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Assessment of Tree Species Diversity in Chilika Lake Ecosystem of Odisha, India

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Abstract

A study was conducted to estimate the distribution and diversity of tree species in Chilika lake ecosystem, the largest lagoon in Asia. The present study was conducted in 2014 by laying out quadrats of desired size to estimate the diversity of tree species in three of the four ecological sectors namely northern, central and southern sector. A total of 69 tree species representing 57 genera and 33 families were recorded from the three ecological sectors of Chilika. Among the three ecological sectors, northern sector was found superior in terms of species richness and diversity with 46 tree species per hectare of area. The total dominance of northern sector was also highest i.e. 36.35m^2/ha. Among the species documented, maximum value of Importance Value Index (IVI) was reported in Teak (21.69) followed by Casuarina (19.02) and Sal (14.95) respectively. The Shannon-Weiner Index value was found in the range of 1.5 to 3.5. It was observed that species diversity in the ecological sectors is substantially influenced by intensity of human interference in and around them. The occurrence of major portion of northern sector within natural forest boundary might have contributed to enhanced species diversity

Keywords: Biodiversity, Ecosystem, Chilika, Ecology, Odisha.

Introduction

Chilika Lake, the largest brackish water lake in India and the largest lagoon in Asia, is situated in the East Coast of India at 19° 28'-19° 54' N latitude and 85^0 05'-85°38' E longitude, connecting Bay of Bengal. The Lagoon is one of the largest brackish water wet land and is also known by one of the Ramsar site in India. It is characterized by a unique combination of marine brackish water and fresh water biodiversity. It covers an area of 1165 sq. km with an average length of about 64 km and an average width of 13.5 km. The lagoon is surrounded by three coastal districts of Odisha namely Puri, Khurda and Ganjam (Figure-1).

The main axis of the lagoon is from southwest to northeast. It is parallel to the coastline, having a maximum width in the Puri and Khurda Districts. The boundaries of Chilika in north to east is mainly cultivated plains of Daya and Bhargavi valleys, at the western side, the lagoon is embraced by a group of hillocks (a portion of the Eastern Ghats, locally known as Dipa Mundia, Kalijugeswara, Manmu Bhanaja, Solari, Bhaleri, Jatia and Ghantasila). As per salinity and depth, the lagoon has been divided into four natural sectors namely the Northern Sector, Central Sector, Southern Sector and Outer Channel[1].

The northern sector is the widest portion of the lagoon, with an average width of near 15 km. The average depth of the lagoon in this region varies from 0.5 to 1 meter, increasing to 1.5 to 2 meters during the rainy season[2].

Chilika lake ecosystem supports a wide range of flora and fauna. Studies have reported the occurrence of 728 species of angiospermic plants belonging to 496 genera and 120 families in this lagoon which is one-fourth of the total plant species in the flora of Odisha[3].

With regards to the phytoplankton community, a mixture of marine and brackish water texas mainly represented by 4 groups of Algae - Diatoms (Bacillariophyceae), Dinoflagellate (Pyrrophyceae), Blue Green Algae (Cyanobacteria) and Green Algae (Chlorophyceae) are found in the lake ecosystem. Diatoms are the dominant groups with the occurrence of 78 species. The Blue Green Algae and Green Algae contribute 18 species each. Macrophytes with a cyclic growth are abundantly found in the Northern and central part of Chilika. Their growths are luxuriant in late monsoon and past monsoon period and with the advent of summer, they start decomposing with the increase in salinity. Chilika is highly diverse by its rich avifauna (both resident and migratory). The lake ecosystem provides livelihoods to the local people from fishing and tourism.

The sustenance of the resources and biodiversity is now under suspicion due to the constant pressure from natural processes and human activities, resulting in the degradation of the lake. In view of the changing biodiversity scenario, the present study was undertaken to assess the tree diversity of three important sectors of Chilika Lake ecosystem namely northern, southern and central sector.

Figure-1
Geographical location of Chilika Lake, Odisha, India

Materials and Methods

The study was based on rigorous field works. Quadrats were laid out randomly and during the survey, each individual within the quadrat was identified up to the species level wherever possible, and individuals of different species in each quadrat were recorded, diameter at breast Height (DBH at 1.37m from the ground) of all the trees with >30 cm girth in each of the quadrats were measured with the help of measuring tape / slide caliper. The data generated from the quadrat sampling were used to compute the analytical features such as density, frequency, basal cover and importance value index (IVI) as per the standard phytosociological methods proposed by researchers[4].

As illustrated previously, our study was confined to three ecological sectors namely northern central sector and southern sector. From each sector 10 study sites were randomly selected and within these, 15 quadrats of size 10m × 10m size were laid out. In total, 150 (15 × 10) quadrats in each area with a total area of 15,000 sq.m. (1.5 ha) in each of the sites and with a total area 45,000 sq.m (4.5 hac.) area was enumerated. The tree species include all the saplings, poles and adult trees present in the study area.

The collected data were quantitatively analyzed for density, frequency and dominance of tree species.

Importance Value Index helps to assess the contribution of a species to the vegetation in which it is found. The values of the relative frequency, relative density and relative dominance were summed up together to calculate the Importance Value Index or IVI of the species. Similarly, a suitable diversity index (a mathematical measure of species diversity in a community) was used to assess diversity of floral elements and numerical structure of the plant community in the study sites.
It was calculated as per the following formula:

IVI = Relative Density + Relative Frequency + Relative Dominance

Uncertainty of a set of species is well judged with the use of Shannon-Weiner Index. This index is often influenced by the number of species and their evenness among each other. It reaches its maximum for a given number of species given the fact that all species are represented with the same number of individuals.

The Shannon-Weiner Index (H') is calculated as per Shannon and Weaver[5]:

$$H' = -\sum pi \ln pi$$

Where: H' = Shannon index of diversity, ρi = the proportion of important value of the i^{th} species

$\rho i = \eta i / N$,

ηi is the important value index of i^{th} species and N is the important value index of all the species

Results and Discussion

A significant variation with respect to the number of species per area was observed among the three sectors studied (Table-1). The study recorded a total of 69 tree species representing 57

genera and 33 families. The number of tree species in the northern, southern central sector were 69, 45 and 40 respectively. Similar trend was observed in case of species per genus i.e. northern sector (1.21) exhibited more number of genus than the central sector (1.11) and southern sector (1.13) respectively. With respect to average number of species per family, northern sector scored 2.09 closely followed by central (1.82) and southern sector (1.61), respectively.

It was also observed that the species distribution and diversity is relatively high in case of northern sector. The most dominant species found were *Simarouba glauca* followed by *Gliricidia sepium, Anacardium occidentale, Azadirachata indica and Acacia mangium.* The species which showed minimum occurrence or less distribution were *Pithecellobium dulce, Grewia tiliifolia, Caesalpinia pulcherrima, Diospyros Montana, Ficus retusa, Ziziphus mauritiana,* and *Carea arborea.* Total dominance value of trees for this sector was 36.35 m^2 ha^{-1} of which maximum basal area observed in *Shorea robusta* which contributes about 9.87% to the total area followed by *Mangifera indica* (7.26%), *Syzygium cumini* (6.38%), *Tectona grandis* (4.79%), *Ficus benghalensis* (4.67%) and *Acacia mangium* (3.90%).

Table-1
General characteristics of the tree layer vegetation of different sectors of Chilika Ecosystem

Parameters	Ecological Sectors		
	NS	CS	SS
Total Number of Species	69	40	45
Total Area Sampled (In ha.)	1.5	1.5	1.5
Total Number of Family	33	22	28
Total Number of Genera	57	36	40
Species Richness ha^{-1}	46	26.67	30
Species/Genus Ratio	1.21	1.11	1.13
Species/Family Ratio	2.09	1.82	1.61

*NS= Northern sector, CS= Central Sector, SS= Southern Sector

In case of Southern sector, the species diversity and species distribution were found to be moderate. The most dominant species found were *Casuarina equisetifolia* followed by *Simarouba glauca, Azadirachata indica, Gliricidia sepium and Eucalyptus tereticornis.* Total dominance value of trees for this sector was 21.32 m^2 ha^{-1} of which maximum basal area was observed in *Shorea robusta* which contributes about 8.14% to the total area followed by *Casuarina equisetifolia* (7.90%), *Syzygium cumini* (7.80%), *Tectona grandis* (6.74%), *Mangifera indica,* (6.20%), *Azadirachata indica* (5.07) and *Cocus nucifera* (4.28%).

The Central sector was characterized with least diversity and distribution of species. The most dominant species in this sector was *Tectona grandis,* followed by *Gliricidia sepium, Eucalyptus tereticornis, Simarouba glauca, Azadirachata indica, Aegle marmelos, Cocus nucifera, Phoenix sylvestris and Acacia mangium*. Total dominance value of trees for this sector was 26.18 m^2 ha^{-1} of which maximum basal area observed in *Mangifera indica* which contributes about 12.25% to the total area followed by *Tectona grandis* (11.85%), *Cocus nucifera* (6.97%), *Syzygium cumini* (6.65%), *Shorea robusta* (6.19%), *Aegle marmelos* (5.76%) and *Azadirachata indica* (4.38%).

The northern sector showed higher diversity which may be ascribed for its location near to natural forest area namely Tangi forest range under Khurda division. The close viccimity to natural forest range might have some contributions towards effective supervision and monitoring by the forest officials. On the other hand, the lowest diversity of trees in central sector is ascribed to a comparatively higher rate of human interference which might have led to the replacement of natural forest with the manmade plantation as per the field observation.

With regards to IVI, *Shorea robusta* was found to be the dominant species in the northern sector of Chilika ecosystem with a IVI value of 14.95 followed by *Syzygium cumini* (11.83), *Mangifera indica* (10.02), *Azadirachata indica* (9.95), *Acacia mangium* (9.82), *Simarouba glauca* (9.34) and *Tectona grandis* (9.12), whereas in the central sector the IVI of *Tectona grandis* was found maximum i.e. 21.69 followed by *Mangifera indica* (17.65), *Cocus nucifera* (15.46), *Aegle marmelos* (14.65), *Azadirachata indica* (13.72) and *Eucalyptus tereticornis* (13.67), and from Southern sector the IVI of *Casuarina equisetifolia* (19.02) was found maximum followed by *Syzygium cumini* (14.45), *Azadirachata indica* (14.42), and *Simarouba glauca* (13.34). All other species of different sectors showed intermediate range of IVI (Table-2).

Shannon Wiener Index value of different tree species varied significantly among different tee species *recorded* in all the three sectors studied (Table-2). In total, the species diversity for northern, central and southern sector were 4.02, 3.50 and 3.62, respectively, which indicates northern sector was comparatively diverse followed by southern and central sector respectively. More information about the species in a particular community can be obtained if it scores a higher Shannon index value. It has been reported that the common range of Shannon diversity is 1.5 to 3.5 though it goes up to 4.5[6]. A similar study conducted in the Eastern Ghats has reported a Shannon Weiner value of 1.85 to 2.05 for most of forest divisions of Odisha with the highest value of 2.05 representing Khurda division, where lies the northern sector of Chilika and as per the findings of the present study this sector represents higher tree species diversity[7].

Table-2
Sector wise IVI and Shannon-Weiner Index value of different tree species

Sl. No.	Species	IVI			SW Index		
		NS	CS	SS	NS	CS	SS
1	*Acacia auriculiformis*	7.689	6.968	5.233	0.050	0.024	0.039
2	*Acacia nilotica*	2.793			0.060		
3	*Acacia mangium*	1.849	17.655	9.038	0.112	0.110	0.127
4	*Acacia pennata*	10.024			0.038		
5	*Adina cordifolia*	1.308			0.054		
6	*Aegle marmelos*	3.18	3.41	6.277	0.091	0.147	0.103
7	*Ailanthus excels*	2.057	2.263	4.772	0.060	0.056	0.08
8	*Anacardium occidentale*	3.266	5.506	7.202	0.094	0.087	0.071
9	*Annona squamosal*	1.31	7.461		0.024	0.051	
10	*Anogeissus latifolia*	7.697			0.066		
11	*Anthocephalus cadamba*	1.848	15.457	10.317	0.077	0.097	0.063
12	*Azadirachata indica*	6.615	8.428	6.397	0.113	0.141	0.146
13	*Bambusa arundinacea*	5.322		3.755	0.052		0.042
14	*Bambusa bambos*	1.073	6.076	3.26	0.058	0.077	0.069
15	*Bauhinia purpurea*	2.655		19.026	0.059		0.036
16	*Bombax ceiba*	3.561	5.179	1.628	0.064	0.060	0.09
17	*Borassus flabellifer*	4.804	2.044	0.914	0.024	0.092	0.09
18	*Bridelia retusa*	4.264		12.766	0.030		0.03
19	*Buchanania lanzan*	3.213			0.044		
20	*Butea monosperma*	14.947	4.11		0.059	0.028	
21	*Caesalpinia pulcherrima*	4.448			0.015		
22	*Calophyllum inophyllum*	0.556			0.020		
23	*Carea arborea*	1.77			0.020		
24	*Cassia fistula*	4.142	4.189	3.056	0.084	0.079	0.055
25	*Cassia siamea*	0.744	10.738	1.761	0.072	0.070	0.049
26	*Casuarina equisetifolia*	4.574	4.395	6.281	0.042	0.034	0.175

Sl. No.	Species	IVI			SW Index		
		NS	CS	SS	NS	CS	SS
27	*Ceiba pentandra*	5.414	1.583		0.039	0.033	
28	*Cocus nucifera*	1.551	6.77	8.416	0.094	0.153	0.116
29	*Dalbergia latifolia*	1.055		1.251	0.064		0.081
30	*Dalbergia sissoo*	7.493	11.266	10.298	0.072	0.086	0.1
31	*Dendrocalamus strictus*	5.743	10.589	7.703	0.062	0.101	0.075
32	*Diospyros melanoxylon*	6.228	6.784	7.546	0.062	0.062	0.047
33	*Diospyros Montana*	6.758			0.012		
34	*Erythrina suberosa*	5.298		3.923	0.027		0.022
35	*Erythrina variegate*	1.068			0.020		
36	*Eucalyptus tereticornis*	2.383	4.116	2.222	0.082	0.141	0.113
37	*Ficus benghalensis*	4.134	5.038	2.682	0.085	0.061	0.073
38	*Ficus hispida*	1.424			0.040		
39	*Ficus religeosa*	4.92	5.89	7.202	0.057	0.042	0.046
40	*Ficus retusa*	4.55			0.024		
41	*Garcinia indica*	2.466		14.418	0.053		0.028
42	*Gliricidia sepium*	9.951	4.186	2.44	0.092	0.123	0.116
43	*Gmelina arborea*	3.356	1.937	11.725	0.071	0.069	0.057
44	*Grewia tiliifolia*	4.212		4.825	0.012		0.033
45	*Holarrhena antidysentrica*	9.819			0.049		
46	*Lagerstroemia parviflora*	2.378			0.038		
47	*Lannea coromandelica*	5.711			0.031		
48	*Leucaena leucocephala*	0.47	13.721	6.419	0.075	0.060	0.066
49	*Mangifera indica*	2.791	1.33	5.46	0.114	0.167	0.106
50	*Michelia champaca*	6.72	9.546		0.067	0.077	
51	*Mimusops elengi*	2.475		3.037	0.045		0.105
52	*Mitragyna parviflora*	3.946			0.052		
53	*Phoenix sylvestris*	1.301	4.248	9.995	0.031	0.100	0.082

Sl. No.	Species	IVI			SW Index		
		NS	CS	SS	NS	CS	SS
54	*Pithecellobium dulce*	6.378			0.010		
55	*Polyalthia longifolia*	11.832	4.297	14.451	0.048	0.037	0.081
56	*Pongamia pinnata*	3.535	2.648	2.684	0.076	0.118	0.094
57	*Prosopis juliflora*	4.064		5.098	0.044		0.082
58	*Samanea saman*	4.417	13.669		0.080	0.086	
59	*Schleichera oleosa*	0.937			0.046		
60	*Shorea robusta*	3.642	12.96	5.652	0.149	0.119	0.134
61	*Simarouba glauca*	5.894	5.878	3.536	0.108	0.135	0.138
62	*Strychnos nux-vomica*	3.539		4.509	0.025		0.042
63	*Syzygium cumini*	7.331	8.459	8.791	0.128	0.136	0.146
64	*Tamarindus indica*	2.967	8.076	8.926	0.085	0.059	0.093
65	*Tectona grandis*	2.928	14.654	6.163	0.106	0.190	0.141
66	*Terminalia arjuna*	4.206	3.879		0.060	0.059	
67	*Terminalia catappa*	9.335	12.91	13.34	0.049	0.060	0.018
68	*Thevetia peruviana*	0.556	21.688	1.943	0.034	0.073	0.066
69	*Ziziphus mauritiana*	9.115		13.702	0.018		0.052
	Total	**300**	**300**	**300**	**4.020**	**3.500**	**3.618**

**The blank box of this table implies that the particular species is not found in that sector.*

Conclusion

The beauty of Chilika lies with its rich and unique ecosystem and services. Trees undoubtedly play a key role in the sustenance and resilience of the ecosystem. The present study establishes the fact that trees are not equally distributed in and around the lake ecosystem and are under severe threats. In addition to the natural processes like cyclone which often take a heavy toll of trees, anthropogenic causes especially deforestation in and around the Chilika lake ecosystem are to be blamed for increased rate of species extinction and mono-culturing of the climate resilient forest ecosystem. Due care must be taken to conserve the forest resources in-situ through increased awareness among the local people and a suitable ecosystem management planning entailed with the participation of all stakeholders. Local institutions need to be involved and empowered in the process of planning and implementation.

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