Plant Community structure and Regeneration potential of Pawalgarh Conservation Reserve, Uttarakhand, India

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Abstract

The unpredicted depletion and lack of regeneration of the forests and their resources have created an alarming situation across the globe and forest conservation has been regarded as one of the prime areas of concern. For the analysis, the reserve area of Pawalgarh in the state of Uttarakhand in India is studied for the structure, regeneration and the plant growth study are considered. The research area of Pawalgarh is covered with the rivers all around as Kosi in the western part, the eastern side has the river Baur while the entire area is intersected with the Dabka river. The potential capacities of regeneration in the plant species of this area are very high. The biodiversity of Pawalgarh is rich and huge with more than 137 species of trees and also has 58 species as well as 52 species of both shrubs and herbs respectively (Bargali, 2016). The phytosociology concept is used for carrying on the analysis that is helpful in describing the healthy vegetative structure of the Pawalgarh area. The structure of the community here is based on the mixed forest types and partially a grassland (Bisht and Joshi, 2020). The lush green vegetation all around the forest area shall be conserved and regenerated in a way so that they do not extinct from the globe and regenerate themselves for having their presence in the forests and growing their community. Phytosociology analysis on this research paper has helped in analyzing the communities and the area of vegetation in a healthier manner and protecting them to maintain the ecological balance as well as the scenic beauty of the world (Bargali, 2016).

Introduction

Pawalgarh is a house of marvelous forests all around, covering the area of 58.25 km^2, majorly the home for tropical vegetation and for the lower altitude terrain. Pawalgarh conservation reserve area is comparatively smaller than other reserves then too it contributes a good range towards the ecological balance as well as the sustainability of the world. The habitat of this research is a house many species of flora and fauna (Bisht and Joshi, 2020). The community of the research is highly diversified with many species belonging to similar communities. Some of the species are from the mountain terrain, alpine ones while the others are shrubs as well as herbs. The structure of vegetation is highly dynamic and is controlling the creation of biomass as well as creating the supplement cycle and having the environmental control by offering a huge variety in species as well.

The pace level of regeneration in the trees cannot be accessed with ease because of the multiple oversaw woods within them. To comprehend an analytical study the body of the tree and the words are studied for making aggravation within the area of the reserve (Bisht and Joshi, 2020). The research area of Pawalgarh is a consistently mixed forest offering lush greenery throughout and is rich in its habitant as well as the surroundings. The entire area has some of the species that were towards their path towards dissemination and for conserving and holding their presence it is necessary for the homo sapiens to conserve their habitat, their survival categories and to develop the nature in their accordance so that they can be protected (Bisht and Joshi, 2020).

Regeneration amongst the species cannot be done independently rather it involves an entire supplement cycle within the process (Mohan and Sondhi, 2015). Not all plants grow and regenerate in a similar process; it is merely fair to say that every species and every community has its own way of regenerating its community in the changing dynamic habitat in which it is surviving. As the regeneration process of shrubs is created in a way that they are dense in their growth process and thus the regeneration of a shrub can be noted with ease due to its expanded density in the area, while on the other hand if the regeneration of the species of huge trees of the reserve area is discussed than it can be analyzed that the regeneration of these is not much strong as they require the higher quantity of minerals as well as nutrients from the land.

Massive impact on regeneration is observed due to the over interaction and human interference within the environmental activities and also creating disruptions with the activities of environment (Mohan and Sondhi, 2015). The reserve areas are created in the area so that the conservation of these species can be made with higher abilities and also have the additional awareness amongst the humans so that they can protect these habitats and give the species back their regenerating capacities and can maintain the ecological balance on the global scale.

Aim

The aim of the study will majorly focus on the following aspects:

1. Phytosociological study is carried down to analyse the forest for the community structure and regeneration potential.
2. To analyze the seasonal regeneration potential including the phytosociological study of its sapling and seedling.

Methodology -

Site description- The present research area is dechori range (Laxampur Beat) of Pawalgarh conservation reserve forest. It is located between $29^{\circ}23'$ N latitude and $079^{\circ}15'$ E longitude & 607 m elevation. It has recently been made a tiger conservation reserve. This forest is a good habitat for birds. It has attracted several workers since long past.

Methods-

Phytosociological assessment of natural forest was studied during 2019 -2020. The data analyzed for density, frequency abundance & IVI (Important value index) etc. following standard ecological method (Curties 1956, Mishra 1968) as displayed below,

Density (D) = Total number of individuals/ Total number of quadrats studied

Frequency (F) = Number of quadrats of occurrence / Total number of quadrats studied × 100

Abundance (A) = Total number of individuals/ Number of quadrats of occurrence

Relative density (RA) = Number of individuals of the species /Number of individuals of all species ×100

Relative frequency (RF) = Number of occurrence of the species /Number of occurrence of all species×100

Relative dominance (RD) = Total basal area of the species / Total basal area of all species ×100

Basal area $= \pi r^2$

Average radius of plant (r) = Average diameter /2

Important Value Index (IVI) = Relative density + Relative frequency+ Relative Dominance

A/F ratio = Abundance/ Frequency

The data analysis is also done by using 20 random quadrats for each i.e.; 10 ×10 m size for tree, 5 ×5 m size for shrubs & saplings & 1× 1 m size for seedlings. To study the regeneration potential three life form of plants species (mature plants, sapling & seedling) have been used here. Individuals having ≥30cm. cbh (Circumference at Breast Height i.e. 1.37m above the ground) were considered mature trees, individuals having ≤10cm. cbh were considered as seedlings and individuals having 10-30cm. cbh were considered as saplings, (Knight 1963). The diameter of shrubs and seedlings has been measured with the help of tape & caliper. The value of density of tree, saplings and seedlings is believed as the symbol of regeneration potential. The distribution pattern is believed regular if the A/F ratio is (0.025), random (0.025-0.050) & contiguous (0.050), (Whitford 1949).

Results and Discussions

The study has focused on studying and analyzing the buffer area of the reserve area along with the study of the two species in dept by carrying their phytosociological study in regards with their seedling and sapling and also their regeneration capacities with the changing atmospheric pressures within the area (Mohan and Sondhi, 2015).

Phytosociological assessment of tree species in the reserve area

Tree Species	Density	Frequency percentage	A/F ratio	IVI	Basal Area
Albizziz procera	30	15	0.13	21.57	0.32
Aegle marmelos	25	20	0.06	12.78	0.10
Anogeissuslatifolia	35	25	0.05	15.06	0.09
Bombax ceiba	20	20	0.05	20.49	0.30
Cordia dichtoma	20	15	0.08	7.45	0.02
Diospyrosmelonoxylon	80	30	0.08	25.39	0.15
Holarrhenaantisenterica	50	40	0.03	18.42	0.03
Holoptelea integrefolia	30	20	0.07	28.28	0.45
Lagerstroemiaparviflora	75	35	0.06	20.84	0.03
Meallotus philippensis	70	50	0.02	23.81	0.03
Meduca indica	10	5	0.4	3.52	0.02
Putranjiva roxburgii	15	10	0.15	5.9	0.03
Shorea robusta	150	65	0.03	56.91	0.45
Syzygium cuminii	25	15	0.11	11.98	0.11
Tectona grandis	15	1 0	0.15	10.96	0.15
Trewia nudiflora	25	20	0.06	10.25	0.04
Terminalia bellerica	10	10	0.1	6.01	0.05
Total=	**685**	**405**	**1.63**	**299.62**	**2.37**

(D= Density/hectare), (F %= Frequency), (A/F ratio= Abundance/ Frequency), (IVI=Important Value Index), (Basal area= Square meter)

Shorea robusta is the densest species amongst all the communities within the area of the reserve and can regenerate itself. This tree species is the one that also has a high frequency percentage so also is its IVI and thus this is the reason why this is an evergreen tree in the reserve area that is maintaining the ecological balance of the state. On the other hand, *Terminalia bellerica* is that tree species amongst the all that has the least density and also the lesser frequency percentage. This tree has the lower capacity of its regeneration as analysed by the phytosociological study carried on in the area of the Pawalgarh reserve.

Density is computed as the density per hectare. The computation of the percentage of the frequency is computed. AF ratio is stated as the abundance to the frequency ratio; in this the abundance rate is kept as the numerator while the frequency figure is kept as the ratio denominator. IVI in the above table stands for the Important Value Index of the entire tree species that is studied for carrying the study of the reserve. Basal area stands for square meter covered area within the reserve is covered by any specific species of the tree that is studied in the above table.

Phytosociological angles incorporate thickness, recurrence, bounty, relative recurrence, relative thickness, and relative strength (Mohan and Sondhi, 2015).

Seasonal Phytosociological assessment of seedlings in the reserve area

Seedlings	**Rainy Season**				**Winter Season**				**Summer Season**			
	D	F (%)	A/F	IVI	D	F (%)	A/F	IVI	D	F (%)	A/F	IVI
Adina cordiflora	-	-	-	-	-	-	-	-	-	-	-	-
Aegle marmelos	1000	20	0.25	52.58	-	-	-	-	-	-	-	-
Anogeissus latifolia	900	25	0.14	38.35	-	-	-	-	-	-	-	-
Cassia fistula	300	10	0.30	51.99	-	-	-	-	-	-	-	-
Diospyros melanoxylon	-	-	-	-	1000	25	0.16	57.35	-	-	-	-
Elaeocorpus genitrus	-	-	-	-	500	20	0.12	34.23	-	-	-	-
Holoptelea integrefolia	-	-	-	-	-	-	-	-	600	20	0.15	74.61
Holarrhena antisenterica	350	15	0.15	39.38	-	-	-	-	-	-	-	-
Largerstroemia parviflora	-	-	-	-	-	-	-	-	1400	30	0.15	124.63
Meallotus philippensis	1550	40	0.09	63.9	-	-	-	-	-	-	-	-
Shorea robusta	1150	30	0.12	53.71	1750	40	0.10	97.6	-	-	-	-
Syzygium cuminii	-	-	-	-	1400	35	0.11	77.44	-	-	-	-
Schleichera oleosa	-	-	-	-	400	15	0.17	33.31	-	-	-	-
Trewia nudiflora	-	-	-	-	-	-	-	-	900	25	0.14	100.72
Total	5250	140	1.05	299.91	5050	135	0.66	299.93	2900	75	0.44	299.96

(D= Density/hectare), (F %= Frequency), (A/F ratio= Abundance/ Frequency), (IVI=Important Value Index),(Basal area= Square meter)

The above given is the table that is showing the seedling activities of the communities and also showing the better analysis in a way that is helpful in making the analysis about how they are behaving with the changing weather and their change in the level of density, frequency, ratio of A/F as well as the IVI in different seasons

and studying the activities that how the communities are responding to the changing environmental conditions.

From the analysis of the above table, it can be regarded that the maximum density of seedling is seen in the rainy reason that means that this season is giving the maximized capacity to the tree species to grow. *Meallotus philippensis* species community is the one that has the maximum density level in the rainy season amongst all the other species though out the year. Summer season is the one that is having the least density as well as the least frequency of regeneration amongst the community of distinct species.

Phytosociological assessment of sapling in the reserve

Sapling	**Rainy Season**				**Winter Season**				**Summer Season**			
	D	F (%)	A/F	IVI	D	F (%)	A/F	IVI	D	F (%)	A/F	IVI
Aegle marmelos	-	-	-	-	160	15	0.17	36.79	300	20	0.18	63.69
Cassia fistula	-	-	-	-	100	15	0.11	29.51	-	-	-	-
Diospyro smelanoxylon	-	-	-	-	-	-	-	-	400	40	0.06	79.17
Holarrhena antisenterica	-	-	-	-	360	35	0.07	-	-	-	-	-
Holoptelea integrefolia	200	20	0.12	47.41	-	-	-	-	-	-	-	-
Largerstroemi parviflora	300	15	0.33	50.94	-	-	-	-	-	-	-	-
Meallotus philippensis	900	55	0.07	106.4	600	60	0.04	71.59	500	50	0.05	105.8
Shorea robusta	780	40	0.12	95.13	580	50	0.05	67.11	-	-	-	-
Syzygium cuminii	-	-	-	-	300	30	0.08	42.02	-	-	-	-
Schleichera oleosa	-	-	-	-	-	-	-	-	160	15	0.17	51.29
Total	2180	130	0.64	299.97	2100	205	0.52	299.9	1360	125	0.46	299.95

(D= Density/hectare), (F %= Frequency), (A/F ratio= Abundance/ Frequency), (IVI=Important Value Index), (Basal area= Square meter)

Rainy season is the most feasible season amongst all as this offers the maximum level of growth to the sapling of the communities. The phytosociological study has helped in analysing that the plant regeneration capacities are highly dependent over the atmospheric pressures and the outside environmental conditions. From the overall study, it can be analysed that the summer season is the least feasible one for the growth of the sapling of the species except the *Schleichera oleosa, Meallotus philippensis, Aegie marmelos* as well as *Diospyros melanoxylon*, also the growth of sapling is not much dense in this season as compared to the density growth of the other seasons. As analyzed from the above table Meallotus philippensisis the tree species that has the maximum growth level and so as its sapling density increment in the rainy season majorly. *Meallotus philippensis* also on the other hand is an evergreen species that is growing and regenerating itself in all the seasons.

The above presented table shows the activities and the behaviour of the sapling of the communities in regards

with its density, IVI, ratio of A/F and the frequency percentage of the community according to the changing weather conditions and how the sapling of the communities are regenerating themselves.

Phytosociological assessment of shrubs in the reserve

Shrub Species	Common Name	Density	Frequency percentage	A/F ratio	IVI	Basal Area
Citrus medica	Pilu	6000	60	0.41	45.09	2.16
Colobrookiaoppositifoia	Binda	1360	30	0.37	24.67	2.32
Clerodentrum viscosum	Bhant	7000	85	0.24	48.18	1.16
Desmodium gangeticum	Salparni	900	9	0.36	15.8	1.24
Helicteres isora	Marodphali	1000	20	0.62	20.3	2.16
Justicia adotoda	Basing	1200	40	0.18	22.2	1.58
Lantana camara	Kuri	5400	50	0.54	37.53	1.58
Murraya koenigii	Kariptta	5520	70	0.28	37.38	0.69
Sida cordifolia	Kharenti	2600	15	2.88	21.76	1.76
Ziziphus mouritiana	Ber	1300	35	0.26	26.92	2.54
Total		32280	430	6.14	299.83	17.19

(D= Density/Hectare), (F %= Frequency), (A/F ratio= Abundance/ Frequency), (IVI=Important Value Index), (Basal area= Square meter)

Bhant has the maximum Important Value Index in the reserve area of Pawalgarh depicting a scenario in which it can be said that the maximum area is covered with this shrub and the basal area of the forest is filled with these shrubs. Also, the community of shrub that has the least presence in the reserve area is the salparni covering the Basal area of 1.24 square hectare of the Pawalgarh reserve.

Vegetation might be characterized as a gathering of plants filling together in a specific area and might be described either by its segment species or by the blend of underlying and practical characters that portray the appearance, or physiognomy, of vegetation and so as the communities of these shrubs described with the phytosociological study.

Woodland people group are the resultant of a total of individual species, and every one of the animal types happening freely inside its own resistance limit (Ghosh-Harihar, et. al., 2019).

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