ECOLOGICAL SAMPLING METHODS IN GURUDAS COLLEGE CAMPUS FOR THE ASSESSMENT OF THE CHANGES IN THE HERBACEOUS ANGIOSPERM SPECIES DIVERSITY OVER TIME: A CASE STUDY

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Abstract

Conservation biologists and environmental planners need reliable methods to evaluate the biological value of sites and to monitor changes over time. A major difficulty encountered when conducting diversity inventories is that species diversity cannot be recorded without reference to space, time and collection method. As biodiversity indices and species richness data are commonly used to assess community variation across sites and at different time periods the data from this study was analyzed using these parameters. The aim of this investigation was to study the changes in the distribution and abundance of the herbaceous angiosperm species found in Gurudas College campus over a period of 9 (Nine) years. The density, relative frequency, abundance and richness of the herbaceous angiosperm components were measured and compared with data taken 9 (nine) years ago at the same site. The results have been achieved by using the quadrat sampling technique. The ability to quantify diversity in this way is an important tool for biologists trying to understand community structure dynamics

Keywords: ecological sampling, species diversity, biodiversity indices, quadrat

Introduction

Various indices and models have been developed to measure diversity within a community (Magurran 1988). In general, three main categories of measures are used to assess species diversity: (1) species richness indices, which measure the number of species in a sampling unit, (2) species abundance models, which have been developed to describe the distribution of species abundances, and (3) indices that are based on the proportional abundances of species.

An index is usually a count statistic that is obtained in the field and carries information about a population (Wilson and others 1996). Several indices have been created to measure the diversity of species; however, the most widely used in the last decades are the Shannon (1948) and Simpson (1949) (Buzas and Hayek 1996; Gorelick 2006), with the components of diversity: richness (*S)* and evenness (*J).* Besides this, the concept of biological diversity is a

central issue in quantitative ecology that has been studied extensively for over 50 years (Patil and Taillie 1982; Magurran 1988).

Density values are significant because they show relative importance of each species. With increasing density the competition stress increases and the same is reflected in poor growth and lower reproductive capacity of the species. Data on population density are often very essential in measuring the effects of reseeding, burning, spraying and successional changes.

Materials and Methods

Quadrat sampling is a classic tool for the study of ecology, especially biodiversity. In general, a series of squares (quadrats) of a set size are placed in a habitat of interest and the species within those quadrats are identified and recorded.

Quadrat sampling is carried out in the Gurudas College campus every year as it is part of the undergraduate Botany Honours curriculum. The quantitative structure of the community is analyzed. In this investigation data from 2008, 2014 & 2016 were compared to see if there was any significant change in the plant community structure.

Sampling procedures

***Quadrat Size*:** Quadrat size is an important consideration in quadrat frequency sampling. The size of the quadrat influences the probability of each species occurring within the quadrat.

Determination of the Minimal size of the quadrat: This was determined at the onset of the investigation following standard procedures. A series of quadrats was made in a nested design and data recorded. The species area curve was used to determine the minimal plot size needed to survey the community of the study area adequately.

Quantitative Structure of Plant Community

Coexistence and competition both are affected directly by the number of individuals in the community. Frequency, relative frequency, density and abundance were calculated to characterize the community as a whole know the quantitative structure of community.

Quantification of Biological Diversity

Biological diversity can be quantified in many different ways. The two main factors taken into account when measuring diversity are richness and evenness. Similarity between samples maybe compared. Richness is a measure of the number of different kinds of organisms present in a particular area. Diversity depends not only on richness, but also on evenness.

1. Richness: The number of different species present per sample is a measure of richness.

2. Evenness: Evenness is a measure of the relative abundance of the different species making up the richness of an area. Evenness compares the similarity of the population size of each of the species present.

3. Similarity: The biodiversity (richness) of two plots using the **Jaccard index (SC_j).** The formula is:

$$SC_j = (c/A+B-c) \times 100$$

Where A and B are the richness of two different plots or samples, and c is the number of species found in both plots.

Statistical analysis

Diversity indices provide important information about rarity and commonness of species in a community. Several indices have been created to measure the diversity of species.

For statistical analysis different diversity indices were calculated as follows: Richness (S), or the number of species or attributes present, is the simplest metric used to represent diversity (Whittaker 1972), and it remains the most commonly applied (Magurran 2004).

- **Species Richness** - The number of different species found in a particular environment.
- **Biodiversity** - The number of different species of organisms in a particular environment.
- **Evenness (E)** - A measure of how similar the abundances of different species are in the community.
- **Shannon-Weiner index (H)** - This diversity measure came from information theory and measures the order (or disorder) observed within a particular system. In ecological studies, this order is characterized by the number of individuals observed for each species in the sample plot (e.g., biofilm on a plexiglass disc).
- **Simpson's index (D)** - The probability that two randomly selected individuals in the community belong to the same category (e.g., species).
- **Simpson's index of diversity (1 - D)** - The probability that two randomly selected individuals in a community belong to different categories (e.g., species).
- **Simpson's reciprocal index (1/D)** - The number of equally common categories (e.g., species) that will produce the observed Simpson's index.

Result

Biodiversity sampling is a basic activity in community ecology. Just as there are many different ways to define biodiversity, there are many different measures of biodiversity. Conservation biologists and environmental planners need reliable methods to evaluate the biological value of sites and to monitor changes over time. A major difficulty encountered when conducting diversity inventories is that species diversity cannot be recorded without reference to space, time and collection method.

The variation in the quantitative composition the common species (5) found in 2008, 2014 and 2016 are shown in Table 1.Only 5 species were common in the study conducted over 8 (eight) years during 2008, 2014 and 2016 in the same site. This indicates that herbaceous plant community structure is changing.

Table 1. Variation in the quantitative composition the common species (4) found in 2014, 2016and 2023 respectively.

Common Plants	2014			2016			2023		
	Relative Frequency (RF)	Density(D)	Abundance (A)	RF	D	A	RF	D	A
*Euphorbia hirta*L.	40%	1	2.5	80%	1.6	2	80%	3.2	4
*Parthenium hysterophorus*L.	20%	0.6	3	100%	2	2	60%	5.8	9.6
Solanum nigrum L.	20%	0.6	3	40%	0.6	1.5	20%	0.2	1
Vernonia cinerea (Linn.) Less.	60%	2.6	4.34	100%	2.6	2.6	100%	1.4	2

Diversity indices were computed for the years 2014, 2016and 2023 as shown in Table 2. The ability to quantify diversity in this way is an important tool for biologists trying to understand community structure.

Table 2. Diversity indices were computed for the years 2014, 2016 and 2023.

	Diversity Indices				
Year of study	**Evenness (E)**	**Simpson's index (D)**	**Simpson's index of diversity (1 - D)**	**Simpson's reciprocal index (1/D)**	**Shannon-Weiner index (H)**
2014	00.949	00.122	00.878	8.197	2.184
2016	00.868	00.116	00.88	8.621	2.458
2023	1.958	00.197	00. 803	5.076	1.958

Discussion

Plants growing together exhibit mutual relationships among themselves and also with the environment. Such a group of plants in an area represent a community. The ability to quantify diversity in this way is an important tool for biologists trying to understand community structure.

The number of individuals of a species varies from place to place, making it necessary to take many random sample areas for reliable results. The application of diversity indices is common in ecological analyses (Izsák 2007).From the results it is there is not much difference in the Shannon's Diversity Index (H´) over the years of study despite the fact that two data were taken after a gap of 9 years. However there is marked difference in the Reciprocal Simpson Index where the value is low in the year 2023 as compared to 2014 and 2016.

Conclusion

The comparative quantitative analysis of the 4 (four) species found in 2014, 2016 and 2023 showed that there was a decline in all the parameters. It could be due to the fact that the area of study is cleared every year for the annual sports of the college in the winter. Due to this regular anthropogenic unrest every year the extent of density and abundance is on the decline. Perhaps this factor is also responsible for the low number of common species found in the study site.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this work.

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