NATURAL REGENERATION POTENTIAL OF TREE FLORA AT BANGABANDHU SHEIKH MUJIB SAFARI PARK (BSMSP), DULAHAZARA, COX'S BAZAR, BANGLADESH

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Abstract

The aim of this study was to evaluate the natural regeneration status of tree flora at Bangabandhu Sheikh Mujib Safari Park (BSMSP) in Dulahazara, Cox's Bazar. Six blocks were created within the safari park to explore regeneration potential. A total of 41 sample plots of 5m × 5m size, each centered in the middle of a 20m × 20m vegetation survey plot, was taken. In total, 835 seedlings representing 56 tree species under 29 families were recorded. Euphorbiaceae was the dominant family with 8 species followed by Myrtaceae (6 species) and Combretaceae (4 species). The highest Family Relative Density (FRD) was represented by Myrtaceae (26.95%) followed by Euphorbiaceae (16.05%) and Dipterocarpaceae (12.93%). Euphorbiaceae showed the maximum Family Relative Diversity Index FRDI (14.29%) followed by Myrtaceae (10.71%) and Combretaceae (7.14%). The highest Family Importance Value Index (FIVI) was observed in Myrtaceae (37.66%), whereas Euphorbiaceae and Dipterocarpaceae represented 30.33% and 18.29%, respectively. Species in the order of descending value of Importance Value Index (IVI) were *Syzygium fruticosum* (24.10), *Aporosa wallichii* (12.30), *Dipterocarpus costatus* (12.10), *Dipterocarpus alatus* (11.60) and *Fernandoa adenophylla* (11.60). The regeneration percentage of seed-originated individuals was 72%, whereas the rest 28% individuals were from coppices. The onset of safe guard and preserve trees with proper management could contribute conserving native gene pool contribution to ecotourism.

Key words: Dulahazara safari park; Natural regeneration; Regeneration potential; Family importance value index.

INTRODUCTION

Natural regeneration is a biological process that naturally regulates the reproduction of plant genetic resources in a forest habitat and it involves the establishment of a new forest from self-sown seeds, coppices and root-suckers. Assessing regeneration is a reliable method for assessing the health of the forest as a whole and can immediately reveal changes in the ecosystem's patterns (Rahman *et al.* 2011, Wang *et al.* 2008). The natural regeneration process determines how a plant community develops and evolves which has significant effects on the structure of forests (Han and Wang 2002). Furthermore, natural regeneration in forests is essential for the conservation and maintenance of floral diversity (Hossain *et al.* 2004). Moreover, research on the regeneration status allows for the prediction of the structure and pattern of tree species' populations (Demel 1996, Dhaulkhandi *et al*. 2008, Nur *et al*. 2016). Plants maintain and expand their populations in time and space by the process of regeneration. Regeneration is a complex ecosystem process involving asexual and sexual reproduction, dispersal and establishment 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). Seedling data can help to predict the Assisted Natural Regeneration (ANR) potential of a forest ecosystem and more research is required to develop simple and effective survey protocols and site assessment indices (Hardwick *et*

al. 2004). There is a need for long-term monitoring of permanent plots where the initial seedlings' conditions of regenerating tree and shrub species is assessed by some variables, like density, frequency, importance value index, diversity indices etc.

Bangabandhu Sheikh Mujib Safari Park (BSMSP) at Dulahazara, Chakaria, Cox's Bazar is the first Safari Park in Bangladesh which started its journey in the 1998-99 fiscal year. In the past, different native trees and wildlife species were found in Dulahazara. Unfortunately, a good number of native plant species and wild animals are disappearing due to human population expansion, urbanization, illicit felling, disappearance of mother trees, encroachment of forest lands, land-use conflicts, etc. The safari park was established with a view to protect the valuable indigenous rare plants and wild animals accompanied by the promotion of tourism, education, and research facilities. Exploring the pattern of natural regeneration is essential to conserve and restore these valuable indigenous species. No research work has yet been conducted to investigate the regeneration potential of trees in this park. Hence, the present study was carried out to explore the natural regeneration status of tree flora at Bangabandhu Sheikh Mujib Safari Park (BSMSP), Dulahazara, Cox's Bazar, Bangladesh.

MATERIAL AND METHODS

Study area

Bangabandhu Sheikh Mujib Safari Park (BSMSP) is located in Chakaria upazila under Cox's Bazar district. It was established in 1996 on the previously declared reserve forest land of Fashiakhali Forest Range. The park lies beside the Chittagong-Cox's Bazar Highway, 47 km north of Cox's Bazar town. It encompasses an area of 900 hectares (Masum *et al*. 2012). The safari park is under the jurisdiction of the Wildlife Management and Nature Conservation Division, Chittagong and lies between 20˚50´-21˚50´North latitude and 92˚00´- 92˚15´East longitude. The Mean Annual Rainfall (MAR), Average Annual Humidity (AAH), and Mean Annual Temperature (MAT) were recorded as 1740.8 mm, 79.3% and 26.60˚C, respectively at BSMSP (Uddin and Misbahuzzaman 2007). The topography of BSMSP is undulated hilly landscape with evergreen and semi-green tree coverage. Many depressions, narrow valleys and perennial natural streams flowing inside the park contain good quality water throughout the year. This park is enriched with native diversified flora as well as wild, semi-wild, and captive wild animals. Some ornamental plants also exist there (Hossen *et al.* 2014).

Method of data collection

A complete random block sampling method was followed to get accurate information about tree regeneration potential and species composition. The entire area was divided into six randomly selected blocks. A total of 41 regeneration plots of 5m × 5m size, each located at the center of a larger 20m × 20m vegetation survey plot, were taken from the aforementioned 6 blocks. The number of plots in each block was proportional to the size of block. Hence, 6 plots were from Old deer-breeding center, 3 from Tiger enclosure, 4 from Lion enclosure, whereas Asian and African herbivorous animal roaming zone, Elephant enclosure, Grazing land and plantation zone had 9, 12, 7 plots, respectively. Seedlings with dbh of ≤ 2 cm were counted and recorded. A Ground Positioning System (GPS) device was used to record the location of each sample plot for future monitoring (Fig. 1).

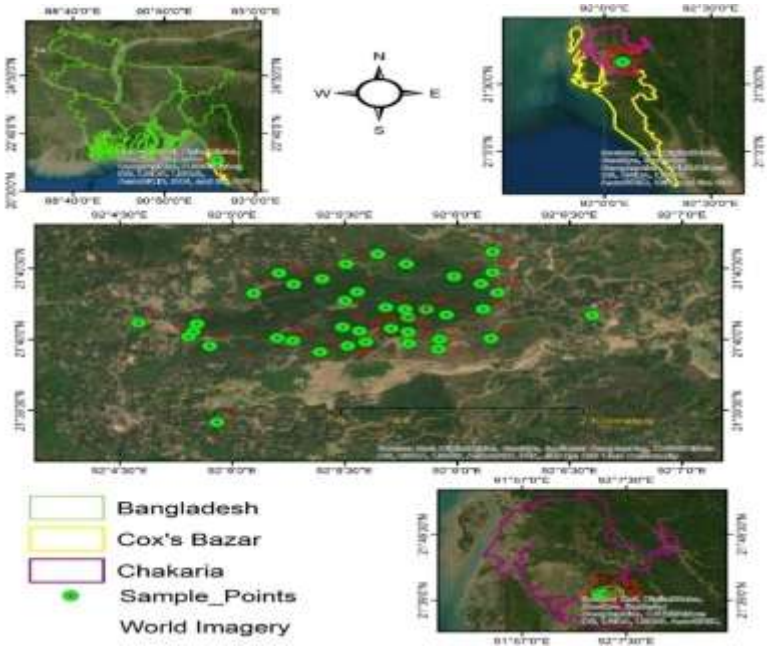

Fig. 1. Location of Bangabandhu Sheikh Mujib Safari Park and surveying points.

Data analysis

The quantitative structure of species was calculated using the following formulae:

a. Relative density (RD) of a species (Dallmeier 1992)

$$= \frac{Total\ no.of\ individuals\ of\ the\ species}{Total\ no.of\ individuals\ of\ all\ species} \times 100$$

b. Frequency of a species (Shukla and Chandel 2000)

$$= \frac{Total\ no.of\ quadrats\ in\ which\ the\ species\ occurs}{Total\ no.\ of\ quadrats\ studied} \times 100$$

c. Relative frequency (RF) of a species (Dallmeier 1992)

$$= \frac{Frequency\ of\ the\ species}{Sum\ of\ all\ frequencies} \times 100$$

d. Abundance of a species (Shukla and Chandel 2000)

$$= \frac{Total\ no.of\ individuals\ of\ a\ species\ in\ all\ the\ quadrats}{Total\ no.\ of\ quadrats\ in\ which\ the\ species\ occurs}$$

e. Relative abundance (RA) of a species (Misra 1968)

$$= \frac{Abundance\ of\ the\ species}{Sum\ of\ abundances\ of\ all\ the\ species} \times 100$$

f. Importance Value Index (Misra 1968)

$$= Relative\ density\ (RD) + Relative\ frequency\ (RF) + Relative\ abundance\ (RA)$$

Different biodiversity and richness indices, Family Relative Density and Family Relative Diversity were calculated using the following formulae:

1. Species diversity index (Odum 1971), $SDi = \frac{S}{N}$
2. Shannon-Wiener's diversity index (Michael 1984), $H = -\sum_{i=1}^{n} P_i \ln P_i$
3. Shannon's maximum diversity index (Kent 2011), $H_{max} = \ln S$
4. Species evenness index (Pielou 1966), $E = \frac{H}{\ln S}$
5. Margalef's diversity index (Margalef 1958), $R = \frac{S-1}{\ln N}$

6. Simpson's diversity index (Simpson 1949), $D = \sum_{i=1}^{n} P_i^2$
7. Dominance of Simpson's index (Magurran 1988), $D' = 1 - D$
8. Simpson's reciprocal index (Keller 2000), $D_r = \frac{1}{D}$
9. Family relative density (Siddiqui *et al*. 2021), $FRD\ (\%) = \frac{N_f}{T_i \times 100}$
10. Family relative diversity index (Siddiqui *et al*. 2021), $FRDI\ (\%) = \frac{N_s}{T_s} \times 100$
11. Family importance value index (Siddiqui *et al*. 2021), $FIVI = FRD + FRDI$

Here,

$S = Total\ number\ of\ species$

$N_f = No.of\ individuals\ in\ a\ family$

$N = Total\ No.of\ individuals\ of\ all\ the\ species$

$P_i = \frac{No.of\ individuals\ of\ one\ species}{Total\ no.of\ individuals}$

$T_i = Total\ no.of\ individuals$

$N_s = No.of\ species$

$T_s = Total\ no.of\ species$

RESULTS AND DISCUSSION

Natural regeneration status in Bangabandhu Sheikh Mujib Safari Park

A total of 835 seedlings of 56 species under 29 families was recorded (Table 1). The dominant family was Euphorbiaceae with 8 species followed by Myrtaceae (6 species) and Combretaceae (4 species).

Table 1. Naturally regenerated seedlings and family in Bangabandhu Sheikh Mujib Safari Park along with their uses.

Scientific Name	Family	Local name	Uses*
Acacia auriculiformis	Mimosaceae	Akashmoni	F, N, T
Acrocarpus fraxinifolius	Caesalpiniaceae	Mandania	T
Anogeissus acuminata	Combretaceae	Sikori	N, T
Antidesma acidum	Euphorbiaceae	Elena	Fd, M
Antidesma ghaesembilla	Euphorbiaceae	Khudi Jam	M, N
Aporosa wallichii	Euphorbiaceae	Dudh Kuruch	M
Azadirachta indica	Meliaceae	Neem	M, N
Bombax insigne	Bombacaceae	Bon Tula	N
Calophyllum inophyllum	Clusiaceae	Punnyal	M, N, T
Cassia fistula	Caesalpiniaceae	Sonalu	Fd, M, N, T
Castanopsis indica	Fagaceae	Shil batna	F, N
Chaetocarpus castanocarpus	Euphorbiaceae	Atailla	F
Cinnamomum iners	Lauraceae	Tez-bohu	M, T
Didymosperma gracilis	Arecaceae	Bon Supari	N, M
Dillenia indica	Dilleniaceae	Chalta	Fd, M, T
Dillenia pentagyna	Dilleniaceae	Hargeza	F, T
Dimocarpus longan	Sapindaceae	Ashphal	Fd, N, M
Dipterocarpus alatus	Dipterocarpaceae	Doilla Garjon	M, T
Dipterocarpus costatus	Dipterocarpaceae	Baitta Garjon	F, N, T
Dipterocarpus turbinatus	Dipterocarpaceae	Teli Garjon	N, T
Elaeocarpus tectorius	Euphorbiaceae	Jalpai	Fd, T
Fernandoa adenophylla	Bignoniaceae	Kala oisha	M

Ficus benjamina	Moraceae	Pakur	F, N
Ficus hispida	Moraceae	Kak Dumur	Fd, M, N
Firmiana colorata	Sterculiaceae	Udal	Fd
Flacourtia jangomas	Flacourtiaceae	Painnagula	Fd, M, T
Garcinia cowa	Clusiaceae	Kao	Fd, N, T
Glochidion lanceolarium	Euphorbiaceae	Lomba kechua	N
Grewia nervosa	Tiliaceae	Assargola	F, M
Holarrhena antidysenterica	Apocynaceae	Kuruch	M
Lepisanthes rubiginosa	Sapindaceae	Horina gula	F, M
Lepisanthes senegalensis	Sapindaceae	Gotaharina	Fd, T
Lithocarpus polystachya	Fagaceae	Batna	F, T
Lithocarpus thomsonii	Fagaceae	Dholi Batna	T
Maesa indica	Myrsinaceae	Maesa	Fd, M
Mangifera sylvatica	Anacardiaceae	Uriam	Fd, N, T
Michelia champaca	Magnoliaceae	Champa	N, T
Mitragyna parvifolia	Rubiaceae	Dakrum	F, T
Phyllanthus emblica	Euphorbiaceae	Amloki	Fd, M, N
Pithecellobium angulatum	Mimosaceae	Kuramara	N
Syzygium claviflorum	Myrtaceae	Nolijam	Fd
Syzygium cumini	Myrtaceae	Kalojam	F, Fd, M, T
Syzygium firmum	Myrtaceae	Dhakijam	Fd, N
Syzygium fruticosum	Myrtaceae	Putijam	F, Fd, N
Syzygium jambos	Myrtaceae	Golapjam	Fd, M, T
Syzygium praecox	Myrtaceae	Dhulijam	Fd, T
Terminalia bellirica	Combretaceae	Bohera	Fd, M, T
Terminalia chebula	Combretaceae	Haritaki	M, N, T
Terminalia citrina	Combretaceae	Choto Haritaki	M
Thespesia populnea	Malvaceae	Umbrella gach	M
Vitex glabrata	Verbenaceae	Goda arsol	Fd, M, T
Vitex peduncularis	Verbenaceae	Goda	Fd, M, T
Vitex pinnata	Verbenaceae	Horina arsol	T
Bixa orellana	Bixaceae	Rong gula	Dye
Xanthophyllum andamanicum	Xanthophyllaceae	Hanshuk	T
Ziziphus mauritiana	Rhamnaceae	Boroi	F, Fd

*F = Fuel wood, Fd = Food and Fodder, M = Medicinal, N = Multiple non-timber uses (other than fuel, food, fodder and medicine), T= Timber

Each of the families Dipterocarpaceae, Fagaceae, Sapindaceae, and Verbenaceae was represented by 3 species. Other families have only 1 or 2 species each (Table 2). Myrtaceae demonstrated the highest (26.95%) Family Relative Density (FRD) followed by Euphorbiaceae (16.05%) and Dipterocarpaceae (12.93%). Maximum (14.29%) Family Relative Diversity Index (FRDI) was shown by Euphorbiaceae, whereas Myrtaceae and Combretaceae had 10.71% and 7.14% FRDI, respectively. Family Importance Value Index (FIVI) was also found to be highest (37.66%) in Myrtaceae followed by Euphorbiaceae (30.33%) and Dipterocarpaceae (18.29%).

Table 2. Family-based orientation of regeneration parameters in Bangabandhu Sheikh Mujib Safari Park.

Family	No. of species	No. of seedlings	FRD (%)	FRDI (%)	FIVI
Anacardiaceae	1	13	1.557	1.786	3.343
Apocynaceae	1	7	0.838	1.786	2.624
Arecaceae	1	2	0.240	1.786	2.025
Bignoniaceae	1	39	4.671	1.786	6.456
Bixaceae	1	2	0.240	1.786	2.025
Bombacaceae	1	1	0.120	1.786	1.905
Caesalpiniaceae	1	4	0.479	1.786	2.265
Clusiaceae	2	25	2.994	3.571	6.565

Combretaceae	4	34	4.072	7.143	11.210
Dilleniaceae	2	14	1.677	3.571	5.248
Dipterocarpaceae	3	108	12.930	5.357	18.290
Euphorbiaceae	8	134	16.050	14.290	30.330
Fagaceae	3	47	5.629	5.357	10.990
Flacourtiaceae	1	4	0.479	1.786	2.265
Lauraceae	1	14	1.677	1.786	3.462
Magnoliaceae	1	1	0.120	1.786	1.905
Malvaceae	1	2	0.240	1.786	2.025
Meliaceae	1	1	0.120	1.786	1.905
Mimosaceae	2	8	0.958	3.571	4.530
Moraceae	2	28	3.353	3.571	6.925
Myrsinaceae	1	38	4.551	1.786	6.337
Myrtaceae	6	225	26.950	10.710	37.660
Rhamnaceae	1	4	0.479	1.786	2.265
Rubiaceae	1	7	0.838	1.786	2.624
Sapindaceae	3	25	2.994	5.357	8.351
Sterculiaceae	1	1	0.120	1.786	1.905
Tiliaceae	1	34	4.072	1.786	5.858
Verbenaceae	3	12	1.437	5.357	6.794
Xanthophyllaceae	1	1	0.120	1.786	1.905
Total	**56**	**835**	**100**	**100**	**200**

Quantitative structure of regenerating tree species in BSMSP

The highest relative density was found in *Syzygium fruticosum* (13.50%), followed by *Aporosa wallichii* and *Dipterocarpus turbinatus* possessing 5.39%, whereas, *Dipterocarpus costatus and Dipterocarpus alatus* showed 5.03% and 4.91%, respectively. *Dipterocarpus turbinatus* showed the highest Relative Frequency (6.25%) followed by *Syzygium fruticosum* (5.86%), which in turn, followed by *Dipterocarpus costatus* (5.08%) and *Fernandoa adenophylla* (5.08%). The highest Relative Abundance was found in *Syzygium cumini* (6.29%) followed by *Syzygium fruticosum* (4.74%) and *Acrocarpus fraxinifolius* (3.77%). The species in the descending the order of Importance Value Index (IVI) were *Syzygium fruticosum* (24.10), *Aporosa wallichii* (12.30), *Dipterocarpus costatus* (12.10), *Dipterocarpus alatus* (11.60), and *Fernandoa adenophylla* (11.60) (Table 3).

Table 3. Relative Density (RD), Relative Frequency (RF), Relative Abundance (RA) and Importance Value Index (IVI) of regenerating tree species recorded from BSMSP.

Scientific Name	RD (%)	RF (%)	RA (%)	IVI
Acacia auriculiformis	0.48	0.78	1.26	2.52
Acrocarpus fraxinifolius	0.72	0.39	3.77	4.88
Anogeissus acuminata	1.32	0.78	3.46	5.56
Antidesma acidum	2.16	1.56	2.83	6.55
Antidesma ghaesembilla	0.24	0.39	1.26	1.89
Aporosa wallichii	5.39	4.3	2.57	12.3
Azadirachta indica	0.12	0.39	0.63	1.14
Bombax insigne	0.12	0.39	0.63	1.14
Calophyllum inophyllum	0.12	0.39	0.63	1.14
Cassia fistula	0.48	0.78	1.26	2.52
Castanopsis indica	1.2	1.95	1.26	4.41
Chaetocarpus castanocarpus	2.04	1.56	2.67	6.27
Cinnamomum iners	1.68	2.34	1.47	5.49
Didymosperma gracilis	0.24	0.39	1.26	1.89
Dillenia indica	0.84	0.78	2.2	3.82
Dillenia pentagyna	0.84	1.17	1.47	3.48
Dimocarpus longan	0.72	0.78	1.89	3.39

Dipterocarpus alatus	4.91	4.3	2.34	11.6
Dipterocarpus costatus	5.03	5.08	2.03	12.1
Dipterocarpus turbinatus	5.39	6.25	1.77	13.4
Elaeocarpus tectorius	0.12	0.39	0.63	1.14
Fernandoa adenophylla	4.67	5.08	1.89	11.6
Ficus benjamina	0.12	0.39	0.63	1.14
Ficus hispida	3.23	2.73	2.43	8.39
Firmiana colorata	0.12	0.39	0.63	1.14
Flacourtia jangomas	0.48	0.39	2.52	3.39
Garcinia cowa	2.87	3.91	1.51	8.29
Glochidion lanceolarium	0.36	0.78	0.94	2.08
Grewia nervosa	4.07	4.3	1.94	10.3
Holarrhena antidysenterica	0.84	1.17	1.47	3.48
Lepisanthes rubiginosa	1.2	1.56	1.57	4.33
Lepisanthes senegalensis	1.08	1.56	1.41	4.06
Lithocarpus polystachya	2.51	1.95	2.64	7.11
Lithocarpus thomsonii	1.92	2.34	1.68	5.94
Maesa indica	4.55	4.69	1.99	11.2
Mangifera sylvatica	1.56	2.73	1.17	5.46
Michelia champaca	0.12	0.39	0.63	1.14
Mitragyna parvifolia	0.84	0.78	2.2	3.82
Phyllanthus emblica	2.63	3.13	1.73	7.49
Pithecellobium angulatum	0.48	0.39	2.52	3.39
Syzygium claviflorum	2.63	1.95	2.77	7.35
Syzygium cumini	1.2	0.39	6.29	7.88
Syzygium firmum	4.43	4.3	2.12	10.8
Syzygium fruticosum	13.5	5.86	4.74	24.1
Syzygium jambos	0.72	0.78	1.89	3.39
Syzygium praecox	4.43	3.91	2.33	10.7
Terminalia bellirica	1.2	2.34	1.05	4.59
Terminalia chebula	1.32	1.56	1.73	4.61
Terminalia citrina	0.24	0.39	1.26	1.89
Thespesia populnea	0.24	0.39	1.26	1.89
Vitex glabrata	0.24	0.39	1.26	1.89
Vitex peduncularis	1.08	1.56	1.41	4.06
Vitex pinnata	0.12	0.39	0.63	1.14
Bixa orellana	0.24	0.78	0.63	1.65
Xanthophyllum andamanicum	0.12	0.39	0.63	1.14
Ziziphus mauritiana	0.48	0.78	1.26	2.52
Total	**100**	**100**	**100**	**300**

Regeneration mode

Out of the total 835 individuals, 602 individuals (72%) of seed-origin and 233 (28%) were of coppice origin (Fig. 2).

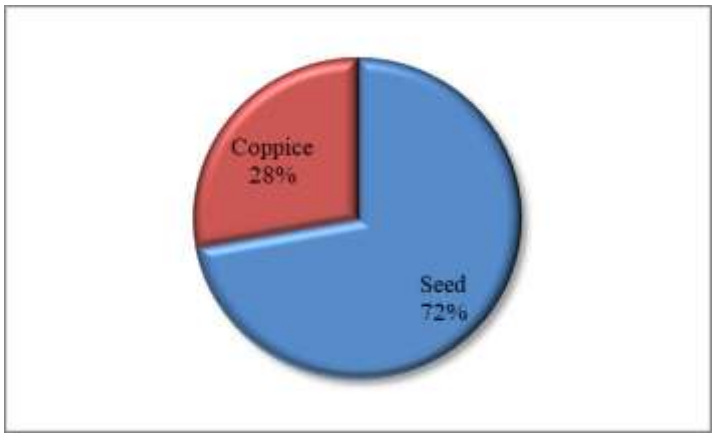

Fig. 2. Regeneration mode of the regenerating trees in BSMSP.

Biodiversity indices for regeneration status of trees at BSMSP

The value of the Species Diversity index (SDi) for the entire survey area was 0.067. The Shannon-Wiener's diversity index (H) for the area was 3.440 with Shannon's maximum diversity index (H_{max}) of 4.025. Species evenness index (E) and Margalef's diversity index (R) were 0.855 and 8.175, respectively. The Simpson's diversity index (D) was 0.046 with Dominance of Simpson's index (D´) of 0.954 and Simpson's reciprocal index (D_r) of 21.585 (Fig. 3). The lower value of Simpson's index indicates diversified tree species in the studied area. The values of Shannon-Wiener's and Margalef's diversity indices also indicate the remarkable presence of tree species in the study area.

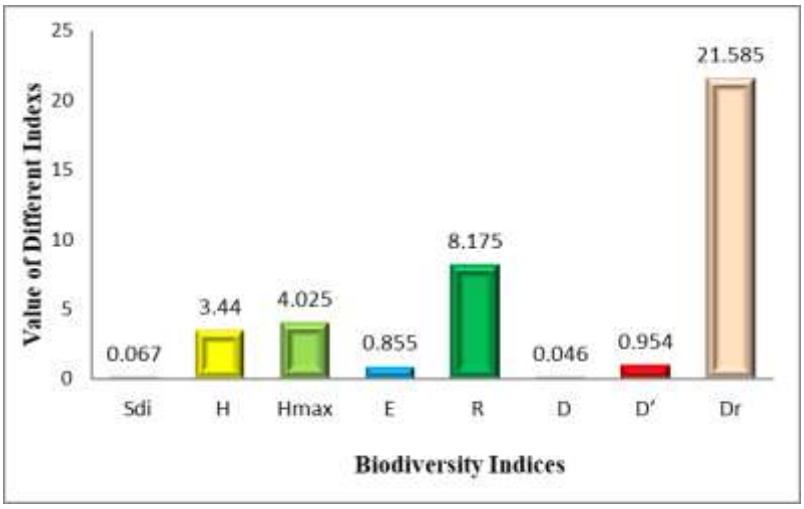

Fig. 3. Different biodiversity indices of regeneration of tree flora at BSMSP.

Ecosystem restoration is a process of reversing the degradation of forest ecosystems to regain their ecological functionality to improve the productivity and capacity of ecosystems to meet the needs of society. This can be done by allowing the natural regeneration of over-exploited ecosystems or by planting trees and other plants (UNEP 2019). Natural regeneration potential is a critical criterion for all forest ecosystems. However, the regeneration status of tree species at BSMSP is little documented. Individuals of only 56 naturally regenerating species under 29 families were recorded. The number of natural regenerations is much lower than that of other similar forests in Bangladesh. A total of 120 naturally regenerating tree species has so far been identified in the natural forests of Dudhpukuria-Dhopachari Wildlife Sanctuary (Hossain *et al.* 2004a). Hazarikhil Wildlife Sanctuary (HWS) in Chittagong North Forest Division has 90 naturally regenerating tree species (Rahman *et al.* 2019) whereas the number is 105 in Chunati Wildlife Sanctuary (Rahman *et al.* 2020). Natural regeneration of tree species in the natural forests of Chittagong South Forest Division represents 64 tree species with average seedlings of 24,767 per ha in comparison to 40 tree species and 18,633 seedlings per ha in enrichment plantations (Hossain *et al.* 2004b). However, the number of regenerating tree species at BSMSP is greater than that of Khadimnagar National Park and Tilagor Eco-Park (55 tree species) (Rahman *et al.* 2011), 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.* 2011). Disturbances in natural forests can modify the habitat appropriateness for plant species, influencing ecosystem functioning and plant species composition (Berhane *et al.* 2013, Wilcox *et al.* 2006). The Importance Value Index (IVI) indicates which species

dominates in a mixed population (Das *et al.* 2018). High IVI values for natural regeneration of *Syzygium fruticosum* (24.10), *Aporosa wallichii* (12.30), *Dipterocarpus costatus* (12.10), and *Dipterocarpus alatus* (12.10), was found in the present investigation. It may be attributed to the greater dispersal capabilities of seeds, pollen grains, and other reproductive organs of these species via the agents like wind, animals, water, bats, humans, birds, etc. However, high IVI values for *Protium serratum* (50.09) and *Bombax ceiba* (39.37) were found in Rampahar Natural Forest Reserve within Rangamati South Forest Division (Chowdhury *et al.* 2018). Seed-originated individuals were 72% in BSMSP, whereas 89% was reported from Babupara VCF and 78% from Renikhayong para VCF of Bandarban district (Kamruzzaman *et al.* 2018, Jannat *et al.* 2020).

Fig. 4. Dipterocarp dominant natural forests of Bangabandhu Sheikh Mujib Safari Park at Dulahazara, Cox's Bazar, Bangladesh.

Species richness is one of the most essential factors for establishing a localized value for biodiversity conservation. The higher the value of diversity, the more stable a community (Jannat *et al.* 2020, Khumbongmayum *et al*. 2005). The Species Diversity index (SDi) value for the entire study area was 0.067. Shannon's maximum diversity index (H_{max}) was 4.025 while the Shannon-Wiener's diversity index (H) was 3.440. The Species evenness index (E) and Margalef's diversity index (R) were 0.855 and 8.175 correspondingly. Simpson's diversity index (D) was 0.046, Simpson's dominance index (D´) was 0.954, and Simpson's reciprocal index (D_r) was 21.585. Species diversity index (0.01), Species richness index (4.92), Shannon-Wiener's index (3.62), Shannon's maximum diversity index (3.62), Species evenness index (2.26), Simpson's index (0.03), and Dominance of Simpson's index (0.97), reported from the biodiversity conservation areas of northeastern Bangladesh (Rahman *et al.* 2011), are supported by the present findings.

Bangabandhu Sheikh Mujib Safari Park is Bangladesh's pioneer safari park (Fig. 4) and has one of the most enrich ecosystems with tremendous regeneration potential. Even though a boundary wall guards against the extreme threat of anthropogenic disturbances, species extinction is being accelerated by the illegal activities of some of the local inhabitants. Wild animals of the park have a

range of impacts on plant regeneration including browsing and seed predation etc. However, this study identifies 56 tree species having significant regeneration potentials with 20,875 seedlings per hectare. The park is the habitat of native species including mother trees of *Dipterocarpus costatus*, *Dipterocarpus turbinatus*, *Dipterocarpus alatus*, *Aporosa wallichii*, *Syzygium fruticosum*, *Fernandoa adenophylla*, *Macaranga denticulata*, *Grewia nervosa*, *Mallotus philippensis* etc. The moment has finally come to adequately safeguard, preserve, and manage the park in order to protect and conserve the gene pool of native and introduced plant species. The park, not to be exaggerated, is contributing to our ecotourism sector and acting as a working ground for researchers and educators.

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