Chapter II

ASSESSMENT OF WOODY VEGETATION

Assessment the diversity of Trees and Lianas

2.1 INTRODUCTION

Dry tropical forests account for 46% of the total forest cover of India (Singh and Singh, 1988) that are largely threatened by lopping, burning, overgrazing and above all clearing for cultivation. Factors governing the dynamics of these forests may be different from those of the rainforests due to differences in climatic factors, size, shape and seasonal timing of canopy gaps which influence the regeneration of woody species (Sukumar *et al.*, 1992).

A constant human interference in hill regions has greatly led to a substantial reduction of the forest cover. The absence of any land use regulation has imposed further constraints on soil and water conservation programme in ecologically crucial and sensitive hilly regions. The vegetation growth efficiency of the region depends upon the type, quantity and stratification of vegetation. Therefore, for any study on ecology of these areas, a quantitative evaluation of its vegetation is a prerequisite (Roomsingh *et al.*, 1991).

Earlier inventories on quantitative plant diversity (mostly of trees or woody vegetation) for peninsular Indian forests include those from the deciduous forest of Mudumalai (Sukumar *et al.*, 1992), dry evergreen forests on the Coromandel coast (Parthasarathy and Karthikeyan, 1997; Parthasarathy and Sethi, 1997),

and from the wet evergreen forests of the Western Ghats (Rai and Proctor, 1986; Parthasarathy *et al.*, 1992; Pascal and Pelissier, 1996; Ganesh *et al.*, 1996) and the Kalrayan hills of the Eastern Ghats (Kadavul and Parthasarathy, 1999).

A combination of data obtained from remote sensing and field data measurements are being applied congruently to evaluate conditions of ecological function over large regions (Mouat *et al.*, 1992). Since remote sensing plays an indispensable role for regional ecological studies, it is expected here to play a major role in biodiversity survey, which includes quantification of biodiversity at population, ecosystem and landscape levels (Tiwari, 1999).

Tiwari (1987) used aerial photographs to prepared forest type maps and this was further elaborated based on the crown cover and distribution of test sites and phytosociological studies. Roy *et al.*, (1993) used remote sensing data for vegetation mapping, initial stratification, and distribution of sample plots and analysis of various phytosociological studies. Homogeneous vegetative strata were identified through visual interpretation of the satellite imagery. The various dominant and co-dominant plant species were listed from phytosociological studies in the Eastern Ghats of Andhra Pradesh (Prasad *et al.*, 1998). Since similar studies are unavailable for the Shervarayan hills, the present study will deal with woody species diversity (> 30 cm gbh) in different vegetation types of the Shervarayan hills.

OBJECTIVES

1. Quantitative analysis of woody vegetation in different forest types, in terms of primary and secondary indices like frequency, density, abundance, basal cover, Shannon and Simpson index, IVI and A/F ratio respectively.
2. To discuss the role of each parameter (including species richness and concentration of dominance) for individual forest types.

2.2 MATERIAL AND METHODS

2.2.1 Sampling Design

Stratified random sampling techniques were adopted for diversity analysis. The number of sampling sites would vary between different forest types. For trees and lianas 20 X 20 m sampling quadrats were laid (**Figure 4**) at random in all forest types following CES (1998). Number of sampling units (small 0.01 % and large area 0.001 to 0.005 %) (Roy, 1999) would also vary on account of the area cover different forest patches. Considering the size of the study area and the forest types, the required sampling units were fixed as shown in the **Table 13** and **14**.

All living trees and lianas > 30 cm girth at breast height (gbh) were measured and their frequency and floristic richness (vascular plants) were recorded. In case of multi-stemmed trees, girths of the boles were measured and basal area calculated and summed up. The understory components were also noted in side the quadrat. The vegetational data were quantitatively analysed for density, abundance, frequency, $A^b/$ %F ratio, relative frequency, relative density, basal area and importance value index (IVI) (Magurran, 1988) of each species

Figure 4: Dimension of the quadrat
(For woody species ≥30cm gbh and species richness)

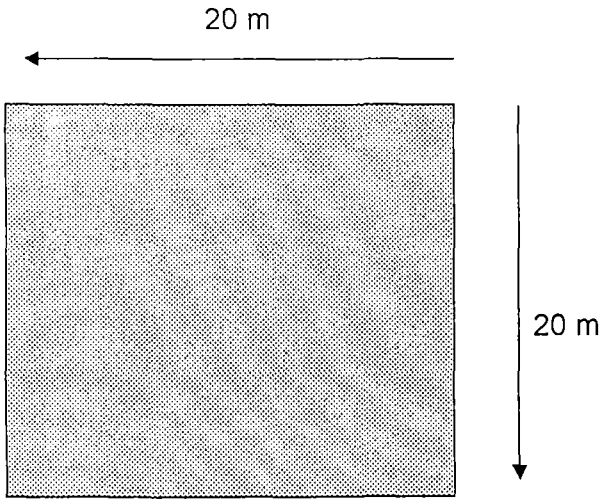


Table 13: Shows the various sample size based on the area

S.No	Area in hectares	% of area sample for the study
1	< 1000	0.5
2	1000 – 2000	0.05
3	> 2000	0.01

Table 14: Vegetation types and their required number of sampling units

S.No	Forest type	Required number of quadrats	Total number of quadrat laid
1	Evergreen	13.90	14
2	Semi Evergreen	13.01	13
3	Riparian	14.20	14
4	Dry mixed deciduous	25.20	25
5	** Evergreen scrub	3.60	4
6	Southern thorn scrub	26.40	26

** As Woody species (> 30 cm gbh) not available in Evergreen Scrub, the quadrats laid is utilized only for calculating the species richness.

were calculated. The abundance to frequency ratio ($A^{b}/$ %F) for different woody species was determined to study their distributional patterns *i.e.* regular (< 0.025), random (0.025 - 0.05) and contagious (> 0.05) (Curtis and Cottam, 1956) and woody vegetation diversity for different vegetation types was determined using Shannon-Wiener index (Shannon and Wiener, 1963), concentration dominance (cd) was measured as per Simpson (1949). All the formulae (given below) were programmed on Minitab 8.2 – a statistical software.

The vascular plant richness of the each quadrat was calculated and used for preparing species richness map, which would be discussed in chapter VI- 6.1 (Conservation).

Density : Number of individuals per quadrat

$$D = \frac{\text{Number of individual of a species}}{\text{Total number of quadrats studied}}$$

Frequency : Total number of sampling units in which a given species occurs

$$\%F = \frac{\text{Total number of quadrats in which species occur}}{\text{Total number of quadrats studied}} \times 100$$

Abundance : Number of individuals per quadrat

$$Ab = \frac{\text{Total number of individual of a species}}{\text{Total number of quadrats in which species occur}}$$

Basal area = $C^2/4\pi$ where C is the circumference at breast height

Importance Value Index: In order to express the dominance and ecological successes of a species, with a single value, the concept of importance value index (IVI) has been developed. This index utilizes three parameters *viz.*, Relative Frequency, Relative Density and Relative Basal Area.

$$\textbf{Relative Density (RD)} = \frac{\text{Density of a species}}{\text{Sum of density of all the species}} \times 100$$

$$\textbf{Relative Frequency (RF)} = \frac{\text{\% Frequency of a species}}{\text{Sum of \% frequency of all the species}} \times 100$$

$$\textbf{Relative Basal Area (RBA)} = \frac{\text{Total basal area of a species}}{\text{Sum of stand basal cover of all the species}} \times 100$$

Diversity indices

Diversity indices weight species according to their relative abundance or rarity. Examples of this type include the Shannon-Wiener and Simpson indices (Pielou, 1977).

Shannon-Wiener diversity index (Shannon and Wiener, 1963)

$$\mathbf{H' = -\Sigma pi \log pi}$$

Simpson diversity index (Simpson, 1949)

$$cd=\Sigma pi^2$$

Where pi - Proportion index

H^1 - Shannon Wiener Diversity Index

Cd - Concentration of Dominance

2.3 RESULTS AND DISCUSSION

Species richness of the various vegetation types, stand density and its basal area and diversity indices are given in **Table 15**. Data pertaining to the indices are presented in **annexure I**.

Table 15: Consolidated details of woody species diversity (> 30 cm gbh) in the sampling sites of the various vegetation types.

Vegetation type/Parameters	No. of Species	No. of Genera	No. of Families	Total no. of Individuals	Total basal area	Shannon-Wiener index	Simpson index
Evergreen	47	46	28	382	21.09	3.0690	0.0735
Semi evergreen	59	46	31	228	10.94	3.6860	0.0347
Dry mixed deciduous	63	59	34	417	21.81	3.5740	0.0431
Riparian	38	37	25	228	39.12	2.7370	0.1238
Southern Thorn Scrub	14	12	9	65	5.57	2.3140	0.1195

2.3.1 Evergreen Forest

2.3.1.1 *Species richness, families and distribution*

Woody species richness (> 30 cm gbh) is 47, belonging to 46 genera in 28 families. The dominant families are *Oleaceae* and *Rubiaceae* (4 sp.each) followed by *Papilionoideae (s.f.)* (3 sp.) contributing to 37.15% (146 stems) of the total stand density.

From the $\frac{A}{F}$ %F ratio *Viburnum punctatum, Psydrax dicoccos, Elaeagnus indica*, *Pterocarpus marsupium* and *Murraya paniculata* are randomly distributed whereas the other species show contagious distribution.

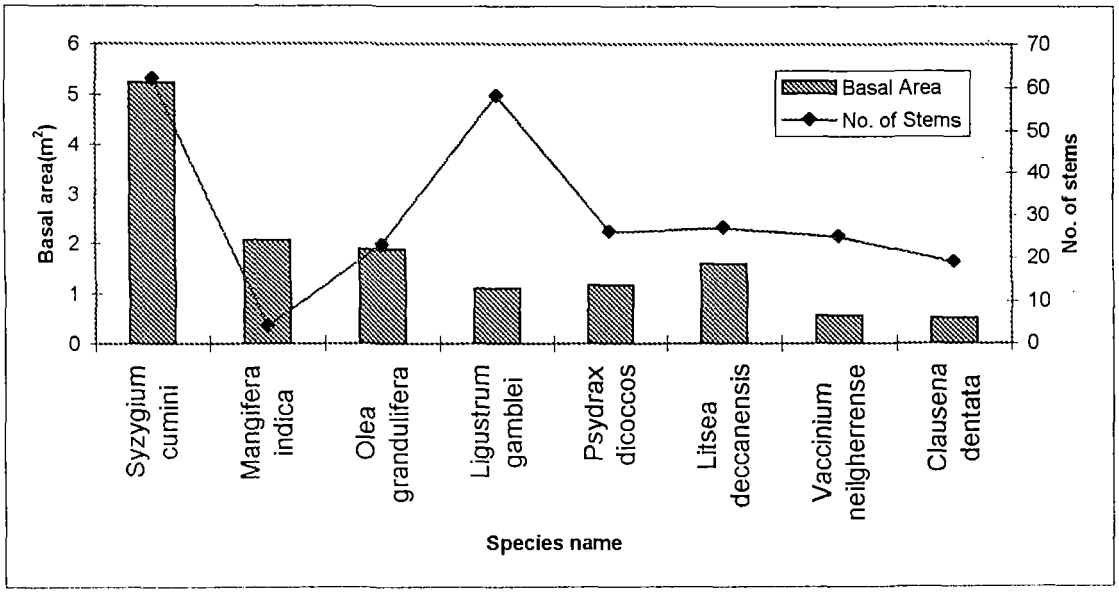
2.3.1.2 *Basal area and Stand density*

Total basal area of this vegetation type is 21.09 m^2 (382 stems) to which *Syzygium cumini* had the highest share 5.2407 m^2 (62 stems), followed by *Chionanthus ramiflorus* 1.7869 m^2 (17 stems), *Bischofia javanica* 1.7568 m^2 (6 stems), *Psydrax dicoccos* 1.1624 m^2 (26 stems) and *Ligustrum gamblei* with 58 stems contributed 1.0998 m^2 of basal area. Lowest basal area has been reported in *Toona ciliata* 0.0101 m^2 with only one stem. Contribution of basal area and stems of dominant species in evergreen type are noted in **Figure 5**.

2.3.1.3 *Importance value index (IVI) and diversity indices*

Highest IVI was observed in *Syzygium cumini* (46.0372) followed by *Ligustrum gamblei* (26.1594) and *Litsea deccanensis* (19.5754) and the lowest was in *Toona ciliata* (1.1510) followed by *Pittosporum floribundum* (1.1780) and *Celastrus paniculatus* (1.2055). The Shannon-Wiener diversity indices of the Evergreen forest are 3.069 and Simpson diversity index is 0.0735.

Figure 5: Basal area and stand density of dominant species in the Evergreen forest



2.3.1.4 *Understory components*

Understory consists of dominant species like *Gnetum edule, Jasminum cuspidatum, Hiptage benghalensis, Ventilago maderaspatana, Maesa indica, Zizyphus oenoplia, Passiflora edulis, Canthium parviflorum, Asparagus racemosus, Peperomia dindigulensis, Elaeagnus indica* and *Psychotria octosulcata.*

2.3.2 Semi Evergreen Forest

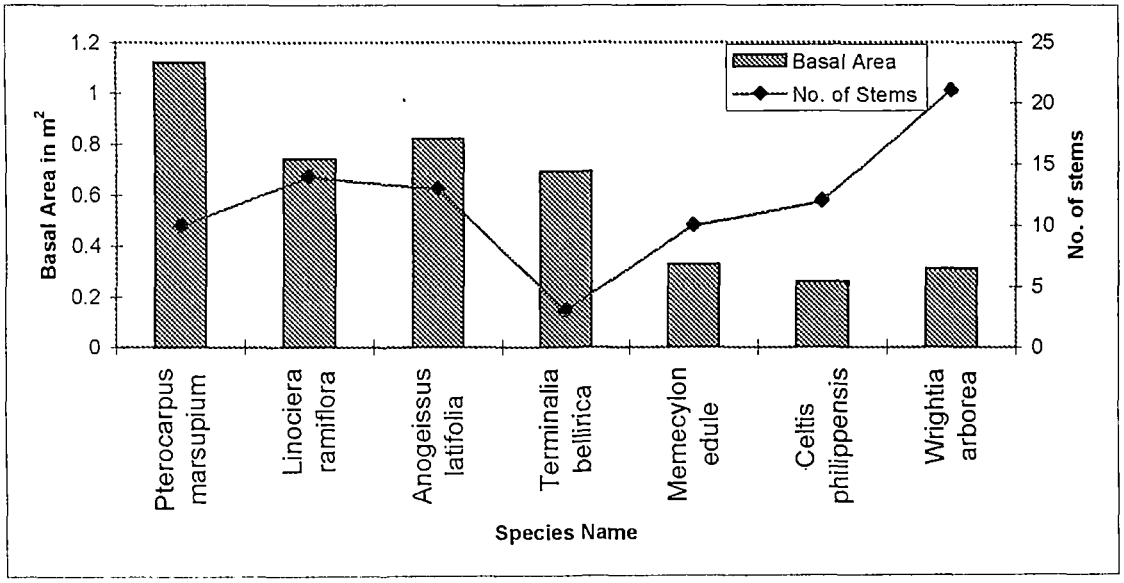
2.3.2.1 *Species richness, families and distribution*

This vegetation type consists of 59 woody species belonging to 46 genera and 31 families. The dominant families are *Papilionoideae (s.f.)* (6 spp.) followed by *Moraceae* (5 spp.) and *Mimosoideae (s.f.)* (4 spp.) and contributed 24.12% from the total stems. *Erythrina variegata* is randomly distributed while all other plant species are contagiously distributed (> 0.05).

2.3.2.2 *Basal area and stand density*

Total basal area of the Semi evergreen forest is 10.94 m^2 (228 stems). Highest basal area value is contributed by *Pterocarpus marsupium* 1.1222 m^2 (10 stems) followed by *Chionanthus ramiflorus* 0.7409 m^2 (14 stems). The lowest basal area value is observed in *Ixora finlaysoniana* and *Erythroxylon monogynum* 0.0071 m^2 (1 stem) followed by *Tectona grandis* 0.0127 m^2 (1 stem). Contribution of basal area and stems of dominant species in semi evergreen types are noted in **Figure 6**.

Figure 6: Basal area and stand density of dominant species in the Semi Evergreen forest



2.3.2.3 *Importance value index (IVI) and diversity indices*

Highest IVI was contributed by *Wrightia arborea* (18.3528) followed by *Pterocarpus marsupium* (18.2459) and *Anogeissus latifolia* (17.6943). The lowest IVI value was encountered in *Ixora finlaysoniana* and *Erythroxylum monogynum* (1.4044) followed by *Anamirta cocculus* (1.4190). Shannon-Wiener diversity index of the vegetation type is 3.686 and Simpson diversity index is 0.0347.

2.3.2.4 *Understory components*

Understory dominant species are *Pavetta indica, Glycosmis mauritiana, Butea parviflora, Stenosiphonium parviflorum, Flueggea virosa, Cipadessa baccifera, Helicteres isora, Carmona retusa, Capsicum frutescens, Celastrus paniculatus, Solanum seaforthianum, Crytococcum trigonum, Shuteria involucrata and Naringi crenulata.*

2.3.3 Riparian Forest

2.3.3.1 *Species richness, families and distribution*

Woody species richness is 38 belonging to 37 genera in 25 families. Dominant families are *Moraceae*, *Euphorbiaceae* and *Combretaceae* (93 species each) and contributed to 22.8% of stems from the total stand density. *Tamarindus indica* (0.02) is found to be distributed regularly while *Ficus microcarpa* and *Terminalia arjuna* (0.05) are randomly distributed and all other species show contagious distribution.

2.3.3.2 *Basal area and stand density*

The total basal area value is 39.12 m^2 contributed by 228 stems. The highest basal area was contributed by *Terminalia arjuna* (22.1780 m^2) with stand

density of 29 stems followed by *Mangifera indica* (4.4385 m^2) with 11 stems, *Pongamia pinnata* (2.9677 m^2) with 34 stems. The lowest basal area is reported in *Hiptage benghalensis* and *Wrightia arborea* (0.0071 m^2) with one stem followed by *Hymenodictyon orixense* (0.0097 m^2). Contribution of basal area and stems of dominant species for riparian forests are described in **Figure 7**.

2.3.3.3 *Importance value index and diversity indices*

The results show that *Terminalia arjuna* has the highest IVI value (80.6679), followed by *Streblus asper* (38.6901) and *Pongamia pinnata* (932.4992). The Shannon-Wiener diversity index is 2.7370 and Simpson index is 0.1238.

2.3.3.4 *Understory components*

Understory dominance is created by the following species: *Solanum surrattense, Digitaria bicornis, Cipadessa baccifera, Pavetta blanda, Hiptage benghalensis, Combretum albidum* and *Zizyphus oenoplia.*

2.3.4 Dry Mixed Deciduous Forest

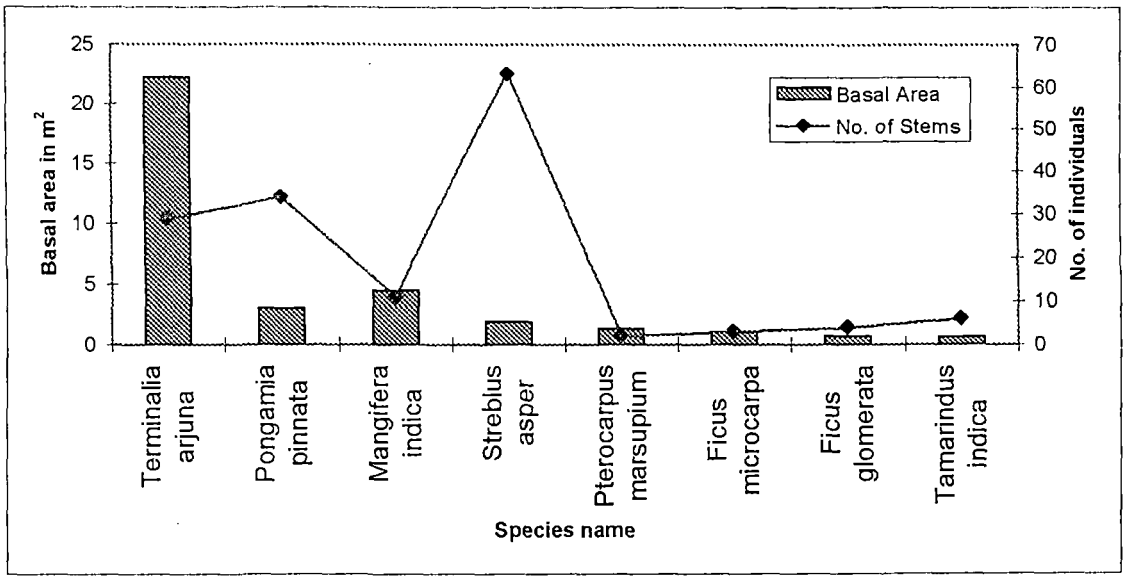
2.3.4.1 *Species richness, families and distribution*

This vegetation type harbours 63 species in 59 genera belonging to 34 families. *Euphorbiaceae* contributed maximum number of species (6 spp.) followed by *Rutaceae* and *Moraceae* (5 spp.). Ab / %F ratio showed that all the species are contagiously distributed.

2.3.4.2 *Basal area and Stand density*

Total basal area value of this vegetation type is 21.81 m^2. *Gyrocarpus asiaticus* shares the highest basal area (2.7493 m^2) followed by *Manihot glaziovii*

Figure 7: Basal area and stand density of dominant species in the Riparian forest



(1.7909 m^2) and *Anogeissus latifolia* (1.5551 m^2). The lowest basal area encountered in *Acacia leucophloea* and *Dolichandrone arcuata* (0.0071 m^2) followed by *Grewia tiliifolia* (0.0087 m^2). *Gyrocarpus asiaticus* has contributed the highest stand density with 42 stems followed by *Manihot glaziovii* (39 stems), *Commiphora caudata* (33 stems), *Anogeissus latifolia* (30 stems) and *Albizia amara* 919 stems). Contribution of basal area and stems of dominant species of dry mixed deciduous type are described in **Figure 8**.

2.3.4.3 *Importance value index and diversity index*

The results show that *Gyrocarpus asiaticus* has the highest IVI value (30.2941) followed by *Manihot glaziovii* (21.0650) and *Commiphora caudata* (19.5982). The lowest IVI values are seen in *Dolichandrone arcuata* (0.8645) followed by *Grewia tiliifolia* (0.8719) and *Combretum albidum* (0.8765). The Shannon-Wiener diversity index is 3.5740 and Simpson diversity index is 0.0431.

2.3.4.4 *Understory components*

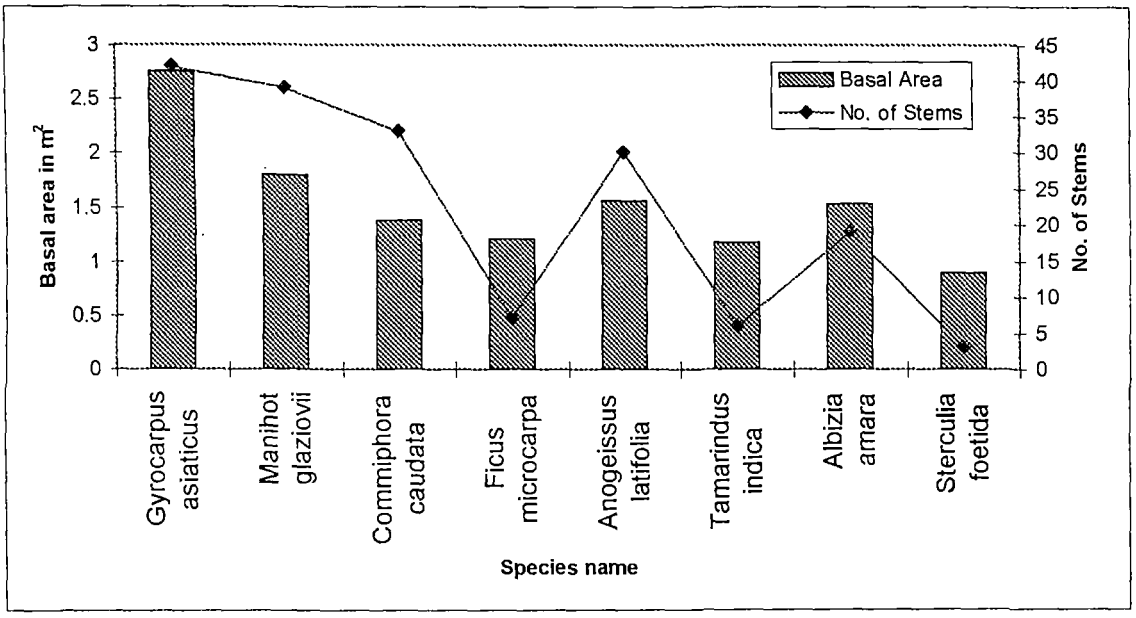
The understory composition consists of *Scutia myrtina, Cipadessa baccifera, Kleinia grandiflora, Stephania japonica, Achyranthus aspera, Acacia torta, Solanum surrattense, Evolvulus alsinoides, Pachygone ovata, Combretum albidum* and *Clausena dentata.*

2.3.5 Southern Thorn Scrub

2.3.5.1 *Species richness, families, distribution*

This vegetation type consists of 14 woody species in 12 genera belonging to 9 families. *Mimosaceae* have contributed maximum number of species (5 species) with 14 stems (21.53%) to the total stand density. Ab / %F ratio shows that the species form contagious distribution.

Figure 8: Basal area and stand density of dominant species in the Dry Mixed Deciduous forest



2.3.5.2 *Basal area and stand density*

Total basal area value of this vegetation type is 5.57 m^2 of which *Tamarindus indica* contributed maximum (2.5510 m^2) followed by *Gyrocarpus asiaticus* (1.4980 m^2) and minimum basal area value was encountered in *Zizyphus oenoplia* (0.0071 m^2). *Gyrocarpus asiaticus* contributes the highest stand density 913 stems) followed by *Tamarindus indica* (10 stems) and *Euphorbia antiquorum* (8 stems). Contribution of basal area and stems of dominant species southern thorn scrub are described in **Figure 9**.

2.3.5.3 *Importance value index and diversity index*

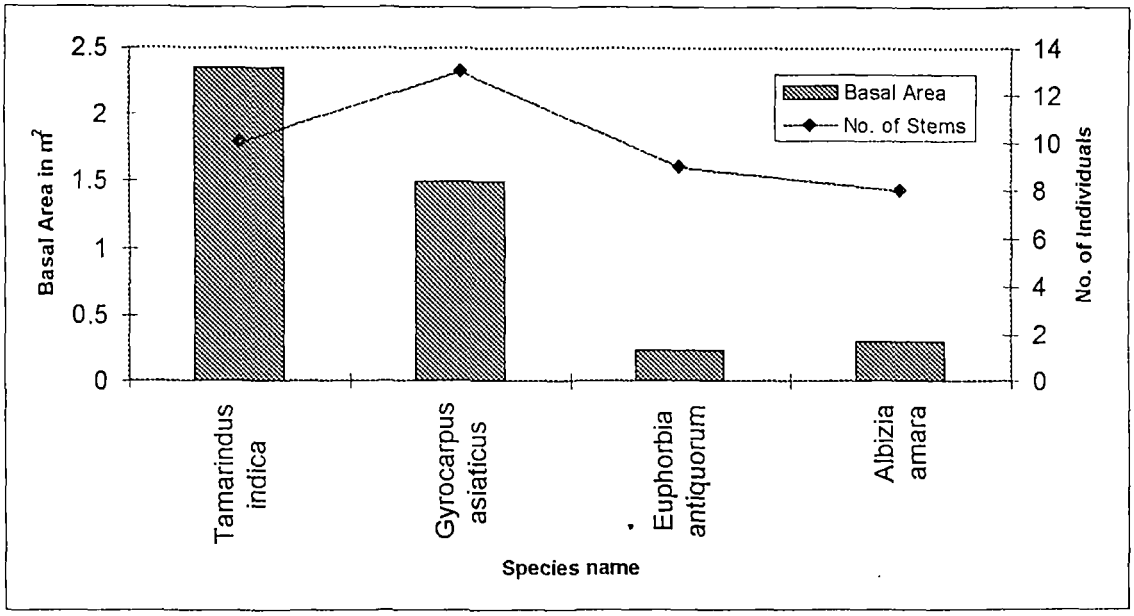
Gyrocarpus asiaticus showed the highest IVI value (66.1440) followed by *Albizia amara* (30.3600) and *Euphorbia antiquorum* (34.5750) and the lowest IVI value is estimated in *Zizyphus oenoplia* (3.6810) and *Albizia lebbeck* (3.8620). Shannon-Wiener diversity index is 2.3140 and Simpson diversity index is 0.119.

2.3.5.4 *Understory components*

Understory consists of *Lantana camara, Shuteria involucrata, Pavonia procumbens, Blepharis maderaspatensis, Boerhavia diffusa, Randia dumetorum, Benkara malabarica, Ageratum conyzoides, Cardiospermum halicacabum, Aerva lanata, Leucas aspera, Flueggea leucopyrus* and *Cocculus hirsutus.*

The diversity indices are higher in tropical forests in general (Pande, 1999), compared to the temperate forests (1.16 - 3.40) (Braun, 1950; Monk, 1967; Singhal *et al.*, 1986) whereas for the Indian forests the ranges varies between 0.83-4.1 (Singh *et al.*, 1984; Sai and Mishra, 1986; Visalakshi, 1995;

Figure 9: Basal area and stand density of dominant species in the Southern Thorn Scrub forest



Pande, 1999). The values obtained in the present study (2.1330 - 3.6860) are well within the range for the tropical forest of the Indian subcontinent.

The values of concentration of dominance (cd) for temperate forests lie within the range of 1.10 - 0.99 (Whittakar and Niering, 1965; Singhal *et al.*, 1986), while for tropical forests the average value is 0.06 Knight (1975), while the ranges for Indian forests are between 0.079 - 0.92 (Sai and Mishra, 1986; Bisht, 1989; Parthasarathy *et al.*, 1992, 1997; Visalashi, 1995; Pande, 1999). Thus the value of the concentration of dominance in the present study falls within the reported range for the tropical forests except the semi-evergreen (0.47) and Dry mixed deciduous (0.0431).

2.4 CONCLUSION

Present study has focused on Protected Areas (reserves) because they (PAs) are repositories of biodiversity in a biogeographic unit. They also function as a refuge for native plants, animals and microorganisms and as an outdoor laboratory (Brandt and Rickard, 1994). It is important to assess possible structural and compositional changes in preparing the management policies for the reserves (Dhar *et al.*, 1997). Broadly, structural changes are not expected in the riparian forests. However, trends in the population structure of the dominant taxa in this forest need to be considered. Among dominant species of riparian forest *Pongamia pinnata* and *Mangifera indica* are early successional native species. Ohsawa (1991) considers them as 'habitat pioneers' owing to their adaptability to specific habitats. Formation of such habitats is a continuous process along the river sources. Therefore, these species will colonize the newly formed sites.

Availability of most of the representative forest types (Evergreen, semi evergreen, riparian and dry mixed deciduous) in the study area suggests its conservation value. Assessment and analyses of structure and composition of different forest type provides baseline data for developing priorities for conservation of these forests.