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PLANT DIVERSITY, CONSERVATION WORTHINESS AND PEOPLE'S PERCEPTION IN FUTURE MANAGEMENT OF PURBACHAL SAL FOREST, BANGLADESH

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Abstract

The Purbachal Sal Forest, a vital ecosystem in the outskirts of Dhaka city facing biodiversity decline, was assessed for its plant composition and public perception of its management and conservation. A total of 190 species under 61 families have been recorded from the study area following the random quadrat method. Analyses showed that among the 190 species, the most abundant tree and shrub in the forest are *Shorea robusta* Roxb. ex Gaertn. and *Melastoma malabathricum* L., respectively. In case of dominance based on the Importance Value Index, *Shorea robusta* is the most dominant tree, followed by *Melastoma malabathricum* as the most dominant shrub. The percentages of native and exotic species were found to be 75% and 25%, respectively. The Shannon-Wiener Diversity Index in the study area was 0.61, whereas Simpson's and Margalef's Indices were 0.178 and 4.77, respectively. From interviews with visitors and stakeholders, this study revealed that the majority of them responded negatively about the presence of exotic species in the forest, and on the other hand, they responded positively on the question of incorporating experts in the management plan of the forest. A number of threats to the species diversity of the forest were recorded through observation in the field and stakeholders' interviews, such as invasive alien species (IAS) intrusion, habitat destruction, agricultural practice, and deforestation. A set of recommendations, including planting more wildlife-supporting native species, preventing the spread of IAS like *Parthenium* L. and incorporating experts in the forest's management, was developed for present and future management of Purbachal Sal Forest.

Introduction

Plant diversity serves as one of the basic eco-services all over the world, and urban vegetation provides an extensive range of ecosystem services, especially to the urban dwellers (Weber, 2013). The expansion of urban areas in Bangladesh has led to the decline of natural ecosystems, including *Shorea robusta* forests. The degradation of these forest ecosystems and biodiversity is caused by anthropogenic activity, including the alteration, reduction, and fragmentation of habitats (Popradit *et al.*, 2015; Tittensor *et al.*, 2014). *Shorea robusta* Roxb. *ex* Gaertn.is a semi-evergreen, tall tree that is naturally distributed on the Pleistocene tracts (Madhupur tracts) in Bangladesh (Rahman and Vacik, 2010; Singh and Kushwaha, 2005). This species is a keystone species that supports various endangered species (Hasnat and Hoque, 2016). The Purbachal Sal Forest is thought to be a part of the Madhupur tracts that encompasses different plant species, with *Shorea robusta* being the dominant one. The management and conservation of this forest are crucial for preserving plant diversity and ensuring the well-being of the local communities. However, the depletion of forests has been accelerated by the anthropogenic activities for implementing the 'Purbachal New Town Project' of RAJUK for the extension of Dhaka city and also by the introduction of some Invasive

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Alien Species (IAS). There is the possibility of decreasing plant diversity, richness, and forest area for the acquisition of land. Therefore, a detailed study is needed to know the present condition of plant diversity and dominance and possible threats to this forest for future management. Moreover, this study aimed to gather stakeholders' perceptions regarding the future management practices of this forest.

Materials and Methods

Study area

The Purbachal Sal Forest, situated in Rupganj Upazila of Narayanganj District and Kaligonj Upazila of Gazipur district, encompasses a vast area of 144 acres located at Sector-24 and Sector-25 in Purbachal. Precisely located between 23.860616° North and 90.497203° East, now this forest is under the management of the Forest Department, which operates under the Ministry of Environment, Forests, and Climate Change of the Government of the People's Republic of Bangladesh. The annual mean air temperature of Purbachal is 28°C, and the annual precipitation is 2400 mm (Shapla *et al.,* 2015). The hilly areas of Purbachal include scattered homesteads (i.e., settlement and residential areas) and homestead vegetation (including trees, shrubs, and herbs on and around the settlement). At the bottom of the valleys and depressions, one crop is cultivated annually (Shapla *et al.,* 2015). Although the crop lands are being developed, Purbachal is a sanctuary of natural ecosystems supporting ecologically important species and habitats (Mamun, 2007).

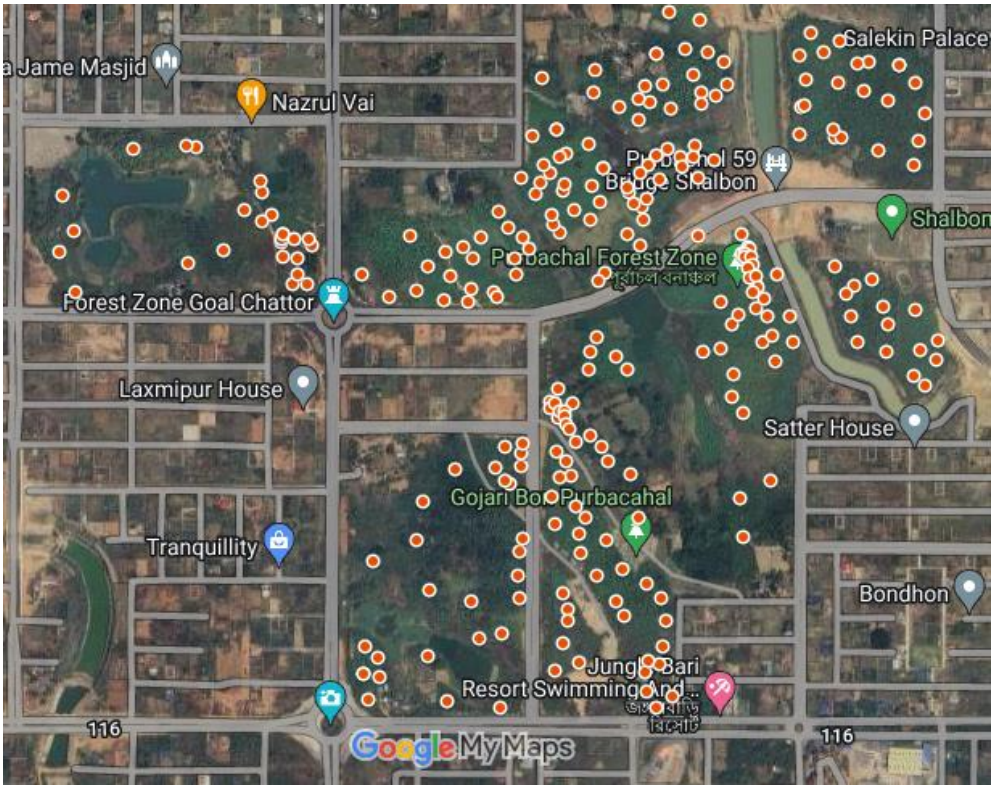

Fig. 1. Map showing locations of quadrats that were studied inside Purbachal Sal Forest.

Floristic survey

The floristic survey covered all the habitats and ecosystems of the study area and it was done covering all the seasons from August 2023 to August 2024 (Fig. 1). Random quadrat method (Subrahmanyam and Sambamurty, 2006) was applied for the survey and a total of 273 quadrats were surveyed in the study area. Sample size was determined using species area curve (Goldsmith and Harrsion, 1976). The quadrat size was taken as 10 m × 10 m for trees, 5 m × 5 m for shrubs and 2 m × 2 m for herbs according to Oosting (1956). In each sampling spots of 10 m × 10 m, names of the tree species present, their number of individuals and Circumference at Breast Height (CBH) (D'Eon *et al.*, 1994) were recorded. Individuals having ≥ 30 cm CBH at breast height (1.3 m) were considered trees (Swaine and Alexander, 1987). For shrubs, species name with the individual numbers were recorded and for herbs, only the species were identified and recorded in their respective quadrats. Using a smartphone, GPS coordinates of the quadrat data were also noted in the same data sheet.

Identification of species

Identification of plant species was mostly done consulting experts and standard floristic literatures such as Ahmed *et al.* (2009a, b, c, d, e), Ahmed *et al.* (2008a, b), Prain (1903) and Hooker (1872-1897). High resolution smartphone camera (Samsung Galaxy S10 Plus) was used to capture close colored photos of plants to aid with identification. Moreover, for unidentified species, herbarium samples were prepared (Hyland, 1972). Some exotic plant species were identified comparing with the reports of Akter and Zuberi (2009) and Hossain and Pasha (2004). Besides, to identify unknown species, taken photographs and prepared herbarium samples were compared with herbarium specimens of Dhaka University Salar Khan Herbarium (DUSH) and Bangladesh National Herbarium (BNH). The family of each species was identified following the classification system of Cronquist (1981).

Determination of phyto-sociological attributes and IVI

Phyto-sociological attributes (density, frequency, abundance, their respective relative parameters and IVI = Importance Value Index) of the recorded tree and shrub species were determined for the whole site following the formulae of Shukla and Chandal (1994), Dallmeier (1992) and Verma and Agarwal (1986). To determine dominant tree and shrub species in the study site, Importance Value Index (IVI) was calculated using the following biostatistical formula (Krebs, 1989).

Species diversity

Species diversity was estimated using Shannon-Wiener diversity index (Shannon, 1948), Simpson's diversity index (Simpson, 1949) and Margalef's index (Margalef, 1957) using the following formulae respectively.

$$Shannon - Wiener\ Diversity\ Index = -\sum p_i ln\ p_i$$

Here,

p_i = Proportion of observations found in category i.

ln = Natural logarithm

$$Simpson's\ Diversity\ Index = 1 - \frac{\sum n\ (n-1)}{N\ (N-1)}$$

Here,

N = Total number of individuals of all species

n = Total number of individuals of a particular species

$$Margalef\ Index = \frac{S-1}{\ln N}$$

Here,

S = Total number of recorded species

N = Total number of individuals of all recorded species

Interviews with stakeholders

To gather the viewpoints of stakeholders on future management of Purbachal Sal Forest, interviews were conducted employing a structured close-ended questionnaire, following the methodology outlined by Alexiades (1996). This approach ensured that each participant was presented with the same set of questions in a consistent manner. Each question was also followed by a discussion on this study's findings on plant diversity, so that the stakeholders could make educated comments.

Results and Discussion

Species composition

A total of 190 species belonging to 61 families have been recorded. Among these species, 42 were tree species, 32 shrub species, 88 herb species and 28 climber species (Table 1). The survey indicated that not all families have equal representations in the study area. Among the 61 families, the largest 5 families contain 42% of the species and the remaining 56 families contain the rest 58% of the total species recorded. Poacea and Fabaceae are the largest family containing 12% each of all the species followed by Euphorbiaceae (8%), Asteraceae (5%) and Cyperaceae (5%).

On average about 33 individuals of tree species has been found in each quadrat having a size of 100 sq. m. This shows a relatively high density of tree population in the study area. This is because that the forest has been left undisturbed for several years and it has observed a good amount of regeneration success, especially of Sal trees. Although Malakar *et al.* (2010) recorded a higher number of tree species (102 species) in the Madhupur Sal Forest compared to our study in Purbachal Sal Forest, this could be attributed to the Madhupur Sal Forest's greater age and larger size. Over centuries, the Madhupur Sal Forest has had more time and space for various species to establish themselves. In contrast, the Purbachal Sal Forest, according to the local people, was once a very dense forest with tall Sal trees. However, that forest underwent enormous logging and land grabbing, and now, it only stands as a small forest with small to medium sized Sal trees. Moreover, its shorter history may also explain the lower richness of tree species compared to the Madhupur Sal Forest.

Based on the usefulness of plants, species found in the study area were categorized into a number of classifications such as medicinal, timber producing, ornamental, edible fruit-bearing, wildlife supporting, fooder and vegetable (Table 1). In some cases, the species are found to have multiple uses. Majority of the plant species recorded from Purbachal Sal Forest have medicinal uses (46%) followed by wildlife supporting (13%), timber producing (10%), fodder (10%), edible fruit bearing (9%), ornamental (7%) and vegetable (5%).

The high percentage of medicinal species stems from the high number of herb species in the total species composition. On the other hand, though wildlife supporting species were recorded in good quantity from the area, these species were not abundant. The limited abundance of wildlife-supporting plant species restricts the forest's ability to support a significant population size of the wildlife.

Considering the IVI, the forest has different fruit bearing species like *Zizuphus mauritiana, Trema orientale* and *Bridelia tomentosa,* these species have very few individuals which are

random but scanty in the whole forest. These species, along with the dominance of *Tectona grandis* were observed in Nawabganj Sal Forest, Dinajpur by Jubair *et al.* (2023). Moreover, Malakar *et al.* (2010) recorded a total of 24 fruit bearing species from Madhupur Sal Forest whereas this present study recorded 17 species of edible fruit bearing trees. Though the number of edible fruit bearing and wildlife supporting species are quite close, the concern lies elsewhere. In case of Purbachal Sal Forest, these species are only found near the periphery of the forest, and in some open spaces inside the forest that have been cleared out of Sal trees by local people.

Table 1. Species composition of the study area (Origin: E = Exotic, I = Indigenous; Use: M = Medicinal, T = Timber producing, O = Ornamental, F = Edible fruit bearing, Fd = Fooder, W = Wildlife supporting, V= Vegetable).

Name of the species	Habit	Origin	Family	Local name	Use
Albizia chinensis (Osb.) Merr.	Tree	E	Mimosaceae	Chakua Koroi	T
Albizia julibrissin Durazz	Tree	E	Mimosaceae	Goalpi Sirish	T
Albizia lebbeck (L.) Benth. & Hook.	Tree	I	Mimosaceae	Kalo Koroi	T
Albizia procera (Roxb.) Benth.	Tree	I	Mimosaceae	Sada Koroi	T
Alstonia scholaris (L.) R. Br.	Tree	I	Apocynaceae	Chhatim	T
Aphanamixis polystachya (Wall.) R.N. Parker	Tree	I	Meliaceae	Royna (Boddira)	M
Azadirachta indica A. Juss.	Tree	E	Meliaceae	Neem	M
Barringtonia acutangula (L.) Gaertn.	Tree	I	Lecythidaceae	Hijol	T
Borassus flabellifer L.	Tree	I	Arecaceae	Tal	F
Bridelia retusa (L.) A. Juss.	Tree	I	Euphorbiaceae	Kamkui	W
Bridelia tomentosa Blume	Tree	I	Euphorbiaceae	Khoi	W
Butea monosperma (Lamk.) Taub.	Tree	I	Fabaceae	Polash	O
Careya arborea Roxb.	Tree	I	Lecythidaceae	Gola Kumbhi	W
Cassia fistula L.	Tree	I	Caesalpiniaceae	Sonalu	O
Catunaregam spinosa (Thunb.) Triveng.	Tree	I	Rubiaceae	Monkanta	M
Dillenia indica L.	Tree	I	Dilleniaceae	Chalta	F
Ficus benghalensis L.	Tree	I	Moraceae	Bot	W
Ficus hispida L.f.	Tree	I	Moraceae	Khoksha	W
Ficus racemosa L.	Tree	I	Moraceae	Jaga Sumur	W
Ficus religiosa L.	Tree	I	Moraceae	Asswath	W
Lagerstroemia speciosa (L.) Pers.	Tree	I	Lythraceae	Jarul	T,O
Lannea coromandelica (Houtt.) Merr.	Tree	I	Anacardiaceae	Jiga	T,M
Lepisanthes rubiginosa (Roxb.) Leenh.	Tree	I	Sapindaceae	Ban Lichu	W
Macaranga peltata (Roxb.) Muell.-Arg.	Tree	I	Euphorbiaceae	Pelta Bura	W
Mallotus polycarpus (Benth.) Kulju & Welzen	Tree	I	Euphorbiaceae	Shindur	T
Mangifera indica L.	Tree	I	Anacardiaceae	Aam	F
Melia azedarach L.	Tree	I	Meliaceae	Ghora Neem	M
Moringa oleifera Lamk.	Tree	I	Moringaceae	Sajna	M,V
Oroxylum indicum (L.) Kurz.	Tree	I	Bignoniaceae	Kanaidingi	T
Phoenix sylvestris Roxb.	Tree	I	Arecaceae	Khejur	F
Phyllanthus emblica L.	Tree	I	Euphorbiaceae	Amloki	F
Shorea robusta Roxb. *ex* Gaertn.	Tree	I	Dipterocarpaceae	Sal	T
Streblus asper Lour.	Tree	I	Moraceae	Sheora	M
Suregada multiflora (A. Juss.) Baill.	Tree	I	Euphorbiaceae	Ban-naranga	F
Syzygium fruticosum DC.	Tree	I	Myrtaceae	Buti Jam	W
Tamarindus indica L.	Tree	E	Caesalpiniaceae	Tentul	F
Terminalia bellirica (Gaertn.) Roxb.	Tree	I	Combretaceae	Bohera	M
Terminalia chebula Retz.	Tree	I	Combretaceae	Haritaki	M
Trema orientalis (L.) Blume	Tree	I	Ulmaceae	Jiban	W

Name of the species	Habit	Origin	Family	Local name	Use
Zanthoxylum rhetsa (Roxb.) DC.	Tree	I	Rutaceae	Bajna	T
Ziziphus mauritiana Lamk.	Tree	I	Rhamnaceae	Boroi	F
Acacia pennata (L.) Willd.	Shrub	I	Mimosaceae	Bon Sirish	T
Dendrophthoe falcata (L. f.) Ettingsh	Semi-parasite	I	Loganiaceae	Dhaerordal	F
Abroma augusta (L.) L. f.	Shrub	I	Sterculiaceae	Ulotkambol	M
Ardisia humilis Thw.	Shrub	I	Myrsinaceae	Chaul Dhoa	O
Bridelia stipularis (L.) Blume	Shrub	I	Euphorbiaceae	Pat Khoi	W
Cajanus cajan (L.) Millsp.	Shrub	I	Fabaceae	Arhor	V
Calamus guruba Buch.-Ham. *ex* Martius	Shrub	I	Arecaceae	Bet	W
Calotropis gigantea (L.) R. Br.	Shrub	I	Asclepiadaceae	Akanda	M
Clerodendrum viscosum Vent.	Shrub	I	Verbenaceae	Bhat	M
Croton caudatus Geiseler	Shrub	I	Euphorbiaceae	Gograil	M
Flacourtia indica (Burm. f.) Merr.	Shrub	I	Flacourtiaceae	Boichi	W
Glochidion multiloculare (Roxb. *ex* Willd.) Muell.-Arg.	Shrub	I	Euphorbiaceae	Keora	W
Glycosmis pentaphylla (Retz.) A. DC.	Shrub	I	Rutaceae	Dantmajon	W
Hibiscus sabdariffa L.	Shrub	E	Malvaceae	Chukhair	M
Jatropha gossypiifolia L.	Shrub	E	Euphorbiaceae	Lalbherenda	O
Lippia alba (Mill.) Briton *et* Wilson	Shrub	E	Verbenaceae	Pichas Lakri	M
Melastoma malabathricum L.	Shrub	I	Melastomataceae	Datranga	M
Morinda angustifolia Roxb.	Shrub	E	Rubiaceae	Rang Gach	M
Phyllanthus reticulatus Poir.	Shrub	I	Euphorbiaceae	Chitki	M
Phyllodium pulchellum (L.) Desv.	Shrub	I	Fabaceae	Jata Salpani	M
Schoepfia fragrans Wall.	Shrub	I	Olacaceae	Guchchho gram	M
Senna alata (L.) Roxb.	Shrub	E	Caesalpiniaceae	Damardan	M
Senna occidentalis (L.) Link	Shrub	E	Caesalpiniaceae	Bara Kalkesunda	M
Senna tora (L.) Roxb.	Shrub	E	Caesalpiniaceae	Chakunda	M
Sesbania bispinosa (Jacq.) Wight	Shrub	I	Fabaceae	Dhoincha	Fd
Sida acuta Burm. f.	Shrub	E	Malvaceae	Kureta	M
Solanum sisymbriifolium Lamk.	Shrub	E	Solanaceae	Kanta-begun	M
Tabernaemontana divaricata (L.) R. Br. *ex* Roem. & Schult.	Shrub	I	Apocynaceae	Tagor	O
Ziziphus oenopolia (L.) Mill.	Shrub	I	Rhamnaceae	Jaungli Boroi	W
Ziziphus rugosa Lamk.	Shrub	I	Rhamnaceae	Bon Boroi	W
Antidesma ghaesembilla Gaertn.	Shrub	I	Euphorbiaceae	Khudijam	W
Grewia nervosa (Lour.) Panigrahi	Shrub	I	Tiliaceae	Assar	W
Achyranthes aspera L.	Herb	I	Amaranthaceae	Apang	M
Ageratum conyzoides (L.) L.	Herb	E	Asteraceae	Fulkuri	M
Alternanthera philoxeroides (Mart.) Griseb.	Herb	E	Amaranthaceae	Malancha Shak	M
Amaranthus spinosus L.	Herb	E	Amaranthaceae	Kantakhure	M
Anisomeles indica (L.) O. Kuntze	Herb	I	Lamiaceae	Gobura	M
Axonopus compressus (Sw.) P. Beauv.	Herb	E	Poaceae	Carpet Durba	Fd
Cheilanthes tenuifolia (Burm.f.)Sw	Herb	I	Pteridaceae	Shuklata	M
Chromolaena odorata (L.) King & Robinson	Herb	E	Asteraceae	Bara Shialmuti	M
Chrysopogon aciculatus (Retz.) Trin.	Herb	I	Poaceae	Chorkanta	Fd
Chrysopogon zizanioides (L.) Roberty	Herb	I	Poaceae	Benna	Fd
Commelina benghalensis L.	Herb	I	Commelinaceae	Kanchira	M
Crotalaria juncea L.	Herb	E	Fabaceae	Jhunjhuni	M

Name of the species	Habit	Origin	Family	Local name	Use
Crotalaria pallida Aiton	Herb	E	Fabaceae	Jhunjhuni	M
Curculigo orchioides Gaertn.	Herb	I	Liliaceae	Tali	O
Curcuma longa L.	Herb	I	Zingiberaceae	Holud	M
Cyanthillium cinereum (L.) H. Rob.	Herb	I	Asteraceae	Kukshim	M
Cynodon dactylon (L.) Pers.	Herb	I	Poaceae	Durba	M
Cyperus distans L. f.	Herb	I	Cyperaceae	Pani Malacha	Fd
Cyrtococcum accrescens (Trin.) Stapf	Herb	I	Poaceae	Not known	Fd
Cyrtococcum oxyphyllum (Steud.) Stapf	Herb	I	Poaceae	Sada kandari	Fd
Desmodium gangeticum (L.) DC.	Herb	I	Fabaceae	Salpani	M
Desmodium heterocarpon (L.) DC.	Herb	I	Fabaceae	Karpo-mpdi	M
Desmodium laxiflorum DC.	Herb	I	Fabaceae	Boro aduulia	M
Desmodium triflorum (L.) DC.	Herb	I	Fabaceae	Kulaliya	M
Desmodium triquetrum (L.) DC.	Herb	I	Fabaceae	Ulucha	M
Elephantopus scaber L.	Herb	I	Asteraceae	Shamdala	M
Emilia sonchifolia (L.) DC.	Herb	I	Asteraceae	Sadimudi	M
Eragrostis cilianensis (All.) Vignolo-Lutati	Herb	E	Poaceae	Dudh Nal	M
Eragrostis tenella (L.) P. Beauv. *ex* Roem. & Schult.	Herb	E	Poaceae	Koni Ghas	Fd
Euphorbia hirta L.	Herb	E	Euphorbiaceae	Dudhia	M
Euphorbia hyssopifolia L.	Herb	E	Euphorbiaceae	Jungli badam	M
Fimbristylis rigidula Nees	Herb	E	Cyperaceae	Hari tandul	Fd
Flemingia javanica C.Y. Wu	Herb	E	Fabaceae	Bara Salpan	M
Floscopa scandens Lour.	Herb	I	Commelinaceae	Hangsapadi Ghas	M
Fuirena ciliaris (L.) Roxb.	Herb	I	Cyperaceae	Mutha	Fd
Glinus oppositifolius (L.) Aug. DC.	Herb	I	Molluginaceae	Gema Shak	V
Heliotropium indicum L.	Herb	I	Boraginaceae	Hatisur	M
Hellenia speciosa (J. Koenig) S.R. Dutta	Herb	I	Costaceae	Keumul	M
Hemarthria protensa Steud.	Herb	E	Poaceae	Challey Ghas	M
Hypolytrum nemorum (Vahl) Spreng.	Herb	I	Cyperaceae	Kodal patar	M
Hyptis suaveolens (L.) Poit.	Herb	E	Lamiaceae	Tokma	M
Imperata cylindrica (L.) P. Beauv. var. *latifolia* (Hook. f.) C. E. Hubb.	Herb	I	Poaceae	chon	Fd
Leersia hexandra Sw.	Herb	I	Poaceae	Arali Ghas	Fd
Leucas aspera (Willd.) L.	Herb	I	Lamiaceae	Dandokolosh	M
Lindernia anagallis (Burm. f.) Pennell	Herb	I	Scrophulariaceae	Pani Ghas	M
Ludwigia prostrata Roxb.	Herb	I	Onagraceae	Shayankura	M
Mimosa diplotricha C. Wright *ex* Sauv. var. *diplotricha* Nielsen	Herb	E	Mimosaceae	Assam Lajuk	O
Murdannia elata (Vahl) Brck	Herb	I	Commelinaceae	Lamba Murdan	M
Mimosa pudica L.	Herb	E	Mimosaceae	Lojjaboti	O
Murdannia spirata (L.) Beck	Herb	I	Commelinaceae	Sishir Murdan	M
Nelsonia canescens (Lamk.) Spreng.	Herb	I	Acanthaceae	Nelson's spurge	M
Oplismenus compositus (L.) P. Beauv.	Herb	I	Poaceae	Ghas	Fd
Panicum brevifolium L.	Herb	I	Poaceae	Ghas	M
Panicum notatum Retz.	Herb	E	Poaceae	Panita Ghas	Fd
Panicum paludosum Roxb.	Herb	I	Poaceae	Ghas	Fd
Panicum repens L.	Herb	I	Poaceae	Dhani Ghas	M
Paspalum conjugatum Bergius	Herb	E	Poaceae	Moisshya Ghas	Fd
Paspalum scrobiculatum L.	Herb	I	Poaceae	Goicha	M

Name of the species	Habit	Origin	Family	Local name	Use
Pennisetum poystachion (L.) Schult.	Herb	E	Poaceae	Shuti Ghas	M
Phyllanthus niruri L.	Herb	E	Euphorbiaceae	Bhui Amla	M
Physalis minima L.	Herb	I	Solanaceae	Ban Tepari	M
Rhynchospora rubra (Lour.) Makino	Herb	I	Cyperaceae	Lalthuti Ghas	M
Rhynchospora rugosa (Vahl) Gale	Herb	E	Cyperaceae	Kadathuti Ghas	M
Richardia scabra L.	Herb	E	Rubiaceae	Nakal Ipecac	M
Saccharum spontaneum L.	Herb	I	Poaceae	Kash	O
Schoenoplectus articulatus (L.) Palla	Herb	E	Cyperaceae	Choto Chenchra	M
Scleria levis Retz.	Herb	I	Cyperaceae	Chas Ghas	Fd
Scleria oblata S.T. Blake	Herb	I	Poaceae	Rialata Ghas	Fd
Scleria terrestris (L.) Fassett	Herb	I	Cyperaceae	Dharalik	M
Scoparia dulcis L.	Herb	E	Scrophulariaceae	Chinigura	M
Spermacoce latifolia Aublet	Herb	E	Rubiaceae	Ban dhatura	M
Sphagneticola trilobata (L.) Pruski	Herb	E	Asteraceae	Tinkona Daisy	M
Spilanthes acmella (L.) L.	Herb	I	Asteraceae	Surjakoynna	M
Strobilanthes hirta (Vahl) Blume	Herb	I	Acanthaceae	Burir Chul	M
Synedrella nodiflora (L.) Gaertn.	Herb	E	Asteraceae	Nak Phul	M
Tephrosia purpurea (L.) Pers.	Herb	I	Fabaceae	Bo Nil	M
Tridax procumbens L.	Herb	E	Asteraceae	Tridahara	M
Triumfetta rhomboidea Jacq.	Herb	I	Tiliaceae	Bon Okra	M
Uraria lagopus DC. var. neglecta (Prain) Ohashi	Herb	I	Fabaceae	Bonkathi	M
Urena lobata L.	Herb	I	Malvaceae	Okra	M
Zingiber montanum (Koen.) Dietr.	Herb	I	Zingiberaceae	Am Ada	M
Christella dentata (Forssk.) Brownsey & Jermy	Herb	E	Theypteridaceae	Bish Deki	M
Diplazium esculentum (Retz.) Sw.	Herb	I	Athyriaceae	Neutenga shak	M
Lygodium flexuosum (L.) Sw.	Herb	I	Lygodiaceae	Lata Dheki	M
Nephrolepis biserrata (Sw.) Schott.	Herb	I	Nephrolepidaceae	Bagan Dheki	M
Pteris pellucida Presl	Herb	I	Pteridaceae	Dheki Shak	M
Bambusa bambos (L.) Voss	Herb	I	Poaceae	Boro Bansh	T
Bambusa vulgaris Scharad. *ex* Wendl.	Herb	E	Poaceae	Jai Bansh	T
Cajanus scarabaeoides (L.) Thouars	Climber	I	Fabaceae	Lata Arhor	V
Coccinia grandis (L.) Voigt	Climber	I	Cucurbitaceae	Telakucha	M
Dioscorea belophylla (Prain) Voigt *ex* Haines	Climber	I	Dioscoreaceae	Shora Alu	M
Dioscorea bulbifera L. var. *bulbifera* L.	Climber	I	Dioscoreaceae	Gonj Alu	M
Dioscorea bulbifera L. var. *sativa* (Hook. f.) Prain	Climber	I	Dioscoreaceae	Gen Alu	M
Dioscorea hamiltonii Hook. f.	Climber	I	Dioscoreaceae	Miltoni Alu	M
Dioscorea pentaphylla L.	Climber	I	Dioscoreaceae	Jhum Alu	M
Dioscorea tomentosa Koen. *ex* Spreng.	Climber	I	Dioscoreaceae	Kenda	M
Dysolobium pilosum (J.K. Klein *ex* Willd.) Maréchal	Climber	I	Fabaceae	Dudhi lata	M
Merremia hederacea (Burm. f.) Hallier f.	Climber	I	Convolvulaceae	Kaladana	M
Mikania cordata (Burm.f.) B.L.Rob.	Climber	E	Asteraceae	Assam-lata	M
Mucuna pruriens (L.) DC.	Climber	I	Fabaceae	Alkushi	M
Mukia maderaspatana (L.) M. Roem.	Climber	I	Cucurbitaceae	Gol Akri	M
Operculina turpethum (L.) S. Manso	Climber	I	Convolvulaceae	Dudh Kolmi	M
Smilax ovalifoila Roxb.	Climber	I	Smilacaceae	Kumarilata	M
Smilax perfoliata Lour.	Climber	I	Smilacaceae	Kumarilata	M
Stephania japonica (Thunb.) Miers	Climber	I	Menispermaceae	Nimukha	M
Tinospora cordifolia (Willd.) Hook. f. & Thoms.	Climber	I	Menispemaceae	Ghora Gulancha	M
Lygodium microphyllum (Cav.) R.Br.	Climber	I	Lygodiaceae	Lata Dheki	M

Name of the species	Habit	Origin	Family	Local name	Use
Dalbergia volubilis Roxb.	Climber	I	Fabaceae	Bara siriskath	M
Derris cuneifolia Benth.	Climber	I	Fabaceae	Shagun	M
Derris scandens (Roxb.) Benth.	Climber	I	Fabaceae	Kali-lata	M
Spatholobus parviflorus (Roxb. *ex* DC.) O. Kuntze	Climber	I	Fabaceae	Hati Lata	M
Hemidesmus indicus (L.) R. Br.	Climber	I	Apocynaceae	Ananta Mul	M
Ipomoea aquatica Forssk.	Climber	I	Convolvulaceae	Kolmi	V
Merremia hirta (L.) Merr.	Climber	I	Convolvulaceae	Ghena lota	M
Merremia umbellata (L.) Hallier f.	Climber	E	Convolvulaceae	Sada Kolmi	M
Pueraria montana (Lour.) Merr.	Climber	E	Fabaceae	Kudzu	M

Exotic Plant Species

The current study revealed that 25% of recorded plant species are exotic whereas 75% are indigenous or native.

As the forest is dominant by a single tree, the number of exotics and their abundance have been found to be very less. These exotics such as *Parthenium hysterophorus, Mimosa pudica, Mikania cordata, Chromolaena odorata* are relatively common in the forest edges and near the roads, not inside the forest vegetation. Besides, different pockets inside the forest and many canals and water bodies also contain these plants in their banks in more or less amount. Though the invasion hasn't gained that much momentum, considering the aspects of accelerated fragmentation and disturbance in the forest, the exotics might be a serious problem in the near future.

While Rahman *et al.* (2010) documented the presence of exotic species like *Acacia auriculiformis, Eucalyptus camaldulensis*, and *A. mangium* in other Sal forests of central Bangladesh, the Purbachal Sal Forest remains free of these species. Unlike in some areas where these exotics have been intentionally planted, the Purbachal Sal Forest has not adopted such practices.

Quantitative Attributes of Tree Species

Importance Value Index (IVI) was calculated to determine the predominant tree species in the overall area of study site. According to the analysis, *Shorea robusta* is the most dominant tree species followed by *Albizia procera, Barringtonia acutangula, Cassia fistula, Trema orientale, Ziziphus mauritiana, Albizia julibrisshin, Lagerstroemia speciosa, Zanthoxylum rhetsa* and *Bridelia tomentosa* (Table 2).

Table 2. Top 10 tree species based on IVI.

Species	RD	RF	RA	IVI
Shorea robusta	85.9	42.9	90	219
Albizia procera	1.88	4.56	1.5	7.94
Barringtonia acutangula	0.67	3.77	2.11	6.56
Cassia fistula	5.22	0.47	0.05	5.74
Trema orientalis	0.6	3.62	0.31	4.53
Ziziphus mauritiana	0.49	3.62	0.12	4.23
Albizia julibrissin	0.36	2.67	0.56	3.6
Lagerstroemia speciosa	0.32	2.36	0.32	2.99
Zanthoxylum rhetsa	0.33	2.52	0.13	2.97
Bridelia tomentosa	0.24	2.36	0.18	2.79

The top 10 most abundant tree species, based on number of individuals, on overall research area are given in Fig. 2. *Shorea robusta* is the most abundant tree species followed by *Albizia procera*, *Barringtonia acutangula*, *Trema orientalis*, *Ziziphus mauritiana*, *Albizia julibrissin*, *Lannea coromandelica*, *Zanthoxylum rhetsa*, *Lagerstroemia speciosa* and *Bridelia tomentosa*.

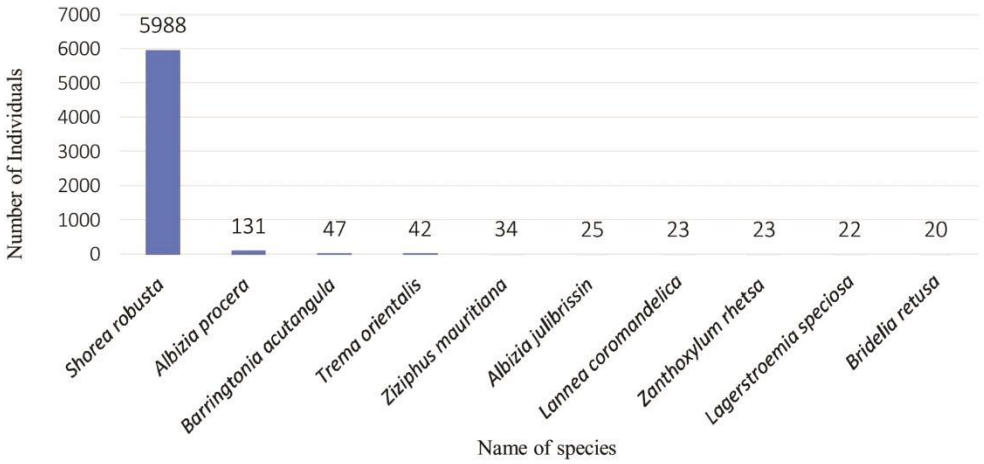

Fig. 2. Top 15 species with individuals.

The Sal tree, *S. robusta*, asserts its dominance with an unparalleled Importance Value Index (IVI) of 219. This metric, a measure of a species' relative abundance, frequency, and dominance within a community, underscores the Sal's exceptional status. In stark contrast, the other species ranked among the top 10 most-IVI-containing species pale in comparison, with IVIs that barely reach 10. The Sal's dominance actually shapes the very fabric of the forest ecosystem. For example, while the Sal trees flourish in the forest area, their less competitive counterparts i.e. other species are relegated to the margins, often confined to areas that have been disturbed by human activities. Though the number of associate trees is greater in Madhupur Sal Forests than in Purbachal Sal Forest, the dominance of Sal in Purbachal exceeds that of Madhpur (IVI 120.99) (Malakar *et al.*, 2010). In case of Bhawal Sal Forest, the dominance of Sal is quite high (277.94), surpassing both the Purbachal and Madhupur Sal Forests (Rahman and Vacik, 2010).

Diversity of Tree Species

Analysis of the Sal Forest's tree species diversity revealed moderate species richness (Margalef's Index: 4.77) contrasting with low diversity (Shannon-Wiener Index: 0.61). This pattern suggests a community with a moderate number of species, but one species, the dominant Sal (*Shorea robusta*), exhibiting significantly higher abundance compared to others. This dominance is further supported by the low Shannon-Wiener index, which incorporates both species richness and evenness of abundance.

While a moderate Simpson's Diversity Index (0.178) might suggest otherwise, the lower value in this context likely reflects the presence of a highly abundant species alongside a less abundant long tail of species. This observed pattern of moderate richness with low diversity is commonly documented in sal forests. Potential explanations for this phenomenon include efficient regeneration strategies of Sal trees, shade tolerance allowing them to thrive under their own canopy, or a combination of these factors.

Quantitative Attributes of Shrub Species

Among the 32 shrub species recorded from the study area, based on IVI, the most dominant shrub plant is *Melastoma malabathricum, Phyllodium pulchellum, Solanum sissymbrifolium, Clerodendrum viscosum, Glycosmis pentaphylla, Calamus guruba, Grewia nervosa, Abroma augusta, Sesbania bispinosa* and *Lippia alba* (Table 3).

Table 3. Top 10 shrub species based on IVI.

Name of the species	RD	RF	RA	IVI
Melastoma malabathricum L.	13.53	13.9	2.94	30.42
Phyllodium pulchellum (L.) Desv.	6.58	5.64	3.54	15.76
Solanum sisymbrifolium Lamk.	5.48	5.04	3.3	13.83
Clerodendrum viscosum Vent.	5.48	4.45	3.74	13.67
Glycosmis pentaphylla (Retz.) A. DC.	4.75	5.93	2.43	13.12
Calamus guruba Buch.-Ham. *ex* Martius	4.75	3.26	4.42	12.43
Grewia nervosa (Lour.) Panigrahi	4.2	5.64	2.26	12.1
Abroma augusta (L.) L. f.	4.02	2.08	5.87	11.97
Sesbania bispinosa (Jacq.) Wight	1.83	0.59	9.34	11.77
Lippia alba (Mill.) Briton *et* Wilson	4.02	4.75	2.57	11.34

According to the analysis, the top 15 most abundant shrub species in the study area are *Melastoma malabathricum, Phyllodium pulchellum, Clerodendrum viscosum, Solanum sisymbrifolium, Calamus guruba, Grewia nervosa, Abroma augusta, Lippia alba, Cajanus cajan, Morinda angustifolia, Croton caudatus, Sida acuta, Ziziphus oenopolia, Bridelia stipularis* and *Ziziphus rugosa*.

It is noteworthy that the IVI of *M. malabathricum* is second to Sal (*Shorea robusta*) when compared to both trees and shrubs, highlighting its relative abundance within the forest community. The presence of a single shrub species, *M. malabathricum*, with such a high IVI alongside Sal trees suggests a possible niche specialization or competitive advantage that allows it to thrive in the understory of the sal forest. Further investigation into the ecological adaptations of *M. malabathricum* could provide insights into how it coexists with Sal trees and other shrub species.

Herb Species of Purbachal Sal Forest

A total 88 herb species belonging to 27 families have been found in the study sites. The scientific name, common name, family, habit, origin and uses were all recorded in the list (Table 1). All plant species in the families, are not equally represented. In this instance, 5 families represent 62% of all species, whereas the remaining 22 families represent 42%. Poaceae is the largest family followed by Fabaceae, Cyperaceae, Asteraceae and Commelinaceae.

People's Perception

One hundred and eight participants were selected for interviews from a variety of backgrounds, including retired and incumbent govt. officers, businessmen, private job holders, housewives, teachers, and plot owners. Each interviewee was asked nine close-ended questions in the form of a questionnaire. Each question resulted in a different percentage of positive and

negative feedback. Moreover, they helped in pointing out many challenges of managing Purbachal Sal Forest and also in suggesting recommendations that were duly noted during the interviews.

The public survey exposes a deep concern for the Purbachal Sal Forest's health. The presence of invasive exotic plants is overwhelmingly disapproved of (90%), highlighting public awareness of the threat they pose. There is near-unanimous agreement (95%) on the importance of consulting environmental specialists for managing plant diversity, reflecting a public desire for professional guidance. Stricter enforcement of laws to protect the forest from human activities like cutting and habitat destruction finds strong support (over 90%), demonstrating public awareness of the anthropogenic pressures on the forest. While nearly three-quarters (76%) see a role for local communities in conservation efforts, a significant minority is unsure, suggesting a need for outreach programs to raise awareness and encourage participation. Public opinion is unanimous (100%) on the need for the government to allocate more resources towards forest protection and management. Reforestation programs that focus on planting native species are overwhelmingly endorsed (89%), aligning with the concern over invasive plants and emphasizing the public's desire to restore the forest's natural heritage. Finally, over three-quarters (77%) believe the loss of the Sal Forest would significantly impact the local climate and ecosystem, highlighting public understanding of the critical role the forest plays in environmental stability. In conclusion, the survey reveals a clear public mandate for protecting the Purbachal Sal Forest. By acknowledging these concerns and incorporating public sentiment into conservation strategies, policymakers and forest managers can develop more effective and well-supported plans for safeguarding this vital ecosystem for the future.

Threats to Plant Diversity in Purbachal

The Purbachal Sal Forest is threatened by multifaceted problems. Invasive alien species like *Chromolaena odorata, Mikania cordata, Mimosa pudica, Parthenium hysterophorus, Sphagneticola trilobata,* and *Acacia auriculiformis* are outcompeting native plants, disrupting the forest's ecosystem balance. Habitat destruction caused by urbanization, deforestation, and unsustainable practices like firewood collection and agricultural expansion is further exacerbating the problem. The clearing of land for various purposes, including infrastructure development and housing, is leading to significant deforestation. Additionally, the dumping of waste is polluting the forest and harming its biodiversity. These combined factors pose a serious threat to the forest's ecological integrity and its ability to provide essential services.

Recommendations

The Purbachal Sal Forest, despite its promising regeneration as evidenced by its high tree density, faces significant challenges posed by invasive species and the uneven distribution of fruit-bearing trees. To address these issues and ensure the forest's long-term health, a comprehensive management plan is essential. This plan should incorporate strategies such as mixed-species regeneration in forest pockets, targeted planting of some wildlife-supporting trees, effective control of invasive species, active community involvement, stricter enforcement of forest laws, and involvement of expert in managing the forests. By implementing these measures, the Purbachal Sal Forest can be effectively protected and its biodiversity could be enhanced, safeguarding this vital ecosystem for future generations.

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