Ecological Study of Family *Poaceae* on Different Land Use Ecosystems in Nnamdi Azikiwe University Awka Campus and Environs in Anambra State, Nigeria

ABSTRACT

Accelerated flora diversity loss through habitat destruction, fragmentation, land use patterns caused by population growth, leading to changing patterns of vegetation has put the survival of many Poaceae species in the Nnamdi Azikiwe University Awka campus and Amansea at risk. This research was an ecological study of Poaceae and soil seed bank dynamics in different land use ecosystem in Nnamdi Azikiwe University, Awka and Amasea. The study evaluated the distribution/population of Poaceae in the different study areas; determine Poaceae diversity in abandoned farmland, Cattle grazed, watershed, and roadside ecosystems (environmental disturbance). Sampling for vegetation above ground was carried out using a 1m x 1m quadrat. Different species of Poaceae were sampled and results tested using analysis of variance and descriptive tools. The species abundance/distribution of Poaceae across various study sites is shown in Tables 1-7. The results revealed that the number of sampled species within the Poaceae family varied across sites, with three (3) species identified in the heavily grazed site, ten (10) in the moderately grazed site, fifteen (15) in the roadside site, six (6) in the abandoned farmland site, twelve (12) each in the footpath and perennial watershed sites, and thirteen (13) in the annual watershed site. The results also indicated that Poaceae species hold significant ecological importance, playing diverse roles within ecosystems. Additionally, the result identified specific Poaceae species that thrived in different locations. Some, like *P. maxium, B. deflexa, M. alternifolius,* and *S. pumila,* performed significantly better due to favourable soil conditions, while others faced challenges in less supportive environments. The study recommended that areas with high Poaceae plant diversity and sensitivity should be targeted for conservation efforts and implementation of protective measures.

KEYWORDS: Diversity, Ecosystem, Farmland, Grazed, Plant, Poaceae, Species, Watershed

INTRODUCTION

The most successful Angiosperms on the earth are the Poaceae, which thrive in every climate, habitat, and phytogeographical zone [1]. Around 15% of the diversity of monocot species is accounted for by the poaceae. Poaceae family members make up around 20% of the land on the earth, making them ecological leaders [1]. Almost all living things get their sustenance mostly from grasses. They contribute significantly to the urban and suburban settings of many nations by generating the majority of human food and a range of livestock feed. Natural pastures and feed grasses are used by the majority of animals. Native Poaceae plant species support soil integrity, water availability, and air quality while offering cattle an affordable source of nutrients. Poaceae are the most important ingredient in crops and animal feed, and they are also the main source of income for many rural residents around the world [1]; [2]; [3]. Grasses are a fundamental food source and a crucial ecological resource. They help to the creation and preservation of soil texture and can be found in all climatic conditions, including subalpine, xerophytic, and aquatic environments. Grasses continuously supply the soil with humus, supplying nutrients and boosting primary production [2].

The family Poaceae, commonly known as grasses, has significant economic importance due to its diverse applications and utilization in various sectors. The brief review below highlights some of the key economic contributions of Poaceae and provides supporting citations. Many Poaceae species are cultivated as staple food crops worldwide. Cereals such as rice (*Oryza sativa*), wheat (*Triticum aestivum*), maize or corn (*Zea mays*), barley (*Hordeum vulgare*), and millets (various species) are essential sources of carbohydrates, proteins, and other nutrients for human consumption [2]. These crops form the basis of diets in numerous regions and contribute to global food security.

Poaceae grasses serve as valuable forage crops for livestock, providing fodder for grazing and animal feed production. Species such as ryegrass (*Lolium* spp.), Timothy grass (*Phleum pratense*), and Bermuda grass (*Cynodon dactylon*) are widely cultivated for their high nutritional value and ability to withstand grazing [3], [4]. The livestock industry heavily relies on Poaceae forage crops to support animal husbandry and meat production.

Certain Poaceae species, such as sugarcane (*Saccharum* spp.), switchgrass (*Panicum virgatum*), and miscanthus (*Miscanthus* spp.), have emerged as important bioenergy crops. These grasses are cultivated for their high biomass production and potential for biofuel production [5], [6]. Poaceae-based bioenergy offers a renewable and sustainable alternative to fossil fuels, contributing to the mitigation of greenhouse gas emissions and reducing dependence on non-renewable energy sources.

Certain Poaceae grasses, such as turf grasses (e.g., Kentucky bluegrass, *Poa pratensis*), are widely used for their ability to control erosion and stabilize soil in landscapes, parks, golf courses, and other areas prone to soil degradation [7]. The extensive root systems and dense vegetation of Poaceae species help prevent soil erosion, retain moisture, and maintain soil structure.

Several Poaceae grasses are cultivated for their aesthetic value, adding beauty and texture to gardens, parks, and landscapes. Ornamental grasses like pampas grass (*Cortaderia* spp.), fountain grass (*Pennisetum* spp.), and Japanese silver grass (*Miscanthus sinensis*) are popular choices for landscaping and horticulture [8], [9]. These grasses enhance the visual appeal of outdoor spaces and are commercially valuable in the ornamental plant industry.

Poaceae grasses provide numerous ecosystem services, including soil conservation, water filtration, carbon sequestration, and habitat creation [10]. They contribute to the maintenance and functioning of ecosystems, supporting biodiversity, wildlife habitat, and ecological balance. The economic importance of Poaceae is multifaceted and encompasses various sectors ranging from agriculture and energy to landscaping and ecosystem services. The utilization of Poaceae grasses plays a vital role in food production, livestock feed, renewable energy, erosion control, aesthetics, and ecological sustainability.

They provide, through direct human consumption, just over one-half (51%) of all dietary energy; rice provides 20%, wheat supplies 20%, maize (corn) 5.5%, and other grains 6%. Some members of the Poaceae are used as building materials (bamboo, thatch, and straw); others can provide a source of biofuel, primarily via the conversion of maize to ethanol[11]; and they help to produce and maintain soil texture. Grasses consistently supply humus to the soil, satisfying nutrient requirements and boosting primary production [1].

The aim of this research was to carry out anecological study of *Poaceae* in different land use ecosystems in Nnamdi Azikiwe University Awka and Amansea. However, for ecologists, this study will offer a deeper understanding of the intricate relationships between *Poaceae* species and their respective ecosystems. Insight into the composition and distribution of these species will aid in deciphering ecological patterns, such as species interactions, niche differentiation, and responses to environmental changes. This knowledge is fundamental for developing effective conservation strategies, habitat restoration plans, and predictions of ecosystem responses to global shifts. For Society, the significance of *Poaceae* species extends to them as well. Grasses serve as the foundation of human food systems, animal husbandry, and economic activities. An informed understanding of their composition and distribution will aid in securing food security, fostering sustainable agricultural practices, and supporting livelihoods for the society. Additionally, heightened awareness of these species' roles in ecosystem services like carbon sequestration and soil stabilization contributes to public appreciation of biodiversity conservation.

MATERIALS AND METHODS

Description of the Study Areas

This study was carried out in the Nnamdi Azikiwe University Awka campus and Amasea areas of Awka South East Nigeria. Awka is located between the coordinates Latitude 6.24678° or 6° 14' 48" North and Longitude 7.11553° or 7° 6' 56" East (Richards, 2015), elevation 54 metres (177 feet). Total area of 4200m^2 was mapped out for the study, each of the mapped out area measuring 600m^2 i.e 30m x 20m^2 each using pegs and ropes for demarcations to identify its borders. Each site's precise location was located using a handheld GPS (Global Positioning System) tool Garmin eTrex (latitude, longitude, and altitude).

Awka is in the tropical rainforest zone of Nigeria and experiences two distinct seasons brought about by the predominant winds that rule the area. The Southwestern monsoon winds from the Atlantic Ocean and the Northeastern dry wind across the Sahara desert. The monsoon winds from the Atlantic creates seven months of heavy tropical rains which occurs between April and October and followed by five months of dryness November to

March. The harmattan is particularly dry, filled with dusty wind which enters Nigeria in late December or in early part of January and is characterized by gray haze limiting visibility and blocking the sun's rays. The temperature in Awka is generally 32^0C to 34^0C between January and April, 27^0C to 30^0C between June and December, with these last few months of dry season marked with intense heat.

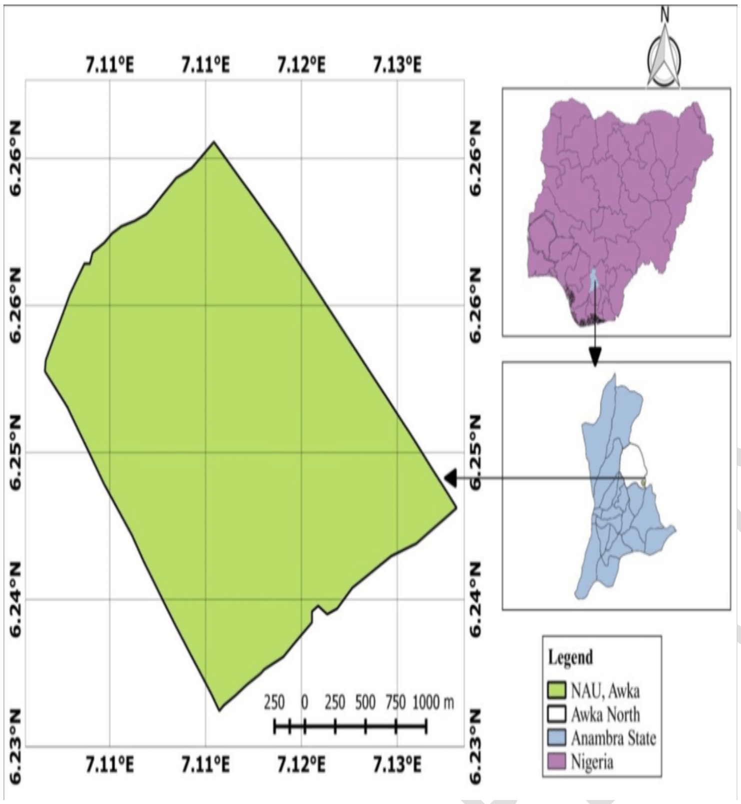

Figure 1: Map showing study location

Site selection:

Study sites where selected and were further split to obtain seven study areas to effectively carry out the study objectives. The seven different terrestrial ecosystems, which served as the study areas or experimental sites, include:

1. Abandoned Farmland located opposite Unizik fire station complex (Site 1)
2. Moderate Grazed Land, located at along Unizik Church complex Gate (Site 2)
3. Heavily Grazed Land, located at Garki Area of Amasea (Site 3)
4. Perennial Watershed, located near UnizikBotany forest (Site 4)
5. Annual Watershed, located near Agric faculty (Site 5)
6. Regularly Used Roadside, located at Science village (Site 6)
7. Footpath located near Botany laboratory (Site 7)

The selection of study sites was systematic to ensure a representative sample of each land use type.

Sampling Techniques

The following sampling techniques where employed in data collection from the various experimental sites in order to test the research objectives and obtain desired results

Sampling for the Vegetation above Ground

Quadrat sampling using randomly selected quadrants within each site to quantify the diversity and abundance of Poaceae species. Quadrats of 1m x 1m size were used and grid method was adopted for each 600m^2 of experimental site.

Field works were conducted to collect data on Poaceae species growing on the experimental sites. The quadrant approaches were used to calculate the quantitative measurements of the vegetation. During the field survey, the study area was delineated using pegs and ropes for clear demarcations while quadrants where placed according to already selected grid to cover the entire experimental plot. Plants species culm, leaves and inflorescence were recorded labelled and photographs taken, over a period of 4weeks at the beginning of the rainy season (March-April) and another 4weeks by the end of the rainy season (Sept-October) to collect Poaceae plant species and also soil for seed bank analysis of each plot sampled. All plant samples collected were taken to the herbarium for identification using the Flora of West Tropical Africa and then cross-referenced with the floristic literature on grasses. The obtained plant samples were identified with voucher numbers, pressed, thoroughly dried, and finally mounted on herbarium sheets that conformed to global standards to aid later identification of the emergent Poaceae species. The composition and density of the plant species were evaluated in each plot to compare the plant species represented in the current above-ground flora and the soil seed banks species. To examine the relationship between diversity and disturbance severity, for each plot we calculated Shannon–Wiener diversity indices, which are widely employed to measure biological diversity [13].

RESULTS

Species Abundance Status of Poaceae across Study Sites

The species abundance distribution of Poaceae across various study sites is depicted in Tables 1-7. The tables revealed that the number of sampled species within the Poaceae family varied across sites, with three (3) species identified in the heavily grazed site, ten (10) in the moderately grazed site, fifteen (15) in the roadside site, six (6) in the abandoned farmland site, twelve (12) each in the footpath and perennial watershed sites, and thirteen (13) in the annual watershed site.

Table 1-7 also revealed the dominant species varied by site. *Cynodon dactylon*was the most prevalent species in the heavily grazed site, while *Pennisetum polystachion* and *Setaria pumila* were the most dominant species of the moderately grazed site. *Panicum maximum* and *Andropogon tectorum* were the most predominant species of the roadside site, *while Eleusine indica* and *Sporobolus pyramidis* were the most abundant species of the abandoned farmland plot. In the footpath plot, *Sporobolus indicus and Cynodon dactylon* were the most abundant species. *Panicum ripens* and *Andropogon gayanus* were the most dominate species of *the* annual watershed site, whereas *Echinochloa colona* and *Hymenache amplexicaulis* were most abundant species in the perennial watershed site.

Table 1: Species Abundance Status of Heavy Grazed Plot

S/No	Plant Species	Density (M^{-2})	Rel. Density (%)	Freq	Rel. Freq (%)	IVI	Rank
1	*Cynodondactylon*	19.3	39.3	4	33.3	72.6	2
2	*Axonopuscompressus*	19.5	39.8	4	33.3	73.1	1
3	*Cenchrus clandestinus*	10.3	20.9	4	33.3	54.3	3
		49	100	12	100.0	200.0	

Table 2: Species Abundance of Moderate Grazed Plot

S/No	Plant Species	Density (M^{-2})	Rel. Density (%)	Freq	Rel. Freq (%)	IVI	Rank
1	*Panicum maxium*	6.8	5.4	4	11.1	16.6	10

2	*Brachiariadeflexa*	16.5	13.3	4	11.1	24.4	3
3	*Mariscusalternifolius*	9.8	7.9	4	11.1	19.0	9
4	*Setaria pumila*	17.5	14.1	4	11.1	25.2	2
5	*Setaria megaphylla*	13.3	10.7	4	11.1	21.8	7
6	*Digitariahorizontalis*	11.0	8.9	4	11.1	20.0	8
7	*Paspalum scrobiculatum*	16.5	13.3	4	11.1	24.4	3
8	*Dactyloctinumaegyptium*	14.3	11.5	4	11.1	22.6	6
9	*Pennisetum polystachion*	18.5	14.9	4	11.1	26.0	1
10	*Cenchrus ciliaris*	15.3	12.3	4	11.1	23.4	5
	Total	124	100	36	100	200	

Table 3: Species Abundance Status of Roadside Plot

S/No	Plant Species	Density (M^{-2})	Rel. Density (%)	Freq	Rel. Freq (%)	IVI	Rank
1	*Panicum maximum*	14.8	9.0	4	6.7	15.6	1
2	*Paspalum distichun*	11.8	7.2	4	6.7	13.8	6
3	*Andropogon tectorum*	13.8	8.4	4	6.7	15.0	2
4	*Sporobolus indicus*	11.3	6.8	4	6.7	13.5	8
5	*Eleusine indica*	13.3	8.1	4	6.7	14.7	4
6	*Dactylocteniumaegyptium*	10.5	6.4	4	6.7	13.1	9
7	*Eragrostistenella*	10.5	6.4	4	6.7	13.1	9
8	*Setari pumila*	8.8	5.3	4	6.7	12.0	13
9	*Acrceraszizaniodes*	3.8	2.3	4	6.7	8.9	15
10	*Panicum ripens*	11.8	7.2	4	6.7	13.8	6
11	*Andropogon gayanus*	9.3	5.6	4	6.7	12.3	12
12	*Imperatacylindrical*	13.3	8.1	4	6.7	14.7	4
13	*Cenchrus clandestinus*	7.5	4.6	4	6.7	11.2	14
14	*Cynodondactylon*	10.5	6.4	4	6.7	13.1	9
15	*Axonopuscompressus*	13.8	8.4	4	6.7	15.0	2
	Total	164.3	100.0	60.0	100.0	200.0	

Table 4: Species Abundance Status of Abandoned Farmland Plot

S/NO	Plant Species	Density (M^{-2})	Rel. Density (%)	Freq	Rel. Freq (%)	IVI	Rank
1	*Sporobolus pyramidis*	15.3	19.1	4	16.7	35.8	2
2	*Paspalum dilatatum*	13.0	16.3	4	16.7	33.0	4
3	*Eleusine indica*	15.5	19.4	4	16.7	36.1	1
4	*Andropogon tectorum*	8.8	11.0	4	16.7	27.6	6
5	*Cynodondactylon*	13.0	16.3	4	16.7	33.0	4
6	*Imperata cylindrica*	14.3	17.9	4	16.7	34.5	3
	Total	79.8	100.0	24.0	100.0	200.0	

Table 5: Species Abundance Status of Footpath Plot

S/No	Plant Species	Density (M^{-2})	Rel. Density (%)	Freq	Rel. Freq (%)	IVI	Rank
1	*Sporobolus indicus*	20.0	14.8	4	8.3	23.2	1
2	*Cynodondactylon*	18.5	13.7	4	8.3	22.1	2
3	*Axonopuscompressus*	12.8	9.5	4	8.3	17.8	5
4	*Setaria barbata*	6.0	4.5	4	8.3	12.8	10
5	*Mariscusalterifolius*	6.0	4.5	4	8.3	12.8	10
6	*Eleusine indica*	14.3	10.6	4	8.3	18.9	4
7	*Paspalum scrobiculatum*	8.3	6.1	4	8.3	14.5	8
8	*Panicum ripens*	11.5	8.5	4	8.3	16.9	6
9	*Kyllinga pumila*	6.5	4.8	4	8.3	13.2	9
10	*Panicum maximum*	10.3	7.6	4	8.3	15.9	7
11	*Paspalum conjugatum*	4.0	3.0	4	8.3	11.3	12
12	*Sporobolus pyramidis*	16.8	12.4	4	8.3	20.8	3
	Total	134.8	100.0	48.0	100.0	200.0	

Table 6: Species Abundance Status of Annual Watershed Plot

S/No	Plant Species	Density (M^{-2})	Rel. Density (%)	Freq	Rel. Freq (%)	IVI	Rank
1	*Andropogngayanus*	16.3	15.0	4	8.3	23.4	2
2	*Setaria pumila*	12.0	11.1	4	8.3	19.4	3
3	*Panicum ripens*	17.3	16.0	4	8.3	24.3	1
4	*Setaria barbata*	9.6	8.9	4	8.3	17.2	5
5	*Arthraxonhispidis*	10.8	10.0	4	8.3	18.4	4
6	*Digitariscilaris*	7.9	7.3	4	8.3	15.6	6
7	*Brachiariadeflexa*	6.9	6.4	4	8.3	14.7	8
8	*Pennisetum purpureum*	7.6	7.0	4	8.3	15.3	7
9	*Cynodondactylon*	4.8	4.4	4	8.3	12.8	12
10	*Sorghum halepense*	6.2	5.7	4	8.3	14.0	9
11	*Hymenacheamplexicualis*	5.3	4.9	4	8.3	13.2	10
12	*Cymbopogon nardus*	3.7	3.4	4	8.3	11.7	13
13	*Panicum maximum*	4.9	4.6	4	8.3	12.9	11
	Total	108.1	100.0	48.0	100.0	200.0	

Table 7: Species Abundance Status of Perennial Watershed

S/No	Plant Species	Density (M^{-2})	Rel. Density (%)	Freq	Rel. Freq (%)	IVI	Rank
1	*Echinochloacolona*	14.8	10.5	4	8.3	18.9	1

2	*Paspalum distichum*	11.5	8.2	4	8.3	16.5	6
3	*Andropogon tectorum*	13.8	9.8	4	8.3	18.2	3
4	*Panicum maximum*	13.8	9.8	4	8.3	18.2	3
5	*Cynodondactylon*	9.3	6.6	4	8.3	14.9	10
6	*Sporobolum indicus*	10.3	7.3	4	8.3	15.7	9
7	*Andropogngayanus*	10.5	7.5	4	8.3	15.8	7
8	*Pennisetum polystachion*	10.5	7.5	4	8.3	15.8	7
9	*Hymenacheamplexicaulis*	14.8	10.5	4	8.3	18.9	1
10	*Eleusine indica*	13.0	9.3	4	8.3	17.6	5
11	*Cenchrus clandestinus*	9.3	6.6	4	8.3	14.9	10
12	*Pennisetum penduculatum*	8.8	6.3	4	8.3	14.6	12
	Total	140	100	48	100	200	

Species Diversity of *Poaceace* Family in the Study Sites

Result of species diversity of *Poaceace* family in the various study sites revealed that all study plots were diverse with species of the *Poaceace* with equitability values close to 1. However, the Perennial watershed and Abandoned Farmland sites recorded the highest species diversity with equitability values of 0.9933 and 0.9914 respectively (Table 8). The derivation of Shannon Weiner's Index of diversities for each site is shown in tables 1-7. Runs-test showed evidence of non-randomness or a systematic pattern in the data ($P<0.05$).

Table 8: Shannon Weiner's Index of Diversities of species of Poaceace family in plot

SN	Study Plots	H^1	Equitability	Rank
1	HG	1.061	0.9658	5
2	MG	2.267	0.9846	4
3	RS	2.672	0.9866	3
4	AF	1.776	0.9914	2
5	FP	2.380	0.9579	6
6	AW	2.338	0.9115	7
7	PW	2.468	0.9933	1

HG- Heavily grazed, MG Moderately grazed, RG-Road side, AF-Abandoned farmland, FP-Footpath, AW-Annual watershed, PW-Perennial watershed

DISCUSSION

Recent literature has increasingly focused on exploring the interplay between Poaceae distribution, seedbank composition, and soil physiochemical properties across diverse ecosystems. However, this study revealed variations in the above-ground presence of Poaceae species across different study locations. Specifically, abandoned farms, moderately grazed areas, and heavily grazed sites exhibited lower species richness compared to perennial watersheds, annual watersheds, roadsides, and footpaths. Previous research by many researchers has highlighted how farming and grazing practices contribute to habitat loss and fragmentation, consequently leading to a decline in Poaceae species diversity [14].

This study also revealed that all study locations were distinct in what was the most abundant *Poaceae*species. The abandoned farmland had *Eleusine indica* and *Sporobolus pyramidis* as the most abundant species while the moderate grazed location had *Pennisetum polystachion*and *Setaria pumila* as the most abundant species. Sato *et al.*[15] study indicated that soil conditions, grazing practices, agricultural and urban activities could contribute to the differences in species characterization of various habitat. Notwithstanding, Li *et al*. [16] has added that the competitive nature of species determines their dominance in certain ecosystem. For instance, Palmer [17] study associated the prevalence of *Sporobolus pyramidalis* in grazeland ecosystem to their competitive nature. Study conducted by Nweze [18] Sato *et al.* [15] observed that cattle grazing led to an increase in the abundance of shorter, more palatable grass species while reducing the prevalence of taller, less palatable ones.

More findings indicated that the heavy grazed location had *Cynodon dactylon* as the most abundant species while the perennial watershed location had *Echinochloa colona* and *Hymenache amplexicaulis* as the most abundant species. *Cynodon dactylon*is perennial grass that occurs on almost all soil types. The dominant and invasive characteristics of *Cynodon dactylon*in grazeland locations have been reported by the Global Invasive Species Database [19]. On the other hand, Peerzada*et al*. [20] and DES [21] study has reported *Echinochloa colona* and *Hymenacheamplexicaulis* as key weed species wetlands of rice fields and watersheds.

Moreso, this study revealed that the most abundant species for the annual watershed location were *Panicum ripens* and *Andropogon gayanus*. This study also revealed that the roadside location had *Panicum maximum,Andropogon tectoru and Axonopus compressus*as the most abundant species while the footpath location had *Sporobolus indicus and Cynodondactylon* as the most abundant species. The capacity of species of *Androgen* and *Panicum* to withstand stress and grazing in range of habitat has been reported by Nweze *et al.* [22]. Already, *Sporobolus indicus* and *Cynodondactylon* has been included as usually non-native and invasive species by the Global Invasive Species Database [19].

Conclusion

This study revealed variations in the distribution and abundance of Poaceae among different study areas. Locations such as perennial watersheds, annual watersheds, roadsides, and footpaths recorded higher Poaceae species compared to sites affected by cattle grazing and abandoned farms. Consequently, researchers aiming to sample a broader range of Poaceae species for ecological studies may encounter limitations when focusing on grazing sites and abandoned farms.

Each study location showed distinct in what was the most abundant Poaceaespecies, suggesting that no single species can adequately represent all areas. Therefore, identifying dominant species of Poaceae for each study area may require a site-specific approach.

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