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OCCURRENCE AND DISTRIBUTION OF INVASIVE PLANTS IN A GUINEA SAVANNA UNIVERSITY CAMPUS

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ABSTRACT

This study was carried out to assess the occurrence and distribution of non-native invasive plants in the Federal University of Lafia campus. Ten quadrants of size 1m^2 was laid out systematically and positioned in alternate format along a 100 m line transect at 5 m interval resulting into 30 quadrants distributed across three areas in the campus (protected area (PA), developed area (DA) and wetland area (WA). The abundance of the non-native invasive plants and other plants found in the quadrants was determined. The diversity indices were also quantified. The PA was observed to have the highest Shannon–Wiener index (H = 2.413) and evenness (0.620). The DA has the lowest plant diversity indices. It was observed that the distribution of non-native invasive species in the study area was influenced by the rate of disturbance occurring in each site. It was also estimated from result that the infestation of these plant species will continue to increase along with continued disturbances from ongoing development of the permanent site of the University.

Keywords: biodiversity; ecosystem disturbance; invasive species; Lafia

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INTRODUCTION

Biological invasions are seen as threats to plant biodiversity, as they can alter the vegetation and change habitats (Mack *et al.*, 2000) and thus reduce diversity (Meiners *et al.*, 2001). In addition, invasion can reduce species richness through interspecific competition (D'Antonio *et al*, 1998). Invasive species usually compete with native plants, which eventually affects species evenness in communities (Sharma *et al.*, 2009). Ongoing climate change and biological invasions are transforming land scapes and ecosystems on a global scale (Vitousek *et al.*, 1997). Each of these phenomena exacts specific effects on biodiversity and ecosystem. The combined effects of climate change and biological invasions are hard to predict (Bradley *et al.*, 2010). Many non-native species are well suited to environmental change, which facilitate their spread to new habitats in their non-native range (Bradley *et al.*, 2010).

Invasive plants are plants that are introduced into an environment in which they did not evolve and thus usually have no natural enemies to limit their reproduction and spread. They often resulted into having a fast growth and high reproductive rates which enable them to "invade" their new habitats (James *et al*, 1991). These alien invasive species do threaten invaded ecosystems, habitats or native species with economic and environmental consequences. Therefore, they are recently considered as the second largest threat to biological diversity (Didham *et al*, 2005; GISP, 2001; Kolar and Lodge, 2001; Simberloff, 1995).

Federal University of Lafia is a government-owned higher institution which is undergoing a

rapid rate of development. There have been visual observations of several invasive plant species at the permanent site of this University which needs to be substantiated with scientific study and documented. This permanent site was formally a natural vegetation which has been encroached due to the development of the University. Therefore, there is need to have an inventory of the types, distribution and abundance of plants that have invaded this permanent site since the onset of the anthropogenic disturbances. The knowledge of the distribution and diversity of alien species which invade a natural ecosystem, following disturbance is important and fundamental to the restoration of such ecosystem and development of appropriate management plans.

MATERIALS AND METHODS

Study area

This study was carried out at the permanent site of Federal University of Lafia (FULafia), Nasarawa State (Figure 1). Lafia is the capital city of Nasarawa State in North-Central Nigeria. The city is characterized by an annual rainfall and growing period which range from 1000 to 1500 mm and 200 to 300 days, respectively (Akomolafe and Rahmad, 2020). The rainy season usually starts from May to late September and the dry season starts from October to April. As a city with guinea savannah vegetation, the dominant plant habits include grasses, shrubs, and a few trees.

Sampling techniques

The sampling was conducted mainly to determine the abundance and distribution of vascular plants of non-native species coexisting in communities of plant across major areas of the university. The permanent site of the University was divided into 3 sections, namely:

i. Protected Areas (the botanical garden, PA)
ii. Developed areas (academic and administrative areas, DA)
iii. Wetland areas (WA)

Ten quadrants of size 1m² laid out systematically and positioned in alternate format along a 100 m line transect at 5m interval resulting into 30 quadrants were distributed across the 3 areas in the University campus. In each quadrant, the abundance of the plants species was determined by counting their numbers. The identification of these non-native invasive species was established by the first author to species level. Also, the invasive status of each plant was determined on the field provided the plant occupies more than 80% of the plant cover of the entire community. Online database such as the invasive species database (https://www.cabidigitallibrary.org/journal/cabicompendium) was consulted to ascertain the invasive status of the plant. The plant voucher specimens were prepared and deposited at herbarium of the Department of Plant Science and Biotechnology, Federal University of Lafia.

Statistical Analysis

The diversity indices of the plant communities were quantified using PAST 3.0 software. Differences in the diversity indices between the 3 different areas were determined using Anova-like Morte-Carlo permutation test.

RESULTS

A total of 39 plant species were observed in the study area. Out of these 39 plants, only 12 plants have been documented as invasive and also showed invasive tendencies in the study area. The IUCN conservation assessment of the invasive species revealed that only *Alternanthera sessilis, Combretum molle, Indigofera linifolia, Ludwigia hyssopifolia, Senna alata and Urena lobata* are Least Concern (LC) while *Chamaecrista rotundifolia, Hyptis spicigera, Hyptis suaveolens, Ipomoea congesta, Oldenland ia corymbosa* and *Sida acuta* have not been assessed. These 12 non-native invasive species belong to eight families and comprise one tree, four shrubs, six herbs and one climber. They spread across the three study areas of the University campus (Table 1).

The members of the family Fabaceae such as *Chamaecrista mimosoides* and *Senna alata* and members of the family Malvaceae such as *Sida acuta* are the highest contributors to the non-native invasive plant communities in the study areas. Family Fabaceae was represented by highest number of invasive species, followed by families Malvaceae and Lamiaceae with two species each in the study area (Figure 2). Our study showed that there are no areas without presence of a non-native invasive plants. However, only one species of non-native plant (*Indigofera linifolia*) was observed in the DA, while the other 11 species were distributed between the PA and WA. *Hyptis suaveolens*

was observed to have the highest abundance (80) at the PA (Table 2).

The PA which is located at the botanical garden has the highest occurrence of invasive plants with the total relative abundance value of 14.8%, greater than WA and DA which have 2.2% and 1.0% respectively. The PA was observed to have the highest plant diversity indices such as taxa, number of individuals, Simpson index, Shannon-Weiner index, evenness index and Margalef index (18, 27, 0.8802, 2.413, 0.6206 and 5.158 respectively) (Table 3). Also, the DA has the lowest diversity indices including taxa, number of individuals, Simpson index, Shannon-Weiner index, evenness index and Margalef index (12, 19, 0.6871, 1.526, 0.3834 and 3.736) respectively.

Table 1: The relative frequencies, invasive and conservation statuses of plant species in the three study areas.

S/No.	Species	PA (%)	DA (%)	WA (%)	Invasive status	Conversation status
1	*Aechynomane Americana*	0	0	10.4	NO	NA
2	*Alchornia laziflora*	0	0	0.1	NO	LC
3	*Alternanthera sessilis*	0	0	2	YES	LC
4	*Aristolocia alba*	0	0.3	0	NO	NA
5	*Calapogonium mucunoides*	0	0.3	0	NO	NA
6	*Centrosema pubeseance*	0	0	1.3	NO	NA
7	*Chamaecrista rotundifolia*	0.8	0	0	YES	NA
8	*Combretum molle*	0.7	0	0	YES	LC
9	*Combretum platypterum*	0	0	0.2	NO	LC
10	*Daniella oliveri*	0.9	0.1	0	NO	LC
11	*Digitaria horizontalis*	0	11.1	0.8	NO	LC
12	*Erasgrostis tremula*	0	1.2	0	NO	NA
13	*Euphorbiaheterophylla*	1.1	0	0	NO	LC
14	*Gomphrena celosoides*	0	0.3	0	NO	NA
15	*Hyparrhenia involacrata*	0	0	0.3	NO	NA
16	*Hyptis spicigera*	0.1	0	0	YES	NA
17	*Hyptis suaveolens*	0.8	0	0	YES	NA
18	*Indigofera linifolia*	0	1	0	YES	LC
19	*Ipomoea involucrata*	0	0	3.1	NO	NA
20	*Ipomoea congesta*	0.9	0	0	YES	NA
21	*Leonotis neptifolia*	0.1	0	0	NO	NA
22	*Ludwigia hyssopifolia*	0	0	0.1	YES	LC
23	*Luffa cylindrical*	0	0	0.1	NO	NA
24	*Mitracarpus scarber*	1.8	0	0	NO	NA
25	*Oplismenus burmanni*	0	0	0.9	NO	NA
26	*Oldenland ia corymbosa*	7.8	0	0	YES	NA
27	*Pennisetum purpurium*	3.9	0	0	NO	LC
28	*Piliostigma thonningii*	0.1	0	0	NO	NA
29	*Sacciolepis africana*	0	0	4.5	NO	LC
30	*Senna alata*	0	0	0.1	YES	LC
31	*Sida acuta*	2.6	0	0	YES	NA
32	*Sida corymbosa*	0	0	0.1	NO	NA
33	*Spilathes aligriosa*	0	0	0.1	NO	NA
34	*Spermacoce radiata*	2.7	0.1	0	NO	LC
35	*Stachytarpheta jamaicensis*	2	0.2	0	NO	LC
36	*Stylosanthes gracitis*	7.2	4.9	0	NO	NA
37	*Schwenakia americana*	0	0.1	0	NO	NA
38	*Tridax procumbens*	1.7	2.9	0	NO	NA
39	*Urena lobata*	1.1	0	0	YES	LC

Keys - PA = Protected area, DA = Developed area, WA = Wetland area, LC = Least Concern, NA = Not Assessed

Table 2: Abundance of invasive plant at the study areas

S/No.	Name of Species	Protected area	Developed area	Wetland area
1	*Alternanthera sessilis*	0	0	20
2	*Chamecrista rotundifolia*	8	0	0
3	*Combretum molle*	7	0	0
4	*Hyptis spicigera*	10	0	0
5	*Hyptis suaveolens*	80	0	0
6	*Ipomoea congesta*	9	0	0
7	*Ludwigia hyssopifolia*	0	0	10
8	*Oldenland ia corymbosa*	78	0	0
9	*Senna alata*	0	0	20
10	*Sida acuta*	26	0	0
11	*Urena lobata*	11	0	0
12	*Indigofera linifolia*	0	10	0

Table 3: Diversity Indices of the Study Areas

Diversity indices	Protected area	Developed area	Wetland area
Taxa_S	18	12	15
Dominance_D	0.1198	0.3129	0.2503
Simpson_1-D	0.8802	0.6871	0.7497
Shannon_H	2.413	1.526	1.771
Evenness_e^H/S	0.6206	0.3834	0.3916
Brillouin	1.058	0.7009	0.8366
Menhinick	2.988	2.53	3.056
Margalef	5.158	3.736	4.673
Equitability_J	0.835	0.6142	0.6538
Fisher_alpha	14.17	10.45	16.97
Berger-Parker	0.1928	0.4889	0.4149
Chao-1	18	12	15

Table 4: Significance difference in the diversity indices between the study areas

Diversity indices	PA and DA	DA and WA	PA and WA
Taxa S	0.0403	0.1796	0.3848
Dominance	0.0001	0.2556	0.0014
Shannon H	0.0001	0.2995	0.0006
Evenness e^H/S	0.0001	0.7492	0.0001
Simpson indx	0.0001	0.2556	0.0014
Menhinick	0.1301	0.1796	0.8188
Margalef	0.0502	0.1796	0.5153
Equitability J	0.0001	0.3796	0.0001
Fisher alpha	0.0069	0.0001	0.3316
Berger-Parker	0.0001	0.3369	0.0016

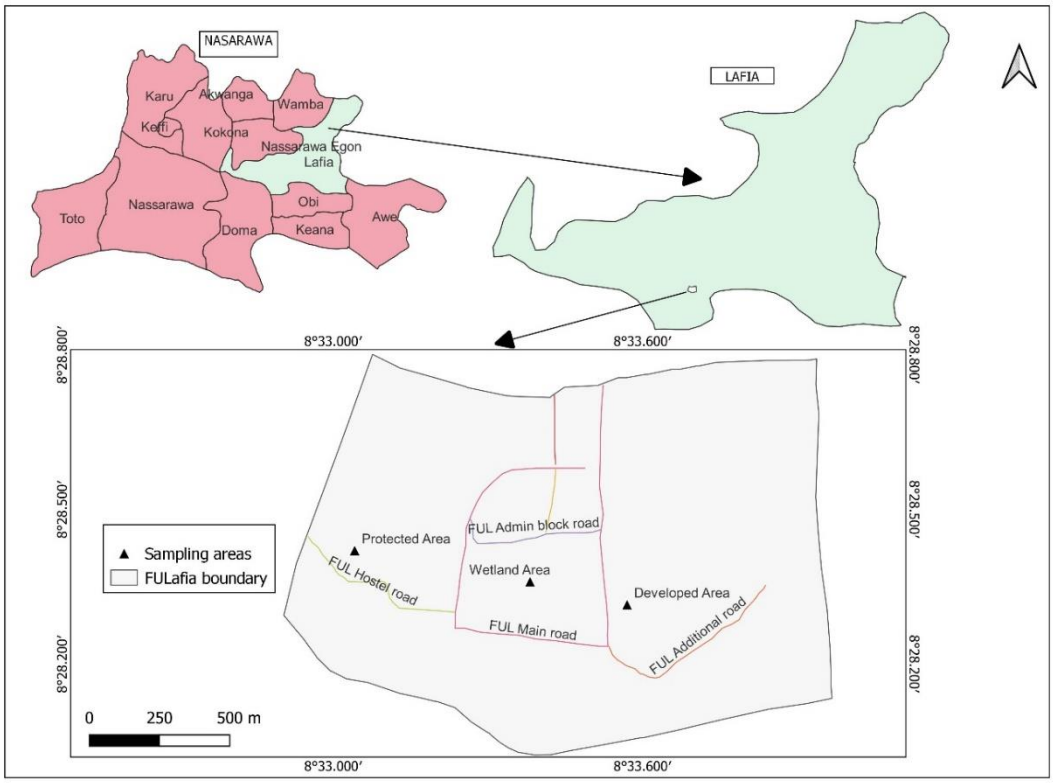

Figure 1: The study area map of FULafia, Nasarawa State

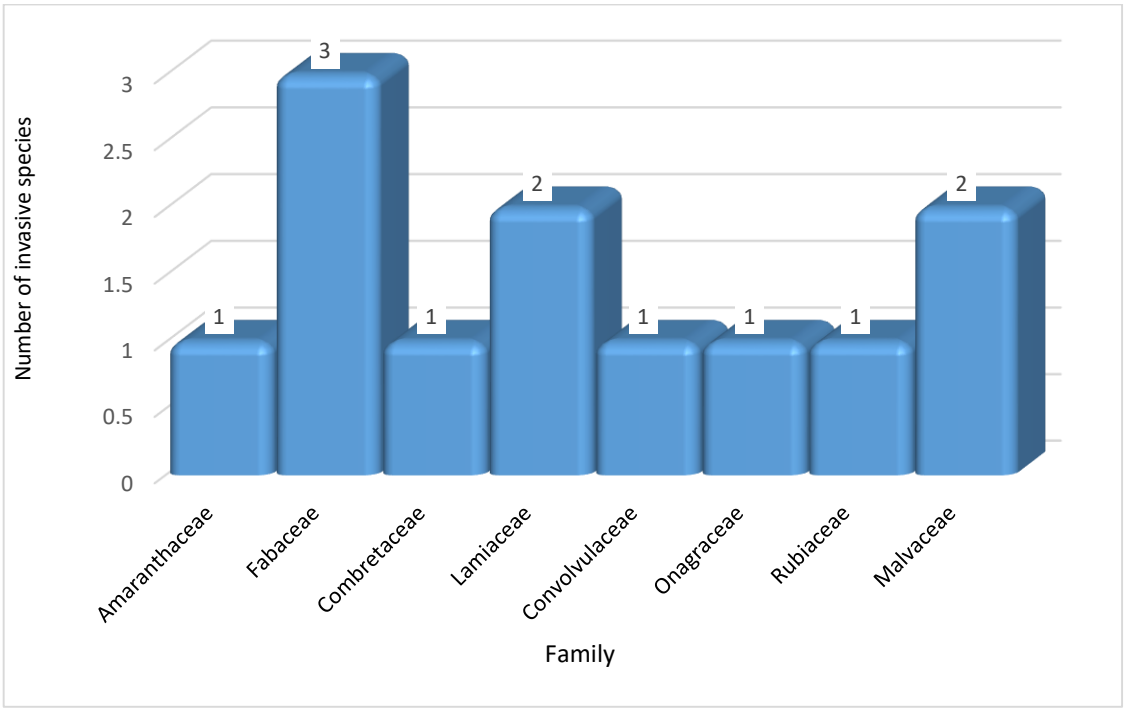

Figure 2: The family of the invasive plants and the corresponding number of species

DISCUSSION

The notable presence of non-native invasive plant species in this university landscape could not have been far from the ecosystem disturbance and removal of native plant vegetation in the area allocated for the university due to infrastructural development (Charly *et al*., 2021). This observation is similar

to the study conducted by Omomoh *et al*. (2022) on the occurrence of non-native invasive plants at a university campus in South Western Nigeria. However, the authors reported most of the invasive plants to be found mainly at the developed part of the university campus. This is contrary to this study in which most of the invasive plants were located at the protected area of the study area.

The botanical garden of the university has the highest occurrence of invasive plants and also has the highest diversity of plants. This is because the habitat may be the most suitable place out of the others areas studied for the occurrence and distribution of these invasive plants. The proliferation of invasive species at this protected area is quite worrisome which reveals the possible disturbance by human activities which have created the chance for the spread and survival of invasive plants there. Besides, there is considerable evidence suggesting that future climate change will further increase the likelihood of invasion of protected areas as well as the consequences of those invasions (Khan *et al*., 2010). This is mainly because of the potential complex interactions between the impact of rainfall changes and global warming on population dynamics and species distributions, coupled with increased ecosystem disturbance such as wildfire, hurricanes and anthropogenic activities.

The result of this study is similar to the findings of Silliman *et al*. (2010) where remote sensing was used to analyze the impact of invasion across some protected areas in China. They observed the presence and impacts of invasive plants at some of the protected forests. The occurrence of the invasive plants was said to have been enhanced by disturbance of the forests. This study then confirms the prevailing theory that disturbance promotes species invasions (Muhammad *et al*., 2012; Silliman *et al*., 2010). Similarly, at a protected tropical grassland of Rajiv Gand hi Orang National Park, Assam, Northeast India, it was discovered that about 30–40% (25–30 km^2) of the protected area (78.8 km^2) have high chances of being invaded by some stubborn plant invaders as a result of disturbances (Mainka *et al*., 2010). These invasive plants can have an adverse effect on rangeland and pastures by altering vegetation dynamics and decreasing ecosystem capacity to recover after disturbance (DiTomaso *et al*., 2010). A very prominent non-native invasive species found across the areas of the university campus is *Hyptis suaveolens*, have been reported to have occupied several parts of Nasarawa State and was also reported to have the potential to dominate several other parts of Nigeria (David *et al.,* 2021). Large patches of this species were found scattered in every part of the university campus.

CONCLUSION

This study revealed that the protected area of the university campus has the highest diversity and occurrence of non-native invasive plant species as compared with the other areas. This study serves as a preliminary investigation which could be useful in the future management of large-scale plant invasions in the university campus. To avert this full-blown invasion predicament, proper monitoring procedures for plant invasions should be put in place, such as monitoring of each non-native invasive species. Extensive mechanical clearing coupled with chemical control of the non-native invasive species at those areas are highly encouraged. Furthermore, it is important to embark on restoration and aggressive replanting of native species to conserve native ecosystems. However, this should be done strategically as all these control methods could also become sources of environmental disturbances.

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