sampling plots should be established to monitor changes in species composition, abundance and diversity as disturbed forests undergo succession.

References

Apgaua, D. M. G., Tng, D. Y. P. Cernusak, L. A., Cheesman, A. W., Santos, R.M., Edwards, W. J & Laurance, S. G. W. (2016). Plant functional groups within a tropical forest exhibit different wood functional anatomy. *Functional Ecology, 31, (3*), 582-591

Barlow, J., Lennox, G. D., Ferreira, J., Berenguer, E., Lees, A. C., Mac Nally, R., Thomson, J. R., Ferraz, S. F. B., Louzada, J., Oliveira, V. H. F., Parry, L., Solar, R. R. C., Aragao, L. E. O. C., Begotti, R. A., Braga, R. F., Cardoso, T. M., de Oliveira, R. C., Souza, C. M., Moura, N. G., Pardini, R., Silveira, J. M., Vaz-de-Mello, F. Z., Veiga, R. C. S., Venturieri, A., & Gardner, T. A. (2016). Anthropogenic disturbance in tropical forests can double biodiversity loss from deforestation. *Nature, 535*, 144-147.

Chazdon, R. L. (2014). Second growth: The promise of tropical forest regeneration in an age of deforestation. University of Chicago Press. https://doi.org/10.7208/chicago/ 9780226118109.001.0001

Fahrig, L. (2003). Effects of habitat fragmentation on biodiversity. *Annual Review of Ecology, Evolution, and Systematics, 34,* 487-515.

FAO (2020). Food and Agriculture Organization of the United Nations. Global Forest Resources Assessment 2020: Main report. FAO, Rome. https://doi.org/10. 4060/ ca9825en

Citation: Ijeoma *et al.* (2026). Plant Species Composition, Abundance, Richness and Diversity of Disturbed and Undisturbed Forest Patches in Egbema, Rivers State, Nigeria. *International Journal of Microbiology and Applied Sciences*, ***5(3)***, 33 – 40.

Fowler, S., Roush, R., & Wise, J. (2013). *Concepts of Biology*. OpenStax. https://openstax.org/books/ concepts -biology/.

Gibson, L., Lee, T. M., Koh, L. P., Brook, B. W., Gardner, T. A., Barlow, J., Peres, C. A., Bradshaw, C. J. A., Laurance, W. F., Lovejoy, T. E., & Sodhi, N. S. (2011). Primary forests are irreplaceable for sustaining tropical biodiversity. *Nature, 478*, 378-381.

Hawthorne, W. D., Cable, S & Marshall, C. A. M (2024). Empirical trials of plant field guides. *Conservation Biology, 28* (3), 654-662

Laliberte, E. Legendre, P. & Shipley, B (2010). FD: Measuring functional diversity from multiple traits and other tools for functional ecology. R. package.

Magurran, A. E. (2013). *Measuring Biological Diversity*. Wiley-Blackwell.

Margalef, R. (1958). Information theory in ecology. *General Systems, 3*, 36–71.

Pan, Y., Birdsey, R. A., Fang, J., Houghton, R., Kauppi, P. E., Kurz, W. A., Phillips, O. L., Shvidenko, A., Lewis, S. L., Canadell, J. G., Ciais, P., Jackson, R. B., Pacala, S. W., McGuire, A. D., Piao, S., Rautiainen, A., Sitch, S., & Hayes, D. (2011). A large and persistent carbon sink in the world's forests. *Science, 333* (6045), 988-993.

NiMET (2020). Nigerian Meteorological Agency: *Annual Climate Report.*

Simpson, E. H. (1949). Measurement of diversity. *Nature, 163,* 688. https://doi.org/10.1038/163688a0.

Citation: Ijeoma *et al.* (2026). Plant Species Composition, Abundance, Richness and Diversity of Disturbed and Undisturbed Forest Patches in Egbema, Rivers State, Nigeria. *International Journal of Microbiology and Applied Sciences*, ***5(3)***, 33 – 40.