



Effectiveness of Protected Areas in Conserving Mammalian Wildlife Diversity: A Case Study from Türkiye

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ABSTRACT

Research on the distribution and diversity of animals in protected and unprotected areas is crucial for the ongoing conservation of wildlife. In this study, conducted between 2016 and 2018 across 327 localities in Bingöl province and its rural surroundings, 18 medium- and large-sized wild mammal species were identified, including nine new records for the area. In the regions established within the study area—Yedisu, Kiğı, Yayladere, and Hacılar—the relative frequency of wild mammal species ranged from 0.3% to 32.0%, with the highest species diversity recorded in Kiğı, where 17 species were identified ($H'=1.83$). This was followed by Yedisu and Yayladere, each with 11 species ($H'=2.19$ and $H'=1.86$, respectively). Based on these results, the Kiğı region should be considered a priority area for conservation. At a time when concerns about the future of biodiversity are growing, studies like this that contribute to mammalian fauna will help preserve species, evolutionary potential, and ecosystem function. The data from this study will significantly support future management and conservation efforts in these key areas.

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Korunan Alanların Memeli Yaban Hayvanlarının Çeşitliliğini Korumadaki Etkinliği: Türkiye’de Korunan ve Korunmayan Alanların Karşılaştırılması

ÖZET

Korunan ve korunmayan alanlardaki hayvanların dağılışı ve çeşitlilikleri üzerine yapılan araştırmalar, yaban hayatının devamı ve korunması açısından oldukça önemlidir. 2016-2018 yılları arasında Bingöl ili ve kırsalında toplam 327 lokalitede yürütülen bu çalışma ile 9'u yeni kayıt olmak üzere alanda 18 orta ve büyük boy memeli yaban hayvanı tanımlanmıştır. Çalışma alanı genelinde oluşturulan Yedisu, Kiğı, Yayladere ve Hacılar bölgelerinde memeli yaban hayvanları göreceli sıklığının %0,3 ile %32,0 arasında değiştiği ve en fazla tür çeşitliliğinin 17 tür ile Kiğı’da ($H'=1.83$) tespit edildiği görülmektedir. Bunu 11 tür ile Yedisu ve Yayladere ($H'=2.19$ ve $H'=1.86$) bölgeleri takip etmiştir. Bu sonuçlara göre Kiğı bölgesi koruma önceliği taşıyan bir alan olarak değerlendirilmelidir. Biyolojik çeşitliliğin geleceğine ilişkin endişelerin arttığı bu günlerde, bu çalışmalar aracılığıyla memeli faunasına yapılacak katkılar yalnızca türlerin değil, aynı zamanda evrimsel potansiyelin ve ekosistem işlevinin de korunmasına yardımcı olacaktır. Bu çalışmadan elde edilen veriler, ileride özel alanların yönetilmesi ve korunması açısından büyük katkılar sağlayacaktır.

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INTRODUCTION

Mammal diversity is a key indicator of ecosystem health (Jorgensen et al., 2005; Metcalfe et al., 2014; Jones et al., 2019; Smith et al., 2022). Mammals shape nutrient cycling, vegetation, and prey dynamics (Doughty et al., 2016).

However, data on their presence, distribution, and populations remain scarce in many regions (Orban et al., 2022; Vinitpornsawan & Fuller, 2023). Protecting large mammals and their habitats is crucial for the broader conservation of wildlife. However, human activities drive ecosystem declines and biodiversity loss worldwide (Brodie et al., 2021; Bedson et al., 2022). Habitat fragmentation is a principal driver, reducing species richness, population density, and distribution. Thus, understanding habitat requirements is vital for effective conservation (Maxwell et al., 2016; Jumeau et al., 2017; Fahrig, 2017; Elith & Leathwick, 2009; Peterson et al., 2011; Schwartz, 2012; Jayaraj et al., 2013).

Türkiye's status in the Palaearctic realm is important for mammalian biodiversity. It contains 13 orders, 42 families, and 843 species (Fitter, 1979; Cole et al., 1994; Kryštufek & Vohralík, 2001, 2005, 2009; Musser & Carleton, 2005; Coğal & Sözen, 2020; Selçuk & Kefelioğlu, 2020; Ulutürk & Yürümez, 2022; Akpınar & Yürümez, 2025). Of these, 172 species from several orders are present in Türkiye (Demirsoy, 1996, 2006; Eken et al., 2006; Yiğit et al., 2006; Ulutürk & Coşkun, 2011; Özkurt & Bulut, 2020; Karataş et al., 2021a, 2021b), and 45 are listed as threatened, with others possibly at risk (IUCN, 2025; Seyfi et al., 2021). Despite this diversity, most studies focus on the cytogenetic and morphological features of small mammals. In contrast, research on medium- and large-sized wild mammals—especially comparisons between protected and unprotected areas—remains limited.

Biodiversity projects by the Ministry of Agriculture and Forestry (2013–2020) expanded studies and completed biodiversity inventories for all 81 provinces. Previously, research on the ecology of large mammals in Bingöl Province and its surroundings was limited. Lehmann (1966) noted *Erinaceus europaeus transcaucasicus* in Bingöl. Çayır et al. (2014) listed large mammals in the Şeytan Mountains Wildlife Reserve Area. Mansuroğlu and Dağ (2016) identified permitted hunting and other species within the Kiğı Şeytan Mountains WRA.

Wild mammals are crucial in maintaining ecosystem balance, serving as prey and predators. In Bingöl Province, the diversity and populations of these species are threatened by habitat fragmentation and human activities. The data show that historical research gaps have limited our understanding of their status. Evidence indicates that several species might decline due to inadequate protection and increasing human pressure. Türkiye faces particular risks because unprotected areas comprise a large part of its landscape, and protected zones are few and fragmented. Without comprehensive, integrated conservation strategies beyond the current protected areas, biodiversity loss could increase.

This study tests explicitly whether protected areas in Türkiye positively impact both the diversity and relative abundance of medium- and large-sized mammal species compared to unprotected areas. It further evaluates whether the current conservation network in Bingöl can effectively sustain regional mammalian biodiversity. Key findings indicate that protected areas support greater species richness and higher abundance of mammals than unprotected sites. Direct comparison of mammalian communities informs evidence-based recommendations for conservation planning, helping to address knowledge gaps and clarify the specific conservation needs of Bingöl's wild mammals.

MATERIAL and METHOD

Study area

This study was conducted in Bingöl, located in the upper Euphrates section of the Eastern Anatolia Region, with an average elevation of 1745 m. The main geographical formations of Bingöl Province are mountainous areas, valleys, plains, and basins. Approximately 2.5% of the area consists of plains, 83% mountains, and 15% valleys (Fig. 1). The elevation of the plateaus and plains on Genç (2940 m), Akçara (2940 m), Şerafettin (2544 m), Bingöl (3250 m), and Şeytan Mountains (2906 m) in Bingöl do not fall below 2000 m. In the province where the terrestrial climate is effective, the climatic elements differ based on the differentiation of the surface forms. The increasing altitude conditions from the Bingöl Plain to the surrounding areas and the alignment of the mountainous regions surrounding the province have affected the differentiation of temperature and precipitation conditions in the same direction. In general, the province of Bingöl has a rich water potential. Numerous small lakes and river systems are also within the city's borders. The most important streams are the Murat River, Göynük Stream, and Peri Stream. Although many lakes are within the borders of the province of Bingöl, none is of significant size. The lakes were formed due to glacial erosion and faulting. While 17.7% of the forests of Bingöl province, which constitute 1.2% of Türkiye's forests and 21% of the forests of the Eastern Anatolia Region, are normal forests, 82.3% are degraded forests. As a result of the destruction of the forests, the plains and depression floors have become mainly the distribution areas of anthropogenic steppe species (Avcı et al., 2018). Bingöl Province contained a range of different vegetation types. The widest distribution of vegetation types is among shrubs (48.8%), followed by steppe areas (39%) and broad-leaved forest areas (11.2%). The least widespread vegetation type is mixed forests (0.9%) and coniferous forests (0.1%). Although oak trees predominate in forest regions, steppe regions are home to a diverse array of trees, including cedar, larch, hawthorn, and juniper (Avcı et al., 2018).

The study area encompasses a range of habitats classified under the European Union's Natura 2000 system. It is mainly mountainous, with extensive grasslands, shrublands, and dry steppes (E1 and E2). There are patches of deciduous and coniferous forests (G1 and G3). Montane and subalpine zones feature alpine and subalpine grasslands (E4), particularly in higher areas, such as the Şeytan Mountains (WRA in Kiğı). River valleys and streams create riparian and freshwater habitats (C1 and C2). Rocky outcrops and cliffs (H3) offer shelter for wild mammals. Together, these habitats support high biodiversity and ecological variety, making Bingöl an important area for conserving medium- and large-sized wild mammals in Türkiye (Fig. 1).

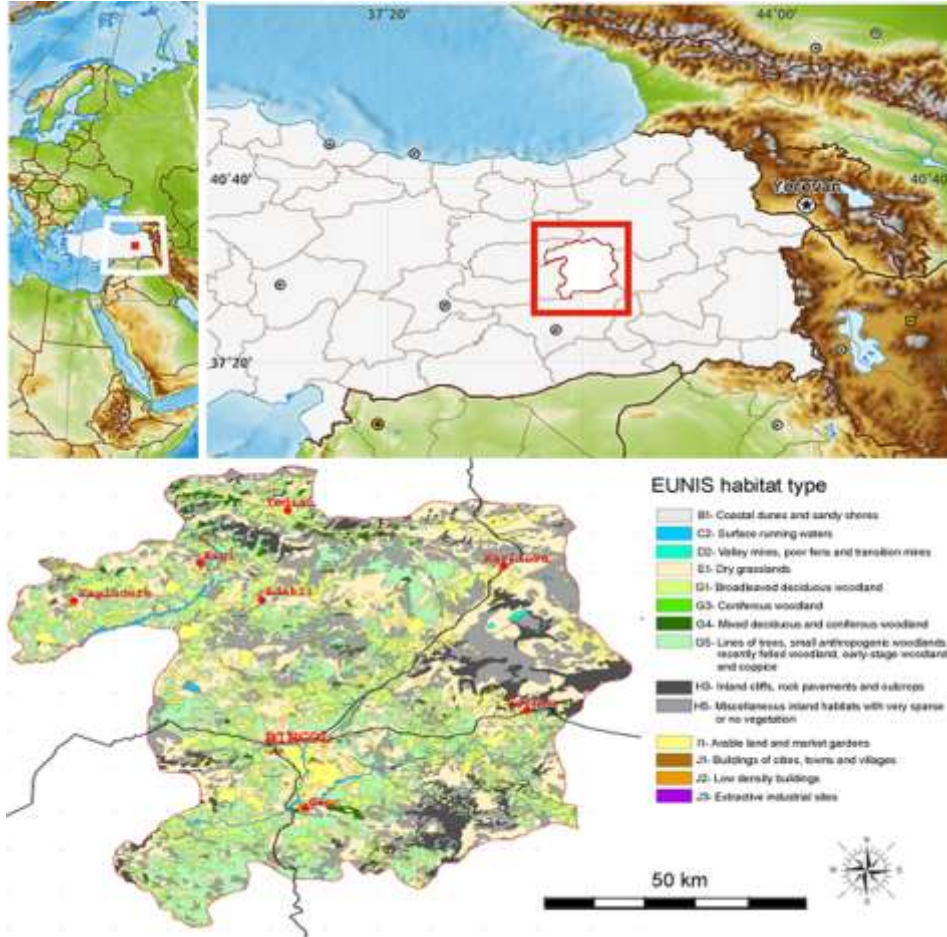


Figure 1. Geographical location of the study area with the distribution of EUNIS habitat types, including protected areas, land use patterns, and topographic elevation.

Şekil 1. Çalışma alanının coğrafi konumu ve korunan alanlar, arazi kullanım desenleri ile topoğrafik yüksekliğin dahil olduğu EUNIS habitat tiplerinin dağılımı

Methods

The wild mammal inventory of Bingöl Province was compiled using three sources: (i) fieldwork, (ii) previous scientific studies, and (iii) surveys with local inhabitants. The study area included 327 localities within 73 plots, as outlined on the 1:25,000 scale map of Bingöl. Project specifications from the Bingöl Provincial Directorate of Nature Conservation and National Parks required a study of at least 10% of each parcel. Work was conducted randomly at 327 locations across all 73 parcels, with a focus on accessible areas suitable for wild animals. Field surveys were conducted on these plots over 55 days in various seasons between 2016 and 2018 (Fig. 2). Both direct and indirect observation techniques were used to document wild mammal species. Direct observations were made using binoculars, video cameras, and DSLR cameras. Indirect methods identified and recorded signs such as footprints, feces, bark stripping, food remains, and scratch marks. Observations were conducted at sunrise and sunset to efficiently sample various habitats, including mountains, forests, moorlands, wetlands, dunes, agricultural zones, and settlements, ranging from the city centre to districts and village centres. Figure 2 illustrates the species distribution in the observed areas.

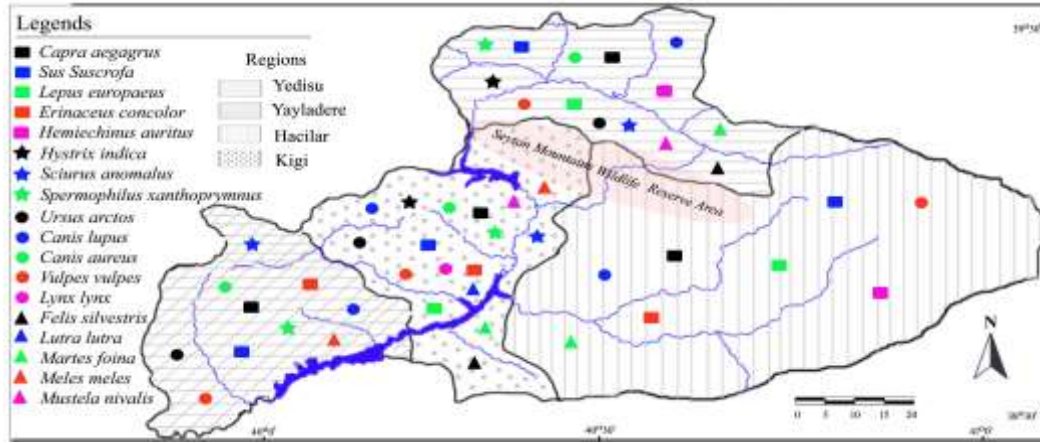


Figure 2: The distribution of wild mammals in the study area across four regions, including protected and non-protected areas.

Şekil 2: Çalışma alanında bulunan yabani memelilerin korunan ve korunmayan alanları kapsayan dört bölgeye dağılımı.

Data analyses

The conservation status of species came from CITES, BERN, and IUCN databases. Mammals in this study were classified by body mass into two categories: medium-sized (2–7 kg) and large-sized (over 7 kg) (Agebo & Tekalign, 2022). The total number of recorded species measures species richness. Relative abundance was calculated as the number of individuals per species divided by the total individuals observed. Mammal diversity was quantified using Shannon's diversity index (H'), which is considered reliable due to its sensitivity to population changes, especially in endangered species.

$$H' = -\sum_{i=1}^S p_i \cdot \ln(p_i) \quad p_i = \frac{n_i}{N}$$

Species evenness was calculated as Shannon's index (H') divided by the natural logarithm of species richness, $\ln(S)$ (Gaunle, 2018). The Simpson index (1-D) was also used to assess dominance and changes among the most abundant species (Solow, 1993).

$$D = \frac{\sum n_i(n_i - 1)}{N(N - 1)}$$

To assess the relative variability in species abundance among sampling sites, the coefficient of variation (CV) was calculated. This allowed for a standardized comparison of species distributions across heterogeneous habitats. Furthermore, 95% confidence intervals (CI) were computed for diversity indices and abundance estimates to assess the statistical reliability of observed patterns. Independent sample t-tests were used to determine whether differences in species richness and diversity between habitat types (e.g., protected vs. unprotected, forested vs. open areas) were statistically significant. When comparing more than two groups, a one-way ANOVA was used to determine which groups differed significantly. For mammal groups with high species richness, pairwise comparisons of species composition were also conducted across all sites to examine faunal similarity and turnover patterns.

$$CI = \bar{x} \pm t \frac{sd}{\sqrt{n}}$$

S = total number of species,

p_i = the proportion of individuals belonging to the i -th species in relation to the total number of individuals,

n_i = number of individuals of the i -th species,

n = sample size,

\bar{x} = sample mean,

sd = standard deviation,

t = t-value for 95% confidence and $(n-1)$ degrees of freedom,

N = total number of individuals across all species.

RESULTS

This initial study on the diversity of wild mammals in Bingöl Province and the evaluation of its biological conservation value led to the identification of 18 medium- and large-sized wild mammal species: *Canis lupus*, *Canis*

aureus, *Vulpes vulpes*, *Martes foina*, *Mustela nivalis*, *Felis silvestris*, *Lynx lynx*, *Lutra lutra*, *Meles meles*, *Ursus arctos*, *Sus scrofa*, *Capra aegagrus*, *Hystrix indica*, *Sciurus anomalus*, *Spermophilus xanthophrymnus*, *Lepus europaeus*, *Erinaceus concolor*, and *Hemiechinus auritus*. These 18 mammal species belong to 5 orders, 10 families, and 17 genera (Table 1).

Table 1. Mammal species recorded in the study area during this and previous studies, along with their national and international conservation statuses.

Çizelge 1. Çalışma alanında bu çalışma ve önceki çalışmalarda tespit edilen memeli türleri ile bu türlerin ulusal ve uluslararası koruma statüleri.

Order/Family	Species	IUCN	BERN	CITES	SIZE	REFERENCE
Cetartiodactyla						
Bovidae	<i>Capra aegagrus</i> Erxleben, 1777	VU		II	Large	This study; (Çayır et al., 2014); (Mansuroğlu & Dağ, 2016)
Suidae	<i>Sus scrofa</i> Linnaeus, 1758	LC			Large	This study; (Mansuroğlu & Dağ, 2016)
Logomorpha						
Leporidae	<i>Lepus europaeus</i> Linnaeus, 1758	LC		III	Large	This study; (Çayır et al., 2014); (Mansuroğlu & Dağ, 2016)
Eulipotyphla						
Erinaceidae	<i>Erinaceus concolor</i> Martin 1837	LC			Medium	This study; (Çayır et al., 2014)
	<i>Hemiechinus auritus</i> (Gmelin, 1770)	LC			Medium	This study
Carnivora						
Ursidae	<i>Ursus arctos</i> Linnaeus, 1758	VU			Large	This study; (Çayır et al., 2014); (Mansuroğlu & Dağ, 2016)
Canidae	<i>Canis lupus</i> Linnaeus, 1758	LC	I	II	Large	This study; (Çayır et al., 2014)
	<i>Canis aureus</i> Linnaeus, 1758	LC			Large	This study
	<i>Vulpes vulpes</i> Linnaeus, 1758	LC			Large	This study; (Çayır et al., 2014)
Felidae	<i>Lynx lynx</i> (Linnaeus, 1758)	LC			Large	This study
	<i>Felis silvestris</i> Schreber, 1777	LC			Large	This study; (Çayır et al., 2014)
Mustelidae	<i>Lutra lutra</i> Linnaeus, 1758	NT	I/w	II	Large	This study
	<i>Martes foina</i> (Erxleben, 1777)	LC	III		Large	This study; (Mansuroğlu & Dağ, 2016)
	<i>Meles meles</i> (Linnaeus, 1758)	LC			Large	This study
	<i>Mustela nivalis</i> Linnaeus, 1766	LC	III		Large	This study
Rodentia						
Hystriidae	<i>Hystrix indica</i> (Kerr 1792)	LC		II	Large	This study
Sciuridae	<i>Sciurus anomalus</i> Gmelin, 1778	LC	II		Medium	This study
	<i>Spermophilus xanthophrymnus</i> Bennett, 1835	NT			Medium	This study

According to the IUCN, *Capra aegagrus* and *Ursus arctos* are classified as Vulnerable (VU), while *Spermophilus xanthophrymnus* and *Lutra lutra* are listed as Near Threatened (NT). The remaining 14 species identified in the study fall under the Least Concern (LC) category (Table 1). However, despite being globally classified as LC, species such as *U. arctos*, *Hystrix indica*, *Canis lupus*, and *Lynx lynx* are considered threatened nationally. Similarly, according to the CITES appendices, *C. lupus* and *L. lutra* are listed in Appendix I, while *Felis silvestris* and *Sciurus*

anomalus are included in Appendix II. *Vulpes vulpes* and *Martes foina* appear in Appendix III (Table 1).

This survey added nine previously unrecorded medium- and large-sized mammal species to the provincial inventory: *Canis aureus*, *Mustela nivalis*, *Lynx lynx*, *Lutra lutra*, *Meles meles*, *Hystrix indica*, *Sciurus anomalus*, *Spermophilus xanthophrymnus*, and *Hemiechinus auritus*. These species were not reported in earlier studies by Çayır et al. (2014) and Mansuroğlu and Dağ (2016). Conversely, the present study did not observe two medium and large-sized mammal species previously documented in the province, *Martes martes* and *Rupicapra rupicapra*. Images of some wild mammals detected during the survey are presented in Figure 3.



Figure 3. Photographs of wild mammal species recorded in the Bingöl region (a- *Vulpes vulpes*, b- *Canis lupus*, c- *Mustela nivalis*, d- footprints of *Canis aureus*, e- feces of *Meles meles*, f- *Lepus europaeus*, g- *Martes foina*, h- footprints of *Lutra lutra*, I- footprints of *Ursus arctos*, j- footprints of *Lynx lynx*, k- *Sus scrofa*, l- *Capra aegagrus*, m- *Hystrix indica*, n- *Spermophilus xanthophrymnus*, o- *Sciurus anomalus*, p- *Hemiechinus auritus*, and q- *Erinaceus concolor*)

Şekil 3. Bingöl yöresinde tespit edilen memeli yaban hayvanlarına ait fotoğraflar (a- *Vulpes vulpes*, b- *Canis lupus*, c- *Mustela nivalis*, d- *Canis aureus* (ayak izi), e- *Meles meles* (dışkı), f- *Lepus europaeus*, g- *Martes foina*, h- *Lutra lutra* (ayak izi), I- *Ursus arctos* (ayak izi), j- *Lynx lynx* (ayak izi), k- *Sus scrofa*, l- *Capra aegagrus*, m- *Hystrix indica*, n- *Spermophilus xanthophrymnus*, o- *Sciurus anomalus*, p- *Hemiechinus auritus* and q- *Erinaceus concolor*).

Surveys conducted at these localities revealed that carnivores, represented by ten species from four families, constituted the most diverse mammalian order in the study area. Kiğı had the highest number of individuals

(N=239) and species richness (R=17). Yedisu (N=203, R=13), Yayladere (N=154, R=11) and Hacılar (N=114, R=8) are followed Kiğı respectively (S1). *Sus scrofa* was the most abundant among all recorded species, with 227 individuals (32.0%), followed by *Capra aegagrus* with 169 individuals (23.8%). Several species were represented by very few individuals, including the Eurasian lynx (*Lynx lynx*, n=2), the Eurasian otter (*Lutra lutra*, n=3), and the Indian crested porcupine (*Hystrix indica*, n=4). These low numbers suggest that such species occur at low densities or are difficult to detect using the applied sampling methods. The relative frequency of wild mammal species across the region ranged from 0.3% to 32.0% (S1). The coefficient of variation (CV) and the confidence interval (CI) were also provided in Supplementary Table 1, separately for each species across different study areas. Accordingly, the coefficient of variation (CV) for the wild goat (*C. aegagrus*) was calculated as 0.443, with a % 95% confidence interval (% 95% CI) of 12.47–72.03. For the wild boar (*S. scrofa*), the CV was 0.487, and the % 95% CI ranged from 12.77 to 100.73 (S1).

According to the statistical analyses, the Shannon-Wiener diversity index was the highest in Kiğı, with an $H'=2.28$ value. In Yedisu, these values were $H'=1.91$, in Yayladere, $H'=1.76$, and in Hacılar, $H'=1.73$. Evenness values varied slightly across the areas, with the lowest in Yayladere (0.734) and the highest in Hacılar (0.835), suggesting that Hacılar, despite having fewer species, had a more balanced distribution of individuals among species (S1). Similarly, the Simpson diversity index values for the four regions were calculated as follows: 0.847 for Kiğı, 0.760 for Yedisu, 0.714 for Yayladere, and 0.767 for Hacılar (S3). The significance between the number of species is as follows, according to the findings of the paired t-test: Kiğı is 3.699 with Yedisu ($p=0.00025$, $sd=415.31884$), 4.727 with Yayladere ($p<0.0001$, $sd=302.73592$), and 5.500 with Hacılar ($p<0.0001$, $sd=272.70038$) (Table 2).

Table 2. Pairwise t-test results comparing the four study regions (t=t-test value, sd=standard deviation, p=significance level)

Çizelge 2. Dört çalışma bölgesini karşılaştıran çift yönlü t-testi sonuçları (t=t-testi değeri, sd=standart sapma, p=anlamlılık düzeyi)

	Yedisu	Yayladere	Hacılar
Kiğı	t=3.699 sd=415.319 p=0.00025	t=4.728 sd=302.736 p=0.0	t=5.500 sd=272.700 p=0.0
Yedisu		t=1.282 sd=328.589 p=0.20079	t=1.625 sd=294.941 p=0.10516
Yayladere			t=0.201 sd=267.861 p=0.84077

DISCUSSION

The wild mammal species recorded in the study area (18 species) represent 10.46% of the total mammal species known to occur in Türkiye (170 species), and account for 71.79% of the country's medium- and large-sized mammal species. In previous studies, Sözen and Çoğal (2020) reported 16 medium- and large-sized mammal species from Zonguldak; Ulutürk and Yürümez (2022) recorded 15 species from Van; Selçuk and Kefelioğlu (2020) documented 21 species from the provinces of Samsun, Amasya, Tokat, and Eskişehir; and Toyran (2016) identified 10 species from Bitlis. When compared with the records provided by previous researchers, *Cervus elaphus*, *Capreolus capreolus*, *Rupicapra rupicapra*, *Felis chaus*, *Oryctolagus cuniculus*, and *Martes martes* were not detected within the boundaries of our study area. The absence of these species—especially *R. rupicapra*, which has historically been recorded in the region—may be more than a result of sampling limitations. Stronger hypotheses can be proposed, linking their absence to ongoing and well-documented regional threats, such as intense poaching, habitat loss due to agricultural expansion, infrastructure development, and overgrazing. For mountain-dwelling species like *R. rupicapra*, illegal hunting and habitat fragmentation likely have a negative impact on population viability and local persistence. Additionally, climate change may alter habitat suitability, vegetation patterns, and water availability at higher elevations, further restricting their distribution. These combined anthropogenic and climatic pressures may explain the disappearance or extreme rarity of such species in recent surveys, highlighting the urgent need for targeted conservation actions to address these threats.

Capra aegagrus, *Ursus arctos*, *Lutra lutra*, and *Spermophilus xanthoprimum* species in Bingöl, which are of high conservation concern according to the IUCN red list, provide important insights into the effectiveness of protected areas and ongoing conservation challenges. *C. aegagrus* was found at relatively high numbers, particularly in the Kiğı region, which includes a protected area, highlighting the role of strict protection in supporting viable populations of globally threatened species. Although *U. arctos* was also detected at lower frequencies, its occurrence spanned protected and unprotected sites, suggesting that broad landscape connectivity remains essential for its conservation. *L. lutra* and *S. xanthoprimum* were observed at low densities and in highly localized habitats, with

records from protected and non-protected areas. However, their limited distribution and low observation numbers may indicate vulnerability to ongoing threats such as habitat fragmentation, water pollution (for otters), and land-use change (for ground squirrels). The presence of these VU and NT species in protected and unprotected parts of the study area underscores the need for integrated conservation strategies that extend beyond formal reserve boundaries and address the specific habitat and management needs of threatened mammals in Bingöl.

This study provides a comprehensive inventory of the medium- and large-sized wild mammals in Bingöl Province, a region previously lacking extensive research on its faunal diversity. The results reveal the presence of 18 mammal species, representing 10.46% of Türkiye's total mammal species. The study identified 18 medium- and large-sized mammal species, adding nine new species to the provincial inventory that were not previously documented in earlier studies. Notably, two medium- and large-sized mammal species previously reported in the region were not observed in the current survey, suggesting potential changes in species distribution or population dynamics.

Statistical analyses reveal significant ecological differences across the four regions studied in Bingöl. The Kiğı region stands out as a critical area for conservation, exhibiting the highest species richness (17 species) and diversity, as measured by the Shannon-Wiener index ($H' = 2.28$) (S1 and S2) and the Simpson index (0.847) (S3). Pairwise t-tests confirmed that the mammal community in Kiğı is significantly richer than in Yedisu, Yayladere, and Hacılar, with highly significant differences detected in species counts. The wild goat (*Capra aegagrus*) and wild boar (*Sus scrofa*) were the most abundant species observed, although several others showed low observation numbers and uneven distribution. The most balanced distribution was observed in the grey wolf (*Canis lupus*), with a low coefficient of variation (CV = 0.255) (S1).

The composition and biodiversity of wild mammals demonstrate significant variations in relation to their specific habitat within the geographical confines of the study area. Observations have demonstrated that Yedisu, Kiğı, Yayladere, and Hacılar are particularly important with respect to mammalian species, which are found mainly in the rocky and forested landscapes of the province, creating a favourable environment for the breeding and feeding of wild mammals. According to the 95% confidence interval (CI) analysis, the lower bounds for *Hystrix indica*, *Meles meles*, *Lutra lutra*, *Felis silvestris*, *Lynx lynx*, and *Hemiechinus auritus* were found to be negative. This indicates that these species were affected by low observation numbers and uneven distribution across the study areas. On the other hand, *Canis lupus* exhibited the most balanced distribution among all species, with a coefficient of variation (CV) of 0.255. In contrast, *H. indica*, *Mustela nivalis*, *M. meles*, *L. lutra*, *F. silvestris*, *L. lynx*, and *H. auritus* also had CV values of 0.255, reflecting a noticeably uneven distribution across the four study sites.

The presence of the Şeytan Mountains Wildlife Development area, along with the Kiğı Dam, indicates that the Kiğı region is a significant protected area. The region is home to a greater diversity of species than other mountainous, forested, or steppe habitats, as with many other protected areas. Several factors can explain this ecological pattern. Firstly, these areas tend to experience lower levels of human disturbance, such as hunting, logging, grazing, and land conversion. This enables species populations to persist and recover more effectively. Secondly, these areas often encompass a variety of habitats and microclimates, which increases the number of ecological niches and supports a broader range of species with different requirements. Thirdly, water, food, and shelter resources are better maintained within protected areas, reducing habitat fragmentation and enhancing opportunities for interspecific interactions. Consequently, reduced human pressure and greater habitat heterogeneity create more favourable ecological conditions, resulting in richer biodiversity in protected areas than in unprotected forested and steppe regions.

Statistical analyses reveal significant ecological differences across the four regions studied in Bingöl. Notably, the pairwise t-test results presented in Table 2 show that Kiğı, which includes a protected area, has a statistically significantly higher species richness compared to the other three regions (Yedisu, Yayladere, and Hacılar) ($p < 0.001$ for all comparisons). This finding directly links the conservation status of the region with its biodiversity outcomes. The higher mammal diversity observed in the Kiğı region is consistent with global and regional studies that demonstrate how protected areas positively impact biodiversity (e.g., Jones et al., 2019). For example, Jones et al. (2019) found that the richness and abundance of mammal species are significantly greater in protected areas compared to unprotected sites. Similarly, other studies from Türkiye and worldwide support the conclusion that adequate protection measures result in higher species richness and community stability. The Kiğı region stands out as a critical area for conservation, exhibiting the highest species richness (17 species) and diversity, as measured by the Shannon-Wiener index ($H'=2.28$) (S1 and S2) and the Simpson index (0.847) (S3). The wild goat (*Capra aegagrus*) and wild boar (*Sus scrofa*) were the most abundant species observed, although several others showed low observation numbers and uneven distribution. The most balanced distribution was observed in the grey wolf (*Canis lupus*), with a low coefficient of variation (CV=0.255) (S1), 2002).

CONCLUSION

The results indicate that large mammal species in our study area face a serious threat of extinction due to hunting, animal husbandry, agriculture, and human activities. The poaching and hunting of mammal species for their fur is a pervasive problem in the study area. These factors cause damage to the habitats of these animals and can even lead to habitat loss in regions where nationally and internationally endangered animals reside. To combat the significant pressures of wild mammals, it is imperative to prioritize their conservation within and outside designated protected areas. Protected areas serve as reservoirs for wild mammals; therefore, it is important to understand the distribution and population size of mammals in these areas for conservation and management purposes. In this context, there is a need to restructure the country's wildlife reserves, increase their capacity, develop ecotourism, and raise public awareness of environmental conservation. The findings of this study emphasize the importance of Bingöl Province as a biodiversity hotspot in Türkiye, especially for its medium- and large-sized wild mammal diversity. However, the data also raise concerns about the conservation status of several species, given that four species are classified as Vulnerable or Near Threatened by the IUCN. The significant differences in species distribution and diversity between the regions, particularly the superior biodiversity of Kiğı, suggest that a targeted and region-specific approach is necessary for effective conservation.

The study also supports the hypothesis that mammal populations in the region may be experiencing declines or range contractions due to insufficient protection and intensified anthropogenic pressures. Therefore, conservation strategies must be directly informed by the study's results and are implemented as concrete protection actions. In this context, the Kiğı region should be recognized as a conservation priority and a key area for sustainable development. However, due to its exceptionally high species richness and diversity, it should be urgently and officially designated as a core protection zone. Immediate and binding management interventions—such as establishing new protected areas, strict anti-poaching enforcement, and robust habitat restoration programs—must be implemented in Kiğı. Conservation authorities and policymakers are strongly urged to act without delay to safeguard this biodiversity hotspot, using the data and recommendations provided by this study as a scientific foundation for concrete, enforceable protection measures. Additionally, conservation plans should be adaptive and evidence-based, utilizing ongoing monitoring and the data generated by this research to guide management decisions. By directly linking scientific findings with actionable conservation measures, the long-term survival of Bingöl's diverse mammalian fauna can be better secured. Further research using different field sampling methods (camera trapping, genetic analyses, long-term monitoring, distance sampling, etc.) should also be conducted to provide a robust database of mammal diversity, which will further inform and refine direct protection efforts. It is hoped that similar studies will increase awareness of the importance and protection of our biological wealth, contributing to the conservation of the region's mammal fauna.

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Contribution Rate Statement Summary of Researchers

The authors declare that they have contributed equally to the article.

Conflict of Interest

The authors have declared no conflict of interest.

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