Examining Some Functional Characteristics in Subalpine Pure Oriental Spruce (*Picea orientalis* (L.) Link) Stands in Turkey

Ali Ömer ÜÇLER[1], *Zafer YÜCESAN[1], Ercan OKTAN[1], Ali DEMİRCİ[1], Hakkı YAVUZ[1], Altay Uğur GÜL[2]

[1]Karadeniz Technical University Faculty of Forestry, Trabzon/TURKEY
[2]Celal Bayar University School of Tobacco Expertise, Manisa/TURKEY
*Corresponding Author: yucesan@ktu.edu.tr

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Abstract

This study was carried out in order to state the functional differences between the pure oriental spruce stands in subalpine zone. In the research, the pure oriental spruce stands in the subalpine zone were evaluated according to their wood production (F1), erosion control (F2), water production (F3), grass productivity-wild life habitat (F4), scenic beauty (F5) and avalanche prevention (F6) functions. Functional characteristics were rated as a scalar value between 1 (the worst) and 5 (the best) according to some observations, and exact differences were fixed between the functional characteristics of the treeline and the timberline stands. Determinations were realized in total of 46 sampling plots. 23 of the sampling plots were in treeline and 23 of them were in timberline. According to the results the F1, F2 and F6 values in the timberline were more effective than treeline stands. However F3, F4 and F5 values in the treeline were more effective than timber line stands. The average F1 value was 1.22 in the treeline and 3.04 in the timberline, F2 value was 3.0 in treeline and 3.61 in timberline, F3 value was 2.91 in the treeline and 2.43 in the timberline, F4 value was 3.35 in the treeline and 2.74 in the timberline, F5 value was 3.70 in treeline and 3.43 in timberline. Average F6 value was 3.52 in the treeline and 3.57 in the timberline. The functional values from treeline and timberline stands were compared by discriminant analysis and 41 of the sampling plots (89%) were estimated in their real groups.

Key words: Oriental spruce, *Picea orientalis*, subalpine forest, forest functions, functional classification

Türkiye'de Subalpin Doğu Ladini (*Picea orientalis* (L.) Link) Meşcerelerinin Bazı Fonksiyonel Özelliklerinin İncelenmesi

Özet

Bu çalışma subalpin basamakta yer alan saf Doğu Ladini meşcereleri arasındaki fonksiyonel farklılıkları ortaya koymak amacıyla gerçekleştirilmiştir. Çalışmada subalpin alanda yer alan saf Doğu Ladini meşcereleri odun üretimi (F1), erozyon kontrolü (F2), su üretimi (F3), ot verimi-yaban hayatı (F4), manzara kalitesi (F5) ve çığ önleme (F6) fonksiyonları açısından değerlendirilmiş ve savaş zonu ve orman sınırında yer alan orman alanları ile ilgili bazı karşılaştırmalar yapılmıştır. Fonksiyonel özellikler rakamsal olarak çalışma heyeti tarafından örnek alanların bazı özelliklerine bağlı olarak 1 en kötü 5 ise en iyi değer olacak şekilde numaralandırılarak savaş zonu ve orman sınırı meşcereleri kıyaslanmış ve net farklılıklar saptanmıştır. 23 adet savaş zonu, 23 adedi orman sınırından olmak üzere toplam 46 örnek alanda çalışmalar gerçekleştirilmiştir. Sonuçlara göre F1 , F2 ve F6 değerleri orman sınırında daha etkili çıkarken, F3, F4 ve F5 değerleri ise savaş zonunda daha etkili bulunmuştur. Ortalama F1 değeri savaş zonunda 1.22 ve orman sınırında 3.04, F2 değeri savaş zonunda 3.0 ve orman sınırında 3.61, F3 değeri savaş zonunda 2.91 ve orman sınırında 2.43, F4 değeri savaş zonunda 3.35 ve orman sınırında 2.74, F5 değeri savaş zonunda 3.70 ve orman sınırında 3.43, F6 değeri savaş zonunda 3.52 ve orman sınırında 3.57 olarak hesaplanmıştır. Tespit edilen sonuçlar Discriminant Analizi ile değerlendirilmiş ve 41 örnek alanın (%89) kendi gerçek gruplarında yer aldıkları belirlenmiştir.

Anahtar Kelimeler: Doğu Ladini, *Picea orientalis*, subalpin ormanlar, orman fonksiyonları, fonksiyonel sınıflandırma

Introduction

The need to incorporate the value of environmental goods and services in private or public investment decision making is a vital requirement for any successful planning process aiming, amongst others, to advance human wellbeing. The concept of environmental value has been broadened away from conventional and strict economic utilitarian issues towards multifaceted notions embracing a diversity of value-types. Use values may include at least those values concerning with the direct, indirect or option use of an environmental resource (Diamond and Hausman, 1993).

Important part of the forests in the world is managed according to the sustainability principles which are suitable for the habitat conditions. Consequently other functions of the forests could be taken under assurance. Sometimes wood production function has no importance among the other forest functions. Especially in landscape protection functioned forests, wood production could have not been composed in major amounts. Although some landscape protection functioned forests should be managed but wood production shouldn't be the primer aim of forestry treatments as well. In many position it is necessary to choose useful management types which could have balanced several requests from forest areas (Dengler, 1980). For example high mountain forests physically include wood production function in fewer amounts but especially its social and protection functions are more important (Brang, 2001; Schönenberger, 2001; Üçler et al., 2001).

Oriental spruce (*Picea orientalis* (L.) Link) is one of the most important species for Turkey because of being the semi monopoly tree with respect to its distribution. Distribution area of pure oriental spruce ranges from 550 to 2400 m in Turkey and it covers total area of 146300 ha (Çalışkan, 1998). Different habitat conditions, altitudes and stand structures cause functional grouping in oriental spruce forests in Turkey. In this sense the functional maps of the whole pure and mixed stands of spruce forests that are suitable for forest ecosystem must be done. The principles of continuous forest exploitation have to be prepared again by the help of forest plans. Also it should not be forgotten that silvicultural treatments except tending could be dangerous and unnecessary in subalpine forest lands that have high protection characteristics against the natural hazards. However all these forests were also intensively used for grazing and illegal tree cutting. But nowadays, oriental spruce forests are valued equally for wood production and landscape, recreation and nature conservation.

The stand structure of the mountain forests is decisive for effective prevention of natural hazards such as snow avalanches, rock fall, erosion, debris flow, landslides and floods, because of including critic ecosystem conditions (Altwegg, 1989; Schönenberger, 1998; Çolak and Pitterle, 1999; Kienholz and Price, 2000; Price and Kohler, 2000; Schönenberger and Brang, 2001). Stand structures are more important in high mountain ecosystems because of being critical. Also in subalpin forest step differences could have been seen in very short horizontal and vertical distances.

Various socio-economic functions are ascribed to forests, based on the differentiated needs of the human population. In Europe, scientific inquiry into forest ecosystems, which is foremost devoted to support forestry, must take these differentiated needs into account–in fact, most scientific questions are raised in order to address the function-related differentiation of forest management. The economic function, i.e. the production of timber and non-timber products, for one's own requirements or commercial purposes, remains the dominant interest everywhere. Historically the recreational functions of forests were appreciated only in special situations (e.g. mountains); now the support of aesthetic and recreational interests is generally and increasingly acknowledged as an important goal of forestry (Dieterich, 1953; Hanstein, 1972).

In practice, the majority of forests are multifunctional in that they fulfill, to varying extent, economic and social functions simultaneously. A decision to devote a forest area to recreational purposes, may have far-reaching consequences fort the habitat quality for deer. Behavioral reactions of the deer population will probably cause severe damage to stands (peeling) and regeneration, thus inducing significant detrimental changes to the further forest development. This damage could be avoided by applying alternative strategies of wild life management involves understanding the systemic capacity, long-term trends and associated costs in maintaining particular functional goals (Führer, 2000).

For instance, protection against soil erosion, torrents and avalanches in mountainous forests depends on structures and development features in particular spatial and temporal arrays. In mountainous regions a forester’s decision can determine landscape hydrology for decades or even centuries. Silviculture here needs reliable hydrological knowledge in order to avoid serious errors. Prevention of catastrophic floods has priority in mountains rich with precipitation, while the maintenance of continuous and high quality water supply is a primary function of forests in dry climates (Mayer, 1976).

The aim of this study, was to upgrade the forestry applications, determine the differences in high mountain forests of pure oriental spruce and simplify the determination of some of forest function values.

Material and Methods

Material

In this research, 46 sampling plots were determined with subjective sampling method (plot size 20 m x 20 m) in the natural distribution area of the pure oriental spruce in the subalpin zone that has less or no anthropogenic effects. 23 of these sampling plots were in the timberline and 23 of them were in the treeline. The study area is located between $40^{0}23^{/}$-$40^{0}50^{/}$ latitudes and $37^{0}40^{/}$-$44^{0}13^{/}$ longitudes in the North Eastern part of Turkey (Figure 1). Altitudes of the sampling plots in timberline were ranged between 1500-2000 meters however it was ranged between 1750-2250 meters in treeline. Slopes of the timberline sampling plots were changed between 40-70%. Those of slope values were changed between 20-80% in treeline sampling plots. Also sampling plots were chosen in every aspect in the study area.

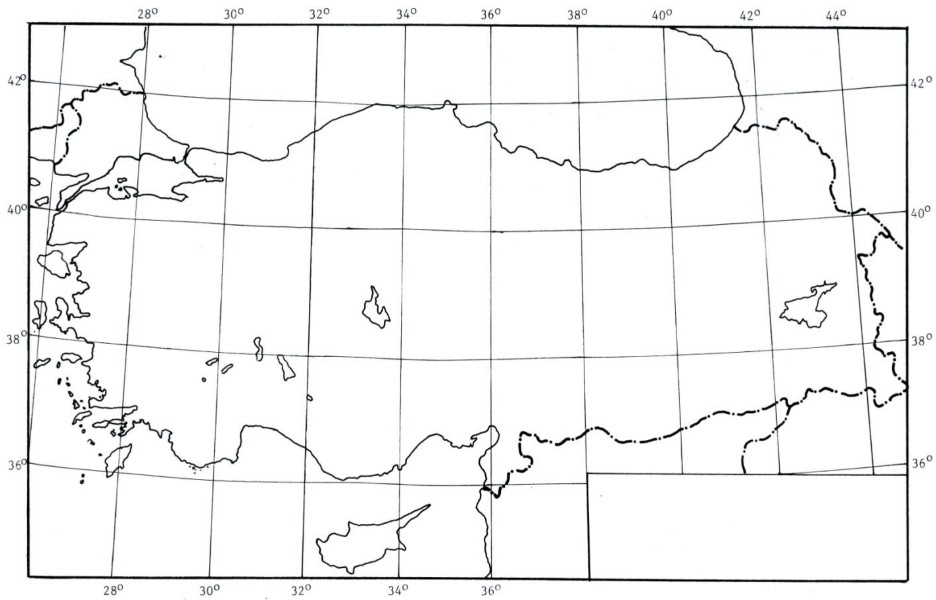

Figure 1. Location of the studied area

Methods

Visual quality forecast was performed in two stage as digitizing the visual quality and development of the visual quality forecast models (Gül, 1996). Howard (1991) generally questioned the applicability of such mathematical programming techniques for ill-structured problems which are quite common in multiple purpose forestry. An alternative was provided by multiple criteria decision making (MCDM) techniques (Hwang and Yoon, 1981). A comparative study was made to explore some specific issues that have received limited attention in previous multiple criteria decision making studies, including scale transformations, criterion weighting, ranking algorithms, choice of criteria, and specification of alternatives (Howard, 1991). The model about the usage of numerical values in determining forest functional characteristics developed by Howard (1991) was used in this study as a sampling model.

Each sampling plot stand was evaluated according to six different functional characteristics as wood production (F1), erosion control (F2), water production (F3), grass productivity-wild life habitat (F4), scenic beauty (F5) and avalanche prevention (F6). In this evaluation numerical scaling was done by giving values between 1 and 5 (1-worst 2- weak 3- average 4- suitable 5- best). The Forest Management, Forest Growth and Yield, Silviculture and Forest Ecology specialists evaluated the functional characteristics using this scale (Table 1).

In numeric detection of the functions given before wood production function was directly but ecological functions were indirectly estimated. In making indirect estimation some constraints were taken into consideration. For example there is a great relation between canopy and erosion. When canopy decreases, carried soil amount increases as well. Effects of the forests on water production are also changed with some characteristics such as tree type, canopy and density, crown height, leaf amount etc. (Asan and Şengönül, 1987). Physical soil characteristics and soil surface, soil moisture, soaking up ability of the soil, temperature and fluidity of the soil water and plant coverage effect infiltration. Under a well crown closure of a plant coverage like forest trees and shrubs infiltration capacity of the soil increases (Balcı and Öztan, 1987). Climate, ground type, plant coverage, soil and human effect soil erosion and avalanche. There is a great relation between grass productivity-wild life and gaps in forests and suitable habitats for wild life. Scenic beauty could be estimated indirectly with appropriateness of the area to the usage for trekking, winter sports, camping, picnic and hunting and the number of the person come to this area for these activities (Gül, 1996).

Each function reflects different characteristic of stand so it is impossible to use sum or average functional values of the stands in making comparisons. Accordingly by taking each function into consideration as a different characteristic or as a whole (just as resultant function) functional comparisons can be done between treeline and timberline. In the first approach estimation of the analysis becomes difficult and complex because of making six different comparisons but in the second approach analysis is easier. Consequently in this study functional values of the treeline and timberline stands were compared by using second approach with discriminant analysis method (Flurry and Riedwyl, 1988; Manly, 1990)

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Table 1. Functional classification values of sampling plots

Sampling Plot		F1	F2	F3	F4	F5	F6
1 (Treeline)		1	2	3	3	5	5
2 (Timberline)		3	3	3	2	3	3
3 (Treeline)		1	2	3	3	5	5
4 (Timberline)		2	5	2	3	3	5
5 (Treeline)		2	2	3	4	5	2
6 (Timberline)		3	3	2	3	4	3
7 (Treeline)		2	5	4	4	4	5
8 (Timberline)		3	3	2	3	3	4
9 (Treeline)		1	5	4	4	4	5
10 (Timberline)		3	4	2	3	4	4
11(Treeline)		1	5	3	3	1	5
12 (Timberline)		3	4	2	3	3	4
13 (Treeline)		1	2	3	4	3	3
14 (Timberline)		3	3	2	2	4	3
15 (Treeline)		2	4	4	3	4	4
16 (Timberline)		3	2	2	2	3	2
17 (Treeline)		1	3	5	3	2	3
18 (Timberline)		3	4	2	2	2	4
19 (Treeline)		2	2	2	3	4	3
20 (Timberline)		4	3	2	3	4	3
21 (Treeline)		2	2	3	4	4	2
22 (Timberline)		3	3	1	3	3	3
23 (Treeline)		1	2	4	4	1	2
24 (Timberline)		2	4	3	4	2	4
25 (Treeline)		1	3	2	3	4	3
26 (Timberline)		3	4	2	3	4	4
27 (Treeline)		1	2	2	3	2	2
28 (Timberline)		4	4	3	1	3	4
29 (Treeline)		1	4	3	5	4	5
30 (Timberline)		1	4	3	4	4	5
31 (Treeline)		1	5	3	3	4	5
32 (Timberline)		2	5	2	2	4	5
33 (Treeline)		1	3	1	2	4	3
34 (Timberline)		4	4	3	3	4	4
35 (Treeline)		1	3	2	3	3	4
36 (Timberline)		4	4	2	3	3	4
37 (Treeline)		1	1	4	4	5	1
38 (Timberline)		4	2	2	3	5	2
39 (Treeline)		1	3	3	4	4	2
40 (Timberline)		3	4	4	3	4	4
41 (Treeline)		1	4	2	3	4	2
42 (Timberline)		4	4	3	3	2	1
43 (Treeline)		1	4	3	3	5	4
44 (Timberline)		3	4	4	3	4	4
45 (Treeline)		1	1	3	2	4	1
46 (Timberline)		3	3	3	2	4	3
Average	Treeline	1.22	3.0	2.91	3.35	3.70	3.52
	Timberline	3.04	3.61	2.43	2.74	3.43	3.57

Each function reflects different characteristic of stand so it is impossible to use sum or average functional values of the stands in making comparisons. Accordingly by taking each function into consideration as a different characteristic or as a whole (just as resultant function) functional comparisons can be done between treeline and timberline. In the first approach estimation of the analysis becomes difficult and complex because of making six different comparisons but in the second approach analysis is easier. Consequently in this study functional values of the treeline and timberline stands were compared by using second approach with discriminant analysis method (Flurry and Riedwyl, 1988; Manly, 1990)

Results

Classification values of wood production (F1), erosion control (F2), avalanche prevention (F3), water production (F4), grass productivity-wild life habitat (F5) and scenic beauty (F6) functions of each sampling plot and discriminant analysis results were given in Table 2 and Table 3. According to the results the wood production, erosion control and avalanche prevention function values in the timberline were more effective than treeline sampling plots. However water production, grass productivity-wild life habitat and scenic beauty values in the treeline were more effective than timber line sampling plots (Table 1).

According to the standardized coefficients of the discriminant while wood production, erosion control, avalanche prevention, grass productivity-wild life habitat functions affected discriminant scores positively, scenic beauty and water production functions affected the score negatively (Table 2).

It can be seen that the sampling plots with the negative discriminant function values were in first group (treeline), and the sampling plots with the positive function values are in the second group (timberline) (Table 3).

When the sample plots have the value lower than zero they should be in the treeline, and the areas have the value higher than zero they should be in the timberline. When the classification constructed with this opinion, it was understood that the sampling plots of 4, 18 and 30 from timberline should be in treeline and the sampling plot of 17 from treeline should be in timberline in real. When the functional values from treeline and timberline were compared by discriminant analysis 41 of the sampling plots (89 %) were estimated in their real groups (Table 3).

The average wood production function values were 1.22 (worst) in the treeline and 3.04 (average) in the timberline (Table 1). The timberline stands had much more canopy and basal area than treeline stands, and this situation affected the amount of wood production.

The average erosion control function values were 3.0 (average) in treeline and 3.61 (suitable) in timberline (Table 1). Most important factors were slope and canopy in determining erosion control function value. The stand slope was quite much either in treeline or in timberline, and the average slopes were 50% in treeline and 53% in timberline. It could be said that the main factor was the stand canopy for the erosion control function in this study.

The average scenic beauty function values were 3.70 (suitable) in treeline and 3.43 (average) in timberline (Table 1). When you compare the considered characteristics between treeline and timberline deal with the scenic beauty function such as increasing amount of dead, dead and down, dead and dying tree, cutting culls, stand density, number of the trees in small size, stand basal area, decreasing amount of litter and weed, stand height and mean diameter, cutting treatments, insect and fungus diseases (Gül, 1996), you can see that there is a similarity between treeline and timberline stands.

According to Brown and Daniel (1984)'s study, the statistical models which related near-view scenic beauty of ponderosa pine stands in the Southwest USA to variables describing physical characteristics. The models suggest that herbaceous and large ponderosa pine contribute to scenic beauty, while numbers of small and intermediate-sized pine trees and downed wood, especially as slash and detract from scenic beauty. Areas of lower overstorey density and less tree clumping were preferred. Moderate harvest of relatively dense stands tends to improve scenic beauty once the stand has recovered from obvious harvest effects. The recovery period can be greatly reduced by slash cleanup. Ionna and Skuras (2004) indicated that the economic value of forests was significantly related to their scenic beauty and especially to their vista view. Thus, surveys designed to estimate the economic value of forests to the public. Especially forest which have a pure ecological or aesthetic and not a productive value, should be conducted by interdisciplinary scientific teams attempting to combine and integrate economic, social and environmental indicators to measure sustainable human well-being (Michalos, 1997). These teams should attempt to incorporate scenic beauty indicators in the estimation procedures of economic valuation techniques. The scenic beauty estimation methodology and contingent valuation provide a promising research pair of methods for the joint estimation of the respondent's individual scenic beauty estimate and welfare in terms of willingness to pay (Michalos, 1997).

Table 2. Results of Discriminant Analysis

Group	Average	Standard Deviation	Sample Number	
		Treeline		
F_1	1.30	0.56	23	
F_2	3.04	1.30	23	
F_3	2.91	1.12	23	
F_4	2.96	0.82	23	
F_5	3.48	1.08	23	
F_6	3.87	1.10	23	
		Timberline		
F_1	3.00	0.80	23	
F_2	3.52	0.85	23	
F_3	2.96	1.15	23	
F_4	2.70	0.70	23	
F_5	3.13	0.76	23	
F_6	3.48	0.85	23	
		Total		
F_1	2.15	1.09	46	
F_2	3.28	1.11	46	
F_3	2.93	1.12	46	
F_4	2.82	0.77	46	
F_5	3.30	0.94	46	
F_6	3.67	0.99	46	
Results of Canonical Discriminant Analysis				
Function	Eigenvalue	% of Variance	Cumulative %	Canonical correlation
1	1.739	100	100	0.797
Wilks' Lambda				
Test of Function	Wilks' Lambda	Chi-Square	df	Sig.
1	0.365	41.31	6	p<0.001
Coefficients of Discriminant Function				
Variables	Unstandardized Canonical Discriminant Function Coefficients		Standardized Canonical Discriminant Function Coefficients	
F1	1.425		0.982	
F2	0.167		0.183	
F3	0.130		0.147	
F4	-0.162		-0.124	
F5	0.051		0.048	
F6	-0.133		-0.131	
Constant term		-3.218		

Table 3. Classification results of Discriminant Analysis

SP	Real Group	Estimated Group	Value of Discriminant Function
1	Treeline	Treeline	-1.967
2	Timberline	Timberline	1.378
3	Treeline	Treeline	-1.967
4	Timberline	Treeline *	-0.271
5	Treeline	Treeline	-0.304
6	Timberline	Timberline	1.239
7	Treeline	Treeline	-0.123
8	Timberline	Timberline	0.953
9	Treeline	Treeline	-1.549
10	Timberline	Timberline	1.171
11	Treeline	Treeline	-1.669
12	Timberline	Timberline	1.120
13	Treeline	Treeline	-1.964
14	Timberline	Timberline	1.299
15	Treeline	Timberline *	0.005
16	Timberline	Timberline	1.214
17	Treeline	Timberline *	1.231
18	Timberline	Treeline	-0.435
19	Treeline	Treeline	-0.435
20	Timberline	Timberline	2.563
21	Treeline	Treeline	-0.589
22	Timberline	Timberline	1.54
23	Treeline	Treeline	-1.776
24	Timberline	Timberline	0.272
25	Treeline	Treeline	-1.606
26	Timberline	Timberline	1.541
27	Treeline	Treeline	-1.636
28	Timberline	Timberline	2.836
29	Treeline	Treeline	-1.240
30	Timberline	Treeline *	-1.291
31	Treeline	Treeline	-1.175
32	Timberline	Timberline	0.362
33	Treeline	Treeline	-1.495
34	Timberline	Timberline	2.805
35	Treeline	Treeline	-1.343
36	Timberline	Timberline	3.100
37	Treeline	Treeline	-2.607
38	Timberline	Timberline	2.240
39	Treeline	Treeline	-1.847
40	Timberline	Timberline	1.217
41	Treeline	Treeline	-1.569
42	Timberline	Timberline	2.683
43	Treeline	Treeline	-1.605
44	Timberline	Timberline	1.217
45	Treeline	Treeline	-2.413
46	Timberline	Timberline	1.032

Average water production function values were 2.91 (average) in the treeline and 2.43 (week) in the timberline stands. In utilization of the water production function infiltrated amount of the water by the soil were taken as basis. Plant coverage diversity and forest floor coverage affected the amount of the infiltrated water (King and Brater, 1959). If the plant coverage diversity increases, the amount of the infiltrated water increases as well. Also vegetation has consumed the soil water by transpiration and by the way the water storage ability of the soil has been increased (Balcı and Öztan, 1987). Generally alpine meadows have snuggled into large gaps of treeline and these large gaps were covered with alpine grasses. So plant coverage diversity and water production amounts were higher in treeline than timberline.

Average grass productivity-wild life habitat function values were 3.35 (average) in the treeline and 2.74 (average) in the timberline stands. In treeline and in closure forest areas large gaps composed suitable habitats for wildlife. Also subalpine forest lands were close to the upland pastures and some upland pastures included settlement areas. If a timberline stand is far away from a settlement area, those of timberline stands can be more suitable for wildlife. Consequently due to the given results grass productivity-wild life habitat function value was more effective in treeline stands.

Average avalanche prevention function values are 3.52 in the treeline and 3.57 in the timberline stands. While determining avalanche prevention function, slope and altitude criteria were taken into consideration. Although there was no exact difference between treeline and timberline sampling plots due to the fact of slope, avalanche damage can be seen much more in treeline stands because of the heavy snow coverage of higher altitudes.

Discussion

Today it is not sufficient to benefit only on wood production from forest. Rapid increase in population, industrialization and urbanization both provide sustaining the ecological environment and obligate responding the non-wood product needs of the population. These needs can be summarized as wood products, ecological characteristics and production of environmental services. When the past and the near future of the forestation policies are considered it is easily understood that nature planning is not a radical newness but it is a necessary development. The most important change of protecting the ecosystem and sustainability principles become important. Adding ecosystem principles to economic respond of the multi-way needs of population, planning has become more complicated. So planning forest according to contemporary forestry understanding, 1- production function value must be determined according to tree species, stand types or divisions, product variety, product quality 2- ecological function value; must be determined according to whole forest, divisions or stand types 3- environmental function value must be determined according to whole forest or areas that are divided according their activity 4- Forest lands that have high slope, risk of erosion and avalanche and close to the alpine zone, must be separated as protection forests because of their low stem quality, low annual growth ability and high avalanche preventing and erosion control characteristics and high aesthetic values. On the other hand, decision making process should be shortened and made easier in planning by evaluating the forest product services with the numerical understanding of forest functions.

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