ISSN 2394 - 7837

ARTICLE

Monitoring pollution using diversity indices, density and biomass of tree species from Kavil Shree Maheswarashramam (Sacred grove) from Nedumangad, Thiruvananthapuram.

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Received 09/01/2016 Accepted 13/04/2016

Abstract

Sacred groves exhibit diversity and are considered as a reservoir of many flora and fauna. A field survey was conducted in Kavil Shree Maheswarashramam, a sacred grove from Nedumangad. The study was undertaken by using mobile measuring application. Various diversity indices were calculated and analysed. The different indices selected for the study gives more information about the abundance and richness of the species present in these groves. It is very important to quantify diversity because it acts as an important tool in understanding the nature of the community. Species density for the sacred grove was also calculated. The aboveground biomass and the total carbon sequestered in the groves were also analysed.

Keywords: Sacred groves, density, biomass, diversity indices

Introduction

Sacred groves are forest patches dedicated to Gods and Goddesses and traditionally protected on the basis of religious faith. They vary in size from small patches with few trees to dense forest and are ecosystems which help to conserve valuable biodiversity. The total number of groves in India is between 1,00,000-1, 50,000. They are considered as hot spots of biodiversity. In India, the earliest documented work on sacred groves was that of the first Inspector General of Forests, Brandis, D. (1897). The first authentic work on sacred groves in Kerala appeared in the census report of Travancore (1891). Lt.Ward and Lt.Conner (1927) reported the presence of 15,000 sacred groves in Travancore.

Diversity concept helps in understanding the plant community and its relationship with the ecological processes. For evaluation and monitoring of the ecosystem, diversity is considered as the most important criteria. The simplest measure of biodiversity is the number of species observed within a geographic unit, but this estimate is strongly affected by sample size (number of specimens) as described by Hellmann and Fowler (1999). It helps to assess the impacts of different levels of disturbance on biological diversity. Mishra *et al.* (2004) has studied that the Margalef index, Shannon diversity index and evenness index has highest values in the moderately disturbed sacred grove in Meghalaya and the Simpson dominance index was highest in the highly disturbed area. Rajendra Prasad *et al.* (1996) have studied the vegetation characteristic and litter dynamics of five bio-climatically diverse sacred groves in Kerala.

Plants are important sinks for atmospheric carbon since 50% of their standing biomass is carbon itself (Ravindranath *et al*, 1997).The estimation of the carbon stored in the aerial parts of the tree as well as in the fallen leaves and litter, allows us to understand the carbon dynamic and the real carbon content on each ecosystem component in detail. Chandrasekara and Sankar (1998) did the comparison of general tree strata, biomass, litter production, nutrient cycling, physical and chemical properties of soil and stake holder analysis. Murali *et al*. (2005) calculated Species level above ground biomass through basal area equations and an indirect estimation was done for calculating below ground biomass.

Materials and Methods

Study area

Kavil Shree Maheswarashramam, Nedumangad lies in the mid land region and is made up of small and tiny hills and valleys. This is an area of intense agricultural activity. This grove is situated in 7 acres of land. It is highly dense forest patch with big canals and small streams. This sacred grove is funded by Govt. of India. As a part of social forestry several trees have been planted here. Flora and Fauna of different species were associated with this grove. Several medicinal plants were also seen in this grove. And the dead and decayed plants were adding to the biomass in natural way. Everything in this sacred grove were natural and without disturbing the environment. But the ecosystem was highly disturbed with numerous invasive plants. Human intrusion was not at all seen. Very less uses of plastics were seen. No

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much construction works have taken place either for buildings or for the pavement. The plant materials were identified with the help of local flora.

Diversity indices

The Scientific names and the number of each tree were noted for calculating the different diversity indices. Species richness, diversity indices and dominance index were calculated.

The different indices used for the calculations were: Shannon-Wiener Index (H') of diversity, Simpson index of dominance, Brillouin's index of diversity, Berger- Parker diversity index, Menhinicks diversity index, Gini - Simpson index and Margalef's index.

Species density

Species density was calculated by uniformly converting the areas into metre square. The equation for species density calculations were done by taking total number of species to the total area. It is equivalent to species area curve inverse.

Tree Height and Diameter at Breast Height (DBH):

Non-destructive method was selected to estimate biomass of different trees. The biomass of each tree was estimated on the basis of DBH and tree height. DBH was determined by measuring the tree Girth at Breast Height (GBH), approximately 1.3 meter above ground surface. The GBH of all perennial trees having diameter greater than 30 cm were measured directly by using a measuring tape. The tree height was measured using Smart measure application on mobile phone. And the same indicator parameters (e.g. tree DBH and height of the tree) were selected for calculating the biomass and for estimating the carbon sequestration.

Above ground biomass (AGB) of trees:

The above ground biomass of trees were calculated by taking into consideration, the whole shoot, branches, leaves, flowers, and fruits. It was calculated using the methodology adopted by Hangarge, L. M. *et al.* Radius of the tree is calculated from GBH of the tree. Tree diameter (D) was measured (3.14) to the actual marked girth of species by applying Bohre *et al.*formulae.

The methodology adopted by Sandra Brown was used to calculate the standard mean density of wood for Asia.

Carbon sequestration

The total carbon sequestered was calculated from Above Ground Biomass using the formulae by Condit, R.

Results and Discussion

The main aim of the study was to monitor the extend of pollution in the Sacred grove by analysing various diversity indices, Species density and biomass of tree species.

The simplest measure of biodiversity is the Species richness. It is the total number of different species in a sample. The Sacred grove exhibited a species richness with 47 species with a total of 145 individuals were present. Species richness determines the state of an ecosystem. If more species are present in an ecosystem then it shows high level of ecosystem stability. Such ecosystems naturally withstand all types of disturbances.

Shannon index explains about species evenness. Theoretically the value of Shannon index varies between 1.5 – 3.5. Hence our findings are consistent with establish understanding the Shannon index. These values of Shannon index can also be explained in terms of stable ecosystem. Greater diversity means greater stability. The value of an ecosystem tends to be less than 1 if it is in highly disturbed condition. Moderately disturbed ecosystem can be characterized between ranges of 1 – 2 and when the value of Shannon index is above 3, it significantly shows that the ecosystem has stable environment conditions. The Shannon index for Western Ghats is between 3.6 - 4.3 (Rajendra Prasad, 1995) and in our study it is always lower than that of the Western Ghats. An increase in Shannon diversity results from a greater number and more even distribution of species. When all species are equally abundant the maximum Shannon diversity for a sample is found.

Simpsons index of dominance assess the dominance and not species richness. The dominance index changes with change in dominant species. It explains the probability that two species randomly selected from the sample belongs to the same species. That means the first and the second species selected remains the same. The value of this index ranges from 0-1. When all species are equally present the value is 0 which shows no dominance and when one species dominates the value becomes 1 which shows no diversity. From the data it's clear that as D increases the diversity decreases. So as probability increases the ecosystem is least diverse. Increased diversity is associated with decreased probability.

Brillouin's index of diversity is calculated for a community with small completely censessed populations. This index is more sensitive to species abundance and is considered as a better measure of index compared to the Shannon index as it measures the diversity of a collection. In the present study, total sampling was done so that the full collections of the tree species were known. Theoretically, the value of this index rarely exceeds 4.5. From our survey it was very clear that the sacred grove showed a highly undisturbed ecosystem.

Margalefs index of species richness is used for comparison of different ecosystems taking only species richness into consideration reflecting sensitivity to sample size. It is not a measure of diversity as it does not include any component of evenness. It doesn't have any limit value.

Higher the value of Berger – Parker index, the higher is the diversity and lower the dominance.

Menhinick diversity index showed close affinity towards Shannon index and it estimates species richness but is independent on the sample size.

The Gini – Simpson index explains about the probability

Table 1. Diversity indices

Sacred Grove	Shannon	Simpson	Berger-Parker	Gini-Simpson	Brillouin	Margalef	Menhinick
Nedumangad	3.30	0.05	8.05	0.94	2.9	9.24	3.9

of two organisms belonging to different species. The value ranges between 0-1. The mature and stable communities have high diversity value varying from 0.6 to 0.9. When the communities are under stress condition, it exhibit low diversity, a value close to zero. When the community is dominated by less number of species, the diversity index is always high. It is very clear that this sacred grove shows a high diversity value for Gini – simpson index. Hence this ecosystem is highly stable.

The total aboveground biomass was 5,95,251.67 tonnes and the carbon sequestered was 2,85,720.80 tonnes in the Sacred grove. All plant tissue falls between 45-50% carbons, so this estimate is reasonable for all dead, live, and non-wood samples. The very importance of estimating the biomass is that it helps in knowing the state of the ecosystem and the number of organisms it can support. The ecological state of these groves can be determined from the biomass calculated. It also helps to locate the amount of energy stored that explains about the primary productivity of the ecosystem. As the diameter of trees increased, its biomass and carbon storage capacity also increased. Hence sequestered more carbon and removes more carbon dioxide from the atmosphere. Trees to a great extent will hold CO_2 gases emitted from automobiles with consequent reduction in health and environmental related issues. By estimating the amount of carbon sequestered by the trees in these sacred groves, help to estimate the amount of carbon emitted into the atmosphere when this ecosystem is degraded. From the calculations it is observed that the sacred grove had high carbon sequestration potential. So this grove contributes more towards reducing the level of carbon dioxide in the atmosphere.

Species density was calculated by converting the area into metre square. The total numbers of species were 47 and the frequency was 145. The species density was calculated to be 0.0016. The frequency and the Species density calculations help us to monitor the changes that take place in an ecosystem and the activities which may cause the extinction of species in near future.

Conclusion

This work was an attempt to monitor the pollution and conservation of a sacred grove in Nedumangad, Thiruvananthapuram. Diversity is expected to give rise to ecosystem stability and decreasing biodiversity will be accompanied by increase in stress within ecosystems. Real ecosystems are undoubtedly complex and diverse. It is hoped that such work may lead to the development of standard monitoring procedures which could be of value in assessing the environmental stability of areas under conservation.

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