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Floristic assessment of semi evergreen forests of a peripheral site in Hadagarh Sanctuary, Odisha, India

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Phytosociological study was carried out in the outer periphery region of Hadagarh Wildlife Sanctuary, Odisha, India. An attempt has been made to find out the characteristics of the vegetation community of the forests of the sanctuary. Analysis of the vegetation was done following the standard ecological methods widely adopted for such studies (quadrat method). A total of 68 plant species from 30 families were documented comprising of 14 species of tree, 42 species of shrubs and saplings and 12 species of herbs and seedlings. This study provides a baseline data for all such future studies as no previous ecological assessment about the forest vegetation of the sanctuary is available. In terms of Importance Value Index (IVI), *Azadirachta indica* with IVI value of 61.45 among trees was found most dominant followed by *Shroea robusta* (46) and *Schleichera oleosa* (37). Similarly most common plant species amongst shrubs and herbs were *Ageratum conyzoides* L. (IVI-40.08) and *Mimosa pudica* L. (IVI-45.67). The sanctuary has been under various anthropogenic pressures resulting in depletion of the vegetation. Near absence of saplings and seedlings of dominant forest trees is a matter of concern in the peripheral region of the sanctuary. The study revealed that, a suitable long term management intervention to step up regeneration of population in this area will go a long way in improving overall ecological and aesthetic value of the forests of the sanctuary area.

Key words: Importance Value Index (IVI), Santhal tribe, natural vegetation, traditional knowledge, strict enforcement.

INTRODUCTION

The concept of Sustainable development has received worldwide acceptance. Sustainable planning of ecologically important regions could not be taken up due to lack of sufficient data on structure and functioning of ecosystem. Hadagarh Wildlife Sanctuary is one such area containing diverse floral and wildlife composition but does not have much information about its phytosociological composition. The floristic composition and phytosociological attributes are useful for comparing one community with the other from season to season and from year to year under certain environmental stress factors (Singh and Weigand, 1994). Large number of animals and plants inhabit the earth in a variety of habitats and ecosystems (Wilson, 1992). Odisha is one of the richest biodiversity regions in Southeast Asia. Saxena and Brahmam (1996) reported 2,727 species of plants under 228 families and 1062 genera of which 2561 species are indigenous and 166 species are cultivated.

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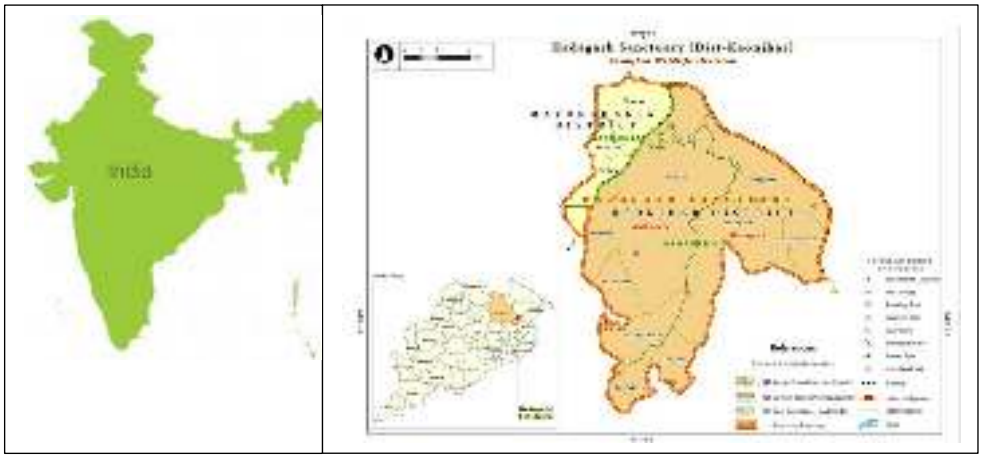

Figure 1. Odisha Wildlife Organisation (2020).

There is such a vast repositories of animals and plants found across the planet with a distinct biological co-relationship maintained and sustained by various adaptations vis a vis changing environment, inter dependence among the different life forms, sustained productivity and food chain/web relationships, nutrient cycling and energy flow etc. Phytosociology reveals the organization and structure of plant diversity which helps in determination of the distribution pattern of individuals among the species in a particular habitat therefore such analysis is important for understanding the functioning of any community (Warger and Morrel, 1976). Phytosociological status of Kuldiha Wildlife Sanctuary Odisha, India reveals that there is a big gap between the values of various structural parameters and tree species having very low values of IVI deserve more attention (Rout et al, 2018). Another study on Similipal Biosphere Reserve (SBR) listed 266 species of angiospermic plants represented under 72 families. Out of 266 plant species 115, 37, 103 and 11 are trees, shrubs, herbs and climbers distributed under 42, 22, 34 and 8 families, respectively (Mishra et al, 2008). Presence of high species richness and diversity, mean stand density and species rarity indicates the uniqueness and potentiality of SBR for conservation of ecosystem in its totality (Reddy et al., 2007). Forests in the peninsular India are decreasing at a fast rate, though the data on structure and functional dynamics of these forests (Parthasarathy and Sethi, 1997) are scarce. A few studies in Eastern Ghats of Tamil Nadu (Kadavul and Parthasarathy, 1999a, b; Chittiibabu and Parthasarathy, 2000; Natarajan et al., 2004) have been conducted reflecting the floristic composition of forests in the area. More studies in tropical forests are (Tripathi and Singh 2009; Hegde et al., 2011, Bajpai et al., 2012; Dangwal et al., 2012; Sahu et al., 2012; Verma et al., 2013; Sangma and Lyngdoh, 2014; Ahmed and Sharma 2014; Pradhan and Rahman, 2015; Knight, 2015; Sundarapandian and Subbiah 2015; Shahid and Joshi, 2016; Bajpai et al., 2017; Masens et al., 2017; Shiferaw et al., 2018). Sahu et al. (2010a) and Bhadra and Pattanayak (2016, 2017, 2019) have also studied tree Species Population Dynamics in the Tropical Dry Deciduous Forest of Gandhamardan Hills, Eastern Ghats, Western Odisha. Behura et al. (2016) highlighted the ecological significance of native species which are effective ecological tools towards conserving the biodiversity and enhancing the ecological services in a restored habitat. From various studies, it is seen that phytosociological characteristics of Western Ghats have been carried out over a period of time on the forest vegetation of the area whereas a few data are available about the forests of Eastern Ghats, particularly about Odisha. The phytosociological studies conducted in other parts of Odisha are by Sahu et al. (2007), Ekka and Behera, (2011), Behura et al. (2015) and Nayak et al. (2016) etc. Odisha accounts for about 45% of the forest area in the Eastern Ghats. Therefore, the present study was aimed at documenting the status of the present vegetation structure of Hadagarh Wildlife Sanctuary through a detailed phytosociological analysis of the forest ecosystem involving parameters like relative density, abundance, relative frequency, relative basal area and Important Value Index, which will be helpful to plan for a better management intervention to enhance the quality of forest ecosystem.

MATERIALS AND METHODS

Study area

The Hadagarh Wildlife Sanctuary spreads across the districts of Keonjhar and Mayurbhanj in the state of Odisha, covering an area of 191.06 Sq Kms (Longitude 86°10' to 86°22' E Latitude 21°23' to 21° 12 'N) which was notified vide Government notification dated 06.12.1978 (Figure 1) (Odisha Wildlife Organization, 2020. www. wildlife. odisha. gov.in). This area, therefore came under the status of a 'protected area' under the provisions of the Government from

Figure 2. A view of study area.

the date of its notification.

It lies in the catchment of Salandi River, one of the major tributaries of river Baitarani and is close to the Hadgarh Reservoir of Salandi dam. This region is rich in mixed deciduous forests and provides ideal habitat to variety of wildlife. The Baula area of sanctuary consists of two hills on either sides of the river and spreads across Satkosia RF of Mayurbhanj and Baula RF of Keonjhar district. The valley comprises of Hadagarh reservoir and its catchments. There are 16 villages, largely dependent on the ecological resources of the sanctuary. The demography of the area reveals dominance of backward classes and tribes like Santhals and Hos. Their regular day to day needs like firewood, grazing of domestic animals, timbers, medicinal plants etc are fulfilled from the resources available within the forests. Villagers' residing near the boundary allow cattle into the sanctuary, which is a common feature in the area. The relative humidity generally remains above 60%, maximum temperature 35°C during April-May and 6 degree Celsius during November –January of the year. Average rainfall ranges from 1718 mm to 2369 mm with 86 rainy days in a year. Cyclone with wind is frequently observed during September to December of the year (Management Plan of Hadagarh Sanctuary, 2011-2012 to 2020-2021).The study area comes under the district Kendujhar, Odisha. The District of Keonjhar is very often visited by calamities like droughts, floods, cyclone and other natural calamities. (District Disaster Management and Response Plan, Keonjhar, 2016).The forest type of this area has been categorised as Dry Peninsular Sal Forests and Northern dry mixed deciduous forests (Champion and Seth, 1968) (Figure 2). The sanctuary comes under Biogeographic classification of Deccan peninsula sub-division of Chotanagpur plateau. Sandy loam is the prominent soil type and Quartzite, Quartz, Schists, Laterite are the main rocks found in the area. (Management Plan of Hadagarh Sanctuary, 2011-2012 to 2020-2021).

Vegetation study

The sampling of vegetation was done for trees and shrubs only once for one year during summer (March –May) and for herbaceous vegetation and seedlings three times in a year i.e. for summer (March-May), winter (December-January) and rainy season (July-September). Similar observation continued for the 2nd year also. The data thus obtained were used for analysis of all structural vegetation parameters for phytosociological analysis.

Random sampling plots were identified for the study. The quadrat size was taken 10 x 10 m for trees, 5 x 5 m for shrubs and 1 × 1 m for herbs and seedlings. All the plants were classified into following three categories taking into account their girth class i.e. circumference at breast height (cbh) (i) Herbs and Seedlings (0-10 cm cbh) (ii) Shrubs and Saplings (10-30 cm cbh) and(iii)Trees - more than 30 cm cbh and a total of 20 quadrats were sampled for each strata of vegetation. The size and number of quadrats, collection of data from the quadrats were based on standard ecological methods of Misra (1968) and Kershaw (1973). Analysis was done for arriving at phyto-sociological parameters following the Philips (1959) and Curtis (1959) to compute density, basal area (BA), frequency, relative density (RD), abundance, relative frequency (RF), relative basal area (RBA) and Important Value Index (IVI).IVI was determined as the sum of the relative frequency, relative density and relative dominance for tree layer. The following formulae were used for calculation:

$$\text{Frequency} = \frac{\text{Number of quadrats in which species occur}}{\text{Total number quadrats under study}} \times 100$$

$$\text{Relative Frequency} = \frac{\text{Number of occurrences of a species}}{\text{Total number occurrences of all species}} \times 100$$

$$\text{Density} = \frac{\text{Total number of individuals}}{\text{Total number of quadrats under study}}$$

Table 1. Species, density, basal area, frequency, distribution pattern and Importance Value Index (IVI) of Tree species of a peripheral site of Hadagarh Sanctuary.

Name of Species	Local name	Denisity/ha	BA m^2/ha	Freq (%)	Abundance	RD	RF	RBA	IVI
Azadirachta indica A Juss.,Mem	*Neemba*	105	0.348	50	2.1	30.435	26.316	4.708	61.459
Shorea robusta Gaertn.f.Fruct	*Sal*	75	0.261	40	1.875	21.739	21.053	3.537	46.329
Schleichera oleosa (Lour.)Oken	Kusum	5	2.407	5	1	1.449	2.632	32.595	36.675
Tamarindus indica L.Sp.Pi	*Tentuli*	20	1.932	5	4	5.797	2.632	26.161	34.590
Naringi crenulata(Roxb.)M.Roem.	*Benta*	10	0.115	10	1	2.899	5.263	23.919	32.081
Lannea corromandelica(Houtt)	Jia	40	0.188	20	2	11.594	10.526	2.541	24.661
Strychnos nux-vomica (L.)	*Kuchila*	20	0.072	15	1.333	5.797	7.895	0.980	14.672
Eucalyptus tereticornis Sm.Spec	*Nilgiri*	20	0.304	5	4	5.797	2.632	4.118	12.547
Protium serratum(Wall.exColebr)	Rimili	10	0.013	10	1	2.899	5.263	0.182	8.344
Cassia fistula L.Sp.Pl	*Sunari*	10	0.001	10	1	2.899	5.263	0.007	8.168
Diospyros malabarica(Desr.)Kostel	*Kali Kendu*	10	0.017	5	2	2.899	2.632	0.235	5.765
Cycas circinalis L.var.orixensis	*Katha Bheru*	10	0.001	5	2	2.899	2.632	0.007	5.537
Acacia nilotica L.	*Babul*	5	0.054	5	1	1.449	2.632	0.737	4.818
Catunaregam spinosa(Thunb.)Tirveng.	*Kalei Kanta*	5	0.020	5	1	1.449	2.632	0.273	4.354

Total Indi.-Total number of individuals, BA-Basal Area, Freq-Frequency, RD-Relative Density, RF-Relative Frequency, RBA-Relative Basal Area, IVI-Important Value Index.

$$\text{Relative Density (RD)} = \frac{\text{Number of Individuals of the species}}{\text{Number of individuals of all species}} \times 10$$

$$\text{Abundance} = \frac{\text{Total number of individuals of the species}}{\text{Total number of quadrats of occurrence}} \times 100$$

Relative Abundance (RA) = Relative Frequency + Relative Density

$$\text{Relative Basal Area (RBA)} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all the species}} \times 100$$

Finally, the Importance Value Index was calculated on the basis of the following formula Importance Value Index (IVI) = Relative Frequency + Relative Density+ Relative Dominance. Specimen were identified with the help of Working Plan (WP,2008,2017) of Keonjhar forest division, Flora of Orissa (Saxena and Brahmam,1994-1996), Botany of Bihar and Orissa(Haines,1921-1925) and herbarium of Botany department, Utkal University, Bhubaneswar, India.

RESULTS AND DISCUSSION

Analysis of vegetation reveals that 68 plant species from 30 families were available in the area with 14 species of tree, 42 species of shrubs and saplings and 12 species of herbs and seedlings (Tables 1 to 3). The species of trees, shrubs and saplings and herbs and seedlings belonged to 13, 29 and 9 families respectively. Importance value Index (IVI) is the measurement of ecological amplitude of species (Ludwig and Reynolds, 1988) which indicates one of the ability of a species to establish over an array of habitats. It gives composite information by taking into account the relative density, relative frequency and relative basal area. The frequency, abundance and density values are suitable for herbs and shrubs (Airi et al., 2000). IVI is an important information for all species. The vegetation characteristics of the area should be looked into through upper-story, middle- story and under- story vegetation for the purpose of a holistic assessment. The high importance value index of the species states its dominance and ecological success, its better power of regeneration and ecological amplitude in the area (Bhandari et al., 1999).

The dominant tree species having maximum RD and RF values were *Azadirachta indica followed* by *Shorea robusta* and *Lannea corromandelica* (Table 1).The IVI of *A. indica* was highest followed by *S. robusta*, *Naringi crenulata, Tamarindus indica and Schleichera oleosa*. Mishra et al., (2012) Shorea robusta was found as the dominant species in the SBR having IVI of 77.67 followed

Figure 3. View of a peripheral site of Hadagarh Sanctuary.

by *Terminalia alata* (16.13) and *Anogeissus latifolia* (13.43). Wendlandia sp. had IVI of 0.25 and was considered as the rare species of the reserve. All other tree species showed intermediate range of IVI Among the shrubs and saplings which occupy the middle storey vegetation *Ageratum conyzoides* exhibited highest IVI followed by *Combretum roxburghii*, *Holarrhena antidysenterica* and *Combretum decandrum* (Table 2).

The middle storey vegetation comprised of a good numbers of woody climbers and liana like *Combretum roxburghii*, *Smilax macrophylla*, *Cissampelos pareira*, *Ichnocarpus frutescens*. Similarly, analysis of herbs and seedlings (understory vegetation) (revealed *Cynodon dactylon* having the highest IVI followed by *Arundo donax, Mimosa pudica* and *Sida rhombifolia*. The plant species observed and encountered in the study belonged to 30 different families with most of the species belonging to Mimosaceae followed by Ebenaceae, Acanthaceae, Asteraceae, Combretaceae etc. It is important to note that majority of the families were represented by only two or less number of species. Though vegetation can be described in terms of a number of parameters including frequency, density and cover the use of any one of these quantitative parameters could lead to over-simplification or under-estimation of the status of the species (Kigomo et al., 1990; Oyun et al., 2009). Low ecological status of most of the tree species in the present investigation as evidenced by the IVIs, may be attributed to lack of dominance by any one of these species, suggesting positive interactions among the tree species (Mishra et al., 2012). In addition to the above findings, several cutting stumps were also observed indicating impact of anthropogenic activities in one of the forest vegetation in the area. Plant species like *Shorea robusta*, *Cassia fistula* have local economic importance. Similarly, plant species like *Diospyros ebenum*, *Acacia nilotica*. *Azadirachta indica*, *Strychnos nux-vomica*, *Andrographis paniculata*, *Alangium salvifolium* , *Holarrhena antidysenterica*, *Smilax macrophylla*, *Asoaragus racemosus*., *Xantolis tomentosa* etc have been used by the local population for years for preparation of medicines. Similar use of such plant species by people have been reported by various studies in India and abroad (Brahmam and Saxena, 1990; Girach, 1992; Sahoo and Mudgal, 1995; Mohanty et al., 1996; Brahmam et al., 1996; Aminnudin and n, 1996; Mehra et al., 2014; Bajpai et al., 2016; Rout et al., 2018). These plant species need urgent attention from the conservation point of view as their numbers are decreasing owing to factors like unsystematic and uncontrolled harvesting, grazing pressure from domestic animals and many other anthropogenic pressures (WP, 2008, 2017).

The population residing inside and adjoining area of the sanctuary have been dependent on the resources of this forest ecosystem which will have long term implications. This may be fairly attributed towards their lack of awareness on the issues concerning ecosystem services. Extensive use of natural vegetation in the sanctuary in the past has led to decrease in the provisioning services and increasing human demands has been the major case of deterioration in the condition of the natural habitats and increasing rarity of plant biodiversity (Giam et al 2010). The middle and lower storey vegetation showed presence of many saplings and seedlings of tree species like *Morinda tinctoria, Cassia siamea, Holarrhena antidysenterica*, *Azadirachta indica, Cesearia elliptica, Acacia nilotica*, *Diospyros ebenum*. These plant species need proper protection to grow as big trees. These plants are facing fierce competition in the ecosystem for space and sunlight due to threat from demands, weed species and other biotic impacts. As a result, there are a low percentage of old grown trees in the peripheral site.

Table 2. Species, density, basal area, frequency, distribution pattern and Importance Value Index (IVI) of Shrubs and saplings of a peripheral site of Hadagarh Sanctuary.

Scientific name	Local name	Frequency	R F	Density	R D	Abundance	RA	IVI
Ageratum conyzoides L.	*Poka Sungha*	62.5	14.164	1290	20.925	5.160	4.994	40.083
Combretum roxburghii Spreng.Syst	*Dhala Atundi*	55	12.465	1065	17.275	4.841	4.685	34.425
Holarrhena antidysenterica Wall.	*Kurei*	15	3.399	430	6.975	7.167	6.937	17.311
Albizia marginata(Lam)	*Beranga*	23.75	5.382	430	6.975	4.526	4.381	16.738
Combretum decandrum Roxb.Pl.	*Atundi (kala)*	12.5	2.833	355	5.758	7.100	6.872	15.463
Diospyros malabarica(Desr.)	*Kali kendu*	28.75	6.516	300	4.866	2.609	2.525	13.907
Strychnos nux-vomica (L.)	*Kochila*	18.75	4.249	290	4.704	3.867	3.743	12.696
Andrographis paniculata(Burm.f.)	*Bhuini Nimba*	10	2.266	235	3.812	5.875	5.686	11.764
Streblus asper Lour.	*Sahada*	26.25	5.949	165	2.676	1.571	1.521	10.146
Cesearia elliptica Willd.	*Khakada*	18.75	4.249	185	3.001	2.467	2.387	9.638
Morinda tinctoria Roxb.	*Achu*	7.5	1.700	150	2.433	5.000	4.839	8.972
Cissus guadrangula L	*Hada shankha*	18.75	4.249	155	2.514	2.067	2.000	8.764
Pergularia daemia(Forssk.)	*Utu rali*	7.5	1.700	145	2.352	4.833	4.678	8.730
Cissampelos pareira L.var.hirsuta	*Akandabindu*	10	2.266	150	2.433	3.750	3.630	8.329
Indigofera cassioides Rottl.	*Gilri*	18.75	4.249	110	1.784	1.467	1.420	7.453
Manilkara hexandra (Roxb.)	*Lal banduri*	17.5	3.966	100	1.622	1.429	1.383	6.971
Jasminum pubescens Wild.Sp.	*Bana malli*	12.5	2.833	115	1.865	2.300	2.226	6.924
Symphorema polyandrum Wight	*Badichang/Mahasindu*	10	2.266	115	1.865	2.875	2.783	6.914
Clerodendrum viscosum Vent.	*Gobra*	13.75	3.116	65	1.054	1.182	1.144	5.314
Woodfordia fruiticosa(L)	*Dhataki*	2.5	0.567	35	0.568	3.500	3.388	4.522
Paederia foetida L.Mant Pl.	*Gandhli*	5	1.133	40	0.649	2.000	1.936	3.718
Acacia nilotica L.	*Babul*	1.25	0.283	15	0.243	3.000	2.904	3.430
Diospyros ebenum Koenig	*Kendu*	1.25	0.283	15	0.243	3.000	2.904	3.430
Asoaragus racemosus Willd.	*Iswari jata*	6.25	1.416	35	0.568	1.400	1.355	3.339
Cassia siamea Lam.	*Chakunda(Desi)*	3.75	0.850	30	0.487	2.000	1.936	3.272
Diospyros montana Roxb.	*Halada*	6.25	1.416	25	0.406	1.000	0.968	2.790
Atalantia monophyla L.	*Narguni*	3.75	0.850	20	0.324	1.333	1.291	2.465
Glycosmis pentaphylla(Retz.)	*Dubuduba/Haumircha*	1.25	0.283	10	0.162	2.000	1.936	2.381
Ichnocarpus frutescens (L.)	*Suama Noi*	2.5	0.567	10	0.162	1.000	0.968	1.697
Impereta cylindrica(L)	*Dara gadi*	2.5	0.567	10	0.162	1.000	0.968	1.697
Alangium salvifolium (L..)Wang	*Ankula*	2.5	0.567	10	0.162	1.000	0.968	1.697
Thunbergia fragrans Roxb.var.hispida Gamble.	*Natka koli*	2.5	0.567	10	0.162	1.000	0.968	1.697
Protium serratum(Wall.exColebr)	*Rimili*	1.25	0.283	5	0.081	1.000	0.968	1.332
Xantolis tomentosa(Roxb.)	*Jyestha madhu*	1.25	0.283	5	0.081	1.000	0.968	1.332
Combretum decandrum Roxb.	*Kala Atundi*	1.25	0.283	5	0.081	1.000	0.968	1.332
Achyranthes aspera L.	*Apa maranga*	1.25	0.283	5	0.081	1.000	0.968	1.332

Table 2. Contd.

Smilax macrophylla Roxb.Fl	*Muturi*	1.25	0.283	5	0.081	1.000	0.968	1.332
Mimosa himalayana Gamble,Kew	*kirki koli kanta*	1.25	0.283	5	0.081	1.000	0.968	1.332
Grewia tillifolia Vahl,Symb	*Kulutha*	1.25	0.283	5	0.081	1.000	0.968	1.332
Flacourtia jangomas (Lour.Raeusch.Nom)	*Mambuli Kuli*	1.25	0.283	5	0.081	1.000	0.968	1.332
Shorea robusta Gaertn.f.Fruct	*Sal*	1.25	0.283	5	0.081	1.000	0.968	1.332
Sida rhombifolia L..Sp.Pl	*Bajramuli*	1.25	0.283	5	0.081	1.000	0.968	1.332

Total Indi.-Total number of individuals, A-Basal Area, Freq-Frequency, RD-Relative Density,RF-Relative Frequency,RBA-Relative Basal Area, IVI-Important Value Index.

Table 3. Species, density, basal area, frequency, distribution pattern and Importance Value Index (IVI) of Herbs and seedling species of a peripheral site of Hadagarh Sanctuary.

Name of Species	Local Name	Frequency	RF	density/m2	RD	Abundance	RA	IVI
Cynodon dactylon L.Sp.Pi	*Duba Ghasa*	23.75	13.768	2.175	30.000	9.158	21.936	65.704
Arundo donax L.	*baunsapatri grass*	31.25	18.116	1.575	21.724	5.040	12.072	51.912
Mimosa pudica L.	*Lajkuli lata*	33.75	19.565	1.250	17.241	3.704	8.871	45.678
Sida rhombifolia L..Sp.Pl	*Bajramuli*	16.25	9.420	0.438	6.034	2.692	6.449	21.904
Blumea lacera(Burm.f)	*Pokasungha*	13.75	7.971	0.438	6.034	3.182	7.621	21.627
Pachyrrhizus sp DC Rich.ex	*Sankha Saga*	13.75	7.971	0.388	5.345	2.818	6.750	20.066
*Andrographis paniculata(*Burm.f)Wall.ex	*Bhuin neemba*	15	8.696	0.363	5.000	2.417	5.789	19.484
Lygodium flexuosum (L.) Sw.J	*Mahajala*	8.75	5.072	0.225	3.103	2.571	6.159	14.335
Ageratum conyzoides L.Sp.Pi	*Bok sunga/ Deksingi*	3.75	2.174	0.100	1.379	2.667	6.387	9.941
Solanum insanum L.Mant.Pl	*Kanta Baigana*	5	2.899	0.113	1.552	2.250	5.389	9.840
Sida acuta Burm.f	*Sunakhadika*	5	2.899	0.113	1.552	2.250	5.389	9.840
Cassis oxidentalis L.Sp.Pi	*Kala Chakunda*	2.5	1.449	0.075	1.034	3.000	7.186	9.670

Total Indi.-Total number of individuals, BA-Basal Area, Freq-Frequency, RD-Relative Density,RF-Relative Frequency,RBA-Relative Basal Area, IVI-Important Value Index.

These species have shown good regeneration pattern in some of the areas of the study. Therefore, it is important that anthropogenic activities in this area like overgrazing, encroachments, illegal felling etc need to be curtailed suitable intervention (WP, 2008, 2017).

Despite having the status of a protected area of the country; the vegetation needs more attention from the habitat conservation point of view. The area needs management intervention for speedy regeneration of plant species. The phyto-sociological analysis reveals good generation potential of the habitat and the tree species having low IVIs , tree saplings and seedlings deserve due attention to ensure strict enforcement of the rules and better monitoring for enhancement of ecosystem stability of this protected area. For addressing forest management issues of the sanctuary, collection and analysis of long term ecological data by scientific baseline studies covering all structural parameters will be helpful to know the present state of ecological health of the ecosystem. Various forms of anthropogenic pressures have affected the habitat which include

logging, illegal hunting, and other development challenges like mining in peripheral areas. The conservation efforts as per working (management) plan prescriptions have not so far yielded desired result. Therefore, for a sustainable ecosystem and community management and for reducing biotic pressure, the management methodology also needs to be modified for developing a Long Term Research Network to ensure improvement in. structure and function of ecosystem.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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