ECOLOGICAL ASSESSMENT OF WEED SPECIES IN TWO SECONDARY FORESTS IN ANAMBRA STATE NIGERIA

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ABSTRACT: *An ecological study was done on weed species in two secondary forests present in Nnamdi Azikiwe University, Awka Campus and Federal College of Education Umunze, Anambra State, Nigeria. Data was collected from the two study sites which were randomly divided for adequate coverage and proper representation. Species dominance, abundance and diversity of weed species were recorded. The result of the study showed that a total of 21 weed species were recorded in Plot 1 study area which is at Nnamdi Azikiwe University, Awka campus; Pennisetum purpureum had the highest species abundance in the study site, with a total frequency of 93 and Dominance index of 28.97. Pennisetum purpureum had a relative density of while Tridax procumbens was the second most abundant with a frequency of 40 and Dominance of 7.10. Rhynchospora corymbosa showed the least abundance with a frequency of 6. The result of Shannon Wiener index for weed species in Plot 1 study was 2.56 and this showed that there is high diversity of weed species in the study area. Meanwhile, the result of the study in Plot 2, which is at Federal College of Education, Umunze showed that a total of 18 weed species were recorded; Imperata cylindrica had the highest species abundance in the study site, with a total frequency of 87 and Dominance index of 27.43, while Cypertrus rotundus was the second most abundant with a frequency of 67 and Dominance index of 10.5. Acanthus Montana showed the least in abundance with a frequency of 6 and Dominance index of 1.02. The result of Shannon Wiener index for weed species in Plot 2 study was 2.47 and this also showed that there is high diversity of weed species in the study area. This result invariably indicates a great potential for utilization in conservation and ecological purposes.*

KEYWORDS: Diversity, Secondary, Weeds, Forests, Vegetation, Ecology, Species, Plant.

INTRODUCTION

Due to the considerable change in forest species management, with rapid changes from the 1980’s, as noted by Primack (1991), notably, our forests, which are the major source of livelihood to people all over the world, are suffering degradation as a result of majorly anthropogenic factors and sometimes natural factors. Some of these anthropogenic factors include logging, urban sprawl, human-caused forest fire, slash/burn practices; while some natural factors include: acid rain, invasive species, etc (Momberg, 1992). Hence, forest scientists or foresters focused on studying our forest species to preserve information on our forest compositions and as well help researchers in conservation and management decision making processes. These forest species include Plants (Weeds, Trees, Shrubs, Herbs), and Animals (Vertebrates and Invertebrates).

The term "weed" is employed in various ways, typically referring to a plant undesirable in a specific context. This definition somehow agrees with the definition of weed by Singh *et al*. (2023); they said that weeds are unwanted and unattractive plants that negatively impact human welfare by interfering with the use of land and water resources. However, the perspective of weeds can be relative being that it is subjective, lacking classification value; as a plant deemed a weed in one setting, it may not be considered as such when growing where it is intended or desired. In fact, many plants labeled as "weeds" are deliberately cultivated by individuals in gardens or other cultivated-plant environments; this is because of weeds’ beneficial impacts to man, his environment and livestock (Ekwealor *et al*., 2019). Invasive species—plants introduced to an environment where their presence negatively impacts the overall functioning and biodiversity of the ecosystem—may also sometimes be considered weeds. Some plants are sometimes called beneficial weeds; therefore, whether a plant is a weed or not depends on context.

Plants commonly defined as weeds broadly share biological characteristics that allow them to thrive in disturbed environments and to be particularly difficult to destroy or eradicate. In particular, weeds are adapted to thrive under human management in the same way as intentionally grown plants (Bridge, 1994). Since the origins of agriculture on Earth, agricultural weeds have co-evolved with human crops and agricultural systems, and some have been domesticated into crops themselves after their fitness in agricultural settings became apparent (Guglielmi *et al.,* 2016). More broadly, the term "weed" is occasionally applied pejoratively for species outside the plant kingdom, species that can survive in diverse environments and reproduce quickly; in this sense, it has even been applied to humans (Schmidt & Pannell, 1996).

More importantly, we study our forest because the survival of forests is crucial for the sustainability of these other key resources of planet Earth. This natural resource by creation exists to serve man. History reveals a consistent relationship between people and forests. Forest products play critical roles in human environment, situation, needs and even lifeline. It is equally evident that throughout the ages, the presence or absence of forests is an indicator of civilization; where there are no trees, such as the polar region, deserts and high mountain tops, human endurance and permanent habitation are virtually nonexistent. By the same token, dense tropical forests exert profound debilitating effects on human development and growth (Adeyoju *et al*., 2001).

Forests are priceless ecological resources that regulate climate, protect land and water resources, control floods, ward off wind and water erosion, store and cycle nutrients, and

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provide habitats for wildlife. They also carry out photosynthesis, the basis of all food chains and the main source of life-giving oxygen. The transformation of forests through loss and regeneration results in the categorization of two main forest types: primary (old-growth) forest and secondary forest (Okereke *et al*., 2014).

Anambra State and its environment has an abundance of weed plant species which are yet to be identified and documented. However, the activities of farmers and indiscriminate burning of bushes have reduced these virgin forests to secondary forests, which threatens the existence and abundance of these species. The scarcity of information on the distribution, abundance, species diversity and proper documentation of these various unidentified weed plant species in secondary forests within Anambra State and its environment, amidst factors from numerous human impacts that threaten the existence of these species, inspired the urgency or need to carry out this study.

In Anambra State and many other parts of Nigeria, some weed species are very important to people because of their beneficial economic importance, most especially as regards their medicinal value. Weed species like *Chromolaena odorata* are used in treating fresh wounds. *Hyptis suaveolens* aroma is used in controlling mosquitos that are vectors of malaria parasite that infects humans. The aim of this study is to carry out an ecological study of weed species in two secondary forests in Anambra State, Nigeria.

MATERIALS AND METHOD

Description of Study Area

The study was carried out in two secondary forests located at Nnamdi Azikiwe University before the new gold center at school gate Enugu-Onitsha expressway and Federal College of Education (Tech), Umunze, at the back of Anyim Ude Hostel in Anambra State, Nigeria, established in the South-eastern zone in 1991. With a mean elevation of 136 meters above sea level, Anambra State has a high potential for agricultural development, because of stretches of fertile land on the plains in Ogbaru, Ayamelum, Oyi, Awka, and Orumba Local Government Areas, according to Anambra State Director of Forestry's report (Ezike, 2011). Egboka (1993) stated that Anambra is a state in South-eastern Nigeria. Its name is an anglicized version of the original 'OmaMbala', the name of the river now known as Anambra River. The state derives its name from the Anambra River, the largest, most southerly, left bank tributary of the River Niger.

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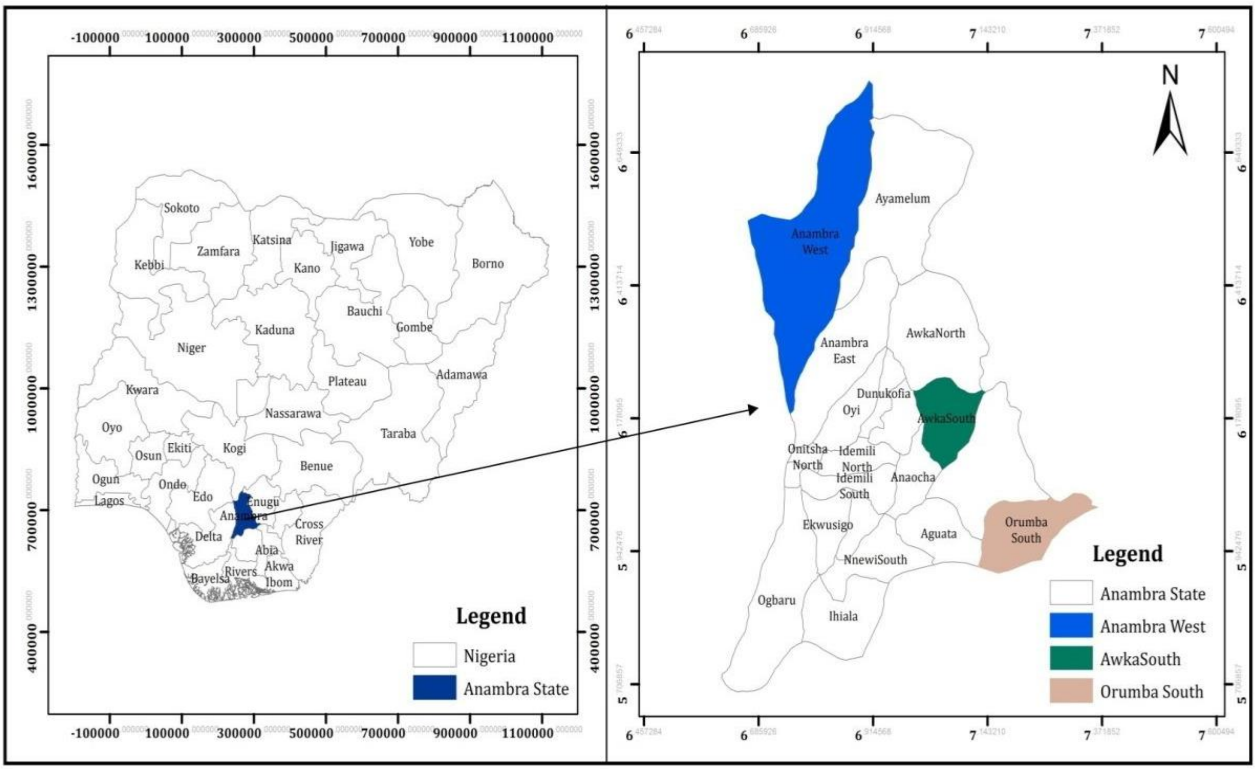

Figure 1: Map of Nigeria Showing Anambra State and the Local Government Areas Where the Forest Sites Studied Are Located (**Map Source:** Iroka *et al*., 2024).

Experimental Design

Two plots, each measuring 20 by 30 (20 x 30) = 600 meters square was used; 10% of the 600 meters square was measured out. 600/10 = 60 square meters. In choosing the quadrat that was used in carrying out the study, the area of the land was divided by the number of throws: 60/15=4; therefore, the quadrat used was a 2 by 2 square meters quadrat.

Plot Determination

Edge effect was carefully avoided by giving 2 m away from the edge of the plot. The homogeneous plots of size 20$m^2 m^2$ by 30$m^2 m^2$ were marked out using rope and pegs.

Data Collection

During the plant species study, various types of weed species seen in the study area were recorded, their distribution, and the abundance within the area of interest. This data does not only involve the species names, other important details of the weed species were noted, like the number of individual plants and their common names.

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Computation And Data Analysis

Density = The average number of individuals per unit area (per acre or hectare).

$$\text{Density} = \frac{\text{Total number of individual species}}{\text{Total area of the plot sampled}}$$

$$\text{Relative density} = \frac{\text{Density of a given species}}{\text{Total density of all the given species}}$$

Frequency = The percentage of inventory points occupied by a given species. It is also said to be a measure of species distribution across the site.

$$\text{Frequency} = \frac{\text{Number of times each species occurred}}{\text{Total area of the plot sampled}}$$

$$\text{Relative frequency} = \frac{\text{Frequency of a given species}}{\text{Total frequency of all the species}} \times \frac{100}{1}$$

Importance value = Relative frequency + Relative density

Dominance: The average dominance of each species within the study area is estimated by its total basal area per unit area.

Measure of species diversity:

Shannon-Wiener index of diversity:

$$H^1 = -\sum_{i=1}^{R} Pi.LnPi$$

where

n = Number of individual

N = Number of individual species

Pi = Proportion of sampled species

H^1H^1 = Species diversity.

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RESULT

The result in Table 1 shows the list of plant species sampled in Nnamdi Azikiwe University, Awka. In the table below, it shows that 21 weed species were sampled with *Pennisetum purpureum* from the Poaceae family having the highest number of occurrence (155), followed by *Chromolaena odorata* from the Asteraceae family (51), followed by *Aspilia africana* from the Asteraceae family (42), and followed by *Tridax procumbens* from the Asteraceae family (38). It also shows plant species that are low in number of occurrences. *Rhynchospora corymbosa* of the Cyperaceae family has the least number of occurrences (5), followed by *Asystasia gangetica* from the Acanthaceae family (6), and followed by *Costus spiralis* from the Costaceae family (8). The result in the table also shows that the 21 weed species came from 11 plant families. The Fabaceae family has the highest number of occurrences (4 times) followed by the Poaceae family and the Asteraceae family which appear to be sharing a similar number of occurrences (3 times). The Laminaceae family, the Commelinaceae family and the Acanthaceae family appeared twice while the Cyperaceae family, the Passifloraceae family, the Costaceae family, the Combretaceae family and the Euphorbiaceae family appeared only once. The forest is composed of weeds species that have both medicinal and economic values.

Table 1: List of Species Sampled in Plot 1

S/N	Plant Species	Family	Common Name	Total Number of Weed Species Sampled in Plot 1
1	*Pennisetum purpureum*	Poaceae	Elephant grass	155
2	*Aspilia Africana*	Asteraceae	Wild sun flower	42
3	*Rhynchospora corymbosa*	Cyperaceae	Golden beaksedge	5
4	*Sorghum halepense*	Poaceae	Johnson grass	24
5	*Mimosa pigra*	Fabaceae	Bashful plant	18
6	*Passiflora foetida*	Passifloraceae	Wild maracuja	14
7	*Mesophaerum suaveolens*	Laminaceae	Pignut	22
8	*Megathyrsus maximus*	Poaceae	Bermuda grass	20
9	*Commelina diffusa*	Commelinaceae	Climbing day flower	25
10	*Acanthus montanus*	Acanthaceae	Mountain thistle	9
11	*Mimosa pudica*	Fabaceae	Touch sensitive plant	12
12	*Abrus precatorius*	Fabaceae	Rosary pea	32
13	*Calapogonium mucunoides*	Fabaceae	Calopo	17
14	*Asystasia gangetica*	Acanthaceae	Creeping foxglove	6
15	*Costus spiralis*	Costaceae	Insulin plant	8
16	*Combretum malabaricum*	Combretaceae	Bush willow	9
17	*Chromolaena odorata*	Asteraceae	Jack in the bush	51
18	*Euphorbia heterophylla*	Euphorbiaceae	Milk weed	9
19	*Tridax procumbens*	Asteraceae	Coatbuttons	38
20	*Commelina benghalensis*	Commelinaceae	Tropical spiderwort	9

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21	*Hyptis suaveolens*	Lamiaceae	Pignut weed	10
	TOTAL			535

The result in Table 2 shows species abundance in Nnamdi Azikiwe University Awka. The study shows 21 species of sampled weed species with *Pennisetum purpureum* showing the highest density of 2.58, followed by *Chromolaena odorata* (0.85), followed by *Tridax procumbens* (0.63), and followed by *Abrus precatorious* (0.53). *Rynchospora corymbosa* shows the least density (0.08), followed by *Asystasia gangetica* from 0.1, and *Costus spiralis* (0.13). The result also shows that *Pennisetum purpureum* has the highest relative density of 0.29, followed by *Chromolaena odorata* (0.096). *Rhynchospora corymbosa* has the least relative density of 0.009, followed by *Asystasia gangetica* (0.011).

The result shows that *Pennisetum purpureum* has the highest frequency (93%), Relative frequency (17.25%), Importance value (17.54), Dominance index (28.97) and Relative abundance (10.3), followed by *Chromolaena odorata* which has a frequency of 53.3%, Relative frequency (9.89%), Importance value (9.99), Dominance index (9.53) and Relative abundance (3.4).

Table 2: Species Abundance in Plot 1

S/N	PLANT SPECIES	D	R.D	F	R.F	I.V	DI	A
1	*Pennisetum purpureum*	2.58	0.29	93	17.25	17.54	28.97	10.3
2	*Aspilia Africana*	0.7	0.079	33.3	6.18	6.26	7.85	2.8
3	*Rhynchospora corymbosa*	0.08	0.009	6.6	1.21	1.21	0.93	0.33
4	*Sorghum halepense*	0.4	0.04	20	3.70	3.74	4.49	1.6
5	*Mimosa pigra*	0.3	0.03	20	3.70	3.73	3.36	1.2
6	*Passiflora foetida*	0.23	0.026	20	3.70	3.72	2.61	0.93
7	*Mesophareum suaveolens*	0.36	0.04	26.6	4.93	4.97	4.11	1.46
8	*Megathyrsus maximus*	0.33	0.037	26.6	4.93	4.97	3.73	1.3
9	*Commelina diffusa*	0.41	0.046	33.3	6.18	6.23	4.67	1.66
10	*Acanthus montanus*	0.15	0.017	13.3	2.47	2.49	1.68	0.6
11	*Mimosa pudica*	0.2	0.023	20	3.70	3.72	2.24	0.8
12	*Abrus precatorious*	0.53	0.059	33.3	6.18	6.77	5.98	2.13
13	*Calopogonium mucunoides*	0.28	0.032	20	3.70	3.73	3.17	1.13
14	*Asystasia gangetica*	0.1	0.011	13.3	2.47	2.48	1.12	0.4
15	*Costus spiralis*	0.13	0.015	13.3	2.47	2.49	1.49	0.53
16	*Combretum malabaricum*	0.15	0.017	13.3	2.47	2.49	1.68	0.6
17	*Chromolaena odorata*	0.85	0.096	53.3	9.89	9.99	9.53	3.4
18	*Euphorbia heterophylla*	0.15	0.017	13.3	2.47	2.49	1.68	0.6
19	*Tridax procumbens*	0.63	0.07	40	7.42	7.49	7.10	3.4
20	*Commelina benghalensis*	0.15	0.017	13.3	2.47	2.49	1.68	0.6
21	*Hyptis suaveolens*	0.16	0.018	13.3	2.47	2.49	1.86	0.66
	TOTAL	8.87	0.989	539.1				

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The result in Table 3 shows the analysis of the species diversity using the Shannon-Wiener index of species diversity which proved that the forest has a high diversity of 2.56 approximately. This showed that the forest has a large number of species that are relatively evenly distributed and almost equally abundant.

Table 3: Species Diversity in Plot 1

S/N	PLANT SPECIES	n	N	Pi	ln(Pi)	Pi x Ln(Pi)	H	E
1	*Pennisetum purpureum*	155	535	0.289	-1.241	-0.359	2.56	
2	*Aspilia Africana*	42	535	0.078	-2.551	-0.199		
3	*Rhynchospora corymbosa*	5	535	0.009	-4.710	-0.042		
4	*Sorghum halepense*	24	535	0.044	-3.123	-0.137		
5	*Mimosa pigra*	18	535	0.034	-3.381	-0.115		
6	*Passiflora foetida*	14	535	0.026	-3.649	-0.095		
7	*Mesophareum suaveolens*	22	535	0.041	-3.194	-0.131		
8	*Megathyrsus maximus*	20	535	0.037	-3.297	-0.122		
9	*Commelina diffusa*	25	535	0.046	-3.079	-0.142		
10	*Acanthus montanus*	9	535	0.016	-4.135	-0.066		
11	*Mimosa pudica*	12	535	0.022	-3.817	-0.084		
12	*Abrus precatorious*	32	535	0.059	-2.830	-0.167		
13	*Calopogonium mucunoides*	17	535	0.031	-3.473	-0.108		
14	*Asystasia gangetica*	6	535	0.011	-4.509	-0.049		
15	*Costus spiralis*	8	535	0.015	-4.199	-0.063		
16	*Combretum malabarium*	9	535	0.017	-4.074	-0.069		
17	*Chromolaena odorata*	51	535	0.095	-2.353	-0.224		
18	*Euphorbia heterophylla*	9	535	0.016	-4.135	-0.066		
19	*Tridax procumbens*	38	535	0.071	-2.645	-0.188		
20	*Commelina benghalensis*	9	535	0.016	-4.135	-0.066		
21	*Hyptis suaveolens*	10	535	0.019	-3.963	-0.075		
			535					

The result in Table 4 shows the list of plant species sampled in Federal College of Education Umunze, Anambra State. From the result, a total number of 587 weed species with 18 species belonging to 10 families were encountered and recorded in the study area. *Imperata cylindrica* from the Poaceae family showed the highest number of count (161), followed by *Cyperus rotundus* from the Cyperaceae family (59), and followed by *Tridax procumbens* from the Asteraceae family (47). It also shows plant species that are low in count. *Acanthus montana* of the Acanthaceae family has the least number of count (6), followed by Striga genus from the Orobanchaceae family (7), followed by *Croton hirtus* from the Euphorbiaceae family and *Commelina benghalensis* from the Commelinaceae family (9 each).

The result in the table also shows that the 18 weed species came from 11 plant families. The Asteraceae family has the highest number of occurrences (4 times) followed by the Acanthaceae family (3 times). The Cyperaceae family, the Euphorbiaceae family, and the Lamiaceae family appeared twice while the Orobanchaceae family, the Commelinaceae family,

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the Convolvulaceae family, and the Poaceae family appeared only once. The forest is composed of weed species that have both medicinal and economic values.

Table 4: List of Species Sampled in Plot 2

S/N	Plant Species	Family	Common Name	Total Number of Weed Species Sampled in Plots 2
1	*Imperata cylindrica*	Poaceae	Congo grass	161
2	*Cyperus rotundus*	Cyperaceae	Coco-grass	59
3	*Euphorbia heterophylla*	Euphorbiaceae	Milkweed	18
4	*Striga genus*	Orobanchaceae	Witchweed	7
5	*Commelina benghalensis*	Commelinaceae	Tropical spiderwort	9
6	*Hyptis spicigera*	Lamiaceae	Black sesame	38
7	*Ipomoea muricata*	Convolvulaceae	Moonvine	32
8	*Aspilia Africana*	Asteraceae	Wild sun flower	28
9	*Tridax procumbens*	Asteraceae	Coatbuttons	47
10	*Ageratum conyzoides*	Asteraceae	Billygoat weed	43
11	*Acanthus Montana*	Acanthaceae	Mountain thistle	6
12	*Asystasia gangetica*	Acanthaceae	Chinese violet	21
13	*Justicia flava*	Acanthaceae	Yellow justice	13
14	*Rhynchospora corymbosa*	Cyperaceae	Golden beaksedge	12
15	*Chromolaena odorata*	Asteraceae	Siam weed	46
16	*Mimosa pudica*	Fabaceae	Sensitive plant	12
17	*Hyptis suaveolens*	Lamiaceae	Pignut	26
18	*Croton hirtus*	Euphorbiaceae	Hairy croton	9
	TOTAL			587

The result in Table 5 shows species abundance in the Federal College of Education Umunze. The study shows 18 pieces of sampled weed species with *Imperata cylindrical* showing the highest density of 2.68 and Dominance of 27.43, followed by *Cyperus rotundus* (0.98) with Dominance index of 10.05, followed by *Tridax procumbens* (0.78) with Dominance index of 8.00, and followed by *Chromolaena odorata* (0.77) with Dominance index of 7.83. shows the least density (0.1) with Dominance index of 1.02, followed by *Striga genus* 0.12 density with Dominance index of 1.19, followed by *Commelina benghalensis* (0.15) density with Dominance index of 1.53. The result also shows that *Imperata cylindrical* has the highest relative density of 0.29. *Acanthus Montana* however showed the least in relative density of 0.01, followed by *Striga genus* (0.012).

The result in Table 5 shows that *Imperata cylindrical* has the highest frequency (approximately 87%), Relative frequency (15.11%), Importance value (15.38) and Relative abundance (10.3), followed by *Cyperus rotundus* which has a frequency of 67% (approximately), Relative frequency (11.62%), Importance value (15.38) and Relative abundance of 3.93. *The Striga* genus shows the least generally.

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Table 5: Species Abundance in Plot 2

S/N	PLANT SPECIES	D	R.D	F	R.F	I.V	DI	A
1	*Imperata cylindrica*	2.68	0.27	86.6	15.11	15.38	27.43	10.73
2	*Cyperus rotundus*	0.98	0.09	66.6	11.62	11.71	10.05	3.93
3	*Euphorbia heterophylla*	0.3	0.03	26.6	4.64	4.67	3.07	1.2
4	*Striga genus*	0.12	0.012	13.3	2.32	2.33	1.19	0.46
5	*Commelina benghalensis*	0.15	0.02	13.3	2.32	2.34	1.53	0.6
6	*Hyptis spicigera*	0.63	0.064	40	6.98	7.04	6.47	2.53
7	*Ipomoea muricata*	0.53	0.053	40	6.98	7.03	5.45	2.13
8	*Aspilia Africana*	0.46	0.046	33.3	2.32	2.36	4.77	1.86
9	*Tridax procumbense*	0.78	0.079	40	6.98	7.06	8.00	3.13
10	*Ageratum conyzoides*	0.77	0.078	40	6.68	7.06	7.32	2.86
11	*Acanthus Montana*	0.1	0.01	6.6	1.15	1.16	1.02	0.4
12	*Asystasia gangetica*	0.35	0.035	20	3.49	3.53	3.58	1.4
13	*Justicia flava*	0.22	0.022	20	3.49	3.51	2.21	0.86
14	*Rhynchospora corymbosa*	0.2	0.02	20	3.49	3.51	2.04	0.8
15	*Chromolaena odorata*	0.77	0.078	46.6	8.14	8.22	7.83	3.06
16	*Mimosa pigra*	0.2	0.02	20	3.49	3.51	2.04	0.3
17	*Hyptis suaveolens*	0.43	0.043	26.6	4.64	4.68	4.43	1.73
18	*Croton hirtus*	0.15	0.015	13.3	2.32	2.34	2.34	0.6
	TOTAL	9.82		572.8				

The result in Table 6 showing the analysis of the species diversity using the Shannon-Wiener index of species diversity proved that the forest has a high diversity of 2.47 approximately. This showed that the forest has a large number of species that are relatively evenly distributed and almost equally abundant.

Table 6: Species Diversity in Plot 2

S/N	PLANT SPECIES	n	N	Pi	In(Pi)	Pi x In(Pi)	E
1	*Imperata cylindrica*	161	587	0.274	-1.294	-0.354	2.46 7
2	*Cyperus rotundus*	59	587	0.1	-2.302	-0.23	
3	*Euphorbia heterophylla*	18	587	0.03	-3.506	-0.105	
4	*Striga genus*	7	587	0.011	-4.504	-0.049	
5	*Commelina benghalensis*	9	587	0.015	-4.199	-0.062	
6	*Hyptis spicigera*	38	587	0.64	-2.748	-0.175	
7	*Cynodon dactylon*	32	587	0.054	-2.918	-0.157	
8	*Aspilia Africana*	28	587	0.047	-3.057	-0.143	
9	*Tridax procumbens*	47	587	0.08	-2.617	-0.202	
10	*Ageratum conyzoides*	43	587	0.073	-2.525	-0.191	
11	*Acanthus Montana*	6	587	0.01	-4.605	-0.046	
12	*Asystasia gangetica*	21	587	0.035	-3.352	-0.117	

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13	*Justicia flava*	13	587	0.022	-3.816	-0.083
14	*Rhynchospora corymbosa*	12	587	0.02	-3.912	-0.078
15	*Chromolaena odorata*	46	587	0.078	-2.551	-0.198
16	*Mimosa pigra*	12	587	0.02	-3.912	-0.078
17	*Hyptis suaveolens*	26	587	0.044	-3.123	-0.137
18	*Croton hirtus*	9	587	0.015	-4.199	-0.062
	TOTAL	587				

The result in Table 7 shows a total of 13 families of the weed species sampled in the 2 plots with the total number of species recorded by each family. From the result, it shows that species from the Poaceae family proved to be dominating the two study locations with a total number of 360 counts, followed by the Asteraceae family, and followed by the Fabaceae family. The Orobanchaceae family showed to be the least, followed by Costaceae and Combretaceae.

Table 7: Family of Weed Species Sampled in the Two Plots Sampled in the 2 Plots

S/N	Family of Plant Species	Total Number of Plant Species
1	Asteraceae	295
2	Poaceae	360
3	Cyperaceae	76
4	Fabaceae	79
5	Commelinaceae	43
6	Lamiaceae	74
7	Euphorbiaceae	36
8	Convolvulaceae	32
9	Acanthaceae	42
10	Combretaceae	9
11	Costaceae	8
12	Orobanchaceae	7
13	Passifloraceae	14

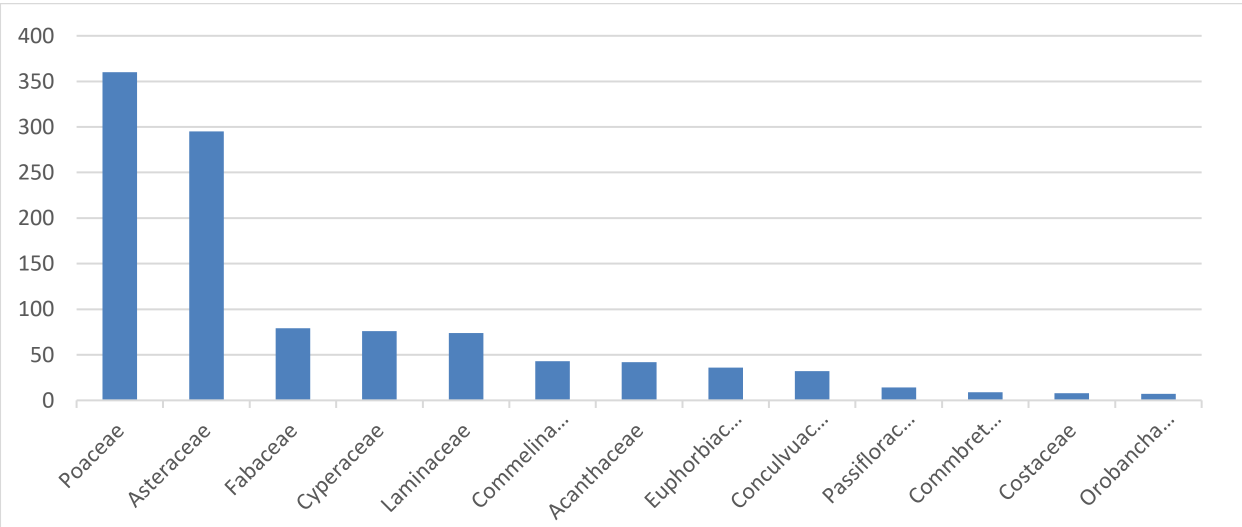

Fig. 2: A chart showing the total sum of families of weed species sampled in the two plots with the total number of weed species recorded in each family.

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DISCUSSION

The present study investigated the weed species present in two selected secondary forests in Awka and Umunze. In accessing the weed species in the study area at Nnamdi Azikiwe University, a total number of twenty-one (21) weed species were identified, comprising eleven (11) different families with *Pennisetum purpureum* from Poaceae family appearing the highest in occurrence with a Dominance index of 28.97. This is supported by the findings of Ekwealor *et al*. (2023), who studied the species of the Poaceae family present in Nnamdi Azikiwe University Campus, Awka. The author stated that the species of plants in the family of Poaceae were the dominant taxa in Awka campus of Nnamdi Azikiwe University, though in addition to other dominant species including *Chromolaena odorata* with Dominance index of 9.89 followed by *Tridax procumbens* with Dominance index of 7.10. Furthermore, despite plant species from the Poaceae family being the dominant species in the study area, other families (Asteraceae and Fabaceae) were also heavily present. The generally dominant occurrence of *Pennisetum purpureum* across the study locations could be associated with its characteristics to dominate tropical forests due to several factors like rapid growth. According to Turner and Corlett (1996), *Pennisetum purpureum* grows quickly and outcompetes slower-growing native species. Again, high biomass production, as stated by Turner and Corlett (1996), could contribute to the dominance of *Pennisetum purpureum* in the study area since it possesses the ability to produce a large amount of biomass which allows it to suppress other plants by shading them out. Adaptability is also another factor responsible for the dominance, as reported by Henderson and Hugles (2001). According to the authors, *Pennisetum purpureum* can thrive in a variety of soil types and conditions, making it highly adaptable to different environments. High reproductive rate could also bring about this dominance, according to Henderson and Hugles (2001). This plant species known as *Pennisetum purpureum* produces a lot of seeds and can spread rapidly, facilitating its dominance in an area.

When other ecological parameters were measured in the study area, it was observed that *Pennisetum purpureum* has the highest frequency of 93%, followed by *Chromolaena odorata* with 53% and *Tridax procumbens* with 40% frequency. However, *Rhynchospora corymbosa* has the least frequency of 6.6%. Interestingly, when a plant species has the highest frequency in a given area, it means that the species is the most common or abundant compared to other species in that same area. This observation aligns with the findings of Preston (1948), who carefully studied the relative abundance of species in collections and communities and observed that when groups of plant species are sampled in a particular community, there are chances of encountering few abundant species and few that are very rare. When the frequency of occurrence of a plant species is high, it can have several implications like reduction in the number of slower growing plant species. Vitousek (1997) carried out an extensive study on the ecological impact of dominant species and he noted that the dominant species can influence the structure and function of the ecosystem, affecting factors like soil composition, light availability, and habitat for other organisms. Connell (1961), who investigated its implication on competition with other plants, noted that the dominant species may outcompete other species for resources such as light, water and nutrients, and this can reduce the diversity of plant species in that area. Tilman (1997) worked on its biodiversity implication and he opined that high frequency of one species might lead to lower biodiversity if it suppresses the growth or establishment of other species. Costanza (1997) has also worked extensively on the ecosystem services of plants that are dominating other species and reported that dominant

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species can affect the ecosystem services, such as carbon sequestration, water regulation, and habitat provision.

In terms of importance value index, *Pennisetum purpureum* also recorded the highest value of 17.54, followed by *Chromolaena odorata* with the value of 9.99 and *Tridax procumbens* with the importance value index of 7.49. However, *Rhynchospora corymbosa* recorded the least with the importance value index of 1.21. The highest importance value index of *Pennisetum purpureum* indicates that it is a species exerting an influence on the structure of the forest weed species in the ecosystem and availability of habitat and distribution of resources. Its prominent presence may signify its importance in maintaining balance and fostering biodiversity (Adekunle *et al.*, 2013). Importance value index of weed species is necessary in ecological research as it offers valuable insights into a species' overall significance within a specific ecosystem. Importance value index is calculated by summing the values of relative frequency and relative frequency, making it an indispensable tool for understanding the ecological roles of species and their impact on forest structure and dynamics.

The species diversity index employed in this research is the Shannon-Wiener Diversity index $(H^1(H^1)$. Since the Shannon-Weiner Diversity index considers both species richness and evenness in a community, it has been widely used by researchers to study ecosystem diversity (Adekunle, 2013; Adeduntan & Olusola, 2015, Oke *et al.*, 2017; Amonum *et al.,* 2019). Species diversity is typically one of the most significant indices used to assess an ecosystem. An ecosystem with great species diversity richness has a significant value$(H^1(H^1)$ (Sobuj & Rahman, 2011). This present study had a high species diversity of 2.56; this may be due to limited or low exploitation of species in the forest habitat and the species' ability to withstand unfavorable environmental variables that are common in the forest.

In accessing the weed species in the study area at Federal College of Education (Tech), Umunze, a total number of eighteen (18) weed species were identified, comprising ten (10) different families, with *Imperata cylindrica* from Poaceae family having the highest occurrence with the dominance index of 27.43. This is in agreement with the findings of Ekwealor *et al.* (2023), who reported a heavy presence of the Poaceae family in Nnamdi Azikiwe University Campus, Awka. He stated that the species of family Poaceae is a dominant plant family in Awka campus of Nnamdi Azikiwe University. This could be because Nnamdi Azikiwe University and Federal College of Education, Umunze are both in one vegetation zone and they share the same climatic conditions; therefore, they may have some structural and composition similarities, both being both secondary forests in Anambra State. In addition, other dominant species include *Cyperus rotundus* with Dominance index of 10.05, followed by *Tridax procumbens* with Dominance index of 8.00. Regardless of the fact that plant species from the Poaceae family were the dominant species in the study area, there were other plant families that were dominating as well (the Asteraceae, Acanthaceae and Cyperaceae families).

The generally dominant occurrence of *Imperata cylindrica* in the study location could be associated with its characteristics to dominate tropical forests due to several factors. According to Smith *et al. (*2000), *Imperata cylindrical* dominates other species by their ability to grow aggressively, by spreading rapidly through their rhizome system. Rhizomatous grasses like *Imperata cylindrica* can form dense mats that outcompete native plants for sunlight, nutrients, and space (Smith *et al*., 2000). Brewer and McCormick (2012) carried out an extensive research to investigate why *Imperata cylindrical* dominates other slower growing species; they observed

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that *Imperata cylindrica* produces large quantities of seeds that are dispersed by wind, enabling it to colonize new areas effectively. In their study, they noted that its seed production and dispersal capabilities contribute significantly to its invasive nature.

In terms of frequency, as measured in the study area, it was observed that *Imperata cylindrica* had the highest frequency of 86.6%, followed by *Cyperus rotundus* with 66.6% and *Chromolaena odorata* with 46%. However, *Acanthus montana* had the least frequency with 6.6%. The findings of Preson (1948) from the study of the relative abundance of species in collections and communities revealed that when a group of plant species in a particular community is investigated, there is a possibility of coming across a few abundant species and few that are very rare. Notably, a species that has the highest frequency of occurrence in a given area is automatically the most common or abundant compared to other species in that same area (Vitousek, 1997).

The results of the Importance value index revealed that *Imperata cylindrical* also recorded the highest value of 15.38, followed by *Cyperus rotundus* with the value of 11.71 and, lastly, *Chromolaena odorata* with the importance value index of 8.22. *Acanthus montana* had the least value with the Importance value index of 1.16. The highest Importance value index of *Imperata cylindrical* indicated that it is a species exerting an influence on the structure of the forests. Its prominent presence may signify its importance in maintaining balance and fostering biodiversity (Adekunle *et al.*, 2013).

The assessment of the weed species in the study area at Federal College of Education (Tech), Umunze revealed a high species diversity of 2.47 which may be due to limited or low exploitation of species in the forest habitat and the species' ability to withstand unfavorable environmental variables that are common in the forest. Authors like Jost (2007), Tuomisto (2010) and Krebs (1999) all reported that species diversity is affected by not only the number of individual species but also by the heterogeneity of the sample. They were also of the opinion that increasing the area sampled increases observed species diversity both because more individuals get included in the sample and that large areas were environmentally more heterogeneous than small areas. Their observation tallies with the present research work because virtually all the sampled forests were highly diverse. The discrepancies in the species diversities could also be attributed to environmental factors, forest management or soil conditions which were not measured. Bush *et al*. (1989) concurred that species diversity increases with environmental complexity or heterogeneity. They however noted that an aspect of environmental structure important to one group of organisms may not have a positive influence on another group.

Generally, the differences observed in the occurrence, population, distribution and density of the herbaceous weed species at the study locations may be attributed to variability in adaptation or tolerance to available environmental factors—sunlight, temperature, and relative humidity (Wyant *et al*., 2019; Yousseff & Al-fredan, 2014). Other factors such as soil water content, nutrient availability, pH, texture, seed bank and depth, respectively, which are commonly edaphic factors, may also alter species densities and distribution (Pinke *et al*., 2012; Anjorin *et al*., 2021). Also, the variations may be ascribed to variations in requirement or uptake of these edaphic factors by each species, and responses of plasticity of morphological and physiological attributes of the individual species (Roach & Wulff, 1987), hence the influences observed in the species distribution and variations leading to the interpopulation and intrapopulation variability (Barbosa *et al*., 2013) of the herbaceous weeds found at the locations.

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The generally dominant occurrence of species from Poaceae family across the study locations may be associated with its characteristic to invade soils where they exist and outcompete all other plants (Anjorin *et al*., 2021), mainly due to their allelopathic nature, seed dimorphism and prolificacy of seed production, and hence, high seed bank and adaption to even adverse environmental conditions, making it an invader of tropical and subtropical regions of the world (Afolayan, 1993). The herbaceous weeds invasion had regulated plants species diversity across tropical grasslands (Maia, 2008; Padalia *et al*., 2014; Schwarzkopf *et al*., 2014), Nnamdi Azikiwe University, Awka and Federal College of Education, Umunze, both in Anambra State, Nigeria may not be exceptions, especially as most of the herbaceous weeds are capable of easy dispersal to undisturbed areas, where they may remain dormant for extended periods, until conditions become suitable (Parsons & Cuthbertson, 2001). The dominance of *Pennisetum purpureum*, *Chromolaena odorata*, *Tridax procumbens*, *Imperata cylindrica*, *Cyperus rotundus* and other weed species, with similar characteristics of withstanding varying climatic conditions, survival mechanisms associated with high seed germination, extended seed dormancy, enduring seed dissemination and vegetative reproduction (Rao, 2006), may be associated with their potential to produce viable and large quantities of seeds with the ability to germinate over a wide range of soils (Kissman & Groth, 1993). The investigation in the study locations however recorded some vulnerable species: *Rhynchospora corymbosa*, *Asystasia gangetica*, *Commelina benghalensis*, *Acanthus Montana*, *Striga genus*, and *Croton hirtus*. The vulnerability of these species requires urgent and prompt conservation attention. The vulnerable weed species were consistently less abundant, and effort should be put in place to domesticate them. These species, however, may be experiencing population reduction with limited distribution, and they are as well prone to human exploitation.

The presence of weed species is a significant environmental and economic problem and of economic importance in the studied areas. According to previously reported studies, the economic importance of weed species is directly related to their high frequency and dominance (Gidesa *et al.*, 2016). It should be noted that weed species with high relative frequency and high relative density showed that they are highly adapted and tolerant to the environmental conditions in which they are found. A high density of weed species is correlated with large seed banks provided that the seeds are viable and conditions are favourable (Nasir & Sultan, 2004). The large seed bank ensures their dense populations as species with high seed output have a high capacity to colonize, perpetuate, and establish themselves (Buhler *et al.*, 2001). Such a scenario is observed in this study. All other weed species with low relative frequency, relative density, and relative dominance values showed that they were either less competitive or were effectively affected by human activities in the study location.

The high values of Importance value index of the encountered weed species on the study locations showed that they are ecologically important in terms of being best adapted to the prevailing environmental conditions in the location where they occurred (Nasir & Sultan, 2004). Notably, almost all the encountered weed species sampled in the study area can be beneficial to the forest ecosystem and as well to man. For instance, they provide vegetative cover to protect the soil surface against water and wind erosion (Soladoye *et al*., 2010). In addition, in regard to their agricultural uses, the majority of the weed species had been reported to have medicinal/economic uses (Adesina *et al.,* 1995; Soladoye *et al*., 2010).

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CONCLUSION

Weed species significantly varied from one forest to another. Diversity indices indicated that weed species richness was highest in Nnamdi Azikiwe University, Awka forest and a little bit lower in Federal College of Education (Tech), Umunze. The evenness was a little bit similar but showed some level of variation in the study locations, as evident from the Shannon-Wiener index values. All the encountered weed species have social and economic advantages, and concerted effort should be put in place to conserve them, most especially, *Rhynchospora corymbosa*, *Striga genus*, *Acanthus Montana*, etc that are not only vulnerable but economically important. We, however, recommend that adequate attention be focused on the dominant weed species in each of the locations studied to check their population to increase productivity in the forest. Further observation showed that clearing of bushes for construction of buildings and roads as well as bush burning for farming are an increasing threat to the existence of these plant species in the study areas and, as such, could lead to a possible decline in the number of species diversity in the study areas, most especially the ones that are few in number. Hence, there should be some level of conservation measures to protect the biodiversity of these weed species for future research works and uses.

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