

NATURAL REGENERATION POTENTIAL OF MADHUPUR NATIONAL PARK, BANGLADESH

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Abstract

Natural regeneration is an essential tool to evaluate the overall health of a forest ecosystem. Natural regeneration of the tree species in Madhupur National Park showed 47 regenerating tree species among which *Shorea robusta* has maximum density (18,046 seedlings per ha) followed by *Aporosa* sp., whereas minimum density (19 seedling per ha) was recorded for *Cassia nodosa*, *Litsea glutinosa*, *Grewia asiatica* and *Syzygium cumini*, respectively. Relative density, relative frequency and relative abundance were estimated to assess the Importance Value Index (IVI) of the seedlings of different tree species. IVI of *S. robusta* was highest (66.25 out of 300) followed by *Mallotus philippensis* (27.33). *G. asiatica*, *Derris robusta*, and *L. glutinosa* showed the lowest IVI (0.93) among the regenerating tree species. Distribution of seedlings into different height classes showed that maximum number (31.4%) of seedlings in the height range of 50 - <100 cm. Among the recorded seedlings, *Protium serratum* showed maximum (11%) recruitment success. Alien invasive species, pineapple and banana based participatory agroforestry, frequent occurrence of fire, extensive collection of fuelwood and litter are the potential threats to the natural regeneration of Madhupur National Park.

Introduction

Natural regeneration is a natural biological process of forest resources reproduction in forest ecosystem. It caused the assessment of regeneration to be an authentic tool to know the overall condition of forest (Wang *et al.* 2008, Rahman *et al.* 2019). Through the natural regeneration process tree dominant plant communities developed and evolved, which has far reaching impact on the structure of forest (Han and Wang 2002). Moreover, regeneration is essential for conservation and maintenance of floral diversity in natural forests (Hossain *et al.* 2004, Rahman *et al.* 2011). Plants maintain and expand their populations in time and space through the regeneration process. This complex ecosystem process involves asexual and sexual reproduction, dispersal of seed and establishment seedlings in relation to environmental factors (Barnes *et al.* 1998). However, the pattern of population structure of woody plants can show the regeneration profile, which is used to determine their regeneration status (Taketay 1996).

Madhupur National Park (MNP), the oldest protected area (PA) comprises a significant part of tropical moist deciduous forest in the central region of Bangladesh. The forest patches of this PA are being encroached and degraded day by day mainly due to anthropogenic disturbances (Rahman *et al.* 2017). Prain (1903) emphasized the exploration of the Madhupur forests which occupies the major Sal forests of the country. Some studies were conducted in MNP or associated Sal forest to explore the flora with particular importance to tree flora i.e. Sattar (1977), Alam (1995), Harun-Or-Rashid and Mia (2001) and Malaker *et al.* (2010). But, no reports are available on the restoration potentials through natural regeneration. It is important to know the natural

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regeneration and recruitment of the regenerated seedlings along with their diversity and composition for undertaking and prioritizing management prescriptions. In this circumstance, the study was undertaken to explore the status of natural regeneration of MNP and compare the restoration potentials of this PA with other similar forests. Outcomes of the study is expected to be helpful to relevant policy makers and forest managers to decide and undertake species specific conservation measures for the seedlings of threatened or rare plants of this park.

Materials and Methods

Madhupur National Park located at 125 kilometers north of Dhaka covering the land area between 24°30' to 24°50'N latitude and 90°00' to 90°10'E longitude is situated on the western side of Tangail-Mymensingh main road (Rahman *et al.* 2017). Administration of the park is under the jurisdiction of Tangail Forest Division (Begum 2011). The park consists of an area of 8,436 ha (20,845.81 acre) of which 8,195.8 ha are under Madhupur Upazila of Tangail district and 240.2 ha are in Muktagacha Upazila of Mymensingh district. The Madhupur Garh forms a slightly elevated tract with maximum height of about 18 - 20 m (60 - 85 feet) from the mean sea level. The soil of Madhupur Sal forest is mixed with yellowish red sandy clay. The soil is compact and hard when dries but melts with the rainfall and becomes soft and tenacious (Mondol 2013).

The field survey was conducted in 4 forest beats of Madhupur National Park. To assess the regeneration status the field work was done through quadrat survey method from January, 2015 to June, 2016. Sample plot survey was fixed to 3 m × 3 m with the help of species area curve. A total of 58 sample plots were taken from all the four beats, e.g. Sadar beat, Lahoria and Gasabari beats of MNP Sadar range and Sadar beat of Dokhola range randomly. Position of each sample plot was recorded by a Ground Positioning System (GPS) device for future monitoring studies. Forest type and disturbance that affect the regeneration of the tree species were recorded for each sample plot. The seedlings were identified and counted by species as well as their heights were measured.

The recorded seedlings were identified in the field by their local or scientific names to the extent possible. Plant samples from the unknown seedlings were collected to prepare herbarium specimen. Taxonomists from the Department of Botany, University of Chittagong and the Bangladesh Forest Research Institute (BFRI) helped in identifying the unknown species.

The data were analyzed for assessing the regeneration composition, relative density (RD), relative frequency (RF), relative abundance (RA) and importance value index (IVI) for each species following Misra (1968), Dallmeier *et al.* (1992) and Shukla and Chandel (2000).

Results and Discussion

The native tree species were regenerating naturally through seeds, coppice and root suckers. The study revealed that 47 tree species belonging to 24 families and 42 genera were regenerating naturally. Physical observation indicated that most of the regeneration occurred from seed where a few were found to grow from coppices. However, the regeneration species composition is less than that of Dudhpukuria-Dhopachari Wildlife Sanctuary (120 species), Chunati Wildlife Sanctuary (105 species), Khadimnagar National Park and Tilagor Eco-Park of 55 species (Rahman *et al.* 2011, Hossain *et al.* 2013a, Hossain and Hossain 2014). But, the number of regenerating tree species is higher than that of Tankawati Natural Forest of Chittagong South Forest Division (29 tree species) (Motaleb and Hossain 2011) and Durgapur hill forest of Netrokona (27 tree species) (Rahman *et al.* 2019a). In addition, Deb *et al.* (2015) recorded the total regenerated understory species was 61 belonging to 27 families but it is not easy to compare with their findings because they have considered not only seedlings but also saplings. Disturbance in natural forests can change habitat suitability of plant species (Wilcox *et al.* 2006) which affects plant species

Table 1. Regenerating tree species with seedling density, frequency, abundance and importance value index (IVI) in Madhupur National Park

No.	Scientific name	Local name	Seedlings/ha	RD (%)	RF (%)	RA (%)	IVI
1	<i>Albizia procera</i>	SadaKoroi	77	0.18	0.47	1.31	1.95
2	<i>Antidesma ghaesembilla</i>	Chokoi	498	1.17	3.03	1.31	5.51
3	<i>Aporosa</i> sp.	Aporosa	3142	7.35	6.76	3.70	17.82
4	<i>Artocarpus lacucha</i>	Borta	38	0.09	0.47	0.65	1.21
5	<i>Bauhinia malabarica</i>	Choka kola	96	0.22	0.47	1.64	2.33
6	<i>Bridelia tomentosa</i>	Sitki	2165	5.07	6.29	2.74	14.10
7	<i>Careya arborea</i>	Gadila	517	1.21	1.86	2.21	5.28
8	<i>Cassia fistula</i>	Sonalu	153	0.36	1.40	0.87	2.63
9	<i>C. nodosa</i>	Bon-Sonalu	19	0.04	0.23	0.65	0.93
10	<i>Cleistocalyx nervosum</i>	Ludijam	153	0.36	0.47	2.62	3.44
11	<i>Cordia dichotoma</i>	Bohal	38	0.09	0.23	1.31	1.63
12	<i>Cryptocarya amygdalina</i>	Ojha	1303	3.05	4.66	2.23	9.94
13	<i>Derris robusta</i>	Katenga	96	0.22	0.70	1.96	2.88
14	<i>Dillenia pentagyna</i>	Ajuli	153	0.36	1.17	1.05	2.57
15	<i>Ficus hispida</i>	Dumor	77	0.18	0.47	1.31	1.95
16	<i>Garuga pinnata</i>	SadaJiga	268	0.63	1.63	1.31	3.57
17	<i>Glochidion multiloculare</i>	Chokoi	268	0.63	0.23	9.16	10.02
18	<i>Grewia asiatica</i>	Kapaia	19	0.04	0.23	0.65	0.93
19	<i>G. nervosa</i>	Datoi	1571	3.68	4.43	2.83	10.93
20	<i>G. serrulata</i>	Kholladamor	364	0.85	1.63	1.78	4.26
21	<i>Haldina cordifolia</i>	Haldu	153	0.36	0.47	2.62	3.44
22	<i>Hymenodictyon orixensis</i>	Bhutum	249	0.58	1.86	1.06	3.51
23	<i>Lagerstroemia parviflora</i>	Sidha	96	0.22	0.70	1.09	2.01
24	<i>L. speciosa</i>	Jarul	153	0.35	0.93	2.18	3.47
25	<i>Lannea coromandelica</i>	Jiga	211	0.49	1.17	1.44	3.10
26	<i>Litsea glutinosa</i>	Menda	19	0.04	0.23	0.65	0.93
27	<i>Mallotus philippensis</i>	Sinduri	3084	7.22	5.59	4.39	27.33
28	<i>Milusa velutina</i>	Gandhi gajari	364	0.85	2.80	1.04	4.69
29	<i>Mitragyna parvifolia</i>	Futikadam	115	0.27	0.47	1.96	2.70
30	<i>Oroxylum indicum</i>	Thona	939	2.20	5.13	1.46	8.78
31	<i>Phyllanthus emblica</i>	Amloki	153	0.36	1.17	1.05	2.57
32	<i>Protium serratum</i>	Neur	307	0.72	1.86	1.31	3.89
33	<i>Schleichera oleosa</i>	Kusum	402	0.94	1.86	1.72	4.52
34	<i>Semecarpus anacardium</i>	Bheula	192	0.45	1.40	1.09	2.94
35	<i>Shorea robusta</i>	Sal	18046	42.24	12.59	11.42	66.25
36	<i>Spondius pinnata</i>	Amla	96	0.22	1.17	0.65	2.04
37	<i>Sterculia villosa</i>	Udal	172	0.40	1.17	1.18	2.75
38	<i>Streblus asper</i>	Sheora	1284	3.00	3.73	2.74	9.48
39	<i>Suregada multiflora</i>	Suregada	153	0.36	0.47	2.62	3.44
40	<i>Syzygium cumini</i>	Kaloram	19	0.04	0.23	0.65	0.93
41	<i>S. fruticosum</i>	Putijam	210	0.49	1.63	1.96	4.09
42	<i>Tamilnadia uliginosa</i>	Pirilagota	594	1.39	2.09	3.10	6.59
43	<i>Terminalia bellirica</i>	Bohera	2490	5.83	4.66	4.25	14.75
44	<i>Vitex glabrata</i>	Baskura	77	0.18	0.70	0.87	1.75
45	<i>Wrightia arborea</i>	Dudhkuruch	421	0.99	2.80	1.20	4.98
46	<i>Zanthoxylum rhetsa</i>	Bajna	172	0.40	2.10	0.65	3.16
47	<i>Ziziphus rugosa</i>	Anaigota	96	0.22	0.93	0.82	1.97
Total			41,282	100	100	100	300

composition and ecosystem functions (Berhane *et al.* 2013). Human-induced disturbances and influences, such as logging, browsing and grazing can significantly modify species diversity and composition. As intensity and frequency of disturbance increases, the availability and abundance of many species could decline with increased risk of local extinction. More abundant and generalized species are less vulnerable to disturbance than rare and specialized species. Disturbance can also change the gap sizes in forest and alter species composition by encouraging pioneer plant species. Madhupur National Park is tremendously disturbed by the local people, but existing control measures are very inadequate to address the issues. As per the findings of the study, the number of species showed the suitability of the forest for regrowth if kept undisturbed.

Among the regenerating tree species, *S. robusta* (18,046 seedlings and saplings per ha) showed highest density followed by *Aporosa* spp. (3142 seedlings and saplings per ha), *M. philippensis* (3084 seedling per ha), and *T. bellirica* (2490 seedling per ha). Besides, minimum seedling density (19 seedling per ha) was recorded for *C. nodosa*, *L. glutinosa*, *G. asiatica* and *S. cumini*, respectively. The maximum relative density (42.24%) was recorded for *S. robusta* followed by *Aporosa* sp. (7.35%), *M. philippensis* (7.22%), *T. bellirica* (5.83%), whereas maximum relative frequency (12.59%) was recorded for *S. robusta* followed by *Aporosa* sp. (6.76%), *B. tomentosa* (6.29%), *M. philippensis* (5.59%). Highest relative abundance (11.42%) was recorded for *S. robusta* followed by *G. multiloculare* (9.16%), *M. philippensis* (4.39%), and *T. bellirica* (4.25%). However, those results are comparable with the findings of Nur *et al.* (2016) where they found *Bursera serrata*, *Toona ciliata*, *Stereospermum chelonoides*, *Ficus hispida*, *Macaranga denticulata*, *Callicarpa macrophylla*, and *Syzygium fruticosum* were dominating (higher numbers of seedlings/ha) among the regenerated tree species at Shitalpur Forest Beat of Chittagong North Forest Division. The IVI values indicating overall dominance of a species in the study area (Das *et al.* 2018) where the maximum IVI value was for *S. robusta* (66.25 out of 300) followed by *M. philippensis* (27.33), *Aporosa* sp. (17.82), *T. bellirica* (14.75), *G. nervosa*, *B. tomentosa* (14.10). On the contrast, *G. asiatica*, *D. robusta*, *L. glutinosa* showed the lowest regeneration IVI (0.93) of the regenerating tree species. However, Chowdhury *et al.* (2018) studied regeneration diversity of Rampahar Natural Forest Reserve in Rangamati South Forest Division, where they recorded the IVI values of regenerating tree species was highest in *P. serratum* (50.09) followed by *B. ceiba* (39.37).

There is lack of published information about the phytosociological attributes of regenerating tree species for similar forests (i.e. deciduous or Sal forest). When compared with the mixed evergreen tropical forests of nearby areas, it was found that *Dipterocarpus turbinatus* (IVI 25.94) is the most frequent regenerating tree species in Dudhpukuria-Dhopachari Wildlife Sanctuary followed by *Aporosa wallichii* (12.36) (Hossain *et al.* 2013a). Rahman *et al.* 2019 reported *Lepisanthes rubiginosa* (IVI 27.59) as the most dominant regenerating tree species in Hazarikhil Wildlife Sanctuary which was followed by *Ficus hispida* (IVI 21.18). Moreover, Kamruzzaman *et al.* (2018) showed *Suregada multiflora* (IVI 21.36) as the profusely regenerating tree species followed by *Brownlowia elata* (IVI 18.73) and *Protium serratum* (IVI 17.69) in a community forest of Bandarban named Babu Para Village Common Forest. The cited literatures indicated that though the forests are of different in nature than the studied Sal forest but there are some species having common in both forest types possessing good regeneration potential.

The percentage distribution of all the recorded seedlings of all species is shown in six height (cm) classes, e.g. 0 - <50 cm, 50 - <100 cm, 100 - <150 cm, 150 - <200 cm, 200 - <250 cm, 250 - <300 cm. It was found that maximum (31.4%) seedlings were within a height range of 50 - <100 cm, whereas, only 0.7% saplings were found in (250 - <300) cm height range (Fig. 1). However, present findings are almost similar to the findings reported by Misbahuzzaman and Alam (2006) who reported highest seedlings in height class 1 - <2 m from natural forest of Sitakunda,

Chittagong. Disturbances were noticed to the regenerating trees in the early stages of the regeneration process. The main disturbances are environmental stress, e.g. exposure to open sun light, moisture deficient and/or anthropogenic factors, e.g. grazing, firewood collection or intentional fire in dry seasons. On the other hand, collection of sapling and pole by local people for fencing resulted in reduced percentage in the higher height classes.

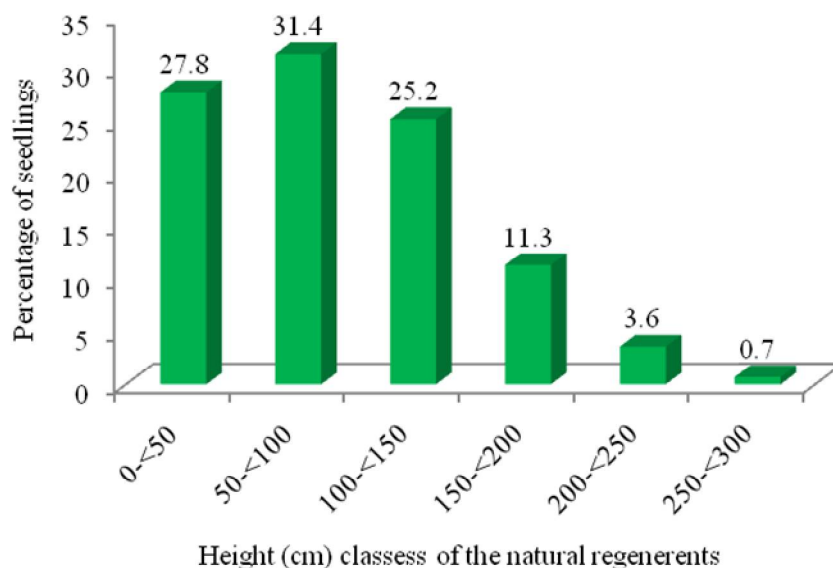


Fig. 1. Percentage distribution of the seedlings into different height (cm) classes.

A comparison among the number of seedlings of five dominating tree species with their corresponding tree stems per hectare shows that *P. serratum* has maximum (11%) seedling recruitment percentage followed by *S. robusta* (6%), *M. philippensis* (2%) and *G. nervosa* (2%) (Table 2). Though seedling density of *S. robusta* is maximum but its recruitment percentage is lower than *P. serratum*. It might be due to collection of young poles for fence post or other purposes by the local people. However, Hossain and Hossain (2014) reported that in Chunati Wildlife Sanctuary the dominant natural tree species was *Dipterocarpus alatus* which showed maximum (11%) seedling recruitment percentage followed by *Lithocarpus polystachya* (5%) and *Syzygium fruticosum* (5%).

The research explored the natural regeneration composition of tree species, phytosociological attributes of the regenerating species, height class distribution and recruitment status of the seedlings in Madhupur National Park. MNP being a major representative of the Sal forest of Bangladesh indicated a good number of naturally regenerating species (47 species) where *S. robusta* is the most dominant one followed by *M. philippensis*. The study also indicated that recruitment percentage of *P. serratum* is maximum followed by *S. robusta* and *M. philippensis*. The frequent fire and indiscriminate cutting of the *S. robusta* pole may cause comparatively lower percentage of recruitment. Presence of 47 regenerating tree species exhibits the potentiality of Madhupur National Park for natural restoration which also emphasizes the conservation needs of the natural ecosystem functioning from disturbances. The major causes of depletion of Sal forests of Madhupur National Park were due to the clearance of land for agriculture, forest fire, fuel wood

collection, litter collection and forest land encroachment by settlement. Almost half of the total Sal forests of the country have already been depleted (Iftekhar and Hoque 2005). The surrounding people collect fuel wood for daily cooking and earning a part of their livelihood by selling the fuel

Table 2. Seedlings stock of 5 major tree species with stem per hectare showing recruitment percentage at Madhupur National Park.

Name of species	(Stem/ha)	Seedling density/ha	Recruitment (%)
<i>Shorea robusta</i>	1069	18046	6
<i>Terminalia bellirica</i>	30	2490	1
<i>Grewia nervosa</i>	23	1571	2
<i>Mallotus philippensis</i>	61	3084	2
<i>Protium serratum</i>	33	307	11

wood in the local market. Hossain *et al.* (2013b) reported that 59% of the surrounding people use 6 - 10 kg wood for their daily cooking purpose, most of which is collected from the Sal forests. The conflict of interest and land occupancy right among the local ethnic community (Garo) and forest department is another major challenge for sustainable management of the Madhupur National Park. In this circumstance, enforcement of forest laws and implementation of conservation and restoration initiative is in a great challenge. Moreover, awareness raising and consciousness among the local people regarding the importance of forestry, wildlife, environmental conservation, biodiversity and endangered ecosystems should be mandatory.

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