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Tree Species Diversity and Their Phytosociological Evaluation in 'Thol Lake Wildlife Sanctuary, North Gujarat"

Science

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ABSTRACT

Present research is aimed to study diversity of tree species and evaluate their phytosociology in the study area. In physiognomic manner forests of North Gujarat are of scrub type where vegetation is open i.e. trees and shrubs are widely spaced. The area fall in a semi-arid zone which mostly composes dry deciduous vegetation but being a wetland Thol Lake Wildlife Sanctuary supports its vegetation and keeps tree layer green most of the time during the year. An attempt has been made in the present study to identify status of tree layer of the study area by enumerating tree species and their diversity along with their phytosociological characters. Dominant tree species also have been evaluated in the same concern to recognize their dominance in the area.

Introduction

Wetlands are among the most productive and diverse ecosystems on earth. They support a great diversity of flora and fauna. Wetlands benefit directly and indirectly to all life forms including human beings. A general definition of wetland is that "wetlands are the areas on the landscape where land and water meet, which usually lie in depression or along rivers, lakes and coastal water where they are subjected to periodic flooding". According to GEC (1999), North Gujarat has 1,10,706.25 hector are under wetlands. There are total 159 wetlands in this region. Present study area "Thol Lake Wildlife Sanctuary" of Mehsana district in North Gujarat is well known for their high diversity and population of the wintering waterfowl. Being familiar with the need of present research at Thol Lake Wildlife Sanctuary popularly known as "Thol Bird Sanctuary (TBS)" since a decade was the major reason behind selecting the area for research. As TBS is a bird sanctuary, obviously a lot of efforts have already been made for research on bird community and fauna. Even though the area is rich in biodiversity (especially in birds and plants), and announced as a protected wetland, no detailed study regarding diversity of tree species and their phytosociological characters have been carried till present study. Hence present subject matter has been selected to be studied at TBS, which is going to be fruitful in respect of sustainable conservation, improvement and development of tree layer.

Study area

Gujarat is unique in considering its wealth of natural and man-made water bodies/wetlands. Four such inland wetlands in the state have been established and designated as sanctuaries primarily for waterfowl. These are Nal sarovar, Khijadia, Porbandar and Thol (Singh, 1998). Though, the selected study area Thol is encompassing irrigation tank, is legally named 'Thol lake Wildlife Sanctuary' as per the notification. It is in fact one of the sanctuaries of the state considering that waterfowl constitute dominant form of the wildlife to be protected.

The area falls under Mehsana district of North Gujarat region, which is a semi-arid zone and mostly composes dry deciduous vegetation. In physiognomic manner forests of the district are scrub type where vegetation is open i.e. trees and shrubs are widely spaced. The vegetation on the whole consists of co-dominant by thorny shrubs and trees capable of resisting drought. Such vegetation falls under Bio-geographic zone – IV. The area under present study also falls under the same conditions and categories naturally. In addition to that it is a protected wetland area. The vegetation found here mainly is of scrub type with mixed flora of aquatic and marshy plants (Vyas, 2014). TBS comprise a total area of 699 ha. with 5.62 km. long periphery. It experiences three distinct seasons, winter, summer and monsoon. Temperature ranges here from as low as 8°C in winter to as high as 43°C in summer. Average annual rainfall is 600 mm, ranging from 100 mm to 800 mm. The study area is also facing anthropogenic pressures viz. agriculture, grazing, industrialization, oil drilling and tourism.

Methodology

Intensive field visits of the study area were organized under present research. For the purpose of data collection, standard quantitative assessment technique like belt transects method (Muller-Dombois and Ellenberg, 1974; Kershaw, 1973) was used. Because the study area holds a water body with variation in water covered area during different seasons of the year, the survey was started from the peripheral region. Meanwhile when and where (mostly in summer) the water lodged areas dried up, were also surveyed. Thus, entire sanctuary was covered to quantify ecological characters. Depending on the width of peripheral region a 100 mt. wide belt was recognized and studied using circular plots of 10 mt. radius each were plotted at every 50 mt. intervals randomly within the belt area for the study of tree species. Same sized plots were plotted within rest of the sanctuary area also, where water was not present. In the circular plots of 10 mt. radius tree species were recorded. All the plant species were identified and documented using 'Flora of the Presidency of Bombay' (Cooke, 1901-1908)' and Flora of Gujarat State' (Shah, 1978). Collected data was analyzed to find out frequency in % along with Raunkiar's five frequency classes, density and abundance of the tree species documented at TBS. Important Value Index (IVI) helps in identifying overall dominant tree species and to obtain general view of the vegetation of any area. Values of relative frequency, relative density and relative dominance of the tree species were added together to determine Important Value Index (IVI).

Results and discussions

Total 207 plots were plotted for the study diversity and phytosociology of tree species. Within that total 36 tree species were documented. Out of which, 30 were falling within the plotted area which was 6.5 ha. in total, while 6 tree species were recorded outside of the plotted area *(table 1)*.

Table 1: Tree species recorded inside and outside of the sample plot area

Sr. No.	Tree species inside the plot area	Sr. No.	Tree species outside the plot area
1	*Azadirechta indica* A. Juss	1	*Polyalthia longifolia* (Sonn.) Thw. Enum
2	*Mangifera indica* L.	2	*Limonia acidissima* L.
3	*Moringa oleifera* Lam.	3	*Delonix regia* (Boj.) Ref.
4	*Butea monosperma* (Lam.) Taub.	4	*Terminalia catappa* L.
5	*Derris indica* (Lam.) Bennet.	5	*Eucalyptus citriodora* Hk.

6	*Cassia fistula* L.	6	*Syzygium cumini* (L.) Skeels
7	*Cassia roxburghii* DC.		
8	*Cassia siamea* Lam.		
9	*Peltophorum peterocarpum* (DC.) Baker ex K. Heyne		
10	*Tamarindus indica* L.		
11	*Acacia auriculiformis* A. Cumn-Benth		
12	*Acacia leucophloea* (Roxb) Willd.		
13	*Acacia nilotica* (L.) Del. subsp. *indica*		
14	*Albizia lebbeck* (L.) Bth.		
15	*Pithecellobium dulce* (Roxb.) Bth.		
16	*Prosopis chilensis* (Molina) Stuntz		
17	*Prosopis cineraria* (L.) Druce		
18	*Madhuca indica* J. F. Gmel.		
19	*Manilkara hexandra* (Roxb.) Dub.		
20	*Mimousops elengi* L.		
21	*Diospyros melanoxylon* Roxb.		
22	*Salvadora oleoides* Decne.		
23	*Salvadora persica* L.		
24	*Cordia gharaf* (Forsk.) E. & A.		
25	*Cordia myxa* auct.		
26	*Holoptelea integrifolia* (Roxb.) Planch.		
27	*Ficus benghalensis* L. var. *benghalensis*		
28	*Ficus racemosa* L.		
29	*Ficus religiosa* L.		
30	*Ficus virens* Ait.		

As a whole frequency % of all the trees species falling under total plotted area was found to be 14.78% categorized as frequency class A. Density and abundance of the same was 0.51 and 1.84 respectively. ***Acacia nilotica* (L.) Del. subsp. *indica*** was found to be the most dominant with 946 individual plants. Its frequency was 78.26%, frequency class was D, density was 4.57 and abundance was 5.84. It was followed by ***Prosopis chilensis* (Molina) Stuntz** (878 individual plants, frequency 75.36%, frequency class D, density 4.24 and abundance 5.84), ***Acacia leucophloea* (Roxb) Willd.** (658 individual plants, frequency 64.25% frequency class D, density 3.18 and abundance 4.95), ***Prosopis cineraria* (L.) Druce** (139 individual plants, frequency 30.92%, frequency class B, density 0.67 and abundance 2.17) and ***Salvadora persica* L.** (89 individual plants, frequency 29.95%, frequency class B, density 0.43 and abundance 1.44) as other dominant tree species of the study area *(table 2)*.

Table 2: Numeric of phytosociological characters of tree species

Sr. No.	Tree species	Species available in No. of plots	Total No. of individuals	Frequency (%)	Frequency class	Density	Abundance
1	*Azadirechta indica* A. Juss	53	67	25.60	B	0.32	1.26
2	*Mangifera indica* L.	4	4	1.93	A	0.02	1.00
3	*Moringa oleifera* Lam.	9	17	4.35	A	0.08	1.89
4	*Butea monosperma* (Lam.) Taub.	42	56	20.29	B	0.27	1.33
5	*Derris indica* (Lam.) Bennet.	12	38	5.80	A	0.18	3.17
6	*Cassia fistula* L.	8	9	3.86	A	0.04	1.13
7	*Cassia roxburghii* DC.	4	6	1.93	A	0.03	1.50
8	*Cassia siamea* Lam.	13	19	6.28	A	0.09	1.46
9	*Peltophorum peterocarpum* (DC.) Baker ex K. Heyne	7	7	3.38	A	0.03	1.00
10	*Tamarindus indica* L.	11	12	5.31	A	0.06	1.09
11	*Acacia auriculiformis* A. Cumn-Benth	2	2	0.97	A	0.01	1.00
12	*Acacia leucophloea* (Roxb) Willd.	133	658	64.25	D	3.18	4.95
13	*Acacia nilotica* (L.) Del. subsp. *indica*	162	946	78.26	D	4.57	5.84
14	*Albizia lebbeck* (L.) Bth.	8	14	3.86	A	0.07	1.75
15	*Pithecellobium dulce* (Roxb.) Bth.	5	6	2.42	A	0.03	1.20
16	*Prosopis chilensis* (Molina) Stuntz	156	878	75.36	D	4.24	5.63
17	*Prosopis cineraria* (L.) Druce	64	139	30.92	B	0.67	2.17
18	*Madhuca indica* J. F. Gmel.	8	8	3.86	A	0.04	1.00
19	*Manilkara hexandra* (Roxb.) Dub.	6	6	2.90	A	0.03	1.00
20	*Mimousops elengi* L.	4	4	1.93	A	0.02	1.00
21	*Diospyros melanoxylon* Roxb.	34	54	16.43	A	0.26	1.59
22	*Salvadora oleoides* Decne.	46	51	22.22	B	0.25	1.11
23	*Salvadora persica* L.	62	89	29.95	B	0.43	1.44
24	*Cordia gharaf* (Forsk.) E. & A.	12	37	5.80	A	0.18	3.08
25	*Cordia myxa* auct.	18	29	8.70	A	0.14	1.61
26	*Holoptelea integrifolia* (Roxb.) Planch.	21	25	10.14	A	0.12	1.19
27	*Ficus benghalensis* L. var. *benghalensis*	5	6	2.42	A	0.03	1.20
28	*Ficus racemosa* L.	4	4	1.93	A	0.02	1.00
29	*Ficus religiosa* L.	3	5	1.45	A	0.02	1.67
30	*Ficus virens* Ait.	2	2	0.97	A	0.01	1.00
Total		918	3198	433.48		15.45	55.25
Average				14.78	A	0.51	1.84

All the tree species documented inside the sampling plot area were scrutinized as per Raunkiar's five frequency classes. There were 23 tree species found to fit in class A, 5 tree species in class B and 3 tree species in class D. While no tree species was found to fit in classes C and E *(figure 1)*.

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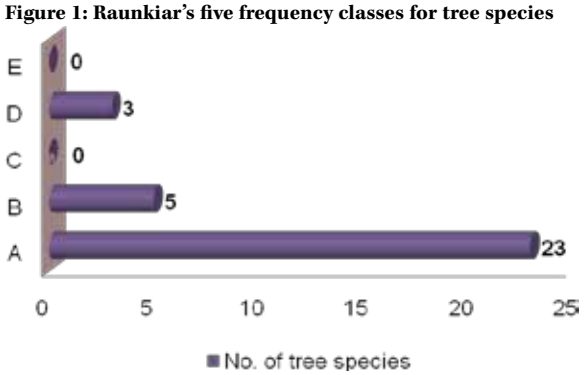
Figure 1: Raunkiar's five frequency classes for tree species



Important Value Index (IVI) of tree species

In the present study the overall IVI was found to be 28.23 including 3.33 of relative frequency, 21.57 relative density and 3.33 relative dominance *(table 3)*.

Table 3: IVI of tree species

Sr. No.	Tree species	Relative frequency	Relative density	Relative dominance	IVI
1	*Azadirechta indica* A. Juss	5.77	37.37	2.45	45.59
2	*Mangifera indica* L.	0.44	2.82	6.08	9.34
3	*Moringa oleifera* Lam.	0.98	6.35	0.97	8.30
4	*Butea monosperma* (Lam.) Taub.	4.58	29.61	4.00	38.19
5	*Derris indica* (Lam.) Bennet.	1.31	8.46	2.25	12.02
6	*Cassia fistula* L.	0.87	5.64	1.45	7.96
7	*Cassia roxburghii* DC.	0.44	2.82	1.87	5.12
8	*Cassia siamea* Lam.	1.42	9.17	1.27	11.85
9	*Peltophorum peterocarpum* (DC.) Baker ex K. Heyne	0.76	4.94	2.10	7.79
10	*Tamarindus indica* L.	1.20	7.76	6.78	15.73
11	*Acacia auriculiformis* A. Cumn-Benth	0.22	1.41	1.88	3.51
12	*Acacia leucophloea* (Roxb) Willd.	14.49	93.77	1.71	109.97
13	*Acacia nilotica* (L.) Del. subsp. *indica*	17.65	114.22	4.02	135.89
14	*Albizia lebbeck* (L.) Bth.	0.87	5.64	1.54	8.05
15	*Pithecellobium dulce* (Roxb.) Bth.	0.54	3.53	2.97	7.04
16	*Prosopis chilensis* (Molina) Stuntz	16.99	109.99	1.44	128.42
17	*Prosopis cineraria* (L.) Druce	6.97	45.12	3.22	55.31
18	*Madhuca indica* J. F. Gmel.	0.87	5.64	4.09	10.60
19	*Manilkara hexandra* (Roxb.) Dub.	0.65	4.23	2.10	6.98
20	*Mimousops elengi* L.	0.44	2.82	2.23	5.49
21	*Diospyros melanoxylon* Roxb.	3.70	23.97	1.30	28.98
22	*Salvadora oleoides* Decne.	5.01	32.43	3.25	40.70
23	*Salvadora persica* L.	6.75	43.71	4.00	54.47
24	*Cordia gharaf* (Forsk.) E. & A.	1.31	8.46	2.59	12.36
25	*Cordia myxa* auct.	1.96	12.69	1.39	16.04
26	*Holoptelea integrifolia* (Roxb.) Planch.	2.29	14.81	4.75	21.85
27	*Ficus benghalensis* L. var. *benghalensis*	0.54	3.53	10.49	14.56
28	*Ficus racemosa* L.	0.44	2.82	5.82	9.08
29	*Ficus religiosa* L.	0.33	2.12	5.23	7.68
30	*Ficus virens* Ait.	0.22	1.41	6.78	8.41
Over all		3.33	21.57	3.33	28.23

' ' rows show dominant tree species

Dominant tree species based on IVI

During present study out of first 5 dominant tree species 4 were belonging to Mimosaceae family. Only one tree species was belonging to Salvadoraceae family. Unsurprisingly, ***Acacia nilotica* (L.) Del. subsp. *indica*** was found to be to most dominant tree species according to IVI, which was 135.89. This species was followed by ***Prosopis chilensis* (Molina) Stuntz** with IVI 128.42, ***Acacia leucophloea* (Roxb) Willd.** with IVI 109.97, ***Prosopis cineraria* (L.) Druce** with IVI 55.38 and ***Salvadora persica* L.** with IVI 54.47 *(table 3)*.

***Acacia nilotica* (L.) Del. subsp. *indica* (Desi-baval, Kalo-baval).**

This species was the most dominant tree species in the study area in the concern of its IVI (*table 3*). Intensive plantation of this tree species in Northern part of the sanctuary was observed. During the study, total 8 dried up trees, 12 fully cut trees, 7 trees cut up to 50% and 22 trees cut up to 25% were also observed.

***Prosopis chilensis* (Molina) Stuntz (Gando Baval)**

This species occupied place to be second most dominant tree species in the sanctuary in the concern of its IVI (*table 3*). Trees of this species were found everywhere in the study area. Existence of *Prosopis chilensis* (Molina) Stuntz at such a high dominance shows presence of grazing pressure in the area. During the study, total 12 dried up trees, 25 burnt trees for the purpose of making charcoal, 28 fully cut trees, 16 trees cut up to 50% and 33 trees cut up to 25% were observed.

***Acacia leucophloea* (Roxb) Willd. (Harmo baval)**

On the basis of its IVI this species was found in third position amongst all dominant tree species of TBS (*table 3*). Trees of this species were found everywhere in the study area. During the study in the plot area 7 dried up trees, 5 fully cut trees, 9 trees cut up to 50% and 4 trees cut up to 25% were observed.

***Prosopis cineraria* (L.) Druce (Khijado)**

This species found in fourth position amongst all dominant tree species of TBS in the concern of its IVI (*table 3*). Trees of this species were found in the peripheral and South-Western part of the sanctuary. During the study in the plot area 1 dried up trees, 3 fully cut trees, 6 trees cut up to 50% and 2 trees cut up to 25% were observed.

***Salvadora persica* L. (Piludi)**

This species hold fifth position in TBS amongst all dominant tree species in the concern of its IVI (*table 3*). Trees of this species were found mostly in South-Western and South-Eastern parts of the sanctuary. During the study in the plot area no dried or cut trees of this species were observed.

Recruitment and regeneration of dominant tree species

Recruitment and regeneration of dominant tree species were also documented during present study. ***Acacia nilotica* (L.) Del. subsp. *indica***, the most dominant tree species was holding total 946 individual trees along with 217 recruitments and 416 regenerations within the total plotted area. The ratio of these three categories was found to be 1 : 0.22 : 0.36. In the same approach second most dominant tree species ***Prosopis chilensis* (Molina) Stuntz** was holding total 878 individual trees along with 672 recruitments and 1145 regenerations. The ratio of them was found to be 1 : 0.76 : 1.30. The third dominant tree species ***Acacia leu-***

***cophloea* (Roxb) Willd.** was holding total 658 individual trees along with 133 recruitments and 239 regenerations within the total plotted area. The ratio of the three categories of the species was found to be 1 : 0.2 :0.36. The fourth dominant tree species ***Prosopis cineraria* (L.) Druce** was holding total 139 individual trees along with 26 recruitments and 32 regenerations within the total plotted area. The ratio of the three categories of the species was found to be 1 : 0.19 : 0.23. The fifth dominant tree species ***Salvadora persica* L.** was holding total 89 individual trees along with 27 recruitments and 19 regenerations within the total plotted area. The ratio of the three categories of the species was found to be 1 : 0.3 : 0.21 *(table 4).* ***Azadirechta indica* A. Juss** another important tree species of the study area was holding total 53 individual trees along with 49 recruitments and 97 regenerations within the total plotted area. The ratio of the three categories of the species 1 : 0.93 : 1.83 which was reasonably higher than that of ***Salvadora persica* L.**, showing the potential to be included in the club of dominant tree species of TBS in future.

Table 4: Ratio of dominant tree species, their recruitment and regeneration

Sr. No.	Tree species	Number of trees	Number of recruitment	Number of regeneration	Ratio tre. : rec. : reg.
1	*Acacia leucophloea* (Roxb) Willd.	658	133	239	1 : 0.2 : 0.36
2	*Acacia nilotica* (L.) Del. subsp. *indica*	946	217	416	1 : 0.22 : 0.44
3	*Prosopis chilensis* (Molina) Stuntz	878	672	1145	1 : 0.76 : 1.30
4	*Prosopis cineraria* (L.) Druce	139	26	32	1 : 0.19 : 0.23
5	*Salvadora persica* L.	89	27	19	1 : 0.3 : 0.21

Conclusion

In the smaller area of the TBS in comparison of other sanctuaries and forest reserve areas of North Gujarat, a good number of tree species were documented. Tree vegetation in the study area is dominated mainly by thorny tree species. Though not at a major extent but cutting and lopping of the dominant tree species and burning of ***Prosopis chilensis* (Molina) Stuntz** has been observed at several spots. It is considered necessary to mention here that the total number of individual trees of ***Acacia nilotica* (L.) Del. subsp. *indica*** is higher than that of the *Prosopis chilensis* (Molina) Stuntz but the ratio of tree to recruitment and tree to regeneration of *Prosopis chilensis* (Molina) Stuntz was moderately higher than that of *Acacia nilotica* (L.) Del. subsp. *indica.* In this apprehension it may be configured that *Prosopis chilensis* (Molina) Stuntz will be a most dominant tree species in upcoming years by overtaking *Acacia nilotica* (L.) Del. subsp. *indica.* It has been indicated by several researchers that invasion of *Prosopis chilensis* (Molina) Stuntz is not a welcome knock for many native plant species. As a solution of the issue intensive plantation of native tree species like ***Azadirechta indica* A. Juss, *Acacia leacophloea* (Roxb) willd., *Acacia nilotica* (L.) Del. subsp. *indica*** and ***Prosopis cineraria* (L.) Druce** may be done in sparse areas in regards of tree layer. This will sustainably improve the habitat for long terms. However removal of *Prosopis chilensis* (Molina) Stuntz. is needed, burning of these trees for the purpose of making coal should be strictly prohibited to avoid soil degradation and destruction to many other adjacent species . Activity of grazing must be stopped at immediate action to control further invasion of the species.

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