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Ecological and conservation study of shrubs in Mukundpur forest area, Satna district, Madhya Pradesh

Prachi Singh, Sherendra K Sahu, PK Singh and Neeta Singh

Abstract

Mukundpur forest range is situated in Amarpatan Tahsil of Satna district of Madhya Pradesh India. This study area is under high ecological stress for mining purposes. For assessment of biodiversity vegetation sampling was done. The calculation of frequency, density and IVI (Important value Index) for the species of shrubs have been done. The threat and conservation status is assessed by Normal Distribution Principle. In the present study the 28 shrubs species have been found. There are no species of shrubs in Category-4. The 11 species which are Category-3 are Dhankat (*Greunia titifolia*), Menhar (*Randia dumetorum*), Siyari (*Nyctanthes arbur-tristis* (Linn)), Arjun (*Terminalia arjuna*), Subabul (*Leucaena leucophala*), kasai (*Bridelia squamosa*), kardhai (*A. pandula*), ratanjot (*Jatropha curcas*), kaligunja (*Abrus* spp), Achar (*Buchnanania lanzan*) and Baheda (*Terminalia bellarica*). Kaligunja (*Abrus* spp) is shrub species which is in the list of vulnerable status by MP Biodiversity board for Vindhyan region and it is in category 3 of threat and conservation status of IVI results. This species should be cared and its seed production behavior and phenology should be monitored regularly to save it for future extinction in wild. Its seed should be protected and tried for future germination in nursery..

Keywords: IVI, Normal Distribution Principle, Frequency class, Raunkier's frequency law, Threat and Conservation Categories

Introduction

India, a land of physical, cultural, social and linguistic diversity is endowed by nature with enormous biological diversity. As a result India ranks amongst one of the 12 mega biodiversity countries of the world and harbors 17,000 flowering plant species. It accounts for 8% of the global biodiversity with only 2.4% of the total land area & the world (Hajara and Mudgal 1997 and Reddy 2008) [7, 23].

A complete picture of threatened status, vulnerability and microclimate are yet has been determined. Conservation status is not properly documented till now. The present work has been taken to assess all relevant information on this aspect. An Assessment of threatened plants of India has been made by Jain and Rao (1983) [8]. Biodiversity Threat assessment of Vindhyan region of Madhya Pradesh has been made by Myres (1988) [13]; Nayar and Sastry (1987, 1988 & 1990) [15-17]; Nautiyal, *et al.* (2003) [14].

Conservation of Threatened species is important for maintaining the ecological balance of the habitat. Conservation of rare and endangered species of India as well as in different parts of world have been popularized through the propagation and preservation of these plant species in the botanical gardens or in the natural habitat. Conservation and economic evaluation of Biodiversity has been done by Nayar, *et al.* (1997) [18]. Status and conservation of rare and endangered medicinal plant in the Indian Trans-Himalaya has been made by Bush (1996) [3]; Kala (2000) [10]; Ayyad, *et al.* (2000) [2]; Okigbo & Ogbogu (2008) [19]; Soetan & Aiyelaagbe, *et al.* (2009) [24]; Dubey, *et al.* (2010) [4]; Oladele, *et al.* (2011) [20].

The studies on threatened medicinal plants of Andhra Pradesh and forest type have been made by Reddy, *et al.* (2001) [21] and Reddy (2007) [22]. National special biodiversity assessment and the use of forest inventory data for a national protected area strategy in Guyana have been made by Tersteeg (1998) [25] and Turpie (2004) [26]. In Madhya Pradesh the forest are of various types and they provide diversity of vegetation. The varied nature of forests needs a thorough investigation of the soil, climate, bio-geochemical nature and Characteristics of vegetation.

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In Satna district of the Madhya Pradesh, observation of Medicinal Importance of Sacred Plants of Chitrakoot Region Satna (M.P.) Lipika Devi Bala, Ravindra Singh (2015) [11]. This study discussed the 13 sacred plants species which are medicinally used by the tribes of Chirtakoot region district Satna, Madhya Pradesh. The local people believe in the efficacy of these herbs along with some divine power, but the knowledge is restricted to very few elderly folks only. The headquarters of Mukundpur range is in Mukundpur village, situated in Amarpatan Tahsil of Satna district in the state of Madhya Pradesh, India. The first white tiger safari is established at this village.

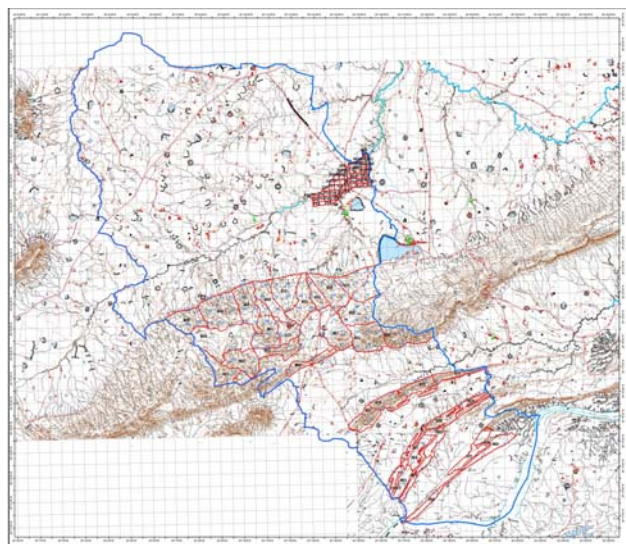
The one of the mandate of this zoo and safari is to establish a small research centre for identification and propagation of various species of medicinal plants naturally occurring in adjoining forest areas.

The Mukundpur range is surrounded by mining areas of bauxite, limestone. The nearby located cement factories are always in search of new areas, besides exploiting existing known areas. These houses may obtain non forest land as compensatory forest land in other district of Madhya Pradesh for diversion. The emission of CO₂ in cement manufacturing across the world accounts for 5% of global CO₂ emission due to intensive and extensive mining activities. Thus area is encountering impact of temperature rise, industrialization, desertification, shifting in the growing seasons of plants, loss of pollinators and seed dispersers, causing extinction of precious plants. Thus area of Mukundpur range will confine to be remained under high ecological stress zone in near future.

Looking at the above reasons, objectives is the identification, characterization, documentation and compilation of data base of threatened and endangered plant and their study of taxonomy, ecology and physiology, exploration of basic and commercial utility of endangered plants.

2. Study Area

Mukundpur region mainly comprises the present area of Mukundpur range of Satna forest division. The range has geographical area of 589.71 km² with forest area 111.55 km². The area lies between north latitude of 24°11'35" to 24°26'25" and east longitude of 81°06'35" to 81°22'20". The famous world white tiger safari is also situated in northern side of this range.



The forest area of this range exists in 7 forest blocks namely Mand, Govindgarh extension, Papra, Jhinna, Sarhai, Kokahansar and Mankesar. The forest blocks of Govindgarh extension and papra extend in Satna and Rewa forest districts. The part of Mankesar forest block lies in submerged area of Bansagar dam.

Northern boundary lies with Beehar River demarcating Satna and Rewa district. The forest of Mand reserve is situated in this area where first white tiger safari is established. Eastern boundary lies mainly with the district boundaries bifurcating Rewa and Satna districts. The famous Charaki ghati forms one of its boundaries. Southern boundary lies mainly with submerged area of Son River and it extends to district boundaries of Shahadol and Satna districts.

3. Material and Method

For the assessment of biodiversity of Mukundpur region, the vegetation sampling was done for the trees, shrubs, herbs, climbers, grasses and tubers. Stratified systematic random sampling method was used for sampling the vegetation Anon (1996) [1]. For determining minimum number of sample points, the formula used is $n = \frac{E^2}{p(1-p)}$ where E= difference

between population proportion mean and sample proportion average, p = population proportion, q= 1- p, z=1.96 for a level of significance of 95% Elhance D.L. (1994) [5].

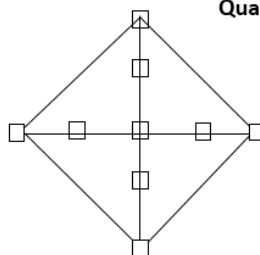
Based on the secondary data from Mukundpur range and Satna forest division, the sample size for various tree parameters i.e. number of trees per hectare, volume per hectare and established regeneration per hectare was calculated at 10% error (E) between population and sample proportion at 95% level of significance keeping in view time and other resources Jain Atul kumar, IFS (2008) [9].

Minimum 95 numbers of sample points were calculated from the above formula to assess the vegetation. The forest maps of Mukundpur range on survey of India topo sheet is of the scale of 1:15000. The grids at 35"x 35" and 30"x30" intervals are drawn by trial and error, for systematic random sampling. The 111 and 151 random points were recorded on above grid. The 151 sample points at 30"x 30" were selected on safer side, so that points may fall in river bed, submergence and encroachments. The longitudes and latitudes of 151 points were noted and listed from topo sheets.

Each sample points were located on ground with the help of GPS.

Sample plot area 0.16 or 0.1 ha

Quadrat of size 2 m x 2m, 9 in number



At each sample points, the layout of sample plot of 0.16 hectare with 9 quadrat of 2mX2m on ground was done with the help of prismatic compass Anon (1996) [1]. At these points recording of data of the girth and species of the trees, along with species of shrubs, climbers and tubers (numbers) were

taken on whole sample plot of 0.16 hectare and data for species of herbs, grasses and established regeneration was recorded at each 9 quadrat of 2mX2m. The Microsoft access program was developed to calculate the number, regeneration of trees per hectare and volume in m³ per hectare by using local volume table, prepared for Satna forest division, the results were analyzed with this program. The calculation for the density, frequency and IVI of the all species of shrubs was done with same program Mishra R. (1968) [12]. All the IVI for all the species was summarized in decreasing order and analyzed further to assess the conservation and protection status of species by using the NORMAL DISTRIBUTION PRINCIPLE Elhance D.L. (1994) [6].

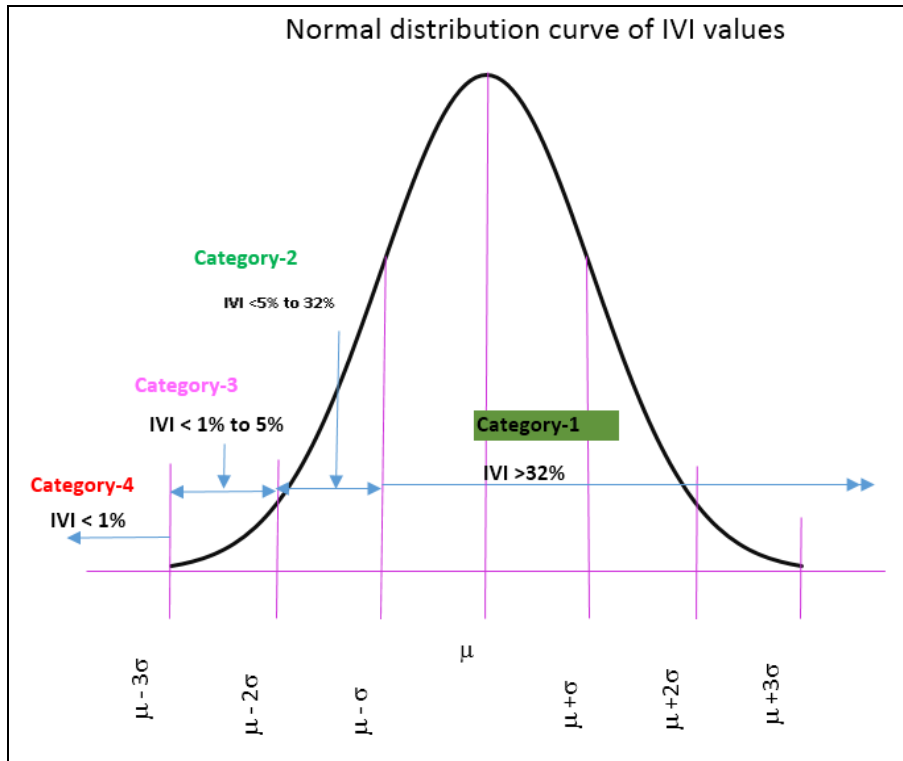
Principle is as under

μ = mean of IVI of all species, σ = standard deviation of IVI,

Then normal distribution principal states that there should be:-

- (a) 68% of total number of species whose IVI is between $\mu + \sigma$ and $\mu - \sigma$.
- (b) 95% of the total number of species whose IVI is between $\mu + 1.96\sigma$ and $\mu - 1.96\sigma$.
- (c) 99% of the total number of species whose IVI is between $\mu + 2.58\sigma$ and $\mu - 2.58\sigma$.

For safer evaluation for IVI, for conditions (b) and (c) $\mu - 2\sigma$ to $\mu + 2\sigma$ and $\mu - 3\sigma$ to $\mu + 3\sigma$ have been calculated and used in further study. Now again here, μ is the population mean and is equivalent to sample average and σ is population standard deviation and here for sample it is replaced by σ/\sqrt{n} i.e. standard error(SE).



Now, with the help of this principle, categorization is done as follows:

- $IVI < \mu - 3\sigma$ (species having IVI less than 1%) - category 4.
- $\mu - 3\sigma \leq IVI < \mu - 2\sigma$ (species having IVI between 1 to 5%) - category 3.
- $\mu - 2\sigma \leq IVI < \mu - \sigma$ (species having IVI between 5 to 32%) - category 2.
- $IVI \geq \mu - \sigma$ (species having IVI greater than 32%) - category 1

The species in category 4 require highest degree of protection. The species in category 3 require lesser protection than category 4. The species in category 2 require lesser protection than category 3. The species in category 1 require least protection and are available in plenty and they are available for harvesting.

4. Result and Discussion

4.1 Analysis of frequency and Density status of Shrubs.

Based on data collected on 143 grid points, shrub data is compiled and expressed in table 1 with their frequency and density.

Table 1

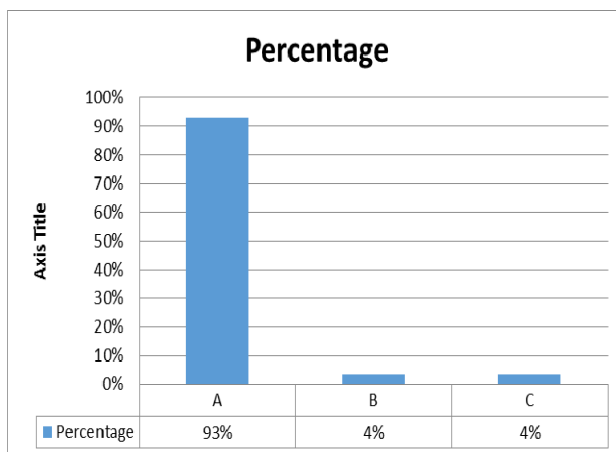
Type	S. No.	Species	Botanical Name	Density	Frequency
Shrub	1	Bhirra	<i>Chloroxylon swietenia</i>	7.82	13.99
Shrub	2	Kari	<i>Milusa tomentosa</i>	2.14	2.8
Shrub	3	Achar/Charoli	<i>Buchmania.lanzan</i>	0.13	0.7
Shrub	4	Kasai	<i>Bridelia.Squamosa</i>	0.48	0.7
Shrub	5	Ghont /Ghatore	<i>Zizyphus xylophyra odoratissima</i>	4.85	5.59
Shrub	6	Amaltas	<i>Cassia fistula</i>	5.77	4.2
Shrub	7	Bel	<i>Aegle marmelos</i>	16.52	3.5
Shrub	8	Bahada	<i>Terminalia bellarica</i>	0.04	0.7
Shrub	9	Arjun/kahu	<i>Terminalia arjuna</i>	1.79	0.7
Shrub	10	Marodfali	<i>Helicterus isora</i>	131.64	19.58
Shrub	11	Menhar	<i>Randia dumetorum</i>	2.23	1.4
Shrub	12	Kardhai-	<i>A. pandula</i>	0.35	0.7
Shrub	13	Ber	<i>Zizyphus mauritiana</i>	9.62	4.2
Shrub	14	Dhawai	<i>Woodfordia fruticosa</i>	55.86	5.59
Shrub	15	Kuretha	<i>Holorhena antidysentrica</i>	52.67	15.38
Shrub	16	Karonda	<i>Carissa spinarum</i>	68.84	20.28
Shrub	17	Siyari	<i>Nyctanthes arbour-tristis (Linn)</i>	5.24	0.7
Shrub	18	SuBabool	<i>Leucaena leucophala</i>	0.79	0.7
Shrub	19	Sitafal	<i>Annonasquamosa</i>	3.67	2.1
Shrub	20	Bans	<i>dendrocalemus strictus</i>	54.5	19.58
Shrub	21	Ratanjot	<i>Jatropha curcas</i>	0.22	0.7
Shrub	22	Lentana	<i>Lantana camara</i>	560.8	54.55
Shrub	23	Makoy	<i>Solanum nigrum</i>	14.55	5.59
Shrub	24	KAITHA	<i>Feronia elephantum</i>	5.77	3.5
Shrub	25	DATUN	<i>Artemisia vulgaris</i>	19.49	1.4
Shrub	26	AKOL	<i>Alanium spp</i>	37.24	4.2
Shrub	27	KALIGUNJA	<i>Abrus spp</i>	0.17	0.7
Shrub	28	DHANKAT	<i>Greunia titifolia</i>	0.44	2.1
			Total	1064	
			Average :	37.99	6.99
			Std :	106.73	11.24

The data shows that some of the species are appearing in both trees and shrub. Those tree species which forms the habit of shrub is also appearing as a shrub. There are 28 shrub species are observed. The most frequent species of shrubs are Lantana (*Lantana camara*), Marodfali (*Helicterus isora*), Karonda (*Carissa spinarum*). The study of shrubs indicate that whole forest area of Mukundpur range is infested with Lantana (*Lantana camara*) invasion and that is to be checked for the appearance of the growth of the shrub species of less presence.

When we categories the frequency of shrub in to various frequency classes to verify the Raunkier law of frequency distribution status of various frequency classes are presented below:-

Table 2

Frequency Class	Number of species in Class	Percentage of species in a class from total number of species
A frequency $\leq 20\%$	26	93%
B frequency 21 to 40%	1	4%
C frequency 41 to 60%	1	3%
D frequency 61 to 80%	0	0
E frequency 81 to 100%	0	0
Total	28	100%



Frequency class D and E are missing from the stand. Raunkier frequency law does not hold good for Shrub Categories ($A > B > C \geq D < E$) as there are no species in D and E classes. The 93% of the total shrub species are in frequency class A. This uneven distribution may be due to Lantana (*Lantana camara*) invasion in Mukundpur area. This Lantana (*Lantana camara*) species prevents the other species to compete in forest area. This may be the cause that some of the shrub species are not converting into tree species and remain in shrub forms.

4.2 Evaluation of IVI of each shrub species

IVI study is presented in table 5.18 with their relative frequency, relative density and IVI.

Table 3

S.N.	Species	Botanical Name	Relative Density	Relative Frequency	IVI	Cat
1	Lantana	<i>Lantana camara</i>	52.73	27.86	80.59	CAT-1
2	Marodfali	<i>Helicterus isora</i>	12.38	10	22.38	CAT-1
3	Karonda	<i>Carissa spinarum</i>	6.47	10.36	16.83	CAT-1
4	Bans	<i>Dendrocalemus strictus</i>	5.12	10	15.12	CAT-1
5	Kuretha	<i>Holorhena antidysentrica</i>	4.95	7.85	12.8	CAT-1
6	Dhawai	<i>Woodfordia fruticosa</i>	5.25	2.85	8.1	CAT-1
7	Bhirra	<i>Chloroxylon swietenia</i>	0.74	7.14	7.88	CAT-1
8	AKOL	<i>Alanium spp</i>	3.5	2.14	5.64	CAT-1
9	Makoy	<i>Solanum migrum</i>	1.37	2.85	4.22	CAT-1
10	Bel	<i>Aegle marmelos</i>	1.55	1.79	3.34	CAT-2
11	Ghont /Ghatore	<i>Zizyphus xylophyra odoratissima</i>	0.46	2.85	3.31	CAT-2
12	Ber	<i>Zizyphus mauritiana</i>	0.9	2.14	3.04	CAT-2
13	Amaltas	<i>Cassia fistula</i>	0.54	2.14	2.68	CAT-2
14	DATUN	<i>Artemisia vulgaris</i>	1.83	0.71	2.54	CAT-2
15	KAITHA	<i>Feronia elephantum</i>	0.54	1.79	2.33	CAT-2
16	Kari	<i>Milusa tomentosa</i>	0.2	1.43	1.63	CAT-2
17	Sitafal	<i>Annona squamosa</i>	0.35	1.07	1.42	CAT-2
18	DHANKAT	<i>Greunia titifolia</i>	0.04	1.07	1.11	CAT-3
19	Menhar	<i>Randia dumetorum</i>	0.21	0.71	0.92	CAT-3
20	Siyari	<i>Nyctanthes arbur-tristis (Linn)</i>	0.49	0.36	0.85	CAT-3
21	Arjun/kahu	<i>Terminalia arjuna</i>	0.17	0.36	0.53	CAT-3
22	SuBabool	<i>Leucaena leucophala</i>	0.07	0.36	0.43	CAT-3
23	Kasai	<i>Bridelia.Squamosa</i>	0.05	0.36	0.41	CAT-3
24	Kardhai-	<i>A. pandula</i>	0.03	0.36	0.39	CAT-3
25	Ratanjot	<i>Jatropha curcas</i>	0.02	0.36	0.38	CAT-3
26	KALIGUNJA	<i>Abrus spp</i>	0.02	0.36	0.38	CAT-3
27	Achar/Charoli	<i>Buchnania.lanzan</i>	0.01	0.36	0.37	CAT-3
28	Bahada	<i>Terminalia bellarica</i>	0	0.36	0.36	CAT-3
				Average :	7.14	
				Std :	15.49	
				Sqrt :	5.291502622	
				StdErr :	2.927606303	

As for as the shrub species are concerned, the basal or girth measurement was difficult and impractical large area of forests so it was avoided. Only frequency and density is evaluated and results are presented in table 5.18.

The first five species having highest IVI are Lantana (*Lantana camara*), Marodfali (*Helicterus isora*), Karonda (*Carissa spinarum*), Bans (*Dendrocalemus strictus*) and kuretha (*Holorhena antidysentrica*). The first five species of lowest IVI are Baheda (*Terminalia bellarica*), Achar (*Buchnania.lanzan*), Kaligunja (*Abrus spp*) and Ratanjot (*Jatropha curcas*). The species of Lantana (*Lantana camara*) evades and check the growth of Baheda (*Terminalia bellarica*) and Achar (*Buchnania.lanzan*) trees and these tree species remain in shrub category.

4.3 Assessment of shrub species for conservation and threat status

The 9 species are exists in this list of category 1. The species are Lantana (*Lantana camara*), Marodfali (*Helicterus isora*), Karonda (*Carissa spinarum*), Bans (*Dendrocalemus strictus*), kuretha (*Holorhena antidysentrica*), Dhawai (*Woodfordia fruticosa*), Bhirra (*Chloroxylon swietenia*), Akol (*Alanium spp*), and Makoy (*Solanum migrum*). These species do not require any protection. But Lantana (*Lantana camara*) should be eradicated on massive scale.

The 8 species are observed in category 2. These species are Bel (*Aegle marmelos*), Ghont (*Zizyphus xylophyra odoratissima*), Ber (*Zizyphus mauritiana*), Amaltas (*Cassia fistula*), Datun (*Artemisia vulgaris*), Kaitha (*Feronia elephantum*), Kari (*Milusa tomentosa*) and Sitafal (*Annona squamosa*). These species require more protection compare to Category 1 species.

There are 11 species in the list of category3. These are Dhankat (*Greunia titifolia*), Menhar (*Randia dumetorum*), Siyari (*Nyctanthes arbur-tristis (Linn)*), Arjun (*Terminalia arjuna*), Subabul (*Leucaena leucophala*), kasai (*Bridelia. Squamosa*), kardhai (*A. pandula*), ratanjot (*Jatropha curcas*), kaligunja (*Abrus spp*), Achar (*Buchnania.lanzan*) and Baheda (*Terminalia bellarica*). These species require more protection then category 2 species as most of tree species remain in bushy and remain in shrub status.

Hence there should be some silvicultural treatment to improve the species of Baheda (*Terminalia bellarica*), Achar (*Buchnania.lanzan*) and kardhai (*A. pandula*). There are no species occurring in this category 4.

5. Conclusion

There are no species under this category 4. Hence no species exists in this endangered category. There are 11 species classified under the category3. These are Dhankat (*Greunia titifolia*), Menhar (*Randia dumetorum*), Siyari (*Nyctanthes arbur-tristis (Linn)*), Arjun (*Terminalia arjuna*), Subabul (*Leucaena leucophala*), kasai (*Bridelia.Squamosa*), kardhai (*A. pandula*), ratanjot (*Jatropha curcas*), kaligunja (*Abrus spp*), Achar (*Buchnania.lanzan*) and Baheda (*Terminalia bellarica*). These species have more threat than category 2 species and they are in danger zone of extinction. Their in-situ and ex-situ cultivation can be promoted by removing the Lantana (*Lantana camara*) and Vantulshi (*Ocimum basilicum*).

Hence there should be some silvicultural treatment to improve the species of Baheda (*Terminalia bellarica*), Achar (*Buchnania.lanzan*) and kardhai (*Anogeissus pandula*). Some of the tree species like Dhawai (*Woodfordia fruticosa*),

Bhirra (*Chloroxylon swietenia*), Achar (*Buchnanania lanzan*), Arjun (*Terminalia arjuna*), Kari (*Milusa tomentosa*), Sitafal (*Annona squamosa*), Bel (*Aegle marmelos*), Ber (*Zizyphus mauritiana*), Amaltash (*Cassia fistula*) and Kardhai (*A. pandula*) are appearing as shrub in survey due to definition of shrubs but these species are under heavy invasion of Lantana (*Lantana camara*) and they are not able to grow as a tree.

MP Biodiversity board has suggested the list for RET species of shrubs for Vindhyan region. The major species of shrubs which is under endangered category for Vindhyan region is Marodfali (*Helicterus isora*). Though, in IVI results their presence and dominance are high in Mukundpur range as it qualifies under conservation and threat status of category 1. Thus this area can be source for Marodfali (*Helicterus isora*) species and this area should be well demarcated and trees should be marked. In Vindhyan region this species is under critically endangered status while for Mukundpur range it is found in abundance and this area can be source of extraction of Marodfali (*Helicterus isora*) seeds as its IVI high i.e. its presence and dominance is high.

The Kuretha (*Holorhena antidysenterica*) and Baheda (*Terminalia bellarica*) is discussed in discussion of tree species hence repetition is avoided here.

Kaligunja (*Abrus spp*) is shrub species which is in the list of vulnerable status by MP Biodiversity board for Vindhyan region and it is in category 3 of threat and conservation status of IVI results. This species should be cared and its seed production behavior and phenology should be monitored regularly to save it for future extinction in wild. Area in Mukundpur forest range should be well demarcated and species should be marked for future protection and care. Its seed should be protected and tried for future germination in nursery.

6. Acknowledgement

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