ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Trees Enumeration and Analysis of Dharoi Range Forest, Mehsana, India

Yogesh B Patel, Nimisha D Patel, Dharmesh G Jaiswal, Dr Himanshu A Pandya and Dr Yogesh T Jasrai
Department of Botany, USSC, Gujarat University, Ahmedabad, Gujarat, India.

Manuscript Info

Manuscript History:

Received: 15 November 2014
Final Accepted: 22 December 2014
Published Online: January 2015

Key words:

Trees, Enumeration, Species, Dominant

Corresponding Author

Yogesh B Patel

Abstract

Forest resources survey was undertaken so as to create database in dharoi range forest for, like such exercises indicate wather a species is holding on and growing successfully to the area or some other species is trying to replace or dominant and also to know status of supply of raw material is possible from forest resources. Dharoi range takes 14 villages and area of 6300.60 hectares. In tree enumeration we used Strip method. Details of enumeration revealed that in Dharoi Range, Gadhavada region is wealthy range with 25,31,130 trees. The Present work deals with 72 Tree species.

INTRODUCTION

The enumeration data give an idea of changes in species composition with respect to time, if past record are compared. It is necessary to know which species needs to be regenerated in the forest and which species removed tree enumeration exercises at regular interval, for example of 10 years, therefore, would be important for the forest management. In order to determine dynamics, structure, composition, status of natural regeneration, rare and endangered species, so as to enhance the understanding about the habitats and to make necessary recommendations for regulation of the ecosystem, a comprehensive survey and enumeration of species of the forest area was carried out.

Importance of tree enumeration:

- Tree enumeration data can compare with remote sensing.
- Calculating green cover.
- Calculate available carbon stock in forest area.
- To balance biodiversity conservation.
- Nitrogen fixation.
- To save native community from invasive species
- Ensuring their sustainability and stable ecosystem. (Patel *et al*, 2014).

Study Area:

Dharoi range forest of Satalaasana taluka, Mehsana district, Gujarat, India. The surrounding of the Range can be mentioned as here: North side: Banaskantha district, South side: Mehsana district, West side: Vadgam of Banaskantha district, East side: Khedbrahma taluka of Sabarkantha district. The vegetation of Dharoi range forest is tropical dry deciduous, scrub and thorn forest type.

- **Soil:** The soil in general, is sandy with varying proportions of loam, generally, plains, valleys and pockets have deep and fertile soil. The soil in hilly areas is very shallow and poor, the soil around the banks of Sabarmati is sandy loam,
- **Climate:** The climate of the tract is characterized by hot summer, cool winter, and general dryness except in the south – west monsoon months. The cold season from December to February is followed by the hot season from March to May. The period from June to September is the monsoon season followed by the post-

monsoon period of October – November. There is considerable variation among different parts of the tract and between the summer and winter months (Jasrai *et al*, 2010)

- **Rainfall:** The rainfall of at Dharoi Range is 630 mm to 1454 mm. About 95% of the rainfalls are received during the monsoon, which is irregular and erratic in nature. On an average, there are about 30 rainy days in a year.
- **Temperature:** The variation in temperature is very wide. The diurnal variation in temperature is large, being about 8^0 C during the monsoon to around 15^0 C in the rest of the year. Summer beings by the end of February and continues up until the end of June to the gradual rise in temperature. April and May are the hottest months (Jasrai *et al*, 2010)
- **Humidity:** Humidity is generally 65% or more during the south – west monsoons out the rest of the year is comparatively dry. During winter period, the relative humidity is generally 55% in the morning and 27% in the evening which gradually rises to 58% and 32% during post monsoon period.

Statement

- Plant composition and configuration that persisted before changed over a period because of variations in climatic conditions.
- This requires a careful planned and detailed forest resource survey for necessary inputs for evaluation and analysis with meticulous planning for conservation, protection and development of forest in desired form.
- People from villages on the fringes of forests collect several NWFPs from the forest.
- These forest resources are essential to understand required database on dependency of local people on forests. (Anonymous, 2008 and Patel *et al*, 2014).

METHODOLOGY:

A study was conducted throughout Dharoi Forest Range, Mehsana district, Gujarat, India. This area has an extent of 6300.60 ha. Extensive field trips were carried out to document the floristic diversity. The stock of each village surveyed was calculated by multiplying stock (10% as surveyed data) in each girth class by 10.

The map of the dharoi range was stratified in 14 villages on the basis of density-composition of species of the particular forest area of 6300.60 hectares. It was surveyed covering the entire area in 20 meter wide strips laid parallel to each other with 200 m distance from one another. The strip enumeration methodology was thus adopted (Jasrai *et al.,* 2010). Total stock of all the surveyed villages was then calculated from the record generated. Then, the total stock, density, percentage distribution of stock of a species over different girth classes and percentage distribution of stock of a species in a girth class to the total stock of all species in that particular girth class was calculated for Dharoi range.

Species enumerated:

A list of common Tree species in the area to be enumerated was prepared before starting the work. Every strip along the base line was enumerated; thus covering a 10 % enumeration. All the tree species occurring in the forests were enumerated in terms of girth classes as 0-30 cm, 31-60 cm, 61-90 cm, 91-120 cm, 121-150 cm and above 150 cm.

The most important part is the correct location of the starting point on the field based on the point marked on the village map. The help of local people and the forest department staff was also essential. This was ascertain with available features on the ground and a peg was fixed at this point with details (corresponding to the details on the map).

Establishing a strip - line on the base-line and enumeration work

The first cruise-line was fixed at right angles to the base line, at 100 m from the starting point. The straight line of cruise-line was created and continued exactly as followed for the base-line with the help of Flagman. The tree standing in the 20 m strip as 10 m on either sides of the cruies-line was requirement to be enumerated in the enumeration. Two labours were posted at the starting of the strip line, one each at 10 m from the cruise-line on right and left flank. Thereafter, at 20 m along the cruise-line, one-one labour was posted. Thus a squre qudrate were enumerated. The labours posted at 10 m to the left and 10 m to the right of the cruise-line proceeded forward by talking care to stay within the quadrant strip. All tree species encountered were recorded with girth details. The strips directed to north direction are called UP and the strips which are south-ward are called DOWN.

RESULTS AND DISCUSSION:

Table – 1: Distribution of forest cover in Gadhvada (Dharoi Forest Range) of Gandhinagar Forest Division

Name of Taluka and District	Forest Area (hr)			
	Reserved	Protected	Unclassed	Total
Satalasana (Mehsana)	1,472.32	-	4,828.28	6300.60
Total	**1,472.32**	-	**4,828.28**	**6300.60**

Result:

Dharoi range has 14 villages. Total number of species present in the range is 72. Plant identification (Shah G L, 1978) and Trees and shrubs enumeration (Patel *et al*, 2014 and Jasrai *et al*, 2010) were done.

The range is dominated by *Anogeissus pendula* Edgew (6,82,290 trees). It makes 25% of the total stock (25,31,130). *Vachelia farnesiana* wight & Arn (6,05,330), *Vachellia tortilis* (Forssk) P J H Hurter & Mabb (3,15,080), *Wrightia tinctoria* R Br (2,30,320) etc are the other leading species in range (Table-2). In higher girth class (above 150 cm) are *Vachellia tortilis* (Forssk) P J H Hurter & Mabb (14.06%), *Boswellia serrata* Roxb (14.06%), *Anogeissus pendula* Edgew (12.5%), *Lannea coromandelica* (Houtt) Herrill (12.5%) (Fig- 2.c).

Total area of range is 6300.60 hectares. Per hectare trees in the range are 402. Most of it ie 361 trees per hectare are in 0-30 cm girth class. The maximum numbers of trees (Fig-1.a) are of *Anogeissus pendula* Edgew (28.61%). Other major species showing high density in the range are *Acacia farnesiana* wight & Arn (26.60%), *Vachellia tortilis* (Forssk) P J H Hurter & Mabb (10.74%), *Wrightia tinctoria* R Br (9.14%) etc. In higher girth classes (above 150 cm), maximum trees are of *Acacia farnesiana* wight & Arn (0.01), *Boswellia serrata* Roxb (0.01), *Anogeissus pendula* Edgew (0.01), *Lannea coromandelica* (Houtt) Herrill (0.01).

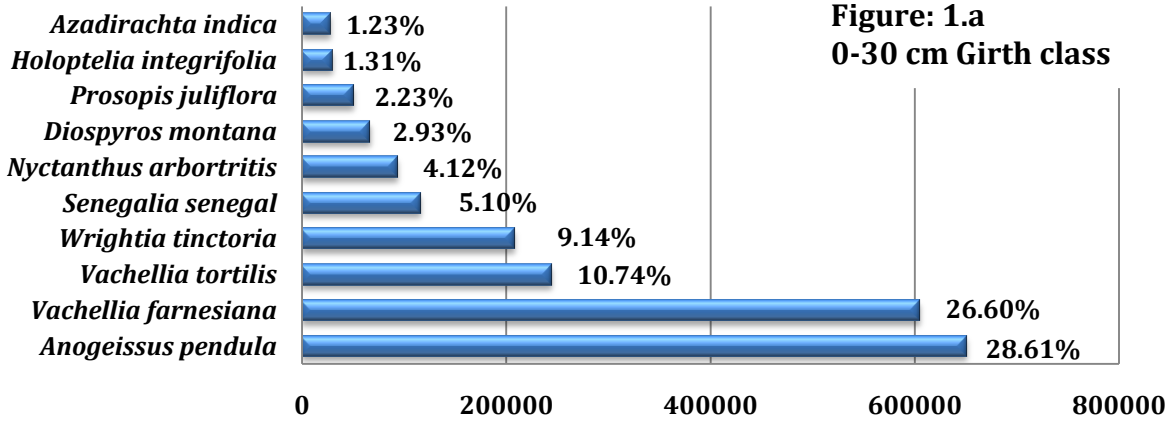


Figure: 1.a
0-30 cm Girth class

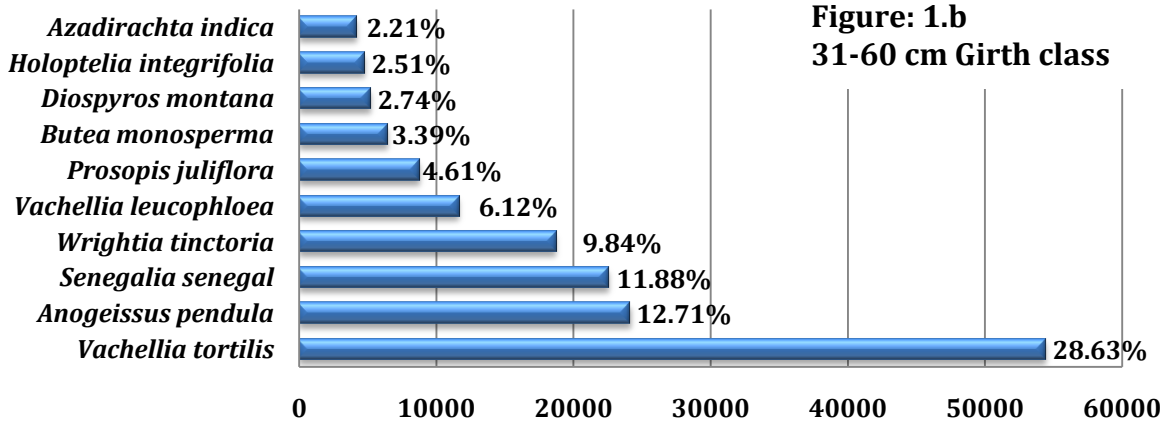


Figure: 1.b
31-60 cm Girth class

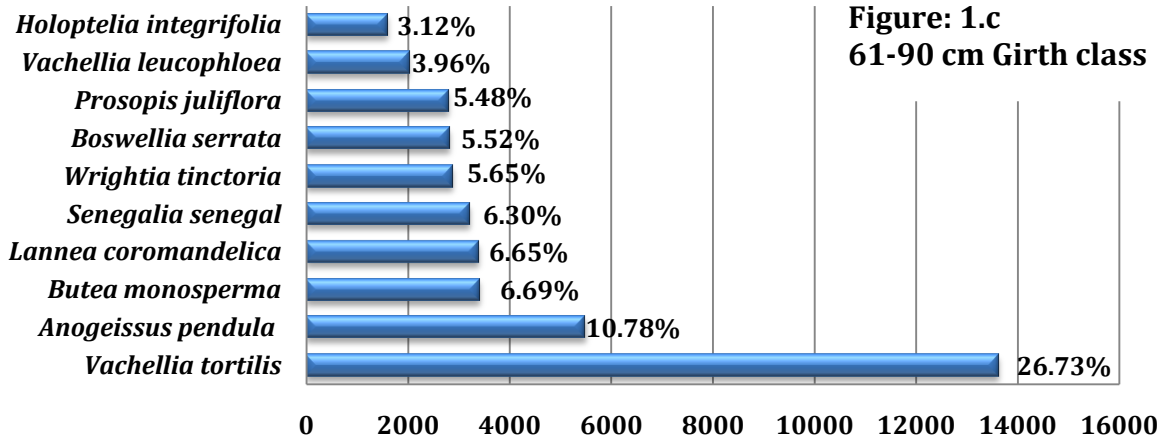
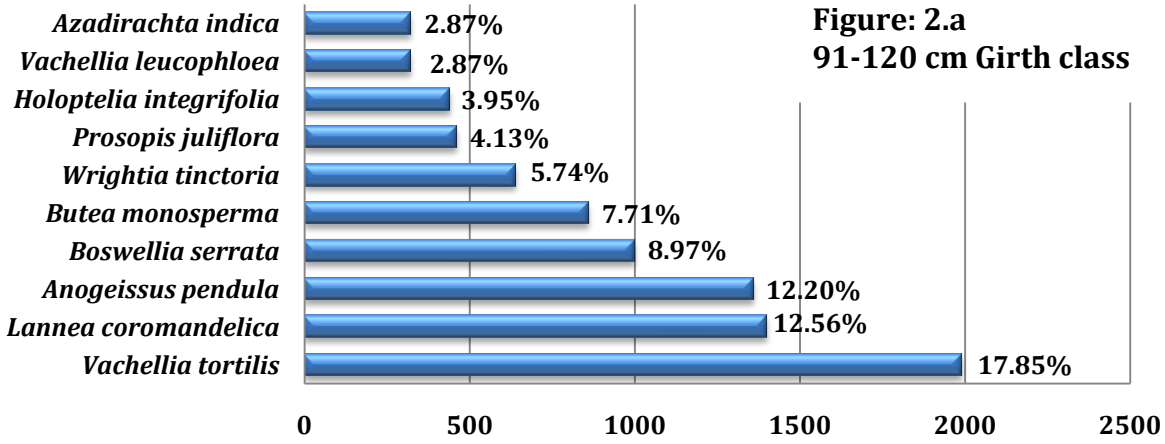
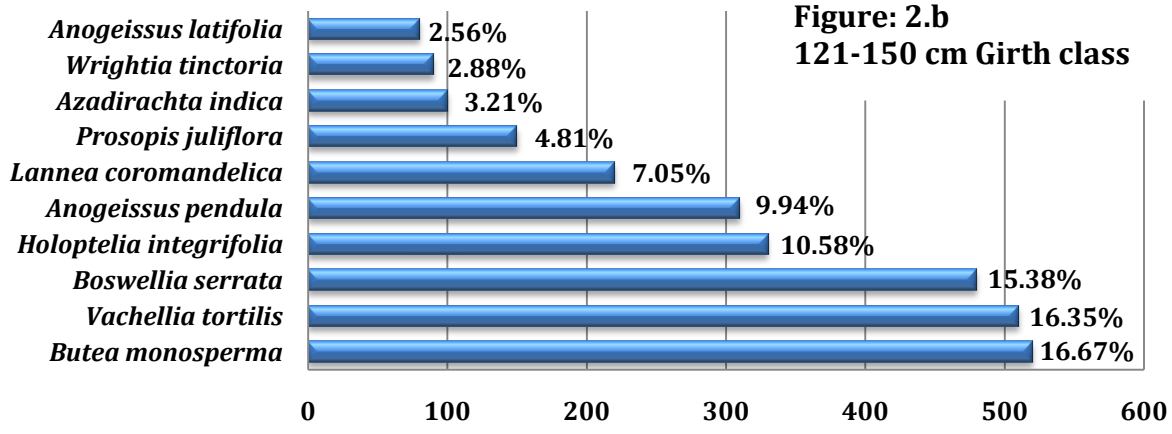


Figure-1: Species wise total number of 10 leading species in different girth classes of Dharoi Range Forest a. 0-30 cm, b. 31-60 cm and c. 61-90 cm





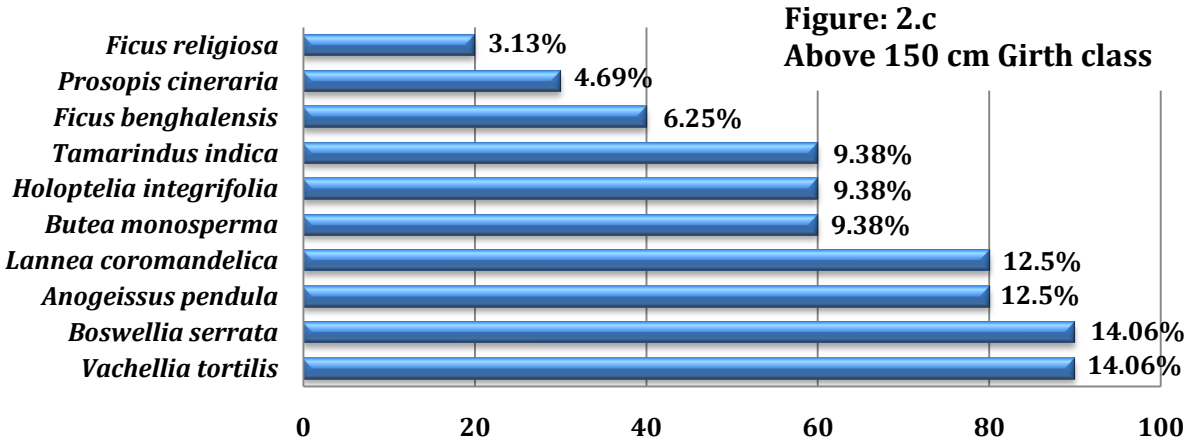


Figure-2: Species wise total number of 10 leading species in different girth classes of Dharoi Range Forest a. 91-120 cm, b. 121-150 cm and c. Above 150 cm

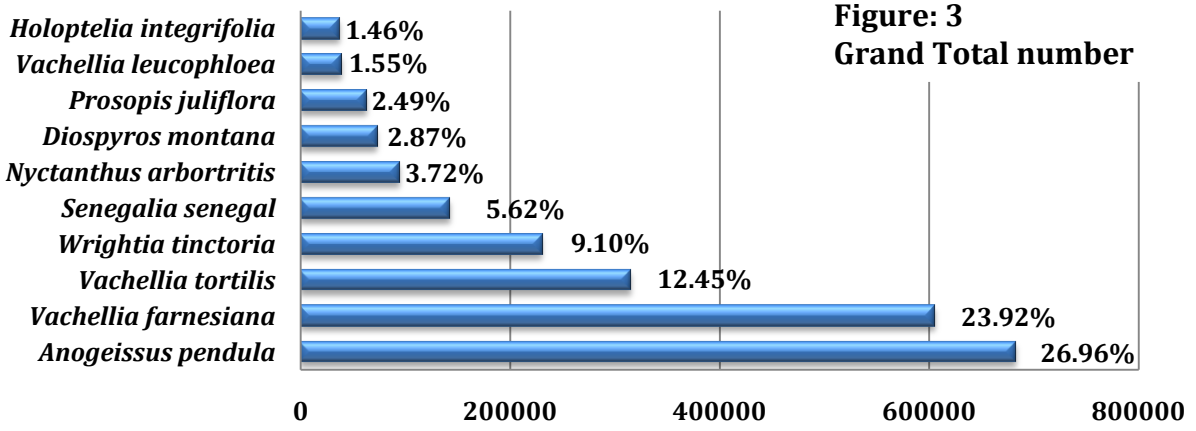


Figure-3: Species wise grand total number of some leading species of Dharoi Range Forest

Details of the total number of trees show that in Dharoi range it is 25,31,130 and 89.88% of the total number of trees in the division are in youngest girth class of 0-30 cm.

In 0-30 cm girth class, the forests of range is a mixture of different species like *Anogeissus pendula* Edgew (28.61%), *Vachellia farnesiana* Wight & Arn (26.60%), *Vachellia tortilis* (Forssk) P J H Hurter & Mabb (10.74%) and *Wrightia tinctoria* R Br (9.14%) and all these species are cover more than 75 % in this girth class. In 31-60 cm girth class, forests of different ranges is dominated by a mixture of different species like *Vachellia tortilis* (Forssk) P J H Hurter & Mabb (28.63%), *Anogeissus pendula* Edgew (12.71%), *Vachellia leucophloea* (Roxb) Maslim, Seigler & Ebinger (11.88%), *Wrightia tinctoria* R Br (9.84%). and all these species are cover more than 60 % in this girth class. In 61-90 cm girth class, forests of different ranges are dominated by a mixture of different species like *Vachellia tortilis* (Forssk) P J H Hurter & Mabb (26.73%), *Anogeissus pendula* Edgew (10.78%), *Butea monosperma* (Lam) Taub (6.69%), *Lannea coromandelica* (Houtt) Herrill (6.65%) and all these species are cover more then 50 % in this girth class. In 91-120 cm girth class, the forest is dominated by *Vachellia tortilis* (Forssk) P J H Hurter & Mabb (17.85%), *Lannea coromandelica* (Houtt) Herrill (12.56%), *Anogeissus pendula* Edgew (12.20%), *Boswellia serrata* Roxb (8.97%) and all these species are cover more than 51 % in this girth class. In 121-150 cm girth class, forest is dominated by *Butea monosperma* (Lam) Taub (16.67%), *Vachellia tortilis* (Forssk) P J H Hurter

& Mabb (16.35%), *Boswellia serrata* Roxb (15.38%), *Holoptelia integrifolia* (Roxb) P (10.58%) and all these species are cover more then 58 % in this girth class.In Above 150 cm girth class, forest is dominated by *Vachellia tortilis* (Forssk) P J H Hurter & Mabb (14.06%), *Boswellia serrata* Roxb (14.06%), *Anogeissus pendula* Edgew (12.5%), *Lannea coromandelica* (Houtt) Herrill (12.5%), and all these species are cover more than 53 % in this girth class.
According to the present survey a total of 25.31 lakh trees exist in Dharoi Forest Range. They belong to 72 species.
In terms of number of trees 89.89 % stock in the Range lies in 0-30 cm girth class while in 31-60 cm girth class it is 7.51 % ; in 61-90 cm girth class it is 2.01 %; in 91-120 cm girth class it is 0.44 %; in 121-150 cm girth class it is 0.12 % and above 150 cm girth class it is 0.02 % only.
Maximum percentage stock of leading species of trees in the Dharoi Range, mention in table-2.

Table-2: Percentage stock of leading species in Dharoi range

Sr no	Local name	Botanical name	percentage
1	Dhav	*Anogeissus pendula* Edgew	26.96
2	Bhoy Bavali	*Vachellia farnesiana* wight & Arn	23.92
3	Isaraili Baval	*Vachellia tortilis* (Forssk) P J H Hurter & Mabb	12.45
4	Dudhi	*Wrightia tinctoria* R Br	9.10
5	Gorad	*Senegalia senegal* (L) Britton & P Wilson	5.62
6	Chhayadi	*Nyctanthus arbortritis* L	3.72
7	Makrod	*Diospyros montana* Roxb	2.87
8	Gandobaval	*Prosopis juliflora* (Sw) DC	2.49
9	Aniyar	*Vachellia leucophloea* (Roxb) Maslim, Seigler & Ebinger	1.55
10	Kanji	*Holoptelia integrifolia* (Roxb) P	1.46
		Other species	9.87
		Total	**100**

Average density in the dharoi range is 401 total trees per hectare. In terms of stock distribution over different girth classes, *Vachellia tortilis* (Forssk) P J H Hurter & Mabb, *Senegalia senegal* (L) Britton & P Wilson, *Anogeissus pendula* Edgew, *Vachellia farnesiana* wight & Arn and *Prosopis juliflora* (Sw) DC show comparatively better distribution of stock in terms of percentage over different girth classes compared to other species.

Discussion:

There is a preponderance of trees of higher girth classes as compare to lower girth classes. The shorage in lower girth classes as a result of lake of regeneration and establishment gradually mixed the structure more and more un balance (Chatervedi and Khanna, 1982). Number of trees in sucessasive diameter/girth classes are in a geomatrix series (Delicourt cited by Chatervedi and Khanna, 1982). Chatervedi and Khanna, 1982, term stands were the number of stems by diameter/girth classes decrease in constant geomatrixprogration as a "balance forest". M.K Thakur and S. S Bhardwaj (2011) were worked for diameter classesat the age of 63 years and maximum dbh was recorded for *Pseudotsuga taxifolia* (45.90 cm), which was significantly at par with *Pinus taeda* (43.39 cm), *Pinus patula* (42.59 cm) and *Pinus laricio* (41.52 cm) and *Taxodium disticum* recorded significantly minimum dbh (19.44 cm) as compared to all other species. Almost a similar trend was observed for dbh atthe age of 71 years of plantation where, *Pseudotsuga taxifolia* recorded maximum dbh (55.26 cm) followed by *Pinus taeda* (47.98 cm), *Pinus patula* (46.70 cm), *Pinus laricio* (44.80 cm), *Cupressus arizonica* (43.08 cm), *Larix leptolepsis* (40.87 cm), *Thuja plicata* (40.34 cm) and *Cupressus torulosa* (40.29cm). *Taxodium distichum* depicted minimum dbh value of 23.33 cm following *Cupressus glabra* (27.15 cm), *Cupressus obtuse* (33.71 cm) and *Pinus ponderosa* (34.23 cm), result indicated that the better growth potential of some tree species as compared to other ones can be credited to better adaptability and utilization of site resources. The inter-specific variation in growth performance of various tree species has also been reported by earlier workers (Bisht and Toky, 1993; Thakur and Mishra, 1998). In Ahemdabad city durin tree enumeration about 60% trees belonged to 10-60 cn girth (GBH) class, 30.3% trees between 60 cm and 120cm, 6.6 % btween 120 cm and 200 cm. and about 1.3 % above 200cm girth class. About 4435 giant trees had girth (GBH) above 300cm. (H.S Singh, 2013). Similar work were done in Chicago Region by United States Department of Agriculture, USDA (2013), Attarsumba range by Patel *et al*, 2014 and in Gandhinagar Forest Division by Jasrai *et al*., 2010.

Table-3: Scientific Name of Tree species in Gadhvada (Dharoi Range Forest), Gandhinagar Forest Division, Gujarat

Sr No	Family	Scientific Name	Local Name
1	Mimosaceae	*Acacia auriculiformis* Wild	-
2	Rutaceae	*Aegle marmelos* (L) Corr	Bili
3	Simaroubaceae	*Ailanthus excelsa* Roxb	Araduso
4	Alangiaceae	*Alangium salvifolium* (L f) Wang	Ankol
5	Mimosaceae	*Albizia amara* (Roxb) B Boivin	Kaliyo
6	Annonaceae	*Annona squamosa* L	Sitafal
7	Combretaceae	*Anogeissus latifolia* (Roxb ex DC) Wall ex Guillem & Perr	Safed Dhav
8	Combretaceae	*Anogeissus pendula* Edgew	Dhav
9	Combretaceae	*Anogeissus sericea* Brandis	Indrok
10	Meliaceae	*Azadirachta indica* A Juss	Limdo
11	Balanitaceae	*Balanites aeguptiaca* (L) Del	Ingoriyo
12	Caesalpiniaceae	*Bauhinia racemosaa* Lam	Asitro
13	Bombacaceae	*Bombax ceiba* L	Simlo
14	Burseraceae	*Boswellia serrata* Roxb	Salai
15	Papilionaceae	*Butea monosperma*n(Lam) Taub	Khakhro
16	Cappraceae	*Capparis grandis* L f	Vatt Bor
17	Caesalpiniaceae	*Cassia fistula* L	Garmalo
18	Ehretiaceae	*Cordia dichotoma* Forst	Motogundo
19	Cappraceae	*Crateva nurvala* Buch Ham	Vay Varno
20	Papilionaceae	*Dalbergia lanceolaria* L f subsp *paniculata* (Roxb) Thoth	Pahi
21	Papilionaceae	*Dalbergia sissoo* Roxb	Sisam
22	Ebenaceae	*Diospyros melanoxylon* Roxb	Timru
23	Ebenaceae	*Diospyros montana* Roxb	Makrod
24	Papilionaceae	*Erythrina suberosa* Roxb	Dhed Khakhro
25	Moraceae	*Ficus arnottiana* (Miq) miq	Khad piplo
26	Moraceae	*Ficus benghalensis* L	Vad
27	Moraceae	*Ficus religiosa* L	Pipal
28	Moraceae	*Ficus virens* Aiton	-
29	Flacourtiaceae	*Flacourtia indica* (Burm f) Merr	Katedi
30	Burseraceae	*Garuga pinnata* Roxb	Kakad
31	Verbinaceae	*Gmelina arborea* L	Sevan
32	Tiliaceae	*Grewia tiliaefolia* Vahl	Dhaman
33	Rubiaceae	*Haldina cordifolia* (Roxb) Ridsdale	Haldu
34	Apocynaceae	*Holarrhena pubescens* Wall ex G Don	Kado
35	Ulmaceae	*Holoptelia integrifolia* (Roxb) P	Kanji
36	Rubiaceae	*Hymenodictyon orixense* (Roxb) Mabb	Madh Mahudo
37	Anacardiaceae	*Lannea coromandelica* (Houtt) Merr	Golaro
38	Rutaceae	*Limonia acidissima* L	Kothi
39	Sapotaceae	*Manilkara hexandra* (Roxb) Dub	Rayan
40	Annonaceae	*Miliusa tomentosa* (Roxb) Sinclair	Umbiyo
41	Rubiaceae	*Mitragyna parvifloa* (Roxb) Korth	Kalam
42	Moringaceae	*Moringa concanensis* Nimmo	Saragvo
43	Oleaceae	*Nyctanthus arbortritis* L	Chhayadi

44	Euphorbiaceae	*Phyllanthus emblica* L	Amla
45	Mimosaceae	*Pithecellobium dulce* (Roxb) Bth	Goras Amli
46	Fabaceae	*Pongamia pinnata* (L) Pierre	
47	Mimosaceae	*Prosopis cineraria* (L) Druce	Khijdo
48	Mimosaceae	*Prosopis juliflora* (Sw) DC	Gando Baval
49	Salvadoraceae	*Salvadora oleoides* Decne	Piludi
50	Salvadoraceae	*Salvadora persica* L	Vagdo
51	Santalaceae	*Santalum album* L	Chandan
52	Sapindaceae	*Sapindus emarginatus* L	Arithi
53	Oleaceae	*Schrebera swietinioides* Roxb	Mokho
54	Mimosaceae	*Senegalia catechu* (L f) P J H Hurter & Mabb	Kher
55	Mimosaceae	*Senegalia senegal* (L) Britton & P Wilson	Gorad
56	Meliaceae	*Soymida febrifuga* (Roxb) A Juss	Royan
57	Sterculiaceae	*Sterculia urens* Roxb	Kadayo
58	Moraceae	*Stribulus asper* L	Haredo
59	Myrtaceae	*Syzygium cumini* (L) Skeels	Jambu
60	Caesalpiniaceae	*Tamarindus indica* L	Amli
61	Bignoniaceae	*Tecomella undulata* (sm) Seems (P)	Rohido
62	Combretaceae	*Terminalia crenulata* Roth	Sadad
63	Papilionaceae	*Thespesia populnea* (L)Sol ex Corr	Paras Piplo
64	Mimosaceae	*Vachellia farnesiana* Wight & Arn	Bhoy Bavali
65	Mimosaceae	*Vachellia leucophloea* (Roxb) Maslim, Seigler & Ebinger	Aniyar
66	Mimosaceae	*Vachellia nilotica* (L) P J H Hurter & Mabb	Deshi Baval
67	Mimosaceae	*Vachellia planifrons* (Wight & arn) Ragup, seigler, Ebinger & Maslin	Akhari baval
68	Mimosaceae	*Vachellia tortilis* (Forssk) P J H Hurter & Mabb	Isaraili Baval
69	Apocynaceae	*Wrightia tinctoria* R Br	Dudhi
70	Apocynaceae	*Wrightia tomentosa* (Dominant) R & S	Nani Dudhi
71	Rhamnaceae	*Zizyphus glabrata* Heyne ex Roth	-
72	Rhamnaceae	*Zizyphus xylopyra* (Retz) Willd	Ghatbor

Table-4: Rare forms of Tree and Shrub species in Gadhvada (Dharoi Forest Range), Gandhinagar Forest Division, Gujarat (based on being endangered, rare, threatened and vulnerable in published records*)

Sr. No.	Status	Botanical name	Family	Habit
1	Endangered	*Boswellia serrata* Roxb	Burseraceae	T
2	Endangered	*Sterculia urens* Roxb	Tiliaceae	T
3	Vulnerable	*Moringa concanensis* Nimmo	Moringaceae	T
4	Vulnerable	*Aegle marmelos* (L) Corr	Rutaceae	T
5	Vulnerable	*Limonia acidissima* L	Rutaceae	T

***: Anonymous (2008), Special habitats and threatened plants of India, Wildlife Institute of India, volume-11**

CONCLUSION:

Tree enumeration The hightest density in dharoi range is 401 tree per hectare. In density top dominant species of the range is Anogeissus pendula Edgew, followed by *Vachellia farnesiana* Wight & Arn, *Vachellia tortilis* (Forssk) P J H Hurter & Mabb, *Wrightia tinctoria* R Br, *Senegalia senegal* (L) Britton & P Wilson and lowest density is *Thespesia populnea* (L) Sol ex Corr, *Stribulus asper* L, *Pithecellobium dulce* (Roxb) Bth, *Terminalia crenulata* Roth, *Salvadora*

oleoides Decne. All plant lowest tree species are in rare like *Boswellia serrata* Roxb and *Sterculia urens* Roxb are categorized in Endengered, *Moringa concanensis* Nimmo, *Aegle marmelos* (L) Corr and *Limonia acidissima* L are categorized in Vulnerable, this all tree species need to conserve. There are lower girth class species which covered aproximetly 89% of total Dharoi range forest area, to get healthy forest in future we have to protect lower girth class species.

References:

Anonymous (2008) Special Habitats and Threatened plants of India wild life institute of India, Dehradun, 11(1).

Bisht, R.P. and Toky, O.P. (1993): Growth pattern and architectural analysis of nine important multipurpose trees in arid region of India. Can. J. For. Res., 23:722-730.

Chaturvedi, A.N. and Khanna, H.S. (1982): Forest Mensuration: Intrenational book distributors, Dehradun, pp.1-104.

Jasrai, Y.T., Paramar S.P., Patel, Y.B., Prajapati A.L., Vyas V.M. and Prajapati K.A. (2010): Forest Resources Survey of Gandhinagar Forest Division, Series-II : Tree Enumeration, Working Plan Circle, Vadodara Circle, Gujarat Forest Department, Van Bhavan, Kothi Annexure, Raopura, Vadodara.

Patel, Y.B., Patel, R.G. and Pandya H.A. (2014): Study for Tree Enumeration of Attarsumba Range, Gandhinagar Forest Division, India. International Journal of Innovative Research in Science, Engineering and Technology., 3(4):11185-11190.

Thakur, M.K. and Bhardwaj S.S. (2011): Growth of Conifer Plantations in Himachal Pradesh, Glimpses of Forestry Research in the Indian Himalayan Region. Special Issue on International Year of Forest, pp. 83-87.
Thakur, P.S. and Mishra, V.K. (1998): Impact of canopy management and root architecture of agroforestry trees. Proc. Nat. Symp. on Multipurpose Tree Species for Agroforestry System, pp. 47.

Shah, G. L. (1978): Flora of Gujarat State.Vol.I & II. Sardar Patel University Press, Vallabh Vidyanagar.

Singh, H.S. (2013): Tree density and canopy cover in the urban areas in Gujarat, India. Current science., 104(10):1294-1299.

United States Department of Agriculture, USDA (2013): The Chicago Region Backyard- Urban Tree Census and published by The Morton Arboretum and a number of other affiliate research institutions.