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SIZE CLASS STRUCURE OF SOME FORESTS FROM HIMALAYAN RANGE OF GILGIT-BALTISTAN

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Abstract

The investigation of forest size class structure was carried out in 40 stands from 15 different locations of Astore, Gilgit and Skardu, districts of Gilgit-Baltistan, Pakistan, ranging from 2616-3735 meters above sea level (a.s.l.). This study attempts to expose the present status and future trends of arboreal vegetation in these areas. Size class showed varied distribution patterns in different stands. Most of the deviation from an ideal distribution may be explained in terms of anthropogenic disturbances, i.e., grazing, cutting, sliding, burning and other human induced factors, therefore, these forests are not in the stable condition. It is concluded that if prompt action not taken to stop current damaging practices, these valuable forests will vanish in a few decades.

Keywords: Stands, Structure, Trends, Anthropogenic disturbances.

Introduction

Vegetation of the Districts Skardu, Giglit and Astore was described in detail by Akbar et al. (2010, 2011)

Forest vegetation and structure ha been studied in Pakistan by many researchers from different locations. Ahmed (1976) carried out multivariate analysis of vegetation of Skardu. Ahmed and Qadir (1976) conducted a study of communities near road sides from Gilgit to Shandur. Ahmed (1986) investigated the vegetation of some foothills of Himalayan range of Pakistan. Ahmed (1988) presented population structure of planted tree species of Quetta, while population structure of *Juniperus excelsa* M.B. and *Pinus gerardiana* Wall.ex Lamb. from Baluchistan was studied by Ahmed et al. (1990) and Ahmed et al. (1991), respectively. Ahmed et al. (2006) also presented phytosociology and structure of various Himalayan forests from different climatic zones of Pakistan. Wahab et al. (2008) carried out Phytosociology and dynamics of some pine forest of Afghanistan, close to the Pakistani border. Vegetation structure of *Olea ferruginea* forest of Lower Dir was presented by Ahmed et al. (2009). Siddiqui et al. (2009) carried out Phytosociology of *Pinus roxburghii* Sergeant (Chir pine) in Lesser Himalayan and Hindu Kush range of Pakistan.

Khan et al. (2010) conducted phytosociology, structure and physiochemical analysis of soil in *Quercus baloot*, forest from District Chitral. Akbar et al. (2010, 2011) also explored the phytosociology, structure and community description of Gilgit, Astore and Skardu District. Hussain et al. (2010, 2011) presented phytosociology, structure and community description of Central Karakorum National Park. Shaheen et al. (2011) studied structural diversity, vegetation dynamics and anthropogenic impact on lesser Himalayan subtropical forests of Bagh district Kashmir.

The above studies include some forested areas of Gilgit-Baltistan, Pakistan, and these are

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not sufficient to describe diverse types of forest communities and population structure in different climatic areas of Gilgit-Baltistan. Therefore, in this paper we tried to include some more locations of different forested areas of Himalayan and Karakorum Range of Pakistan which is expected to extend the information about the forest structure of this area. It is hoped that this study would help to mange and conserve the valuable natural forest in future.

Map of sampling area

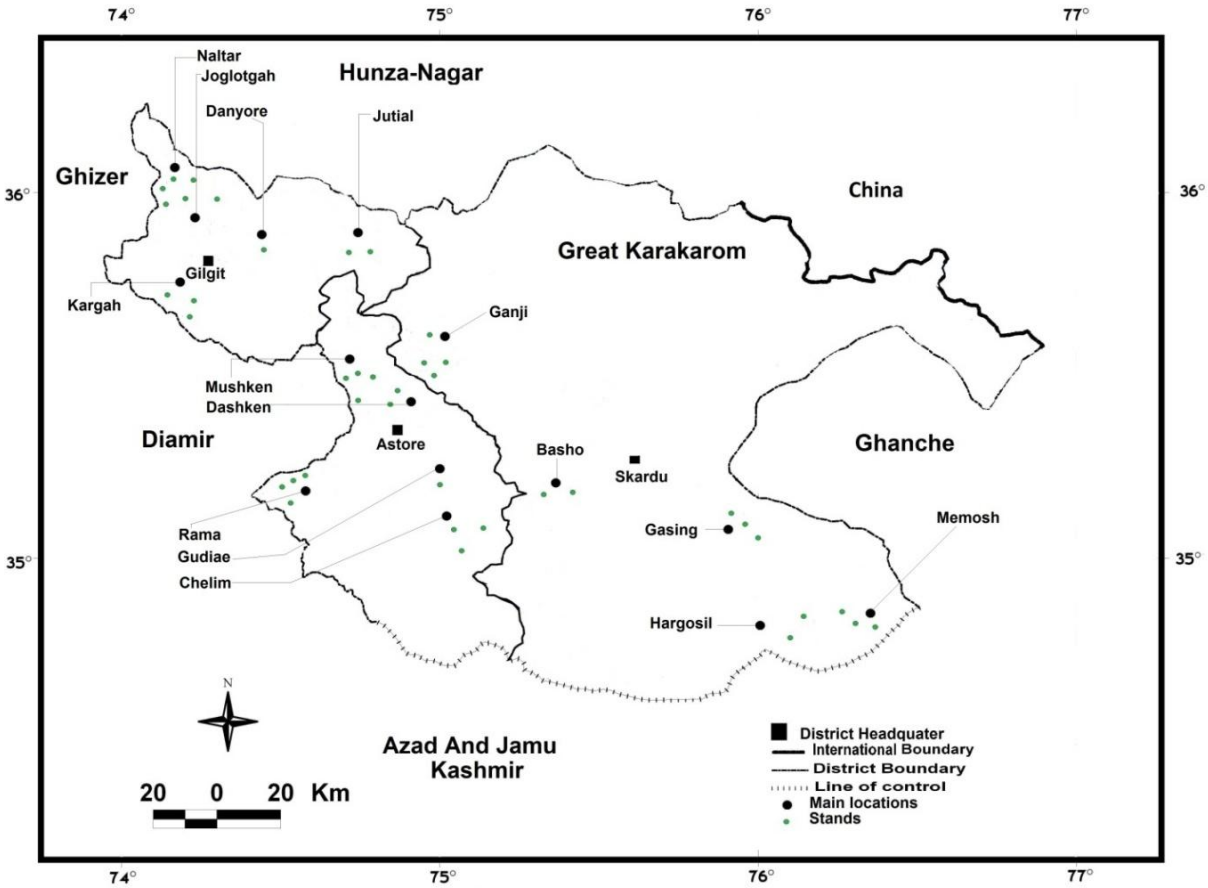


Fig.1. Map showing main sites of Gilgit, Astore and Skardu Districts of Gilgit-Baltistan. Details of stands are given by Akbar et al. (2011).

Materials and Methods

The study was conducted using Point Centered Quarter method of Cottam and Curtis (1956) applied in different forests of Skardu, Gilgit and Astore Districts. Twenty points were taken at 20-meter intervals. Vegetation sampling was carried out according to the criteria that it contained trees at least (60 cm dbh) (diameter at breast height) and covering at least two hectares (ha) in area. Environmental characteristics, i.e., slop angle, geographical coordinate, elevation and aspect, were recorded by GPS.

Diameters at breast height (dbh) of each tree species in a stand were divided into (10cm dbh) various size classes and size structures of coniferous trees are presented using MS Excel 2003, furthermore, in each stand, size classes divided into four categories, i.e., small size classes (10 to 30 cn dbh), middle size classes (40 to 60 dbh cm), large size classes (70 to 90) and above (90 dbh) extra large size classes. Plants specimens were collected from the studied area and identified with the help of flora of Pakistan (Nasir and Ali, 1972).

Results and Discussion

Study area map is shown in Fig.1. Only well-known areas and the closest locations are shown in the Fig. 1 with details of study sites as given by Akbar et al. (2011). Diameter size class structure of each stand is presented in Fig. 2. The size-class structure are described and discussed below:

Stand No. 01: Basho-A stand was located in between 35°.17 and 71°.38 E with 3700 m a.s.l. *Pinus wallichiana* was found as leading tree species with 148 stems ha^{-1} with moderate canopy on North East exposure. The slope angle of this stand was 35°. Basho is one of the remote valley of Skardu District. *Juniperus excelsa* was observed as co-dominant species attaining 18stems ha^{-1}. Size class structure of *Pinus wallichiana* was satisfactory because in small size classes, it appeared with 28% individuals, in middle with 51% and large classes showed 12% distribution while there were no extra large trees. *Junipersus excelsa* showed 7% trees in small size classes and it showed some gaps in middle classes with 2% density. No tree was seen in higher classes, therefore, the size class structure of *Juniperus excelsa* was not satisfactory. The gap in small size classes indicating no regenerations possibility because seedlings were destroyed due to the extensive grazing by livestock. This situation may be improved by controlled grazing and replanting seedlings. The structure of this stand showed more or less normal distribution with some positive skewness. This means that this stand shows very low reproduction, low recruitment and high number in medium size class. Sliding, cutting and grazing were common phenomena while many boulders were exposed due to soil erosion in this forest. If the present activities do not stop these Juniper trees will disappear in the years to come.

Stand No. 02: Basho-B was also situated on north-east exposure having same geographical coordinates closed to stand one with open canopy and 3350 meter above sea level. The slope was 30°. *Pinus wallichiana* was as a dominant species having 159 stems ha^{-1}. This species contributed 28% in small size classes, 54% in middle classes, and 10% in large classes while no extra large tree was recorded. *Juniperus excelsa* appeared as a co-dominant species with 12 stems ha^{-1} and this species entertained 3% in small size classes, 3% in middle size classes and 2% in large size classes. The size classes of *Pinus wallichiana* showed ideal distribution pattern while size class of *Juniperus excelsa* showed some gaps in small size classes. No tree of *Juniperus excelsa*was observed above 60 dbh cm. Size class structures of this stand designate normal with slight positive skewness. Huge cutting, soil erosion and sliding were observed in this site. Grazing was common in this forest. Due to the poor distribution in small size classes, *Juniperus excelsa* seems to be loosing ground in this forest.

Stand No. 03: Gasing-A lies between 35°.09 N and 75°.98 E with 3500 m a.s.l. facing the East facing slope. The slope angle of this stand was 25° with moderate canopy. Gasing forest is located on the upper site near Deosai plateau. Three tree species were recorded, among them *Piuns wallichiana* was the first leading dominant species showing the highest density of 132 stems ha^{-1} while the 2nd leading species *Juniperus excelsa* was observed with 42 stems ha^{-1}. The associated angiospermic tree *Betula utilis* appeared with 21 stems ha^{-1}. In small size classes *Pinus wallichiana* received higher density with 39% individuals, in middle size classes 27% individuals while large size classes received 2%. *Juniperus excelsa* was attained higher value 16% in small size classes and gradually decreases when dbh size classes increase so in the middle size classes 4% individuals were present. *Juniperus excelsa* showed some gaps in large size classes with 1% individuals, these gaps indicated that the large size trees of this species were removed in the past. The dbh size classes showed roughly inverse J-shaped structure. This is an ideal structure of size classes in this forest, the lower size classes show high number of individuals with decreases with the respect of the middle and higher size classes. In this forest, *Juniperus excelsa* was highly under pressure due to the disturbances, i.e., cutting, grazing etc. *Pinus wallichiana* is showing better distributional pattern while *Juniperus excelsa* showing gape in large classes, indicating the old trees that were removed from this forest. If special action will not apply to save this species, it will be disappeared first from this forest.

Stand No. 04: The study site Gasing-B was also situated between 35°.09 N and 75°.98 on west exposure with close canopy. The slope was 20°

with 3400 m a.s.l. *Pinus wallichiana* was appeared as first leading species with 132 trees/ha, while the second dominant species was *Juniperus excelsa* obtained 42 stems ha^{-1}. *Betula utilis* also associated as 3rd dominant with 21 stems ha^{-1}. In this stand, trees above than 60 dbh cm were not found. In small size classes, *Juniperus excelsa* received high density with 22% individuals but decreases in middle size classes with 1% individuals. No *Juniperus excelsa* trees were found above 40 dbh cm. *Pinus wallichiana* and *Betula utilis* showed suitable distribution pattern in every class in small and middle size classes with 27% and 9%, 29% and 12%, respectively. Due to the heavy cutting, large size classes are vanished. The size classes of Gasing-B showed normal distribution with positive skewness. Mostly trees were in bad shape due to the cutting and grazing practices. Future trend of this forest cannot be considered acceptable.

Stand No. 05: This forest was explored from Gasing valley of Sub Division Kharmang between 34°.68 N and 75°.98 E on 3600 m a.s.l. The slope was 27° facing on North, while due to the heavy cutting the canopy was opened. Three different tree species, *Pinus wallichiana*, *Juniperus excelsa*, and *Betula utilis*, were recorded having 19 trees/ha, 129 trees/ha, and 14 stems ha^{-1}, respectively. In this forest, trees in large size classes were not seen. *Juniperus excelsa* received 70% individuals in small and 10% in middle size classes. This species showed the best distribution as compared to other two species. *Pinus wallichiana* and *Betula utilis* appeared in small size classes with 10%, 7% and in middle 1%, 2% individuals, respectively. These two species showed very poor distribution due to the excessive cutting. Entire stand size classes showed inverse J-shaped structure. The distribution of *Pinus wallichiana* and *Juniperus excelsa* is not satisfactory. If prompt action is not taken and conservation plan is not imposed these species will vanish in near future.

Stand No. 06: On the East exposure with scattered canopy and 20° slope, the Hargosil-A was located between 34.75 N to 76.14 E on the elevation of 3586 m a.s.l. This is one of the nearest sites to Kargil Border. *Piuns wallichiana* attained 73 density/ha as leading species while the co-dominant *Juniperus excelsa* showed 10 stems ha^{-1}. Due to cutting and other anthropogenic disturbances, the canopy was scattered. Small and middle size classes of *Pinus wallichiana* attained higher values with 59% and 23%, while decreased values in large size classes. Small size classes of *Juniperus excelsa* attained 10% and middle size classes 2% individuals. There were no *Juniperus excelsa* trees above 50 dbh cm. Size classes showed incomplete normal distribution (right half). This means that there is no reproduction, occurring only the medium sized trees are present. In this forest, the future trend of *Pinus wallichiana* is better than that of *Juniperus excelsa* because the distribution pattern of *Juniperus excelsa* is unsatisfactory. Therefore, proper management and conservation plan should be introduced by the stakeholders to save the future of this forest.

Stand No. 07: This was recorded from Hargosil valley of Sub Division Kharmang between 34°.68 N to 76°.15 E and the elevation was 3464 m a.s.l. This was also nearest to Kargil border. The slope was 15°, while the canopy was opened, facing on north exposure. *Pinus wallichiana* was recorded as dominant species with 39 density/ha, while the *Juniperus excelsa* recorded as co-dominant species with 3 stems ha^{-1}. *Pinus wallichiana* received 51% in small, 32% in middle and 5% individuals in large size classes while *Juniperus excelsa* showed 10% in small and 2% individuals in middle size classes. In this stand, *Juniperus excelsa* received less density as compared to *Pinus wallichiana* and no tree of *Juniperus excelsa* was found above 40 dbh cm. It is anticipated that *Juniperus excelsa* species will disappear soon. The size classes of this stand showed inverse-J-shaped structure on overall bases.

Stand No. 08: Memosh is one of the remote and small valleys of Sub Division Kharmang. Memosh-A stand distributed between 34°.71 N and 76°.17 E on north-east facing with (35°) slope and open canopy with the 3463 meters elevation above sea level. *Pinus wallichiana* occupied 114 density/ha as first dominant species and the co-dominant species *Juniperus excelsa* showed 11 trees/ha while the associated *Betula utilis* contributed 3 stems ha^{-1}. The density of *Pinus wallichiana* was satisfactory showing 46% individuals in small, 35% in middle and 8% in large size classes while *Juniperus excelsa* occupied 2% individuals in small, 3% in middle

and 4% in large size classes. The small size trees of *Juniperus excelsa* may be removed soon, showing gapes in small class. *Betula utilis* appeared just in size class number 2 and 4 with 2% individuals. Size classes of this stand represented part of normal distribution (right half). Illegal cutting and soil erosion disturbed trees were recorded in this site. The distribution pattern of *Juniperus excelsa* and *Betula utilis* showing these species may be vanished with the passage of time if suitable action is not taken immediately.

Stand No. 09: Memosh-B site is located between 34°.72 N and 76°.17 E facing slopes with 3414 m a.s.l. The canopy was opened while the slope angle was 30°. *Pinus wallichiana* was the first leading species with 158.4 density/ha and the co-dominant species *Juniperus excelsa* occupied 22.49 density/ha while the associated angiospermic tree *Betula utilis* showed 6.15 trees/ha. In small size classes, *Pinus wallichiana* showed 44% trees, in middle size classes 38%, and in large size classes 10% individuals. This species showed better distribution as compared to other two species. However, due to cutting, no tree was seen above 80 dbh cm. *Juniperus exscela* attained 2% in small and 2% individuals in large, showing gaps in middle classes. Therefore, in this forest *Juniperus excelsa* may disappear first, followed by *Betula utilis*. To save these two species, conservation plan and regeneration of seedlings must be promoted by the forest departments and other concern stakeholders. Due to the illegal cutting and other anthropogenic disturbances this forest is highly under pressure. Cut stem and misshaped stems were observed in whole forest. However, the size classes of this stand show roughly linear negative relationship. This means that this stand is showing high reproduction and recruitment and a constant decrease in large size-classes.

Stand No. 10: This stand was situated between 34°.73 N and 76°.18 east longitude, facing on east exposure with 23° slopes. The elevation was 3477 m a.s.l., while the canopy of the forest was moderate. Memosh-C is also near to Kargil border. *Pinus wallichiana* was the leading species, having 180 stems ha^{-1} and *Juniperus excelsa* appeared as co-dominant species with 23 stems ha^{-1} while the associated angiospermic tree *Betula utilis* attained 8% stems ha^{-1}. Small size classes of *Pinus wallichiana* received 52% individuals and it is decreased in middle (31%) and large size classes showed 2% individuals. *Betula utilis* and *Juniperus excelsa* showed 5% and 1% in small size classes and 5% and 2% in middle size classes, respectively. In large size classes, no individual of *Juniperus excelsa* was seen while 1% individuals of *Betula utilis* were present. This shows that these species were under high stress. In this forest, distribution pattern of *Pinus wallichiana* is satisfactory while *Juniperus excelsa* and *Betula utilis* indicated that these species may vanish soon from this forest. Conservation plan should be introduced immediately to save the future of these two species. Size classes of this stand showed roughly linear with negative trend due to illegal cutting, sliding, and grazing. If present practices will not stop, these species will be disappeared with the passage of time.

Stand No. 11: Ganji is one of a small valley of Sub-Division Rundo. Ganji-A is located between 35°.56 N and 78°.98 E with 15° slope and South-East facing exposure. The elevation was 3310 m a.s.l., while the canopy was closed. This was pure stand of *Pinus wallichiana* having 309 stems ha^{-1}. The size classes showed close to normal distribution but some gaps were found in lower classes with the density of 5%, while in the medium size classes, it was 56%. The stand showed satisfactory that gradually decreased in the large size classes with 39% but no extra large trees were seen. Low density in smaller size classes indicates that there is very poor recruitment of seedlings. This situation may be improved by promoting the seedling growth.

Stand No. 12: This mix forest of *Pinus wallichiana*, *Betula utilis* and *Juniperus excelsa*, Ganji-B is located at 3472 meters elevation between north latitude 35°.56 and east longitude 74°.98 on South-West, facing with the slope of 35°. The total tree density was 214 stems ha^{-1}. The dominant tree *Pinus wallichiana* and co-dominant *Betula utilis* were determined 99 and 78 $stemsha^{-1}$, respectively, while the associated *Juniperus xcelsa* attained 37 stems ha^{-1}. Small size classes of *Pinus wallichiana* shared 5% individuals but the number of individuals increases with increase in the dbh size. In middle 16% and in large size classes 25% individuals were recorded. *Betula utilis* contributes 3% in

small size classes, 30% in middle size classes and 4% individuals in large size classes. *Juniperus excelsa* attained 8% individuals in small size classes, 7% in middle and 2% in large size classes. In this stand, small size classes of *Pinus wallichiana* and *Betula utilis* showed low density. This shows that lesser numbers of seedlings are reproducing or the seedlings are under the pressure by the livestock's grazing. This situation may be prevented by proper regenerations of seedlings and conservation plan. Size class diagram showed roughly normal with some negative skewness. No extra large tree was observed. This forest is also under the natural and human induced turbulence. If the proper conservation activities will not be imposed this forest may disappear in upcoming years.

Stand No. 13: *Pinus wallichiana* and *Betula utilis* forest is situated on Ganji-C at the elevation of 3585 meter a.s.l., with the closed canopy between north latitude 35°.56 and east longitude 74°.98 on south-east exposure. The slope angle was 37° degrees. This stand was studied on the upper site of Ganji valley. The dominant tree species *Pinus wallichiana* occupied 168 stems ha^{-1}, while *Betula utilis* covered only 64 stems of total stand density. Distribution of trees of *Pinus wallichiana* was13% in small size classes, 24% in middle size classes and 35% in large size classes. Small size classes received less individuals, showing the disturbed regeneration process. *Betula utilis* also showed low density of 9% in small size classes while middle classes attained 19% individuals. Low density in small size classes identifying that there is poor recruitments of seedlings or the seedlings are destroyed by the grazing of huge livestock. This situation may be controlled by promoting of seedling growth and applying conservational activities. The size classes of this stand showed roughly normal with some negative skewness both species attained low density in small size classes between 10 to 30 dbh cm while showed large density between50 to 60 dbh cm. No individual of *Betula utilis* was observed above 60 dbh cm, while *Pinus wallichiana* was present in large size classes. The future of this stand does not seem to be secure.

Stand No 14: This stand was surveyed from Ganji-D located between 35°.60 north latitude and east longitude 74°.96 on south-east exposure at 3374 meter elevation a.s.l., with close canopy and 35° slope angle. Dominant tree *Pinus wallichiana* covered with 103 stems ha^{-1}, while the *Betula utilis* appeared with 49 stems ha^{-1}. *Pinus wallichiana* received 16% individuals in small size classes, 22% in middle and 6% in large size class individuals. In small size classes, *Betula utilis* distribution was very poor, small size classes and middle classes attained 13% and 18% individuals, respectively. The large trees were removed, therefore, no tree was seen in large size classes. Both species showed almost flat structure. In class 6, *Betula utilis* attained low density as compared with *Pinus wallichiana* but no *Betula utilis* was observed above 60 dbh cm, while *Pinus wallichiana* showed excellent density in higher size classes 70 dbh to 80 dbh cm. Few individuals were also present in the class 9 but no extra large individual was found in this forest. Forest showed roughly normal size class structure. In this forest, both species are showing poor density in small size classes. This pattern shows that there is poor recruitment of seedlings while the gaps in small size class show harvesting. In this forest, all the species are under risk if no conservational action is taken.

Stand No. 15: This mono-specific pure stand (Kargah-A) of *Picea smithiana* was observed from Kargah Valley of District Gilgit which was located at 3255 a.s.l. meters elevation between North latitude 35°.76 and East longitude 74°.17 on North-East exposure with 35° slope angle and moderate canopy. The density of *Picea smithiana* was 92 stems ha^{-1}. In this stand, middle and large size classes showed good distribution with 48% and 34% individuals while small size classes received 14% individuals. Density of small size class shows poor recruitment of seedlings while gaps in early class indicated no recruitments. This situation may be recovered by promoting seedlings regeneration. The size class structure represented roughly normal with platykurtic trend. This means that this stand is showing low reproduction and recruitment with relatively greater number in medium size-classes and also shows an adequate reproduction and recruitment but gaps in large size-classes indicates excessive harvesting in these size-classes. Gap was found in the begging but middle and large classes showed high density beside some extra large individuals were also found in this stand. Future of this forest

is under threat due to gaps in small size classes, however, this forest may be saved by little effort.

Stand No. 16: Kargah-B Stand situated at 3427 meters elevation a.s.l., on East exposure between North longitude 35°.74 and East longitude 74°.19 with 33° slope angle and open canopy. The density of this forest was 106 stems ha^{-1}. In this forest, the *Picea smithiana* received few trees (9%), while middle size classes and large size classes attained 42% and 41%, correspondingly. In this stand some extra large size trees were recorded. Size class structure showed roughly normal distribution with negative skewness. Less number of individuals in small size classes indicated that there was no proper recruitment. This situation may be controlled by promoting seedlings regeneration.

Stand No. 17: Kargah-C forest was located between North latitude 35°.72 and East longitude 74°.18 at 3216 meters elevation a.s.l., on South-East exposure with 25° slope angle and open canopy. This was mono-specific pure forest of *Pinus wallichiana*. The density of this species was 99 stems ha^{-1}. Small size classes attained 23% trees and also a gap was found. The middle size and large size classes attained 39% and 37% individuals while no extra large trees were seen. This was also unsound. Size class structure showed roughly normal but missed small size classes. The gap and low density of small size classes show that there is no recruitment of seedlings in this forest or it may be destroyed due to grazing by the livestock of local people. This situation may be easily controlled by reproducing seedlings and controlled grazing.

Stand No. 18: *Picea smithiana* and *Juniperus excelsa* forest stand (Jutial-A) was situated at 3250 meters elevation with moderate canopy between 35°.90 north latitude and 74°.75 east longitude facing North exposure and having steep slope 40°. The total density was 235 stems ha^{-1}, where the dominant *Picea smithiana* and co-dominant *Juniperus excelsa* added 161 and 73 stems ha^{-1}, respectively. *Picea smithiana* was not present in first size class, so there was a gap, while the small size classes received 6% whereas middle and large size classes showed 38% and 21% trees distribution respectively. *Juniperus excelsa* shared 20% in small, 6% in middle, 3% and 3% in large size classes. Size class structure showed roughly normal distribution with platykurtic trend. This forest is also under threat due to cutting and overgrazing. The distribution patterned of *Juniperus excelsa* seemed close to satisfactory whereas *Picea smithiana* showed very low density with gaps in small size classes. This shows almost no regeneration of seedlings, therefore, to save this species prompt action should be taken.

Stand No. 19: This pure *Picea smithiana* forest stand (Jutial-B) was situated at 3250 meters elevation between North latitude 35°.90 and east longitude 74°.74 facing on north exposure. The canopy was moderate with steep 40° slope. In this stand, single pure tree species density was 105 stems ha^{-1}. The size classes of the stand were roughly normal with some negative skewness. Due to the minor (19%) trees in small size classes, satisfactory condition is not shown. However, it could be controlled easily by adding seedlings and restricted grazing. In middle size and large size classes, tree distribution was better with 28% and 46% individuals, while some extra large size classes were seen. The future of this forest was also not secure because small size trees showed poor distribution.

Stand No. 20: *Picea smithiana* pure mono-specific stand (Naltar-A) distributed between North latitude 36°.09 and East longitude 74°.11 at 2930 m elevation asl. The canopy was moderate facing on south exposure with 36° slope angle. In this forest, the stand density was 237 stems ha^{-1}. Size classes of *Picea smithiana* showed in this stand more or less approaching normal distribution. The density was increasing from small size to middle but decreases towards the large size classes. In small size classes, 14% individuals were present, while the middle and large classes received 61% and 21% individuals, respectively. Some extra large trees were found in this stand. Cut stems, dead fallen trees and grazing was also recorded. Therefore, it is anticipated that small size trees were destroyed by grazing of cattle or there is no any recruitments of seedlings in this forest. However, this situation may be controlled by reproducing seedlings and the forest is still manageable.

Stand No. 21: Mono-specific *Betula utilis* stand (Naltar-B) was recorded between North latitude 36°.08 and East longitude 74°.11 at 2401 meters

elevation above sea level. This forest was facing on South with moderate canopy and on a steep slope of 40° degree. The tree density was 96 stems ha^{-1}. Structure of forest showed roughly normal with some skewness. The density distribution in small size classes was poor with 36% individuals but its increase in middle size classes (58%) and decrease towards large size classes 6% trees. Low density of small size classes indicated poor recruitments of seedlings while low density of large size classes points to the extensive cutting. No tree was observed above 70 dbh cm. Misshaped trees were recorded while soil erosion was seen. This forest also shows influence of disturbance. Large sized trees and small size trees were extensively cutting, so the future trend of this forest seems in unstable condition.

Stand No. 22: This pureforest of *Pinus wallichiana* (Naltar-C) was situated at 2893 meters elevation a.s.l. between north latitude 36°.11 and 74°.18 east longitude on slightly plain surface (5° degree). The canopy of this forest was moderate. Trees density was recognised as 113 stems ha^{-1}. Small size classes attained less number (35) of trees but, in middle classes, it increases and attained 62% trees, while in large classes few (3%) individuals were present but no old tree with 70 dbh cm was observed. The future of this forest may be protected. For this purpose, cutting, grazing and other kinds of disturbances should be stopped. The size classes of this forest showed roughly normal distribution.

Stand No. 23: *Betula utilis* pure forest (Naltar-D) was located at 2893 meters elevation a.s.l. between north latitude 36°.11 and 74°.18 east longitude on slightly plain surface. The slope angle was 5° degree with the moderate canopy. In this forest, the density of stand was 74 stems ha^{-1}. The small size classes received 13% trees with gap in first class. The middle size classes showed stable distribution with 77% individuals while large size classes also received less value 10% trees but no tree above 70 dbh cm were found. Distribution pattern of this forest was not satisfactory due to the gap in the first size class. It seems that small size class would show more gaps in future. This forest may be saved by promoting seedlings in this stand. Size classes of this forest showed roughly normal distribution with some negative skewness and gaps.

Stand No. 24: This mono-specific pure *Juniperus macropoda* stand was recorded only from Danyore between north latitude 35°.90 and east longitude 74°.42 at 3736 meters above sea level on steep (40°) slope facing North-East exposure with open canopy. Size class structure diagram showed more or less normal distribution with platykurtic trend. Small size classes have lower density with 24% trees, while the middle size classes showed higher density with 57% trees. Large size classes received 19% individuals. Middle class have stable distribution, while small classes have unstable distribution pattern. This shows huge cutting of young and old trees or poor recruitment from seedling. From an ecological point of view this forest is unstable.

Stand No. 25: At Joglotgah *Picea smithiana* forest lies between north latitude 36°.07 and east longitude 74°.24 at 3523 meters a.s.l., facing on West exposure. The canopy was moderate while slope angle was 35^0 degree. The density of pure forest was 216 stems ha^{-1}. Size class structure is approaching normal distribution. Small size classes have low density with 31% trees whereas middle size classes were showing higher density with 45% individuals and large size classes have low density with 24% trees. This suggests that due to poor regeneration of seedlings or extensive grazing by the livestock, small size classes are with low individuals. This may be controlled by promoting regeneration of seedlings, while the low number in older classes shows extensive cutting. This forest may be maintained with some efforts towards protection.

Stand No. 26: *Betula utilis* pure forest (Joglotgah-B) was studied between north latitude 36°.07 and east longitude 74°.22 at 3055 meters a.s.l., with moderate canopy and slightly plain surface. The stand density of this forest was 122 stems ha^{-1}. Size classes' structure showed roughly normal with negative skewness. In this forest, the density of small size classes showed poor distribution with 38% trees but it increases from small to middle size classes and showed 62% individuals. Large size class was without any individuals, which shows that the trees above 60 dbh cm were removed. Low number in small size classes indicated poor recruitments in this forest. These may be replaced by promoting regeneration of seedlings. Future of this forest is threatened by

extensive cutting and other kinds of disturbances. However, this forest can be saved by little efforts.

Stand No. 27: Thismono-specific forest of *Betula utilis* (Rama-A) was located between north latitude 35°.20 and east longitude 74°.48 at 3508 meters above sea level facing North-East exposure with open canopy and steep (40°) slope. This pure forest attained total density of 106 stems ha^{-1}. Size class structure documented roughly normal distribution with positive skewness. In this forest, the small size classes were showing good recruitment of seedling with 56% individuals. Middle size classes received 40% trees, while large size classes attained less than 4% trees as compared to earlier classes. Overall, small size classes showed good recruitments of seedlings, therefore, future of this forest can be assumed to be satisfactory.

Stand No. 28: *Abies pindrow* pure forest (Rama-B) was situated at 3464 meters above sea level, facing on North-West exposure between north latitude 35°.20 and east longitude74°.48 with moderate canopy and on steep 45° slope angle. Density of this forest was 107 stems ha^{-1}. This forest was only found in Rama Astore in whole study area. Size class structure was approximately normal with platykurtic trend. Small size classes show 37% individuals, while middle size classes received 47% trees, whereas large size classes attained 16% trees. The future trend of this forest is somewhat satisfactory because the value of smaller classes and middle classes were showed good regeneration of seedlings.

Stand No. 29: Mix forest of *Picea smithiana* and *Pinus wallichiana* (Rama-C) was observed at 3275 meters above sea level between north latitude 35°.20 and 77°.48 east longitude on South, facing with an open canopy and 35° slope angle. The total density was 68 stems ha^{-1} in which *Picea smithiana* and *Pinus wallichiana* contributed 45 stems ha^{-1} and 23 stems ha^{-1}. respectively. The size classes were showing some distribution from normal with a positively skewed trend. *Picea smithiana* received high value 35% trees in small size classes and in middle classes 21%, while in large classes 10% individuals. This feature shows satisfactory regenerations of seedling and normal distribution pattern. Small size classes of *Pinus wallichana* showed 10% individuals with a gap in first few classes while it attained 15% trees in middle classes and 9% in large size classes. In this forest, *Pinus wallichana* seems to be disappearing soonly because the gap in first class indicated no recruitment of seedling, so the future of *Pinus wallichiana* is not protected but *Picia smithina* showed good distribution.

Stand No. 30: *Pinus wallichiana,* pure forest (Rama-D), was studied at 3016 meters a.s.l. between north latitude 35°.20 and east longitude 74°.48 facing South exposure with moderate canopy and 15° slope angles. The density of this forest was 115 stems ha^{-1}. Small size classes received low density with 37% trees, while middle and large size classes attained 40% and 32% individuals, respectively. The size classes of this forest showed roughly normal with negative skewness. Due to poor recruitments of young seedlings, the earlier size classes have low number of individuals. This can be maintained by reproducing seedlings in this forest. Large size class structure showed a sign of disturbances. Presence of low number of individuals in small and large size classes is indicating that this forest is unstable and disturb condition. It is suggested that immediate consideration should be given to stop these activities otherwise this forest may be destroyed with the passage of time.

Stand No. 31: Another pure forest of *Pinus wallichiana* (Mushken-A) was found at 2691 meters elevation above sea level between north latitude 34°.49 and east longitude 74°.72, facing on East exposure on steep 40° slope angle with moderate canopy. The density of this forest was 99 stems ha^{-1}. Size class structure of this forest showed roughly normal distribution with platykurtic trend. The small size classes received low density with 31% trees as compared to middle size classes. Middle size classes attained 46% individuals, while large classes entertained 23% individuals. No extra large tree was seen in this forest. The first small class received very low density which indicates that the seedling recruitment is poor, while the large size classes received also low value indicating that this forest is highly disturbed due to cutting. Seedlings must be introduced for proper recruitment and special attention should be given to save the future of this valuable forest.

Stand No. 32: Mix forest of *Pinus wallichiana* and *Picea smithiana* (Mushken-B) was

distributed between north latitude 35°.48 and east longitude 74°.73 at 2719 meters above sea level facing South-East exposure with close canopy and 35° slope angle. Total density of forest was 138 stems ha^{-1}. *Pinus wallichiana* and *Picea smithiana* shared 95 stems ha^{-1} and 43 stems ha^{-1}, respectively. In this forest, *Pinus wallichiana* showed somewhat better distribution pattern in small size classes with 30% and 32% individuals, respectively, while large size classes attained 6% trees. *Picea smithiana* also showed satisfactory distribution pattern in small and large size classes with 10% and 4% individuals, while in middle size classes its received 18% trees. The low value of small size classes and large size classes identified anthropogenic disturbances. This situation may be ameliorated by promoting regeneration in this stand.

Stand No. 33. *Pinus wallichiana,* mono-specific pure forest (Mushken-C) was located at 2659 meters above sea level between north latitude 35°.48 and east longitude 74°.74, facing North-East exposure with 25° slope angle and close canopy. *Pinus wallichiana* attained 156 stems ha^{-1} density. The size classes showed normal distribution with platykurtic trend. The younger size classes received low density with 31% trees but the distribution of trees increases with middle size classes and large size classes attained 33% and 36% individuals, respectively. Earlier small size classes have low number of individuals indicating disturbance. It is suggests that the small sizes classes may show gaps in future. However, this distribution pattern may be recovered by promoting seedling regeneration in this forest.

Stand No. 34: Mushken- D pure forest of *Pinus wallichiana* situated between north latitude 35°.48 and east longitude 74°.74 at 3078 meter elevation above sea level, facing Northeast exposures with steep (40°) slop and moderate canopy. The density of this forest was 142 stems/ha. Size class showed somewhat bimodal distribution. This means that this stand is showing heaters harvesting in medium size classes. Small and large size classes obtained high value of 33% and 35% correspondingly while middle size classes received 31% trees. The distribution patterns in small and large size classes are satisfactory, while the middle size classes showed disturbances. In near future, this forest have no threat, however, situation may be improved by focusing attention on regeneration and stop logging.

Stand No. 35: This forest of *Pinus wallichian* and *Pinus gerardiana* (Mushken-E) was distributed at 2636 meters between north 35°.49 latitude and east longitude 74°.75, on North-East exposure with 30° slop angles and closes canopy. Here, the total density was 99 stems ha^{-1}, the leading species *Pinus wllichiana* attained 56 stems ha^{-1}, while the co-dominant *Pinus gerardiana* occupied 42 stems ha^{-1}. In this forest, *Pinus wallichiana* shows gap and 7% trees in smaller size classes while middle and large size classes received 30% and 35% individuals. *Pinus gerardiana* obtained high density (30% trees) and 12% individuals in middle size classes. *Pinus gerardiana* trees above 50 cm dbh were logged from this stand. Size classes of this forest showed somewhat bimodal structure. Distribution of *Pinus wallichiana* showed this species is deteriorating because gap is present in first class and small size classes received very low density. This gap may be controlled by promoting regeneration. *Pinus gerardiana* is showing satisfactory distribution pattern in small and middle classes though large sized trees have been cut down. The condition of the forest can be improved by paying attention to regeneration and seedling recruitment.

Stand No. 36: This mix forest of *Picea smithiana* and *Juniperus excelsa,* Dashken was located between 35°.46 north latitude and east longitude 74°.77 at 2616 meters above sea level, facing East exposure with the moderate canopy on steep (40°) slope. Total density of this forest was 108 ha^{-1}. *Pinus wallichiana* and *Juniperus excelsa* contributed 78 stems ha^{-1} and 30 stems ha^{-1}, respectively. The stand size class structure showed bimodal distribution. Illegal cutting and soil erosion were also seen in this forest. Small size classes of *Picea smithiana* attained low density with 16% trees, while middle and large size classes contained 33% and 23% individuals. *Juniperus excelsa* attained 15% trees with a gap in small classes, while middle size classes received 12% individuals, whereas, few (1%) trees were recorded. In this stand, *Juniperus excelsa* may disappear first because smaller classes have gaps and large trees have been cut

down. Diagram shows no recruitments in Juniper and poor recruitment in *Pinus wallichian*.

Stand No. 37: At Gudaie, *Pinus wallichiana* pure forest was situated at 3775 meters a.s.l. between north latitude 35°.17 and east longitude 74°.97 facing East exposure. The canopy was closed, having steep (50°) slop. *Pinus wallichiana* attained 147 density m/ha. Size classes showed roughly normal distribution but with some negative skewness. The distribution pattern of this forest is not showing stability. Small and large size classes show low density with 37% and 17% individuals while the middle size classes show stable distribution with 46% individuals. This situation indicates the disturbances in small size classes and large size classes. The future of this forest may be protected by promoting regeneration and proper management to control the illegal cutting and other anthropogenic activities.

Stand No. 38. This mono-specific pure forest (Chelim-A) was distributed at 3458 meters above sea level between 35°.03 north latitude and 75°.01 east longitude. Forest was facing on South-East exposure with close canopy, having steep (45°) slop. Here, the density was 108 ha^{-1}. The distribution pattern seems to be satisfactory. In small size classes, the density was high with 55% young trees though early size class showed low number of individuals indicating low recruitment. Middle and large size classes have 41% and 4% individuals, respectively. No sign of recent disturbances was recorded in this forest though large size trees, which were logged in the past. The future trend of this forest can be improved with some attention. Size class structure showed roughly normal but with positive skewness.

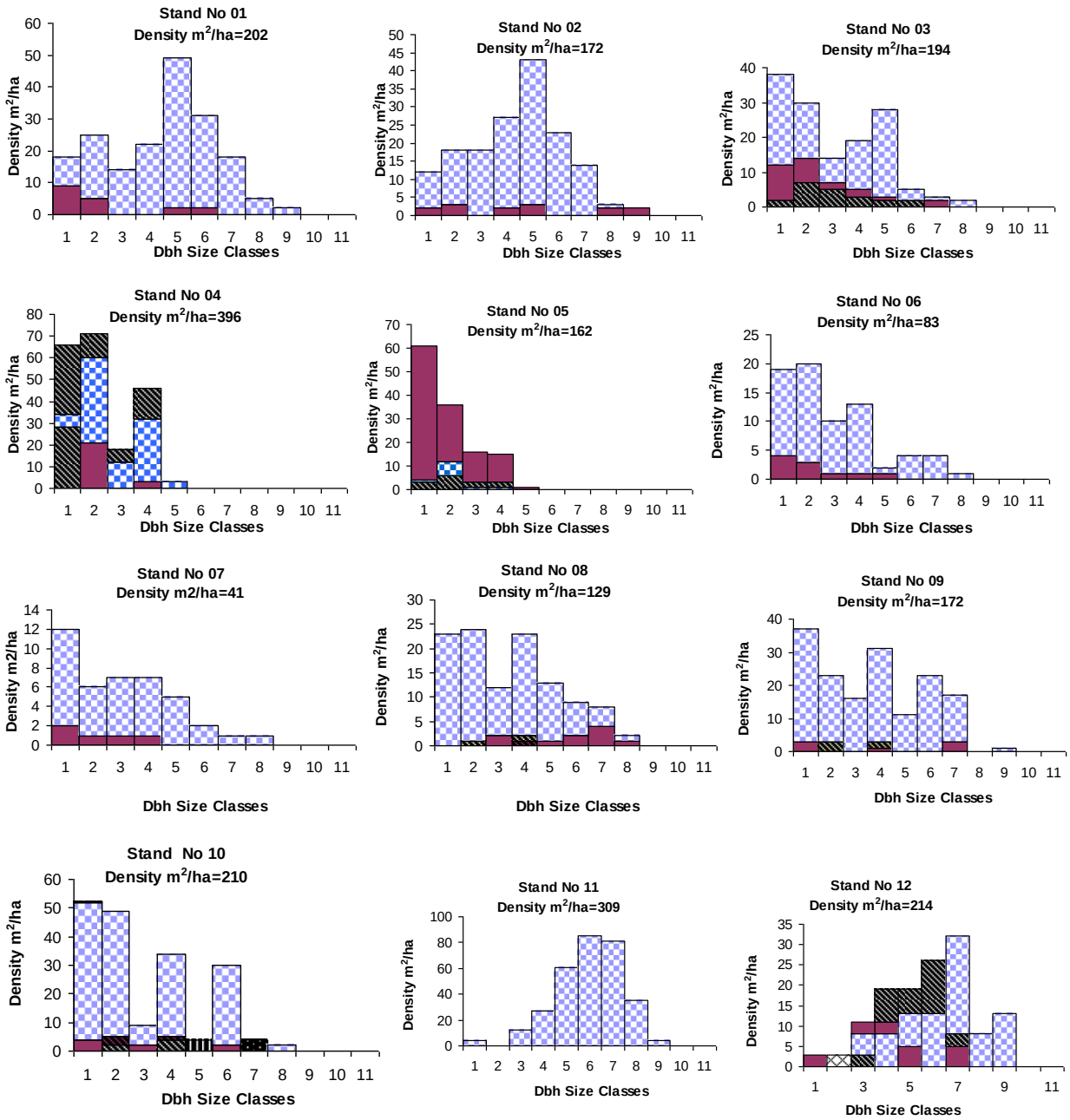
Stand No. 39: *Pinus wallichiana* and *Betula utilis* mix forest (Chelim-B) was investigated between north latitude 35°.01 and east longitude 75°.07 at 3559 meters above sea level, facing east on steep (40°) slop with moderate canopy. Total density of this forest was 122 m^2/ha. *Pinus wallichana* and *Betula utilis* shared 92 and 30 stems ha^{-1}, respectively. In this stand, *Pinus wallichiana* shows low density 18% trees with gap found in early class. Middle and large size classes attained 36% and 12% individuals. *Betula utilis* showed 23% trees in small size classes and 10% in middle size classes, while no large size tree above 50 dbh cm was seen. Size classes of this forest showed normal distribution with some fluctuations. This means that this stand indicates harvesting irrespectively of size classes. Low density in smaller size classes shows overgrazing of livestock while gaps in early class showed lack of seedling recruitment. The gap may be recovered by reproducing seedlings. The low number in large size classes shows extensive cutting. Therefore, the future of this forest may be affected by these disturbances so immediate action should be taken to save this forest. In general, the distribution patterns of both species were satisfactory though *Pinus wallichiana* has gap in early class. However, this situation can be improved by promoting young seedlings and controlled grazing.

Stand No. 40: Pure forest of *Pinus wallichiana* (Chelim-C) was studied at 3596 meters above sea level between north latitude 35°.00 and east longitude 75°.06, facing East with 20° slopes. Here the density of stand was 92 density/ha. In this stand, small size classes attained low (25%) density with a gap. Middle and large classes received 48% and 27% trees. The gap shows that the forest is highly disturbed due to the grazing and burning and the canopy seen scattered. This condition may be controlled by seedling regeneration. If urgent action is not taken to protect this forest it may be vanish gradually in future.

Present study shows that *Pinus wallichiana* is present in 14 stands as the leading dominant tree and as second dominant in 3 stands, while this species is distributed as pure stands at 10 sites. *Juniperus excelsa* appeared as first dominant only in Gasing-C with 72 stems ha^{-1}, while in 10 stands this species occurred as second dominant. *Betula utilis* was present in 1 stand as first dominant and in 4 stands as second abundant species, while it was also found in pure form in 4 stands. *Picea smithiana* was not recorded in any location of District Skardu, while from Giligit and Astore this species was recorded as a leading dominant in 1 stand, second leading in 3 stands and as pure population in 4 stands. *Juniperus macropoda* was recorded only from Gilgit in 1 stand as pure population. *Pinus gerardiana* was present only in Astore in 1 stand as second dominant. *Abies*

pindrow was only recorded from Astore in 1 stand as pure form. Most of the forests show gaps in earlier size classes with low density. This situation shows livestock overgrazing and cutting of young trees in which it is hard for young seedlings to survive. This situation may be overcome by promoting seedling regeneration in these areas but many stands also show gaps in large size classes, indicating extensive cutting. Due to the extensive cutting, the soil erosion was a common phenomenon in these forests and in many places rocks and boulders were exposed.

Size classstructureof 40 stands of the stduy area



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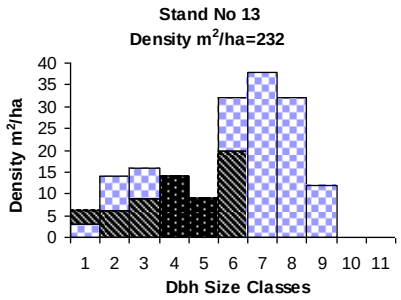

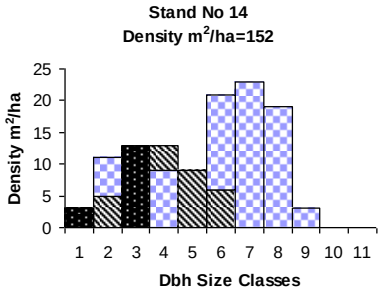

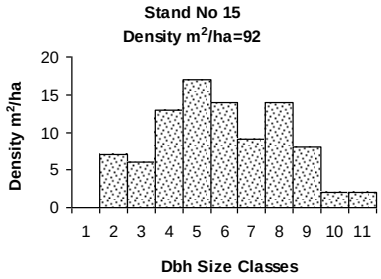

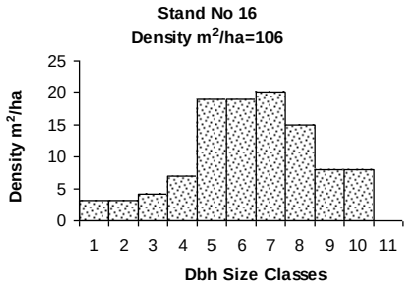

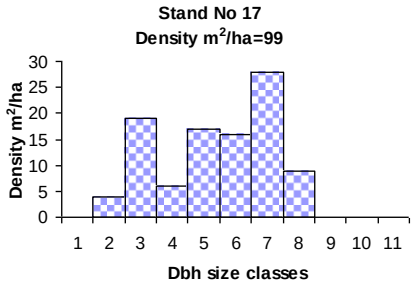

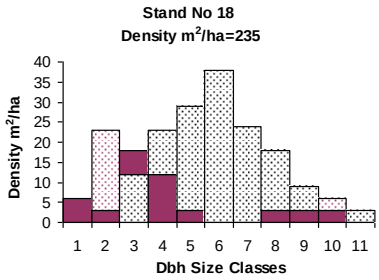

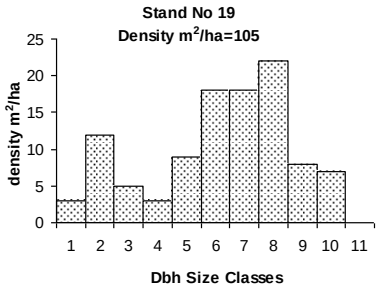

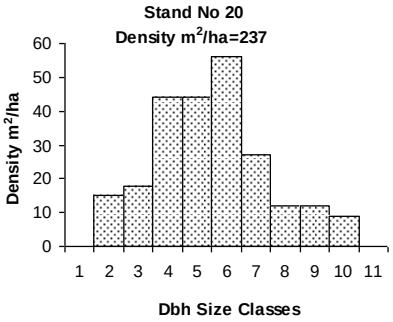

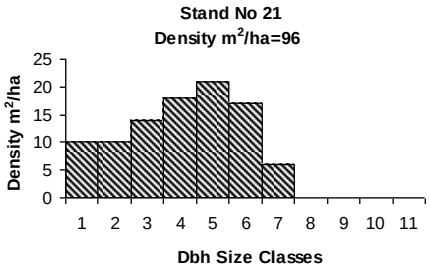

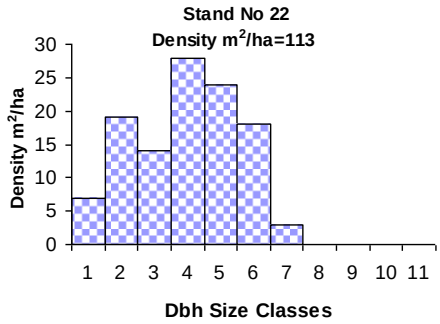

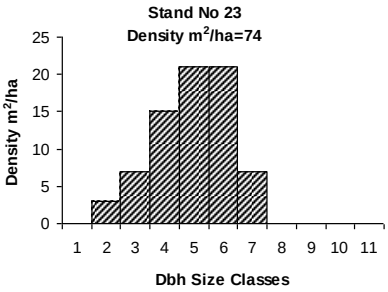

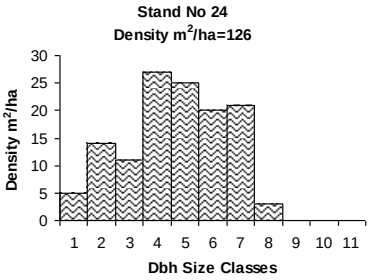

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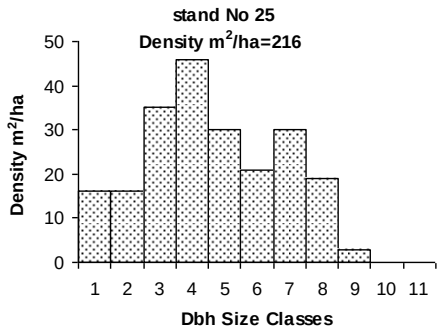

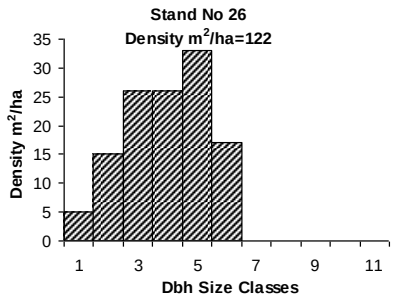

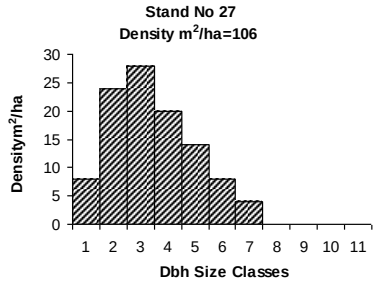

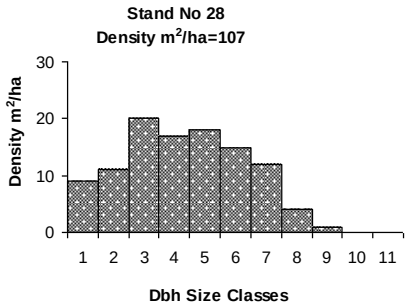

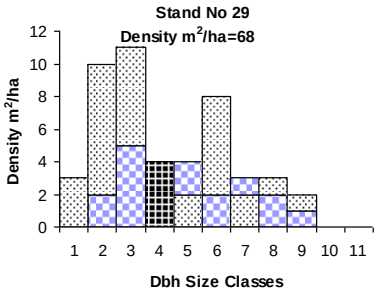

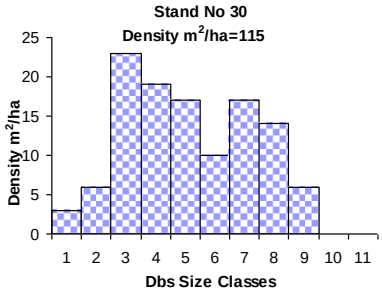

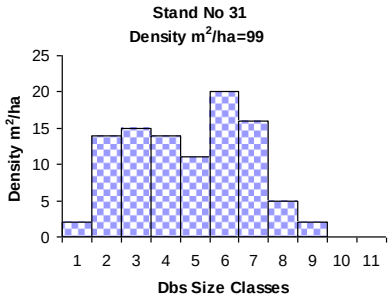

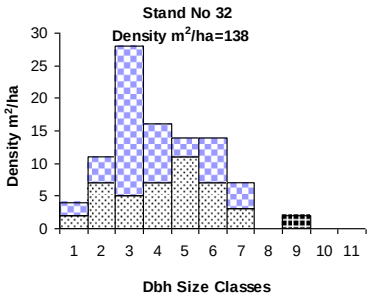

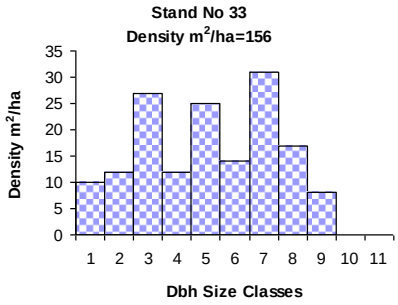

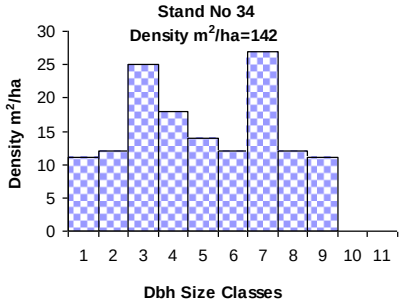

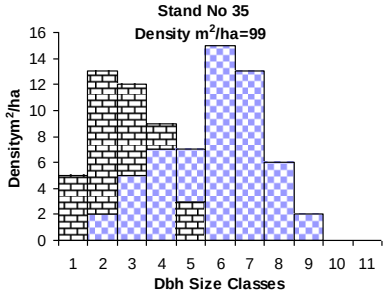

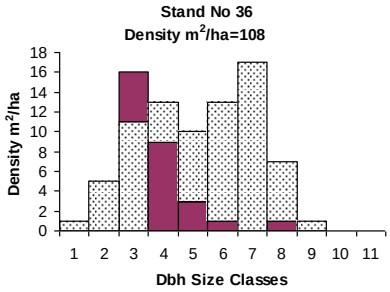

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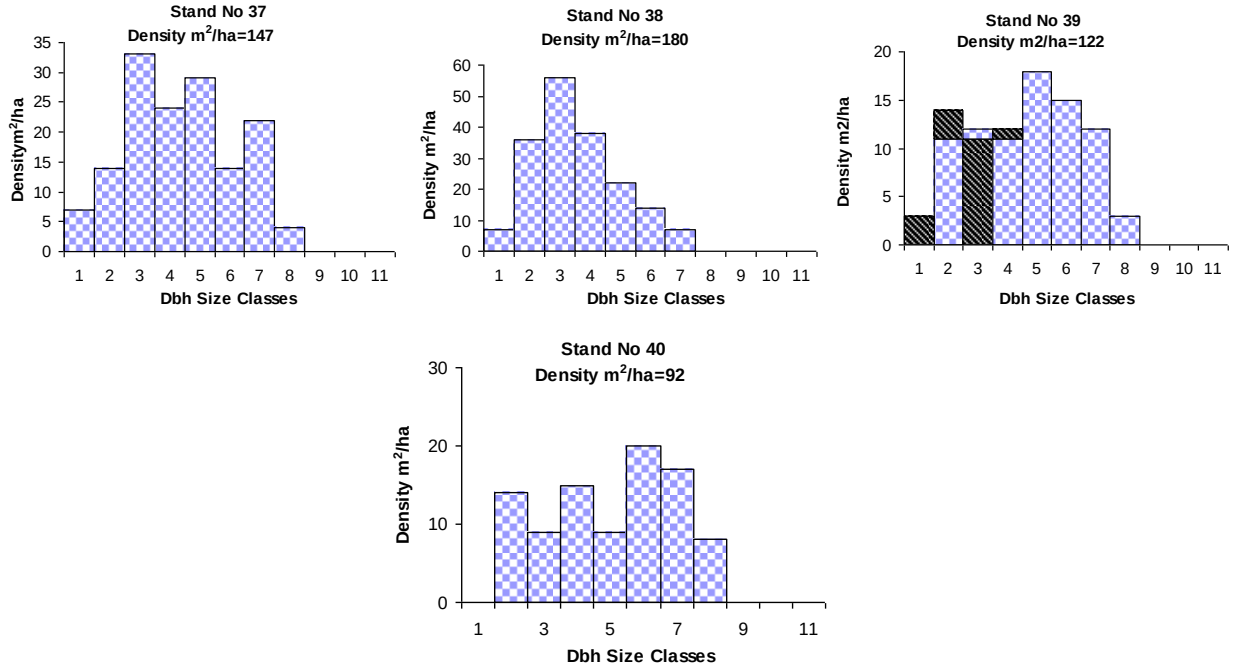
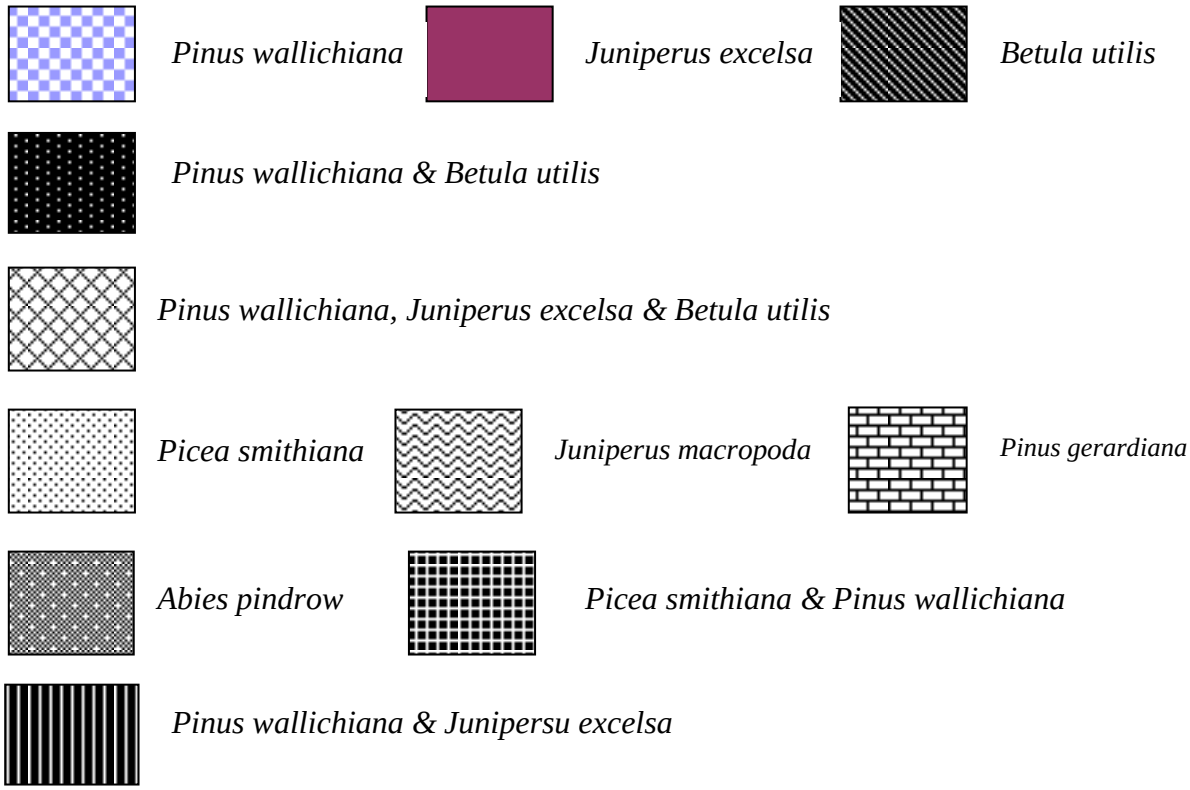


Fig. 2. (Dbh cm) Size class structure of 40 stands of the stduy area.



Note: P.W= *Pinus wallichiana*, P.S = *Picea smithiana*, P.G = *Pinus gerardiana*, J.E = *Juniperus excelsa*, A.B=*Abies pindrow*, J.E=*Juniperus macropoda*, B.U=*Betula utilis*

The density of sampled forests ranged between 3 to 309 stems ha^{-1}, with 1.6 to 51 basal area m^2 ha^{-1}. Among the stands, *Juniperus excelsa* occupied very low density with 3, 8 and 9 stems ha^{-1} from Hargosil-B, Memosh-B respectively, while *Betula utilis* recorded with 3,6 and 7 stems ha^{-1} from Memosh-A, Memosh-B and C, respectively. The highest density was recorded from *Pinus wallichiana* at Ganji-B with 309 stems ha^{-1} as pure form, while second and third highest density were recorded *Picea smithiana* with 237 and 216 at Naltar-A and Joglotgah-A, correspondingly. *Juniperus excelsa* attained the highest value from Gasing-B and C with 96 and 129 stems ha^{-1}, whereas *Betula utilis* occupied the highest density 159 and 121 stems ha^{-1} from Joglotgah-B and Gasing-C. *Pinus wallichiana* attended low density from Gasing-C which was 19 stems ha^{-1}, while the low density of *Picea smithiana* was recorded 42 stems ha^{-1} from Mushken-B. Two species *Juniperus macropoda* and *Abies pindrow* were appeared only in one location Danyore and Rama-B as pure form with 126 and 107 stems ha^{-1} consequently. Among the 40 stands, the highest density was recorded from *Pinus wallichiana* at Ganji-B with 309 stems ha^{-1} as pure form, while *Pinus wallichiana* attended low density from Gasing-C which was 19 stems ha^{-1}. Ahmed and Naqvi (2005) recorded 96 stems ha^{-1} of *Pinus wallichiana* with 18% relative basal area from Miandam. Ahmed et al. (2006) recorded the densities of *Pinus wallichiana* 337 stem ha^{-1} and 232 stems ha^{-1} from different climatic zones of Pakistan and Takht-e-Silaiman (Baluchistan), respectively. We also recorded the same species from Astore Rama with 387 stems ha^{-1}. The present finding was supported to these values mentioned above. Himalayan pine also known as evergreen *Pinus wallichiana* tree which is naturally distributed from Afghanistan to all Himalayan region, including, Pakistan, India, Nepal and Bhutan, having altitude ranging from 1800-3900 meters (Singh and Yadav, 2007). Ahmed and Naqvi (2005) and Ahmed et al. (2006) described that *Pinus wallichiana* may grow in moist temperate as well as in dry temperate. This shows the wide ecological amplitude of this species.

In this study, *Picea smithiana* attained with 237 and 216 density at Naltar-A and Joglotgah-A correspondingly, whereas low density of *Picea smithiana* was recorded 42 stems ha^{-1} from Mushken-B. Many other worker also studied this species, i.e., Ahmed et al. (2006) described a density 333 stems ha^{-1} with 167 m^2 ha basal area from Gilgitin Naltar forest and Wahab et al. (2008) reported the lowest density 35 stems ha^{-1} from Afghanistan. The deference of these may be due to the huge cutting and other disturbances in these areas. Human induced factors, overgrazing of livestock, cutting of timber for domestic needs, and other Natural disturbances have been also reported by Champion et al. (1965) and Hussain and Illahi (1991). *Betula utilis* recorded with 3, 6 and 7 stems ha^{-1} from Memosh-A, B and C, respectively. Here, *Betula utilis* occupied the highest density with 159 and 121 stems ha^{-1} from Joglotgah-B and Gasing-C. Hussain (1984) recorded this species between timber line a snow zones of from Kagan, Swat, Baltistan, Gilgit, Chitral and Koh Safed region on elevation from 2350 to 3500. Ahmed et al. (2006) described also *Betula utilis* as co-dominant with *Pinus wallichiana* near Matiltan, the same species also recorded from Naltar (Gilgit) with 666 stems ha^{-1} and 30 m^2 ha basal area. Champion et al. (1965) described this forest as a sub-alpine birch forest. In this study, the results are within the range of previous researchers.

Among the stands, *Juniperus excelsa* occupied very low density with 3, 8 and 9 stems ha^{-1}, from Hargosil-B, Memosh-B, respectively. *Juniperus excelsa* attained the highest value from Gasing-B and C, with 96 and 129 stems ha^{-1}. The same species also studied Ahmed et al. (2006) with 175 stems $ha^{-1}$and 42 m^2ha basal area from Baluchistan province. In this study, the finding of Gasing-C is near to these values. *Abies pindrow* was appeared only in one location Rama-B as a pure form with 126 stems ha^{-1}. Ahmed et al. (2006) also reported *Abies pindrow* community with 134 stems ha^{-1} and 16 m^2 ha basal areas near the lake Rama, Astore. These results are more or less similar to each other. *Juniperus macropoda* is only recorded from Danyore of District Gilgit as in pure condition with 107 stems ha^{-1} at 3700 elevation above sea level. The same species also reported by Rawat et al. (2010) with density of 160 stems ha^{-1} and 15 m^2 ha basal from the neighboring country of

Pakistan, Lahil valley northwestern Himalaya India at 3400 to 3600 elevation above sea level.

The pattern of Dbh size classes' distribution of different species indicates about the present status and the future trend of these forests. Among the 40 stands, the distribution of individuals, i.e., *Betula utilis* (Rama-A), mix forest of *Pinus wallichiana* and *Picea smithiana* (Mushken-B), Mushken-D, pure forest of *Pinus wallichiana* were satisfactory and these can be assumed regular distribution pattern whereas most of the stands sowed unsatisfactory. The variation of distribution pattern of size classes, density and basal may be due to the overgrazing, illegal cutting, or various other disturbances. These kinds of reason also discussed by the previous researcher during the survey of different forested area, i.e., Beg and Khan, 1984, Ahmed (1984), Ahmed et al. (2009), Wahab et al (2008), Siddiqui et al. (2009) and Khan et al. (2010).

In the light of this study, it is concluded that each forest is disturbed, unstable and showing varied size distribution. Most of the forests have low seedlings, young trees or they do not show signs of seedling recruitment. Anthropogenic disturbances, i.e., illegal cutting, grazing, and sliding, burning, etc., are most familiar in these areas. Present practices are threatening and alarming for the future of these forests. So proper regeneration activities, management skills and conservation plan should be introduced and applied immediately to rehabilitate and save these valuable forests.

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References

Ahmed, M. 1976. Multivariate analysis of the vegetation around Skardu. *Agri-Pak.* 2(17):177.

Ahmed, M. 1984. Ecology and Dendro-chronological studies of Aganthis australis Salin, Kauri. Ph.D thesis, University of Auckland, New Zealand.

Ahmed, M. 1986. Vegetation of some foothill of Himalayan range in Pakistan. *Pak. J. Bot.* 18(2): 261-269.

Ahmed, M. 1988. Population studies of some planted tree species of Quetta. *J. Pure. Appl. Sci*. 7: 25-29. Baluchistan. *Pak. J. Bot*. 21(1): 118-127.

Ahmed, M. and S.A. Qadir. 1976. Phytosociological studies along the way of Gilgit to Gopis, Yasin and Shunder. *Pak. J. Forest.* 26: 93-104.

Ahmed, M., S.S. Shaukat and A.H. Buzadar. 1990. Population structure and dynamics of *Juniperus excelsa* in Baluchistan. *J. Veg. Sci.* 1: 271-276.

Ahmed, M., M. Ashfaq, Amjad. and M. Saeed. 1991. Vegetation structure an dynamics of *Pinus gerardiana* forests in Baluchistan. *J. Veg. Sci.,* 2: 119-124.

Ahmed, M. and S.H. Naqvi. 2005. Tree ring chronologies of *Picea smithiana* (wall.) Boiss, and its quantitative vegetation description from Himalayan range. *Pak. J. Bot.* 37(3): 697-70.

Ahmed, M., T. Hussain, A.H. Sheikh, S.S. Hussain and M.F. Siddiqui. 2006. Phytosociology and structure of Himalayan forests from different climatic zones of Pakistan. *Pak. J. Bot.,* 38(2): 361-383.

Ahmed, M., N. Khan, M. Wahab, H. Salma, F. Siddiqui, K. Nazim and U. Khan. 2009.

Description and Structure of *Olea ferruginea* (Royle) forests of Dir lower District of Pakistan. *Pak. J. Bot*., 41(6): 2683-2695.

Ahmed. M. and S.S. Shaukat. 2012. A Text Book of Vegetation Ecology. Abrar Sons new Urdu Bazar, Karachi, Pakistan.

Akbar, M., M. Ahmed, A. Hussain, M.U. Zafar and M. Khan. 2011. Quantitative forests description from Skardu, Gilgit and Astore Districts of Gilgit-Baltistan, Pakistan. *FUUAST J. of Biology*. 1(2):149-160.

Akbar, M., M. Ahmed, M.U. Zafar, A. Hussain and M.A. Farooq. 2010. Phytosociology and structure of some forests of Skardu district of Karakoram range of Pakistan. *American-Eurasian J. Agric. and Environ. Sci.*, 9(5): 576-583.

Ali, S.I. 1971-95. "Flora of West Pakistan". Department of Botany, University of Karachi, Karachi.

Beg, A.R. and M.H. Khan. 1984. Some more plant communities and the future of dry oak forest zone in Swat valley. *Pak. J. For*., 34: 25-35.

Brown, R.J. and Curtis, J.J. 1952. The upland conifer-hardwood communities of southern Wisconsin. *Ecol. Monog*. 22: 217-234.

Champion, G.H., S.K. Seth and G.M. Khattak. 1965. *Forest types of Pakistan*. Pakistan Forest Institute.

Cottam, G. and J.T. Curtis. 1956. The use of distance measures in phytosociological sampling. *Ecology* 37(3): 451-460.

Hussain, A., M.A. Farooq, M. Ahmed, M.U. Zafar and M. Akbar. 2010. Phytosociology and structure of Central Karakoram National Park (CKNP) of Northern areas of Pakistan. *World Applied Sciences Journal*, 9(12):1443-1449.

Hussain, A., M. Ahmed, M. Akbar, M.U. Zafar, K. Nazim and M. Khan. 2011. Quantitative community description from Central Karakorum National Park Gilgit-Baltistan, Pakistan. *FUUAST J. Biology*, 1(2): 135-143.

Hussain, S.S. 1984. *Pakistan Manual of Plant Ecology*. National Book Foundation. Islamabad. pp. vi + 255.

Hussain, F. and I. Illahi. 1991. Ecology and Vegetation of lesser Himalayan Pakistan. Botany Department, University of Peshawar, pp. 187.

Khan, N., M. Ahmed, M. Wahab, K. Nazim and M. Ajaib. 2010. Studies along an altitudinal gradient in *Monotheca buxifolia* forest of District Dir Lower, Pakistan. *Pak. J. Bot*. 42(4): 2429-2441.

Khan N, M. Ahmed, M .Wahab and M. Ajaib 2010. Phytosociology, structure and Physiochemical analysis of soil in Quercus baloot Griff, District Chitral Pakistan. *Pak. J. Bot*., 42(4): 2429-2441.

Mueller-Dombois, D. and Ellenburg, H. 1974. Aims and Methods of vegetation Ecology. John Iviley and Sons. Inc., New York. 547pp.

Nasir, E and S.I. Ali, 1972. Flora of West Pakistan. Published under P. L. 480, Research project of U.S.A.D., with coordination of A.R.C. Pakistan, 1-1028.

Rawat, Y.S., S.C.R. Vishvakarma, S. Oinam and J.C. Kuniyal. 2010. Diversity, distribution and vegetation assessment in the Jahlmanal watershed in cold desert of the Lahil valley, North Western Himalaya, India. iForest, 3: 65-71.

Shaheen, H., R.A. Qureshi and Z.K. Shinwari. 2011 Structural diversity, vegetation dynamics and anthropogenic impact on lesser Himalayan subtropical forests of Bagh district Kashmir. *Pak. J. Bot*. 43(4): 1861-1866.

Siddiqui, M.F., M. Ahmed, M. Wahab and N. Khan. 2009. Phytosociology of *Pinus roxburghii* Sergeant (Chir Pine) in lesser Himalayan and Hindu Kush range of Pakistan. *Pak. J. Bot*., 41(5): 2357-2369.

Singh, J. and R.R. Yadav. 2007. Dendroclimatic potential of millennium-long ring-width chronology of Pinus gerardiana from Himachal Pradesh, India. *Current Science*, 93 (6), 833–837.

Wahab, M., M. Ahmed and N. Khan. 2008. Phytosociology and dynamics of some pine forests of Afghanistan. *Pak. J. Bot*., 40(3): 1071-1079.