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Indicator species of essential forest tree species in the Burdur district

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Abstract

The forests of Burdur district for long have been subjected to over grazing and individual selection. As a result of this, majority of the forest areas in the district were degraded. In the district, afforestation efforts included majority of forestry implementations. It is well known that selecting suitable species plays an important role for achieving afforestation efforts. In this context, knowing the indicator species among the target species would be used in afforestation efforts, studies on the interrelationships between environmental factors and target species distribution is vital for selecting suitable species for a given area. In this study, Anatolian Black pine (*Pinus nigra*), Red pine (*Pinus brutia*), Crimean juniper (*Juniperus excelsa*) and Taurus cedar (*Cedrus libani*), essential tree species, were considered as target species. The data taken from 100 sample plots in Burdur district was used. Interspecific correlation analysis was performed to determine the positive and negative indicator species among each of the target species. As a result of ICA, 2 positive (*Berberis crataegina, Juniperus oxycedrus), 2 negative (Phillyrea latifolia, Quercus coccifera) for Crimean Juniper, 1 positive (Juniperus oxycedrus), 3 negative (Onopordium acanthium, Fraxinus ornus, Phillyrea latifolia) for Anatolian black pine, 3 positive (Paliurus spina-christi, Quercus coccifer, Crataegus orientalis), 2 negative (Berberis crataegina, Astragalus nanus) for Red pine and 3 positive (Berberis crataegina, Rhamnus oleoides, Astragalus prusianus) 2 negative (Paliurus spina-christi, Quercus cerris) for Taurus cedar* were defined as indicator plant species. In this way, practical information was obtained for selecting the most suitable species, among the target species, for afforestation efforts in Burdur district.

Key words

Burdur district, Target Species, Indicator Plant Species, Correlation analysis

Introduction

Turkey possesses a rich expansive forests. The country is home to approximately 21.6 million ha of forest land, covering more than one fourth of the total area. In addition, several extensive planting operations have begun for past several years (Anonymous, 2012). It is well known that the selection and consideration of different plant species is an important factor for the success of these operations. While choosing suitable species in planting areas, the recognition of not only the relationship between the distribution of target species and site factors, but also of indicators of these target species is vital.

This present study was conducted in Burdur district. Recently, forest lands of this location have been degraded largely due to human activities such as overgrazing, fire and illegal logging. The reason is the region's history which stretches back thousands of years. Ancient people of this district have utilized forests for shelter, protection, nourishment and defense (Kınal, 1987). Due to aforementioned forest degradation, majority of forest activities in the district now solely consist of planting.

As Turkey is mountainous, local climatic features can be quite diverse. Therefore, the climate of the land to be planted in a local area often differs from that of larger district (Gulsoy *et al.*, 2013). For this reason, it is not only necessary to determine climatic features of the district but also forest site factors of specific areas in order to predict suitable species for planting (Atalay and Efe, 2010a; Atalay and Efe, 2010b).

Plant species that share similar forest site features constitute 'vegetation community'. The type of vegetation that thrives under different site conditions helps in determining the species is most efficient to be planted.

The presence/absence of a plant species in a region is an indicator for its ability to or not to survive in that environment. In other words, when a species is found in a certain region, it can be said that another species that share ecological features has the potential to use this area to grow and expand. However, the opposite also applies: if two different species do not exist in the same environment, they are negative indicators of each other.

In view of the above, the present study aimed to determine indicator species of essential forest trees in Burdur district, which has undergone high forest degradation. Through this study, practical information will be put forward regarding the selection of suitable plant species to be planted within Burdur district.

Materials and Methods

The study was undertaken around Burdur district (37°08' N and 30°33' E) found in the western Mediterranean region of Turkey (Fig. 1). The area is also called Burdur Lake basin, comprising of 3263 km^2 area consisting of land from both Burdur and Isparta provinces (Atatol, 2010). The altitude of the area varies between 780-2320 m. The northern and eastern regions of the basin are surrounded by mountains over 2000 m high. The highest altitude of the basin is Katrancık Mountain (2328 m), located in the northwest Burdur district. Old Mesozoic limestones are widespread in many areas of the basin. Other common bedrocks include conglomerate, sandstone, claystone and siltstone, respectively. The soil types of the basin are chestnut colored soil and brown forest soil.

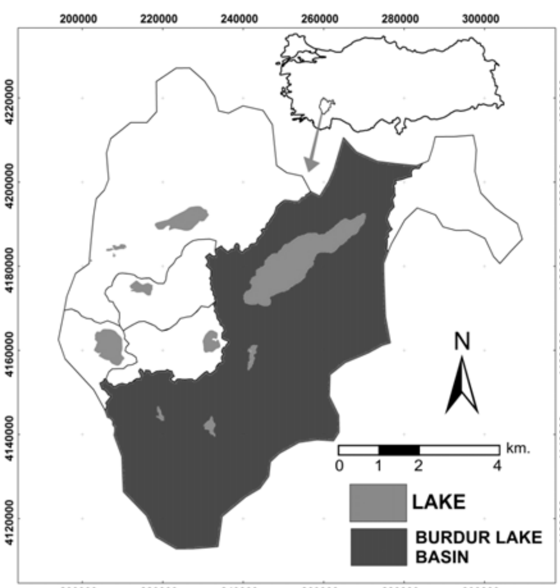

Fig. 1 : Map of the Study Area

The district has transitional climatic features indicative of both Mediterranean and Continental climate (DMI, 2011). With average annual rainfall of 474 mm, and average annual temperature of 13.1 °C; the hottest month is July and the coldest month is January (Yayintas, 1989).

Area surrounding Burdur Lake, forests are located in both eastern and northern parts, possess a growth rate of 7 %. The plant types in these areas include: Anatolian black pine (*Pinus nigra*), Red pine (*Pinus brutia*), Crimean juniper (*Juniperus excelsa*), rarely Taurus cedar (*Cedrus libani*) and Turkey oak (*Quercus cerris*) (OBM, 2010). Cetin and Secmen (2008) reported approximately 850 plant taxa from 82 families and 339 genera from Burdur region. They reported that around 179 species (21 %) of these plant taxa were endemics.

Field studies : 100 samples from several plots were obtained from the Burdur Lake basin. The woody plant species were recorded for inventory from these plots. Inventory records were kept as 'presence or absence'. In sample plots, a data matrix consisting of inventoried essential forest tree species and 48 woody plant species were arranged. In this way, the data was prepared for statistical evaluation. The Latin names of the plant species were encoded before the analysis for easier statistical evaluation (Table 1).

Statistical evaluation : Interspecific correlation analysis was performed by SPSS package program, in order to determine the indicator species of the Anatolian black pine, Red pine, Crimean juniper and Taurus cedar trees, which are essential tree species widely found in the district (Ozkan, 2006; Celik et al., 2006). The C3 coefficient recommended by Ozkan (2002) was used as correlation coefficient. Cole (1949) stated that in order to perform interspecific correlation, the following steps should be followed:

2 x 2 table should be drawn (Table 2)

Chi-square value should be obtained by the formula :

$$x^2 = \frac{(ad-bc)^2 n}{(a+b)\ (a+c) + (c+d)\ (b+d)}$$

p (significance level) value should be found for n-1 from Chi-square scale.

On the condition that a significant dependency between A

Table 1 : Plant species detected in sample plots and their codes before statistical analysis

Code	Species name	Code	Species name
Acaspp.	*Acanthalimon* spp.	Junoxy	*Juniperus oxycedrus* L.
Altoff	*Althaea officinalis* L.	Lonetr	*Lonicera etrusca* Santi var. *Etrusca*
Amepar	*Amelanchier parviflora* Boiss.	Onoaca	*Onopordium acanthium* L.
Aspacu	*Asparagus acutifolius* L.	Orioni	*Origanum onites* L.
Astnan	*Astragalus nanus* DC.	Palspi	*Paliurus spina-christi* Mill.
Astpru	*Astragalus prusianus* Boiss.	Philat	*Phillyrea latifolia* L.
Bercra	*Berberis crataegina* DC.	Phlarm	*Phlomis armeniaca* Willd.
Cedlib	*Cedrus libani* A. Rich.	Phlgra	*Phlomis grandiflora* H.S. Thomson
Cersil	*Cercis siliquastrum* L.	Pinbru	*Pinus brutia* Ten.
Cirarv	*Cirsium arvense* L.	Pinnig	*Pinus nigra* Arn. ssp. *pallasiana* (lamb.) Holmboe
Cispar	*Cistus parviflorus* Lam.	Pister	*Pistacia terebinthus* L. subsp *palaestina* (Boiss) Engler
Cissal	*Cistus salviifolius* L.	Pruspi	*Prunus spinosa* L.
Colarb	*Colutea arborescens* L.	Pyrcom	*Pyrus communis* L. subsp. *Communis*
Cotnum	*Cotoneaster nummularia* Fisch. & Mey.	Quecer	*Quercus cerris* L.
Craori	*Crataegus orientalis* Pallas ex Bieb. var. *Orientalis*	Quecoc	*Quercus coccifera* L.
Cupsem	*Cupressus sempervirens* L.	Queinf	*Quercus infectoria* Olivier subsp.*boissieri* (reuter) O. Schweiz
Dapser	*Daphne sericea* Vahl.	Rhaole	*Rhamnus oleoides* L.
Eryspp.	*Eryngium* spp.	Rhucor	*Rhus coriaria* L.
Eupcha	*Euphorbia characias* L. subsp. *Wulfenii*	Roscan	*Rosa canina* L.
Fraorn	*Fraxinus ornus* L. subsp. *Cilicica*	Rubcan	*Rubus canensis* DC.
Inuocu	*Inula oculus-christi* L.	Saltom	*Salvia tomentosa* Miller
Jasfru	*Jasminum fruticans* L.	Sorumb	*Sorbus umbellata* (Desf) Fritsch var *umbellata*
Juncom	*Juniperus communis* L.	Thytar	*Thymelaea tartonraira* L.
Junexc	*Juniperus excelsa* Bieb.	Verspp.	*Verbascum* spp.

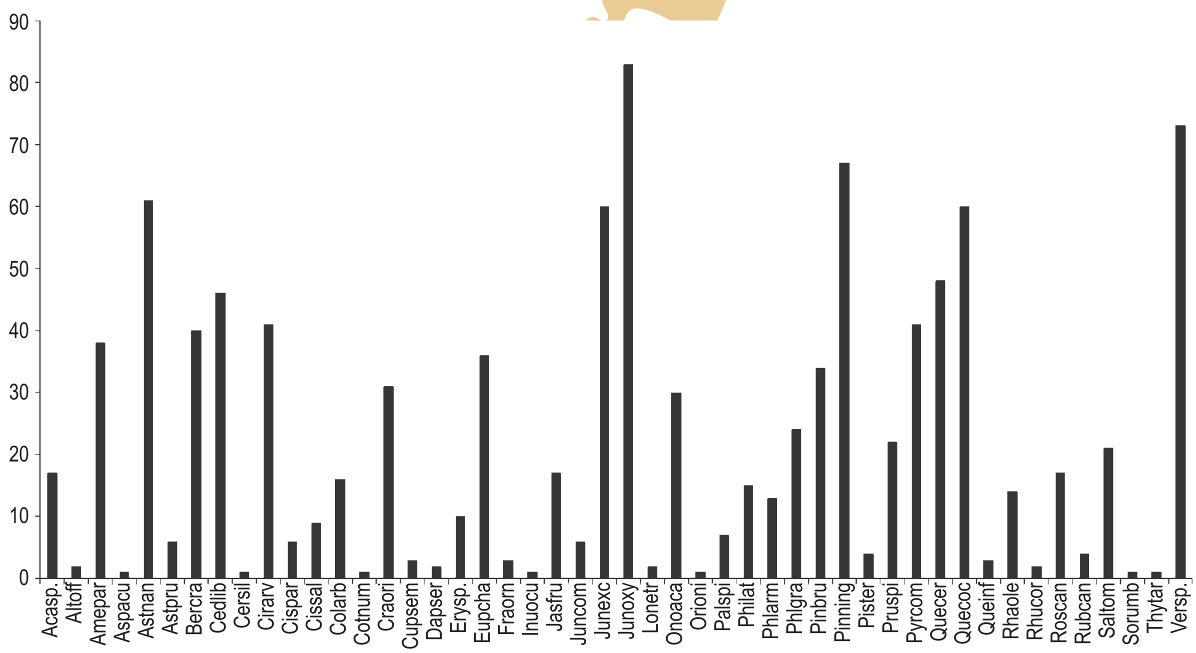

Fig. 2 : Frequencies of woody plant species in the study area

Table 2 : 2 X 2 Table for interspecific correlation analysis

	Type A			
Difference Groups B	Available	Not Available		Total
	Available	a	b	a+b
	Not-Available	c	d	c+d
	Total	a+c	b+d	n=a+b+c+d

Table 3 : Positive (P) and negative (N) indicator plant groups of essential forest trees in Burdur and their significance level

Essential Forest Trees	Species	Ki kare	Signif-icance	Level C3
Crimean Juniper	Bercra*	8.507	0,004	0.529501
	Junoxy*	7.985	0,005	0.372893
	Acaspp*	4.264	0,039	0,303878
	Juncom*	4.255	0,039	0.190779
	Roscan *	4.264	0,039	0.303878
	Philat	11.765	0.001	-0.419433
	Craori	4.122	0.042	-0.344698
	Quecoc	8.507	0.004	-0.529500
	Queinf	4.639	0.031	-0.134881
Black Pine	Cissal*	4.871	0.027	0.231669
	Junoxy*	7.985	0,005	0.372893
	Philat	5.816	0.016	-0.212307
	Rhaole	4.292	0.038	-0.236281
	Fraorn	6.279	0.012	-0.138620
	Altoff	4.143	0.042	-0.093673
	Palspi	5.027	0.025	-0.185517
	Ciravr	5.594	0.018	-0.405786
	Onoaca	21.97	0.000	-0.625580
Red Pine	Craori*	6.211	0.013	0.391538
	Altoff*	3.962	0.047	0.093484
	Palspi*	8.970	0.003	0.246174
	Quecoc*	8.088	0.004	0.507692
	Pister*	8.088	0.004	0.182068
	Eupcha*	6.471	0.011	0.417997
	Bercra	3.929	0.047	-0.362776
	Eryspp	5.724	0.017	-0.268138
	Astnan	17.771	0.000	-0.6561199
	Acaspp	10.551	0.001	-0.4622151
Taurus Cedar	Bercra*	7.307	0.007	0.4896142
	Rhaole*	4.238	0,004	0.2738461
	Astpru*	7.493	0.006	0.2492307
	Acasp.*	7.656	0.006	0.3881603
	Onoaca*	9.938	0.002	0.5224963
	Palspi	6.412	0.011	-0.2566759
	Quecer	4.162	0.041	-0.3907692

**: positive indicator*

and B variables is detected, the direction of this dependency (if ad>bc, it is positive; if bc>ad, it is negative) should be determined.

Correlation coefficient should be found:

$$C_3 = \frac{4(ad - bc)}{(a+b)^2 + (b+c)^2}$$

Results and Discussion

48 different woody plant taxa were determined within 100 sampling plots (Table 1). Essential tree species in the Burdur region included of Anatolian black pine, Red pine, Taurus cedar and Crimean juniper. In addition, *Juniperus oxycedrus*, *Verbascum* spp., *Quercus coccifera*, *Astragalus nanus*, *Berberis crataegina*, *Prunus spinosa*, *Quercus cerris* and *Pyrus communis* ssp. *communis* taxa were found in high frequency, in the district (Fig. 2).

The results of interspecific correlation analysis are presented in Table 3. Accordingly, *Berberis crataegina*, *Juniperus oxycedrus*, *Acanthalimon* spp., *Juniperus communis* and *Rosa canina* taxa constituted of positive indicator group, while *Phillyrea latifolia*, *Crataegus orientalis* var. *orientalis*, *Quercus coccifera* and *Quercus infectoria* ssp. *boissieri* constituted of negative indicator group for Crimean juniper. *Cistus salviifolius* and *Juniperus oxycedrus* were positive indicators, while *Phillyrea latifolia*, *Rhamnus oleoides*, *Fraxinus ornus* ssp. *cilicica*, *Althaea officinalis*, *Paliurus spina-christi*, *Cirsium arvense* and *Onopordium acanthium* were negative indicator groups for Anatolian black pine. *Crataegus orientalis*. var. *orientalis*, *Althaea officinalis*, *Paliurus spina-christi*, *Quercus coccifera*, *Pistacia terebinthus* ssp. *palaestina* and *Euphorbia characias* ssp. *wulfenii* were positive indicators, while *Berberis crataegina*, *Eryngium* spp., *Astragalus nanus* and *Acanthalimon* spp. were negative indicator species for Red pine. It was observed that *Berberis crataegina*, *Rhamnus oleoides*, *Astragalus prusianus*, *Acanthalimon* spp., *Onopordium acanthium* were positive indicators while *Paliurus spina-christi* and *Quercus cerris* were negative indicator species for Taurus cedar.

Some important studies have been conducted to determine the correlation between distribution, productivity of essential tree species of Turkey and forest site factors (Ozkan, 2004; 2006). In addition to these studies in forestry practices, there is a great need for studies on the indicator species of woody tree species in certain regions. In order to fulfill this requirement, present study was conducted with the purpose of determining negative and positive indicator species of the target species. Ozkan (2002) conducted a study around the Beyşehir lake basin and determined that Anatolian black pine was the target species. In the present study, most significant indicator species for Anatolian black pine was *Cistus laurifolius*. In order to detect indicator plant species through statistical methods, Gulsoy *et al.* (2013) conducted a study in the Acıpayam region and determined that Anatolian black pine was the target species in the district. They found that *Amygdalus orientalis* and *Vicia sativa* were the strongest positive indicators and *Styrax officinalis* was the most significant negative indicator species for Anatolian black pine in the district.

In this study, Taurus cedar, Crimean juniper, Anatolian black pine and Red pine were separately determined as target species and their positive and negative indicator species were established. Positive indicator species for Red pine had typical Mediterranean climatic features. Especially, *Quercus coccifera*, *Pistacia terebenthus* and *Althaea officinalis* were the most remarkable positive indicator species for Red pine. These species were mostly distributed from sea level to 800-900 m altitude and were generally found in southern parts of the district. Negative indicator species of Red pine (*Berberis crataegina*, *Astragalus nanus* etc.) were found at higher altitudes and in more humid environmental conditions. The southern areas of the Burdur district, with low altitude, could be potential planting land for Red pine, but humid sites at higher altitudes were not suitable for stands consisting of this species. As for indicator species of Anatolian black pine, it was observed that species adaptable to both Mediterranean and Continental climatic features were positive indicator species; however negative indicator species for Black pine did not clearly show typical Mediterranean or Continental climatic features. It can be said that in transitional regions with both Mediterranean and Continental climatic features (1100-1700 m), Anatolian black pine could be more productive. As for negative and positive indicator species of Taurus cedar species in the areas with high altitude and intense snow fall were detected to be positive indicators and those at lower altitudes were negative indicator species in the district. It can be said that higher mountainous areas of the district were more suitable for Taurus cedar. Similar was the case for Crimean juniper which had similar indicator species with Taurus cedar in the district. In other words, it can be said that the suitable lands for Taurus cedar can be potential areas for Crimean juniper as well.

Most of the forests in the study area have been destroyed (Ozsait, 1985). Therefore, studies on afforestation is necessary, around the district and should be carried out by authorized agency and institutions; and the most important subject is that suitable species should be chosen according to the site factors for efficient adaptation of the species to the land. These operations demand high productivity from plants. The indicator species can be vital in getting the most productive areas for the target species in forests. Guner *et al.* (2011) conducted a study on the productivity criterion of Black pine and determined the indicator species of the study area and investigated their correlation with productivity and separated indicator species having good site index values. The results obtained from the present study could be helpful in future studies regarding the productivity of essential forest tree species. This study sheds light on the efficiencies of future reforestation studies.

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