Original Article

Structure and composition of woody vegetation in western Kachchh, Gujarat

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Abstract

Present study deals with quantitative assessment of the woody species of the western part of Kachchh region of Gujarat state. Based on the species composition of vegetation, the study area was classified into the four major habitats such as Acacia habitat, Prosopis habitat, mixed thorn habitat and mixed habitat. To understand the habitat characteristics data on various aspects like density, abundance, percentage frequency, Important Value Index and species diversity (H') index were calculated. During present study a total of 13 tree and 37 shrub species were recorded. Results shows that, Acacia senegal and Prosopis juliflora were the most dominant and well distributed within all habitats. All habitats were heterogeneous in nature which reveals the habitat facing threats of defragmentation due to illegal cutting of native species. Due to unique ecological integrity of Acacia forest and mixed thorn forest in the study area, some conservation significance forest patches of these habitats would be proposed as Ecologically Sensitive Area (ESAa). Considering the high species diversity, some of the Reserve Forests should be give more attention towards the conservation through Forest Department. Some of them should also be trait as the natural seed bank for threatened species of arid region.

Keywords: *Distribution, Diversity, Tree, Shrub, Western Kachchh*.

INTRODUCTION

Plant community dynamics and species diversity is an important aspect of forest ecology which entails contribution of various species in determining structure of specific habitats (Kumar et al., 2006). Studies on the distribution and diversity pattern of plant communities reveals their structure but the way to identify them by their distribution, characterization, identification, classification and their utility is a challenging work (Bhatt, 1993), which is the base for understanding of plant community. GUIDE and GEER (1998 and 2001) conducted a study to gain understanding about the ecological situation of different habitat and ecosystems with management perspective of Narayan Sarovar Sanctuary (NSS) and this sanctuary is also considered as a biodiversity rich area (GEC, 1996). Generating the information on diversity and distribution of tree and shrub species for any given areas is the foremost priority to suggest conservation strategies (Kumar et al., 2006). In

addition, phytosociological analysis of a plant community is an important aspect of ecological study of vegetation and it reveals the structural arrangement of various components of plant community and helps in understanding the community dynamics (Gaval et al., 2005). Whitford (1948) used the value of abundance and percentage frequency to evaluate the species distribution. In view of diverse ecological and ethnic diversity of plant communities of arid and semi arid regions, there is tremendous potential for research on plant community dynamics (Gaval et al., 2005). In the western part of the Kachchh various types of habitats were observed, which are based on the dominant species of the particular area including

and their status in this region. In total 518 plant species were recorded in western Kachchh, including tree, shrub, straggling shrubs, climbers, herbs, sedge and grasses by Bhatt (1993). In addition, almost 17 RET plant species have been

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documented in Kachchh region (WCMC, 1994; GES, MSU and GUIDE, 2002). Tree and shrub characterization is a basic need to understand the plant community dynamics, which has never been studied in western Kachchh. In view of this, the present study focuses on the tree and shrub species distribution and diversity with an attempt to unravel their community structure.

MATERIALS AND METHODS

Study area

Due to its unique ecological setting and geographical situation, Kachchh is classified as biotic province "3A" -Kachchh desert of biogeographic zone the Indian desert (Rodgers and Panwar, 1988). According to Champion and Seth (1968), a total of ten forest types are represented in and around the Narayan Sarovar Sanctuary (NSS). In which open scrub, dense scrub and grassland area represent broad terrestrial vegetation while during the understanding the vegetation type, total nine types of habitats were identify on the basis of the association, viz. A. nilotica scrub, A. senegal scrub, A. nilotica thorn forest, A. nilotica –P. juliflora scrub, Mixed thorn forest, P. juliflora scrub, S. oleoides, Grassland/ Savannah and Open land (GUIDE and GEER, 2001). The study area covering over 5000 km2 area in western Kachchh region encompasses parts of Lakhpat, Abdasa and Nakhtrana talukas of Kachchh of Gujarat state. This zone is representative of Kachchh with all landscape elements like forests, agriculture, industries, mining areas, grassland, mangroves, salt pans, rocky barrens, wetlands and waste land. The climatic condition is arid to semi arid type with extreme weather condition in three different seasons. The average rainfall of western Kachchh is 350 mm per annum and most of the rainy days occur during July to September (South West Monsoon). The minimum and maximum temperature recorded is 2ºC (winter) and 44ºC (summer), respectively (GMDC, 2009b). As mentioned above, in western Kachchh low precipitation and poor condition of soil, exclude perennial plants species except some xerophytes and the tree species cover is comparatively less than shrubs.

Sampling method

Enumeration of the tree and shrub species of study area was carried out by a simple, systematic and predetermined technique. Vegetation in the selected habitats were surveyed using a line transect of 1.1 km length. Quadrate method as suggested by Misra (1968) and Muller-Dombois and Ellenberg (1974) was used to record the various ecological characteristics of selected species in various habitats. By using the species area curve method, plots of 20X20 m2 and 8X8 m2 were employed to enumerate and recorded characters of tree and shrub species, respectively. Total 140 sample plots were laid, among them, 30, 35, 35 and 40 sampling plots were employed in Acacia dominant, Prosopis dominant, mixed thorn habitat and mixed habitats, respectively. Number of individuals of Tree species along with their GBH (girth breast height) was recorded for tree species, while for shrubs only the number within the plot was recorded. Tree GBH was measured at 130 cm above at ground level and the stem of tree was considered as round. In total 140 plots of specific dimension in selected habitat were studied.
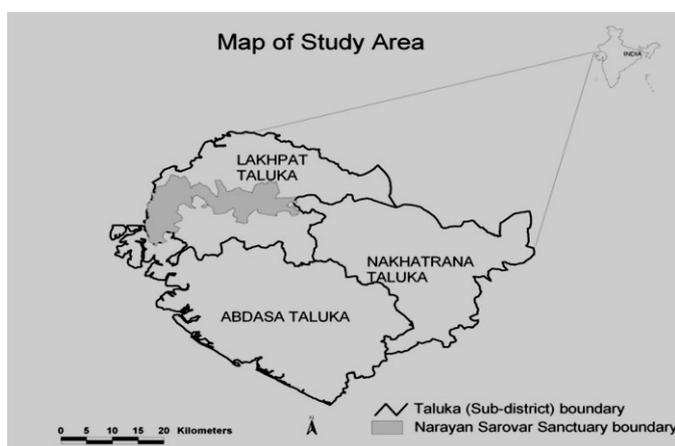

Fig 1. Map of study are

Data analysis Phytosociological analysis was done by calculating density, abundance, percentage frequency, IVI and distribution pattern for each plant species as per Misra (1968). The distribution pattern of species was studied using the ratio of abundance to frequency. If a species has high frequency and low abundance, it indicates regular distribution while low frequency with high abundance indicates contagious distribution (Misra, 1968). Species diversity was calculated and represented by Shannon-Wiener diversity index (H') and this index for a plant community study is derived using PAST software. (Hammer et. al., 2001 and http://folk.uio.no/ohammer/past). Various habitats were compared for quantified phytosociological parameters. Frequency diagram was prepared using the frequency classes (later it is address as FC) as suggested by Raunkaier (1934) and it was compared with the normal frequency diagram (Misra, 1968). Flora of Gujarat State (Shah, 1978) and Flora of the Indian desert (Bhandari, 1990) were used to identify the collected plant specimens and all the herbarium were deposited in the herbaria of GUIDE (Gujarat Institute of Desert Ecology), Bhuj, Kachchh. RESULTS As discussed above the western Kachchh region encompasses various types of habitat, which mainly support thorny vegetation. During the present study four major vegetation types viz. Acacia dominant, Prosopis dominant, mixed forest and mixed habitat were considered and explored in terms of data collection. Among them, six transects (and 30 plots), 7 (35 plots), 7 (35 plots) and 8 (40 plots) were laid, respectively. A total of 668 numbers of 13 tree species and 1731 numbers of 37 shrub species were recorded. All the enumerated species of tree and shrub with their habitat is representing in Annexure 1 & 2, respectively. It reveals that this region has sparse tree cover compared to shrub species. Quantitative assessment of various habitats was done by the calculating the density, abundance, % frequency, IVI and diversity. Acacia dominant habitat (ADH) Sampling location of this habitat were nearby or in the villages or reserve forest such as Kanyari RF, Gugaryari RF, Haripar, Laxmipar, Lifri, Ravapar etc., which are still protected because of the declared as reserve forest or fall under the vicinity of the Narayan Sarovar Sanctuary (NSS). Composition of the Acacia forest is mainly consists of species of Acacia genus of Mimosaceae family. Major species were Acacia senegal (L.) Willd. and A. nilotica (L.)

Del. subsp. indica (Bth.) Brenan. In total 10 and 22 tree/ small tree and shrub/ under shrub were recorded, respectively in which overall tree and shrub species densities were 215 and 332 individuals/ha. Acacia senegal (L.) Willd. was most dense tree species (131 individuals/ ha) followed by Commiphora wightii (Arn.) Bhandari (38 indi./ha) and Bauhinia racemosa Lam. and Moringa concenensis Nimmo were sparsely distributed species (1 and 2 indi./ha) (Table.1). Prosopis juliflora (Sw.) DC. was most dominant and dense shrub species (53 indi./ha) followed by Euphorbia caducifolia Hains. (37 indi./ha), Mimosa hamata Willd., Aerva persica (Burm. f.) Merrill., Hibiscus ovalifolius (Forsk.) Vahl. and Abutilon indicum subsp. guineense (Schum.) Bross. were with very low density (2 indi./ha) (Table.2). Except to Prosopis juliflora (Sw.) DC., a second dominant species, Euphorbia caducifolia Hains. grow in clumpy habit, which support the various plant species, including species of conservation significance, also. Distribution pattern of tree species reveal that all species were regularly distributed except to Acacia senegal (L.) Willd. Among the shrub species, such as Tephrosia falciformis Ramaswami, Campylanthus ramosissimus Wt., and Waltheria indica L. were contagiously distributed, while remaining were regularly distributed. Although dominant species of habitat, Acacia senegal (L.) Willd facing the threats by turn down the abundance while foremost shrub species were regular distributed with low anthropogenic pressure. Prepared frequency diagram of tree and shrub species compared with the normal frequency diagram as suggested by Raunkaier (1934), reveal that the tree species composition was heterogeneous while shrubby community was homogeneous (Fig. 1). Diversity (H') index of tree species was 1.33 while shrub species diversity was 2.69, suggest the shrub species is well diverse in compare of tree species within this habitat. Prosopis dominant habitat (PDH) This habitat is mainly found in areas, where resources are scares such as water and soil are in its extremely poor condition. To combat desertification in arid and semi arid climatic zone of Gujarat state, Prosopis juliflora (Sw.) DC., an exotic species, was introduced in 1882 (Harsh and Tewari, 1993). This species is spreading aggressively and its expansion has been recorded in some ecologically important regions and the study area also influence by the invasion of such species.
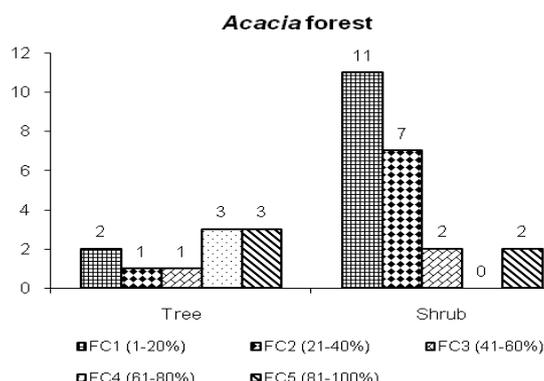

Acacia forest

- FC1 (1-20%)
- FC2 (21-40%)
- FC3 (41-60%)
- FC4 (61-80%)
- FC5 (81-100%)

Fig. 2. Frequency diagram of *Acacia* habitat

Table.1 Density, Abundance, diversity and IVI value of tree species among various habitats

No.	Habitat type/ Species	*Acacia* forest				*Prosopis* forest				Mixed thorn forest				Mixed habitat			
		Density/Ha	Abundance	Diversity(H')	IVI	Density	Abundance	Diversity(H')	IVI	Density	Abundance	Diversity(H')	IVI	Density	Abundance	Diversity(H')	IVI
1	*Salvadora oleoides* Decne.	15	22.5	1.33	41.01	15.71	18.33	1.52	109.65	15	17.5	1.69	48.6	34.38	39.29	1.66	115.92
2	*Acacia nilotica* (L.) Del. subsp. *indica*(Bth.) Brenan	10.83	16.25		10.46	6.43	11.25		26.08	12.14	14.17		31.75	33.75	33.75		68.76
3	*Acacia senegal* (L.) Willd.	130.83	130.83		178.42	19.29	33.75		111.4	45.71	45.71		124.67	25	25		53.75
4	*Prosopis cineraria* (L.) Druce	5	7.5		6.52	4.29	15		26.38	2.86	6.67		8.48	6.88	9.17		26.7
5	*Commiphora wightii* (Arn.) Bhandari	37.5	37.5		43.88	3.57	12.5		16.66	20.71	24.17		48.89	8.13	13		16.98
6	*Maytenus emarginata* (Willd.) D. Hou	6.67	8		6.67	-	-		-	5.71	6.67		12	3.13	6.25		6.05
7	*Acacia leucophloea* (Roxb.) Willd.	3.33	6.67		4.5	-	-		-	-	-		-	1.25	10		2.87
8	*Balanites aegyptiaca* (L.) Del.	3.33	10		3.22	-	-		-	0.71	5		1.32	-	-		-
9	*Bauhinia racemosa* Lam.	0.83	5		0.92	-	-		-	-	-		-	-	-		-
10	*Moringa concanensis* Nimmo	1.67	10		4.4	-	-		-	-	-		-	-	-		-
11	*Salvadora persica* L.	-	-		-	2.14	7.5		9.82	3.57	12.5		16.28	3.75	10		8.97
12	*Capparis grandis* L. f.	-	-		-	-	-		-	1.43	10		5.53	-	-		-
13	*Acacia tortalis* (Forsk.) Hayne.	-	-		-	-	-		-	0.71	5		2.49	-	-		-

Mapping of Prosopis juliflora (Sw.) DC., in NSS, showing that annually it is occupy about 113 ha area (GUIDE and GEER, 2001). To evaluate this habitat, two sampling on coal mining dump near Akari village, Kanyari, Kotda, Naredi, Subhashpar were also sampled. This invasive species is becoming dominant species among various mixed thorn components and form the Prosopis dominant habitat and some of them have been enumerated during this study. Only six tree species and 22 shrub species were recorded in which density of Acacia senegal (L.) Willd. was 19 indi./ha followed Salvadora oleoides Decne. with 16 individuals per ha among recorded tree species (Table.1). Apart from the studied all four habitat, this habitat recorded as lowest number of tree species because of the illicit cutting of Prosopis juliflora (Sw.) DC. and this activity influences to the tree species as illegal cutting of various trees for better fuel wood or charcoal production. Prosopis juliflora (Sw.) DC., a shrub

species was recorded as 139 individuals per ha, i.e. the highest density of single species within the habitat and among all studied habitat which shows its vigorous growth , results in invasion. Salvadora persica L. and Commiphora wightii (Arn.) Bhandari. an ecologically significant component of scrub forest, had recorded as very few individuals i.e. 2 and 4 per ha, respectively (Table. 1). Same situation was observed in case of shrub species like Calotropis procera (Ait.) R. Br. and Senra incana Cav. with only 1 individuals /ha (Table. 2). Acacia senegal (L.) Willd. was the most dominant and ecologically well established species of the habitat with the highest IVI value of 111.4 followed by Salvadora oleoides with 109.65 (Table.1). Distribution pattern of the tree species was regular. Shrub species, such as Zizyphus nummularia (Burm. f.) W. & A., Lycium barbarum L., Sesbania sesban (L.) Meer. subsp. sesban var. sesban , Leptadenia pyrotechnica (Forsk.) Decne. and Campylanthus ramosissimus

Wt. were contagiously distributed while remaining 17 species were regularly distributed. Frequency diagram revealed that vegetation type of Prosopis forest was heterogeneous in term of nature which leads to unevenness in species distribution among the habitat (Figure.2). Shannon diversity index (H') of tree species was 1.52 and 1.84 for shrub species. It shows that there was not much different between the tree and shrub species number of this habitat. Mixed thorn habitat (MTH) This is the major and dominant unique ecosystem of the arid and semi- arid climatic zone and as a part of tropical desert thorn forest, which is consisted by most diverse and perennial species having xerophytic adaptation with shrubby or bushy life form. Such habitat was evaluated form Audhi wandh, Laxmipar, Lifri, Murachban, Ravleshwer, Subhashpar and Sujawali wandh villages of study area. In the present study 10 tree and 24 shrub species were recorded from mixed thorn habitat.
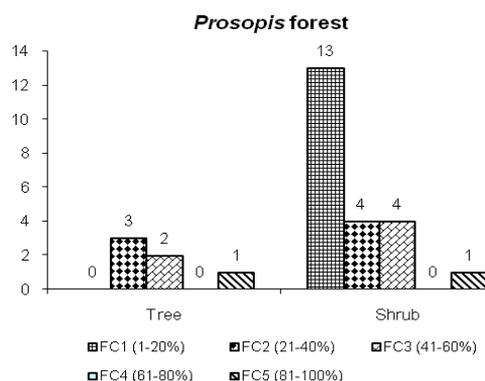

Fig. 3. Frequency diagram of *Prosopis* habitat

Table.2 Density, abundance and diversity value of shrub species among various habitat

No.	Habitat types/ Species	Acacia forest			Porsopis forest			Mixed thorn forest			Mixed habitats		
		Density	Abundance	Diversity	Density	Abundance	Diversity	Density	Abundance	Diversity	Density	Abundance	Diversity
1	*Prosopis juliflora* (SW.) DC.	52.50	52.50		138.57	161.67		98.57	98.57		131.88	131.87	
2	*Capparis decidua* (Forsk.) Edgew.	13.33	16.00		10.00	17.50		12.86	12.86		12.50	12.50	
3	*Grewia tenax* (Forsk.) Fiori	30.83	30.83	2.69	10.71	18.75	1.84	23.57	27.50	2.37	36.88	36.88	2.31
4	*Cordia perrottetii* Wt.	10.00	10.00		5.71	13.33		12.86	15.00		13.75	13.75	
5	*Grewia villosa* Willd.	16.67	20.00		8.57	15.00		7.14	16.67		18.75	25.00	
6	*Zizyphus nummularia*	27.50	33.00		12.86	45.00		27.14	27.14		37.50	37.50	

No.	Species								
	(Burm. F.) W. & A.								
7	*Euphorbia caducifolia* Hains.	36.67	36.67	1.43	10.00	17.86	31.25	32.50	52.00
8	*Lycium barbarum* L.	-	-	2.14	15.00	2.14	15.00	0.63	5.00
9	*Clerodendrum phlomidis* L.	-	-	-	-	-	-	1.25	10.00
10	*Periploca aphylla* Decne	16.67	33.33	-	-	1.43	10.00	1.25	10.00
11	*Mimosa hamata* Willd.	1.67	5.00	-	-	2.86	20.00	13.13	21.00
12	*Aerva persica* (Burm.f.) Merrill	1.67	10.00	-	-	-	-	-	-
13	*Premna resinosa* Schau	33.33	40.00	7.14	25.00	34.29	40.00	6.88	18.33
14	*Hibiscus ovalifolius* (Forsk.) Vahl	1.67	10.00	-	-	3.57	25.00	3.75	15.00
15	*Abutilon indicum* (L.) Sw. subsp. *guineense* (Schum.) Borss.	1.67	10.00	-	-	2.14	15.00	-	-
16	*Pupalia lappacea* (L.) Juss.	33.33	40.00	7.86	27.50	10.00	35.00	5.00	20.00
17	*Melhania futteyporensis* Munro ex Masters var. *futteyporensis*	7.50	15.00	-	-	-	-	-	-
18	*Tephrosia falciformis* Ramaswami	6.67	40.00	-	-	-	-	-	-
19	*Indigofera oblongifolia* Forsk.	-	-	-	-	1.43	10.00	-	-
20	*Campylanthus ramosissimus* Wt.	7.50	45.00	19.29	135.00	-	-	-	-
21	*Sesbania sesban* (L.) Meer. subsp. *sesban* var. *sesban*	6.67	20.00	3.57	25.00	4.29	30.00	-	-
22	*Waltheria indica* L.	7.50	45.00	-	-	-	-	-	-
23	*Maerua oblongifolia* (Foeak.) A. Rich.	11.67	14.00	5.71	20.00	7.86	18.33	14.38	16.43
24	*Ephedra foliata* Boiss. & Kotschy ex Boiss.	2.50	15.00	-	-	-	-	0.63	5.00
25	*Crotalaria burhia* Buch-Ham. ex Bth	-	-	-	-	-	-	13.13	26.25
26	*Senra incana* Cav.	-	-	0.71	5.00	3.57	25.00	-	-
27	*Leptadenia pyrotechnica* (Forsk.) Decne.	-	-	2.14	15.00	-	-	-	-
28	*Calotropis procera* (Ait.) R. Br.	-	-	0.71	5.00	-	-	-	-
29	*Vernonia cinerascens* Sch.-Bip.	-	-	1.43	10.00	1.43	10.00	1.88	15.00
30	*Solanum albicaule* Kotschy ex Dunal	-	-	1.43	10.00	1.43	10.00	-	-
31	*Asparagus racemosus* Willd. *var. javanicus* (Kunth) Baker	-	-	1.43	10.00	1.43	10.00	3.13	8.33
32	*Cadaba fruticosa* (L.) Flem.	-	-	1.43	10.00	-	-	1.25	10.00
33	*Capparis cartilaginea* Decne.	-	-	-	-	4.29	30.00	-	-
34	*Sarcostemma acidum* (Roxb.) Voigt	-	-	-	-	-	-	3.13	12.50
35	*Abutilon fruticosum* Guill. var. *fruticosum*	4.17	12.50	1.43	10.00	2.14	15.00	3.75	15.00
36	*Aloe barbandensis* Mill.	-	-	-	-	5.71	40.00	-	-
37	*Suaeda fruticosa* (L.) Forsk. ex Gmel.	-	-	1.43	10.00	-	-	-	-

Among the studies habitats, this one is recorded with maximum tree and shrub species number, which reveals that this is the vulnerable habitat for species diversity in face of various kinds of threats. Maximum densities of tree and shrub species were 46 indi. / ha (Table.1) of Acacia

senegal (L.) Willd and 99 indi./ha of Prosopis juliflora (Sw.) DC. (Table.2). Balanites aegyptiaca (L.) Del. and Acacia tortalis (Forsk.) hayne. were recorded as minimum density among the tree species i.e. only 1 indi./ha (Table.1). Mixed thorn habitat support the second level density value (21 indi./ha), a species of conservation significant with highly medicinal value. While shrub species like Periploca aphylla Decne., Vernonia cineranscens Sch.-Bip., Solanum albicule Kotschy and Asparagus racemosus Willd var. javanicus (Kunth) Baker recorded as only 1 indi./ha. Species distribution revealed, among this habitat all tree species were regularly distributed and in shrub species, excluding Lycium barbarum Linn., Sesbania sesban (L.) Meer. subsp. sesban, Mimosa hamata Willd., Senra incana Cav., Hibiscus ovalifolius (Forsk.) Vahl., Abutilon indicum (L.) Sw. subsp. Guineense (Schum.) Borss., Pupalia lappacea (Linn.) Juss, Clerodendrom phlomidis L. f. and Abutilon remosum (Cav.) Guill & per. were regular. These are the major component of mixed thorn habitat

but their distribution and quantity in such habitat is going to downward, shows the critical threats to disappearance of it. Acacia senegal (L.) Willd. is not only in this habitat (higher IVI value i.e. 124.66) (Table.1), but among the all studied habitat, it rise-up as dominant tree species with higher rank of ecologically establishment. Frequency diagram of the habitat showed that the habitat was heterogeneous in nature, mean habitat facing threats of fragmentation or some ecological process like succession (Figure.3). Shannon diversity index of tree species was 1.69 and shrub species diversity was 2.34. As per above discussion, diversity index also support such results the shrub species is the major component of this habitat in compare to tree species.
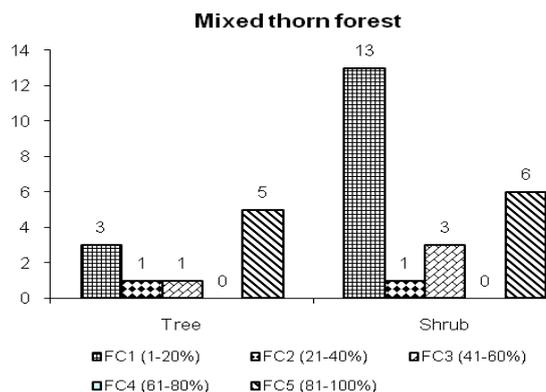

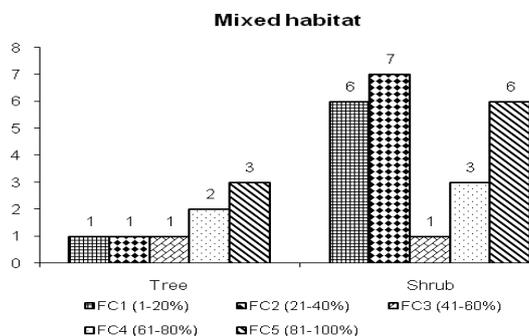**Fig. 4.** Frequency diagram of mixed thorn habitat

Fig. 5. Frequency diagram of mixed habitat

Mixed habitat (MH)

Some forest patches were species specific but they were not well distributed within the study area, those are included in the mixed habitat type. In this habitat type no species or group was dominant and their distribution was scattered within study. Under this habitat, currant and fallow agricultural land, wasteland, degraded land and area near the wetland habitat were included. Such kinds of habitats were enumerated from the villages/area like Bitiyari, Denma, Dhareshi, Fulra, Mundhay, Kuryani, Pranpar and Umarsar of study area. Enumerated area represents six tree and 26 shrub species. Salvadora oleoides Decne. and Acacia nilotica (L.) Del. subsp. indica (Bth.). Brenan. were the dense tree species with the recorded density of 34 indi./ha. This habitat were mostly assess form the wasteland, current and fellow agriculture land, which have not more cover of indigenous wild species but they have some tree cover on hedge and mainly hedge form by Acacia nilotica (L.) Del. subsp. indica (Bth.). In addition degraded land species or land cover with poor quality of soil supports the Salvadora Oleoides Decne. to grow. Prosopis juliflora (Sw.) DC., a shrub species had highest number of individuals i.e. 132/ha. Evaluated species distribution revealed that all tree species were regularly distributed while shrub species such as Aerva persica (Burm. f.) Merrill and Vernonia cineranscens Sch.-Bip. were contagiously distributed and remaining all was regular among this habitat. This reveals that all species of tree and shrub species were sparsely distributed except to said two shrub species, which were due to distribution in clump. Salvadora oleoides was ecologically most successful species of this habitat with high IVI value of 115.92. Frequency diagram of the habitat revealed that the vegetation type of this habitat was heterogeneous in nature. Species diversity index of the tree species was 1.66 and 2.31 of shrub species, which shows shrub species diversity was the dominant life form of this habitat.

DISCUSSION

Present study deals with the quantitative and qualitative assessment of the unique ecosystem, tropical desert thorn forest of Western Kachchh region of Gujarat State. Acacia senegal (L.) Willd. was the most dominant and well diverse tree species with high IVI value in major three habitats such as Acacia forest, mixed thorn forest and Prosopis forest while only mixed habitat had Salvadora oleoides – ecologically well established species (Table.3). IVI value of Acacia nilotica and

A. senegal in Gugaryana RF was 118.33 and 53.79 while in Lifri RF; it was 118.34 and 62.80, respectively. Gugaryana RF was only o.3 KM away from Mata-na-madh mining, so facing the reduction of the density (GMDC, 2009a). During present study, IVI value of Acacia senegal and A. nilotica was 117.06 and 34.26, respectively. This comparative results shows that the drastic reduction of Acacia nilotica for the Such RFs and now A.senegal also facing same problems i.e. Lifri RF is ecologically sensitive for unique habitat. Acacia forest also support to Commiphora wightii as second most diverse and dominant species, which under threatened category with maximum density (per ha) was 37.50 while Parmar (2003) recorded the 70- 110 per ha among Bhuj, Anjar and Nakhtrana talukas. Relative density of C. wightii was comparatively less in study area from eastern Kachchh (GUIDE, 2007), it reveals that this region is vulnerable for species of conservation significance. Dixit and Rao (2000) describe the tapping and collection of gugal gum by unscientific method is the major threat to loss of important species- Commiphora wightii. Prosopis juliflora a shrub species was at highest rank or value of all analysis revealed most dominant and diverse shrub species among all study area (Table. 4). In the Narayan Sarovar Sanctuary (NSS), density of this species was 21 (no. /ha) (GEER and GUIDE, 2001) and during present study, results reached to 51.42. It reveals the increase the population exotic species and loss of indigenous species. Most of the tree species were regularly distributed while some shrub species, which was encountered at very less time, was contagiously distributed. Campylanthus ramosissimus and Ephedra foliata, shrub species of conservation significance were also recorded from Acacia forest. Mixed thorn forest supports some uncommon species such as Mimosa hamata, Sarcostermma acidium, and Clerodendrom Phlomidis. Prosopis forest also supports some species of conservation significance such as Commiphora wightii and Campylanthus ramosissimus. Study reveals that the top canopy cover formed by Acacia senegal, while second layer of canopy was formed by shrub species, Prosopis juliflora. Vegetation nature of all studied habitat were heterogeneous i.e. habitats facing the problems of de-fragmentation or some kind of ecological succession. Acacia and mixed thorn habitat now mainly found in the reserve forest area like Kanyari RF, Gugaryani RF, Laxmipar RF, Lifri RF, Ravleshwer RF, Subhashpar RF because of these area only under the proper protection but mining activities changes the

species composition and distribution pattern. In addition RF like Kanyari, Gugaryani and Lifri are fall in the close proximity of lignite mining. These both habitats support the maximum number of species of tree and shrub. Some area that having mining spoil dump like Akari, Kotda, Subhashpar area showing the lower species diversity and dominancy of single species, Prosopis juliflora (Sw.)DC. and these affect the peripheral area of dump by creating mine spoil. Excessive demand for fuel wood due to inflow of extra labour for carrying out mining operation and transportation activities also tend to exploit more and more wild plant species. With the clear understanding of environmental, ecological and social component with respect to the vegetation formation in the western Kachchh and widely available management options the following strategies are suggested as conservation measures for the conservation significance species as well as habitats:

• Considering the high floral diversity of these habitats, it has been suggested that, these habitats should be declared as Ecologically Sensitive Areas (ESAs).

• Identification of the hot spot area of natural resources for fodder and fire wood collection and tie-up with various NGOs and research institute for the promotion for the other alternative to reduce the anthropogenic pressure on such areas including socio-economic benefits.

• Creation of village level forest and resources management committee and monitoring of the ESA is suggested.

• Reserve forest like, Kanyari RF, Gugaryani RF, Laxmipar RF, Lifri RF, Ravleshwer RF, Subhashpar RF should be protected with the natural or live fencing of Euphorbia caducifolia Hains. and Balanites aegyptica (L.) Del.

• These protected sites in RFs should be restored with the threatened plant and it can be act as natural seed bank for the vulnerable species.

• Wasteland or fallow land should be restored through restoration programmes with ecologically important and their associated species.

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