

Diversity pattern of habitats of Macrophytes in Keibul Lamjao National Park (KLNP), a floating mat (*Phumdi*) environment of Loktak Lake, Manipur, India

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ABSTRACT

*Keibul Lamjao National Park (KLNP), Loktak lake Manipur, north-east India which is one of the 25 Ramsar sites of international importance and the biggest fresh water Lake in India. Macrophytes of the floating Phumdi mat environment of KLNP play an important role in the aquatic environment. An investigation was planned during the period of about three years from March, 2010 to December 2012, to study the diversity pattern of habitats of macrophytes available in six study sites of KLNP viz., 1.Kumbi, 2.Khordak, 3.Keibul, 4.Toya, 5. Nongmaikhong and 6. Sargam. All total 85 dominant plant species were recorded. Maximum plant species (49) was observed in Site-1 Kumbi (Altitude-780m) and minimum (27) in Site-3 Keibul (Altitude-772). The variation of plant species may be because of the slight variation of altitude. As the six study sites are distributed as floating aquatic environment in KLNP Loktak Lake, there is favourable place of the plants in higher altitude and altitude represents a complex gradient along which many environmental variables change concomitantly. In all the six study sites, common distribution of ten dominant plant macrophytes viz., *Ageratum conizoides*, *Hedychium coronarium*, *Leersia hexandra*, *Oenanthe javanica*, *Phragmites karka*, *Polygonum sagittatum*, *Saccharum munja*, *Thelypteris interrupta* and *Zizania latifolia* was noticed. Individual dominant plant was recorded in other sites also viz., *Azola piñata* in site-6; *Xanthium atrumarium*, *Polygonum orientale*, *Dichrocephala latifolia* and *Cymbopogon citratus* in site-2; *Arundo plinii*, *Cuscuta reflexa*, *Gnaphalium luteo-album*, *Hydrilla verticillata*, *Marsilia minuta*, *Saccolipsis interrupta*, *Selvenia cuculata* and *Utricularia spp.* in site-1. Variation of IVI value of*

*dominant plant species was observed in this study. Even though 85 dominant plants were selected for all the 6 sites, however, maximum plant richness expressed in IVI was recorded in case of *Zizania latifolia* (Site-5, IVI-87.5) and minimum IVI in case of *Xanthium strumarium* (Site-2, IVI-1.13). The diversity pattern and habitats of macrophytes in KLNP Phumdi environment might be due to water availability along the altitudinal gradient and other environmental factors suited in the study sites and expected to be an important factor affecting the survival and fecundity of plant population. We need to conserve the natural habitat of KLNP thereby maintaining the luxuriant growth of the seasonal and perennial, macrophytes, so as to maintain the natural flora and fauna of the park. These plants are the food of man and animal therefore, it needs a proper care and attention to protect them from over exploitation. Considering the diversity pattern of habitats of Macrophytes in KLNP, a floating mat Phumdi environment with high floral diversity and unique vegetation assemblage, it has been suggested that this track and adjoining sites should be declared as ecologically sensitive area not only the World Heritage Site.*

Key words: Diversity pattern, Macrophytes, Keibul Lamjao National Park (KLNP), Loktak Lake, Importance value index (IVI).

Introduction

In an aquatic environment, may be marshy area, stagnant wetlands or pond, lake etc. some macroscopic plants c.f. microphytes prevail, which can be seen by our naked eyes, otherwise termed as macrophytes. These aquatic macrophytes may be grouped into three vegetative categories viz., emergent, submerged and floating because of their habitats. Aquatic macrophytes facilitated to provide a cover for fish habitat and as a substrate for the aquatic invertebrates and insects as well as to produce oxygen and serve as food for some fishes and other wild life including terrestrial and birds. Crowder and Painter (1991) opined that, lack of macrophytes in an aquatic system, where they are expected to occur may suggest a reduced population of sport and forage fish and waterfowl. In addition, the absence of macrophytes may also indicate water quality problems as a result of excessive turbidity, herbicides, or sanitization. However, an overabundance of macrophytes can result from high nutrient levels and may interfere with lake processing, recreational activities (e.g., swimming, fishing, and boating), and detract from the aesthetic appeal of the system. Several works have been done on the phyto-sociology of different macrophytic species in different freshwater bodies of India and abroad (Cottam and Curtis, 1956; Unni, 1971; Mishra, 1974; Hutchinson, 1975; Crowder, *et al.*, 1977; Shah and Abbas, 1979; Zutshi, *et al.*, 1980; Billore and Vyas, 1981; Dey, 1981; Purohit and Singh, 1981; Biswas and Calder, 1984; Dey and Kar, 1989; Kar and Barbhuiya, 2007). Studies on aquatic flora of India are in its juvenile phase. Earlier, Subrahmanyam (1962) has described 117 aquatic angiosperms. Lavania, *et al.* (1990) has compiled the wetland flora of India; Cook (1996) has published the aquatic and wetland flora of India.

The Aquatic and Wetland plants filled up the space of an ecological niche, with a variety of shape and sizes of life forms. They do not belong to a particular plant family; however, they are derived from various land plant families and try to adapt to the wet environment and modified into various forms to withstand to the changing environment. The definition of Aquatic is of different interpretations; however, they do not always fit rigid definitions. An aquatic plant is a form of plant group which starts its life cycle in water and must grow for at least a part of their life cycle in water, either completely submerged or emerged. Wetlands are distributed worldwide and are found in many climates, from the tropics to the tundra and are considered the most biologically diverse of all ecosystems. They provide habitat for a great number of water and land species. They are also an important environment to many migratory bird species. Different types of wetlands include swamps, bogs, marshes and estuaries.

In due course of time, among the natural vegetations of the aquatic and wetland plants come to change the phyto-sociology in the trend of changing environmental factors due to the influx of invasive and alien species like *Alternanthera philoxeroides* (Mart.) Griseb., *Brachiaria mutica* (Forssk.) Stapf., *Ipomoea cairica* (L.) Sweet, *Cassia mimosoides* L., *Cuphea carthagensis* (Jacq.) J.F. Macbr., *Lantana camara* L. etc. Thereafter, problems do arise in wetland plants, so as to increase weeds and thereby creating excessive algal growth, emergent vegetation and results to lower water level, which dries out vegetation in shallow water areas.

From the above mentioned facts an investigation was planned during the period of about three years from March, 2010 to December 2012, to study the diversity pattern of habitats of macrophytes available in KLNP, a floating mat (*Phumdi*) environment of Loktak Lake, Manipur, which is the largest fresh water in north-east India.

Materials and methods

Study site

The KLNP is the only floating National park (*phumdi*) in the globe. KLNP is located in the south-eastern corner of Loktak Lake (287 km² in area) a fresh water lake of Manipur which is one of the 25 Ramsar sites of international importance in India (Fig. 1). The park covers an area of about 40 km² and situated between 24°27'N to 24°31'N latitude and 93°53'E to 93°55'E longitudes having two distinct geographical zones. In zone-i, the *phumdi* area is about 29 km², which is constituted by the combination of soil, vegetation and organic matter in different stages of decay forms the major area and the zone-ii, is a Water body area (9 km²) around the floating portion. Six study sites of KLNP were selected for the study viz., 1.Kumbi, 2.Khordak, 3.Keibul, 4.Toya, 5. Nongmaikhong and 6. Sargam (Fig. 2).

The Park supports macrophytes and wetland vegetation. The park's *phumdi* is very rich in plant diversity. About 48 species of plants have been recorded in the park (Singh and Singh, 1994), 145 species by Singh (2002b), Deb (1961a, b) listed 125 species, Sinha (1990 a, b) recorded 157 species of wet land species, Singh (2002a) recorded ethnobotanically uses of 24 plants on the *phumdi* of Loktak Lake and Trisal and Manihar (2004) described the highest number of 132 plant species in KLNP. Some floating plants are the primary plants involved in the formation of the *phumdi*. It had the association of plants species from different groups and families. These plants are very useful as food (Wild edible), fuel, medicine, fodder and fencing and also for many other purposes.

Macrophytes

Macrophytes, literally-large plants, which can be seen by our naked eyes, are the aquatic plants that grow in or near water i.e. based on where and how they grow. Macrophytes which are found inside the water body may be: Emergent or emerged-the plants are rooted in the substrate and protrude up above the water surface as an amphibious habit, Submergent or submersed-the plants grow below the water surface and Floating-the plants may be purely floating on the water surface or the rooted plants that have leaves float on the water surface. Macrophytes which are near the water body like, lake or river may be termed as Riparian plants. These plants that lines the banks of the water body protect the banks and ranges from grasses to trees. Venable (1914) categorized aquatic and wetland plants into six categories as follows: i) Free floating, such as duckweed, ii) Totally submerged, such as naiad, iii) Bottom rooted and floating, such as waterlily, iv) Emergent and rooted, such as quillwort, v) Totally emergent, such as cattails and vi) Stream-bank and wet area plants, such as alders. In general he further elaborated the types of aquatic habitat are also classified as: i) wet (riparian), ii) shallow standing water (marsh), and open water (aquatic).

Collection of Macrophytes and Identification

Several fieldworks cum survey were undertaken in the 6 selected villages (study sites) residing in the vicinity of the park from March, 2010 to December 2012 in KLNP. Plant species mentioned by the traditional communities were collected from the field. The plant specimens collected from the study area were pressed between the absorbents under heavy pressure immediately after reaching the laboratory. Dried specimens were poisoned by dipping the whole plant in a solution of mercuric chloride in ethyl alcohol (115 g mercuric chloride dissolved in 4.5 liter ethyl alcohol, called *Kew Mixture*). After the specimens were poisoned, they were dried and affixed (along with a label) on a mounting sheets [28 cm X 42 cm (± 1 cm) dimension] by using Fevicol glue. Identification is done by referring to relevant state flora (Singh et al., 2000). Plants were identified in the Department of Life Sciences, Manipur University, Canchipur, Imphal and Botanical Survey of India, Eastern Circle, Shillong. Voucher specimens were deposited at the

herbarium of Department of Life Sciences, Manipur University. Plant names were cross checked with International Plant Name Index (www.ipni.org) and Plant List websites (www.theplantlist.org).

Quantitative Method

Regular periodical survey and stumping of the vegetation during the months of February, May, September and November at different sites were carried out. The floristic composition of the species as changes in the distribution in the different study sites was properly analyzed. For the phytosociological study, complete plant inventory was carried out to estimate plant density, frequency, dominance (Curtis, 1959; Mishra, 1968, Mueller-Dombois and Ellenberg, 1974). Quantitative characters like frequency, density and abundance were analyzed by using quadrates (50 × 50) cm² and each site 5 quadrates were utilized for sampling.

Important value Index (IVI)

To obtain an overall picture of the ecological importance and to express the dominance or ecological success of any species with a single value, the concept of importance value index has been developed. This index is obtained by summing up the value of relative frequency, relative density and relative dominance (Phillips, 1958; Curtis, 1959; Misra, 1968). The value of IVI for a species is less than 300.

[Importance Value Index (IVI) = Relative frequency + Relative density + Relative dominance]

$\Sigma RF + \Sigma RD + \Sigma Rd$ (Curtis, 1959)

Where, ΣRF , ΣRD and ΣRd is the sum of the values of relative frequency, relative density and relative dominance of all the species.

Results and Discussion

During the study, vegetation composition of the six study sites (1.Kumbi, 2.Khordak, 3.Keibul, 4.Toya, 5. Nongmaikhong and 6. Sargam) of Keibul Lamjao National Park (KLNP), Loktak Lake, Manipur was observed between the period from March 2010 to December 2012 (Table-1). In Manipur monsoon comes during the period of March-April, so optimum luxuriant growth of the vegetation of the study sites is during the period from May to September. Table-1 shows the dominant vegetation which was sampled during the period of September to November 2010. However, all total 85 dominant plant species were recorded (Table-2). Maximum plant species (49) was observed in Site-1 (Fig. 3) Kumbi (Altitude-780m) and minimum (27) in Site-3 (Fig. 5) Keibul (Altitude-772). The variation of plant species may be because of the slight variation of altitude. As the six study sites are distributed as floating aquatic environment in KLNP Loktak Lake, there is favourable place of the plants in higher altitude. This finding is in conformity with other findings viz., Nautiyal *et al.* (2011) reported that altitude represents a complex gradient along which many environmental variables change

concomitantly. However, the patterns in species richness decrease with altitude (Rahbek, 1997).

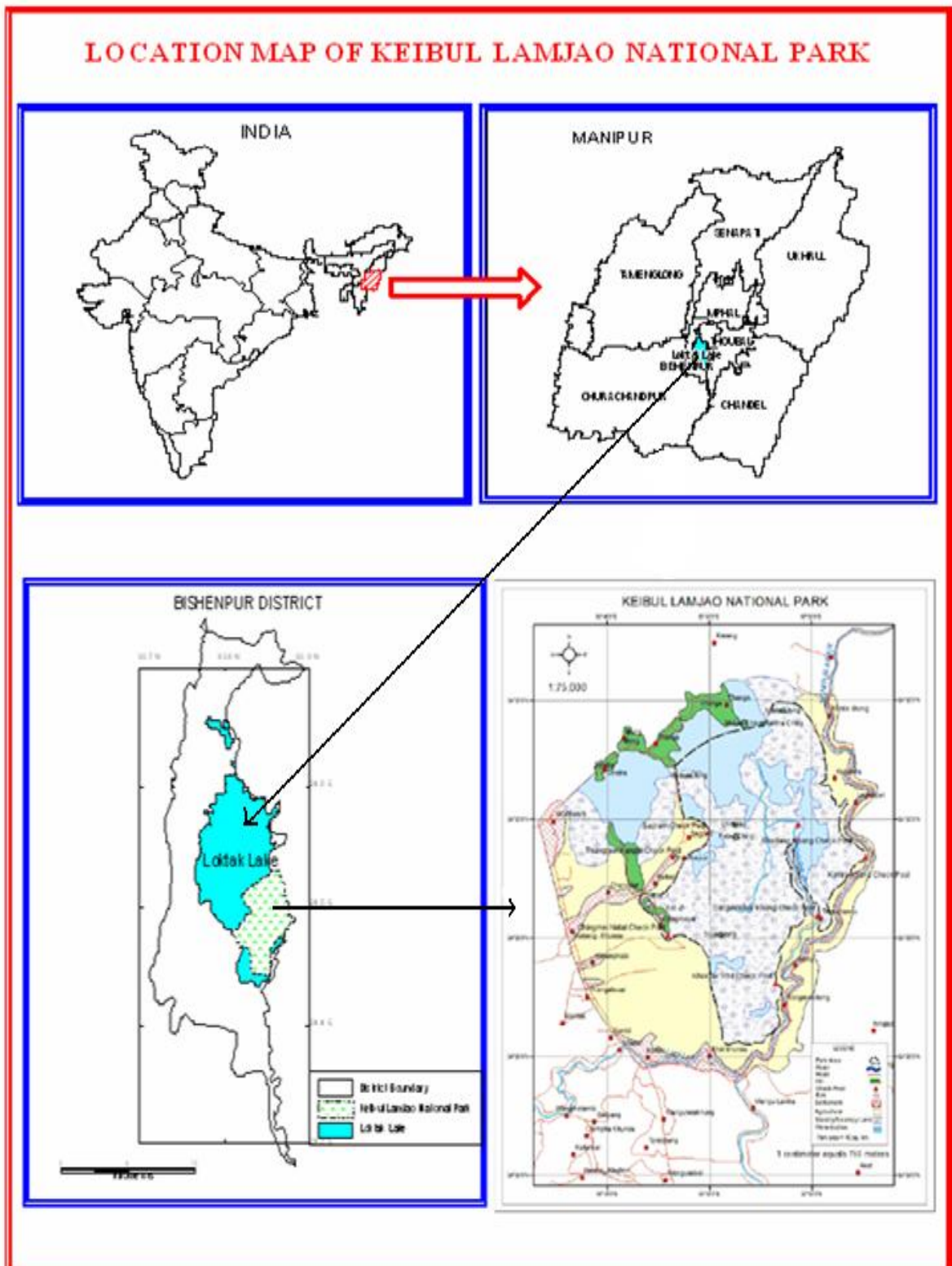


Fig. 1. Map showing the location of study site in the Indian sub-continent, Manipur State, Loktak Lake in Bishnupur District and Keibul Lamjao National Park (KLNP), Loktak Lake, Manipur

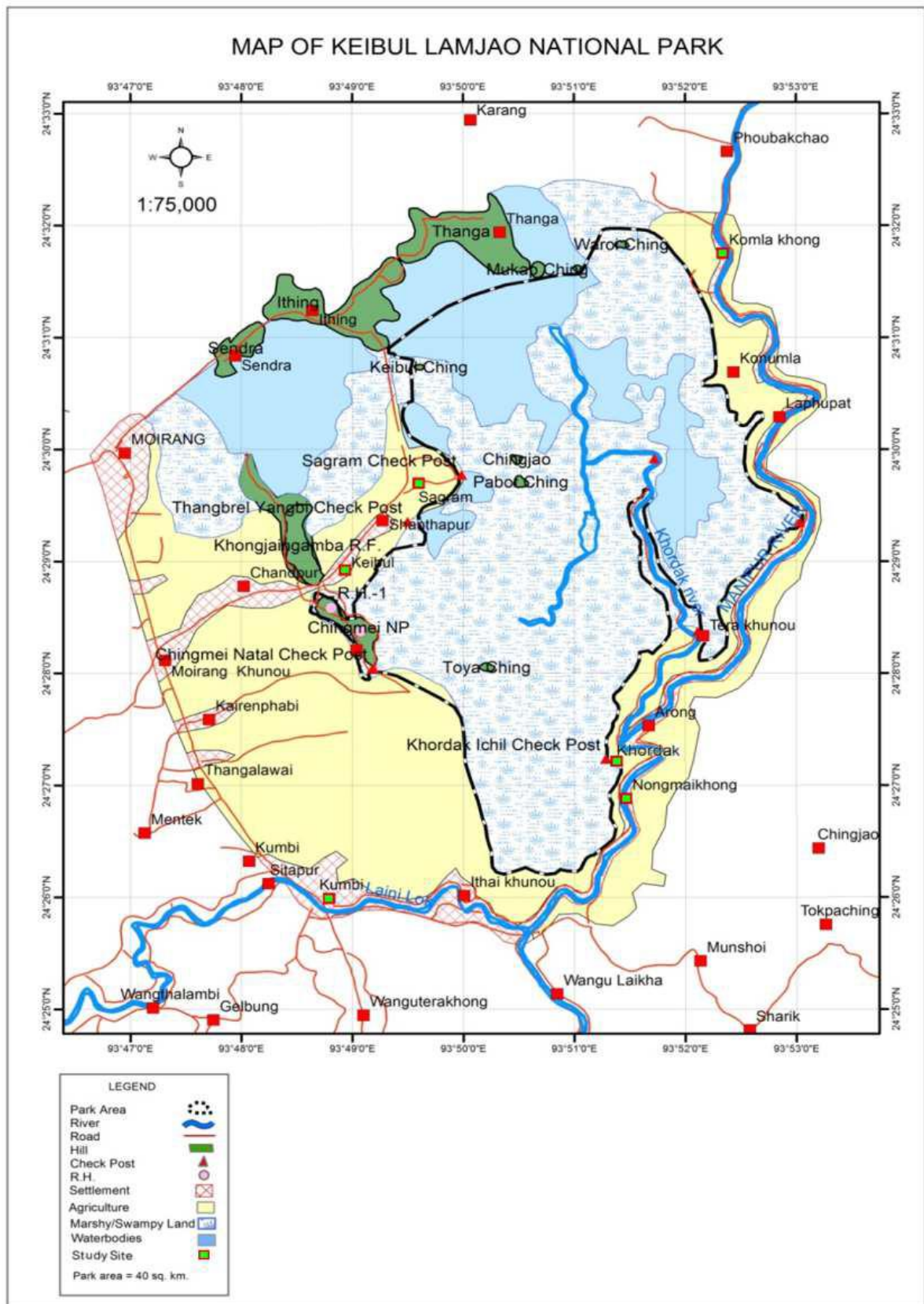


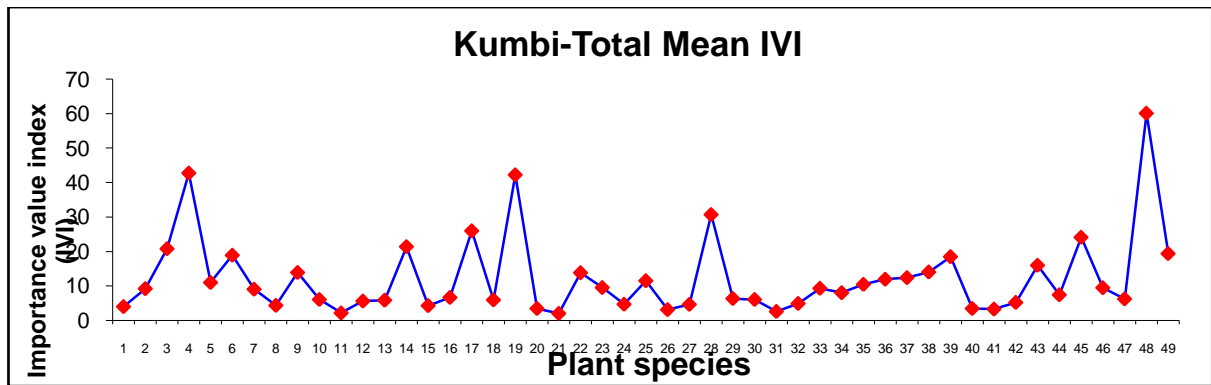
Fig. 2. Map of Keibul Lamjao National Park (KLNP), Loktak Lake, Manipur, showing the six study sites viz., 1)Keibul, 2)Nongmaikhong, 3)Sargam, 4)Kumbi, 5)Khordak and 6)Komlakhong.

Table 1. Vegetation composition of the six study sites (1.Kumbi, 2.Khordak, 3.Keibul, 4.Toya,5. Nongmaikhong and 6. Sargam) of Keibul Lamjao National Park (KLNP), Loktak Lake, Manipur during the period from September to November, 2010, Quadrat Size=50 x 50cm² [Q=Quadrat, BA=Basal area, RD=Relative density, Re.Freq.=Relative frequency, Rel Dom=Relative Dominance, IVI=Important value index].

Site-1

	Local name	Scientific name	Q1	Q2	Q3	Q4	Q5	No of species	Q area	Density	Fre-quency	BA	R.D.	Re. Freq.	Domi-nance	Rel Dom	IVI
1	Khongjainapi	<i>Alternanthera philoxeroides</i>	15	8	3	2	0	28	1.25	5.60	80	0.28	5.38	5.33	6.33	7.54	18.26
3	Luwangtou	<i>Arundo plinii</i>	1	0	0	1	1	3	1.25	0.60	60	0.20	0.58	4.00	0.47	0.56	5.14
4	Kangkup	<i>Azolla pinnata</i>	50	20	3	20	2	95	1.25	19.00	100	0.20	18.27	6.67	14.92	17.76	42.70
5	Sajik tujombi	<i>Brachiaria mutica</i>	3	0	4	2	5	14	1.25	2.80	80	0.13	2.69	5.33	1.41	1.68	9.70
12	Chumthangmacha	<i>Cyperus brevifolius</i>	3	2	0	1	0	6	1.25	1.20	60	0.07	1.15	4.00	0.34	0.40	5.56
17	Kabokang	<i>Eichhornia crassipes</i>	10	8	7	6	3	34	1.25	6.80	100	0.95	6.54	6.67	25.84	30.77	43.98
18	Komprektujombi	<i>Enhydra fluctuans</i>	1	0	0	1	0	2	1.25	0.40	40	0.20	0.38	2.67	0.31	0.37	3.43
25	Kolamani	<i>Ipomoea aquatica</i>	10	8	12	10	11	51	1.25	10.20	100	0.20	9.81	6.67	8.01	9.54	26.01
28	Hoop	<i>Leersia hexandra</i>	8	10	7	15	6	46	1.25	9.20	100	0.03	8.85	6.67	1.16	1.38	16.89
29	Eshingkundo	<i>Ludwigia clavelliana</i>	0	0	1	0	0	1	1.25	0.20	20	0.07	0.19	1.33	0.06	0.07	1.59
30	Chaoradebo	<i>Ludwigia octovalvis</i>	0	1	1	0	0	2	1.25	0.40	40	0.13	0.38	2.67	0.20	0.24	3.29
33	Ngachak komol	<i>Nymphoides indicum</i>	2	4	1	1	2	10	1.25	2.00	100	0.07	1.92	6.67	0.57	0.67	9.26
36	Wanamambi	<i>Panicum sphaerocarpon</i>	7	3	1	0	1	12	1.25	2.40	80	0.03	2.31	5.33	0.30	0.36	8.00
37	Phumhawai	<i>Phaseolus mungo</i>	15	10	20	12	22	79	1.25	15.80	100	0.07	15.19	6.67	4.47	5.32	27.18
39	Tou Angouba	<i>Phragmites karka</i>	1	4	3	2	3	13	1.25	2.60	100	0.64	2.50	6.67	6.61	7.88	17.04
42	Ishing Lilhar	<i>Polygonum sagittatum</i>	1	1	2	1	0	5	1.25	1.00	80	0.07	0.96	5.33	0.28	0.34	6.63
43	Khoimom	<i>Saccharum munja</i>	8	7	10	12	10	47	1.25	9.40	100	0.20	9.04	6.67	7.38	8.79	24.49
45	Salvinia (Kangkup)	<i>Salvinia cuculata</i>	30	10	5	7	15	67	1.25	13.40	100	0.07	12.88	6.67	3.79	4.51	24.06
49	Ishing Kambong	<i>Zizania caduciflora</i>	2	2	1	0	0	5	1.25	1.00	60	0.38	0.96	4.00	1.54	1.83	6.79
								520		104	1500	3.97	100.00	100.00	83.96	100.00	300.00

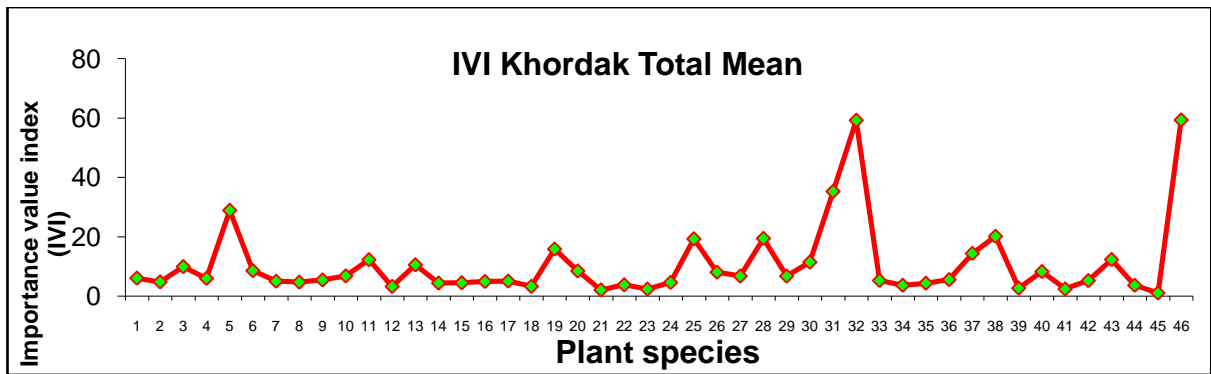
Fig.3. SITE-1. 1. *Ageratum conyzoides*, 2. *Alternanthera philoxeroides*, 3. *Arundo plinii*, 4. *Azolla pinnata*, 5. *Brachiaria mutica*, 6. *Carex setigera*, 7. *Chrysopsis mariana*, 8. *Coix lachryma-jobi*, 9. *Colocasia esculenta*, 10. *Crasscephalum crepidioides*, 11. *Cuscuta reflexa*, 12. *Cyperus brevifolius*, 13. *Cyperus cyperoides*, 14. *Cyperus digitatus*, 15. *Cyperus rotundus*, 16. *Cyperus umbellatus*, 17. *Eichhornia crassipes*, 18. *Enhydra fluctuans*, 19. *Saccharum arundinaceum*, 20. *Floscopa scandens*, 21. *Gnaphalium luteoalbum*, 22. *Hedychium coronarium*, 23. *Hydrilla verticillata*, 24. *Impatiens chinensis*, 25. *Ipomoea aquatica*, 26. *Ipomoea cairica*, 27. *Jussiaea suffruticosa*, 28. *Leersia hexandra*, 29. *Ludwigia clavelliana*, 30. *Ludwigia octovalvis*, 31. *Marsilia minuta*, 32. *Mikania cordata*, 33. *Nymphoides indicum*, 34. *Oenanthe javanica*, 35. *Oryza rufipogon*, 36. *Panicum sphaerocarpon*, 37. *Vigna mungo*, 38. *Phragmites australis*, 39. *Phragmites karka*, 40. *Persicaria barbata*, 41. *Persicaria glabra*, 42. *Persicaria sagittata*, 43. *Saccharum bengalens*, 44. *Saccolipsis interrupta*, 45. *Salvinia cuculata*, 46. *Sparganium emersum*, 47. *Thelypteris interrupta*, 48. *Utricularia aurea*, 49. *Zizania latifolia*



Site-2

	Local name	Scientific name	Q1	Q2	Q3	Q4	Q5	No of species	Q area	Density	Fre-quency	BA	R.D.	Re. Freq.	Domi-nance	Rel Dom	IVI
1	Khongjainapi	<i>Ageratum conyzoides</i>	2	0	1	1	0	4	1.25	0.8	60	0.03	2.20	4.76	0.10	0.39	7.35
4	Kabo napi	<i>Alternanthera philoxeroides</i>	1	0	2	0	0	3	1.25	0.6	40	0.28	1.65	3.17	0.68	2.64	7.46
7	Langtherimanbi	<i>Chrysopsis mariana</i>	1	0	0	0	0	1	1.25	0.2	20	0.03	0.55	1.59	0.03	0.10	2.23
8	Terapaibi	<i>Crasscephalum crepidiodes</i>	0	1	0	0	0	1	1.25	0.2	20	0.13	0.55	1.59	0.10	0.39	2.53
9	Charot	<i>Cymbopogon citratus</i>	0	1	0	1	0	2	1.25	0.4	40	0.20	1.10	3.17	0.31	1.22	5.50
13	Chumthang	<i>Cyperus umbellatus</i>	4	3	4	2	2	15	1.25	3	100	0.07	8.24	7.94	0.85	3.30	19.48
14	Lalukok	<i>Dichrocephala latifolia</i>	0	0	1	1	0	2	1.25	0.4	40	0.03	1.10	3.17	0.05	0.20	4.47
17	Lam thangiou	<i>Fuirena umbellata</i>	0	1	0	2	0	3	1.25	0.6	40	0.03	1.65	3.17	0.08	0.29	5.12
19	Loklei	<i>Hedychium coronarium</i>	4	3	2	2	1	12	1.25	2.4	100	0.38	6.59	7.94	3.69	14.38	28.91
20	Phum khujang	<i>Impatient chinensis</i>	1	2	0	1	0	4	1.25	0.8	60	0.13	2.20	4.76	0.40	1.57	8.53
24	Cheiteklei	<i>Jussiaea suffruticosa</i>	0	0	1	0	1	2	1.25	0.4	40	0.07	1.10	3.17	0.11	0.44	4.71
25	Hoop	<i>Leersia hexandra</i>	6	5	0	6	3	20	1.25	4	80	0.03	10.99	6.35	0.50	1.96	19.30
26	Uri hingchabi	<i>Mikania cordata</i>	3	4	2	1	2	12	1.25	2.4	100	0.03	6.59	7.94	0.30	1.17	15.70
28	Waimuchara	<i>Oryza rufipogon</i>	2	4	2	3	4	15	1.25	3	100	0.07	8.24	7.94	0.85	3.30	19.48
32	Tou	<i>Phragmites karka</i>	1	1	0	0	1	3	1.25	0.6	60	0.64	1.65	4.76	1.53	5.94	12.35
33	Yellang	<i>Polygonum barbatum</i>	0	0	1	0	0	1	1.25	0.2	20	0.07	0.55	1.59	0.06	0.22	2.36
35	Chaokhong	<i>Polygonum orientale</i>	0	2	0	1	0	3	1.25	0.6	40	0.07	1.65	3.17	0.17	0.66	5.48
38	Khoimom	<i>Saccharum munja</i>	3	4	5	7	2	21	1.25	4.2	100	0.20	11.54	7.94	3.30	12.84	32.32
43	Lai changkhrang	<i>Thelypteris interrupta</i>	6	5	3	4	3	21	1.25	4.2	100	0.07	11.54	7.94	1.19	4.62	24.10
46	Kambong	<i>Zizania caduciflora</i>	4	8	10	5	10	37	1.25	7.4	100	0.38	20.33	7.94	11.39	44.35	72.62
								182		36.4	1260	2.94	100.00	100.00	25.67	100.00	300.00

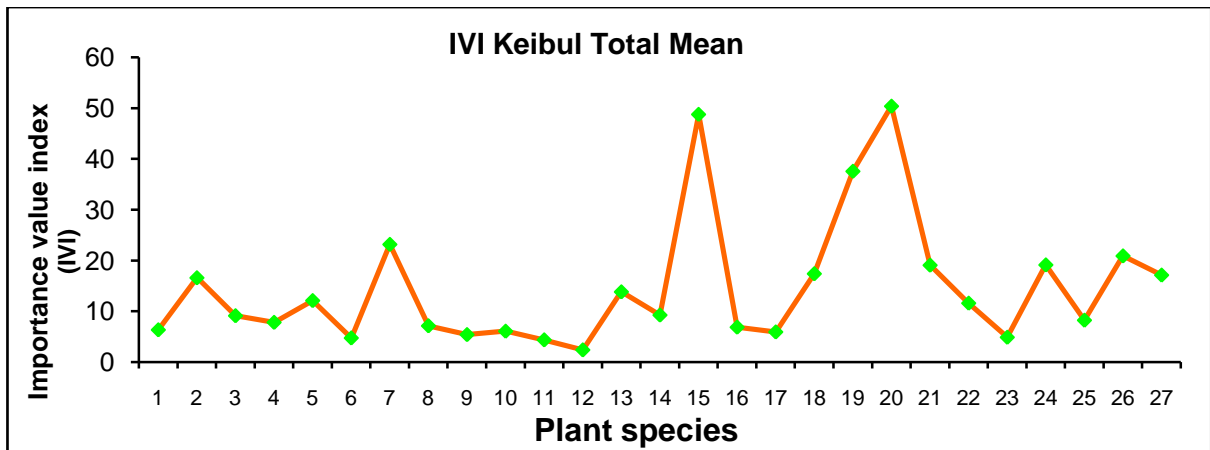
Fig. 4.SITE-2. 1. *Ageratum conyzoides*, 2. *Ageratum haustonianum*, 3. *Alpinia nigra*, 4. *Alternanthera philoxeroids*, 5. *Arundo plinii*, 6. *Brachairia mutica*, 7. *Chrysopsis mariana*, 8. *Crasscephalum crepidiodes*, 9. *Cymbopogon citratus*, 10. *Cyperus brevifolius*, 11. *Cyperus digitatus*, 12. *Cyperus rotundus*, 13. *Cyperus umbellatus*, 14. *Dichrocephala latifolia*, 15. *Echinochloa curjbelli*, 16. *Enhydra fluctuans*, 17. *Fuirena umbellata*, 18. *Grangea maderaspatana*, 19. *Hedychium coronarium*, 20. *Impatient chinensis*, 21. *Ipomoea aquatica*, 22. *Ipomoea cairica*, 23. *Ipomoea cairica*, 24. *Jussiaea suffruticosa*, 25. *Leersia hexandra*, 26. *Mikania cordata*, 27. *Oenanthe javanica*, 28. *Oryza rufipogon*, 29. *Osbeckia chinensis*, 30. *Panicum sphaerocarpon*, 31. *Panicum sphaerocarpon*, 32. *Phragmites karka*, 33. *Persicaria barbata*, 34. *Persicaria glabra*, 35. *Polygonum orientale*, 36. *Persicaria sagittata*, 37. *Rotala rotundifolia*, 38. *Saccharum bengalens*, 39. *Saccolipsis interrupta*, 40. *Setaria pumila*, 41. *Sida rhombifolia*, 42. *Solanum rudepannum*, 43. *Thelypteris interrupta*, 44. *Urena lobata*, 45. *Xanthium strumarium*, 46. *Zizania latifolia*



Site-3

Sl. No.	Local name	Scientific name	Q1	Q2	Q3	Q4	Q5	No of species	Q area	Density	Frequency	BA	R.D.	Re. Freq.	Dominance	Rel Dom	IVI
1	Khongjainapi	<i>Ageratum conyzoides</i>	4	0	0	3	0	7	1.25	1.4	100	3.14	0.70	9.62	17.58	7.93	18.25
2	Pullei	<i>Alpinia nigra</i>	2	0	0	3	16	21	1.25	4.2	80	0.79	2.11	7.69	13.19	5.95	15.76
4	Sajik tujombi	<i>Brachiaria mutica</i>	13	0	0	9	18	40	1.25	8	80	0.03	4.03	7.69	1.00	0.45	12.17
7	Chaning	<i>Coix lachryma-jobi</i>	8	0	2	8	0	18	1.25	3.6	60	0.03	1.81	5.77	0.45	0.20	7.79
10	Tingthou	<i>Cynodon dactylon</i>	0	0	50	28	41	119	1.25	23.8	40	0.07	11.98	3.85	6.73	3.03	18.86
13	Loklei	<i>Hedychium coronarium</i>	3	0	3	12	2	20	1.25	4	40	2.01	2.01	3.85	32.15	14.51	20.37
14	Phumkhujang	<i>Impatiens chinensis</i>	8	3	7	0	5	23	1.25	4.6	80	0.79	2.32	7.69	14.44	6.52	16.52
15	Hoop	<i>Leersia hexandra</i>	46	126	75	70	0	317	1.25	63.4	60	0.03	31.92	5.77	7.96	3.59	41.29
16	Chaoradebo	<i>Ludwigia octovalvis</i>	4	0	0	4	0	8	1.25	1.6	60	1.77	0.81	5.77	11.30	5.10	11.67
18	Wainuchara	<i>Oryza rufipogon</i>	16	0	40	0	32	88	1.25	17.6	60	0.20	8.86	5.77	13.82	6.23	20.86
19	Wanamanbi	<i>Panicum sphaerocarpon</i>	45	12	70	0	0	238	1.25	47.6	40	0.38	23.97	3.85	73.24	33.04	60.85
20	Tou angouba	<i>Phragmites karka</i>	3	8	4	7	4	26	1.25	5.2	60	0.13	2.62	5.77	2.61	1.18	9.57
21	Yellang	<i>Polygonum barbatum</i>	4	0	2	4	0	10	1.25	2	60	0.03	1.01	5.77	0.25	0.11	6.89
22	Ishing Lilhar	<i>Polygonum sagittatum</i>	4	0	8	0	0	12	1.25	2.4	60	1.13	1.21	5.77	10.85	4.90	11.87
25	Kombirei-manbi	<i>Sparganium angustifolium</i>	1	5	0	0	0	6	1.25	1.2	80	3.14	0.60	7.69	15.07	6.80	15.10
26	Lai Changkhrang	<i>Thelypteris interrupta</i>	2	11	0	0	0	13	1.25	2.6	40	0.03	1.31	3.85	0.33	0.15	5.30
27	Ishing Kambong	<i>Zizania caduciflora</i>	4	0	1	12	10	27	1.25	5.4	40	0.03	2.72	3.85	0.68	0.31	6.87
								993		198.6	1040	13.72	100.00	100.00	221.67	100.00	300.00

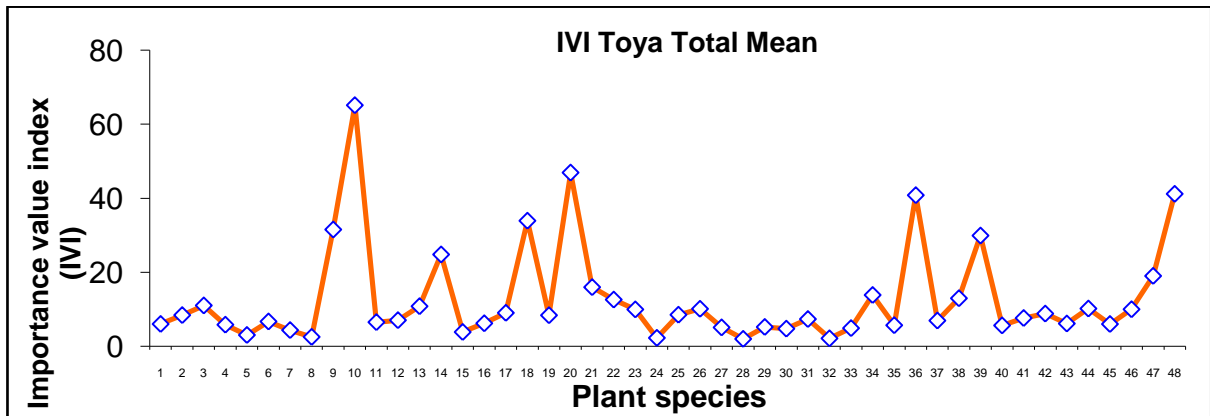
Fig. 5. SITE-3. 1. *Ageratum conyzoides*, 2. *Alpinia nigra*, 3. *Alternanthera philoxeroides*, 4. *Brachiaria mutica*, 5. *Carex setigera*, 6. *Chrysopsis mariana*, 7. *Coix lachryma-jobi*, 8. *Colocasia esculenta*, 9. *Crasscephalum crepidioides*, 10. *Cynodon dactylon*, 11. *Cyperus brevifolius*, 12. *Fuirena umbellata*, 13. *Hedychium coronarium*, 14. *Impatiens chinensis*, 15. *Leersia hexandra*, 16. *Ludwigia octovalvis*, 17. *Oenanthe javanica*, 18. *Oryza rufipogon*, 19. *Panicum sphaerocarpon*, 20. *Phragmites karka*, 21. *Persicaria barbata*, 22. *P. glabra*, 23. *P. sagittata*, 24. *Saccharum bengalens*, 25. *Sparganium emersum*, 26. *Thelypteris interrupta*, 27. *Zizania latifolia*



Site-4

	Local name	Scientific name	Q1	Q2	Q3	Q4	Q5	No of species	Q. area	Density	Frequency	BA	R.D.	Re. Freq.	Dominance	Rel Dom	IVI
1	Khongjainapi	<i>Ageratum conyzoides</i>	2	0	2	0	1	5	1.25	1	60	0.03	1.67	5.36	0.13	0.51	7.54
2	Pullei	<i>Alpinia nigra</i>	0	0	1	0	2	3	1.25	0.6	40	0.28	1.00	3.57	0.68	2.77	7.35
3	Kabonapi	<i>Alternanthera philoxeroides</i>	7	0	0	3	0	10	1.25	2	40	0.13	3.34	3.57	1.00	4.11	11.03
4	Chengkruk	<i>Amaranthus spinosus</i>	3	0	0	1	0	4	1.25	0.8	40	0.07	1.34	3.57	0.23	0.92	5.83
5	Uripudingbi	<i>Argyrea nervosa</i>	0	1	0	0	0	1	1.25	0.2	20	0.28	0.33	1.79	0.23	0.92	3.05
8	Hameibon	<i>Callicarpa macrophylla</i>	0	1	0	0	0	1	1.25	0.2	20	0.13	0.33	1.79	0.10	0.41	2.53
9	Humdang	<i>Carex cruciata</i>	20	25	0	0	15	60	1.25	12	60	0.07	20.07	5.36	3.39	13.87	39.30
12	Moirangkhanum	<i>Clerodendrum serratum</i>	1	0	0	0	0	1	1.25	0.2	20	0.28	0.33	1.79	0.23	0.92	3.05
13	Chaning	<i>Coix lachrymal-jobi</i>	0	2	0	1	0	3	1.25	0.6	40	0.64	1.00	3.57	1.53	6.24	10.82
14	Lampan	<i>Colocasia esculenta</i>	0	1	1	0	0	2	1.25	0.4	40	3.14	0.67	3.57	5.02	20.55	24.80
16	Terapaibi	<i>Crasscephalum crepidiodes</i>	2	0	0	1	0	3	1.25	0.6	40	0.38	1.00	3.57	0.92	3.78	8.35
17	Yaiple	<i>Curcuma angustifolia</i>	3	0	0	0	0	3	1.25	0.6	20	0.64	1.00	1.79	1.53	6.24	9.03
22	Lamthangjou	<i>Fuirena umbellata</i>	3	2	0	0	1	6	1.25	1.2	60	0.03	2.01	5.36	0.15	0.62	7.98
24	Loklei	<i>Hedyctium coronarium</i>	3	2	0	1	0	6	1.25	1.2	60	0.07	2.01	5.36	0.34	1.39	8.75
25	Phumkhujiang	<i>Impatiens chinensis</i>	0	2	4	0	0	6	1.25	1.2	40	0.03	2.01	3.57	0.15	0.62	6.19
26	Cheiteklei	<i>Jussiaea suffrutcosa</i>	2	1	0	0	0	3	1.25	0.6	40	0.07	1.00	3.57	0.17	0.69	5.27
27	Hoop	<i>Leersia hexandra</i>	20	10	0	0	30	60	1.25	12	60	0.03	20.07	5.36	1.51	6.17	31.59
29	Lamthabi	<i>Melothria purpusilla</i>	2	0	0	0	0	2	1.25	0.4	20	0.20	0.67	1.79	0.31	1.28	3.74
30	Urihingchabi	<i>Mikania cordata</i>	0	1	2	0	0	3	1.25	0.6	40	0.03	1.00	3.57	0.08	0.31	4.88
31	Kangphalekaithabi	<i>Mimosa pudica</i>	5	0	0	2	0	7	1.25	1.4	40	0.03	2.34	3.57	0.18	0.72	6.63
32	Lamkarot	<i>Momordica charantia</i>	1	0	0	0	0	1	1.25	0.2	20	0.01	0.33	1.79	0.01	0.03	2.15
35	Yachubi	<i>Osbeckia chinensis</i>	1	0	0	1	0	2	1.25	0.4	40	0.07	0.67	3.57	0.11	0.46	4.70
36	Wanamanbi	<i>Panicum sphaerocarpon</i>	25	36	0	0	15	76	1.25	15.2	60	0.03	25.42	5.36	1.91	7.81	38.59
44	Tinkhak manbi	<i>Setaria pumila</i>	6	3	0	4	0	13	1.25	2.6	60	0.01	4.35	5.36	0.08	0.33	10.04
45	Kombireimanbi	<i>Sparganium angustifolium</i>	0	0	1	1	0	2	1.25	0.4	40	0.13	0.67	3.57	0.20	0.82	5.06
46	Lai changkhrang	<i>Thelypteris interrupta</i>	0	3	2	0	3	8	1.25	1.6	60	0.03	2.68	5.36	0.20	0.82	8.85
47	Tekhoyaiakhu	<i>Zingiber cassumunar</i>	0	3	0	0	5	8	1.25	1.6	40	0.64	2.68	3.57	4.07	16.65	22.90
								299		59.8	1120	7.47	100.00	100.00	24.44	100.00	300.00

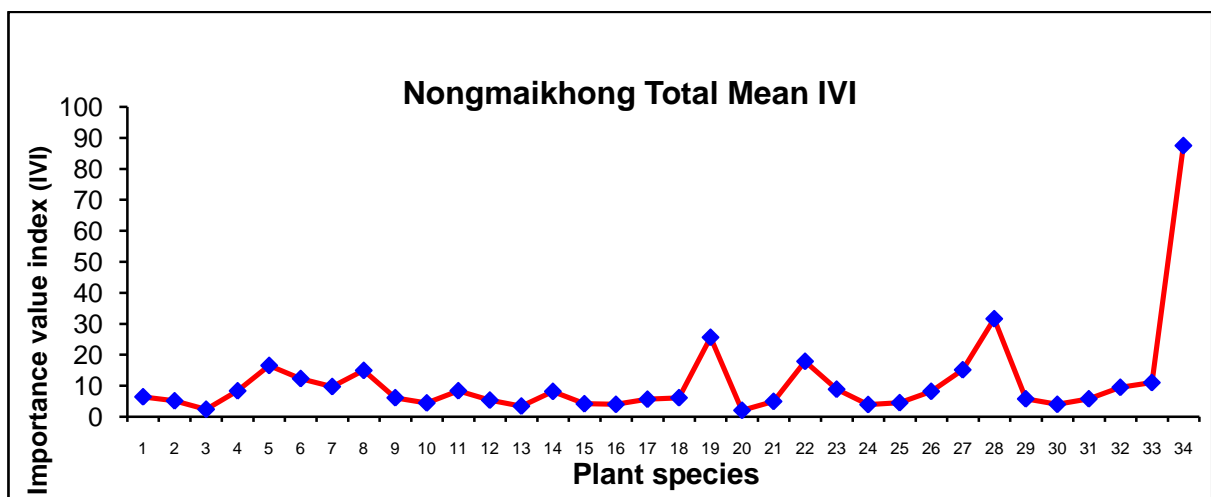
Fig. 6. SITE-4. 1. *Ageratum conizoides*, 2. *Alpinia nigra*, 3. *Alternanthera philoxeroides*, 4. *Amaranthus spinosus*, 5. *Argyreia nervosa*, 6. *Artemisia nilagirica*, 7. *Arundo plinii*, 8. *Capparis acutifolia*, 9. *Carex setigera*, 10. *Cephalanthus tetrandrus*, 11. *Chrysopsis mariana*, 12. *Rotheca serrata*, 13. *Coix lachryma-jobi*, 14. *Colocasia esculenta*, 15. *Commelina bengalensis*, 16. *Crasscephalum crepidiodes*, 17. *Curcuma angustifolia*, 18. *Cymbopogon nardus*, 19. *Cyperus umbellatus*, 20. *Saccharum arundinaceum*, 21. *Chromolaena odorata*, 22. *Fuirena umbellata*, 23. *Grangea maderaspatana*, 24. *Hedychium coronarium*, 25. *Impatiens chinensis*, 26. *Jussiaea suffruticosa*, 27. *Leersia hexandra*, 28. *Ludwigia octovalvis*, 29. *Melothria purpusilla*, 30. *Mikania cordata*, 31. *Mimosa pudica*, 32. *Momordica dioica*, 33. *Monochoria hastaeifolia*, 34. *Oenanthe javanica*, 35. *Osbeckia chinensis*, 36. *Panicum sphaerocarpon*, 37. *Persicaria chinensis*, 38. *Phragmites australis*, 39. *Phragmites karka*, 40. *Persicaria barbata*, 41. *Persicaria sagittata*, 42. *Rotala rotundifolia*, 43. *Saccharum bengalens*, 44. *Setaria pumila*, 45. *Sparganium emersum*, 46. *Thelypteris interrupta*, 47. *Zingiber montanum*, 48. *Zizania latifolia*



Site-5

	Local name	Scientific name	Q1	Q2	Q3	Q4	Q5	No of species	Q area	Density	Frequency	BA	R.D.	Re. Freq.	Dominance	Rel Dom	IVI
4	Kabo napi	<i>Alternanthera philoxeroides</i>	2	0	1	1	2	6	1.25	1.2	80	0.13	2.07	6.35	0.60	1.22	9.64
5	Luwangtou	<i>Arundo sp.</i>	0	0	1	1	1	3	1.25	0.6	60	0.13	1.03	4.76	0.30	0.61	6.41
6	Sajik tujombi	<i>Brachiaria mutica</i>	1	2	0	2	0	5	1.25	1	60	0.03	1.72	4.76	0.13	0.25	6.74
7	Lai changkhrang	<i>Christella parasitica</i>	3	6	4	5	7	25	1.25	5	100	0.01	8.62	7.94	0.16	0.32	16.87
9	Lampan	<i>Colocasia esculenta</i>	0	1	0	1	0	2	1.25	0.4	40	3.14	0.69	3.17	5.02	10.16	14.02
11	Terapaibi	<i>Crasscephalum crepidiodes</i>	1	0	1	0	0	2	1.25	0.4	40	0.13	0.69	3.17	0.20	0.41	4.27
14	Hoop	<i>Echinochloa stagnina</i>	11	4	2	6	7	30	1.25	6	100	0.03	10.34	7.94	0.75	1.52	19.81
15	Uchi sumban	<i>Eclipta prostrata</i>	0	0	1	0	1	2	1.25	0.4	40	0.07	0.69	3.17	0.11	0.23	4.09
16	Komprek tujombi	<i>Enhydra fluctuans</i>	0	2	1	1	0	4	1.25	0.8	60	0.13	1.38	4.76	0.40	0.81	6.95
19	Kolamani	<i>Ipomoea aquatica</i>	1	0	0	1	0	2	1.25	0.4	40	0.28	0.69	3.17	0.45	0.91	4.78
23	Lamthabi	<i>Melothria purpusilla</i>	4	8	9	6	9	36	1.25	7.2	100	0.20	12.41	7.94	5.65	11.43	31.78
24	Urihingchabi	<i>Mikania cordata</i>	4	1	2	1	1	9	1.25	1.8	100	0.03	3.10	7.94	0.23	0.46	11.50
25	Ngachak komol	<i>Nymphoides indicum</i>	1	0	0	0	1	2	1.25	0.4	40	0.03	0.69	3.17	0.05	0.10	3.97
29	Tou Angouba	<i>Phragmites karka</i>	5	7	6	7	8	33	1.25	6.6	100	0.64	11.38	7.94	16.79	33.95	53.26
30	Yellang	<i>Polygonum barbatum</i>	1	3	0	1	0	5	1.25	1	60	0.07	1.72	4.76	0.28	0.57	7.06
32	Ishing lilhar	<i>Polygonum sagittatum</i>	0	3	1	2	1	7	1.25	1.4	80	0.03	2.41	6.35	0.18	0.36	9.12
33	Khoimom	<i>Saccharum munja</i>	1	0	1	2	0	4	1.25	0.8	60	0.13	1.38	4.76	0.40	0.81	6.95
34	Ishing Kambong	<i>Zizania caduciflora</i>	30	20	25	20	18	113	1.25	22.6	100	0.20	38.97	7.94	17.74	35.88	82.78
								290		58	1260	5.39	100.00	100.00	49.45	100.00	309.00

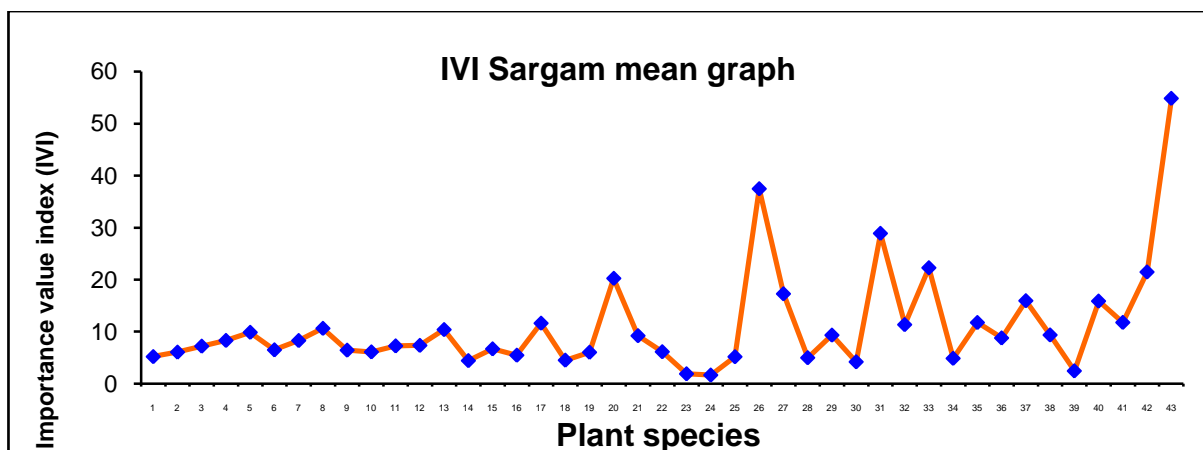
Fig. 7. SITE-5. *Ageratum conyzoides*, 2. *Ageratum haustonianum*, 3. *Alpinia nigra*, 4. *Alternanthera philoxeroides*, 5. *Arundo plinii*, 6. *Brachiaria mutica*, 7. *Chrysopsis mariana*, 8. *Colocasia esculenta*, 9. *Commelina benghalensis*, 10. *Crasscephalum crepidioides*, 11. *Cyperus digitatus*, 12. *Cyperus umbellatus*, 13. *Eclipta prostrata*, 14. *Enhydra fluctuans*, 15. *Floscopa scandens*, 16. *Hedychium coronarium*, 17. *Ipomoea aquatica*, 18. *Jussiaea suffruticosa*, 19. *Leersia hexandra*, 20. *Ludwigia octovalvis*, 21. *Ludwigia clavelliana*, 22. *Melothria purpusilla*, 23. *Mikania cordata*, 24. *Nymphoides indicum*, 25. *Oenanthe javanica*, 26. *Vigna mungo*, 27. *Phragmites australis*, 28. *Phragmites karka*, 29. *Persicaria barbata*, 30. *P. glabra*, 31. *P. sagittata*, 32. *Saccharum bengalens*, 33. *Thelypteris interrupta*, 34. *Zizania latifolia*



Site-6

	Local name	Scientific name	Q1	Q2	Q3	Q4	Q5	No of species	Qarea	Density	Frequency	BA	R.D.	Re. Freq.	Dominance	Rel Dom	IVI
1	Khongjainapi (w)	<i>Ageratum conyzoides</i>	2	0	1	0	0	3	1.25	0.6	40	0.05	0.85	2.38	0.12	0.90	4.12
2	Khongjainapi (v)	<i>Ageratum haustonianum</i>	1	0	1	1	2	5	1.25	1	80	0.02	1.41	4.76	0.07	0.54	6.71
3	Pullei	<i>Alpinia nigra</i>	0	2	1	0	1	4	1.25	0.8	60	0.05	1.13	3.57	0.16	1.20	5.90
4	Kabonapi	<i>Alternanthera philoxeroides</i>	3	0	0	6	0	9	1.25	1.8	40	0.03	2.54	2.38	0.23	1.73	6.64
6	Sajik tujombi	<i>Brachiaria mutica</i>	5	0	3	0	2	10	1.25	2	60	0.02	2.82	3.57	0.14	1.08	7.47
7	Lai changkhrang	<i>Christella parasitica</i>	3	2	1	4	0	10	1.25	2	80	0.00	2.82	4.76	0.02	0.12	7.70
9	Moirangkhanum	<i>Clerodendrum serratum</i>	3	0	1	4	0	8	1.25	1.6	60	0.01	2.25	3.57	0.05	0.38	6.21
10	Lampan	<i>Colocasia esculenta</i>	1	0	1	0	0	2	1.25	0.4	40	0.01	0.56	2.38	0.01	0.10	3.04
11	Wadengkhoibi	<i>Commelina benghalensis</i>	4	2	3	0	1	10	1.25	2	80	0.00	2.82	4.76	0.02	0.12	7.70
12	Terapaibi	<i>Crasscephalum crepidiodes</i>	0	3	2	1	0	6	1.25	1.2	60	0.13	1.69	3.57	0.60	4.60	9.86
16	Chumthang	<i>Cyperus umbellatus</i>	2	0	0	0	4	6	1.25	1.2	40	0.01	1.69	2.38	0.04	0.29	4.36
17	Urichak	<i>Echinochloa curjbelli</i>	1	0	2	0	1	4	1.25	0.8	60	0.03	1.13	3.57	0.10	0.77	5.47
18	Hoop	<i>Echinochloa stagnina</i>	30	20	15	0	8	73	1.25	14.6	80	0.01	20.56	4.76	0.46	3.50	28.82
19	Singnang	<i>Erianthus procerus</i>	10	0	3	0	4	17	1.25	3.4	60	0.03	4.79	3.57	0.43	3.26	11.62
21	Lamthangjou	<i>Fuirena umbellata</i>	3	0	2	1	0	6	1.25	1.2	60	0.01	1.69	3.57	0.04	0.29	5.55
22	Loklei	<i>Hedychium coronarium</i>	2	2	0	0	3	7	1.25	1.4	60	0.50	1.97	3.57	2.81	21.47	27.02
23	Phumkhuang	<i>Impateins chinensis</i>	2	4	1	0	0	7	1.25	1.4	60	0.20	1.97	3.57	1.10	8.39	13.93
24	Kolamni	<i>Ipomoea aquatica</i>	2	0	0	1	0	3	1.25	0.6	40	0.16	0.85	2.38	0.38	2.91	6.14
25	Mayeplei(White)	<i>Ipomoea cairica</i>	1	0	0	0	0	1	1.25	0.2	20	0.07	0.28	1.19	0.06	0.43	1.90
26	Mayeplei(Violet)	<i>Ipomoea cairica</i>	0	1	0	0	0	1	1.25	0.2	20	0.03	0.28	1.19	0.03	0.19	1.66
27	Cheiteklei	<i>Jussiaea suffruticosa</i>	0	1	0	1	0	2	1.25	0.4	40	0.05	0.56	2.38	0.08	0.60	3.54
28	Chouradevo	<i>Ludwigia octovalves</i>	2	0	3	0	0	5	1.25	1	40	0.44	1.41	2.38	1.77	13.48	17.27
29	Urhingchabi	<i>Mikania cordata</i>	1	0	0	1	0	2	1.25	0.4	40	0.16	0.56	2.38	0.25	1.94	4.89
30	Komprek	<i>Oenanthe javanica</i>	2	1	0	0	1	4	1.25	0.8	60	0.02	1.13	3.57	0.06	0.43	5.13
32	Wanamanbi	<i>Panicum sphaerocarpon</i>	20	10	0	25	15	70	1.25	14	80	0.01	19.72	4.76	0.44	3.36	27.84
33	Tou(Angamba)	<i>Phragmites communis</i>	0	2	2	1	1	6	1.25	1.2	80	0.02	1.69	4.76	0.08	0.65	7.10
34	Tou(Angouba)	<i>Phragmites karka</i>	4	0	0	2	1	7	1.25	1.4	60	0.07	1.97	3.57	0.40	3.02	8.56
35	Yellangkhwaisabi	<i>Polygonum glabrum</i>	1	0	1	0	0	2	1.25	0.4	40	0.03	0.56	2.38	0.05	0.38	3.33
36	Ishing Lilhar	<i>Polygonum sagittatum</i>	0	1	0	2	1	4	1.25	0.8	60	0.71	1.13	3.57	2.27	17.30	22.00
43	Kambong	<i>Zizania caduciflora</i>	15	10	24	0	12	61	1.25	12.2	80	0.02	17.18	4.76	0.86	6.58	28.52
								355		71	1680	2.88	100.00	100.00	13.10	100.00	300.00

Fig. 8. SITE-6. *Ageratum conyzoides*, 2. *Ageratum haustonianum*, 3. *Alpinia nigra*, 4. *Alternanthera philoxeroides*, 5. *Artemisia nilagirica*, 6. *Brachiaria mutica*, 7. *Clerodendrum indicum*, 8. *Rotheca serrata*, 9. *Colocasia esculenta*, 10. *Commelina benghalensis*, 11. *Crasscephalum crepidiodes*, 12. *Cymbopogon nardus*, 13. *Cynodon dactylon*, 14. *Cyperus brevifolius*, 15. *Cyperus umbellatus*, 16. *Echinochloa curjbelli*, 17. *Saccharum procerum*, 18. *Chromolaena odorata*, 19. *Fuirena umbellata*, 20. *Hedychium coronarium*, 21. *Impateins chinensis*, 22. *Ipomoea aquatica*, 23. *Ipomoea cairica*, 24. *Ipomoea cairica*, 25. *Jussiaea suffruticosa*, 26. *Leersia hexandra*, 27. *Ludwigia octovalves*, 28. *Mikania cordata*, 29. *Oenanthe javanica*, 30. *Osbeckia chinensis*, 31. *Panicum sphaerocarpon*, 32. *Phragmites australis*, 33. *Phragmites karka*, 34. *Persicaria glabra*, 35. *Persicaria sagittata*, 36. *Rotala rotundifolia*, 37. *Saccharum bengalens*, 38. *Setaria pumila*, 39. *Sida rhombifolia*, 40. *Sparganium emersum*, 41. *Thelypteris interrupta*, 42. *Zingiber montanum*, 43. *Zizania latifolia*



Altitudinal gradients are complex gradient and involved many factors such as topography, soil and climate (Fossa, 2004). This study shows that altitude controlled the diversity and distribution of plant species and community. The species richness data on vascular plant species from this study support the hypothesis that species richness decrease with altitude (Brigitta *et al.*, 2006; Kessler, 2009).

Table 2. Mean IVI of the six study sites (1.Kumbi, 2.Khordak, 3.Keibul, 4.Toya,5. Nongmaikhong and 6. Sargam) of Keibul Lamjao National Park (KLNP), Loktak Lake, Manipur, during the year 2010 to 2012, Quadrat Size=50 x 50cm².

Sl No	Name of Dominant Macrophytes	IVI of Site-1 Kumbi Longitude- 093°50 /13.2//E Latitude- 24° 26 / 44.2 // N Altitude- 780m	IVI of Site-2 Khordak Longitude- 093°51/20.8/ / E Latitude- 24°29 / 23.4// N Altitude- 778m	IVI of Site-3 Keibul Longitude- 093° 48 / 52.7 // E Latitude- 24° 28 / 44.6 // N Altitude- 772m	IVI of Site-4 Toya Longitude- 093° 52 / 20.55 // E Latitude- 24° 31 / 44.77 // N Altitude- 778m.	IVI of Site-5 Nongmaikhong Longitude- 093 0 51 / 07.1 // E Latitude- 24° 27 / 05.7 // N Altitude- 772m	IVI of Site-6 Sargam Longitude- 093° 49 / 53.7 // E Latitude- 24 0 29 / 50.4 // N Altitude- 772m
1	<i>Ageratum conizoides</i>	3.95	6.13	6.36	6.02	6.46	5.2
2	<i>Ageratum haustonianum</i>		4.84			5.16	6.06
3	<i>Alpinia nigra</i>		10.00	16.61	8.42	2.44	7.21
4	<i>Alternanthera philoxeroides</i>	9.16	6.03	9.14	11.03	8.39	8.31
5	<i>Amaranthus spinosus</i>				5.83		
6	<i>Argyrea nervosa</i>				3.05		
7	<i>Artemisia parviflora</i>				6.7		9.87
8	<i>Arundo plinii</i>	20.75					

9	<i>Azolla pinata</i>	42.7	28.93		4.37	16.57	
10	<i>Brachiria mutica</i>						6.5
11	<i>Callicarpa macrophylla</i>		8.62	7.83		12.35	
12	<i>Carex cruciata</i>	10.94			2.53		
13	<i>Cephananthus tetrandrus</i>	18.86		12.12	31.54		
14	<i>Chrysopsis mariana</i>	9.0			65.11		
15	<i>Clerodendrum indicum</i>		5.07	4.76	6.52	9.77	8.29
16	<i>Clerodendrum serratum</i>				7.05		10.63
17	<i>Coix lachryma-jobi</i>	4.3		23.19	10.82		
18	<i>Colocasia esculenta</i>	13.84		7.15	24.8	14.97	6.44
19	<i>Commelina bengalensis</i>				3.86	6.16	6.11
20	<i>Crasscephalum crepidioides</i>	6.02		5.42	6.21	4.48	7.26
21	<i>Curcuma angustifolia</i>				9.03		
22	<i>Cuscuta reflexa</i>	2.11					
23	<i>Cymbopogon citratus</i>		5.5				
24	<i>Cymbopogon nardus</i>				33.91		7.36
25	<i>Cynodon dactylon</i>			6.09			10.39
26	<i>Cyperus brevifolius</i>	5.56	6.88	4.38			4.43
27	<i>Cyperus cyperoides</i>	5.8					
28	<i>Cyperus digitatus</i>	21.34	12.33			8.42	
29	<i>Cyperus rotundus</i>	4.24	3.32				
30	<i>Cyperus umbellatus</i>	6.61	10.61		8.38	5.39	6.69
31	<i>Dichrocephala latifolia</i>		4.47				
32	<i>Eclipta prostrata</i>					3.47	
33	<i>Eichhornia crassipes</i>	25.93					
34	<i>Echinochloa curbelli</i>		4.57				5.47
35	<i>Enhydra fluctuans</i>	5.9	4.98			8.21	
36	<i>Erianthus arundinaceus</i>				15.97		
37	<i>Erianthus</i>	42.18					11.62

	<i>procerus</i>						
38	<i>Eupatorium odoretum</i>				12.61		4.52
39	<i>Floscopa scandes</i>	3.4				4.22	
40	<i>Fuirena umbellata</i>		5.12	2.4	9.96		6.03
41	<i>Gnaphalium luteo-album</i>	1.97					
42	<i>Grangea maderaspatana</i>		3.35		2.27		
43	<i>Hedychium coronarium</i>	13.78	15.9	13.84	8.52	4.03	20.24
44	<i>Hydrilla verticillata</i>	9.48					
45	<i>Impatiens chinensis</i>	4.65	8.53	9.27	10.12		9.22
46	<i>Ipomoea aquatica</i>	11.46	2.15			5.68	6.14
47	<i>Ipomoea cairica</i>	3.08	3.88				1.9
48	<i>Jussiaeae suffruticosa</i>	4.59	4.66		5.1	6.16	5.18
49	<i>Leersia hexandra</i>	30.65	19.33	48.8	46.91	25.65	37.45
50	<i>Ludwigia clavelliana</i>	6.29				4.98	
51	<i>Ludwigia octovalvis</i>	6.01		6.88	2.0	2.1	17.27
52	<i>Marsilia minuta</i>	2.55					
53	<i>Melothria purpusilla</i>				5.22	17.91	
54	<i>Mikania cordata</i>	4.86	8.1		4.76	8.91	4.99
55	<i>Mimosa pudica</i>				7.35		
56	<i>Momordica charantia</i>				2.15		
57	<i>Monochoria hastaefolia</i>				4.9		
58	<i>Nymphoides indicum</i>	9.26				3.97	
59	<i>Oenanthe javanica</i>	7.98	6.81	5.94	13.85	4.56	9.33
60	<i>Oryza rufipogon</i>	10.41	19.48	17.41			
61	<i>Osbeckia chinensis</i>		6.8		5.69		4.2
62	<i>Panicum sphaerocarpon</i>	11.89	11.49	37.59	40.81		28.88
63	<i>Persicaria chinensis</i>				6.95		
64	<i>Phaseolus mungo</i>	12.34				8.23	
65	<i>Phragmites</i>	14.0	35.3		12.97	15.17	11.35

	<i>communis</i>						
66	<i>Phragmites karka</i>	18.43	59.22	50.41	29.9	31.64	22.27
67	<i>Polygonum barbatum</i>	3.4	5.33	11.61	5.64	5.81	
68	<i>Polygonum glabrum</i>	3.24	3.72	4.89		4.04	4.87
69	<i>Polygonum orientale</i>		4.41				
70	<i>Polygonum sagittatum</i>	5.16	5.62	19.09	7.63	5.82	11.75
71	<i>Rotala rotundifolia</i>		14.49		8.83		8.79
72	<i>Saccharum munja</i>	15.93	20.19	19.15	6.15	9.53	15.94
73	<i>Saccolipsis interrupta</i>	7.38					
74	<i>Selvenia cuculata</i>	24.06					
75	<i>Setaria pumila</i>				10.19		
76	<i>Setaria viridis</i>						9.36
77	<i>Sida rhombifolia</i>						2.46
78	<i>Sparganium angustifolium</i>			8.25	6.01		15.87
79	<i>Sparganium simplex</i>	9.43					
80	<i>Thelypteris interrupta</i>	6.19	12.37	20.92	10.0	11.06	11.77
81	<i>Urena lobata</i>		3.71				
82	<i>Utricularia sp.</i>	60.09					
83	<i>Xanthium strumarium</i>		1.13				
84	<i>Zinziber cassumnar</i>				19.0		21.46
85	<i>Zizania latifolia</i>	19.33	59.31	17.14	41.16	87.5	54.81

In all the six study sites, common distribution of ten dominant plant macrophytes viz., *Ageratum conizoides*, *Hedychium coronarium*, *Leersia hexandra*, *Oenanthe javanica*, *Phragmites karka*, *Polygonum sagittatum*, *Saccharum munja*, *Thelypteris interrupta* and *Zizania latifolia* was noticed (Table 2). Individual dominant plant was recorded in other sites also viz., *Azola piñata* in site-6 (Fig. 8); *Xanthium atrumarium*, *Polygonum orientale*, *Dichrocephala latifolia* and *Cymbopogon citratus* in site-2 (Fig. 4); *Arundo plinii*, *Cuscuta reflexa*, *Gnaphalium luteo-album*, *Hydrilla verticillata*, *Marsilia minuta*, *Saccolipsis interrupta*, *Selvenia cuculata* and *Utricularia spp.* in site-1 (Fig. 3). Variation of IVI value of dominant plant species was observed in this study. Even though 85 dominant plants were selected for all the 6 sites, however, maximum plant richness expressed in IVI was recorded in case of *Zizania latifolia* (Site-5 Fig. 7, IVI-87.5) and minimum IVI in

case of *Xanthium strumarium* (Site-2, Fig. 4, IVI-1.13) (Table-2). The diversity pattern and habitats of macrophytes in KLNP *Phumdi* environment might be due to water availability along the altitudinal gradient and other environmental factors suited in the study sites and expected to be an important factor affecting the survival and fecundity of plant population (Hegazy *et al.*, 2008)

On the other hand, the distribution and occurrence of species were mainly affected by human interventions (Singh and Singh, 1987). The human influences are mainly by commercial exploitations, agricultural requirements, fire and grazing pressure (Singh and Singh, 1992). Further, Devi *et al.* (2014) reported that overharvesting of these plants may cause serious competition for food to the animals and will certainly may become endanger their existence.

Conclusion

KLNP is a highly potential area of International importance, and life line for the lake dwellers. Because of its being the habitat of endemic and endangered the only deer in this globe, *Sangai* (*Rucervus eldii eldii* McClelland) and other wild animals and availability of their food plants the park is rich in bioresources of endemic flora and fauna.

During the study four species such as *Ageratum conyzoides*, *Alternanthera philoxeroides*, *Leersia hexandra*, *Hedychium coronarium* were recorded throughout the year in all the six sites which are important for both man and animals, needs sustainable conservation in near future. *Ageratum conyzoides* is also used as hair lotion and growing in association of other plants. Among these, 3 plants (*Alternanthera philoxeroides*, *Leersia hexandra*, *Hedychium coronarium*) are the food plant of *Sangai*, however, *Hedychium coronarium* is the food plant of human beings also.

We need to conserve the natural habitat of KLNP thereby maintaining the luxuriant growth of the seasonal and perennial, macrophytes observed during the flowering periods, so as to maintain the natural flora and fauna of the park. These plants are the food of man and animal therefore, it needs a proper care and attention to protect them from over exploitation (Devi *et al.*, 2014). Considering the diversity pattern of habitats of Macrophytes in KLNP, a floating mat *Phumdi* environment with high floral diversity and unique vegetation assemblage, it has been suggested that this track and adjoining sites should be declared as ecologically sensitive area not only the World Heritage Site (Joshi, 2002, Joshi *et al.*, 2011).

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