World Applied Sciences Journal 9 (12): 1443-1449, 2010
ISSN 1818-4952

Phytosociology and Structure of Central Karakoram National Park (CKNP) of Northern Areas of Pakistan

[1]*Alamdar Hussain,* [2]*M. Afzal Farooq* [1]*Moinuddin Ahmad,*
[1]*Muhammad Akbar and* [2]*Muhammad Usama Zafar*

[1]Laboratory of Dendrochronology and Plant Ecology, Department of Botany,
[2]Department of Environmental Sciences, Federal Urdu University of Arts,
Science and Technology, Gulshan-e-Iqbal, Karachi, 75300, Pakistan

Abstract: A study was carried out to asses the phytosocology and structures of National Park. For tree species, point center quarter method (PCQ) and understorey vegetation, 1.5m circular plot at each PCQ point, while for bushes 20 quadrats 3x5 m were used. Five stands dominated by trees and eight stands of bushes were recorded. *Picea smithiana and Pinus wallichiana* form a community in two sites, associated with *Juniperus excels*a. These pine tree species were also distributed as a pure stands in different sites with higher density and basal area. In pure stands, *Juniperus excels*a attained lowest density ha^{-1} with highest basal area m^2 ha^{-1}. Stands of mixed species stands show considerable low basal area. Diameter size class structure of tree species and bushes gives the current status and future trend of these forests. These forests show uneven and disbalanced size class distribution, therefore need special attention to save and protect these forests and vegetation.

Key words: CKNP · Phytosociological · Trees · Bushes · Understory vegetation

INTRODUCTION

Central Karakoram National Park (CKNP) is located in Northern Areas of Pakistan. It is one of the 24 national parks of Pakistan. Because of its unique and diverse habitat of flora and fauna, it was declared as National Park in the year 1993. The CKNP extends from 35°N to 36.5°N Latitude and from 74°E to 77°E Longitude. Elevation ranges from 2000m-6000m.Climate of the park is cold arid and dry temperate in the lower elevation. Various researchers have studied the vegetation from different sites of Northern areas of Pakistan. Stewart [1] worked on the flora of Deosai plains.

Ahmed *et al.* [2] described phytosociology and structure of Himalayan forest of different climatic zones of Pakistan.According to Ahmed and Qadir [3] a phytosociological study along Gilgit to Gupis revealed that *Juniperus macropda, Pinus geradiana, Pinus wallichiana, Cedrus deodara, Astragalus spp, Thumus serphyllum, Nepeta spp, Taraxacum affinale* were the dominant species. Ahmad and Qadir [3] described many communities near road site from Gilgit to shandur. Ahmed [2] studied the vegetation of some foothills of Himalayan range in Pakistan along the great silk rout from Gilgit to Passu. First multivariate analysis of Skardu was presented by Ahmed [4]. Hussain and Mustafa [5] reported ecological studies of plants in relation to animal, found in Nasirabad valley Hunza Pakistan. Rasool [6] had provided a detailed account of the northern areas plants of economically important. Alpine deserts have little values as grazing lands due to the absence of forage and difficult topography. Alpine pastures were subjected to heavy grazing during summer. No planned grazing system is still followed in this area. According to a study by WWF (2000) in northern areas, the pattern of species richness showed a general trend of increase richness in plant species from north to south and from west to east. Shinwari and Gilani [7] surveyed the Astore area to provide information on the conservation of plant diversity. Ahmed *et al.* [8] described Community of deodar forests from Himalayan range of Pakistan. Over all vegetation of CKNP was presented by WWF (2009) using remote sensing and satellite images techniques. Besides these studies there is no comprehensive quantitative

Corresponding Author: Alamdar Hussain, Laboratory of Dendrochronology and Plant Ecology, Department of Botany Federal Urdu University of Arts, Science and Technology, Gulshan-e-Iqbal, Karachi, Pakistan. E-mail: alamdar_alasri@hotmail.com.

investigations carried out to describe various types of forest, communities and vegetation structure in different areas of Central Karakoram National park of Pakistan. Bearing these points in mind this paper is presented to describe vegetation structure and quantitative description of different areas of National park, which can be helpful to understand the present status and future trend of the park.

MATERIALS AND METHODS

The investigation divided into two parts on the basis of different types of vegetation. Point centered quarter method of Cottam and Curtis [9] was applied for coniferous tree species. In each stands, 20 points were taken at every 20 meter interval. Trees smaller than 10 cm were included in understorey study and considered seedling and sapling stage, following Ahmad .Same number of 1.5 m circular plots at each PCQ point were used for understorey vegetation. Quadrat method (3X5m) of Cox, (1990) was used for shrubs and herbs. Phytosociological attributes (relative frequency, density and basal area) and absolute values (stand density ha^{-1} and basal area m^2 ha^{-1}), were calculated according to the method described by Mueller-Dombois andEllenberg [10]. Importance value index was used to rank each species and the plant species with the highest importance value in the stand was considered as dominant species. The plant community of a particular area was named on the basis of first two dominant species. Diameter size class structure of each forested stands is prepared on the basis of 10cm interval for trees and 100cm for bushes. GPS was used to record elevation, position of stands and aspect while degree of slope was recorded from slope meter.

RESULTS AND DISCUSSION

Figure 1 shows that the sampling sites in CKNP while ecological description of these sites are giving in Table 1. Phytosociological summary and absolute values of trees and bushes are presented in Table 2. On the basis of phytosociological analysis, floristic composition of species and importance value index, following one tree community, two pure forest type and three bushes communities were recognized and described quantitatively.

- Picea-Pinus community
- Picea smithiana pure stand
- Juniperus excelsa pure stand
- Rosa-Hippophae community
- Rosa-Ribes community
- Hippophae-Berberis community

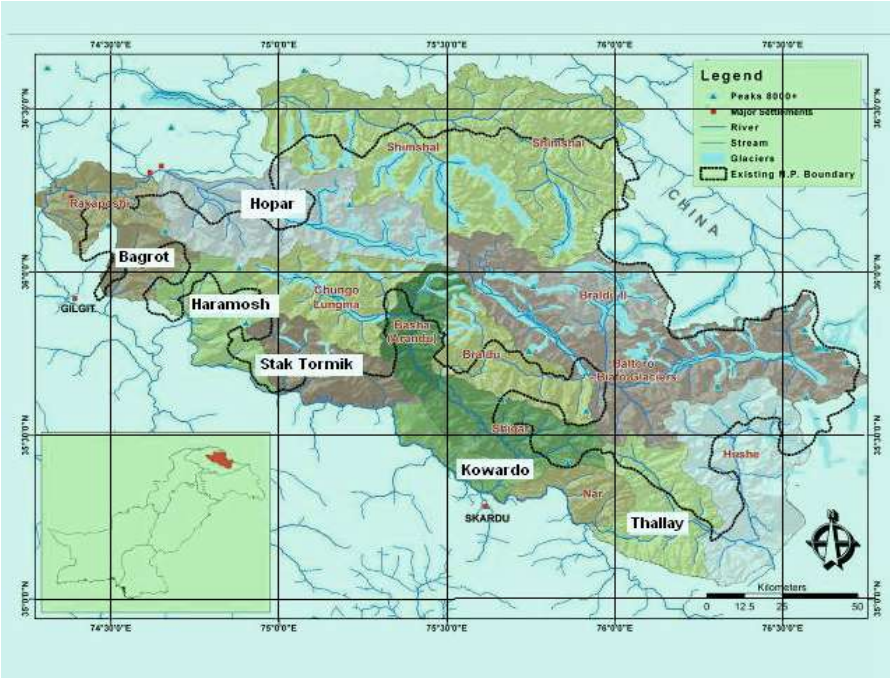

Fig. 1: Part of the Northern areas of Pakistan, showing the boundary and main study sites of CKNP (Source: Land cover mapping of CKNP by WWF)

Table 1: Environmental characteristics of forest and bushes area of CKNP

Stand No	Main location	Lat.(N)	Long.(E)	Elevation	Aspect	Slope	CN/CS
	Forest area						
1	Bagrot	36°01.751′	74°36.094′	3130m	E	45°	Moderate
2	Haramosh	35°53.033′	74°53.06′	3296m	E/S	53°	Open
3	Hopar	36°08.567′	74°56.643′	3486m	E	49°	Closed
4	Stak 1	35°45.541′	75°03.204′	3344m	E	35°	Moderate
5	Stak 2	35°46.439′	75°02.580′	3600m	E	20°	Moderate
	Bushes area						
6	Bagrot	36°02.040′	74°34.641′	2774m	N	Plain	Flat
7	Hopar	36°09.755′	74°50.592′	3353m	N/E	30°	Flat
8	Stak 1	35°44.349′	75°03.566′	2949m	E/N	35°	Flat
9	Stak 2	35°44.675′	75°03.561′	2782m	E/N	20°	Flat
10	Stak 3	35°44.432′	75°03.391′	2942m	E	Plain	Flat
11	Thallay 1	35°10.361′	76°20.212′	3300m	E	20°	Flat
12	Thallay 2	35°10.545′	76°20.064′	3500m	E/N	25°	Flat
13	Kowardo	35°24.367′	75°36.500′	3559m	E	50°	Flat

Lat: Latitude, Long: Longitude, CN: Canopy, CS: Covered surface

Table 2: Phytosociological attributes and absolute values of forest and bushes of CKNP

(Phytosociological attributes)			(Absolute values)						
Stand No	Location	Name of Species	R.F	R.D	R.B.A	IVI	Rank	D ha^{-1}	B.A $m^2 ha^{-1}$
Forest area									
1	Bagrot	*Picea smithiana*	51.82	61.25	73.47	64.91	1st	66.71	17.48
		Pinus wallichiana	28.2	28.2	23.75	20.06	2nd	16.67	4.87
		Juniperus excelsa	20.51						
2	Hopar	*Juniperus excelsa*	100	100	100	100	pure	122.5	86.14
3	Haramosh	*Picea smithiana*	43.47	61.25	57.31	57.34	1st	74.62	21.55
		Pinus wallichiana	30.43	23	21.83	25.33	2nd	28.93	6.98
		Juniperus excelsa	26.08	15	10.85	17.31	3rd	18.27	3.47
4	Stak 01	*Picea smithiana*	100	100	100	100	pure	109.36	165.83
5	Stak 02	*Juniperus excelsa*	100	100	100	100	pure	105.7	188.7
	Bushes area								
6	Bagrot	*Rosa webbiana*	18.42	24.07	38.61	25.03	1st	866.6	1239.5
		Hippophae rhamnoides	13.15	14.81	26.59	18.18	2nd	533.3	853.46
7	Hoper	*Rosa webbiana*	15.38	16.14	35.74	22.4	1st	666.7	1238.6
		Hippophae rhamnoides	12.82	12.91	30.3	18.67	2nd	533.4	1050.12
8	Stak 1	*Rosa webbiana*	11.11	14.2	36.2	20.5	1st	333.3	570.08
		Hippophae rhamnoides	9.2	11.1	25	15.1	2nd	466.6	946.75
9	Stak 2	*Hippophae rhamnoides*	11.7	10.8	21.03	14.5	1st	266.6	429.11
		Berberis lycium	7.8	9	22.7	13.1	2nd	333.3	674.9
10	Stak 3	*Rosa webbiana*	5.7	8.7	24.06	12.8	1st	333.3	563.4
		Hippophae rhamnoides	7.6	9	18.42	11.5	2nd	333.3	431.3
11	Thallay 1	*Hippophae rhamnoides*	17.39	20.2	47.6	28.5	1st	800	1688.2
		Rosa webbiana	15.21	15.38	27.09	19.2	2nd	600	960.3
12	Thallay 2	*Rosa webbiana*	12	19	50.1	27	1st	733	1616
		Hippophae rhamnoides	8	9	12.4	9.8	2nd	333	400
13	Kowardo	*Rosa webbiana*	23.8	26.27	49.49	33.1	1st	1066.7	2197.9
		Ribes orientale	9.52	11.49	17.78	12.93	2nd	466.6	790.02

R.F: Relative frequency, R.D: Relative density, R.B.A Relative basal Area, IVI: Important value index, Dha^{-1}: Density per hectare

Picea-Pinus Community: This community was present in Bagrot and Haramosh velley of Central Karakoram National Park on east and south facing aspects with 45° to 53° slopes at 3130-3296m elevation (Table 1). In these valleys, *Picea smithiana* is dominant species and associated species were *Pinus wallichiana* and *Juniperus excelsa*. In Bagrot, *Picea smithiana* showed 65% importance value with 67 density ha^{-1} and 17.4 basal area m^2 ha^{-1}, while associated species *Pinus wallichiana and Juniperus excelsa were with low* density ha^{-1} and basal area. In Haramosh *Picea smithiana* showed 57.3% importance value with 74.6 density ha^{-1} and 21.5 basal area m^2 ha^{-1}, while associated species *Pinus wallichiana* and *Juniperus excelsa* were with low basal area (Table 2). It is suggested that these low values may be related to the continuous cutting for decoration and fuel purposes. According to Wali [11] it is estimated that in the last 10 years about 30,000 trees of *Pinus wallichiana* and *Picea smithiana* from this valley and more than 15000 trees from Bagrote valley have been exported to the local market of Gilgit city. The forests in both valleys are at threats and under pressure. Ground flora was composed 25 species in Bagtrot and 27 species in Haramosh.In these stand commonly found species were, Artemesia maritime, Astragalus gilgitensis, Fragaria nubicola, Geranium neplensis, Impatiens balfourii,Thymus linearis, Trifolium repnes, Rubus irritans,Taraxacum karakorium, Taraxacum affinis.

Picea Smithiana Pure Stand: This pure stand of *Picea smithiana* was distributed in Stak 1 on east facing with 35° at 3344m elevation (Table 1). In this stand *Picea smithiana* is the only distributed tree species with 109 density ha^{-1} and 166 m^2 ha^{-1}basal area (Table 2). This species showed low density ha^{-1} and highest basal area m^2 ha^{-1} in this location. Ahmed [8] reported this community from Naltar near Gilgit at 3100-3250 m elevation at north facing, but there was highest density ha^{-1} and highest basal area m^2 ha^{-1} was recorded. Wahab [12] also reported this pure stand from Afghanistan. The understorey vegetation is comprised 19 species. In which, Rubus irritans 55%, Artimisia maritime 45%, Geranium pratens, Taraxacum affinis and Thymuus linearis found 40% of the plots.

Juniperus Excelsa Pure Stand: This pure stand was located in Hopar and Stak 2 on east facing with 20° to 49° slope from 3486 to 3600m elevation (Table1). In Hopar *Juniperus excelsa* was present with 123 density ha^{-1} and 86.14 low basal area m^2 ha^{-1} (Table2). In Stak kutia 2 J*uniperus excelsa* was present with 106 density ha^{-1} and basal area m^2 ha^{-1} 188.7.A density of 54 to 154 ha^{-1} with 9.0 to 77 m^2 ha^{-1} basal area was reported by Ahmed *et al*. [13,14] from Juniper forest of Rodhmallazi, Balochistan. Ahmed *et al*. [2] presented similar values of stand density and basal area m^2 ha^{-1} from various Himalayan forest of Pakistan. It is suggested that these low values may be related to anthropogenic disturnbance. The ground flora composed 28 species in Hopar and 23 species in Stak 2.In these stands commonly found species were i.e. Berberis vulgaris, *Cicer aritanum, Fragaria nubicola, Juniper communis, Sedum multicepes, Tanactum artemisioides, Taraxacum affinis, Trifolium repnes.Taraxacum nigrum* was repoted from Hopar while *Potentilla baltistana, Taraxacum baltistanicum* were reported only from Stak 2.

Rosa-Hippophae Community: This bushy community was distributed in Bagrot, Hopar, Stak 1, Stak 3, Thallay 1 and Thallay 2 locations, on east and north facing with plain to 35° slope at 2742-3500m elevation (Table 1). In this community *Rosa webbiana* was dominant species with IVI ranges from 9.1-33.1%, density ha^{-1} from 333.3-1066.7 and basal area m^2 ha^{-1} from 563.4 to 2197.9. The co-dominant species was *Hippophae rhamnoides* (Table 2). Wali [11] studied in Bagrot and Haramosh and suggested that many shrubs and herbs were disturbed due to anthropogenic disturbance. A large number of trees and shrubs have been over-exploited by local people for fuel and commercial purposes. Therefore no tree species existed in these areas.

Rosa-Ribes Community: This community was present in Kowardo on east facing with 50° slope at 3559 m elevation. In this community *Rosa webbiana* was dominant species with 33.1 IVI, 1067 density ha^{-1} and 2198 basal area m^2 ha^{-1}, while associated species *Ribes orientale* with 12.93 IVI, 467 density ha^{-1} and 790 basal area m^2 ha^{-1} (Table 2). Similar results have been found while working on Gharo, Dhabeji, Mangohopir industrial area Ahmed [15] and Himalayan range Ahmed [16].

Hippophae -Berberis Community: This community was recorded in Stak 2 on east/south facing with 20° slope at 2782 m elevation. In this community *Hippophae rhamnoides* was dominant species with 14.5 IVI, 267 density ha^{-1} and 429 basal area m^2 ha^{-1}. Associated species was *Berberis lycium* with IVI 13.1, density ha^{-1} 333 and basal area m^2 ha^{-1} 674 (Table 2). Human disturbance and seasonal activities changes the shape of the communities [17]. According to Nafeesa *et al.* [18] in

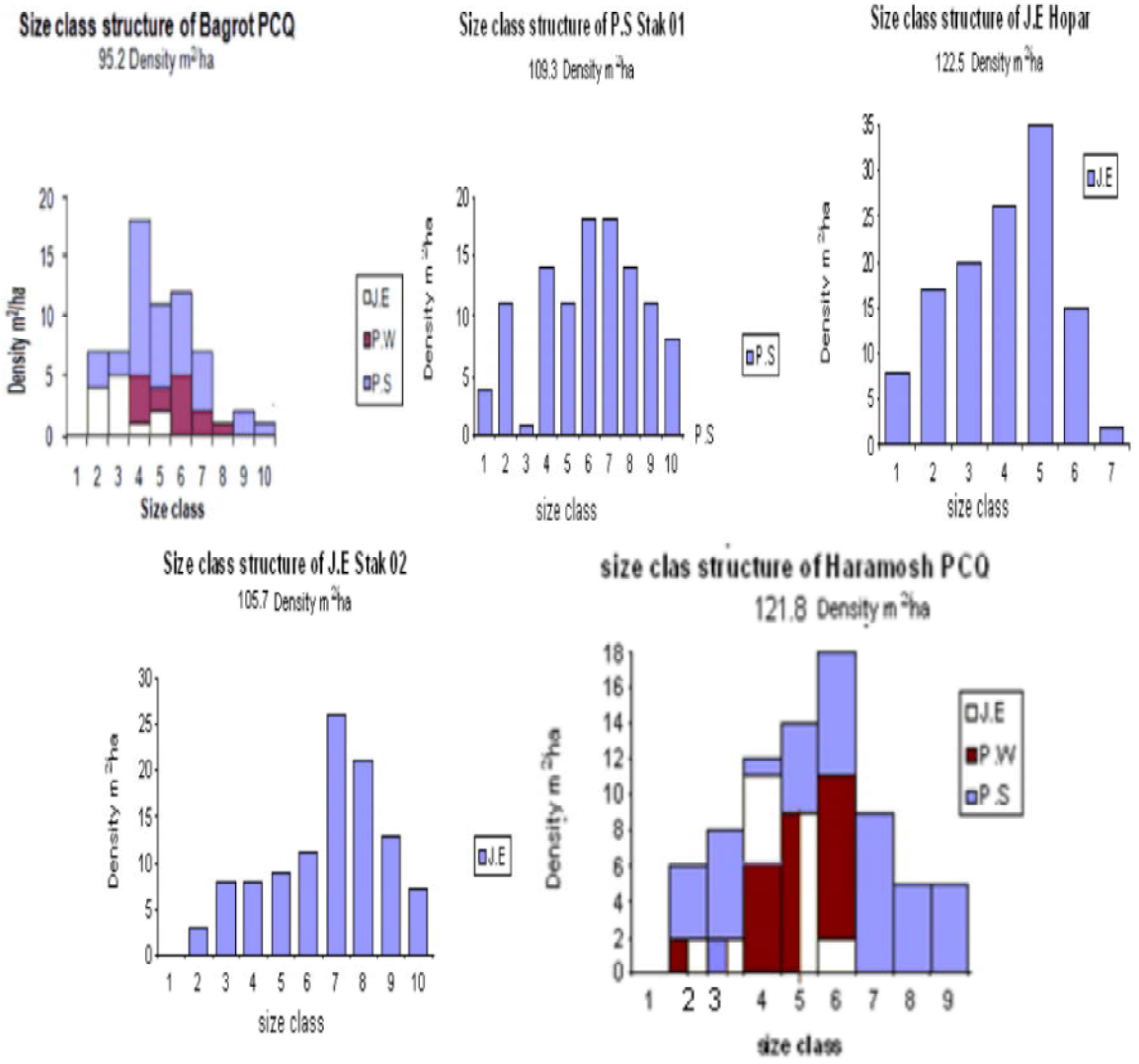

Fig. 2: Density size classes of tree species from different sampling area. Class interval =10cm dbh. PS:*Picea smithiana*, PW:*Pinus wallichiana*, JE:*Juniperus excelsa*

the study area, the woody and perennial species almost remained the same while the composition of community changed due to the predominance of annuals during spring, which showed seasonal effect. Similar situation exist in this community.

Floristic composition of canopy species in all communities is same but there is a difference in phytosociological attributes (Table 2).The ground flora of forested area was mostly common. In this forest community dominant species show 61.2% density and 67.6 to73.4% basal area and associated species *Pinus wallichiana and Juniperus excelsa* show 15 to 24% density and 6 to 22 % basal area (Table 2). Highest basal area m^2 ha^{-1} (166) recorded from pure stand *of Picea smithiana* and Stak 02 and lowest basal m^2 ha^{-1} (1.4) area recorded from associated species of *Juniperus excelsa* from Bagrot (Table2). In bushes community dominant species show 8.7 to 26.2% density and 17.7 to 50.1 % basal area. The highest basal area (2197 m^2 ha^{-1}) of *Rosa webbiana* from Kowardo and lowest basal area (400 m^2 ha^{-1}) of *Hippophae rhamnoides is recorded* from Thallay 2 (Table 2).

Size Class Structure: Community Structures analyzed and interpret the plants at different exposures and provide first hand information about the vegetation basis for prediction of future changes. Diameter Size class structure diagram prepared for each tree species. Figure 2. Showed that all stands are composed of mixed size classes and in some stands low numbers of individuals are found in

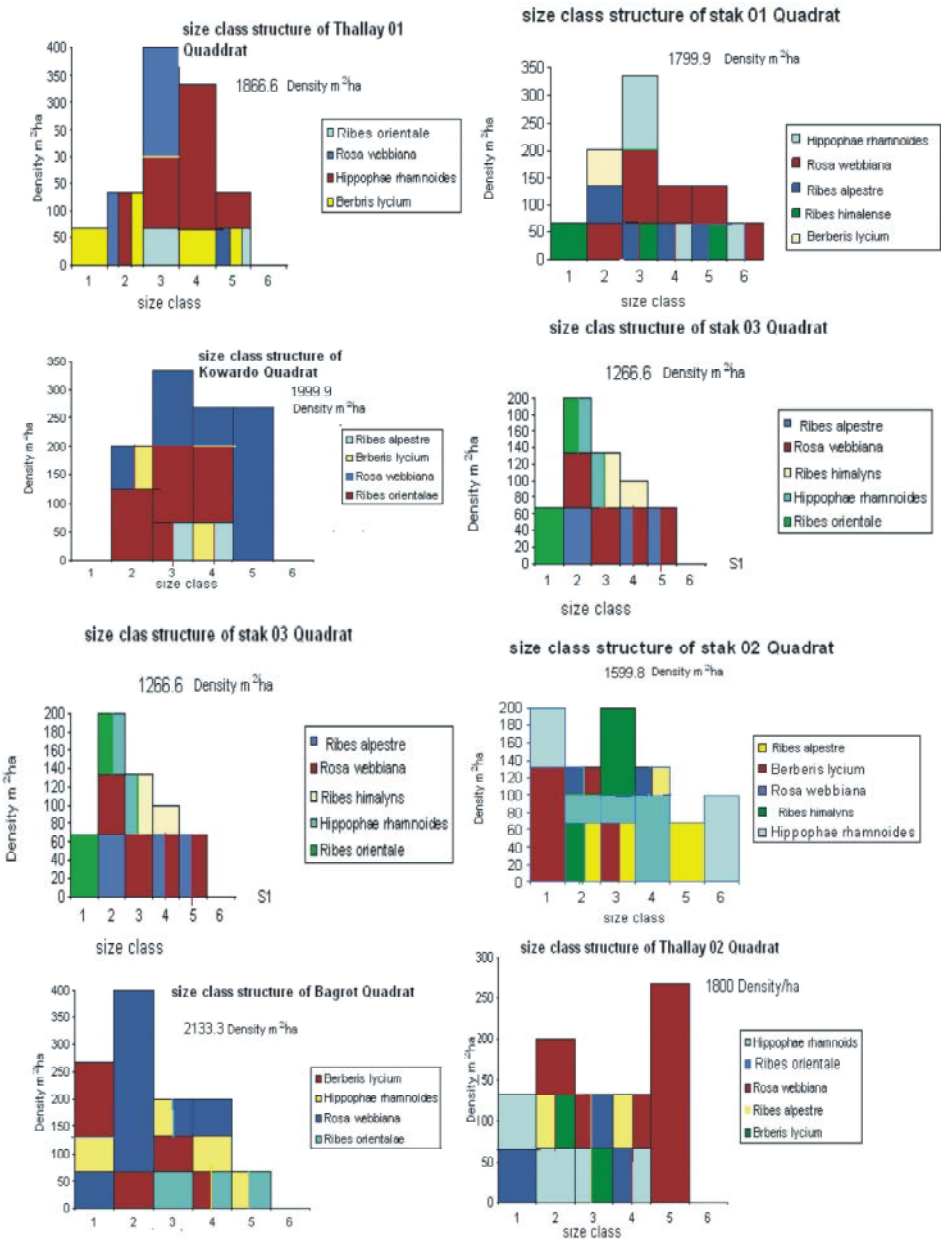

Fig. 3: Density size classes of non tree species from different sampling area. Class interval =100cm circumference

young classes with a gradual increase in bigger size classes and again decrease in mature size classes. Size class structure shows many gaps due to the absence of individuals in this size classes. Ahmed *et al.* [13,14] and Wahab *et al*. [12] also reported these gaps in the population structure of many tree species. These gaps at the beginning may be the result of over grazing at seedling/sapling stage while in the middle, may be the results of storm or cutting. Size class distribution of this community occupies more trees in medium size classes and decreasing individual both towards the higher and lower size. Ahmed *et al.* [2] found the same in other forests of northern areas of Pakistan. In Bagrot 10 to 20 cm tress of *Picea smithina* and *Juniperus excelsa* are absent, while *Pinus wallichiana* is absent in three of the beginning classes, therefore this species may be eliminated in the future, since no new individuals are including in this stand. Other associated species are also showing the sign of disturbance which may create unbalance structure, therefore this forst may be vanished in future. Similar situation existed in Haramosh stand, where *Picea smithiana, Pinus wallichiana* and *Juniperus*

excelsa were in a bad shape due to the same problem of anthropogenic disturbance. Pure stand of *Picea smithiana* in Stak 1 and *Juniperus excelsa* in Stak 2 also indicating unbalanced population structure, while pure stand of *Juniperus excelsa* in Hopar is almost in a same condition. In these stands small classes are low in number which gradually increases in middle size classes. It shows that this forest is not supporting new recruitment.

Size class structure of bushes was presented in figure 3. In Bagrot 4 dominant shrub species were recorded and plot a diagram between density m^2 ha^{-1} and classes, which shows that *Rosa webbiana* is the dominant species with 867 density m^2 ha^{-1} in different classes distribution and associated species are *Hippophae rhamnoides, Berberis lycium and Ribes orientale.* Major factors that influenced vegetation structure are again human disturbance, extensive grazing, storm and mortality of plants. Therefore populations of these species are rapidly decreasing. It seems that in future these species may be included in red list. Similarly in Stak 1, Stak 2, Hopar, Thallay 2 and Kowardo *Rosa webbiana* is dominant species with 667, 333, 333, 333 and 467 density ha^{-1} respectively. Associated species are *Hippophae rhamnoides, Berberis*, *lycium, Ribes orientale and Ribes alpestre,* while in Stak 2 and Thallay 1 *Hippopha rhamnoides* is dominant species with 267 and 800 density/ha respectively. Associated species are *Rosa webbiana, Berberis lyceum, Ribes alpstre, Ribes himalensis.* On the basis of above results and discussion it may be concluded that extreme human disturbance prevail in this ecologically important national park. Therefore for the sack of future generation and research this park should be protected and managed.

REFERENCES

1. Stewart, R.R., 1961. The Flora of Deosai plains Pakistan J. Forestry, XI(3): 225-295.
2. Ahmed, M., T. Husain, A.H. Sheikh, S.S. Hussain and M.F. Siddique, 2006. Phytosociology and structure of Himalayan Forests from different climatic zones of Pakistan. Pak. J. Bot., 8(2): 361-383.
3. Ahmed, M. and S.A. Qadir, 1976. Phytosiological studies along the way of Gilgit to Gopis, Yasin and Shunder. Pak. J. Forest, 26: 93-104.
4. Ahmed, M., 1976. Multivariate analysis of the vegetation around Skardu. Agri-Pak., (17) 2:177.
5. Hussain, F. and G. Mustafa, 1995. Ecological studies on some pasture plants in relation to animal used found in Nasirabad valley, Hunza, Pakistan. Pak. J. Pl. Sci., 1: 263-272.
6. Rasool, G., 1998. Medicinal Plants of the Northern Areas of Pakistan: Saving the plants that save us. Gilgit, Pakistan.
7. Shinwari, Z.K. and S.S. Gilani, 2003. Sustainable harvest of medicinal plants at Bulashbar Nullah, Astore (Northern Pakistan). J. Ethno Pharmacol., 84: 289-298.
8. Ahmed, M., K. Nazim, M.F. Siddique, M. Wahab, N. Khan, M.U. Khan and S.S. Hussain, 2010. Community description of deodar forests from Himalayan range of Pakistan. Pak. J. Bot., 42(5): 3091-3102.
9. Cottam, G. and J.T. Curtis, 1956. The use of distance measures in phytosociologyical sampling. Eco., 37(3): 451-460
10. Mueller-Dombois, D. and H. Ellenburg, 1974. Aims and methods of vegetation Ecology. Jhon Iviley and sons. Inc. New York, pp: 547.
11. Wali, S. and S. Khatoon, 2007. Ethnobotanical studies on useful trees and shrubs of Haramosh and Bugrote valleys, in Gilgit northern areas of Pakistan. Pak. J. Bot., 39(3): 699-710.
12. Wahab, M., M. Ahmed and N. Khan, 2008. Phytosociology and dynamics of some pine forests of Afghanistan. Pak. J. Bot., 40(3): 1071-1079.
13. Ahmed, M., E.E. Naqi and E.L.M. Wang, 1990a. Present state of Juniper in Rodhmallazi forest of Baluchistan. Pakistan. Pak. J. Forestry, pp: 227-236.
14. Ahmed, M., S.S. Shaukat and A.H. Buzdar, 1990b. Population structure and dynamics of *Juniperus excelsa* in Baluchistan, Pakistan. J. Veg. Sci., 1: 271-276.
15. Ahmed, M., 1973. Phytosociological studies around Gharo, Dhabeji and Manghopir Industrial Area, Pakistan (unpublished, M.Sc. Thesis department of Botany University of Karachi).
16. Ahmed, M., 1986. Vegetation of some foothills of Himalayan range of Pakistan. Pak. J. Bot., 18(2): 261-269.
17. Malik, Z.H., 2005. Comparative study on the vegetation of Ganga Chotti and Bedori hills District Bagh, Azad Jammu and Kashmir with special reference to Range conditions. Ph.D. Thesis, University of Peshawar.
18. Nafeesa, Z., 2007. Phytosociological Attributes of Different Plant Communities of Pir Chinasi Hills of Azad Jammu and Kashmir. International Journal of Agriculture Andbiology 1560-8530/2007/09-4-569-574.