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FUTURE TRENDS OF THE VEGETATION FROM CENTRAL KARAKORAM NATIONAL PARK, GILGIT-BALTISTAN, PAKISTAN

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Abstract

This study was conducted to assess the present status and future trends of 32 stands of forest, shrubs and herbs from Central Karakoram National Park (CKNP), Gilgit-Baltistan, Pakistan. On the basis of phytosociological analysis and maximum important value index (IVI), first three dominant species were selected to examine size class distribution in non-forested vegetation while in forested area all species were considered for further analysis. In forested areas, *Picea smithiana, Pinus wallichiana* and *Juniperus excelsa* formed either pure stands or mixtures of various species, which shows that certain combinations of environmental factors, including disturbance, play a role in non-forested sites *Rosa webbiana, Hippo phaerhamnoides, Berberis lycium*, *Tamarix indica*, *Ribes orientale*, *Ribes alpestre* and *juniper communis* were associated with disturbed and unstable conditions. Most of the stands did not show the ideal situation and no inverse J-shaped curve was formed. Seven stands showed the positive skewness distribution, 5 stands attained flat distribution, 4 stands normal distribution, 3 stands distributed in rectangular manner, 3 stands gave bimodal shape, 3 stands attained unimodal shape while the remaining stands were distributed with U-shaped and leptokurtic shape. In these stands, young classes are absent indicating cessation of further recruitment. Poor floristic similarities between stands at different elevations and slopes were observed but *Rosa webbiana* and *Picea smithiana* showed higher density within such stands. Pine tree species were also distributed in different areas with higher density and basal area. It is shown that vegetation is deteriorating under anthropogenic disturbances, which predicts dangerous situation for future. Therefore, special attention is needed to protect these forests and the natural vegetation upon which the wildlife depends.

Keywords: Future trend, Structure, Phytosociology, CKNP, Disturbance.

Introduction

Central Karakoram National Park (CKNP), situated in Gilgit-Baltistan, Pakistan, is one of the 24 national parks of Pakistan. Elevation ranges from 2000m to 6000m. Climate of this region is cold in high elevations while hot in lower elevations. Phytosociology and vegetation community description of CKNP is presented by Hussain et al. (2010, 2011). The distributions of vegetation, density, basal area, and canopy cover, are often used to model bio-mass distribution in forest communities (Goff and Zedler, 1968). Spatial forest structure is an important parameter to determine the habitat and diversity of the species (Pommerening, 2002). Structure, composition and function are important factors of the forest (Gairola et al., 2008). Different researchers stated that using of diameter distribution transversely a range of diameter class is an aspect of stand structure (Koop et al., 1994). The structure and future trend of forests would be better by selected cutting (Uuttera et al., 2000).

According to FAO (2009) the forest cover of Pakistan is 2% whereas 4% of the country's land

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is covered by trees, planted in gardens, cities, along rivers, canals and agricultural lands. Ahmed (2009) reported that most of the forest cover is found in Northern Areas of Pakistan. These forests are deteriorating with the passage of time, due to poor management, less research and anthropogenic disturbance.

Forest management can be characterised by silviculture practices which maintain the age class of forests (Matthews, 1999; Schütz, 2001). The cutting of these forests should be selective with extensive practice of silviculture, which could be changed in different times, depending on the need of forest owners and market situation. Additionally, the system of proportion among small, medium and large dbh size tress should be applied. Secondly, the possibility of cutting trees from different species stands (Brang, 2001). Single tree selection silviculture maintains stand growth, different size classes and a reverse J-shaped diameter distribution (Matthews, 1991). The structure of the forest has been studied at different levels through different communities (Ogden et al., 1987; Kimmins, 1987). The structure of vegetation is determined by the presence of species, quantitative relation between the species, species distribution and interaction between them (Boncina, 2000) or even succession (Begon et al., 1990; Cook, 1996). Ahmed (1986) used this method for the vegetation of some foothills of Himalayan range of Pakistan. Ahmed et al. (1990 a, b) also described the status and population structure of *Juniperus excelsa* in Baluchistan. Ahmed et al. (1991) worked on the vegetation structure and dynamics of *Pinus gerardiana* forest of Baluchistan. Malik (2005) conducted a comparative study with special reference to range conditions on the vegetation of Ganga Chotti and Bedori Hills, District Bagh, Azad Jammu Kashmir. Wahab et al. (2008) described the phytosociology and dynamics of some forests of Afghanistan. Ahmed et al. (2009) described the vegetation structure of *Olea ferruginea* Royle Forests of lower Dir. Khan et al. (2010) described the phytosociology, structure and chemical analysis of soils in *Quercusbaloot* Griff forest from district Chitral. Akbar et al. (2010, 2011) also studied the phytosociology and structure of Skardu district while Siddique (2011), Khan (2011) and Wahab (2011) studied the structure, present status and future trend of different species from regions of the country.

Beside the above studies, no such type of study has been conducted to explore the present status and future trend of the vegetation from the CKNP. This study is useful to the management of forests and also expected to be helpful in preserving and conserving the flora of the park.

Materials and Methods

Field Methods

This study was conducted during 2010-2012, in the different regions of CKNP, Gilgit-Baltistan, Pakistan. For quantitative sampling, mature and least disturbed sites were selected. Point Centered Quarter Method of Cottam and Curtis (1956) was applied for tree species. In each stands, 20 points were taken at every 20m interval. Quadrat method size (3m x 5m) of Cox (1990) was used for shrubs and herb species. GPS was used to record the elevation and coordinates while degree of slope was recorded by slope meter.

Data analysis

Phytosociological attributes and absolute values were calculated according to the method described by Mueller-Dombois and Ellenburg (1974) and Ahmed and Shaukat (2012). Species with the highest important value in the stand was considered as its dominant species (Brown and Curtis, 1952). Plant community of a particular area was named on the basis of first two dominant species following Hussain (1989). Important value gives extensive information about the species as compared to any single phytosociological attribute (Brown and Curtis, 1952). For preparation of size class structure, interval of classes in forested areas was 10cm while in non-forested areas, class interval was 50cm. Structure of vegetation is divided into three classes viz. young class (10-30cm), middle class (40-70cm) large class (80-100cm) following Wahab (2011), Khan (2011) and Siddiqui (2011). Plant species were identified with the help of Flora of Pakistan (Nasir and Ali, 1972) and University of Karachi Herbarium. Phytosociological attributes and absolute values were calculated, following the formulae of Ahmed and Shaukat (2012).

Fig. 1. Map of CKNP and sampling locations
(Details of stands are given in Hussain et al., (2011)

Results and Discussion

Vegetation of CKNP is divided into forested and non-forested vegetation. Present status and future trend of each stand are described separately and the main sampling location is shown in Fig. 1, while dbh (diameter at breast height) size class structure diagrams are shown in Fig.2. Vegetation distribution pattern is also discussed.

A. Forested area

Stand # 1 – Bagrot

This is located in Bagrot valley at an elevation of 3130m above sea level, while degree of slope is 45° on East exposure. The total density of this area was 96 individuals ha^{-1}. *Picea smithiana* was leading dominant species with a density of 67 ha^{-1} while *Pinus wallichiana* and *Juniperus excelsa* attain 17 and 12 individuals ha^{-1}, respectively. This structure shows close to normal distribution but is positively skewed. 24% individuals of *Picea smithiana* and *Juniperus excelsa* were found in small class, 71 % individuals of all species in middle class and 5% of *Picea smithiana* and *Pinus wallichiana* individuals were found in large class. The structure diagram shows that in the small class, *Pinus wallichiana* is absent which indicates that this species may be vanishing before some of the other species. Some gaps have been seen in large class. These gaps are created due to illegal cutting that required a prompt action in this regard (Fig.2.1).

Stand # 2 – Haramosh

Haramosh is situated in District Gilgit with the elevation of 3296m while degree of slope was 53°. Exposure of this area is South-East facing. Total density was 122 ha^{-1}. *Picea smithiana* was the leading dominant species, with density 75 ha^{-1} and the associated species, *Pinus wallichiana,* occupied 29 density ha^{-1} while *Juniperus excelsa* attains 18 individuals ha^{-1}. The size class structure of this stand was close to symmetrical normal distribution. The coordinates of Bagrot and Haramosh are close together, therefore, vegetation, type and distribution were also similar. In this area, small classes occupied 18% individuals of all species, middle classes have 73% of all species and only 9% *Picea smithiana* individuals were found in the large classes. In this stand, *Juniperus excelsa* was absent. In the beginning two classes, i.e., *Pinus wallichiana* and *Picea smithiana* were absent in first class. It is indicated that *Juniperus excelsa* shows dangerous sign of vanishing first. This forest is also not reproducing well and if care is not taken and new seedlings are not planted or regenerated, important tree vegetation is expected to vanish in future (Fig. 2.2).

Stand # 3 – Hopar

Hopar is located in District Hunza-Nagar at an elevation of 3486m while degree of slope was 49° on East exposure. *Juniperus excelsa* exists as a pure forest which occupied 123 individuals ha^{-1}. Boulders and cut poles are seen in this forest. Soil erosion can also be seen in the forested and non-forested areas. This distribution was somewhat negatively skewed. In the small class, 37% individuals were found, 63% individuals were categorised as "middle class" while no tree in large class showed gaps. These gaps are produced as a result of illegal cutting. This structure is the sign of unstable forest due to the small amount of individuals in small class. If no seedlings are recruited, this forest may disappear with the passage of time (Fig. 2.3).

Stand # 4 – Stak 1

Stak 1 is situated in Baltistan region with the elevation of 3344m and East exposure while degree of slope was 35°. *Picea smithiana* existed as pure species and occupied 109 density ha^{-1}. This distribution was a unimodal with somewhat platykurtic distribution. In the forest ground, cut stems and dead stems were found. Soil erosion was seen due to the anthropogenic disturbance and the melting of glaciers. In this area, small class received 28% individuals and 66% in middle class while in large class 6% individuals were found. This structure shows anthropogenic disturbance but the future of this forest may be secured if illegal cutting is ceased and seedling development is promoted (Fig. 2.4).

Stand # 5 – Stak 2

Stak 2 is also located in Baltistan region with an elevation of 3600m above sea level on East-facing slope while degree of slope was 20°. *Juniperus excelsa* was distributed as a pure population in this forest with the density of 106 density ha^{-1}. The distribution was negatively skewed and normal. Small classes occupied 18% tree and in middle classes 75% individuals while in large class, 8% trees were found. This forest was also unstable and it is suggested that this forest can be maintained by increasing the number of seedlings and reducing the degree of disturbance. It seems that if no recruitment takes place, this plant would eventually vanish from the site with time (Fig. 2.5).

Stand # 6 – Rakaposhi 1

Rakaposhi 1 is situated in District Hunza-Nagar of Gilgit-Baltistan with the elevation of 3444m on North exposure while degree of slope was 70°. *Juniperus excelsa* was the dominant species and forms pure population with high density of 135 ha^{-1}. This was a unimodal distribution with some positive skewness. The diagram of the structure showed that small class has 51% individuals, 49% trees were classified in middle class while no large classes exist. Large number of individuals in small class shows better recruitment. Therefore, it is hoped that though large-sized trees are currently absent, in future, this species may prevail (Fig. 2.6).

Stand # 7 – Rakaposhi 2

Rakaposhi 2 is also located in District Hunza-Nagar with an elevation of 3263m above sea level on North exposure with a degree of slope was 59°. *Picea smithiana* existed as pure forest, which attained 143 density ha^{-1}. The distribution seems to be flat with some normal gaps. In this stand, small size class received 29% individuals, middle class has 65% and large class has 6% individuals. Middle to old classes have stable distribution but the small class has low number of individuals, indicating disturbances in the young population. Small size class seems to show gaps in future. The forest may be saved by promoting seedling growth in this stand (Fig. 2.7).

Stand # 8 – Rakaposhi 3

Rakaposhi 3 was situated in District Hunza-Nagar. Elevation of this forest above sea level was 3188m on North facing slope while degree of slope was 64°. *Pinus wallichiana* was distributed as pure species have 94 density ha^{-1}. This was a platykurtic normal distribution with marked positive skewness. This diagram shows that small class occupied 19% of the individuals, middle classes have 73% individuals while 8% trees were found in large classes. Gap in small classes may be due to cutting or no recruitment. Low density shows extensive cutting. This unstable forest may disappear with time if no action is taken for its conservation (Fig. 2.8).

Stand # 9 – Rakaposhi 4

Rakaposhi 4 was also located in District Hunza-Nagar. Elevation of this forest above sea level is 3512m on North-East facing while degree of slope is 70°. *Picea smithiana* was the leading dominant species with a density of 62 ha^{-1} while *Pinus wallichiana* and *Juniperus excelsa* attained 21 and 16 density ha^{-1}, respectively. This was a unimodal distribution with certain irregularities. In this area, 29% of the individuals of all tree species were found in small class, 67% of all three species in the middle classes while 4% individuals of only *Picea smithiana* were found in large class which gradually decreased with large classes. There is no evidence of *Juniperus excelsa* individuals in young classes. It shows that there is no evidence of regeneration and forest is unstable and disturbed. Other species also have irregular size-distribution without seedlings in small size-class. It is indicated that this forest needs special attention otherwise all species may disappear with time (Fig. 2.9).

(B) Non-forested area

Stand # 10 – Bagrot

This is located in Bagrot valley at the elevation of 2774m and on lightly North facing surface. In this stand, total density was 1733 ha^{-1}. *Rosa webbiana* was the leading dominant species with a density of 667 ha^{-1} whereas associated species *Hippo phaerhamnoides* and *Berberis lycium* have 533 ha^{-1}density. The size-distribution diagram shows a distribution close to normal with some positive skewness and irregularities. In this area, the small class has 11% of *Rosa webbiana* and *Hippo phaerhamnoides* with some gaps, middle class has 82% bushes of all species while in the large class, 7% individuals of *Rosa webbiana* and *Hippo phaerhamnoides* were found. It shows that this is an irregular shape structure of non-forested area which is the sign of disturbance. The gaps in small class shows that there is anthropogenic activity and indicate that this vegetation may vanish in future if illegal cutting and over-grazing are not checked (Fig. 2.10).

Stand # 11 – Hopar

This stand is situated in Hopar valley. Elevation of this area above sea level was 3353m on North-East facing while degree of slope was 30°. Total density was 1600 ha^{-1}. *Rosa webbiana* was the leading dominant species which attains a high density of 667 ha^{-1} and associated species, *Hippo phaerhamnoides*, have 533 individuals ha^{-1} whereas *Berberis lycium* occupied a density of 400 ha^{-1} density. The distribution was also normal but with irregularities. In this non forested area, there are no individuals found in beginning five classes and the small class has only 8% individuals of *Rosa webbiana* and *Berberis lyceum*. In the middle class, 75% individuals of all species were found while in large class, 17% trees of *Rosa webbiana* and *Hippo phaerhamnoides* were recorded. This is similar to previous stand which shows gaps and irregularities. It is indicated that these important bushy area may disappear in future if special attention is not given for its restoration (Fig.2.11).

Stand # 12 – Stak 1

This area is located in Stak 1 with the elevation of 2949m above sea level on East-North facing while degree of slope was 35°. Total density was 1199ha^{-1}. *Hippo phaerhamnoides* was the leading dominant species which obtained a high density of 466 ha^{-1}. Associated species *Ribes alpestre* has 400 density ha^{-1} and *Rosa webbiana* has 333 density ha^{-1}. This diagram appears to be a bimodal distribution. In this stand, small class has no individuals, the middle class has 76% individuals of all species while in large class, 24% individuals of all species were recorded. Gaps in small class were observed, which may be attributed to human influence and overgrazing. This structure is an irregular and unstable structure of non-forested area. This forest may vanish in future if overgrazing is not restricted (Fig. 2.12).

Stand # 13 – Stak 2

This stand situated in Stak 2. Elevation of this area was 2782m on East-South facing while degree of slope was 59°. Total density of this stand was 1000ha^{-1}. *Hippo phaerhamnoides*, the leading dominant species, attained 400 density ha^{-1}and associated species *Ribes alpestre* and *Rosa webbiana* occupied 333 density ha^{-1} and have 267 density ha^{-1} and 333 density *ha*$^{-1}$, respectively. This shows a bimodal pattern with some gaps. In this location, small class occupied 13% individuals of *Hippo phaerhamnoides*, middle class has 73% individuals of all species while 14% individuals of *Hippo phaerhamnoides* and *Ribes alpestre* were recorded in the large class. Some gaps were also observed. These gaps are due to illegal cutting and overgrazing. It is indicated that these bushy areas may vanish in future if no proper actions are taken (Fig. 2.13).

Stand # 14 – Stak 3

This stand is located at Stak 3. Elevation of this area was 2742m on East facing while on plain surface. *Rosa webbiana, Hippo phaerhamnoides* and *Ribes alpestre* were the top three dominant species of this stand. Total density of these species was 866 ha^{-1}. *Rosa webbiana* was the leading dominant species and obtained 333 density ha^{-1}. Associated species *Hippo phaerhamnoides* shared 333 density ha^{-1} whereas *Ribes alpestre* had 200 density ha^{-1}. In the small classes, there is no evidence of the presence of any species. 85% individuals of all species were recorded in middle class while in the large class, only 15% bushes of *Rosa webbiana* were found with some gaps. It shows that there is an irregular and disturbed structure which may vanish in future if vegetation growth is not promoted (Fig.2.14).

Stand # 15 – Thally 1

This stand is situated in Thally 1. Elevation of this location above sea level is 3300m on East facing while degree of slope is 20°. *Rosa webbiana*, *Hippo phaerhamnoides* and *Berberis lycium* are the top three dominant species of this stand. Total density is 1733 ha^{-1}. Among these, the leading dominant species was *Hippo phaerhamnoides* with the higher density of 800 ha^{-1} while associated species *Rosa webbiana* had a density of 600 ha^{-1} and *Berberis lycium* accounted with 333 density ha^{-1}. This distribution appears to be normal but contains some gaps or irregularities. In this stand, small class received only 4% individuals of *Berberislycium* with some gaps which are due to overgrazing while in middle class, 76% individuals of all species were recorded with some gaps and 20% individuals of all species were found in large class. These gaps and irregular structure shows that the vegetation is unstable which indicates that these important species need special attention. If no rules and regulations are imposed, then this vegetation may gradually disappear in future (Fig. 2.15).

Stand # 16 – Thally 2

This is located in Thally 2 with the elevation of 3500m above sea level on East-South facing while degree of slope was 25°. *Rosa webbiana*, *Hippo phaerhamnoides* and *Ribes alpestre* were the top three dominant species of this stand. Total density of the species was 1333 ha^{-1}. *Rosa webbiana* is the leading dominant species with 733 density ha^{-1}. Associated species *Hippo phaerhamnoides* obtained 333 density ha^{-1} and *Ribes alpestre* have 267 density ha^{-1}. This appears to be a U-shaped distribution. Small classes have 10% individuals of *Hippo phaerhamnoides* with some gaps, in the middle class, 62% individuals of all species were recorded while in large class, 28% individuals of *Ribes alpestre* and *Rosa webbiana* were found. Some gaps were seen in small and middle class which are due to overgrazing and cutting. The distribution is an irregular shaped structure which shows disturbance. Future of this vegetation is insecure unless steps are taken to cease anthropogenic disturbance (Fig. 2.16

Stand # 17 – Kowardo

This stand is located in Kowardo with an elevation of 3559m above sea level on East-North exposure while degree of slope was 50°. *Rosa webbiana, Berberis lycium* and *Ribes orientale* are the three dominant species of this stand. Total density of these species was 1867 ha^{-1}. *Rosa* *webbiana* was leading dominant species which contributed very high density of 1066 ha^{-1} while associated species *Ribes orientale* and *Berberis lycium* attained 467 density ha^{-1} and 333 density ha^{-1}, respectively. This was somewhat flat distribution. In this stand, small class has gaps, whereas, in the middle class 79% individuals of all three species were recorded. In the large classes, 21% individuals of *Rosa webbiana* and *Ribes orientale* were found. These gaps show disturbance and unstability which indicates that this vegetation may vanish in future (Fig. 2.17).

Stand # 18 – Arandu 1

This stand is situated in Arandu 1 at elevation 2790m above sea level with South-West facing while degree of slope was 30°. *Rosa webbiana, Hippo phaerhamnoides* and *Berberis lycium* were the top three dominant species of this location. Total density of this stand was 733 ha^{-1}. *Hippo phaerhamnoides* was the leading dominant species which attained 333 individuals ha^{-1} and associated species *Rosa webbiana* had 267 density ha^{-1} whereas *Berberis lycium* shared 133 density ha^{-1}. This stand shows leptokurtic distribution. In this stand, small class received 40% individuals of all three species. In the middle class, 60% individuals of all three species were present while in large class, there was no evidence of any species with an impression of some gaps that indicate extreme disturbance in this area. This vegetation may disappear in future by time. It can be saved by promoting growth of the vegetation (Fig. 2.18).

Stand # 19 – Arandu 2

This stand is located in Arandu 2. Elevation of this area is 2815 on South exposure while degree of slope is 20°. *Rosa webbiana, Hippo phaerhamnoides* and *Berberis lycium* were the top three dominant species of this location. Total density was 1600 ha^{-1}. Densities of 600 ha^{-1}, 533 ha^{-1}, and 467 ha^{-1} were reported for *Berberis lycium* and its associated species *Rosa webbiana* and *Hippo phaerhamnoides*, respectively. This was a somewhat normal distribution with some irregularities. In this stand, young class had 18% individuals of *Rosa webbiana* and *Berberis lycium*; in the middle class, 73% individuals of all three species were present while in large class, 9% individuals of *Rosa webbiana* and *Hippo phaerhamnoides* were recorded. Some gaps were also seen in small and large classes which show that these species are deteriorating under anthropogenic disturbance (Fig. 2.19).

Stand # 20 – Arandu 3

This is situated in Arandu 3, at an elevation of 2875m with South-West facing while degree of slope was 35°. *Rosa webbiana, Hippo phaerhamnoides* and *Berberis lycium* were the top three dominant species of this location. Total density was 1267 ha^{-1}. *Rosa webbiana* was the leading dominant species which attained 467 density ha^{-1} and associated species *Hippo phaerhamnoides* and *Berberis lycium* occupied 400 individuals ha^{-1}. This was close to normal distribution with some gaps. In this stand, small middle classes received 28% and 68%, respectively, of all three species while in the large class, only *Hippo phaerhamnoides* was found with 10% of individuals. Some gaps were reported in the small and large classes which show disturbance. It is indicated that these species may vanish in future if proper ameliorative actions are not taken (Fig. 2.20).

Stand # 21 – Shigar 1

This stand is located in Shigar 1, at the elevation of 2527m on North-East exposure while the degree of slope was 40°. *Rosa webbiana, Hippo phaerhamnoides* and *Berberis lycium* were the top three dominant species of this location. Total density was 1199 ha^{-1}. *Rosa webbiana* was the leading dominant species, attaining 533 density ha^{-1} and associated species *Hippo phaerhamnoides* and *Berberis lycium* covered 333 density ha^{-1}. This can be regarded as a flat distribution with two modes. In this stand, small class occupied 28% individuals of *Hippo phaerhamnoides* and *Berberis lycium* while *Rosa webbiana* was absent. In the middle class, all three species occupied 72% individuals while in large class, there is no evidence of any species but gaps were observed which shows that this is unstable vegetation. It is indicated that these important species may disappear with the passage of time. These species need more promotion of vegetation for future existents (Fig. 2.21).

Stand # 22 – Shigar 2

This stand is situated in Shigar 2, with elevation above sea level 2444m on East facing while degree of slope was 35°. *Rosa webbiana, Hippo phaerhamnoides* and *Tamarix indica* were the top three dominant species of this location.

Total density was 1266 ha^{-1}. *Hippo phaerhamnoides* was the leading dominant species, containing 533 density ha^{-1} and associated species were *Rosa webbiana*, obtaining 400 density ha^{-1} and *Tamarix indica* shared 333 density ha^{-1}. This was also more or less flat but with two modes. In this location, small class occupied 53% individuals of all three species; in the middle class, 45% individuals of all three species were found while in the large class, only *Rosa webbiana* was found with only 2% individuals. Some gaps were also observed in the large classes. These gaps, due to illegal cutting, show extreme disturbance and unstable vegetation. Proper actions should be taking to maintain the vegetation and the anthropogenic disturbance should be halted (Fig. 2.22).

Stand # 23 – Shimshal 1-1

This site is located in Shimshal 1-1, at the elevation of 3047m on East-South facing while on plain surface. *Rosa webbiana, Hippo phaerhamnoides* and *Tamarix indica* were the top three dominant species of this location. Total density was 867 ha^{-1}. *Tamarix indica* was the leading dominant species, which attained 333 density ha^{-1} and associated species were *Hippo phaerhamnoides* and *Rosa webbiana*, containing 267 density ha^{-1}. This was a rectangular distribution with a gap. In this area, small class had all three species, containing 39% individuals. In the middle class, all species were found with the density of 54% while in the large class, only *Rosa webbiana* was found with the density of 7%. Some gaps were also seen in the large class, which show extreme disturbance. It is indicated that these important species may disappear in future with the passage of time, if no serious action is taken (Fig. 2.23).

Stand # 24 – Shimshal 1-2

This stand is situated in Shimshal 1-2. The elevation was 3065m on East-South facing while on plain surface. *Ribes orientale, Hippo phaerhamnoides* and *Tamarix indica* were the top three dominant species of this location. Total density among these species was 1266 ha^{-1}. *Hippo phaerhamnoides* was the leading dominant species with 600 density ha^{-1} and associated species were *Rosa webbiana* and *Tamarix indica,* which recorded 333 density ha^{-1}. This was a flat distribution but has a number of modes. In this area, small class had all three species which occupied 53% density. In the middle class, all three species were recorded with the density of 42% while in the large classes only *Hippo phaerhamnoides* was found with the low density of 5%. Structure of this area showed that all three species were found in the young and middle class, gradually decreased to the large classes. In the large class, *Hippo phaerhamnoides* was found in only one class and some large classes were absent which show extreme disturbance and unstable ecosystem. It appears that the vegetation is in serious threat and it may vanish in future (Fig. 2.24).

Stand # 25 – Shimshal 2-1

This stand is located in Shimshal 2-1 at the elevation of 3076m on East-South facing while on plain surface. *Hippo phaerhamnoides, Tamarix indica* and *Juniperus communis* were the top three dominant species of this location. Total densities among these species were 1266 ha^{-1}. *Hippo phaerhamnoides* was the leading dominant species and attained 533 density ha^{-1}. Associated species *Tamarix indica* recorded 333 density ha^{-1} and *Juniperus communis* have 400 individuals ha^{-1}. This was a positively skewed distribution. This distribution shows that all three species were in good association and found in small class with the density of 68% which gradually decreases to the large class. In the small class, *Tamarix indica* and *Hippo phaerhamnoides* were occupied by 27% density while *Juniperus communis* was absent in this class. In the large class, only *Hippo phaerhamnoides* was found, having 5% density with wide gaps. Future of this vegetation is also at stake which may disappear in future. These important species need special attention from the concerned authorities (Fig. 2.25).

Stand # 26 – Shimshal 2-2

This stand is located in Shimshal 2-2 at an elevation of 3097m on East-South facing on plain surface. *Hippo phaerhamnoides, Tamarix indica* and *Rosa webbiana* were the top three dominant species of this location. Total density among these species was 1399 ha^{-1}. *Hippo phaerhamnoides* was the leading dominant species containing 533 individuals ha^{-1} and associated species *Tamarix indica* shared 533 density $ha^{-1}$and *Rosa webbiana* attained 333 density ha^{-1}. The distribution was irregular with gaps and fluctuations. In this area, the structure for small class showed all three species with density of 62%, while in middle classes *Rosa webbiana* and *Hippo phaerhamnoides* were found with the density of 28%. In the large class, *Rosa webbiana* and *Hippo phaerhamnoides* were found with low density of 10%. In the middle and large class, some gaps were observed. It shows that this vegetation is deteriorating and under the threat of anthropogenic disturbance. It seems that these species are gradually vanishing in this stand (Fig. 2.26).

Stand # 27 – Braldu 1-1

This area is situated in Braldu 1-1, at the elevation of 2895m above sea level on East facing while degree of slope was 25°. *Rosa webbiana*, *Hippo phaerhamnoides* and *Berberis lycium* were the top three dominant species of this location. Total density was 1266 ha^{-1}. *Rosa webbiana* was the leading dominant species, attained 400 density ha^{-1} and associated species were *Hippo phaerhamnoides* and contributed 533 density. *Berberi slycium* attains 333 density ha^{-1}. The distribution was flat to positively skewed distribution. In this stand, *Berberis lycium* were found in the beginning first class while two classes, *Berberis lycium* and *Hippo phaerhamnoides* were found with similar density. In the middle class, all three species were found with similar density with different species associations while in the large class, there is no evidence of any species, which indicates unstable situation of the ecosystem mainly due to anthropogenic disturbance (Fig. 2.27).

Stand # 28 – Braldu 1-2

This area is situated in Braldu 1-2, at the elevation of 2910m above sea level and East facing while degree of slope was 20°. *Berberis lycium, Hippo phaerhamnoides* and *Tamarix indica* were the top three dominant species of this location. Total density is 1267 ha^{-1}. *Berberis lycium* was the leading dominant species and observed 467 density ha^{-1}. Associated species were *Hippo phaerhamnoides,* attained 467 density ha^{-1} and *Tamarix indica* shared 333 individuals ha^{-1}. This distribution was somewhat positively skewed with some gaps. In this stand, the diagram shows that in the small class, all three species were recorded with the density of 68% while in middle class, all three species were found with the density of 21%. In the large class, 11% individuals of *Hippo phaerhamnoides* were found. In the beginning, in the first class, *Berberislycium* and *Tamarix indica* were found while in second and third classes *Berberis lycium* and *Hippo phaerhamnoides* were found with similar density. Some gaps were also seen in the middle and large classes which may be due to overgrazing and illegal cutting. If this activity is not discouraged, these species may disappear in the future (Fig. 2.28).

Stand # 29 – Braldu 2-1

This area is situated in Braldu 2-1, at the elevation of 3076m above sea level on East-South facing while degree of slope was 35°. *Rosa webbiana*, *Berberis lyceum* and *Hippo phaerhamnoides* was the top three dominant species of this location. Total density is 1133 ha^{-1}. *Rosa webbiana* was the leading dominant species, obtaining 400 density ha^{-1}. Associated species were *Hippo phaerhamnoides* with density 333ha^{-1} and *Berberis lycium* shared 400 ha^{-1}. This was also more or less positively skewed with some gaps. In this location, the diagram of population structure showed that the first small class was absent. However, in the next small class, all three species occupied 47%. In the middle class, association of *Rosa webbiana* and *Hippo phaerhamnoides* and *Berberis lycium* were found with some gaps while in the large class, only *Rosa webbiana* appeared with very low density of 6%. Some gaps were also seen in the large class, which shows that this vegetation is unstable and needs special attention for future existence (Fig. 2.29).

Stand # 30 – Braldu 2-2

This area is located in Braldu 2-2, at the elevation of 3055m above sea level on East facing while degree of slope was 30°. *Rosa webbiana*, *Berberis lycium* and *Hippo phaerhamnoides* were the top three dominant species of this location. Total density was 1133 ha^{-1}. *Rosa webbiana* was the leading dominant species, attaining 467 density ha^{-1} and associated species *Hippo phaerhamnoides* and *Berberis lycium* shared 333 density ha^{-1}. This distribution was somewhat rectangular with mode at the extreme left. In this area, *Berberis lycium* was found in the first small class while in next classes *Berberis lycium* was associated with *Rosa webbiana, Hippo phaerhamnoides* and in this class, all three species were recorded with the density of 35%, while in the middle class, association of *Rosa webbiana*, *Hippo phaerhamnoides* and *Berberis lycium* were observed 65% density with some gaps. In the large class, there was no evidence of any individual which shows that this area is extremely disturbed and unstable. It is indicated that these important species may disappear if no counter measures are taken (Fig. 2.30).

Stand # 31 – Chungo 1

This stand is situated in Chungo 1. The elevation is 3010m above sea level on North exposure while degree of slope was 40°. *Rosa webbiana*, *Ribes orientale* and *Hippo phaerhamnoides* were the top three dominant species of this location. Total density was 1000 ha^{-1}. *Hippo phaerhamnoides* was the leading dominant species, containing 400 density ha^{-1}, associated species were *Rosa webbiana*, attaining 333 density ha^{-1} and *Ribes orientale* have 267 density ha^{-1}. This was also rectangular but with a modal value. In this structure, some individuals of *Rosa webbiana* were found in first small class while in the next class, all three species were found with almost similar density. In the next few classes, association of *Hippo phaerhamnoides* and *Ribes orientale* was found. The whole density of this class was 53%. While in middle class, some individuals of *Rosa webbiana*, *Hippo phaerhamnoides* and *Ribes orientale* were found with the density of 33% but some gaps were also seen. In the large class, some individuals of *Rosa webbiana*, *Hippo phaerhamnoides* were found with low density (14%) and also observed some gaps which suggests disturbance. These species need special attention for future existence (Fig. 2.31).

Stand # 32 – Chungo 2

This stand is located in Chungo 2. The elevation was 3109m above sea level on North-East facing while degree of slope was 35°. *Rosa webbiana*, *Berberis lycium* and *Hippo phaerhamnoides* were the top three dominant species of this location. Total density was 1200 ha^{-1}. *Hippo phaerhamnoides* was the leading dominant species with 400 density ha^{-1}. Associated species *Rosa webbiana* attained 333 density ha^{-1} and *Berberis lycium* shared 467 density ha^{-1}. This stand seemed to have a bimodal distribution but showed tendency towards being rectangular. In this diagram, small classes have all three species with the density of 55% while in the middle class, all three species were recorded with the density of 45%, which gradually decreased up to large class. There was no individual recorded in the large class. It shows that this vegetation is deteriorating under anthropogenic disturbance and that this bushy area may vanish in future. It is suggested that legal actions be taken to save these important species (Fig. 2.32).

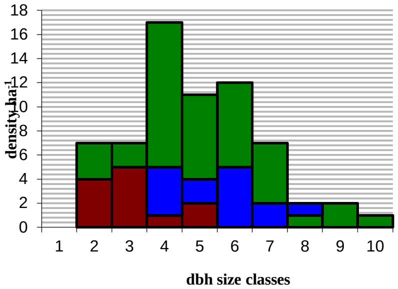
Discussion

Size class structure was prepared for each tree and bushy stand. In the forested area, *Picea smithiana, Pinus wallichiana* and *Juniperus excelsa* species existed while in non-forested areas *Rosa webbiana, Hippo phaerhamnoides, Berberis lycium, Ribes orientale, Ribes alpestre, Juniperus communis* and *Tamarix indica* were the major species. Among the forest stands, the highest density was recorded from Rakaposhi 2 (143 individuals ha^{-1}). *Picea smithiana* also existed as pure species and was dominant in 4 stands out of 9. Other associated species *Pinus wallichiana* occupied 17 to 94 individuals ha^{-1} while *Juniperus excelsa* attained 12 to 123 individuals ha^{-1}. In the small class, number of individuals was less which indicates that the recruitments of these forests are absent. Ahmed and Naqvi (2005) also found less individuals (12%) of *Picea smithiana* in 10 to 30cm class, 24% individuals in 50 to 70cm class and 46% individuals in 30 to 60cm classes. The present study also ranges with this study. Ahmed (1984) found low number of individuals in small class of Kauri with dense under-storey vegetation. On the other hand, Ahmed et al. (2006) observed high individuals (170 ha^{-1}) of *Pinus wallichiana* in the small class which gradually decreases in the large class.

dbh size classes of forested and non-forested vegetation of CKNP

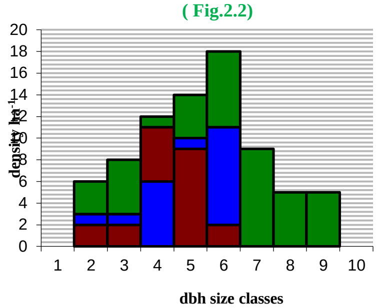
Stand 1
96 Density ha^{-1}

(Fig.2.1)



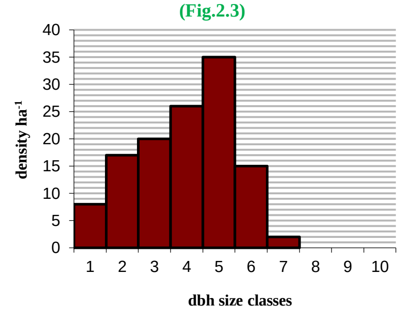
Stand 2
122 Density ha^{-1}

(Fig.2.2)



Stand 3
123 Density ha-^{1}

(Fig.2.3)

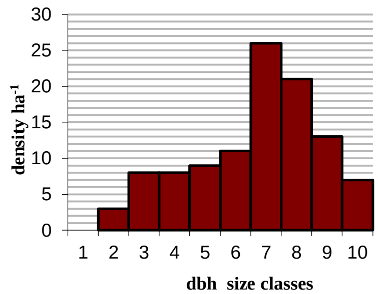


Stand 4
109 Density ha^{-1}

(Fig.2.4)

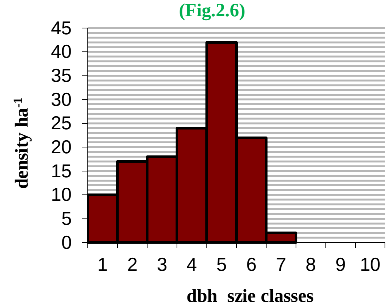
Stand 5
106 Density ha-1

(Fig.2.5)



Stand 6
135 Density ha^{-1}

(Fig.2.6)

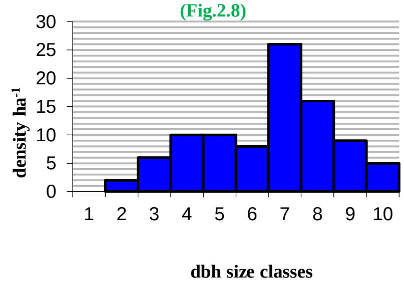


Stand 7
143 Density ha^{-1}

(Fig.2.7)

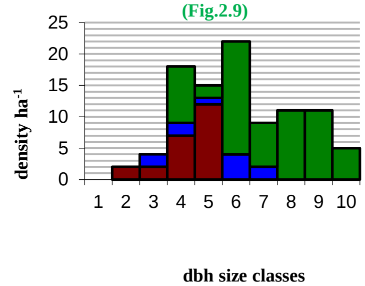
Stand 8
94 Density ha^{-1}

(Fig.2.8)



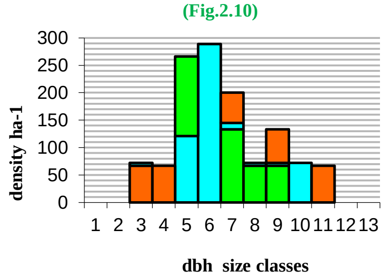
Stand 9
146 Density ha^{-1}

(Fig.2.9)



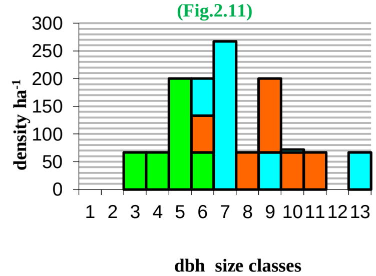
Stand 10
1733 Density ha-1

(Fig.2.10)



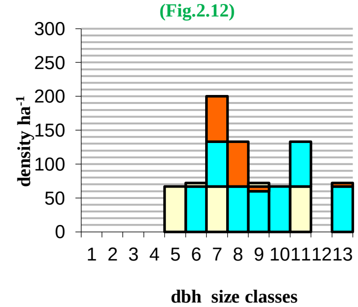
Stand 11
1600 Density ha^{-1}

(Fig.2.11)

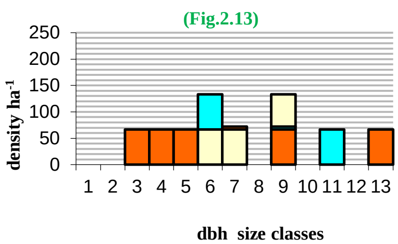


Stand 12
1200 Density ha^{-1}

(Fig.2.12)

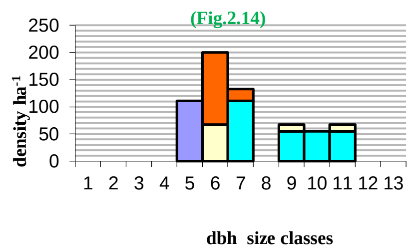


Stand 13
1000 Density ha^{-1}



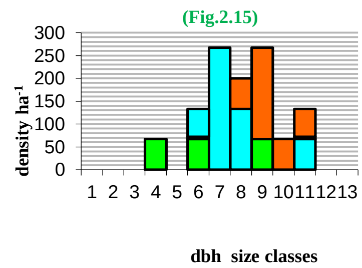
(Fig.2.13)

Stand 14
866 Density ha^{-1}



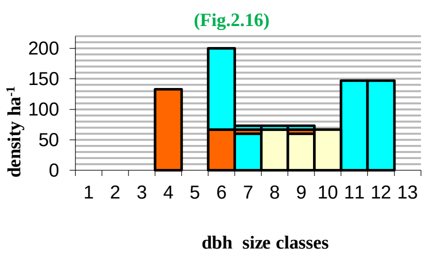
(Fig.2.14)

Stand 15
1733 Density ha^{-1}



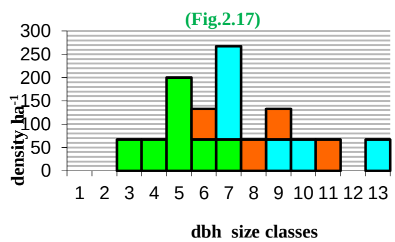
(Fig.2.15)

Stand 16
1333 Density ha^{-1}



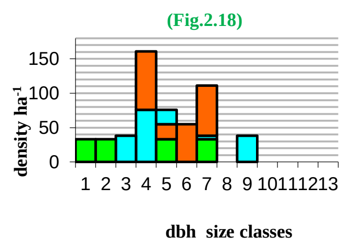
(Fig.2.16)

Stand 17
1867 Density ha^{-1}



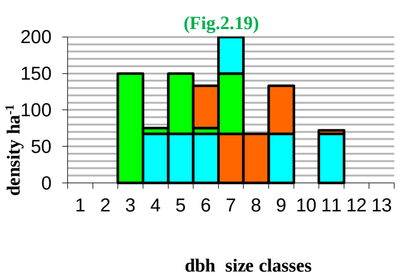
(Fig.2.17)

Stand 18
733 Density ha^{-1}



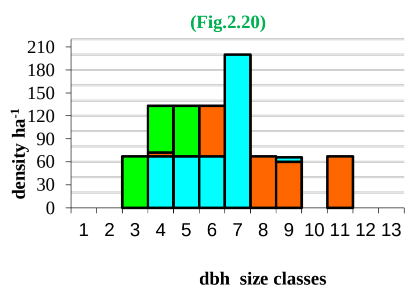
(Fig.2.18)

Stand 19
1600 Density ha^{-1}



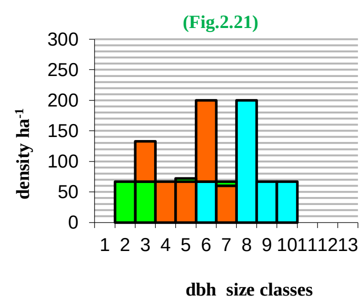
(Fig.2.19)

Stand 20
1267 Density ha^{-1}



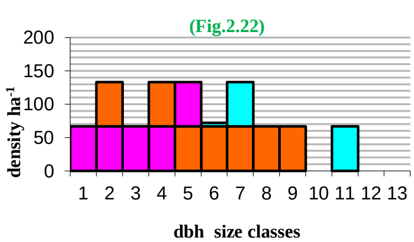
(Fig.2.20)

Stand 21
1199 Density ha^{-1}



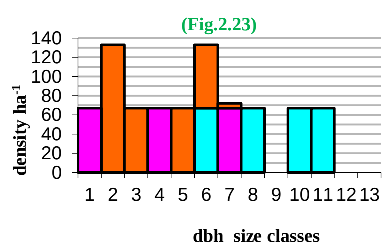
(Fig.2.21)

Stand 22
1266 Density ha^{-1}



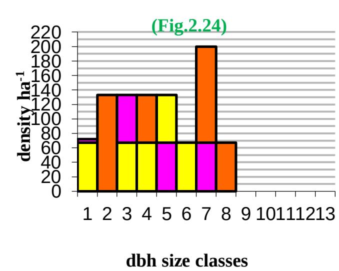
(Fig.2.22)

Stand 23
867 Density ha^{-1}

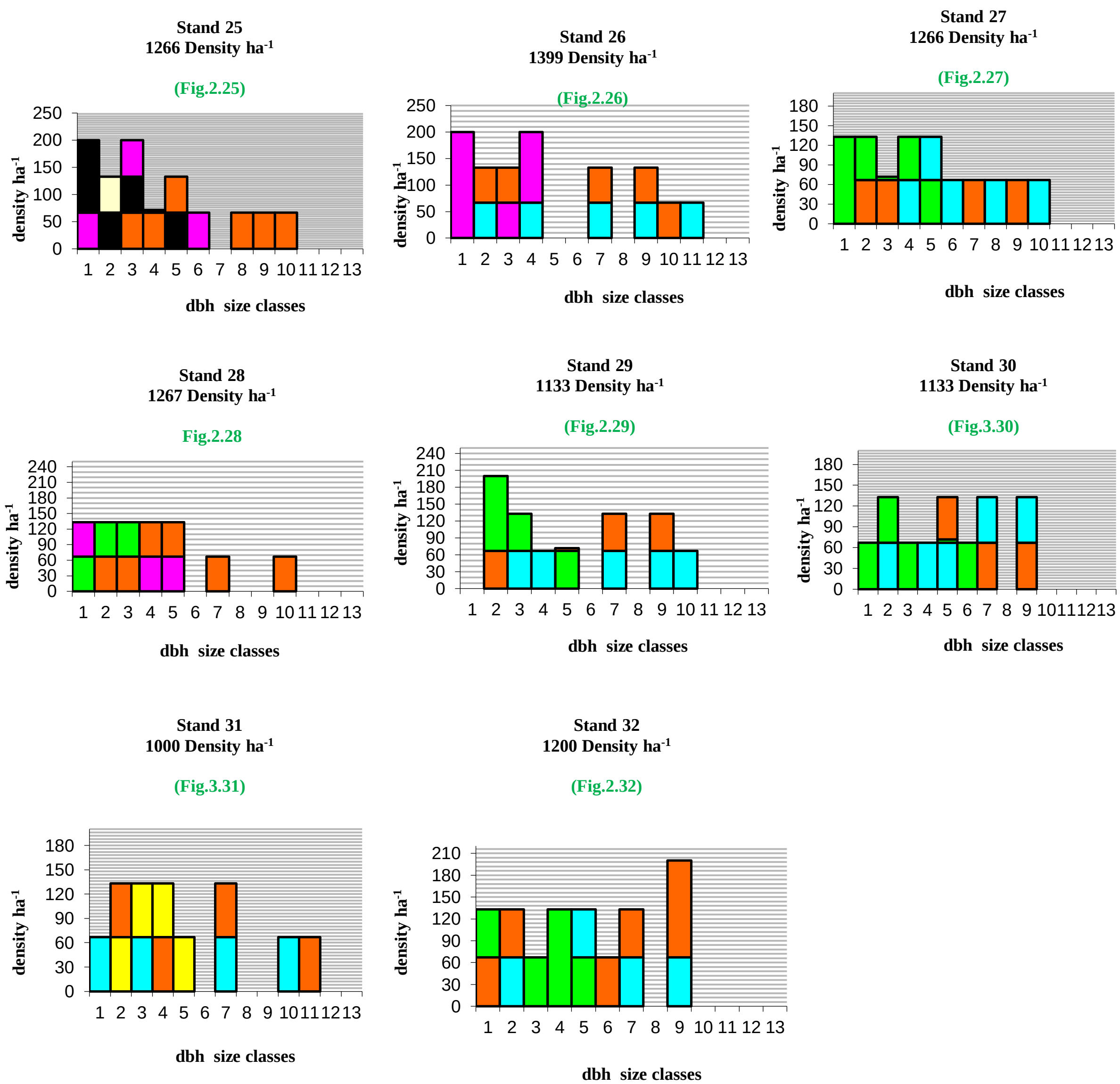


(Fig.2.23)

Stand 24
1266 Density ha^{-1}



(Fig.2.24)



Picea smithiana	
Pinus wallichiana	
Juniperus excelsa	
Rosa webbiana	
Hippo phaerhamnoides	
Berberis lycium	
Ribes alpestre	
Tamarix indica	
Ribes orientale	
Juniperus communis	

(Legend of the figures)

Fig. 2. dbh size classes of forested and non-forested vegetation of CKNP

Siddique (2011) also reported gaps in the different dbh classes from the moist temperate forest of Pakistan. These gaps do not mean that the particular size class species are absent but can rather be attributed to poor recruitment (Ahmed, 1984). Khan (2011) also reported some gaps in small size classes of *Picea smithiana* and Abiespindrow from the forests of Chitral Gol National Park. Wahab (2011) also found low individuals of *Pinus wallichiana* from Batharae valley and suggested that the seedling of the plant species need shelter and protection for better growth and survival. However, *Juniperus excelsa* attained high individuals (135ha^{-1}) in pure stand and small class also obtain high individuals as compared to other species. Khan (2011) found J-shaped uneven structure of forest *Pinus wallichiana* from Chitral Gol National Park while abundant individuals were found in the small classes (<30smdbh) in *Juniperus excelsa*. Wahab (2011) also found high density of recruitment from the valleys of Shahoor, Pennakot and Markhno forest of Dir district. The abundant amount in the small class indicates that there is a balanced structure of forest and in the future, these forests may attain a positive outcome to control human disturbance, overgrazing, logging and soil erosion. In the present study, it is noted that the forest is deteriorating with the passage of time. It may be due to human induced disturbance, overgrazing, soil erosion and logging.

In non-forested area, the highest density (1866 ha^{-1}) was recorded from Kowardo. In this stand, *Rosa webbiana, Ribes orientale* and *Berberis lycium* were found while *Rosa webbiana* was the leading dominant species among non-forested stands which appeared in 16 stands out of 23. The structure of these vegetation types show that there is a major influence of human beings, overgrazing by domesticated animals, soil erosion, storm and floods. Therefore, vegetation constituted by these important species is deteriorating and rapidly dwindling down with time. It is indicated that these economically and medicinally important species may be included in the red list. It is concluded that extreme anthropogenic disturbance prevails in this important national park. In forested area, gaps in small size class indicate about illegal cutting of young trees or no natural recruitment of the seedlings. Therefore, seedlings should be planted and grazing should be restricted. Gilgit, Baltistan and KPK have the highest annual rates of deforestation of about 34,000 and 8000ha, respectively (Ahmed et al., 2012).

In non-forested areas, gaps in young classes show sign of overgrazing. It seems that species distributed in one or low number of classes may disappear with time. However, species existing in greater number of size classes certainly have greater chances to prevail for greater duration. On the other hand, Cameron (1954) reported that due to lesser individuals of mature trees**,** their seedlings do not approach until the dense mature canopy begins to thin out by mortality. This situation creates regeneration gaps in their size structure**.** Competition also affects the dbh size class structure of the forest (Robbins, 1962). Ahmed (1984) added that the gaps in size class structure do not mean that the particular size class is absent from the stand and is due the poor recruitment potential in the past.

On the basis of above studies, it may be concluded that the species that are not reproducing or have lesser recruitment have greater chances of disappearing completely from the vegetation. The size class structure data is useful to understand the present status and future trend of the vegetation. The concept of climax species should be well represented in all size classes which is showing regeneration and replacing itself from a region. However, the species which are found in the largest size class may gradually disappear from the population (McCune and Grace 2002). It is desirable to resolve the relative importance of the undetermined factors associated with the present status, future trend and the interaction of the species to understand the structure of the forest (White, 1979).

In the study area, most of the stands did not show the ideal situation and no inverse J-curve is formed. Seven stands showed the positively skewed distribution, 5 stands attained flat distribution, 4 stands achieved normal distribution, 3 stands distributed in rectangular shape, 3 stands have bimodal shaped, 3 stands attained unimodal while the remaining stand distributed with U- and leptokurtic shapes. Such distribution indicates disturbance (Spies, 1998).

The old growth forests are approaching an equilibrium condition and exhibited an irregular size structure but anthropogenic disturbance allowing new individuals to emerge and creating unimodal, bimodal and multimodal distributions, such as, those which were observed in the present study (Leak, 1996). In the study area, the small classes are absent or less individuals found. This may be anthropogenic disturbance because people used poles (small size trees) to make huts and construct houses. This is a non-ideal situation in which the small class has less individuals. Therefore, the regeneration of these forests is poor and these frosts are in critical situation. Some gaps were also noticed in the middle and large size classes. This may be due to illegal cutting and soil erosion. In the study area, flat distribution is reported from some stands. This type of structure does not suggest any future trend which was primarily due to the extensive cutting, soil erosion and logging.

However, less individuals in small class indicated lack of recruitments in the area. Wahab et al. (2008) also reported this type of distribution in *Picea smithiana* from Afghanistan. Ahmed et al. (2010) also found the similar situation in *Cedrusdeodara* from the Hindukush and Himalayan regions of Pakistan. It is suggested that due to the different disturbances, present status and situation of recruitments, each forest should be treated on individual basis. These forests could be managed after full protection of seediness. The size class structure not only indicated present status but also shows future trend of the forest. If prompt and essential steps are not taken to protect these forests, this vegetation will disappear with the passage of time. Ahmed (1988), Ahmed et al. (1990, 1991, 2006, 2009, and 2012), have similar observations from different regions of the Pakistan. Considering special need, special attention for the sake of future generation and biodiversity should be given. In this regard, it is suggested that legal action be to protect this important park

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