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Quantitative evaluation of biological spectrum and phenological pattern of vegetation of a sacred grove of West Midnapore District, Eastern India

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Abstract. *Sen UK, Bhakat RK. 2021. Quantitative evaluation of biological spectrum and phenological pattern of vegetation of a sacred grove of West Midnapore District, Eastern India. Asian J For 5: 83-100.* Sacred groves, small forests patches devoted to deities and ancestral spirits, are classic examples of community-based, culturally aware, natural resource management. To indigenous groups that care for them, display rich biodiversity, and provide ecological services to local groups that have sustained the environment over the years, sacred groves have cultural and spiritual significance. This studied sacred forest hosts 312 plant species belonging to 257 genera under 78 families of 34 orders according to APG IV. Poales, 73, 23.40% and Poaceae, 48, 15.38% were the dominant order and family. Therophytes, cryptophytes and chamaephytes constitute a higher percentage 16.81%, 3.62% and 3.18% respectively than the normal spectrum exhibiting "thero-crypto-chamaephytic" phytoclimate. Leaf size spectra showed that the plant with leptophyll, 83, 26.60% and ovate, 59, 18.91% type's leaf lamina were dominant. The findings may have a heuristic value in developing future monitoring schemes and assessing the effects of global change in this varied but poorly studied area.

Keywords: Biodiversity, biological spectra, leaf size spectra, life form, sacred grove, West Midnapore

INTRODUCTION

Sacred groves have a wealth of history, traditions and ancient links between ecosystems and their local peoples (Anthwal et al. 2010). Across several countries of the world, sacred groves have been found to have a major effect on biodiversity and the environment because of the limitations associated with them (Bhagwat et al. 2005). Traditional environmental protection and limits on entry to sacred groves in otherwise deteriorated habitats have also contributed to well-preserved areas with high biodiversity (Tanyanyiwa and Chikwanha 2011; Rath and John 2018). Sacred groves are scattered throughout the glove and diverse cultures acknowledge various positions in their defense in different ways. There are many parts of India, especially where indigenous communities live (Maffi and Woodley 2012). These are known to the ethnic people who give them various names. Its diversity has been documented as a unique example of traditional conservation practices. Many workers have discussed their potential for conservation worldwide (Laird 2002). They are thought to be more effective than government-protected areas because they are community-managed and cover a wide variety of habitats. Sacred groves are remaining patches of virgin tropical forests, which are rarely destroyed by human activity but are conserved and protected by local people and serve as ecological and archaeological historical markers (Verschuuren et al. 2010). There was a general understanding among the ancients that the godly element was actively at work in places of natural sacred sites. Consequently, the forest was considered sacred for the neighboring people. These sites continue to exist today and play a significant role at various ecological levels (Wild et al. 2008).

The adaptation of a plant to certain ecological conditions determines a life form; hence, it is an important physiognomic feature that has been commonly used in the study of vegetation. This shows a certain area's macro and microclimate and human disturbance (Van der Maarel and Franklin 2012). The word "Biological Spectrum" was coined by Raunkiaer (1934) to describe the distribution of life-forms in flora as well as the phytoclimate in which the dominant life-forms evolved. Under this scheme, the plant species may be grouped into five main groups, i.e. phanerophytes, chamaephytes, hemicryptophytes, cryptophytes, and therophytes. The proportion of groups brought together in different life forms is called the biological continuum. Raunkiaer has developed a standard spectrum that can serve as a model against which spectra can be compared to different forms of life. Raunkiaer's standard range reveals a phanerophytes group, and the deviation (from that) defines the phytoclimate of an environment.

Under a specific climate regime, climatic types can be characterized by the prevailing plant life forms in plant communities (da Costa et al. 2007). The Indian region's biological spectrum is related to specific edaphic, altitudinal and climatic factors (Sen and Bhakat 2019; 2021). As a result, next to floristic composition, the analysis of life-form is a valuable method for describing vegetation. The biological continuum is also useful as an indicator of the state of health of the forest ecosystem (Ingegnoli 2015). Life type can also be graded using the size of the leaf. It has some justification for using a leaf

size to characterize different types of vegetation based on percentages of the different leaf sizes present (Dolph and Dilcher 1980). However, when performed at periodic intervals, the biological spectrum may set guidelines for the optimization and eco-restoration of a community. Life type can also be graded using the size of the leaf even within the same genotype (Alvarez-Clare et al. 2013). As a result, the current study of a sacred grove in India may be used as a model for other sacred groves in general, and in particular for the study of phytoclimatics.

MATERIALS AND METHODS

Study site

The present sacred grove, popularly known as "Kankabati Sitabala Than (KST)" located at latitude 22º25'15.12"- 22º25'15.55" N and longitude 87º15'11.90"-87º15'12.16", at an altitude of 36.26 m asl is named after its presiding folk deity Sitabala or Sitala (Figure 1), is situated 7 km from the West Midnapore district (India) headquarters town of Midnapore along the Midnapore-Jhargram road running east-west under the Midnapore Sadar block. The grove spreads over an area of 4 acres on public land at the common outskirts of the villages of Badhi, Kankabati and Lodhasai. This semi-evergreen, part-marshy, part-terrestrial 800-year-old grove stands amid crop fields as an island of woodland. In addition to the regular worship given to the deity of the grove, local people, both tribal (Bhumij, Kora, Santal) and non-tribal from the surrounding villages visit the sacred forest en masse during the annual 'Makar Sankranti' (Mid-Month of January) during the two-day village fair. Strictly adhering to the taboos and ethics, people do not cut any grove plants or foul the area's serenity since the grove is the goddess's abode. Worshipping the goddess, according to folklore, grants immunity to pox, as well as village well-being and wealth to heralds.

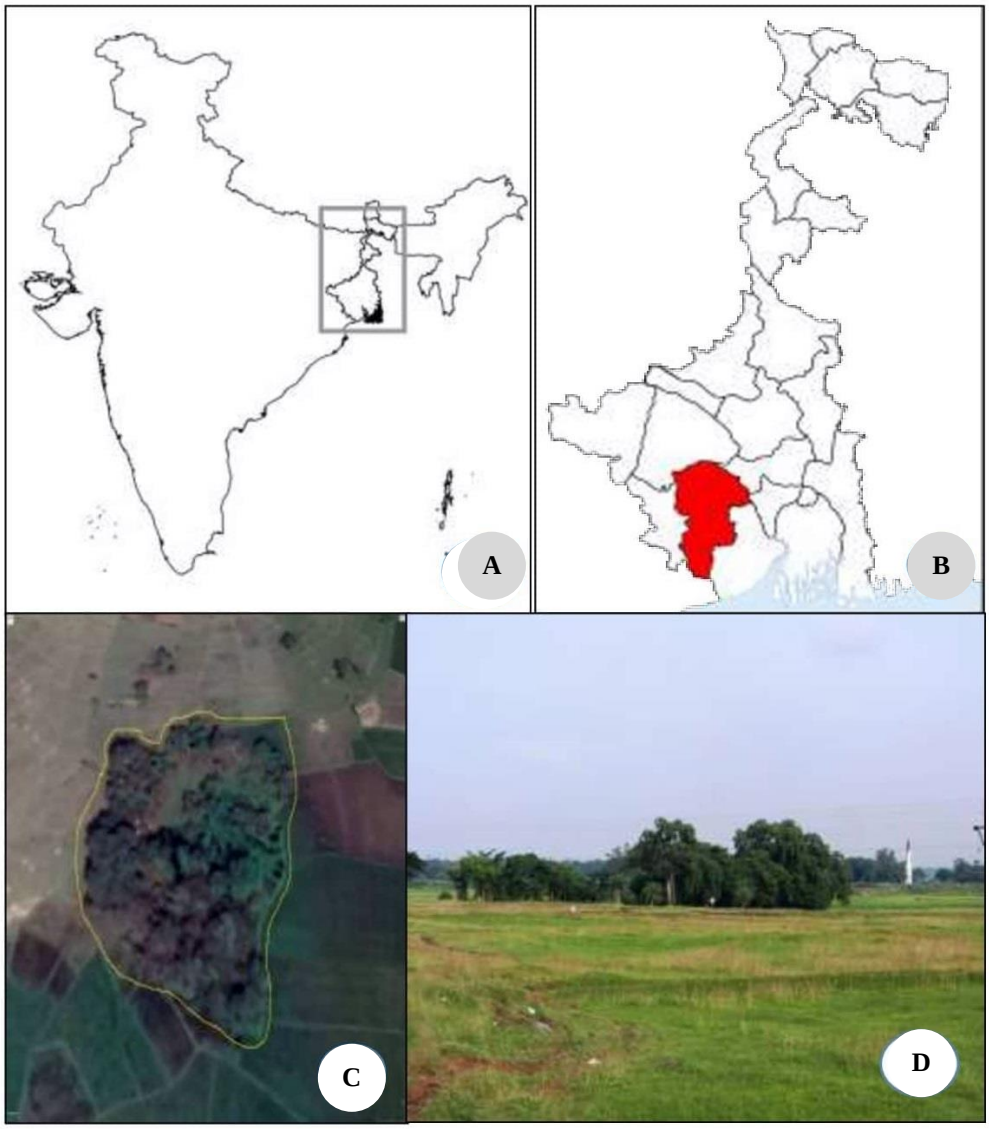

Figure 1. Location of the study area (A) location of the state of West Bengal (boxed) within India; (B) location of West Midnapur district in West Bengal; (C) Google Earth image of Kankabati Sitabala Than (KST) and (D) Field picture of KST.

Field survey and data collection

The research area was extensively surveyed at different seasons during the period from September 2014 to October 2019 to examine botanical and social perspectives. Floristic surveys have been conducted based on "spot identification". For unknown plants, samples were collected of plants with flowers or fruits. After collection, the specimens were processed, stored, poisoned and placed on herbarium sheets using traditional and modern herbarium techniques (Jain and Rao 1977). Photographs of some common, locally uncommon, endangered, and valuable plant species were taken at the sacred grove. Herbarium sheets were described by matching properly annotated materials available on the Herbarium at Vidyasagar University. For identification purposes, several related catalogs (Anderson 1862), regional floras (Hooker 1872-1897; Prain 1903; Haines 1921-1925; Bennet 1979; Sanyal 1994), monographs (Mitra 1958), revision works (Datta and Majumdar 1966) and other literature were consulted. The plant's scientific names were checked with the WCVP (World Checklist of Vascular Plant) (WCVP 2021) website and only accepted names were considered. The socio-cultural functions surrounding the grove were documented through information gathered from interviews and cross-interviews with devotees and local people during the Paus Sankranti festival.

Analysis of vegetation

In the systematic enumeration of taxa, the following terms were used: class, order, family, species along with voucher number, habit, life-span, nativity, flowering and fruiting time, life-form of Raunkiaer with subtype, leaf spectra, the shape of the lamina, IUCN red list status (IUCN 2021) and plant growing seasons and then they were arranged according to the classification of Angiosperm Phylogeny Group IV (Chase et al. 2016) (Table 1). The total number of orders, families, genera and species in dicots and monocots were summarized (Table 2). All the species were categorized into different groups of Raunkiaer's life-form based on the location of regenerating parts or propagules in all the species collected and a biological spectrum was prepared for the grove, which was subsequently compared to the Raunkiaer's usual spectrum to determine the grove's phytoclimate (Raunkiaer 1934) (Table 1, 3). Knowledge of leaf size in understanding the physiological development of plants and plant communities was utilized to classify associations of plants. Diverse plant leaf sizes were arranged with their respective Raunkiaer life forms (Table 4). Plants were divided into (i) leptophyll (< 25 mm^2), (ii) nanophyll (25-225 mm^2), (iii) microphyll (225-2025 mm^2), (d) notophyll (2025-4500 mm^2), (e) mesophyll (4500-18225 mm^2), (f) microphyll (18225-164025 mm^2) and (g) megaphyll (> 164025 mm^2) (Raunkiaer 1934).

RESULTS AND DISCUSSION

Different plant taxa

In this study, a total of 312 species belonging to 256 genera distributed among 78 families of 34 orders were reported from the sacred grove according to the APG IV (2016) classification. Rosids and Asterids were the top two clades. More than 80% of the flora was represented by orders from Eudicot and Core Eudicot, of which the major contributions (≥10 species) were from Poales, 73, (23.40%); Fabales, 39, (12.50%); Malpighiales, 20, (6.41%); Alismatales, 18, (5.77%); Lamiales, 16, (5.13%); Asterales, 14, (4.49%); Caryophyllales, 14, (4.49%); Malvales, 14, (4.49%) and Myrtales, 10, (3.21%) (Table 1; Figure 2).

Only sixteen out of the total families, show ≥5 species were Poaceae, 48 (15.38%); Fabaceae, 37 (11.86%); Cyperaceae, 23 (7.37%); Asteraceae, 14 (4.49%); Malvaceae, 14 (4.49%); Euphorbiaceae, 11 (3.53%); Araceae, 7 (2.24%); Cucurbitaceae, 7, (2.24%); Lamiaceae, 7, (2.24%); Commelinaceae, 6, (1.92%); Acanthaceae, 5, (1.60%); Dioscoreaceae, 5, (1.60%); Hydrocharitaceae, 5, (1.60%); Menispermaceae, 5, (1.60%); Rubiaceae, 5, (1.60%) and Vitaceae, 5, (1.60%) in descending array (Figure 3). Another four families had 4 species (1.28%); eight families had 3 species (0.96%) and eighteen families each had 2 species (0.64%) species, each, while thirty-two families were represented by just one species (Table 1).

The ten dominant plant families with declining numbers (≥6 species) comprised more than 51 % genera were Fabaceae, 14 (8.33%); Apocynaceae, 11 (6.55%); Asteraceae, 11 (6.55%); Lamiaceae, 9 (5.36%); Malvaceae, 9 (5.36%); Poaceae, 9 (5.36%); Acanthaceae, 6 (3.57%); Cyperaceae, 6 (3.57%); Euphorbiaceae, 6 (3.57%) and Rubiaceae, 6 (3.57%) (Table 1).

The eleven genera which are well represented are *Cyperus* (13 spp.), *Dioscorea* (4 spp.), *Fimbristylis* (4 spp.), *Setaria* (4 spp.), *Chrysopogon* (3 spp.), *Crotalaria* (3 spp.), *Euphorbia* (3 spp.), *Ficus* (3 spp.), *Panicum* (3 spp.), *Phyllanthus* (3 spp.) and *Sida* (3 spp.). *Agave*, *Annona*, *Cajanus*, *Chamaecrista*, *Commelina*, *Cyanotis*, *Eragrostis*, *Eriocaulon*, *Hygrophila*, *Jatropha*, *Murdannia*, *Potamogeton*, *Rhynchospora*, *Sacciolepis*, *Senna*, *Solanum*, *Tephrosia*, *Terminalia* and *Trichosanthes* were the nineteen well-represented genera with 2 species. There were only one species in another 224 genera (Table 1).

Species diversity in different growth form

The current sacred grove floristic study showed that it harbored a total of 312 plant species (dicots, 189, 60.58% and monocots, 123, 39.42%) of the genera 256 (dicots, 168, 65.63% and monocots, 88, 34.37%) of 78 families (dicots, 56, 71.80 % and monocots, 22, 28.20%) under 34 orders (dicots, 25, 73.53% and monocots 9, 26.47%). Of the reported species, 197, 63.14% were herbs. Other species reported were shrubs 38, 12.18%; trees 30, 9.62% and climbers 47, 15.06%. Herbs, shrubs, trees, and climbers made up 88, 35, 28, 38, and 109, 3, 2, 9 species respectively, accounting for 28.21%, 11.22%, 8.97%, 12.18%, and 34.94%, 0.96%, 0.64%, 2.88% of the total species (Table 2; Figure 4).

Table 1. Summary of the angiosperm taxa available in Kankabati Sitabala Than, eastern India

Clade	Order	Family	Habit			Raunkiaer's life-form							Leaf spectra						Total	
			H	S	T	C	Ph	Ch	He	Cr	Th	Le	Na	Mi	No	Me	Ma	Mg	Genus/ Genera	Species
	Nymphaeales	Nymphaeaceae	1							1								1	1	1
Mesangiosperms Magnoliids																				
	Piperales	Aristolochiaceae				1				1					1				1	1
	Magnoliales	Annonaceae			2		2									2			1	2
Independent Lineage Monocots																				
	Alismatales	Araceae	6			1				7		2	1	1			1	2	7	7
		Alismataceae	3						3					2			1		3	3
		Hydrocharitaceae	5							5		3	2						5	5
		Aponogetonaceae	1							1							1		1	1
		Potamogetonaceae	2						2							2			1	2
	Dioscoreales	Burmanniaceae	1								1	1							1	1
		Dioscoreaceae	1			4				5			1			4			2	5
	Pandanales	Pandanaceae		1			1											1	1	1
	Liliales	Colchicaceae				1	1									1			1	1
		Smilacaceae				1	1										1		1	1
	Asparagales	Orchidaceae	2				1			1				1	1				2	2
		Hypoxidaceae	1							1				1					1	1
		Xanthorrhoeaceae	2					1			1				2				2	2
		Amaryllidaceae	1							1								1	1	1
		Asparagaceae		2		1		2		1		1						2	2	3
	Arecales	Arecaceae			2	1	3							2				1	3	3
	Commelinales	Commelinaceae	6								6		4	2					3	6
	Zingiberales	Costaceae	1							1							1		1	1
		Zingiberaceae	4							4							3	1	4	4
	Poales	Eriocaulaceae	2								2	2							1	2
		Cyperaceae	23						23			19	4						7	23
		Poaceae	48						48			40	1		7				38	48
Eudicots	Ranunculales	Papaveraceae	2								2						2		2	2
		Menispermaceae				5	5									5			5	5
Rosids	Vitales	Vitaceae		1		4	4	1							3	2			5	5
	Fabales	Fabaceae	13	7	8	9	16	9			12		18	9	5	4	1		31	37
		Polygalaceae	2								2					2			2	2
	Rosales	Rhamnaceae				2	2								1	1			2	2
		Ulmaceae			1		1									1			1	1
		Moraceae			4		4							1		1	2		2	4
		Urticaceae	1								1	1							1	1
	Cucurbitales	Cucurbitaceae				7	7							1		6			6	7
	Celastrales	Celastraceae				1	1							1					1	1
	Oxalidales	Oxalidaceae	1								1		1						1	1
	Malpighiales	Hypericaceae	1								1	1							1	1
		Elatinaceae	1								1		1						1	1
		Violaceae	1								1		1						1	1
		Passifloraceae				1	1								1				1	1
		Salicaceae		1				1						1					1	1
		Euphorbiaceae	5	2	3	1	4	2			5	1	2	1	3	2	2		8	11
		Phyllanthaceae	3	1				1			3	1	2	1					2	4
	Myrtales	Combretaceae			2	1	3									1	2		2	3
		Lythraceae	4							1	3	3			1				3	4
		Onagraceae	1								1			1					1	1
		Myrtaceae			1		1									1			1	1
		Melastomataceae	1								1			1					1	1
	Sapindales	Sapindaceae		1		2	3								3				3	3
		Meliaceae			2		2								2				2	2
	Malvales	Malvaceae	9	5				4			10		1	7	4	2			12	14
	Brassicales	Capparaceae			1	1	2								1	1			2	2
		Cleomaceae	1								1			1					1	1

Superasterids	Santalales	Santalaceae		1						1	1							1	1
		Loranthaceae		2			2							2				2	2
	Caryophyllales	Polygonaceae	1			1	1			1		2						2	2
		Droseraceae	1							1	1							1	1
		Caryophyllaceae	3					2		1	2	1						3	3
		Amaranthaceae	3							3		1	2					3	3
		Aizoaceae	1							1			1					1	1
		Nyctaginaceae	1							1			1					1	1
		Portulacaceae	1							1			1					1	1
		Cactaceae		2				2			2							2	2
Asterids	Cornales	Cornaceae			1		1								1			1	1
	Ericales	Primulaceae	1							1			1					1	1
	Gentianales	Rubiaceae	2	2	1		2	1		2		2		2		1		5	5
		Loganiaceae	1		1		1			1		1			1			2	2
		Apocynaceae		1		2	2	1					1	1	1			3	3
	Boraginales	Boraginaceae	1							1				1				1	1
	Solanales	Convolvulaceae	2							2		1		1				2	2
		Solanaceae	1	1				1		1						2		1	2
	Lamiales	Plantaginaceae	2							2		2						2	2
		Acanthaceae	4	1				2		3			4	1				4	5
		Verbenaceae		2				2					1	1				2	2
		Lamiaceae	2	4	1		1	5		1		1	3		2	1		7	7
	Asterales	Asteraceae	13	1				1		13	2	2	6	3	1			14	14
	Apiales	Apiaceae	1							1				1				1	1
Total			197	38	30	47	75	38	76	30	93	83	52	55	48	44	21	9	256	312

Note: Habit: C: Climber, H: Herb, S: Shrub, T: Tree; Raunkiaer's Life: form and Sub: type: Ch: Chamaephytes, Cr: Cryptophytes, H: Hemicryptophytes, M: Mesophanerophyte, MM: Megaphanerophytes, N: Nanophanerophytes, Ph: Phanerophytes, T: Therophytes; Leaf spectra: Le: Leptophyll, Na: Nanophyll, Mi: Microphyll, No: Notophyll, Me: Mesophyll, Ma: Macrophyll, Mg: Megaphyll

Table 2. Taxonomic and habit distribution of angiosperm taxa in Kankabati Sitabala Than, eastern India

Group	Orders	Families	Genera	Species				
				Herbs	Shrubs	Trees	Climber	Total
Dicots	25	56	168	88	35	28	38	189
Monocots	9	22	88	109	3	2	9	123
Total	34	78	256	197	38	30	47	312

Table 3. Life-form analysis with different leaf sizes

Raunkiaer's life form	Leaf spectra							Total
	Le	Na	Mi	No	Me	Ma	Mg	
Ph	1	4	14	19	29	6	2	75
MM	0	0	2	0	5	4	1	12
M	0	0	1	6	3	1	0	11
N	1	4	11	13	21	1	1	52
Ch	3	7	9	8	4	5	2	38
He	59	5	2	7	2	1	0	76
Cr	6	4	3	2	4	6	5	30
Th	14	32	27	12	5	3	0	93
Total	82	52	55	48	44	21	9	312

Table 4. Biological spectrum (% of all life forms) of sacred grove and its comparison with Raunkiaer's normal spectrum

Life forms	Total no. of species	Biological spectrum (%) of the sacred grove	Raunkiaer's normal spectrum (%)	Deviation= (Raunkiaer's normal spectrum- Biological spectrum)
Phanerophytes (Ph)	75	24.04	46.00	-21.96
Megaphanerophytes (MM)	12	3.85	3.00	0.85
Mesophanerophyte (M)	11	3.53	28.00	-24.47
Nanophanerophytes (N)	52	16.66	15.00	1.67
Chamaephytes (Ch)	38	12.18	9.00	3.18
Hemicryptophytes (He)	76	24.36	26.00	-1.64
Cryptophytes (Cr)	30	9.62	6.00	3.62
Therophytes (Th)	93	29.81	13.00	16.81
Total	312	100	100	

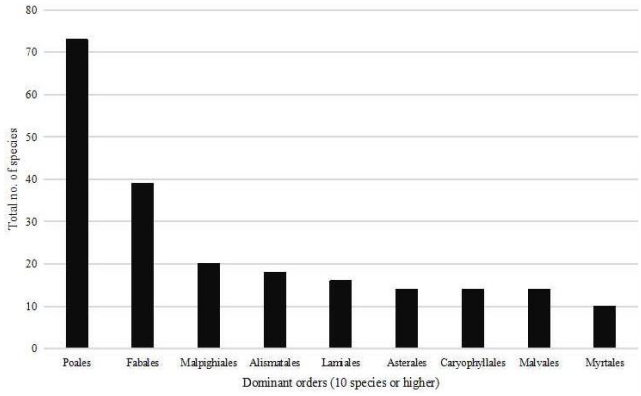

Figure 2. Dominant orders in the Kankabati Sitabala Than, eastern India

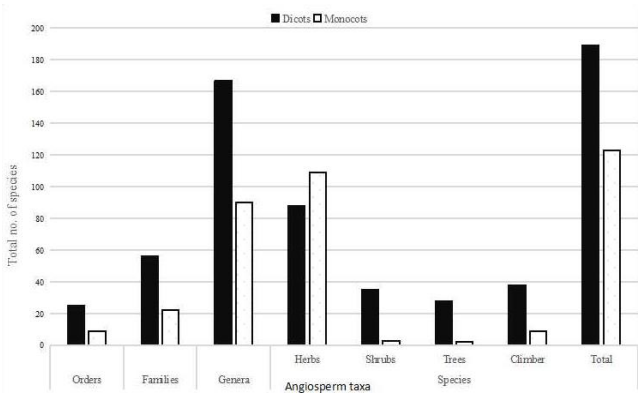

Figure 4. Diversity of different taxa in the Kankabati Sitabala Than, eastern India

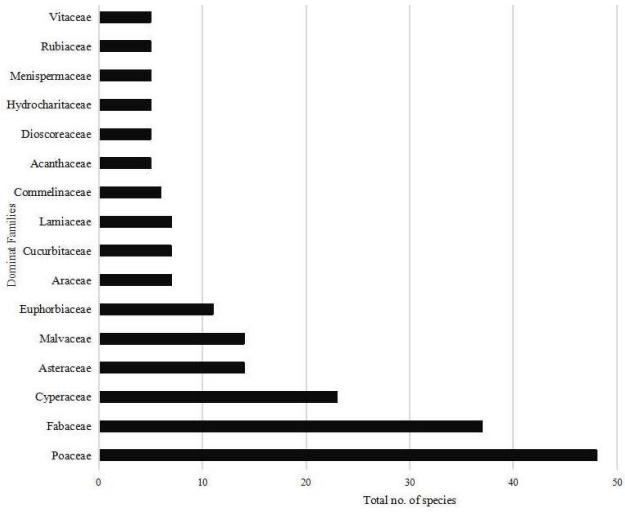

Figure 3. Dominant families in the Kankabati Sitabala Than, eastern India

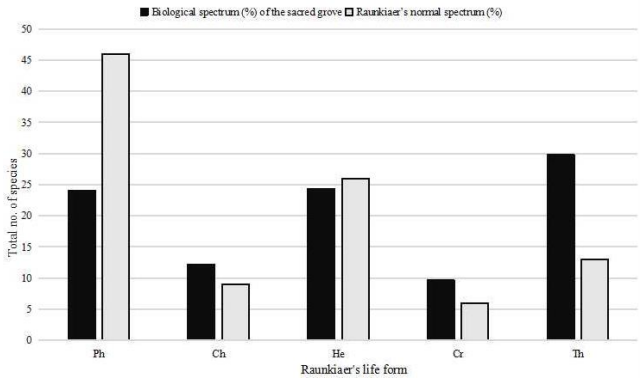

Figure 5. Comparison of biological spectrum of Kankabati Sitabala Than, eastern India with Raunkiaer's normal spectrum

Major seven herbaceous families (≥5 species) were Poaceae, 48 (24.37%); Cyperaceae, 23 (11.68%); Asteraceae, 13 (6.60%); Fabaceae, 13 (6.60%); Malvaceae, 9 (4.57%); Araceae, 6 (3.05%) and Commelinaceae, 6 (3.05%) held above 59% of the total herb population. The three major less-woody shrub families were Fabaceae, 7 (18.42%); Malvaceae, 5 (13.16%) and Lamiaceae, 4 (10.53%) held above 42% of the total shrubs population. Fabaceae, 8 (26.67%); Moraceae, 4 (13.34%) and Euphorbiaceae, 3 (10%) were three highly diversified families with over 50% of the total tree population. There were two trees in another four families, as well as seven families of single tree species. The five most speciose families in descending manner included Fabaceae, 9 (19.15%); Cucurbitaceae, 7 (14.89%); Menispermaceae, 5 (10.64%; Dioscoreaceae, 4 (8.51%) and Vitaceae, 4 (8.51%) clasp above 61% of the total liana population (Table 1).

Life span and nativity

In the sacred grove, in one growing season, 130 (41.67%) of annual plants would go through their life cycle. There were 1 (0.32%) biennial plants with a two-year life cycle and 181 (58.01%) perennial plants that could survive the most unfavorable conditions and stay alive for more than two years. In all, 225 (72.12%) species were native, while 87 (27.88%) species were exotic (Table 1).

Raunkiaer's life form and its distribution

One of Raunkiaer's life-form groups is phanerophyte, which is a plant whose perennial buds or shoot apices bore on aerial shoots, with the three most speciose families (≥5 species) mentioned in descending form included Fabaceae, 16 (21.34%); Cucurbitaceae, 7 (9.34%) and Menispermaceae, 5 (6.67%) containing more than 37% of the total phanerophytes. Three major descending chamaephyte families (≥4 species) were Fabaceae, 9 (23.68%); Lamiaceae, 5 (13.16%) and Malvaceae, 4 (10.53%); with a total population of (47.37%). Two leading hemicryptophytic families Poaceae, 48 (63.16%) and Cyperaceae, 23 (30.26%); explicitly contained 93.42% of the total population. Araceae, 7 (23.34%); Dioscoreaceae, 5 (16.67%); Hydrocharitaceae, 5 (16.67%) and Zingiberaceae, 4 (13.34%) were four dominant descending

cryptophytes families total contained above 70% of the population. The five main therophyte families (≥5 species) were Asteraceae, 13 (13.98%); Fabaceae, 12 (12.90%); Malvaceae, 10 (10.75%); Commelinaceae, 6 (6.45%) and Euphorbiaceae, 5 (5.38%) of the total population of 49.46% (Table 1).

Life form and biological spectrum

The biological spectrum shows that therophytes, 93 (29.81%) were the dominant, followed by hemicryptophytes, 76 (24.36%); phanerophytes, 75 (24.04%); chamaephytes, 38 (12.18%) and cryptophytes, 30 (9.62%). Of the phanerophytes, nanophanerophytes, 52 (16.67%) was dominant than megaphanerophytes, 12 (3.85%) and mesophanerophytes, 11 (3.53%) (Table 4).

This study revealed that therophytes, cryptophytes and chamaephytes constitute the higher percentage 16.81%, 3.62% and 3.18% respectively than the normal spectrum exhibiting "thero-crypto-chamaephytic" phytoclimate. Further, the number of phanerophytes, 21.96% and hemicryptophytes, 1.64% is comparatively smaller in percentage than the Raunkiaer's normal spectrum. Out of the total phanerophytes, nanophanerophytes, 1.67% and megaphanerophytes, 0.85% was somewhat larger and mesophanerophyte, 24.47% was a comparatively smaller value than the Raunkiaer's normal spectrum (Table 4; Figure 5).

Leaf size spectra

The overall spectrum of leaf sizes showed that leptophyll, 83 (26.60%); nanophyll, 52 (16.67%); microphyll, 55 (17.63%); notophyll, 48 (15.38%); mesophyll, 44 (14.10%); macrophyll, 21 (6.73%) and megaphyll, 9 (2.88%) existed. As regards the spectrum of the leaf size, leptophyll is the high followed by microphyll, nanophyll, notophyll, mesophyll, macrophyll and megaphyll. Poaceae, 40 (12.82%); Fabaceae, 18 (5.77%); Fabaceae, 9 (2.88%); Poaceae, 7 (2.24%); Cucurbitaceae, 6 (1.92%); Zingiberaceae, 3 (0.96%) and Araceae, 2 (0.64%) were dominant leptophyll, nanophyll, microphyll, notophyll, mesophyll, macrophyll and megaphyll families (Table 1, 3; Figure 6).

The shape of the leaf lamina and phenology

The leaf is generally a flat, green photosynthetic organ on the stem. As regards the shape of leaf lamina, ovate, 59 (18.91%) has been found to be the maximum followed by lanceolate, 46 (14.74%); cordate, 44 (14.10%); acicular, 39 (12.50%); linear, 41 (13.14%); sagitate, 16 (5.13%); obovate 14 (4.49%); subulate, 11 (3.53%); oblong, 9 (2.88%); hastate, 7 (2.24%); spathulate, 6 (1.92%); reniform, 5 (1.60%); orbicular, 4 (1.28%); cuneate, 3 (0.96%); palm like, 3 (0.96%); sabulate, 3 (0.96%); and lunate, 2 (0.64%) (Table 1).

The vegetation phenology observed during different seasons revealed that most of the species were dominant in rainy seasons, 311 (99.68%); followed by winter, 218 (69.87%) and summer, 93 (29.81%). Seasonally habit-wise species content varied; in the summer season, tree>climber>herb>shrub; rainy season, herb>climber> shrub>tree; winter season, herb>climber>shrub>tree, respectively (Table S1; Figure 7).

IUCN categories

230 plants have not yet been evaluated still now. There have been 80 species of Least Concerned (LC). *Cayratia pedata* was the vulnerable liana, whereas *Pterocarpus indicus* was the IUCN-species of a vulnerable tree (Table 1).

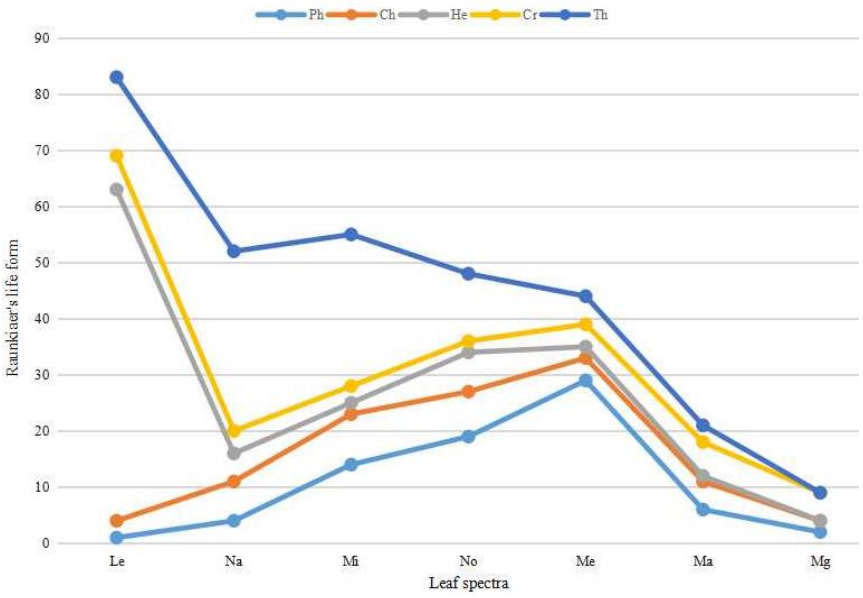

Figure 6. Leaf spectral variation in the Kankabati Sitabala Than, eastern India

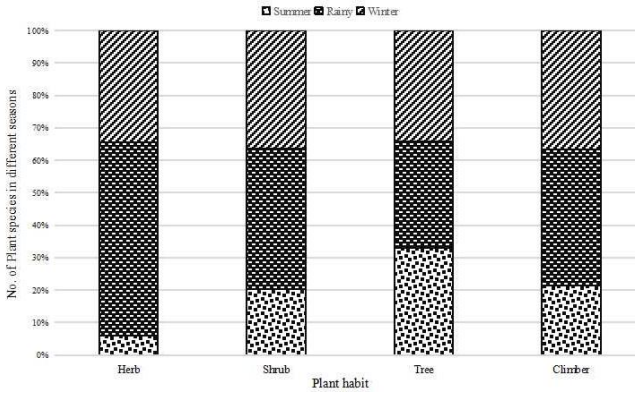

Figure 7. Vegetation phenology in the Kankabati Sitabala Than, eastern India

Discussion

Dominant taxa and climatic factors

The presence in the studied KST sacred grove of 312 plant species belonging to 256 genera, 78 families and 34 orders indicates a considerable level of plant diversity. Such species have developed diverse societies adapted to their ecological needs and the management that human beings have implemented in recent years. High plant diversity in the area appeared to have been due to topographical, edaphic and physiographic conditions. Of course, the micro-climate factor was also effective in this respect, but variations in the area's climatic conditions were smaller than the other factors (Kargar-Chigani et al. 2017). From the analysis, it can be established that Rosids and Asterids were the dominant clades (Gastauer and Meira-Neto 2017). Poales, Fabales, Malpighiales, Alismatales, Lamiales, Asterales, Caryophyllales and Malvales were major contributing orders in terms of descending species number in the grove. The top ten families in descending form were Fabaceae, Apocynaceae, Asteraceae, Lamiaceae, Malvaceae, Poaceae, Acanthaceae, Cyperaceae, Euphorbiaceae and Rubiaceae (Sen and Bhakat 2018).

Biological spectrum

The phanerophytic life form had the third-highest percentage (24.04%), which was partially due to local security under some sacred grove taboos. The therophytes, cryptophytes and chamaephytes life forms had the highest 16.81%, 3.62% and 3.18% respectively, of the normal spectrum exhibiting "thero-crypto-chamaephytic" phytoclimate; phanerophytes (21.96%) were reasonably smaller in percentage than the normal spectrum probably partly due to the local threat. The dominant therophytes, cryptophytes and chamaephytes altogether constituted 51.61% of the life forms proportion. Therophytes showed the maximum divergence of the normal spectrum; a similar phytoclimatic association had also been reported by other workers for different tracks of vegetation (da Costa et al. 2007; De Mera and Vicente Orellana 2007; Sahu et al. 2012; Ceschin and Caneva 2013; Raju et al. 2014; Jakhar 2015; Yifru et al. 2015; Hamid and Raina 2019; Das et al. 2020; Zeb et al. 2020).

The highest percentage of therophytes taking place in the area was the trait of the subtropics and often related to soil and climatic conditions (Cornelissen et al. 2003). The prevalence of therophytes is accredited to diverse factors like widespread microclimate of the region united with anthropogenic activities like grazing, lopping, felling, deforestation, the introduction of annual weeds etc., was also reported by other workers (Khan et al. 2018; Sen and Bhakat 2018). In comparison to standard biological spectra, the present study shows that the vegetation was primarily sub-tropical in nature, with a higher percentage of therophytes and chamaephytes. Based on this study, the phytoclimate of the area, as per Raunkiaer's terminology, has been described as a "thero-crypto-chamaephytic" phytoclimate. This indicates the influence of anthropogenic activities in the study area which favors the chances of growth of short-lived annuals. It was also reported that therophytes stood next to phanerophytes. The prevalence of therophytes is also an indicator of biotic pressure (Halmy 2019). The growth of therophytes was much favored in disturbed areas (Lavorel et al. 1998). The bioclimate of the region, according to Meher-Homji (1964), reflected the life forms. Because of the favourable growing season, therophytes and nanophanerophytes are dominant throughout the year, particularly during the rainy season. During the start of the rainy season, there is always a flush of annual plants. The dominance of therophytes occurs due to unfavorable habitat conditions as suggested by others (Nazir and Malik 2006; Manhas et al. 2010; Sen and Bhakat 2020), and the findings agree with them.

Batalha and Martins (2004) and Ihsan et al. (2016) also considered therophytes, cryptophytes and chamaephytes as the major life forms in unfavorable conditions in the desert and open physiognomies. The hot, dry, and waterlogged conditions in the investigated region, combined with overgrazing, resulted in harsh conditions. The results also agree with those of Sher and Khan (2007), who also stated that therophytes and nanophanerophyes were characteristics of subtropical habitats. Sahu et al. (2012) discovered that therophytes and nanophanerophytes predominated in Odisha, India. Structurally and floristically the sub-tropical dry forests are less complex than wet forests, comprising about half or less of the tree species of the wet forest (Castro-Esau and Kalacska 2008). Cryptophytes are relatively fewer in number and are not a dominant life form of any particular climate (Box 2012). Cryptophytes, on the other hand, die back to underground storage organs in the Indian tropics to withstand unfavorable dry periods, fires, and other natural disasters. Cryptophytes are thought to be remnants of the paleoclimate that existed prior to the current extinction of the Indian subcontinent in the tropical ecosystem. According to Seward (2010), a fraction of the flora of a place may be in discordance with the present-day climate and could be the remnant of past climate. In this regard, the KST is floristically diverse and has the potential for future study. The dominance of therophytes, 93 species, 29.81% indicates that the investigated area was under moderate biotic pressure due to deforestation, overgrazing and agricultural land encroachment. Many plant species in the

region were on the decline. The local people will have a moral and ethical obligation to protect the plant resources. The majority of the medicinal plants were uprooted and grazed by livestock for burning purposes. Most of the fuelwood was extracted from the forests. The groves served as a haven for rare and precious animals and plants. More research is required to measure the data and propose conservation strategies for the sacred grove.

Patterns in leaf size spectra, leaf lamina and phenology

The present study recorded dominance of leptophyll during all seasons; microphyll and nanophyll were the next in order. Leaf spectra tell us about plant adaptation and association in a community. Small-sized leaves were present at the base while the large leaves were present at high altitudes as well as correlated with climatic warming and water availability in the soil (Tareen and Qadir 1993; Nicotra et al. 2011). The smaller type of leaf size indicates the climate was a sub-tropical type. Lepto and microphyllous elements were dominant in the sacred grove, which shows moisture and perennial water availability or wet condition. Seasonal changes are followed by changes in species diversity within the population. The vegetation phenology observed during different seasons revealed a substantial difference in vegetation among the seasons, owing to the study region's well-defined seasons. Most species dominated during the rainy season (99.68%), followed by winter (69.87%) and summer (29.81%). Expectedly, it may be attributed to the fact that a high proportion of therophytes and chamaephytes in the region appeared during the rainy and winter seasons.

In the present study, the proportion of different classes of leaf size was observed to change seasonally due to the presence of therophytes, cryptophytes, and chamaephytes. However, the nanophanerophytes and some chamaephytes (perennials and evergreens) almost retained the same status in all the seasons. Batalha and Martins (2004) also noted that the leaf size was related positively to drought and soil conditions. Badshah et al. (2010) identified the dominant leaf sizes of Kotli Azad Kashmir and Waziristan as being nanophyllous and microphyllous. This disparity was largely due to altitude variability in climate and ecosystem conditions. The size of the leaves alone could not be used to assess a specific leaf zone or climate. Other plant characteristics like habit and root system may also play a significant role. For the ecological study of a sacred grove in a region, the leaf spectra and biological spectrum alone are not ample, but quantitative studies such as vegetation structure and conservation are equally consequential.

IUCN categories

Given the above phytosociological analysis with ecological information about IUCN Red Listed plants reveals that the plants are still present and regenerate in the sacred groves but locally vanishing in nearby forests. Following the criteria devised by IUCN (2021), this report will highlight the status and distribution of the species in the study area, the ecological characteristics required for their survival, and the threats faced by some of the species designated. Various factors caused the increase in the numbers of vulnerable species in the area. Overgrazing was a major cause that led to the destruction of seedlings. In contrast, restricted population and low natural reproduction were determined to be the factors most effective on the vulnerability of *Cayratia pedata* and *Pterocarpus indicus*. Human behavior, such as overexploitation of the plant and land-use transition, was the most significant factor in the species' decline.

To conclude, sacred groves are the regenerated forest areas that surround places of worship. Sacred groves aid in the conservation of many rare and threatened species of plants and animals found in an area. Tribals in this area specifically forbid the practice of deforestation. Sacred groves are unquestionably hotspots of biological and socio-cultural diversity. It is also clear that many sacred groves are in jeopardy, whether they are managed by one or a few families or by entire communities. As sacred grove management is generally affected by a variety of social and economic factors, it is very difficult to pinpoint the specific strategies for their successful conservation. However, some common approaches to sacred grove management, that could be adopted with required changes to suit the needs of given sacred grove management, are as follows: self-imposition of a full ban on biomass removal for preserving ecosystem sustainability, creation of awareness among local people and stakeholder groups, identification of the type of contribution a stakeholder group can offer in management, and encouragement of all stakeholders to take part in sacred grove management, taking into account the wisdom and interests of the main stakeholder groups.

The present study denotes the possibility of using Raunkiaer's approach to ascertain the remarkable distinctions between the populations of angiosperm plants in a forested landscape or biome and their associations, the portion of species in the proportion of floristic life-forms that led by the current ecological parameters and environmental gradients. The biological spectrum of the sacred grove may be seen through the analysis of life forms. Dominant therophytes, cryptophytes and chamaephytes share, in the present study, the importance of depicting the phytoclimate "thero-crypto-chamaephytic." It may also be noted that in the future, the data obtained from this study will serve as a life-form database for change detection studies and bioclimatic or phytoclimate tenacity. It would also be helpful to compare and contrast the pattern of adjacent natural strands along the environmental gradients, revealing more than the mere forest covers in the ecosystem information, suggests that biotic factors play an important role in shaping a landscape's vegetation by directing successions. This indicates the presence in the sacred grove of anthropogenic disturbances promoting the development of more therophytes. Consequently, further disruption to the present sacred grove may encourage the potential changes to its present phytoclimate.

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Table S1. List of angiosperm taxa of KST sacred grove

Name of the species	Voucher No.	Habit	Life-span	Nativity	Fl. & Fr. time	Raunkiaer's life-form	*Sub-type*	Leaf spectra	Shape of the lamina	IUCN Red List Status	Seasons		
											Summer	Rainy	Winter
Nymphaeales Salisb. ex Bercht. & J.Presl													
Nymphaeaceae Salisb.													
Nymphaea nouchali Burm. f.	USNY1	H	P	N	Aug.-Dec.	Cr		Mg	Or	LC	A	P	P
MESANGIOSPERMS													
MAGNOLIIDS													
Piperales Bercht. & J.Presl													
Aristolochiaceae Juss.													
Aristolochia indica L.	USAS1	C	A	N	Jul.-Jan.	Cr		No	La	NE	A	P	P
Magnoliales Juss. ex Bercht. & J.Presl													
Annonaceae Juss.													
Annona reticulata L.	USAN1	T	P	E	Jul.-Dec.	Ph	*N*	Me	La	Lc	P	P	P
Annona squamosa L.	USAN2	T	P	E	Mar.-Sep.	Ph	*N*	Me	La	Lc	P	P	P
INDEPENDENT LINEAGE: UNPLACED TO MORE INCLUSIVE CLADE													
MONOCOTS													
Alismatales R.Br. ex Bercht. & J.Presl													
Araceae Juss.													
Alocasia macrorrhizos (L.) G. Don	USAR1	H	P	E	Apr. -May	Cr		Mg	Sg	NE	P	P	P
Amorphophallus bulbifer (Roxb.) Blume	USAR2	H	P	N	May-Nov.	Cr		Mg	Ha	NE	A	P	P
Lemna perpusilla Torr.	USAR3	H	A	N	Jun.-Jan.	Cr		Le	Cu	LC	A	P	P
Pistia stratiotes L.	USAR4	H	A	E	Apr.-Oct.	Cr		Na	Cu	LC	A	P	P
Scindapsus officinalis (Roxb.) Schott	USAR5	C	P	N	-	Cr		Ma	Ov	NE	P	P	P
Typhonium trilobatum (L.) Schott	USAR6	H	A	N	Sep.-Oct.	Cr		Mi	Co	NE	P	P	P
Wolffia arrhiza (L.) Horkel ex Wimm.	USAR7	H	A	N	Jun.-Oct.	Cr		Le	Lu	LC	A	P	P
Alismataceae Vent.													
Butomopsis latifolia (D.Don) Kunth	USAL1	H	P	N	Sep.-Feb.	He		Mi	La	LC	A	P	P
Caldesia parnassifolia (Bassi) Parl.	USAL2	H	P	N	Apr.-Sep.	He		Mi	Re	LC	P	P	P
Sagittaria guayanensis Kunth	USAL3	H	P	N	Aug.-Nov.	He		Ma	Lu	LC	P	P	P
Hydrocharitaceae Juss.													
Blyxa octandra (Roxb.) Planch. ex Thwaites	USHD1	H	A	N	Nov.-Jan.	Cr		Le	La	LC	A	P	P
Hydrilla verticillata (L.f.) Royle	USHD2	H	A	N	Nov.-Mar.	Cr		Le	Li	LC	A	P	P
Najas graminea Delile	USHD3	H	A	N	Nov.-Jan.	Cr		Na	Ac	LC	A	P	P
Nechamandra alternifolia (Roxb. ex Wight) Thwaites	USHD4	H	A	N	Nov.-Feb.	Cr		Na	Li	LC	A	P	P
Ottelia alismoides (L.) Pers.	USHD5	H	A	N	All	Cr		Le	Sp	LC	A	P	P
Aponogetonaceae Planch.													
Aponogeton natans (L.) Engl. & K.Krause	USAN1	H	P	N	Aug.-Nov.	Cr		Ma	Li	LC	A	P	P
Potamogetonaceae Bercht. & J. Presl													
Potamogeton crispus L.	USPM1	H	A	N	Feb.-Apr.	He		Me	La	LC	A	P	P
Potamogeton nodosus Poir.	USPM2	H	A	E	Oct.-Dec.	He		Me	Oo	LC	A	P	P
Dioscoreales Mart.													
Burmanniaceae Blume													
Burmannia coelestis D.Don	USBU1	H	A	N	May.-Aug.	Th		Le	Li	LC	A	P	A
Dioscoreaceae R. Br.													
Dioscorea belophylla (Prain) Voigt ex Haines	USDI1	C	P	N	Sep.-Mar	Cr		Me	Re	NE	A	P	P
Dioscorea glabra Roxb.	USDI2	C	P	N	Sep.-Mar.	Cr		Me	Sg	NE	A	P	P
Dioscorea pentaphylla L.	USDI3	C	P	N	Sep.- Feb.	Cr		Me	Co	NE	A	P	P
Dioscorea pubera Blume	USDI4	C	P	N	Oct.-Jan.	Cr		Me	Co	NE	A	P	P
Tacca leontopetaloides (L.) Kuntze	USDI5	H	P	N	Aug.-Nov.	Cr		Na	Sp	LC	A	P	P
Pandanales R. Br. ex Bercht. & J. Presl													
Pandanaceae R. Br.													
Pandanus odorifer (Forssk.) Kuntze	USPN1	S	P	N	Jul.-May	Ph	*N*	Mg	Ob	LC	P	P	P
Liliales Perleb													
Colchicaceae DC.													
Gloriosa superba L.	USCO1	C	P	N	Jul.-Sep.	Ph	*N*	Me	Su	LC	A	P	A

Smilacaceae Vent.													
Smilax ovalifolia Roxb. ex D.Don	USSM1	C	P	N	Jun.-Dec.	Ph	*N*	Ma	Sg	NE	P	P	P
Asparagales Link													
Orchidaceae Juss.													
Geodorum recurvum (Roxb.) Alston	USOR1	H	P	N	Jul.-Aug.	Cr		Mi	La	LC	A	P	P
Vanda tessellata (Roxb.) Hook. ex G. Don	USOR2	H	P	N	Apr.-Jul.	Ph	*N*	No	Su	LC	P	P	P
Hypoxidaceae R. Br.													
Curculigo orchioides Gaertn.	USHP1	H	P	N	Aug.-Oct.	Cr		Mi	La	NE	A	P	A
Xanthorrhoeaceae Dumort.													
Aloe vera (L.) Burm.f.	USXA1	H	P	E	Dec.-Feb.	Ch		No	Su	NE	P	P	P
Asphodelus tenuifolius Cav.	USXA2	H	A	E	Jan.-Mar.	Th		No	La	NE	A	P	P
Amaryllidaceae J. St.-Hil.													
Crinum viviparum (Lam.) R.Ansari & V.J.Nair	USAY1	H	P	N	Aug.-Oct.	Cr		Mg	Li	LC	P	P	P
Asparagaceae Juss.													
Agave sisalana Perrine	USAP1	S	P	E	Mar.-Oct.	Ch		Mg	Su	NE	P	P	P
Agave vivipara L.	USAP2	S	P	E	Mar.-Oct.	Ch		Mg	Su	VU	P	P	P
Asparagus racemosus Willd.	USAP3	C	P	E	Aug.-Dec.	Cr		Le	Ac	NE	P	P	A
Arecales Bromhead													
Arecaceae Bercht. & J.Presl													
Borassus flabellifer L.	USAE1	T	P	E	Mar.-Oct.	Ph	*MM*	Mg	Pa	NE	P	P	P
Calamus viminalis Willd.	USAE2	C	P	N	Sep.-May.	Ph	*N*	Mi	Pa	NE	P	P	P
Phoenix sylvestris (L.) Roxb.	USAE3	T	P	N	Feb.-Jun.	Ph	*M*	Mi	Pa	NE	P	P	P
Commelinales Mirb. ex Bercht. & J.Presl													
Commelinaceae Mirb.													
Commelina benghalensis L.	USCM1	H	A	N	Aug.-Nov.	Th		Mi	Ov	LC	A	P	A
Commelina diffusa Burm.f.	USCM2	H	A	N	Aug.-Nov.	Th		Mi	Ov	LC	A	P	A
Cyanotis axillaris (L.) D.Don ex Sweet	USCM3	H	A	N	Sep.-Dec.	Th		Na	Su	LC	A	P	A
Cyanotis tuberosa (Roxb.) Schult. & Schult.f.	USCM4	H	A	N	Jul.-Sep.	Th		Na	Su	NE	A	P	A
Murdannia nudiflora (L.) Brenan	USCM5	H	A	N	Jul.-Nov.	Th		Na	Su	NE	A	P	A
Murdannia spirata (L.) G.Brückn.	USCM6	H	A	N	Sep.-Jan.	Th		Na	Su	LC	A	P	A
Zingiberales Grisebach													
Costaceae Nakai													
Hellenia speciosa (J.Koenig) S.R.Dutta	USCS1	H	P	E	Jul.-Sep.	Cr		Ma	Oo	LC	P	P	P
Zingiberaceae Martinov													
Alpinia calcarata (Andrews) Roscoe	USZI1	H	P	E	Apr.-Jun.	Cr		Ma	Li	NE	A	P	P
Curcuma aromatica Salisb.	USZI2	H	P	N	May-Jun.	Cr		Mg	Oo	NE	A	P	P
Globba marantina L.	USZI3	H	P	N	Aug.-Sep.	Cr		Ma	La	Lc	A	P	P
Zingiber capitatum Roxb.	USZI4	H	P	N	Jul.-Aug.	Cr		Ma	La	NE	A	P	P
Poales Small													
Eriocaulaceae Martinov													
Eriocaulon cinereum R.Br.	USER1	H	A	N	Oct.-Jan.	Th		Le	Ac	NE	A	P	P
Eriocaulon quinquangulare L.	USER2	H	A	N	Oct.-Feb.	Th		Le	Li	NE	A	P	P
Cyperaceae Juss.													
Bulbostylis barbata (Rottb.) C.B.Clarke	USCY1	H	P	E	Jul.-Oct.	He		Na	La	LC	A	P	A
Carex filicina Nees	USCY2	H	P	N	Sep.-Dec.	He		Na	Ac	LC	A	P	P
Cyperus brevifolius (Rottb.) Hassk.	USCY3	H	P	E	May-Oct.	He		Le	Ac	LC	A	P	A
Cyperus difformis L.	USCY4	H	P	E	Jul.-Nov.	He		Le	Li	LC	A	P	P
Cyperus rotundus L.	USCY5	H	P	E	Sep.-Dec.	He		Na	Ac	LC	A	P	P
Cyperus compactus Retz.	USCY6	H	P	N	Sep.-Nov.	He		Le	Ac	LC	A	P	P
Cyperus compressus L.	USCY7	H	P	N	Jul.-Nov.	He		Le	Ac	LC	A	P	P
Cyperus cyperoides (L.) Kuntze	USCY8	H	P	N	Aug.-Sep.	He		Le	Ac	LC	A	P	A
Cyperus distans L.f.	USCY9	H	P	E	Jul.-Sep.	He		Le	Ac	LC	A	P	A
Cyperus haspan L.	USCY 10	H	P	E	May-Jun.	He		Le	Ac	LC	A	P	P
Cyperus iria L.	USCY11	H	P	E	Aug.-Dec.	He		Le	Ac	LC	A	P	P
Cyperus laevigatus L.	USCY12	H	P	N	Aug.-Oct.	He		Le	Ac	LC	A	P	A
Cyperus pangorei Rottb.	USCY13	H	P	N	Oct.-Feb.	He		Le	Ac	LC	A	P	P
Cyperus paniceus (Rottb.) Boeckeler	USCY14	H	P	N	Jul.-Sep.	He		Na	Li	LC	A	P	A
Cyperus tenuispica Steud.	USCY15	H	P	E	May-Dec.	He		Le	Ac	LC	A	P	P
Fimbristylis aestivalis (Retz.) Vahl	USCY16	H	P	E	Feb.-May	He		Le	Ac	NE	A	P	P
Fimbristylis dichotoma (L.) Vahl	USCY17	H	P	E	Aug.-Oct.	He		Le	Ac	LC	A	P	A
Fimbristylis quinquangularis (Vahl) Kunth	USCY18	H	P	E	Aug.-Nov.	He		Le	Li	LC	A	P	P
Fimbristylis schoenoides (Retz.) Vahl	USCY19	H	P	N	Jul.-Oct.	He		Le	La	LC	A	P	A
Fuirena ciliaris (L.) Roxb.	USCY20	H	P	E	Sep.-Jan.	He		Le	Ac	LC	A	P	P
Rhynchospora colorata (L.) H.Pfeiff.	USCY21	H	P	E	May-Oct.	He		Le	Li	NE	A	P	A
Rhynchospora wightiana (Nees) Steud.	USCY22	H	P	N	Aug.-Oct.	He		Le	Li	NE	A	P	A
Schoenoplectiella articulata (L.) Lye	USCY23	H	P	N	Oct.-Feb.	He		Le	Li	LC	A	P	P

Poaceae Barnhart													
Alloteropsis cimicina (L.) Stapf	USPA1	H	A	E	Jul.-Oct.	He		Le	Co	NE	A	P	A
Apluda mutica L.	USPA2	H	P	N	Sep.-Nov.	He		Le	La	NE	A	P	P
Aristida setacea Retz.	USPA3	H	P	N	Aug.-Dec.	He		Le	Ac	NE	A	P	P
Arthraxon lancifolius (Trin.) Hochst.	USPA4	H	P	N	Sep.-Dec.	He		Le	Ac	NE	A	P	P
Cenchrus pedicellatus (Trin.) Morrone	USPA5	H	P	N	Oct.-Dec.	He		Le	Ac	LC	A	P	A
Chloris barbata Sw.	USPA6	H	P	E	Aug.-Nov.	He		Le	Li	NE	A	P	P
Chrysopogon aciculatus (Retz.) Trin.	USPA7	H	P	N	Sep.-Dec.	He		Le	Li	NE	A	P	P
Chrysopogon lancearius (Hook.f.) Haines	USPA8	H	P	N	Sep.-Dec.	He		Le	Ac	NE	A	P	P
Chrysopogon zizanioides (L.) Roberty	USPA9	H	P	N	Aug.-Dec.	He		Le	Li	NE	A	P	P
Coix lacryma-jobi L.	USPA10	H	A	N	Aug.-Jan.	He		No	Sg	NE	A	P	P
Cymbopogon martini (Roxb.) W.Watson	USPA11	H	A	N	Oct.-Dec.	He		No	Li	NE	A	P	P
Cynodon dactylon (L.)Pers.	USPA12	H	P	E	All	He		Le	Li	NE	P	P	P
Dactyloctenium aegyptium (L.) Willd.	USPA13	H	P	E	Jul.-Nov.	He		Le	La	NE	A	P	P
Desmostachya bipinnata (L.) Stapf	USPA14	H	P	E	Jun.-Oct.	He		Le	Ac	LC	A	P	A
Digitaria bicornis (Lam.) Roem. & Schult.	USPA15	H	P	N	Jul.-Oct.	He		Le	Ac	NE	A	P	A
Eleusine indica (L.) Gaertn.	USPA16	H	P	N	Aug.-Nov.	He		Le	Li	LC	A	P	P
Elytrophorus spicatus (Willd.) A.Camus	USPA17	H	P	N	Nov.-Jan	He		Le	Ac	LC	A	P	P
Eragrostiella brachyphylla (Stapf) Bor	USPA18	H	P	N	Aug.-Oct.	He		Le	Li	NE	A	P	A
Eragrostis viscosa (Retz.) Trin.	USPA19	H	P	E	Aug.-Feb.	He		Le	Li	NE	A	P	P
Eragrostis coarctata Stapf	USPA20	H	P	N	Aug.-Feb.	He		Le	Ac	LC	A	P	P
Hackelochloa granularis (L.) Kuntze	USPA21	H	P	N	Aug.-Nov.	He		No	Ac	NE	A	P	P
Hemarthria compressa (L.f.) R.Br.	USPA22	H	P	N	Jul.-Oct.	He		Le	Ac	LC	A	P	A
Heteropogon contortus (L.) P.Beauv. ex Roem. & Schult.	USPA23	H	P	N	Sep.-Jan.	He		Le	Ac	NE	A	P	P
Hygroryza aristata (Retz.) Nees ex Wight & Arn.	USPA24	H	A	N	Oct.-Mar.	He		No	La	NE	A	P	P
Hymenachne amplexicaulis (Rudge) Nees	USPA25	H	P	E	Oct.-Dec.	He		Le	Su	NE	A	P	P
Imperata cylindrica (L.) P.Beauv.	USPA26	H	P	E	Oct.-Dec.	He		Le	Li	LC	A	P	P
Isachne globosa (Thunb.) Kuntze	USPA27	H	P	N	Sep.-Feb.	He		Le	Li	LC	A	P	P
Leersia hexandra Sw.	USPA28	H	A	E	Sep.-Dec.	He		Le	Li	LC	A	P	P
Microchloa indica (L.f.) P.Beauv.	USPA29	H	P	N	Aug.-Oct.	He		Le	Li	NE	A	P	A
Miscanthus fuscus (Roxb.) Benth.	USPA30	H	P	N	Aug.-Oct.	He		Le	Ac	NE	A	P	A
Oplismenus burmanni (Retz.) P.Beauv.	USPA31	H	P	N	Sep.-Nov.	He		Le	Ov	NE	A	P	P
Oryza sativa L.	USPA32	H	P	N	Sep.-Dec.	He		No	Li	NE	P	P	P
Panicum curviflorum Hornem.	USPA33	H	P	N	Sep.-Dec.	He		Le	Ac	NE	A	P	P
Panicum notatum Retz.	USPA34	H	P	N	Sep.-Nov.	He		No	Li	NE	A	P	A
Panicum sumatrense Roth	USPA35	H	P	N	Aug.-Nov.	He		No	La	LC	A	P	A
Paspalum distichum L.	USPA36	H	P	N	Sep.-Nov.	He		Le	Li	LC	A	P	P
Perotis indica (L.) Kuntze	USPA37	H	P	N	Jul.-Nov.	He		Le	Ac	NE	A	P	A
Pogonatherum paniceum (Lam.) Hack.	USPA38	H	P	N	All	He		Le	La	LC	A	P	P
Sacciolepis myosuroides (R.Br.) Chase ex E.G.Camus & A.Camus	USPA39	H	P	N	Sep.-Dec.	He		Le	Ac	LC	A	P	P
Sacciolepis interrupta (Willd.) Stapf	USPA40	H	P	N	Sep.-Nov.	He		Le	Li	LC	A	P	P
Setaria flavida (Retz.) Veldkamp	USPA41	H	P	N	Aug.-Nov.	He		Le	Li	NE	A	P	A
Setaria parviflora (Poir.) Kerguélen	USPA42	H	P	N	Aug.-Nov.	He		Le	Li	LC	A	P	A
Setaria verticillata (L.) P.Beauv.	USPA43	H	P	N	Aug.-Nov.	He		Le	Li	NE	A	P	P
Setaria viridis (L.) P.Beauv.	USPA44	H	P	N	Jul.-Oct.	He		Le	Ob	NE	A	P	A
Sporobolus coromandelianus (Retz.) Kunth	USPA45	H	P	N	Aug.-Nov.	He		Na	Ac	NE	A	P	A
Tragus mongolorum Ohwi	USPA46	H	P	N	Aug.-Oct.	He		Le	Ac	NE	A	P	A
Urochloa ramosa (L.) T.Q.Nguyen	USPA47	H	P	N	Jul.-Nov.	He		Le	Co	LC	A	P	P
Urochloa reptans (L.) Stapf	USPA48	H	A	N	Aug.-Oct.	He		Le	La	LC	A	P	A
EUDICOTS													
Ranunculales Juss. ex Bercht. & J.Presl													
Papaveraceae Juss.													
Argemone mexicana L.	USPP1	H	A	E	Dec.-Apr.	Th		Ma	Sp	NE	P	A	P
Fumaria indica (Hausskn.) Pugsley	USPP2	H	A	E	Jan.-Mar.	Th		Ma	Sp	NE	A	P	P
Menispermaceae Juss.													
Cissampelos pareira L.	USMN1	C	P	N	Jul.-Jan.	Ph	*N*	Me	Co	NE	P	P	P
Cocculus hirsutus (L.) W.Theob.	USMN2	C	P	N	Aug.-Nov.	Ph	*N*	Me	Co	NE	P	P	P
Stephania japonica (Thunb.) Miers	USMN3	C	P	N	Jul.-Dec.	Ph	*N*	Me	Or	NE	P	P	P
Tiliacora acuminata (Lam.) Miers	USMN4	C	P	N	Nov.-May	Ph	*N*	Me	Ov	NE	P	P	P
Tinospora sinensis (Lour.) Merr.	USMN5	C	P	N	Feb.-Jun.	Ph	*N*	Me	Co	NE	P	P	P
ROSIDS													
Vitales Juss. Ex Berht. & Presl.													
Vitaeae Juss.													
Ampelocissus tomentosa (Roth) Planch.	USVT1	C	P	N	Aug.-Dec.	Ph	*N*	Me	Sg	NE	P	P	P

Causonis trifolia (L.) Mabb. & J.Wen	USVT2	C	P	N	Aug.-Dec.	Ph	*N*	No	Co	NE	A	P	P
Cayratia pedata (Lam.) Gagnep.	USVT3	C	P	N	Aug.-Feb.	Ph	*N*	No	Ov	VU	P	P	P
Cissus quinquangularis Chiov.	USVT4	C	P	N	Jul.-Jan.	Ph	*N*	No	Co	NE	P	P	P
Leea macrophylla Roxb. ex Hornem.	USVT5	S	P	N	Jul.-Sep.	Ch		Me	Sg	NE	P	P	P
Fabales Bromhead													
Fabaceae Lindl.													
Abrus precatorius L.	USFA1	C	P	N	Aug.-Mar.	Ph	*N*	Na	Ob	NE	A	P	P
Adenanthera pavonina L.	USFA2	T	P	N	Mar.-Jan.	Ph	*M*	No	Co	LC	P	P	P
Albizia lebbeck (L.) Benth.	USFA3	T	P	N	Mar.-Feb.	Ph	*MM*	Mi	Sb	NE	P	P	P
Alysicarpus monilifer (L.) DC.	USFA4	H	A	N	Aug.-Nov.	Th		Mi	Ob	NE	A	P	A
Brachypterum scandens (Roxb.) Miq.	USFA5	C	P	N	Jul.-Jan.	Ph	*N*	Na	Ob	NE	P	P	P
Cajanus cajan (L.) Huth	USFA6	S	P	E	Aug.-Feb.	Ch		Me	La	NE	A	P	P
Cajanus scarabaeoides (L.) Thouars	USFA7	C	A	N	Sep.-Feb.	Ph	*N*	Mi	Ov	NT	A	P	P
Cassia fistula L.	USFA8	T	P	N	Feb.-Dec.	Ph	*N*	No	Sb	NE	P	P	P
Chamaecrista absus (L.) H.S.Irwin & Barneby	USFA9	H	A	E	Aug.-Dec.	Th		Na	Ov	LC	A	P	A
Chamaecrista mimosoides (L.) Greene	USFA10	H	A	N	Mar. -Dec.	Th		Na	La	LC	A	P	A
Codariocalyx gyroides (Roxb. ex Link) Hassk.	USFA11	S	A	N	Aug.-Dec.	Ch		Na	La	NE	A	P	A
Crotalaria calycina Schrank	USFA12	S	A	N	Jul.-Nov.	Ch		Na	Li	NE	A	P	P
Crotalaria pallida Aiton	USFA13	S	A	E	Aug.-Jan.	Ch		Na	Ov	NE	A	P	P
Crotalaria retusa L.	USFA14	S	A	E	Jul.-Jan.	Ch		Mi	Ov	NE	P	P	P
Dalbergia sissoo Roxb. ex DC.	USFA15	T	P	E	Feb.-Aug.	Ph	*MM*	Mi	Ov	NE	P	P	P
Flemingia strobilifera (L.) W.T.Aiton	USFA16	H	A	N	Feb.-Sep.	Ch		Na	Ov	NE	A	P	P
Guilandina bonduc L.	USFA17	C	P	N	Aug.-Apr.	Ph	*N*	Me	Co	LC	P	P	P
Indigofera linifolia (L.f.) Retz.	USFA18	H	B	E	Aug.-Nov.	Th		Na	Oo	LC	P	P	P
Lablab purpureus (L.) Sweet	USFA19	C	A	E	Nov.-Mar.	Ph	*N*	Mi	Co	NE	A	P	P
Mimosa pudica L.	USFA20	H	P	E	Jul.-Nov.	Th		Na	La	LC	A	P	P
Mucuna pruriens (L.) DC.	USFA21	C	A	N	Sep.-May	Ph	*N*	No	Co	NE	A	P	P
Neptunia prostrata (Lam.) Baill.	USFA22	H	A	N	Sep.-Nov.	Th		Na	La	NE	A	P	P
Neustanthus phaseoloides (Roxb.) Benth.	USFA23	C	P	N	Aug.-Jan.	Ph	*N*	Mi	Co	NE	P	P	P
Pleurolobus gangeticus (L.) J.St.-Hil. ex H.Ohashi & K.Ohashi	USFA24	H	A	N	Oct.-Dec.	Th		Na	Ov	NE	A	P	A
Pongamia pinnata (L.) Pierre	USFA25	T	P	N	Apr.-Feb.	Ph	*M*	Me	Co	LC	P	P	P
Pseudarthria viscida (L.) Wight & Arn.	USFA26	H	P	N	Oct.- Jan.	Th		Mi	Ov	NE	A	P	A
Pterocarpus indicus Willd.	USFA27	T	P	N	Jul.-Dec.	Ph	*M*	No	Ov	EN	P	P	P
Samanea saman (Jacq.) Merr.	USFA28	T	P	E	Mar.-Feb.	Ph	*MM*	Me	Co	LC	P	P	P
Senegalia torta (Roxb.) Maslin, Seigler & Ebinger	USFA29	C	P	N	Feb.-Dec.	Ph	*N*	Na	Sb	NE	P	P	P
Senna alata (L.) Roxb.	USFA30	S	A	E	Aug.-Nov.	Ch		Ma	Ob	LC	A	P	P
Senna occidentalis (L.) Link	USFA31	S	P	E	Aug.-Dec.	Ch		No	Co	NE	A	P	P
Sesbania grandiflora (L.) Poir.	USFA32	T	P	N	Dec.-Mar.	Ch		Na	Ob	NE	P	P	P
Tephrosia candida DC.	USFA33	H	P	N	Sep.-Dec.	Th		Na	Ob	NE	A	P	P
Tephrosia pumila (Lam.) Pers.	USFA34	H	P	N	Jul.-Oct.	Th		Na	Oo	NE	A	P	P
Uraria rufescens (DC.) Schindl.	USFA35	H	P	N	Aug.-Dec.	Th		Na	Oo	NE	A	P	A
Vigna vexillata (L.) A.Rich.	USFA36	C	A	N	Jul.-Oct.	Ph	*N*	Mi	Co	NE	A	P	A
Zornia gibbosa Span.	USFA37	H	A	N	Aug.-Nov.	Th		Na	La	NE	A	P	A
Polygalaceae Hoffmanns. & Link													
Polygala crotalarioides Buch.-Ham. ex DC.	USPO1	H	A	N	Aug.-Nov.	Th		Me	Ov	NE	A	P	A
Salomonia ciliata (L.) DC.	USPO2	H	A	N	Aug.-Nov.	Th		Me	Li	NE	A	P	A
Rosales Bercht. & J.Presl													
Rhamnaceae Juss.													
Ventilago denticulata Willd.	USRH1	C	P	N	Nov.-Mar.	Ph	*N*	Me	La	NE	P	P	P
Ziziphus oenopolia (L.) Mill.	USRH2	C	P	N	Nov.-Mar.	Ph	*N*	No	Co	LC	P	P	P
Ulmaceae Mirb.													
Holoptelea integrifolia (Roxb.) Planch	USUL1	T	P	N	Jan.-Jun.	Ph	*MM*	Me	Ov	NE	P	P	P
Moraceae Gaudich.													
Ficus benghalensis L.	USMO1	T	P	N	Mar.-Sep.	Ph	*MM*	Ma	Co	NE	P	P	P
Ficus lacor Buch.-Ham.	USMO2	T	P	N	Mar.-Sep.	Ph	*MM*	Me	Co	NE	P	P	P
Ficus racemosa L.	USMO3	T	P	N	Mar.-Aug.	Ph	*M*	Ma	Co	Lc	P	P	P
Streblus asper Lour.	USMO4	T	P	N	Feb.-Jun.	Ph	*N*	Mi	Oo	Lc	P	P	P
Urticaceae Juss.													
Pouzolzia zeylanica (L.) Benn.	USUR1	H	A	N	Sep.-Jan.	Th		Le	Ov	NE	A	P	A
Cucurbitales Juss. ex Bercht. & J. Presl													
Cucurbitaceae Juss.													
Cayaponia laciniosa (L.) C.Jeffrey	USCU1	C	A	N	Jun.-Jan.	Ph	*N*	Mi	Sg	NE	A	P	A
Cucumis melo L.	USCU2	C	A	N	Jul.-Feb.	Ph	*N*	Me	Sg	NE	A	P	P
Diplocyclos palmatus (L.) C.Jeffrey	USCU3	C	P	N	Aug.-Oct.	Ph	*N*	Me	Sg	NE	A	P	P

Melothria trilobata Cogn.	USCU4	C	A	N	Jul.-Feb.	Ph	*N*	Me	Ov	NE	A	P	P
Solena amplexicaulis (Lam.) Gandhi	USCU5	C	A	N	Apr.-Dec.	Ph	*N*	Me	Sg	NE	A	P	P
Trichosanthes cucumerina L	USCU6	C	P	N	Aug.-Dec.	Ph	*N*	Me	Sg	NE	P	P	P
Trichosanthes tricuspidata Lour.	USCU7	C	A	N	Apr.-Sep.	Ph	*N*	Me	Ha	NE	P	P	P
Celastrales Link													
Celastraceae R.Br.													
Celastrus paniculatus Willd.	USCL1	C	P	N	Apr.- Dec.	Ph	*N*	Mi	Ov	NE	A	P	P
Oxalidales Bercht. & J. Presl													
Oxalidaceae R. Br.													
Oxalis corniculata L.	USOX1	H	A	E	All	Th		Na	Cu	NE	P	P	P
Malpighiales Juss. ex Bercht. & J.Presl													
Hypericaceae Juss.													
Hypericum japonicum Thunb.	USHY1	H	A	N	Feb.-Apr.	Th		Le	Co	NE	A	P	P
Elatinaceae Dumort.													
Bergia ammannioides Roxb.	USEL1	H	A	N	Nov.-Mar.	Th		Na	Ov	LC	A	P	P
Violaceae Batsch													
Afrohybanthus enneaspermus (L.) Flicker	USVI1	H	P	N	Jul.-Nov.	Th		Na	La	NE	A	P	A
Passifloraceae Juss. ex Roussel													
Passiflora foetida L.	USPS1	C	A	E	Aug.-Nov.	Ph	*N*	No	Sg	NE	P	P	P
Salicaceae Mirb.													
Flacourtia indica (Burm. f.) Merr.	USSA1	S	P	N	Sep.-May.	Ch		Mi	Ov	LC	P	P	P
Euphorbiaceae Juss.													
Acalypha lanceolata Willd.	USEU1	H	A	N	Aug.-Nov.	Th		No	Ov	NE	A	P	P
Chrozophora rottleri (Geiseler) Spreng.	USEU2	H	A	E	Jul.-Feb.	Th		Na	Co	NE	A	P	P
Croton bonplandianus Baill.	USEU3	H	P	E	All	Th		No	Co	NE	P	P	P
Euphorbia antiquorum L.	USEU4	T	P	N	Jan.-Apr.	Ph	*N*	Le	Oo	NE	P	P	P
Euphorbia hirta L.	USEU5	H	A	E	Feb.-Dec.	Th		Na	Co	NE	A	P	P
Euphorbia tithymaloides L.	USEU6	H	P	N	Mar.-Apr.	Th		No	Co	LC	P	P	P
Jatropha gossypiifolia L.	USEU8	S	P	E	Mar.-Aug.	Ch		Ma	Oo	LC	P	P	P
Jatropha curcas L.	USEU7	S	P	E	Mar.-Aug.	Ch		Ma	Sg	LC	P	P	P
Mallotus repandus (Willd.) Müll.Arg.	USEU9	T	P	N	Nov.-Apr.	Ph	*M*	Me	Co	NE	P	P	P
Suregada multiflora (A.Juss.) Baill.	USEU10	T	P	N	Mar.-Jul.	Ph	*N*	Mi	Ov	NE	P	P	P
Tragia involucrata L.	USEU11	C	P	N	Mar.-Jan.	Ph	*N*	Me	Ov	NE	A	P	P
Phyllanthaceae Martinov													
Breynia vitis-idaea (Burm.f.) C.E.C.Fisch.	USPY1	S	P	N	Apr.-Dec.	Ch		Mi	Ov	LC	P	P	P
Phyllanthus debilis J.G.Klein ex Willd.	USPY2	H	A	N	Apr.-Sep.	Th		Le	Ov	NE	A	P	P
Phyllanthus fraternus G.L.Webster	USPY3	H	A	N	Apr.-Sep.	Th		Na	Ov	NE	A	P	P
Phyllanthus virgatus G.Forst.	USPY4	H	A	N	Apr.-Sep.	Th		Na	La	NE	A	P	P
Myrtales Juss. ex Bercht. & J.Presl													
Combretaceae R.Br.													
Combretum roxburghii Spreng.	USCB1	C	P	N	Nov.-May	Ph	*N*	Me	Ov	NE	P	P	P
Terminalia arjuna (Roxb. ex DC.) Wight & Arn	USCB2	T	P	N	Apr.-Mar.	Ph	*MM*	Ma	Oo	NE	P	P	P
Terminalia catappa L.	USCB3	T	P	N	Apr.-Feb.	Ph	*MM*	Ma	Oo	LC	P	P	P
Lythraceae J. St.-Hil.													
Ammannia multiflora Roxb.	USLY1	H	A	N	Nov.-Mar.	Th		Le	Li	LC	A	P	A
Ammannia cordata Wight & Arn.	USLY2	H	A	N	Jun.-Feb.	Th		Le	Li	LC	A	P	A
Rotala rotundifolia (Buch.-Ham. ex Roxb.) Koehne	USLY3	H	A	N	Jan.-May	Th		Le	Li	LC	A	P	A
Trapa natans var. *bispinosa* (Roxb.) Makino	USLY4	H	A	N	Jun.-Nov.	Cr		No	Ha	NE	A	P	A
Onagraceae Juss.													
Ludwigia octovalvis (Jacq.) P.H.Raven	USON1	H	A	E	Sep.-Jan.	Th		Mi	Ov	LC	A	P	A
Myrtaceae Juss.													
Syzygium cumini (L.) Skeels	USMY1	T	P	N	Mar.-Jul.	Ph	*MM*	Me	La	LC	P	P	P
Melastomataceae Juss.													
Sonerila erecta Jack	USME1	H	A	N	Jun.-Dec.	Th		Mi	Ov	NE	A	P	A
Sapindales Juss. ex Bercht. & J.Presl													
Sapindaceae Juss.													
Allophylus cobbe (L.) Forsyth f.	USSP1	C	P	N	Jul.-Oct.	Ph	*M*	No	Ov	NE	A	P	A
Cardiospermum halicacabum L.	USSP2	C	A	N	Jul.-Dec.	Ph	*N*	No	Sp	LC	A	P	P
Dodonaea viscosa Jacq.	USSP3	S	P	N	Nov.-Apr.	Ph	*N*	No	Ob	LC	A	P	P
Meliaceae Juss.													
Azadirachta indica A. Juss.	USML1	T	P	N	Mar.-Jul.	Ph	*M*	No	La	LC	P	P	P
Melia azedarach L.	USML2	T	P	E	Feb.-Nov.	Ph	*M*	No	La	LC	P	P	P
Malvales Juss. ex Bercht. & J.Presl													
Malvaceae Juss.													
Abelmoschus crinitus Wall.	USMA1	S	A	N	Mar.-Sep.	Ch		No	Ov	LC	A	P	P

Azanza lampas (Cav.) Alef.	USMA2	S	A	N	Sep.-Dec.	Ch		No	Sg	NE	P	P	P
Byttneria herbacea Roxb.	USMA3	H	A	N	Sep.-Nov.	Th		No	Co	NE	A	P	P
Corchorus aestuans L.	USMA4	H	A	E	Jul.-Nov.	Th		Me	Ov	NE	A	P	A
Hibiscus mutabilis L.	USMA5	S	P	N	Aug.-Feb.	Ch		Me	Or	NE	P	P	P
Malachra capitata (L.) L.	USMA6	H	A	E	Sep.-Nov.	Th		Mi	Ha	NE	A	P	A
Malvastrum coromandelianum (L.) Garcke	USMA7	H	A	E	Jul.-Nov.	Th		Mi	Co	NE	A	P	A
Melochia corchorifolia L.	USMA8	H	A	E	May.-Jun.	Th		Na	Co	LC	A	P	A
Sida cordata (Burm.f.) Borss.Waalk.	USMA9	H	A	N	Aug.-Feb.	Th		Mi	Co	NE	A	P	A
Sida cordifolia L.	USMA10	S	A	N	Aug.-Dec.	Th		Mi	Co	NE	A	P	A
Sida mysorensis Wight & Arn.	USMA11	H	A	N	Sep.-Dec.	Th		Mi	Co	NE	A	P	A
Triumfetta rhomboidea Jacq.	USMA12	H	A	E	Sep.-Jan.	Th		Mi	Ha	NE	A	P	A
Urena lobata L.	USMA13	S	A	E	Sep.-Dec.	Ch		No	Ha	LC	A	P	P
Waltheria indica L.	USMA14	H	P	E	Aug.-Nov.	Th		Mi	Co	NE	A	P	A
Brassicales Bromhead													
Capparaceae Juss.													
Capparis zeylanica L.	USCP1	C	P	N	Mar.-Oct.	Ph	*M*	No	La	NE	P	P	P
Crateva magna (Lour.) DC.	USCP2	T	P	N	Mar.-Jul.	Ph	*M*	Me	Ov	NE	P	P	P
Cleomaceae Bercht. & J.Presl													
Cleome monophylla L.	USCE1	H	A	E	Aug.-Oct.	Th		Mi	Co	NE	A	P	P
SUPERASTERIDS													
Santalales R.Br. ex Bercht. & J.Presl													
Santalaceae R. Br.													
Viscum multinerve (Hayata) Hayata	USSN1	S	P	N	Mar.-Jul.	Th		Le	La	NE	P	P	P
Loranthaceae Juss.													
Dendrophthoe falcata (L.f.) Ettingsh.	USLO1	S	A	N	Nov.-Mar.	Ph	*N*	No	Ov	NE	A	P	P
Macrosolen capitellatus (Wight & Arn.) Danser	USLO2	S	A	N	Mar.-Sep.	Ph	*N*	No	Li	NE	A	P	P
Caryophyllales Juss. ex Bercht. & J.Presl													
Polygonaceae Juss.													
Antigonon leptopus Hook. & Arn.	USPL1	C	A	E	Aug.-Jan.	Ph	*N*	Na	Co	NE	P	P	P
Persicaria hydropiper (L.) Delarbre	USPL2	H	A	N	May-Jan.	Th		Na	La	LC	A	P	P
Droseraceae Salisb.													
Drosera burmanni Vahl	USDR1	H	A	N	Nov.-Apr.	Th		Le	Or	LC	A	P	A
Caryophyllaceae Juss.													
Polycarpon prostratum (Forssk.) Asch. & Schweinf.	USCR1	H	A	N	Dec.-Apr.	Ch		Na	Co	LC	A	P	A
Spergula arvensis L.	USCR2	H	A	N	Jan.-Mar.	Ch		Le	Ac	NE	A	P	A
Vaccaria hispanica (Mill.) Rauschert	USCR3	H	A	N	Jan.-Mar.	Th		Le	Su	NE	A	P	A
Amaranthaceae Juss													
Achyranthes aspera L.	USAM1	H	A	N	Sep.-Feb.	Th		Mi	Ov	NE	A	P	A
Alternanthera sessilis (L.) R. Br. ex DC.	USAM2	H	A	E	Jul.-Feb.	Th		Mi	Ov	LC	P	P	P
Amaranthus spinosus L.	USAM3	H	A	E	All	Th		Na	Ov	NE	P	P	P
Aizoaceae Martinov													
Trianthema portulacastrum L.	USAI1	H	A	E	Apr.-Oct.	Th		Mi	Oo	NE	P	P	P
Nyctaginaceae Juss.													
Boerhavia diffusa L.	USNC1	H	A	N	Jun.-Dec.	Th		Mi	Re	NE	A	P	A
Portulacaceae Juss.													
Portulaca oleracea L.	USPR1	H	A	E	Jun.-Dec.	Th		Mi	Oo	NE	P	P	P
Cactaceae Juss.													
Cereus pterogonus Lem.	USCC1	S	P	N	Jun.-Jul.	Ch		Le	Ac	LC	P	P	P
Opuntia stricta (Haw.) Haw.	USCC2	S	P	E	Apr.-Aug.	Ch		Le	Ac	LC	P	P	P
ASTERIDS													
Cornales Link													
Cornaceae Bercht. & J.Presl													
Alangium salviifolium (L.f.) Wangerin	USCN1	T	P	N	Mar.-Jul.	Ph	*N*	Me	Ov	LC	P	P	P
Ericales Dumortier													
Primulaceae Batsch ex Borkh.													
Lysimachia arvensis (L.) U.Manns & Anderb.	USPI1	H	A	E	Jan.-Mar.	Th		Mi	Ov	NE	A	P	P
Gentianales Juss. ex Bercht. & J.Presl													
Rubiaceae Juss.													
Benkara malabarica (Lam.) Tirveng.	USRU1	S	P	N	Apr.-Nov.	Ch		No	La	NE	P	P	P
Gardenia resinifera Roth	USRU2	S	P	N	Feb.-Jun.	Ph	*N*	No	Ov	NE	P	P	P
Neolamarckia cadamba (Roxb.) Bosser	USRU3	T	P	N	Jul.-Nov.	Ph	*MM*	Ma	Ov	NE	P	P	P
Scleromitrion pinifolium (Wall. ex G.Don) R.J.Wang	USRU4	H	A	N	Sep.-Nov.	Th		Na	Li	NE	A	P	A
Spermacoce brachystema R.Br. ex Benth.	USRU5	H	A	E	Jul.-Dec.	Th		Na	Ov	NE	A	P	A

Loganiaceae R. Br. ex Mart.													
Mitrasacme prolifera R.Br.	USLO1	H	A	N	Aug.-Dec.	Th		Na	Li	NE	A	P	A
Strychnos nux-vomica L.	USLO2	T	P	N	Mar.-Jan.	Ph	*MM*	Me	Ov	NE	P	P	P
Apocynaceae Juss.													
Gymnema sylvestre (Retz.) R.Br. ex Sm.	USAO1	C	P	N	Apr.-Mar.	Ph	*N*	Mi	La	NE	A	P	P
Pergularia daemia (Forssk.) Chiov.	USAO2	C	P	N	Sep.-Jan.	Ph	*N*	Me	Co	NE	A	P	P
Rauvolfia tetraphylla L.	USAO3	S	P	N	Feb.-Dec.	Ch		No	La	NE	P	P	P
Boraginales Juss. ex Bercht. & J.Presl													
Boraginaceae Juss.													
Heliotropium indicum L.	USBO1	H	A	N	Oct.-Jan.	Th		No	Co	NE	A	P	P
Solanales Juss. ex Bercht. & J.Presl													
Convolvulaceae Juss.													
Evolvulus alsinoides (L.) L.	USCV1	H	A	N	Jul.-Feb.	Th		Na	La	NE	A	P	P
Ipomoea aquatica Forssk.	USCV2	H	P	N	All	Th		No	Co	LC	P	P	P
Solanaceae Juss.													
Solanum americanum Mill.	USSO1	H	A	E	Dec.-Jun.	Th		Ma	Ov	NE	A	P	A
Solanum sisymbriifolium Lam.	USSO2	S	A	E	Jul.-Mar.	Ch		Ma	Ov	NE	A	P	P
Lamiales Bromhead													
Plantaginaceae Juss.													
Bacopa monnieri (L.) Wettst.	USPT1	H	A	N	Sep.-Jan.	Th		Na	Re	LC	A	P	A
Limnophila indica (L.) Druce	USPT2	H	A	N	Sep.-Jan.	Th		Na	Ac	LC	A	P	A
Acanthaceae Juss.													
Andrographis paniculata (Burm.f.) Nees	USAC1	H	A	N	Sep.-Apr.	Th		No	Ov	NE	A	P	A
Barleria prionitis L.	USAC2	S	P	N	Dec.-Apr.	Ch		Mi	La	NE	A	P	A
Ecbolium viride (Forsk.) Alston	USAC3	H	P	N	Dec.-Apr.	Ch		Mi	Ov	NE	A	P	A
Hygrophila auriculata (Schumach.) Heine	USAC4	H	A	N	Sep.-Jan.	Th		Mi	La	LC	A	P	A
Hygrophila polysperma (Roxb.) T.Anderson	USAC5	H	A	N	Sep.-Jan.	Th		Mi	La	NE	A	P	A
Verbenaceae J.St.Hil.													
Lantana camara L.	USVE1	S	P	E	Nov.-Feb.	Ch		No	Ov	NE	P	P	P
Lippia javanica (Burm.f.) Spreng.	USVE2	S	P	N	Sep.-Apr.	Ch		Mi	Ov	NE	P	P	P
Lamiaceae Martinov													
Anisomeles indica (L.) Kuntze	USLA1	H	A	N	Sep.-Jan.	Ch		Mi	Ov	NE	A	P	A
Clerodendrum infortunatum L.	USLA2	S	P	N	Feb.-Jul.	Ch		Ma	Co	NE	A	P	P
Leonotis nepetifolia (L.) R.Br.	USLA3	S	A	E	Apr.-Jul.	Th		Me	Co	NE	A	P	A
Leonurus sibiricus L.	USLA4	S	A	N	Sep.-Feb.	Ch		Mi	La	NE	A	P	A
Mesosphaerum suaveolens (L.) Kuntze	USLA5	S	A	E	Sep.-Jan.	Ch		Me	Ov	NE	A	P	A
Ocimum basilicum L.	USLA6	H	P	N	May-Jul.	Ch		Na	Ov	NE	A	P	A
Vitex negundo L.	USLA7	T	P	N	Mar.-Jun.	Ph	*N*	Mi	Ov	NE	P	P	P
Asterales Link													
Asteraceae Bercht. & J.Presl													
Ageratum conyzoides (L.) L.	USAT1	H	A	E	Nov.-Mar.	Th		Mi	Ov	LC	A	P	P
Ayapana triplinervis (Vahl) R.M.King & H.Rob.	USAT2	H	A	N	Sep.-Feb.	Th		No	La	NE	A	P	A
Blumea lacera (Burm.f.) DC.	USAT3	H	A	E	Aug.-Feb.	Th		Mi	La	NE	A	P	P
Chromolaena odorata (L.) R.M.King & H.Rob.	USAT4	S	A	E	Mar.-Sep.	Ch		Mi	Ov	NE	A	P	P
Cyanthillium albicans (DC.) H.Rob.	USAT5	H	A	N	Aug.-Mar.	Th		Mi	Li	NE	A	P	P
Eclipta prostrata (L.) L.	USAT6	H	A	E	All	Th		Mi	La	LC	A	P	P
Elephantopus scaber L.	USAT7	H	A	N	Sep.-Jan.	Th		No	Oo	NE	A	P	A
Enydra fluctuans Lour.	USAT8	H	A	N	Dec.-Mar.	Th		Mi	La	LC	A	P	P
Grangea maderaspatana (L.) Poir.	USAT9	H	A	E	Dec.-May	Th		Le	Sp	LC	A	P	P
Sonchus oleraceus L.	USAT10	H	A	N	Sep.-Jan.	Th		Na	Ha	NE	A	P	P
Sphaeranthus senegalensis DC.	USAT11	H	A	E	Nov.-Apr.	Th		Le	Ov	LC	A	P	P
Synedrella nodiflora (L.) Gaertn.	USAT12	H	A	E	Sep.-Jan.	Th		No	Ov	NE	A	P	P
Tridax procumbens L.	USAT13	H	A	E	All	Th		Na	Sg	NE	A	P	A
Xanthium strumarium L.	USAT14	H	A	E	Sep.-Apr.	Th		Me	Sg	NE	A	P	A
Apiales Nakai													
Apiaceae Lindl.													
Centella asiatica (L.) Urb.	USAP1	H	A	N	Jul.-Jan.	Th		No	Re	LC	A	P	A

Note**:** *Habit*: C: Climber, H: Herb, S: Shrub, T: Tree. *Life: Span*: A: Annual, B: Biennial, P: Perennial. *Nativity*: E: Exotic, N: Native. *Flowering and Fruiting time*: Jan.: January, Feb.: February, Mar.: March, Apr.: April, Jun.: June, Jul.: July, Aug.: August, Sep.: September, Oct.: October, Nov.: November, Dec.: December, All: All season. *Raunkiaer's Life: form and Sub: type*: Ch: Chamaephytes, Cr: Cryptophytes, H: Hemicryptophytes, M: Mesophanerophyte, MM: Megaphanerophytes, N: Nanophanerophytes, Ph: Phanerophytes, T: Therophytes. *Leaf spectra*: Le: Leptophyll, Na: Nanophyll, Mi: Microphyll, No: notophyll, Me: Mesophyll, Ma: Macrophyll, Mg: Megaphyll. *IUCN Status*: EN: Endangered, LC: Least Concern, NE : Not Evaluated, NT: Nearly Threatened, VU: Vulnerable. *Leaf Lamina*: Ac: Acicular, Co: Cordate, Cu: Cuneate, Ha: Hastate, La: Lanceolate, Li: Linear, Lu: Lunate, Ob: Oblong, Oo: Obovate, Or: Orbicular, Ov: Ovate, Pa: Palm like, Re: Reniform, Sb: Sabulate, Sg: Sagitate, Sp: Spathulate, Su: Subulate. *Seasons*: A: Absent, P: Present