

Phytosociology and Diversity Assessment of tree species of Northern Delhi Ridge Forest

Ravi Kumar¹, Ratul Baishya², Sandeep Gawdiya³ and Ankur Verma⁴

^{1,2}*Department of Botany, University of Delhi, Delhi, India*

³*Division of Agronomy, ICAR-IARI, New Delhi*

⁴*Department of Environmental Studies, University of Delhi, Delhi, India*

(Received 9 September, 2021; Accepted 18 October, 2021)

ABSTRACT

The interaction of biodiversity with the physical environment is the bedrock of sustainable development. The world's forests covered more than 4 billion hectares, accounting for 31% of total land area or 0.6 ha per capita. Tropical forests in India, which are mostly deciduous, are poorly understood in terms of phytodiversity, phytosociology, and quantification regimes. Ridge forests of Delhi are of great interest for biodiversity management in the city. Phytodiversity inventories set a baseline for other forest management studies and initiatives. The Northern Delhi Ridge also known as the Kamla Nehru Ridge the study area for the current work, is located in Delhi, India, one of the significant biodiversity rich areas in the Delhi, to study the phytosociological attributes of tree species from the sampled inventory of different tree taxa. The study revealed that average tree density per hectare for the Northern ridge forest as 322 trees/ha.

Key words : Northern ridge forest. Phytosociology, Tree species.

Introduction

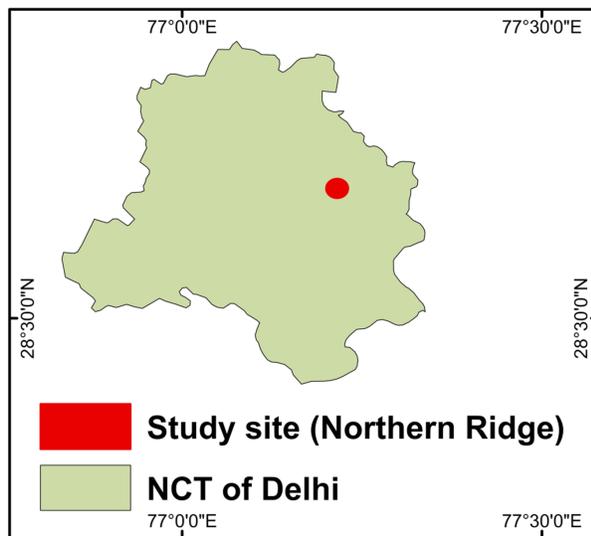
Forest stands are defined as the primary mapping and description units, which delineate patches of relatively homogeneous forest in terms of tree cover and site conditions. The study of social interaction and composition of the species in community is called vegetation ecology (Mueller-Dombois and Ellenberg, 1974). Studies like this are a source of information for community organization, niche resource distribution, species diversity and turnover rate of species in an ecosystem (Mandal and Joshi, 2014). Phytosociology is the study of quantification of forest vegetation (Braun-Blanquet, 1932), it classifies and describes the pattern of vegetation and predicts its distribution pattern in future (Odum, 1971). Phytosociological analysis is important for ecological study of forest, focusing on structure and func-

tion. Proper monitoring and management is required for maintaining species and habitat diversity of trees (Attua and Pabi, 2013; Turner, 1987) for direct successional processes these aspects are very important (Rennolls and Laumonier, 2000). The inventory of tree species is a useful tool for providing information on diversity of forest and maximize the biodiversity conservation.

Materials and Methods

Study area: The Northern Delhi Ridge also known as the Kamla Nehru Ridge is 87 ha forested area near University of Delhi. Due to its elevational crest, it is geographically termed as ridge. Northern ridge of Delhi lies between latitude 28°41'36.03"N to 28°40'3.71"N and longitude 77°12'39.42"E to 77°13'1.87"E as shown in the (Map 1). The northern

ridge is one of the four ridge forests found in Delhi which are a part of Aravalli Hill Ranges (Sinha *et al.*, 2014). The climate of the area is semi-arid due to poor rainfall (66.6 cm annually), however it receives significant rainfall in the monsoon months. The vegetation of Northern Ridge is soft horny scrub type, which is similar to the arid and semi-arid zones. The area falls under Northern Tropical Thorn Forest category of forest type classification as per Champion and Seth, (1968). *Prosopis juliflora* forms the dominant tree species of this region along with other indigenous species like *Prosopis cineraria*, *Acacia nilotica*, *Salvadora oleoides*, *Acacia nilotica*, *Acacia leucopholea* etc.



Map 1. Study area

Methods

Sampling : After a brief reconnaissance study of the study site random sampling method for the survey was chosen where 1 hectare area of forest site was sampled. Random sampling method was used to lay quadrats randomly to obtain unbiased data of the forest. 10 quadrats of 31.6 x 31.6 meters were laid with each covering an area (~0.1 hectare) (FSI, 2009). Keeping the total area 1 hectare per forest site, community analysis was done.

Phytosociology Analysis : Quantitative analysis was done for the trees. The trees with circumference greater than 31.4 cm at breast height (1.37m from ground) were considered trees (Knight, 1975). For all the tree species density, frequency, basal area, abundance, dominance was calculated and through their

relative values IVI (Importance value index) was calculated. Importance value index chart and phytograph (Lutz, 1930) were created to understand tree phytosociology of the forests. Community analysis was done using the following formulas for tree species:

Tree density = Total number of trees per hectare

$$\text{Density} = \frac{\text{Total number of individuals of a species in all the quadrats}}{\text{Total number of quadrats studied}}$$

$$\text{Relative Density (\%)} = \frac{\text{Total number of individuals of a species in all the quadrats}}{\text{Total no. of individuals of all the species in all the quadrats}} \times 100$$

$$\text{Frequency} = \frac{\text{Total number of quadrats in which species occurred}}{\text{Total number of quadrats studied}}$$

$$\text{Relative Frequency (\%)} = \frac{\text{Total number of quadrats in which species occurred}}{\text{Total number of quadrats studied}} \times 100$$

$$\text{Relative Dominance (\%)} = \frac{\text{Total basal area of a species}}{\text{Total basal area of all the species quadrats studied}} \times 100$$

$$\text{Abundance} = \frac{\text{The number of individuals of a species in all the quadrats}}{\text{Total number of quadrats in which species occurred}}$$

$$\text{Relative Abundance (\%)} = \frac{\text{Abundance of a species per quadrat}}{\text{Total abundance value of all the species}} \times 100$$

Importance Value Index (IVI) = Relative Density + Relative Frequency + Relative Dominance

Basal area (sq.cm) = πr^2 , where r is the radius of tree obtained from the CBH.

Results and Discussion

Phytosociology: Phytosociological analysis revealed that the total tree density per hectare was found to be 322, the maximum values of number of trees/ha, basal area and IVI were of *Prosopis juliflora* (160, 18.98 m², 125.08) as given in (Table 2). Based on IVI values the dominant and co-dominant species were *Prosopis juliflora* and *Cordia dichotoma*. A total of 35 different tree species were found in the sampled area of 1 hectare. *Leucaena leucocephala* was the third most abundant species with total 19 individuals present having a basal area of 0.75 m² however, *Senna siamea* has a larger basal area of 1.01 m² even with a lesser number of individuals that is 9.

Diversity Analysis

The A/F ratio showed that the distribution of species was contiguous 91.42% species in Northern ridge forest (Table 3) while only 8.57% species showed random distribution in Northern ridge forest. The Marglef's index (SR) and Menhinick index (MeI) were 5.89 and 1.95 respectively. The obtained

Table 1. Formulae for various diversity indices used in the study.

Diversity Index	Formula	Denotations	Reference
Margalef index of species richness	$SR = S - \frac{1}{\ln(N)}$	S = Number of species N = total number of individuals.	(Margalef, 1958)
Menhinick's index of species richness	$MeI = \frac{S}{\sqrt{N}}$	S= number of species. N= total number of individuals.	(Whittaker, 1977)
Shannon-Wiener diversity index	$H' = -\sum \frac{ni}{n} * \ln\left(\frac{ni}{n}\right)$	ni = the IVI value of a species. n = sum of total IVI values of all species	(Shannon & Weaver, 1963)
Simpson's concentration of dominance	$Cd = \sum \left(\frac{ni}{n}\right)^2$	ni = the IVI value of a species. n = sum of total IVI values of all species	(Simpson, 1949)
Simpson's diversity index	$D = 1 - Cd$	Cd = Simpson's concentration of dominance	(Simpson, 1949)
Pielou's Evenness index	$J = -\frac{Cd}{\ln n}$	H'=Shannon-Wiener information index n = sum of total IVI values of all species	(Pielou, 1966)

Table 2. Table showing values for various phytosociological parameters of the study.

Sl. No.	Tree Species	Northern ridge forest							
		Trees Per ha	Basal Area (m ²)	IVI	SN	Tree Species	Trees	Basal Per ha	IVI Area (m ²)
1	<i>Acacia leucophloea</i>	5	0.42	5.79	19	<i>Jacaranda mimosifolia</i>	1	0.23	2.49
2	<i>Ailanthus excelsa</i>	1	0.22	2.46	20	<i>Leucaena leucocephala</i>	19	0.75	9.75
3	<i>Albizia lebeck</i>	4	0.78	8.10	21	<i>Madhuca longifolia</i>	1	0.05	1.92
4	<i>Alstonia scholaris</i>	1	0.08	2.02	22	<i>Mimusops elengi</i>	1	0.01	1.79
5	<i>Azadirachta indica</i>	2	0.81	4.68	23	<i>Mitragyna parviflora</i>	1	0.05	1.92
6	<i>Bischofia javanica</i>	1	0.02	1.81	24	<i>Morus alba</i>	3	0.11	4.19
7	<i>Callistemon viminalis</i>	2	0.10	2.39	25	<i>Pithecellobium dulce</i>	1	0.41	3.09
8	<i>Cassia fistula</i>	6	0.56	8.01	26	<i>Pongamia pinnata</i>	4	0.09	4.42
9	<i>Cordia dichotoma</i>	27	0.56	15.99	27	<i>Prosopis juliflora</i>	160	18.98	125.08
10	<i>Crateva adansonii</i>	3	0.10	2.69	28	<i>Putranjiva roxburghii</i>	6	0.22	4.02
11	<i>Diospyros montana</i>	13	0.49	14.30	29	<i>Schleichera oleosa</i>	6	0.51	4.96
12	<i>Ehretia laevis</i>	13	0.62	13.28	30	<i>Senna siamea</i>	9	1.01	14.73
13	<i>Eucalyptus spp.</i>	9	0.90	7.14	31	<i>Syzygium cumini</i>	4	0.18	3.26
14	<i>Ficus benghalensis</i>	1	0.32	2.79	32	<i>Tabebuia aurea</i>	1	0.04	1.89
15	<i>Ficus racemosa</i>	1	0.67	3.90	33	<i>Tectona grandis</i>	1	0.01	1.79
16	<i>Ficus relogiosa</i>	6	0.83	7.42	34	<i>Thevetia peruviana</i>	1	0.01	1.80
17	<i>Ficus virens</i>	1	0.09	2.04	35	<i>Toona ciliata</i>	4	0.06	2.89
18	<i>Grevillea robusta</i>	3	0.87	5.17					
	Total	99	8.44	109.98		Total	223	22.72	189.99

Table 3. Table showing distribution pattern and diversity for the study sites Northern Ridge Forest (NRF).

Study Site	A/F Distribution (%)			Diversity Indices					
	Random	Contiguous	TSR	Margalef Index (SR)	Menhinick Index (MeI)	Shannon-Wiener Index(H')	Simpson Conc. of Dominance (Cd)	Simpson diversity (D)	Pielou's Evenness Index(J)
NRF	8.57	91.42	35	5.89	1.95	2.58	0.01	0.99	0.73

*TSR = Total Species Richness.

values for Shannon-wiener index (H') and Simpson diversity (D) were 2.58 and 0.99 respectively. Pielou's evenness index (J) was 0.73 for Northern ridge forest.

Phytograph analysis revealed that the influence of basal area, frequency and density on the dominance of dominant species was analyzed by plotting a phytograph (Figure 1). It clearly showed that the dominance of *Prosopis juliflora* in Northern ridge forest.

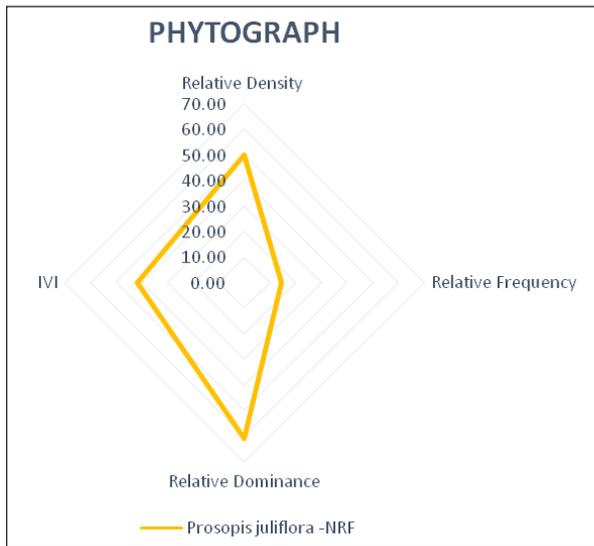


Fig. 1. Phytograph

Conclusion

The total tree density in the Northern ridge forest was 322 trees per ha, the value for Shannon wiener index obtained was 2.58 which was close to the reported value of 2.10 Asola Bhatti wildlife sanctuary in Delhi by (Sharma and Chaudhry, 2018). The total number of species in Northern ridge forest were 35 which and the dominant species i.e. *Prosopis juliflora* as seen in southern ridge forest of Delhi as reported by (Kushwaha *et al.*, 2014). This study paves the way for integration of this baseline data with the biomass studies and satellite data of the forest. In the future it can save time for forest inventory as time and cost-

effective method for forest studies.

References

- Attua, E. and Pabi, O. 2013. Tree species composition, richness and diversity in the northern forest-savanna ecotone of Ghana. *Journal of Applied Biosciences*. 69(0): 5437. <https://doi.org/10.4314/jab.v69i0.95069>
- Braun-Blanquet, J. 1932. Plant sociology. The study of plant communities. First ed. *Plant Sociology. The Study of Plant Communities. First Ed.* <https://www.cabdirect.org/cabdirect/abstract/19331600801>
- Knight, D. H. 1975. A Phytosociological Analysis of Species-Rich Tropical Forest on Barro Colorado Island, Panama. *Ecological Monographs*. 45(3) : 259–284. <https://doi.org/10.2307/1942424>
- Kushwaha, S. P. S., Nandy, S. and Gupta, M. 2014. *Growing stock and woody biomass assessment in Asola-Bhatti Wildlife Sanctuary, Delhi, India*. 5911–5920. <https://doi.org/10.1007/s10661-014-3828-0>
- Lutz, H. J. 1930. The Vegetation of Heart's content, A Virgin Forest in Northwestern Pennsylvania. *Ecology*, 11(1) : 1–29. <https://doi.org/10.2307/1930778>
- Mandal, G. and Joshi, S. P. 2014. Analysis of vegetation dynamics and phytodiversity from three dry deciduous forests of Doon Valley, Western Himalaya, India. *Journal of Asia-Pacific Biodiversity*. 7(3) : 292–304. <https://doi.org/10.1016/J.JAPB.2014.07.006>
- Mueller-Dombois, D. and Ellenberg, H. 1974. *Aims and methods of vegetation ecology*. Wiley.
- Odum, E. 1971. *Fundamentals of Ecology : 3d ed.* Saunders. <https://www.worldcat.org/title/fundamentals-of-ecology-3d-ed/oclc/757358068>
- Rennolls, K. and Laumonier, Y. 2000. Species diversity structure analysis at two sites in the tropical rain forest of Sumatra. *Journal of Tropical Ecology*. 16(2) : S0266467400001395. <https://doi.org/10.1017/S0266467400001395>
- Sharma, V. and Chaudhry, S. 2018. Vegetation composition and plant diversity in mining disturbed tropical thorn forest of Asola-Bhatti Wildlife Sanctuary, Northern India. *Taiwania*. 63(3) : 267–280. <https://doi.org/10.6165/tai.2018.63.267>
- Sinha, G. N., Varsha, Solanki, S., Singh, N., Basu, A., Shukla, A. K. and Sharma, B. 2014. *An Introduction to the Delhi Ridge*. 180.
- Turner, M. Goigel. 1987. *Landscape Heterogeneity and Disturbance*. Springer New York.