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The indicator plant species of wild animals in the Gidengelmez mountains district

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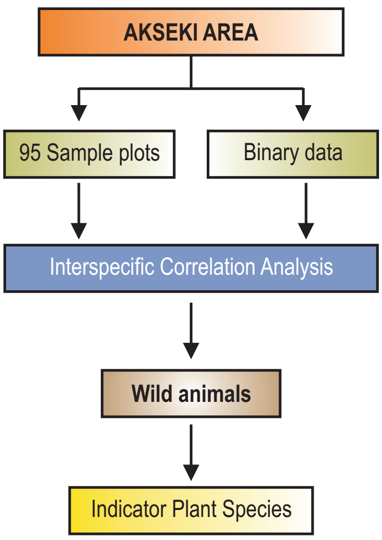
Abstract

Aim : The present study was carried out to identify indicator plant species of wild animals in the Gidengelmez mountains district.

Methodology : The data was collected from 95 sample plots. Since all the data used were is binary, inter-specific, correlation analysis was applied to examine the interrelationships between wild animals and plant taxa.

Results : It was found that the most important indicator plants of wild animals were *Salvia tomentosa*, *Micromeria myrtifolia*, *Vicia cracca* subsp. *stenophylla*, *Arum dioscoridis* var. *spectabile*, *Rosa canina*, *Juniperus oxycedrus* and *Berberis crataegina*. *Vicia cracca* subsp. *stenophylla* was the common indicator species for European hare (*Lepus europaeus*) and Badger (*Meles meles*), whereas *Salvia tomentosa* and *Micromeria myrtifolia* were significantly associated with Beech marten (*Martes foina*) and Red fox (*Vulpes vulpes*) The most important indicator plant for Wild boar (*Sus scrofa*) was *Berberis crataegina*. With regard to wild goat (*Capra aegagrus*) and brown bear (*Ursus arctos*), no plant was found to have strong indicatory value.

Interpretation : Correlation between occurrence and richness of wild animals and plant species richness was examined by Spearman correlation and Pearson correlation analysis. Among wild animals, only European hare was significantly related to plant species richness at the level of 0.05. The relationship between wild animal richness and species richness was found insignificant.



Introduction

Protection of wildlife and their habitats is the primary objective of natural resource management both for ecological and social reasons (Grimm, 1995; Decker *et al.,* 2001; Morzillo *et al.,* 2014). It is significant to have relevant information about biodiversity concepts for the protection of wild animals, ensuring continuation of their generation, and the species diversity (Aksan *et al.,* 2014). It is essential to effectively use knowledge, experience and financial resources in order to manage wildlife resources. Therefore, the people interested in wildlife should be adequately trained for the effective use of resources and efficient, systematic and continuous plans (Bryan and Crossman, 2008). There are numerous approaches in order to obtain this information in a qualified manner (Westoby *et al.,* 1989; McCann *et al.,* 2006, Campomizzi *et al.,* 2008; McRae *et al.,* 2008; Phillips and Dudík, 2008). Most of these approaches reveal the need of wild animals by mainly comparing environmental variables (Johnson, 1980; Buckland and Elston, 1993; Boyce and McDonald, 1999).

Monitoring the change of natural resources in time is of great importance for the protection of wildlife. For this purpose natural degradation, human impact, management style, environmental factors and vegetation change need to be analyzed (Wisdom *et al.,* 2002; Evers *et al.,* 2011; Morzillo *et al.,* 2012). The studies that include one or more of these factors can be regarded as reliable, practical and constant. It is known that wild animals are in connection with biotic and abiotic factors in the ecosystem and they are an indicator of ecosystem (Grimm, 1995; Bolen and Robinson, 1999; Miller and Eddleman, 2000; Connelly *et al.,* 2004; Evers *et al.,* 2011). Vegetation is one of the elements that has no monitoring unit and is focused regarding the wildlife studies. Therefore, it remains superficial in many studies. However, it is quite significant for wild animals to make plans based on vegetation characteristics and monitoring them in time (Morzillo *et al.,* 2012). The reason is that vegetation changes based on environmental factors and it has an impact on wild animals.

Identifying the indicator species of wild animals, distribution of species, ecological conditions, and following the changes over time is very important (Atalay and Efe, 2015; Süel *et al.,* 2013). The reason for this is that wild animals depend on plants for their needs of food, shelter, nesting, hiding and hunting (Bolen and Robinson, 1999; Oğurlu, 2016). Therefore, it can be concluded that vegetation is essential for each species, regardless of the type of feeding of wild animals.

In determining the indicator plant species of wild animals, interspecific correlation analysis is usually used. Özkan (2002) states that this analysis method has been by used by Holbrook (1979) and Shmida and Whittaker (1981) for assessing the relationship between plant species. Oğurlu and Aksan (2013) and Süel *et al.* (2013) conducted studies using interspecific correlation analysis about indicator plant species for wild animals, and reported successful results.

It is a known fact that the indicator species of both animals and plants in an area can be identified as positive and negative. Positive or negative relationship of the specific animals with plants can thus be predicted making use of indicator plant species in field inventory. Relationship between vegetation and the changes occurring in wild animals in time can be monitored. This study analyzes the relationship between wild animals and vegetation in Giden-Gelmez mountains located on the city borders of Antalya's Akseki town, and the results suggest a relationship between indicator plant species and species richness of wild animals.

Materials and Methods

Study area : The study area is located in Giden-Gelmez Mountains Mediterranean floristic region, which his in the northeast of Antalya at 37° 17' 16" N latitude and 31° 50' 11" E longitude. The area reaches about the boundaries of Akseki (Antalya) and Seydişehir (Konya) from south to north. In the western side of the area are located Bademli and Cevizli villages and Kuyucak mountain, while Ahırlı Village and Suğla Lake are located in the eastern part. In Seydişehir, which is in the north of the area, the total annual rainfall is around 447.7 mm and this figure is tripled in Akseki reaching up to 1355.5 mm. The lowest altitude in the area is 1190 m, while the highest altitute is 2370 m, average altitude being around 1814 m. In general, there is a transitional climate in the area varying from Mediterranean climate to terrestrial climate. Average rainfall during November-March is relatively more than during April, May, September and October. There is almost no rainfall during June-August. The lowest average temperatures are in December-February, and the highest average temperatures are in June-August (Özkan *et al.,* 2014).

Data collection of plants and wild animals in study area : The inventory of wild animals for this study was prepared for 30 plots located inside the 95 sample areas in the dimensions of 100x100 m. In each plot, feces, footprints and other signs and marks of animals were recorded. These records were identified with the help of contributor resources. Vegetation inventory prepared for these sample fields through Braun-Blanquet method, and plant species in these areas were identified. Quantal responses (1-0) of both plants and animals were marked.

Statistical analysis : Ninety eight plant taxa and five wild animal species (Table 1) were found during the study. These species were given codes in order to ease the statistical analysis procedure (Table 3).

Interspecific correlation analysis was firstly conducted in this study in order to identify the correlation between wild animals and 98 plant species. Chi-square test was done through *SPSS*

Table 1 : Animal species and frequency percentages

Species	Beech marten	European hare	Badger	Red fox	Wild boar
Frequency (%)	20	44	12	17	59

Table 2 : C3 formula used for identifying the direction of the inter-species correlation

		Species A		
		Presence	**Absence**	**Total**
Species B	Presence	a	b	a+b
	Absence	c	d	c+d
	Total	a+c	b+d	a+b+c+d.

C3 formula: $[4*(ad-bc)] / [(a+d)^2+(b+c)^2]$

20.0 software for analyzing data, and the direction of the relationship was identified using C3 formula based on this data. Calculations regarding the presence and abundance of wild animals and the presence of plant species were done using *PAST* software, and the correlations among them were analyzed by Spearman and Pearson correlation analysis.

Four figures 2x2 table was formed while calculating C3 coefficient in order to define the coefficient and direction of the correlation based on the quantal responses (Table 2). Then, C3 coefficients were identified using C3 formula (Cole, 1949; Özkan, 2002).

Results and Discussion

Chi-square (χ^2), significance level (p) and correlation direction coefficients (C3), were obtained based on the interspecific correlation analysis used for wild animal species and plant species (Table 4).

AruDio (p:0.001), CloArb (p:0.001), QueLib (p:0.002), OnoAca (p:0.003), MicMyr (p:0.004), QueCoc (p:0.005) and SalTom (p:0.000) were found to be positive indicator species for the presence of beech marten. It is also understood that they prefered these species for nutrition.

VicCra (p:0.002), DiaZon (p:0.001), JunOxy (p:0.006), and SedCae (p:0.003) were positive indicator species for European hare. VicCra, DiaZon and SedCae species were used for nutrition, while JunOxy was used for the purposes of hiding and shelter.

While RosCan (p:0.000) and VicCra (p:0.001) were positive indicators for badger, VerOre (p:0.000) and DapOle (p:0.002) were negative indicator species. Badger is known to be an omnivorous animal. This animal feeds on pieces of RosCan and VicCra and their fruits and it deserts the areas where VerOre and DapOle are found because VerOre and DapOle do not provide enough cover and limit its movement.

Although red fox is a carnivorous species, it behaves as an omnivorous animal in its nutrition habits. However, preference for nutrition was found in this study. MicMyr (p:0.008) and SalTom (p:0.003) are positive indicators for fox. It is also concluded that the red fox meets its nutrition and shelter needs through indirect methods. The negative indicator species of red fox was AcaUli (p:0.005) because it didnot provide any food, shelter or hiding possibility. Common indicator species of European hare and badger is VicCra, while it is SalTom and MicMyr for beech marten and fox. It was also observed that common indicator plant species met different habitat demands of different animals.

BerCra (p:0.000), TriArv (p:0.003), and JunCom (p:0.005) were positive indicator species for wild boar, and it uses these species for feeding. Wild boar feeds on both animal and plantal foods. In addition, AruDio (p:0.005), QueLib (p:0.000), and JunFoe (p:0.008) were significant negative indicator species. It was found that the environment where AruDio and QueLib grow was not suitable for wild boar.

The correlations between the presence and abundance of wild animals and plant species richness were analyzed by Spearman and Pearson correlation analysis. While a correlation was found between wild animals and plant species richness, no correlation was found between wild animal presence and plant species richness.

As a result of the evaluation, it was found out that there was a correlation at 0.05 significance level only between European hare, out of all wild animals, and plant species richness. The correlation with plant species richness was found for the reasons of spread of European hare in quite diverse areas, various plant species involved its feeding, and meeting the cover demand of many different plants (Table 5).

The study area, located in the Central Taurus with its characteristics of the Taurus belt, consists of two terrestrial ecosystems of forest and subalpine (Özgül, 1997; Özkan *et al.,*

Table 3 : Plant names and codes used for statistical analysis

Codes	Plant species	Codes	Plant species
AbiCil	*Abies cilicica* (Ant. & Kotschy) Carr.	NepNud	*Nepeta nuda* L.
AcaUli	*Acantholimon ulicinum* (Willd. ex Schultes) Boiss.	OnoSpi	*Ononis spinosa* L.
AceHyr	*Acer hyrcanum* Fisch. & Mey.	OnoAca	*Onopordum acanthium* L.
AceMon	*Acer monspessulanum* L.	OriSac	*Origanum saccatum* P. H. Davis
AchBie	*Achillea biebersteinii* Afan.	OstCar	*Ostrya carpinifolia* Scop.
AjuCha	*Ajuga chamaepitys* (L.) Schreber	PapPil	*Papaver pilosum* Sibth. & SM.
AllMyr	*Allium myrianthum* Boiss.	PelEnd	*Pelargonium endlicherianum* Fenzl
AltOff	*Althea officinalis* L.	PhlExa	*Phleum exaratum* Hochst. ex Griseb.
AmePar	*Amelanchier parviflora* Boiss.	PhlArm	*Phlomis armeniaca* Willd.
AntCre	*Anthemis cretica* subsp. *tenuiloba* (DC.) Grierson	PhlGra	*Phlomis grandiflora* H. S. Thompson
AruDio	*Arum dioscoridis* var. *spectabile (schott) Engl.*	PhlSam	*Phlomis samia* L.
AspAcu	*Asparagus acutifolius* L.	PinNig	*Pinus nigra* J. F. Arnold
AstMic	*Astragalus microcephalus* Willd.	PoaAng	*Poa angustifolia* L.
BalGla	*Ballota glandulosissima* Hub.-Mor. & Patzak	PopTre	*Populus tremula* L.
BerCra	*Berberis crataegina* DC.	PruDiv	*Prunus divaricata* Ledeb.
CapBur	*Capsella bursa-pastoris* (L.) Medik.	PyrEla	*Pyrus elaeagnifolia* Pallas
CedLib	*Cedrus libani* A. Rich	QueCer	*Quercus cerris* L.
CenUrv	*Centaurea urvillei* DC.	QueCoc	*Quercus coccifera* L.
CirLau	*Cistus laurifolius* L.	QueLib	*Quercus libani* Olivier
CliVul	*Clinopodium vulgare* L.	RhaOle	*Rhamnus oleoides* L.
ColArb	*Colutea arborescens* L.	RhaNit	*Rhamnus nitidus* Davis
CraMon	*Crataegus monogyna* Jacq.	RhuCor	*Rhus coriaria* L.
DacGlo	*Dactylis glomerata* L.	RosCan	*Rosa canina* L.
DapOle	*Daphne oleoides* Schreber	RosPul	*Rosa pulverulenta* Bieb.
DapSer	*Daphne sericea* Vahl	RubCan	*Rubus canescens* DC.
DiaZon	*Dianthus zonatus* Fenzl	SalScl	*Salvia sclarea* L.
DigDav	*Digitalis davisiana* Heywood	SalTom	*Salvia tomentosa* Miller
DigFer	*Digitalis ferruginea* L.	SamEbu	*Sambucus ebulus* L.
DryPal	*Dryopteris pallida* (Bory) C.Chr. ex Maire & Petitm.	ScoHis	*Scolymus hispanicus* L.
EchVis	*Echinops viscosus* DC.	SedAlb	*Sedum album* L.
EryFal	*Eryngium falcatum* Delaroche.	SedCae	*Sedum caespitosum* (Cav.) DC.
EupKot	*Euphorbia kotschyana* Fenzl	SidLib	*Sideritis libanotica* Labill.
FerTra	*Ferulago trachycarpa* Boiss.	SidCon	*Sideritis condensata* Boiss.
FibEri	*Fibigia eriocarpa* (DC.) Boiss.	SilAda	*Silene adantopetala* Fenzl
FraOrn	*Fraxinus ornus* L.	SorTor	*Sorbus torminalis* (L.) Crantz
GalVer	*Galium verum* L.	SorUmb	*Sorbus umbellata* (Desf.) Fritsch
HelAre	*Helichrysum arenarium* (L.) Moench	StyOff	*Styrax officinalis* L.
HiePan	*Hieracium pannosum* Boiss.	Telİmp	*Telephium imperati* L.
InuHet	*Inula heterolepis* Boiss.	LonNum	*Lonicera nummularifolia* Jaub. & Spach
JunCom	*Juniperus communis* subsp. *nana* Syme.	TeuCha	*Teucrium chamaedrys* L.
JunDru	*Juniperus drupacea* Lab.	TeuPol	*Teucrium polium* L.
JunExc	*Juniperus excelsa* M. Bieb.	SatCun	*Satureja cuneifolia* Ten.
JunFoe	*Juniperus foetidissima* Willd.	TriArv	*Trifolium arvense* L.
JunOxy	*Juniperus oxycedrus* L.	UlmGla	*Ulmus glabra* Hudson
LamCar	*Lamium cariense* R. Mill	UrtDio	*Urtica dioica* L.
LonEtr	*Lonicera etrusca* Santi	VerOre	*Verbascum oreophilum* C. Koch
MarGlo	*Marrubium globosum* Montbret et Aucher ex Bentham	VerChe	*Verbascum cheiranthifolium* Boiss
MelCli	*Melica ciliata* L.	VicCra	*Vicia cracca* L. subsp. *stenophylla* Vel.
MicMyr	*Micromeria myrtifolia* Boiss. et Hohen.	XerCyl	*Xeranthemum cylindraceum* SM.

Table 4 : Indicator plant species for mammalian wildlife

No	Species classification	Beech Marten			European hare			Badger			Wild Boar			Red fox		
		χ^2	p	C3	χ^2	p	C3	χ^2	p	C3	χ^2	p	C3	χ^2	p	C3
1	AruDio	10,200	0,001	0,236							14,775	0,005	- 0,621			
2	Cloarb	10,200	0,001	0,236												
3	QueLib	9,500	0,002	0,444							12,403	0,000	-0,599			
4	OnoAca	8,741	0,003	0,313												
5	MicMyr	8,278	0,004	0,255										6,964	0,008	0,216
6	QueCoc	8,017	0,005	0,166												
7	Saltom	12,931	0,000	0,504										8,072	0,003	0,390
8	Bercra										14,775	0,000	0,621			
9	TriArv										8,660	0,003	0,291			
10	JunCom										7,860	0,005	0,523			
11	JunFoe										6,591	0,008	-0,249			
12	RosCan							23,182	0,000	0,283						
13	VerOre							43,000	0,000	-0,204						
14	DapOle							9,822	0,002	-0,342						
15	Viccra				9,444	0,002	0,435	10,782	0,001	0,232						
16	DiaZon				10,311	0,001	0,529									
17	JunOxy				7,560	0,006	0,464									
18	SedCae				9,444	0,003	0,301									
19	AcaUli													7,851	0,005	-0,423

Table 5 : Correlation coefficients between wild animals and plant species richness

Species		Beech marten	European hare	Badger	Wild boar	Red fox
Plant species richness	Correlation coefficient	0,061	0,251*	0,066	0,026	0,169
	Significance Level	0,555	0,014	0,525	0,802	0,103

2014). Most of the region reserve dolines and limestone pavement surfaced in carstic terrain is a unique feature of the area (Doğan, 2002). Considering all the characteristics of the area, it is seen that it has its own specific values and biodiversity. Therefore, many different plant indicator species were identified for wild animals. It was also concluded that many different factors impact on the analysis of these indicator species (Gülsoy and Özkan, 2013; Gülsoy *et al.,* 2013, Negiz *et al.,* 2015)

Berberis crataegina, *Trifolium arvense* and *Juniperus communis* are positive indicator species for wild boar, which is an omnivorous animal. These animals feed on fruits, shells, leaves, and trunks of these plants (Bratton, 1974; Schley and Roper, 2003; Herrero *et al.,* 2006). The wild boar has a wide food preferences and especially likes fruit plants and prefers plants that are watery in summers and have dried fruits rich in fat in winters (Oğurlu and Aksan, 2013).

Arum dioscoridis var. *spectabile*, *Quercus libani*, and *Juniper foemina* are significant negative indicator species. It was observed that the environments where *Arum dioscoridis* var. *spectabile* and *Quercus libani* were present were not suitable for wild boars, because they prefer areas which enable them to hide and cover, and feed themselves with tuberous plants. Areas with no hiding cover, cliffs and slopes do not meet the preservation and feeding needs of this animal. Therefore, wild boars tend to live preferably in areas that provide hiding and covering needs and then feeding themselves in a proper way (Oğurlu, 2016; Süel *et al.,* 2013).

The areas where indicator plants are found for European hare are forested and meet the covering and feeding needs of these animals. Forest communities are more in number in the field and the diversity of plant species is very high. These areas are preferred by European hare as they are rich in food. European hare eats *Vicia cracca* subsp. *stenophylla*, *Dianthus zonatus* and *Sedum caespitosum* (Reichlin *et al.,* 2006; Karmiris and Nastis, 2010; Karmiris and Tsiouvaras, 2013; Freschi *et al.,* 2015). European hare eats the leaves and the other parts of *Vicia cracca* subsp. *stenophylla* and *Dianthus zonatus* and eats whole of *Sedum caespitosum*. Despite the fact that European hare lives in relatively dense forest regions, located between 1500 m and 1670 m, spoilt juniper areas with high diversity of plant species and communities, forestation areas, and agricultural areas are most preferred habitat types (Oğurlu, 1997). The European hare generally prefers open habitats covered with vegetation (Peschel *et al.,* 2011; Süel *et al.,* 2013). This animal uses *Juniperus oxycedrus* for hiding and shelter purposes (Karmiris and Nastis, 2010).

Although beech marten is known to be a predator, feeding and hiding opportunities of plants play a key role in identifying habitat preferences (Virgos *et al.,* 2010), it is an omnivorous animal. Plants, birds, and insects are in its food chain. *Arum dioscoridis* var. *spectabile*, *Onopordum acanthium*, *Salvia tomentosa* and *Micromeria myrtifolia* are known to be visited by many insects and the other creatures (Briese, 2006; Revel *et al.,* 2012). Some plants are also known to be used for the treatment of animals (Viegi *et al*., 2003). *Micromeria myrtifolia* was used for this purpose for beech marten. Therefore, these indicator species are indirectly preferred for feeding purposes. *Colutea arborescens*, *Quercus libani* and *Quercus coccifera* are preferred for both covering and feeding, because beech marten does not directly eat these species. However, it feeds on insects, birds and the other creatures (Süel *et al.,* 2013). Additionally, beech marten feeds on bird eggs. In these cases, *Quercus libani* and *Quercus coccifera,* that can provide shelter for some bird species, are used as indicators (Herrero *et al*., 1981; Lopez and Moro, 1997).

While *Rosa canina* and *Vicia cracca* subsp. *stenophylla* are positive indicators for badger, *Verbascum oreophilum* and *Daphne oleoides* are negative indicator species. Badger especially eats fruits of *Rosa canina* and *Vicia cracca* subsp. *stenophylla* (Luís *et al.,* 2009; Pamukoğlu and Albayrak, 2014). Ünal (2011) stated that badgers mainly prefers forest openings and forests. These fields are also suitable for badgers to dig. This is a significant reason for preference for badgers who feed by digging (Özen and Uluçay, 2010). The areas where fructus cynosbati and *Vicia cracca* subsp. *stenophylla* are available provide avenues for badger to dig. It avoids fields with *Verbascum oreophilum* and *Daphne oleoides*. The reason is that these species cannot provide enough cover and limit the mobility of badger (Süel *et al.,* 2013).

Red fox is an omnivorous animal. In addition to the fact that there are some plants that feeds directly, there are also species that provide indirect food (Süel *et al.,* 2013). *Micromeria myrtifolia* and *Salvia tomentosa* are useful for fox to feed indirectly; they also provide hiding and shelter for the animal. *Acantholimon ulicinum* is a negative indicator species because it limits the moving capability of fox and does not provide enough shelter. Therefore, red fox avoids fields where *Acantholimon ulicinum* grows.

Some indicator plant species have been identified for various wild animals in Giden-Gelmez Mountains. As a result of these findings, the existence of wild animals based on the plants types found in the area can be predicted, and thereby some predictions regarding the vegetation that can affect the existence of which animals can be made. Thanks to this prediction, the study can be redirected, or the type, time and the other factors of the study can be modified, and better results could be obtained by better planning (Oğurlu and Aksan, 2013). Additionally, the changing conditions of wild animals can be tracked through the vegetation change. This means that environmental and anthropogenic influences on vegetation can be understood whether they affect wild animals or not, and early measures can be taken for conservation activities.

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References

Aksan, Ş., İ. Özdemir and İ. Oğurlu: Modeling the distributions of some wild mammalian species in Gölcük Natural Park. Turkey *Biol. Divers. Conservat*., **7**, 1-15 (2014).

Atalay, İ. and R. Efe: Biogeography of Turkey (Türkiye Biyocoğrafyası). Meta Press, Izmir, Turkey (2015).

Bolen, E.G. and W.L. Robinson: Wildlife ecology and management, fourth edition. Upper Saddle River, NJ: Prentice Hall (1999).

Boyce, M.S. and L.L. McDonald: Relating populations to habitats using resource selection functions. *Trends Ecol. Evol.*, **14**, 268-272 (1999).

Bratton, S.P.: An integrated ecological approach to the management of the European wild boar (*Sus scrofa*) in Great Smoky Mountains National Park Report to the National Park Service. Mimeo., (1974).

Briese, D.: Can an apriori strategy be developed for biological control. The case of *Onopordum* spp. thistles in Australia. *Aust. J. Entomol.*, **45**, 317–323 (2006).

Bryan, B.A. and N.D. Crossman: Systematic regional planning for multiple objective natural resource management. *J. Environ. Manag.*, **88**, 1175–1189 (2008).

Buckland, S.T. and D.A. Elston: Empirical models for the spatial distribution of wildlife. *J. Appl. Ecol.*, **30**, 478-495 (1993).

Campomizzi, A.J., J.A. Butcher, S.L. Farrell, A.G. Snelgrove, B.A. Collier, K.J. Gutzwiller, M.L. Morrison and R.N. Wilkins: Conspecific attraction is a missing component in wildlife habitat modeling. *J. Wildl. Manag.*, **72**, 331–336 (2008).

Cole, L.C.: The measurement of interspesific association. *Ecology*, **30**, 411-424 (1949).

Connelly, J. W., S. T. Knick, M. A. Schroeder and S. J. Stiver: Conservation assessment of greater sage-grouse and sagebrush habitats. Cheyenne, Wyoming: Western Association of Fish and Wildlife Agencies. (2004).

Decker, D.J., T.L. Brown and W.F. Siemer: Human dimensions of wildlife management in North America. Bethesda, MD: The Wildlife Society. (2001).

Doğan, U.: Geomorphological evolution of the Manavgat River's basin. *Gazi University J. Gazi Educational Faculty,* **22,** 51-65 (2002).

Evers, L., R.F. Miller, M. Hemstrom, J. Merzenich, R. Neilson and P. Doescher: Estimating historical sage-grouse habitat abundance using a state-and-transition model. *Nat. Resour. Environ.,* **17**, 117-129 (2011).

Freschi, P., S. Fascetti, M. Musto, E. Mallia, C. Cosentino and R. Paolino: Diet of the Italian hare (*Lepus corsicanus*) in a semi-natural landscape of southern Italy. *Mammalia*, **79**, 51-59 (2015).

Grimm, N.B.: Why link species and ecosystems? A perspective from ecosystem ecology. In: Linking species and ecosystems (Eds.: C.G. Jones and J.H. Lawton). Chapman and Hall, New York (1995).

Gülsoy, S. and K. Özkan: Determination of environmental factors and indicator plant species for site suitability assessment of Crimean Juniper in the Acipayam District, Turkey. *Sains Malaysiana*, **42**, 1449–1457 (2013).

Gülsoy, S., Ö. Şentürk and M.G. Negiz: Identification of indicatory plant species for target species by using quantitative methods: A case study from Acıpayam district. *Turk. J. Fores.,* **14**, 10-14 (2013).

Herrero, J., A. García-Serrano, S. Couto, V.M. Ortuño and R. García-González: Diet of wild boar *Sus scrofa* L. and crop damage in an intensive agroecosystem. *Eur. J. Wildl. Res.*, **52**, 245-250 (2006).

Holbrook, S. J.: Habitat utilization, competitive interactions and coexistence of three species of cricetine rodents in East-Central Arizona. *Ecology*, **60**, 758-769 (1979).

Johnson, D.H.: The comparison of usage and availability measurements for evaluating resource preference. *Ecology*, **61**, 65-71 (1980).

Karmiris, I. and A. Nastis: Diet overlap between small ruminants and the European hare in a Mediterranean shrubland. *Cent. Eur. J. Biol.*, **5**, 729-737 (2010).

Karmiris, I. And K. Tsiouvaras: Effects of several plant species on the spatial distribution of the European hare (*Lepus europaeus*) at the microhabitat scale. Dry Grasslands of Europe: Grazing and Ecosystem Services Proceedings of 9th European Dry Grassland Meeting (EDGM) Prespa, Greece, pp. 169-174 (2013).

Lopez, G. and M.J., Moro: Birds of Aleppo Pine Plantations in South-East Spain in relation to vegetation composition and structure. *J. Appl. Ecol.*, **34**, 1257-1272 (1997).

Luís, M., L.M. Rosalino and M. Santos-Reis: Fruit consumption by carnivores in Mediterranean Europe. *Mamm. Rev.*, **39**, 67–78 (2009).

McCann, R.K., B.G. Marcot and R. Ellis: Bayesian belief networks: Applications in ecology and natural resource management. *Can. J. Forest. Res.*, **36**, 3053–3062 (2006).

McRae, B.H., N.H. Schumaker, R.B. McKane, R.T. Busing, A.M. Solomon and C.A. Burdick: A multi-model framework for simulating wildlife population response to land-use and climate change. *Ecol. Model.*, **219**, 77–91 (2008).

Miller, R.F. and L. Eddleman: Spatial and temporal changes in sage grouse habitat in the sagebrush biome. Tech. Bull. 151. Corvallis, Oregon: Oregon State University; Agricultural Experiment Station, USA (2000).

Morzillo, A.T., P. Comeleo, B. Csuti and S. Lee: Application of state-and-transition models to evaluate wildlife habitat. US Forest Service General Technical Report. Pages 129-145 in Halofsky, J. E., Creutzburg, M.K., & Hemstrom, M. A., (technical editors). Integrating social, economic, and ecological values across large landscapes. Pacific Northwest Research Station General Technical Report PNW-GTR-896. Portland, OR:USDA Forest Service, (2014).

Morzillo, A.T., J.S. Halofsky, J. DiMiceli and M. Hemstrom: Balancing feasibility and precision of wildlife habitat analysis in planning for natural resources. In: Proceedings of the first landscape state-and-transition simulation modeling conference (Eds.: B.K. Kerns, A. Shlisky and C. Daniel). Gen. Tech. Rep. PNW-GTR-869. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 103-114 (2012).

Negiz, M.G., Y., Eser, E., Kuzugüdenli and K. Özkan: Indicator species of essential forest tree species in the Burdur district. *J. Environ. Biol*., Special issue, **36**,107-111 (2015).

Oğurlu, İ.: Habitat Use and Food Habits of Brown Hare (*Lepus europaeus* (Pallas)) in a Woodland. *Turkish J. Zoology,* **21**, 381-398 (1997).

Oğurlu, İ.: Wildlife Ecology (Yaban Hayatı Ekolojisi). Süleyman Demirel University Press, Isparta, Turkey (2016).

Oğurlu, İ. and Ş. Aksan: Determination of indicator woody plant species for potential habitats of some wild mammalian species. *SDU Faculty of Forestry J.*, **14**, 81-87 (2013).

Özen, A.S. and İ. Uluçay: Ecological, biological And taxonomical characteristics of *Meles meles* Linnaeus, 1758 (Mammalia: Carnivora) In Kütahya. *J. Instit. Sci. Technol. Dumlupınar University,* **21**, 9-20 (2010).

Özgül, N.: Stratigraphy of The Tectonostratigraphic Units Around Hadim-Bozkir-Taşkent Region (Northern Part of The Central Taurides, Turkey). *Bull. Mineral Res. Explor.*, **119**, 113-174 (1997).

Özkan, K.: The measurement of interspecific association by interspecific correlation analysis. *SDU Faculty of Forestry J.*, **2**, 71-78 (2002).

Özkan, K., H. Fakir, Y. Ünal, A. Baygal, V. A. Karacan and R. Aygün: Antalya Cevizli Gidengelmez Mountain Wildlife Development Area Management and Development Plan (Antalya Cevizli Gidengelmez Dağı Yaban Hayatı Geliştirme Sahası Yönetim Ve Gelişme Planı). Ministry of Forest and Water Affairs, General Directorate of Nature Conservation and National Parks, pp. 156 (2014).

Pamukoğlu, N. and İ. Albayrak: The Taxonomy and Ecology of *Meles meles* (L., 1758) in Western Turkey. *Hacettepe J. Biol. Chem.*, **42**(4), 451–458 (2014).

Peschel, U., S. Fuchs, N. Klar and C.C. Voigt: Home range and habitat use of the brown hare (*Lepus europaeus*) on organic farmland, Bundesamt für Naturschutz (Bfn) - Federal Agency for Nature Conservation, German (2011).

Phillips, S.J. and M. Dudík: Modeling of species distributions with Maxent: New extensions and a comprehensive evaluation. *Ecography*, **31**, 161–175 (2008).

Reichlin, T., E. Klansek and K. Hackländer: Diet selection by hares (*Lepus europaeus*) in arable land and its implications for habitat management. *Eur. J. Wildl. Res.*, **522**, 109–118 (2006).

Revel, N., N. Alvarez, M. Gibernau and A. Espíndola: Investigating the relationship between pollination strategies and the size-advantage model in zoophilous plants using the reproductive biology of *Arum cylindraceum* and other European *Arum* species as case studies. *Arthropod-Plant Interactions*, **6**, 35-44 (2012).

Schley, L. and T. J. Roper: Diet of wild boar *Sus scrofa* in Western Europe, with particular reference to consumption of agricultural crops. *Mamm. Rev.*, **33,** 43–53 (2003).

Shmida, A. and R. H. Whittaker: Pattern and biological microsite effects in two shrub communities, Southern California. *Ecology*, **62**, 234-251 (1981).

Süel, H., E.T. Ertuğrul, Ş. Aksan, Y. Ünal, D. Akdemir, G. Cengiz, H. Bayrak, M.Ö. Ersin, İ. Oğurlu, K. Özkan and İ. Özdemir: Indicator species of habitat preferences to wildlife animals in Köprüçay district. 3rd International Geography Symposium, p. 553 (2013).

Viegi, L., A. Pieroni, P.M. Guarrera and R. Vangelisti: A review of plants used in folk veterinary medicine in Italy as basis for a databank. *J. Ethnopharmacol.*, **89**, 221-44 (2003).

Virgos, E., S. Cabezas-Díaz, J. G. Mangas and J. Lozano: Spatial distribution models in a frugivorous carnivore, the stone marten (*Martes foina*): Is the fleshy-fruit availability a useful predictor?. *Animal Biology*, **60**, 423-436 (2010).

Westoby, M., B. Walker and I. Noy-Meir: Opportunistic management for rangelands not at equilibrium. *J. Rangeland Manag.*, **42**, 266–274 (1989).

Wisdom, M.J., M.M. Rowland, B.C. Wales, M.A. Hemstrom, W.J. Hann, M.G. Raphael, R.S. Holthausen, R.A. Gravenmier and T.D. Rich: Modeled effects of sagebrush-steppe restoration on Greater sagegrouse in the Interior Columbia Basin, U.S.A. *Conservat. Biol.*, **16**, 1223–1231 (2002).