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Regeneration and Species Status in Bhoramdeo Wildlife Sanctuary of Chhattisgarh, India under Different Anthropogenic Disturbance Regimes

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ABSTRACT
The present work is done in the protected area of Kawardha (Bhoramdeo Wildlife Sanctuary) forest division (Chhattisgarh), India to assess the abundance, species distribution and regeneration status under different level of disturbance regimes. The floristic survey was done in three circles of sanctuary each having three levels of disturbance regimes. A total of 43 species across the sanctuary area were encountered. Overall highest species were recorded in Jamunpani circle (31) followed by Bhoramdeo (30) and Salhewara circle (25). The sapling layer reflected 36 different species across the circle in different sites of the sanctuary area. A sum of 30 species was documented in the seedling layer among the different sites and circle of the sanctuary area. The species richness across the site showed least diversity for Salhewara circle. The rare class was prevalent in the sanctuary area and the species with high occurance was almost negligible. The regeneration potential was found to be decreased as the level of anthropogenic disturbances increased. The findings of the study reflected differences in abundance, species distribution and regeneration status in highly disturbed sites compared to least disturbed site in different circle. Therefore, proper monitoring, documentation and subsequent management implication is needed for the conservation of these valuable forest resources.
***Keywords*:** *Abundance, disturbance regimes, regeneration status, species richness*

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INTRODUCTION

Tropical forests are one among the richest and complex terrestrial ecosystems, consists a variety of life forms and have a tremendous intrinsic ability for self-maintenance. However, many of these forests are losing this ability due to existing pressure of excessive biotic interference [1-6]. The depletion of forest resources in the dry tropics of India seems to be substantial and the precise data base on this aspect is lacking. Shrinking of tree species due to various disturbances especially in species poor system will influence the integrity of local forest ecosystem and will tend to lead genetic impoverishment of species and decline of forest area and its quality into a considerable level [7-8].

Various factors like forest fire, grazing, trampling, removal of forest floors etc. affect the forest regeneration and subsequently endangering the future forest stand. In India context destruction of habitat, over exploitation, introduction of species and pollution are recognized as prime causes of biodiversity loss [9]. Various factors influence the natural regeneration regimes and subsequent survival of seedlings in forest ecosystems. The success of natural regeneration is governed by seed factors or regenerative propagules of the species [10]. Furthermore, disturbances either by natural of anthropogenic means in a stand can leads towards alteration in species richness and vegetation mix. Assessment of regeneration of forest is essential towards find out the actual condition of forests either they are in progression or in retrogression. The information related to these aspects is essential towards forest management and conservation priority. Therefore, the present study was carried out to quantify the floristic richness, species abundance and regeneration status under different anthropogenic disturbance regimes of Bhoramdeo wildlife sanctuary.

MATERIAL AND METHODS

The present study was conducted in the sanctuary area (Bhoramdeo wildlife sanctuary), placed in Kawardha district (C.G.), India. The sanctuary area is located at 21º23'-22º00' N latitude and 80º58'-82º 34' E longitudes. The sanctuary area possesses rich and wide floral and faunal diversity. Therefore, it is known as an important protected area from tourism point of view and well connected with Kanha national park. The topography of the sanctuary is undulating which falls in Maikal range of Satpura hills. The altitude of the area ranges upto 900 m from the sea level. The climate of the region is characterized as dry tropical and comprised of more than 1000 mm average annual precipitation. The forest of the sanctuary area reflected wide vegetation diversity and forest types. Natural forest in addition to the plantations mainly occupy in the region [11, 5-6].

The experiment was carried out in three circles (Bhoramdeo, Jamunpani and Salhewara) of the sanctuary area which comprised of three levels of disturbance regimes (high, medium and low severity) in each circle. The floristic survey was done after marking of 1 hectare permanent plot in each site of the circle. The tree and sapling were enumerated within the quadrat sized of 10 m x 10m while the seedling was measured within the 2m x 2m sized quadrats. All the vegetation were documented and recorded at species level. Then the collected data were analysed for quantitative parameters such as frequency, abundance and density [12]. Further vegetation data were examined for the assessment of species rarity or commonness in the sanctuary area by using frequency class [13]. In this classification, the percentage frequency of the species was classified as A, B, C, D, and E, where A represents rare, B represents low frequency, C represents intermediate frequency, D represents moderately high frequency, and E represents high frequency or common [13]. Regeneration status of vegetation in different sites and circle was assessed through the population size of seedling and sapling [14].

RESULTS AND DISCUSSION

A total of 43 species across the sanctuary area were encountered. The highest species were recorded in Jamunpani circle (31) followed by Bhoramdeo (30) and Salhewara circle (25). The species richness across the site showed least diversity for Salhewara circle.

In case of tree layer a sum of 37 tree species were enlisted across the circle in different study sites. The maximum tree species was recorded under the Jamunpani circle (28) followed by Bhoramdeo (23) and least in the Salhewara circle (19), respectively. *Adina cordifolia*, *Bauhinia racemosa* and *Bauhinia variegata* species totally absent in Salhewara and Bhoramdeo circle and only found in moderately disturbed sites of Jamunpani circle. *Anogeissus latifolia* and *Bauhinia retiosa* species, *Boswellia serrata* were frequently found in the entire circle. *Bombax ceiba* was found only in moderately disturbed site of Bhoramdeo circle (Table 1).

The sapling layer reflected 36 different species across the circle in different sites of the sanctuary area (Table 2). The highest species were found jointly in Jamunpani and Bhoramdeo circle (23 species each) and least in the Salhewara circle (18 species), respectively. Among the all recorded sapling species it was found that about 50% species were not distributed over the Salhewara circle while the 36.11% species were not recorded both in Jamunpani and Bhoramdeo circle, respectively as compare to the total. The species such as *Bauhinia retiosa*, *Bauhinia variegata*, *Boswellia serrata*, *Casearia graveolens*, *Choloroxylon swietenia*, *Dalbergia latifolia*, *Dalbergia paniculata*, *Elaeodendron glancnnl*, *Ficus religiosa*, *Hymenodictylon orixens*, *Kydia calycina*, *Mitragyna parviflora*, *Saccopetalum tomentosum*, *Semicarpus anacardium*, *Shorea robusta*, *Sterculia urens*, *Sterculia villosa* and *Terminalia bellerica* were found to be totally absent in two circle.

A sum of 30 species was documented in the seedling layer among the different sites and circle of the sanctuary area (Table 3). The highest seedling species were recorded for Salhewara and Jamunpani circle (19 species each) while the least for Bhoramdeo circle (13 species). Species such as *Bauhinia retiosa*, *Bombax ceiba*, *Careya arborea*, *Casearia graveolens*, *Dalbergia latifolia*, *Elaeodendron glancnnl*, *Flacourtia indica*, *Gardenia resinifera*, *Garuga pinnata*, *Holarrhena pubescens*, *Hymenodictylon orixens*, *Pterocarpus marsupium*, *Saccopetalum tomentosum*, *Sterculia urens* and *Syzygium cumini* were found to be absent in two circle in seedling stage.

Table 4 showing the species rarity or commonness of the different species encountered in different circle among the different sites. The rare class was prevalent in the sanctuary area followed by low and intermediate occurance of the species. Moderately high occurrence were least and generally reported under the low to moderate disturbed site while in the high disturbed site it reflected nil or negligible representation. The species with high occurrence was almost negligible over the sanctuary area. In tree layer across the site and circle about 43.75-71.43% species of the respective total of the site were distributed in the rare category, while in the low occurance this value ranged from 7.69-37.50%, respectively. Further in the intermediate class 0-26.67% species were recorded whereas under the

category of moderately high 0-18.18% species were recorded. In the high abundance class 0-9.09% species were noticed. In sapling layer no single species was found under the category of high frequency class while in the seedling layer two species were recorded under the category of high frequency class.

The regeneration status in the sanctuary area reflected that the good regeneration ranged from 5.56-47.62%, fair regeneration from 4.35-27.78%, poor regeneration from 18.75-47.83% and species under the category of not regenerating from 5.26-50.0%, respectively across the circle and different sites under studied. The regeneration potential was found to be decreased as the level of anthropogenic disturbances increased (Table 5).

Under HDS (Heavily disturbed site) of Bhoramdeo circle only *Lagerstroemia parviflora*, has the good regeneration potential. In MDS (Moderately disturbed site) *Cassia fistula*, *Choloroxylon swietenia*, *Diospyros melanoxylon*, *Lagerstroemia parviflora*, *Lannea coromandelica* and *Terminalia chebula* were found to be have good regeneration status. In LDS (Lightly disturbed site) *Anogeissus latifolia*, *Buchanania lanzan*, *Choloroxylon swietenia*, *Diospyros melanoxylon*, *Lagerstroemia parviflora*, *Lannea coromandelica*, *Ougeinia oojeinensis*, *Sterculia urens* and *Terminalia chebula* were found to be good regeneration status. From the results it revealed that *Lagerstroemia parviflora* proliferate in considerable level in all the disturbance regimes of the Bhoramdeo circle. Therefore it can be recommended for the plantation due to its cosmopolite distribution, regeneration status and higher ecological amplitude over the Bhoramdeo circle.

In Jamunpani circle, *Cassia fistula* and *Diospyros melanoxylon* have good regeneration potential in HDS, whereas in MDS *Buchanania lanzan*, *Casearia graveolens*, *Cassia fistula*, *Diospyros melanoxylon*, *Lannea coromandelica* and *Saccopetalum tomentosum* were found to regenerate well. Under the LDS *Anogeissus latifolia*, *Casearia graveolens*, *Dalbergia latifolia*, *Diospyros melanoxylon*, *Lagerstroemia parviflora*, *Madhuca latifolia*, *Ougeinia oojeinensis*, *Schleichera oleosa* and *Terminalia tomentosa* were regenerating in good quantity. The species *Diospyros melanoxylon* were distributed commonly over this circle and also reflecting good population size under different disturbance regimes. Therefore this species can be recommended in Jamunpani circle for the protection, plantation and extension due to its wider distribution and adaptation under different site conditions.

Under the HDS in Salhewara circle, *Buchanania lanzan*, *Diospyros melanoxylon*, *Gardenia resinifera*, *Lagerstroemia parviflora*, *Ougeinia oojeinensis* and *Terminalia chebula* were found to have good regeneration status while in the MDS *Anogeissus latifolia*, *Bombax ceiba*, *Diospyros melanoxylon*, *Grewia tiliaefolia*, *Lagerstroemia parviflora*, *Ougeinia oojeinensis* and *Terminalia tomentosa* were reflected good regeneration potential. The species *Anogeissus latifolia*, *Buchanania lanzan*, *Diospyros melanoxylon*, *Elaeodendron glancnnl*, *Gardenia resinifera*, *Grewia tiliaefolia*, *Lagerstroemia parviflora, Shorea robusta*, *Terminalia chebula* and *Terminalia tomentosa* were possess good population in a stand under different life form in LDS of Salhewara circle. *Diospyros melanoxylon*, *Lagerstroemia parviflora* and *Terminalia* species can be recommended for the plantation programmes due to wider adaptability under different disturbance regimes.

Site condition and anthropogenic disturbance can influence the regeneration of forest species. The conversion of seedling into sapling and subsequently to tree class was found to get reduced due to disturbance. Similar findings were also reported for the tropics of Chhattisgarh India [2, 10]. The success of regeneration influenced by the ability to initiate new seedlings, ability of seedlings and saplings to survive and the ability of seedlings and saplings to grow in the given site in a specific period of time [15].

Table 1 Abundance and distribution of species under tree layer in different sites and circle of Bhoramdeo wildlife sanctuary

Species	Salhewara			Jamunpani			Bhoramdeo		
	HDS	MDS	LDS	HDS	MDS	LDS	HDS	MDS	LDS
Adina cordifolia Hook.f.	--	--	--	X	√	X	--	--	--
Anogeissus latifolia Wall.	X	√	√	√	√	√	√	√	√
Bauhinia racemosa Lam.	--	--	--	X	√	X	--	--	--
Bauhinia retiosa Roxb.	√	√	√	√	√	X	--	--	--
Bauhinia variegata Linn.	--	--	--	X	√	X	--	--	--
Bombax ceiba L.	--	--	--	--	--	--	X	√	X
Boswellia serrata Roxb.	√	√	√	X	X	√	√	√	√
Bridelia retiosa Roxb.	--	--	--	√	√	X	X	√	X
Buchanania lanzan Spreng.	√	√	√	X	√	√	X	√	X

Careya arborea Roxb.	--	--	--	X	√	X	--	--	--
Cassia fistula Linn.	--	--	--	√	X	X	√	X	X
Choloroxylon swietenia D.C.	--	--	--	--	--	--	X	√	√
Dalbergia latifolia Roxb.	--	--	--	√	X	√	--	--	--
Dalbergia paniculata Roxb.	--	--	--	--	--	--	√	√	X
Diospyros melanoxylon Roxb.	√	√	√	√	√	√	X	X	√
Elaeodendron glancnnl Pers.	X	X	√	--	--	--	X	X	√
Emblica officinalis L.	√	√	√	X	√	X	√	√	X
Flacourtia indica (Burm. f.)Merr.	--	--	--	--	--	--	√	X	X
Gardenia resinifera Roth.	√	X	√	X	X	√	--	--	--
Garuga pinnata Roxb.	--	--	--	X	X	√	√	X	X
Grewia tiliaefolia Vahl.	√	√	X	√	√	√	--	--	--
Hymenodictyon orixens (Roxb.) Mabb.	√	X	X	--	--	--	X	√	√
Kydia calycina Roxb.	--	--	--	√	X	X	X	√	X
Lagerstroemia parviflora Roxb.	√	√	√	√	X	√	√	√	√
Lannea coromandelica (Houtt.) Merr.	√	X	√	√	√	√	√	√	√
Madhuca latifolia Roxb.	X	√	X	X	X	√	√	X	√
Mimusops hexandra Roxb.	√	X	√	--	--	--	--	--	--
Mitragyna parviflora Roxb.	--	--	--	√	√	X	√	X	X
Ougeinia oojeinensis Benth.	√	√	√	√	√	√	√	X	X
Pterocarpus marsupium Roxb.	X	√	X	√	X	X	--	--	--
Saccopetalum tomentosum H.F &Thoms.	--	--	--	X	√	X	--	--	--
Schleichera oleosa Willd.	--	--	--	√	X	√	√	X	X
Semicarpus anacardium L.f.	--	--	--	X	X	√	--	--	--
Shorea robusta Roxb.	√	√	√	X	√	√	--	--	--
Sterculia urens Roxb.	--	--	--	--	--	--	X	X	√
Terminalia chebula Retz.	√	X	√	--	--	--	√	√	√
Terminalia tomentosa W&A.	√	√	√	√	√	√	--	--	--

Note: √ indicating presence of the species, X indicating absent of the species in particular site whereas – indicating totally absent of the species in respective circle

Table 2 Abundance and distribution of species under sapling layer in different sites and circle of Bhoramdeo wildlife sanctuary

Species	**Salhewara**			**Jamunpani**			**Bhoramdeo**		
	HDS	**MDS**	**LDS**	**HDS**	**MDS**	**LDS**	**HDS**	**MDS**	**LDS**
Adina cordifolia Hook.f.	X	X	√	X	√	X	√	√	X
Anogeissus latifolia Wall.	√	√	√	X	X	√	√	√	√
Bauhinia racemosa Lam.	--	--	--	X	√	X	--	--	--
Bauhinia retiosa Roxb.	√	√	X	X	√	X	--	--	--
Bauhinia variegata Linn.	--	--	--	X	√	X	--	--	--
Bombax ceiba L.	X	√	X	--	--	--	--	--	--
Boswellia serrata Roxb.	--	--	--	--	--	--	X	X	√
Buchanania lanzan Spreng.	√	√	√	X	√	√	X	X	√
Casearia graveolens Dalz.	--	--	--	X	√	√	--	--	--
Cassia fistula Linn.	--	--	--	√	√	X	X	√	X
Choloroxylon swietenia D.C.	--	--	--	--	--	--	X	√	√
Dalbergia latifolia Roxb.	--	--	--	√	X	√	--	--	--
Dalbergia paniculata Roxb.	--	--	--	--	--	--	X	√	X
Diospyros melanoxylon Roxb.	√	√	√	√	√	√	X	√	√

Elaeodendron glancnnl Pers.	X	X	√	--	--	--	--	--	--
Emblica officinalis L.	√	√	√	X	√	√	X	√	√
Ficus religiosa Linn	--	--	--	--	--	--	X	X	√
Flacourtia indica (Burm. f.)Merr.	X	√	X	--	--	--	√	X	X
Gardenia resinifera Roth.	√	X	√	--	--	--	√	√	X
Grewia tiliaefolia Vahl.	X	√	√	X	√	X	X	√	√
Hymenodictyon orixens (Roxb.) Mabb.	--	--	--	--	--	--	X	X	√
Kydia calycina Roxb.	--	--	--	X	√	X	--	--	--
Lagerstroemia parviflora Roxb.	√	√	√	√	X	√	√	√	√
Lannea coromandelica (Houtt.) Merr.	√	√	√	X	√	√	√	√	√
Madhuca latifolia Roxb.	X	X	√	X	X	√	X	X	√
Mitragyna parviflora Roxb.	--	--	--	X	X	√	--	--	--
Ougeinia oojeinensis Benth.	√	√	√	√	√	√	√	√	√
Saccopetalum tomentosum H.F &Thoms.	--	--	--	X	√	X	--	--	--
Schleichera oleosa Willd.	--	--	--	X	√	√	√	X	X
Semicarpus anacardium L. f.	--	--	--	X	X	√	--	--	--
Shorea robusta Roxb.	X	X	√	--	--	--	--	--	--
Sterculia urens Roxb.	--	--	--	--	--	--	X	X	√
Sterculia villosa Roxb.	--	--	--	--	--	--	X	X	√
Terminalia bellirica Roxb.	--	--	--	--	--	--	X	√	X
Terminalia chebula Retz.	√	X	√	X	√	X	X	√	√
Terminalia tomentosa W&A.	√	√	X	X	√	√	--	--	--

Note: √ indicating presence of the species, X indicating absent of the species in particular site whereas – indicating totally absent of the species in respective circle

Table 3 Abundance and distribution of species under seedling layer in different sites and circle of Bhoramdeo wildlife sanctuary

Species	**Salhewara**			**Jamunpani**			**Bhoramdeo**		
	HDS	**MDS**	**LDS**	**HDS**	**MDS**	**LDS**	**HDS**	**MDS**	**LDS**
Anogeissus latifolia Wall.	X	√	√	X	X	√	X	X	√
Bauhinia retiosa Roxb.	--	--	--	√	X	X	--	--	--
Bombax ceiba L.	X	√	X	--	--	--	--	--	--
Buchanania lanzan Spreng.	√	X	√	X	√	X	X	X	√
Careya arborea Roxb.	--	--	--	√	X	X	--	--	--
Casearia graveolens Dalz.	--	--	--	X	√	√	--	--	--
Cassia fistula Linn.	√	√	√	√	√	√	√	√	√
Choloroxylon swietenia D.C.	X	√	X	--	--	--	X	√	√
Dalbergia latifolia Roxb.	--	--	--	X	X	√	--	--	--
Diospyros melanoxylon Roxb.	√	√	√	√	√	√	√	√	√
Elaeodendron glancnnl Pers.	X	X	√	--	--	--	--	--	--
Flacourtia indica (Burm. f.)Merr.	X	X	√	--	--	--	--	--	--
Gardenia resinifera Roth.	√	√	√	--	--	--	--	--	--
Garuga pinnata Roxb.	X	X	√	--	--	--	--	--	--
Grewia tiliaefolia Vahl.	X	√	√	√	X	√	--	--	--
Holarrhena pubescens (Buch.-Hum.)	--	--	--	--	--	--	√	√	X
Hymenodictyon orixens (Roxb.) Mabb.	√	X	X	--	--	--	--	--	--
Kydia calycina Roxb.	--	--	--	X	X	√	X	X	√

Lagerstroemia parviflora Roxb.	√	√	√	X	X	√	√	√	√
Lannea coromandelica (Houtt.) Merr.	--	--	--	X	√	X	X	√	√
Madhuca latifolia Roxb.	X	√	X	X	X	√	--	--	--
Ougeinia oojeinensis Benth.	√	√	X	X	X	√	X	X	√
Pterocarpus marsupium Roxb.	√	X	X	--	--	--	--	--	--
Saccopetalum tomentosum H.F &Thoms.	--	--	--	X	√	√	--	--	--
Schleichera oleosa Willd.	--	--	--	X	X	√	X	√	X
Shorea robusta Roxb.	√	X	√	X	X	√	--	--	--
Sterculia urens Roxb.	--	--	--	--	--	--	X	√	√
Syzygium cumini (L.)	--	--	--	X	√	X	--	--	--
Terminalia chebula Retz.	X	√	√	--	--	--	X	√	√
Terminalia tomentosa W&A.	√	√	√	X	X	√	--	--	--

Note: √ indicating presence of the species, X indicating absent of the species in particular site whereas – indicating totally absent of the species in respective circle

Table 4 Distribution of vegetation layers according to Raunkiaer's classification scheme

Layers	Circle	Sites	A	B	C	D	E
Tree	**Bhoramdeo**	HDS	10	3	1	0	0
		MDS	9	1	1	2	0
		LDS	7	1	0	2	1
	Jamunpani	HDS	10	4	1	0	0
		MDS	10	2	4	0	1
		LDS	7	6	2	1	0
	Salehwara	HDS	8	4	2	0	1
		MDS	7	4	2	0	0
		LDS	7	3	4	0	1
Sapling	**Bhoramdeo**	HDS	7	0	0	1	0
		MDS	8	3	3	0	0
		LDS	10	3	2	1	0
	Jamunpani	HDS	4	0	1	0	0
		MDS	11	5	0	1	0
		LDS	9	3	2	0	0
	Salehwara	HDS	7	2	2	0	0
		MDS	5	3	3	1	0
		LDS	8	3	2	1	0
Seedling	**Bhoramdeo**	HDS	1	3	0	0	0
		MDS	4	2	1	2	0
		LDS	8	1	0	2	0
	Jamunpani	HDS	3	1	1	0	0
		MDS	3	2	0	2	0
		LDS	7	6	0	0	1
	Salehwara	HDS	7	1	2	0	0
		MDS	8	2	1	1	0
		LDS	7	3	1	1	1

Table 5 Regeneration status (%) of species in different forest circle followed by anthropogenic disturbance regimes

Circle	Site	Good regeneration	Fair regeneration	Poor regeneration	Not regenerating
Bhoramdeo	HDS	5.56	16.66	38.89	38.89
	MDS	26.09	13.04	34.78	26.09
	LDS	47.37	10.53	36.84	5.26
Jamunpani	HDS	12.50	18.75	18.75	50.00
	MDS	26.08	4.35	47.83	21.74
	LDS	40.90	22.73	22.73	13.64
Salehwara	HDS	33.33	27.78	22.22	16.67
	MDS	35.00	25.00	25.00	15.00
	LDS	47.62	14.29	23.80	14.29

CONCLUSION

A wide floral diversity was recorded in the different sites of the sanctuary area. The present findings report the vegetation abundance, distribution and regeneration status in the concerned study sites. Drastic reductions in different vegetation attributes were recorded as the intensity of the disturbances were increases in the different circle. Salhewara circle was found to be much degraded and affected due to the anthropogenic disturbances. Overall in the sanctuary area it was found that the most of the recorded species were rare in the occurance which have to be protect otherwise it will disappears as the progression of the time besides the different level and magnitude of the disturbance pressure. Further some species have good regeneration potential under different disturbance regimes. Screening of such species followed by afforestation and reforestation activity with the incorporation of such potential species may help towards the sustainable development of the forest stand

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