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Classification of Argözü Valley (Kıbrıscık-Bolu) Plant Communities according to EUNIS Habitat Types

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ABSTRACT
In this study, the habitat types and associated plant communities of the Argözü Valley were identified and classified in accordance with the European Nature Information System (EUNIS). A total of 13 plant communities were distinguished within the study area, representing six major vegetation types: forest, shrubland, streamside vegetation, high mountain steppe, moist meadow, and rocky vegetation. These communities were further categorized into 11 distinct habitat types under the E and G habitat classes of the EUNIS classification system. The findings provide a foundational basis for biodiversity conservation initiatives and the formulation of effective habitat management strategies. Nevertheless, ongoing transhumance and grazing activities constitute significant threats to the ecological integrity of these habitats. In particular, areas with high levels of endemism—such as Scots pine (*Pinus sylvestris* L.) forests, alpine communities, and moist meadows—require urgent conservation prioritization to ensure their long-term sustainability.

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ÖZET
Bu çalışma ile Argözü Vadisi'nin bitki topluluklarının dahil olduğu Avrupa Doğa Bilgi Sistemi (EUNIS) habitat tipleri belirlenmiştir. Çalışma alanında belirlenen orman, çalı, dere, yüksek dağ stebi, nemli çayır ve kayalık vejetasyonu olmak üzere 6 farklı vejetasyon tipine ait 13 bitki topluluğu EUNIS'e göre sınıflandırılmıştır. Bu bitki toplumları için E ve G sınıfları altında 11 farklı habitat tipi tanımlanmıştır. Elde edilen veriler, doğa koruma ve yönetim stratejilerinin geliştirilmesine destek sağlayacaktır. Öte yandan, yaylacılık ve otlatma faaliyetleri bu habitat ve türler için potansiyel tehditlerdir. Özellikle endemik türlerce zengin olan sarıçam ormanı ile alpin ve nemli çayır topluluklarının bulunduğu habitatlar korunmalıdır.

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INTRODUCTION
The concept of habitat is defined as the specific location where a species resides—essentially, the area in which it can be found and where conditions are suitable for sustaining its vital functions. A population refers to a group of individuals of the same species inhabiting a defined geographic area, interacting as part of a broader biotic community comprising multiple species (Kara & Işık, 2008). The characteristics and spatial distribution of habitats occupied by populations are shaped by the interplay of climatic, edaphic, and biotic factors. Among these influences, anthropogenic activities that lead to habitat fragmentation play a particularly critical role in altering the structure, distribution, and abundance of biodiversity. When natural habitats are extensively degraded, the resulting loss of

biodiversity is often substantial and, in many cases, irreversible (Işık & Kurt, 2005; Palabaş et al., 2012).

Phytosociological studies offer valuable insights that can inform the resolution of various ecological challenges, including biodiversity conservation and management. Such studies provide critical data for assessing environmental impacts, evaluating the effectiveness of management practices, and forecasting potential ecological changes (Kent & Coker, 1996). Effective ecosystem management necessitates a comprehensive understanding of the information derived from plant sociology, including its floristic, structural, and ecological dimensions (Kavgacı & Özalp, 2006). This integrative knowledge base is fundamental to the development of strategies aimed at conserving biodiversity and promoting its long-term sustainability.

In recent years, the focus of biodiversity conservation has progressively shifted from species-level protection toward the conservation of populations (Işık & Kurt, 2005). This shift has underscored the critical importance of preserving the habitats that support these populations. Effective conservation efforts require the identification and classification of these habitats, a process that necessitates the application of a rigorous scientific classification framework.

To support these conservation efforts, a comprehensive framework for habitat classification has been established in Europe, wherein specific habitat types are systematically defined. This classification relies on a set of descriptive parameters, including key habitat attributes, to distinguish among different habitat types. The classification system constitutes a fundamental component of the European Nature Information System (EUNIS) (Davies et al., 2004).

The European Nature Information System (EUNIS) offers a detailed and standardized classification system for both terrestrial and marine habitat types across the European continent and its surrounding seas. This system plays a vital role in conducting habitat inventories at biogeographic, national, and local scales. Additionally, it supports biodiversity monitoring and reporting, facilitates the identification of species-specific habitat requirements, and underpins the development of legal and policy frameworks aimed at habitat protection.

Although Türkiye has acknowledged the importance of concepts such as habitat classification and mapping, studies in this field remain limited (Arslan et al., 2012; Mergen & Karacaoğlu, 2015; Güneş Özkan, 2016; Geven et al., 2016; Çakmak, 2017; Yıldırım et al., 2019; Çakmak & Aytaç, 2020; Satıl et al., 2020; Karaköse & Terzioğlu, 2020; Özen &Ürker, 2020; Çakmak & Aytaç, 2021, Demir et al., 2022; Tekeli &Aslan 2024; Tüfekcioğlu et al., 2024; Tel et al., 2025a; Tel et al., 2025b). However, habitat factors are among the most significant determinants in the formation of plant communities. Thus, habitat classification is crucial for understanding and interpreting phytosociological and ecological data.

In this study, the potential habitats of plant communities in Argözü Valley (Kıbrıscık-Bolu) were classified according to the EUNIS.

MATERYAL and METOD

Research Area

Kıbrıscık district is located on the southern slopes of the Köroğlu Mountains in the southeastern part of Bolu province, forming the eastern section of the Aladağ Stream basin. Situated 66 km from Bolu, it lies south of the Köroğlu Mountains on a plateau intersected by two significant rivers, the Uludere and the Argözü streams. The district's geographical boundaries are positioned between 40°18'00" and 40°31'18" north latitude, and 31°40'45" and 31°56'21" east longitude. Argözü Valley, which serves as the study area, is located in the northeastern part of the Kıbrıscık district (Anonymous, 2012). According to the grid system in P.H. Davis' Flora of Turkey and the East Aegean Islands Vol:1, the valley is situated within square A3 (Figure 1). It lies within the Euxine sub-region of the Euro-Siberian flora zone and spans the submontane, montane, and alpine steppe zones. Additionally, it marks the transition point between the Sub-Euxine and Xero-Euxine sub-regions. The elevation of the research area varies between 1200-2100 m.

Climate

Precipitation data for the study area were calculated using the interpolation method based on data from the Seben Meteorological Station (700 m), the nearest observation point. Accordingly, the average annual precipitation in the study area ranges between 700 mm and 1200 mm, depending on elevation. The average annual temperature is 11°C (Anonymous, 2005). According to Emberger's method, a Mediterranean climate with low precipitation is observed between 1200 m and 1700 m in the area, while a Mediterranean climate with higher precipitation prevails above 1700 m (Kılınç et al., 2006).

Bedrock, Land Structure, and Soil Characteristics

Located in the north of the Aladağ Stream basin, Kıbrıscık and its surroundings are characterized by andesite, tuff, and agglomerates, which are elements of the Köroğlu volcanic massif. Brown forest soils are observed in the southern parts of the area, while non-calcareous brown forest soils dominate the northern parts (Şahin, 1984).

Young volcanic rocks cover extensive areas from southern Bolu to Gerede, Kızılcahamam, and Kıbrıscık. The sediments and intermediate deposits observed in certain locations indicate that volcanism began in the Eocene and continued until recent times. Additionally, the presence of perlite and sepiolite formations—natural clay minerals—as well as small-scale manganese mineralization's has been identified in the Kıbrıscık district (Irkeç and Ünlü, 1993; Anonymous, 2021).

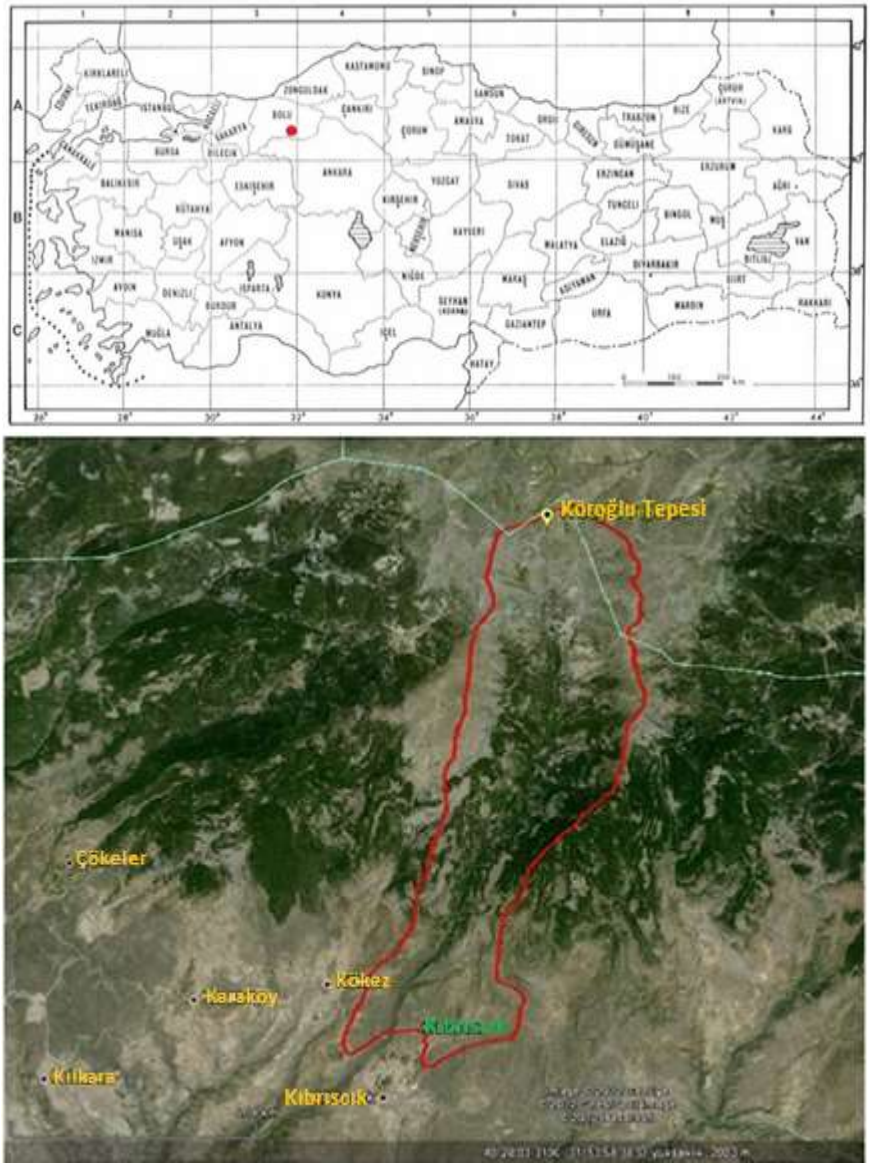

Figure 1. Boundaries and location of the study area in the grid system (Google Earth).
Şekil 1. Çalışma alanının sınırları ve grid sistemindeki yeri

Vegetation

An examination of the general vegetation in the research area reveals 13 plant communities classified into six vegetation types: forest, shrub, stream, high mountain steppe, moist meadow, and rocky vegetation. Shrub vegetation dominated by junipers is observed at lower elevations. At approximately 1200 meters, tall junipers (*Juniperus excelsa* M.Bieb.) and blackthorns (*Paliurus spina-christi* Mill.) form the *Junipero-Palieretum spinae-christi* community, while at around 1300 meters, a degraded oak community (*Junipero oxycedri-Quercetum pubescentis* Türe, Tokur and Ketenoğlu 2005) emerges, dominated by tar junipers (*Juniperus oxycedrus* L.) and downy oaks (*Quercus pubescens* Willd.). Between 1300 and 1600 meters, a *Junipero-Pinetum nigrae* association,

featuring larch (*Pinus nigra* J.F.Arnold subsp. *pallasiana* (Lamb.) Holmboe) mixed with juniper, and a *Querco-Pinetum nigrae* association, mixed with downy oak, are observed. From 1500 to 1900 meters, *Doronico-Pinetum sylvestris* and *Pyrolo-Pinetum sylvestris* associations, dominated by Scots pine (*Pinus sylvestris* L. var. *hamata* Steven), prevail. As elevation increases, forest vegetation transitions to steppe vegetation. From 1790 meters altitude, high mountain steppe communities such as *Hordeo-Alopecuretum arundinacei* and *Astragalo-Festucetum cyllenicae* appear. These communities, dominated by species like *Astragalus amoenus* Fenzl, *Festuca cyllenica* Boiss. & Heldr., *Alopecurus arundinaceus* Poir., and *Hordeum bulbosum* L., constitute the dominant vegetation up to an altitude of 2150 meters.

In a section of Köroğlu Hill at elevations of 1960–1985 meters, a *Mentho-Caricetum nigrae* moist meadow community is observed, where *Carex nigra* (L.) Reichard and *Mentha longifolia* (L.) L. species, along with many aquatic species, thrives due to a high groundwater table. In areas where volcanic rocks dominate, rocky vegetation communities such as *Sileno-Daphnetum oleoidis*, *Centaureo-Sedetum confertiflorae*, and *Saxifrago-Sedetum albae* are found. These communities are dominated by species like *Daphne oleoides* Schreb., *Silene supine* M.Bieb., *Sedum confertiflorum* Boiss., *Centaurea olympica* (DC.) K.Koch, *Sedum album* L., and *Saxifraga exarata* Vill.. Along the Argözü Stream, which lends its name to the valley, stream vegetation (*Heracleo-Salicetum albae*) is observed, dominated by *Heracleum platytaenium* Boiss. and *Salix alba* L. (Güneş Özkan, 2016).

Method

This study is based on the doctoral thesis entitled "Flora and Vegetation of Argözü Valley (Kıbrıscık-Bolu)". The following literature were used for the identification of plant taxa into families, genera, species and subspecies categories; Aedo et al. (2005), Aichele and Schwegler (1996), Atay et al. (2009), Baytop (1998), Çolak et al. (2005), Davis (1965-1988), Davis et al. (1988), Ekici et al. (2004), Erik et al. (1998), Eröz Poyraz (2008), Fiori (1993), Fitter (1987), Güner et al. (2000), Güner et al. (2012), Hamzaoğlu (2009), Kaynak et al. (2007), Koca (2003), Kreutz (2003), Kreutz et al. (2009), Lidén et al. (1997), Lipert and Podlech, Rose (1981), Rothmaler (1991), Savran et al. (2009), Schonfelder et al. (1990), Seçmen et al. (1996), Serin (2005), Tekin (2005), Tutin et al. (1964-1980), Uluocak (1984), Uzunhisarcıklı et al. (2012), Yıldırımlı (1988), Yıldız et al. (1997), Yıldız et al. (2004).

To identify the phytosociological units in the study area, sample plots were selected. Within these plots, characteristic species, diagnostic species, associates, some quantitative attributes, and environmental factors were recorded and tabulated using the Braun-Blanquet method for multidimensional classification (Kılınç, 2005). The floristic and ecological characteristics of the plant communities identified through the analysis of these tables were evaluated collectively. Comparisons were made with the relevant literature based on the character, diagnostic, and dominant species present, and EUNIS habitat codes were assigned accordingly Comparisons with relevant literature were made based on character, diagnostic and dominant species present, and EUNIS habitat codes were assigned, consisting of 11 main habitat classes listed below (Davies et al., 2004; Moss, 2008; Crosswalk, 2016; Anonymous, 2025).

A: Marine habitats

B: Coastal habitats

C: Inland surface waters

D: Mires, bogs, and fens

E: Grasslands and lands dominated by forbs, mosses, or lichens

F: Heathland, scrub, and tundra

G: Woodland, forest, and other wooded land

H: Inland unvegetated or sparsely vegetated habitats

I: Regularly or recently cultivated agricultural, horticultural, and domestic habitats

J: Constructed, industrial, and other artificial habitats

X: Habitat complexes

EUNIS habitat types and plant association boundaries were determined using the Thiessen polygon method, a deterministic interpolation approach used in ArcGIS to generate spatial distribution maps from point-collected plant samples. Sampling points were defined as input data using the 'Create Thiessen Polygons' tool (Analysis Tools → Proximity) in ArcGIS 10.x, and the resulting polygons were intersected by the study area boundaries. Each polygon was designed to take the attribute value of the point from which it was generated, thus representing each location in the study area with the nearest sampling point (Wilkin et al., 2007; Khaddari et al., 2022).

The conservation status of endemic taxa distributed within the habitats was assessed according to the Red Data Book of Turkish Plants (Ekim et al., 2000) and the International Union for Conservation of Nature (IUCN) categories (Anonymous, 2015b). The threat categories included CR (Critically Endangered), EN (Endangered), VU (Vulnerable), and NT (Near Threatened).

RESULTS and DISCUSSION

Flora and vegetation studies conducted in the Argözü Valley between 2012 and 2015 resulted in the identification of 13 distinct plant communities, representing six major vegetation types: forest, shrubland, streamside vegetation, high mountain steppe, moist meadow, and rocky vegetation. The habitat types corresponding to these plant communities were classified according to the European Nature Information System (EUNIS) framework (Davies et al., 2004; Anonymous, 2015b). Habitat classifications at the third, fourth, and fifth hierarchical levels are detailed in Table 1, while a spatial representation of habitat distribution was generated using the ArcGIS Desktop 10.4 software (Figure 2). Analysis of the classification reveals that the plant communities within the study area are predominantly associated with two principal EUNIS habitat classes: E (forest and other wooded land) and G (inland surface waters and wetlands).

Table 1. Plant communities in the study area and habitat types according to EUNIS
Çizelge 1. Çalışma alanındaki bitki toplumları ve EUNIS'e göre habitat tipleri

EUNIS Code	Habitat Name Plant Community	Habitat Name Plant Community
G3.4	Scots pine woodland south of the taiga	
G3.4E	Ponto-Caucasian Scots pine forests	*Doronico-Pinetum sylvestris*
G3.4	Scots pine woodland south of the taiga	
G3.4E	Ponto-Caucasian Scots pine forests	*Pyrolo-Pinetum sylvestris*
G3.5	Black pine (*Pinus nigra*) woodland	
G3.564	Anatolian Pallas' pine forests	*Querco-Pinetum nigrae*
G3.5	Black pine (*Pinus nigra*) woodland	
G3.564	Anatolian Pallas' pine forests	*Junipero-Pinetum nigrae*
G3.9	Coniferous woodland dominated by [Cupressaceae] or [Taxaceae]	
G3.935	Anatolian Grecian juniper woods	*Junipero-Palieretum spinae-christi*
G4.B	Mixed mediterranean pine - thermophilous oak woodland	*Junipero oxycedri-Quercetum pubescentis*
G1.11	Riverine willow woodland	
G1.111	Middle European white willow forests	*Heracleo-Salicetum albae*
E4.4	Calcareous alpine and subalpine grassland	
E4.41	Closed calciphile alpine grassland	*Hordeo-Alopecuretum arundinacei*
E4.3	Acid alpine and subalpine grassland	
E4.3922	Balkan [*Festuca balcanica*] grasslands	*Astragalo-Festucetum cyllenica*
E5.4	Moist or wet tall-herb and fern fringes and meadows	
E5.41	Screens or veils of perennial tall herbs lining watercourses	*Mentho-Caricetum nigrae*
E1.2	Perennial calcareous grassland and basic steppes	
	Irano-Anatolian steppes	
E1.2E		*Sileno-Daphnetum oleoidis*
E1.21	Helleno-Balkanic savory steppes	*Centaurea-Sedetum confertiflorae*
E1.1	Inland sand and rock with open vegetation	
E1.11	Euro-Siberian rock debris swards	*Saxifragae-Sedetum albae*

Two forest communities identified within the study area—*Doronico-Pinetum sylvestris* and *Pyrolo-Pinetum sylvestris*—are classified under the G3.4E habitat type, designated as Ponto-Caucasian Yellow Pine Forests according to the EUNIS system. This habitat type is primarily characterized by the presence of *Pinus sylvestris* subsp. *Hamata*, a taxon with a distribution extending across the Pontic region, the Caucasus, and the Crimean Mountains. It comprises pine-dominated forests that include a range of intermediate forms (Figure 3). Within the research area, the *Doronico-Pinetum sylvestris* community represents this habitat and is found on the Karadoğan

Plateau at elevations between 1,620 and 1,990 meters on northwest-facing slopes, as well as on the Bölücekkaya Plateau between 1,730 and 1,850 meters on east- and southeast-facing slopes. The soils in these locations are predominantly loamy sand to sandy loam in texture. *Pinus sylvestris, Doronicum caucasicum* M.Bieb., *Festuca valesiaca* Schleich. Ex Gaudin is both a dominant and diagnostic species of the plant community.

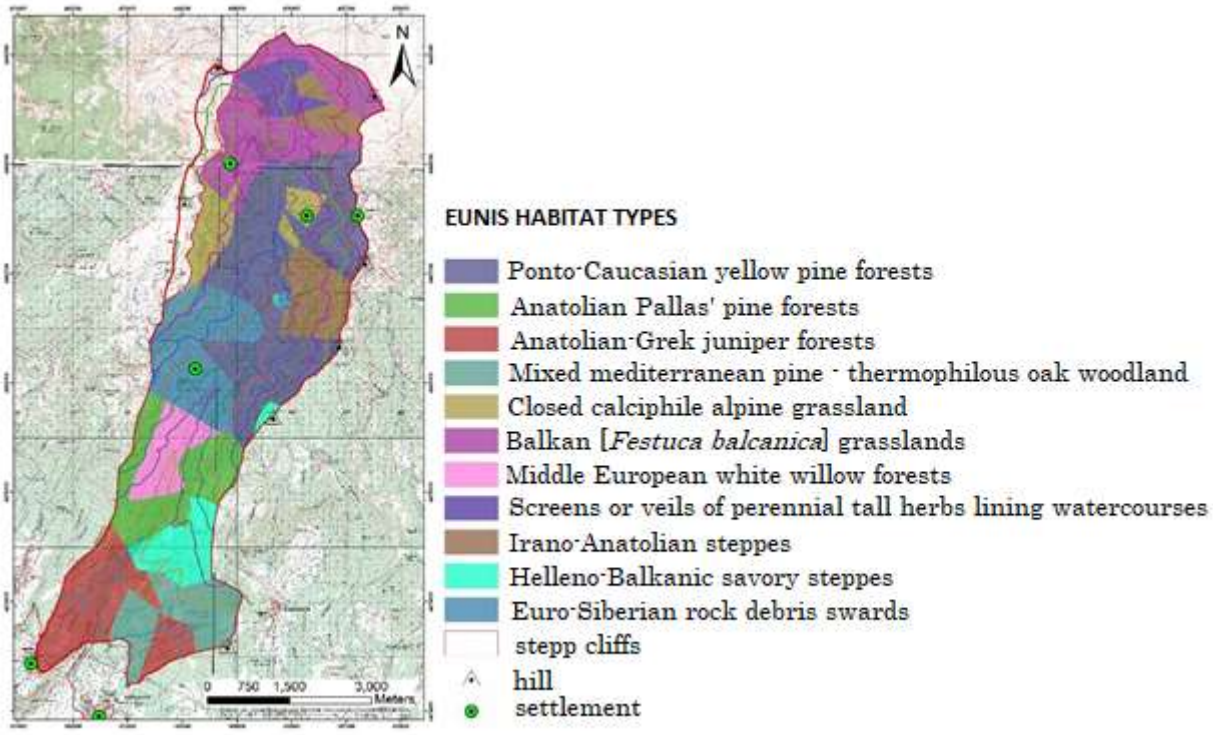

Figure 2. Habitat types map of the study area according to EUNIS
Şekil 2. Çalışma alanının EUNIS'e göre habitat tipleri haritası

The *Pyrolo-Pinetum sylvestris* community occurs in several locations within the study area. It is present along the Karadoğan Plateau road in the Argözü Valley at elevations ranging from 1,540 to 1,760 meters, situated on west- and northwest-facing slopes with an average slope gradient of approximately 30%. It is also found along the Bölücekkaya Plateau road between 1,670 and 1,780 meters on southeast-facing slopes, where the average slope is around 10%. A third occurrence is located in the Göknarlık area, at elevations between 1,710 and 1,790 meters on west-, southwest-, and northwest-facing slopes, with an average slope of 25%. The soils across these sites are primarily loamy sand to sandy loam in texture. *Pinus sylvestris*, *Abies nordmanniana* ssp. *equi-trojani* (Asch. & Sint. ex Boiss.) Coode & Cullen, *Vicia cracca* L. are diagnostic species of the plant community. Notably, this habitat type supports eight endemic taxa, all of which are classified within high-threat conservation categories. (Table 2).

Figure 3. *Doronico-Pinetum sylvestris* and *Pyrolo-Pinetum sylvestris* communities representing Ponto-Caucasian yellow pine forests in the study area
Şekil 3. Çalışma alanında Ponto-Kafkasiyan sarıçam ormanlarını temsil eden Doronico-Pinetum sylvestris ve Pyrolo-Pinetum sylvestris toplumları

Table 2. Habitat class and endemic taxa of yellow pine forests in the study area
Çizelge 2. Çalışma alanındaki sarıçam ormanlarının habitat sınıfı ve endemik taksonları

EUNIS Code	Habitat Class	Community
G3.4E	Ponto-Caucasian Scots pine forests	*Doronico-Pinetum sylvestris* *Pyrolo-Pinetum sylvestris*
Endangered Endemic Taxa		IUCN Category
1. *Lamium purpureum* var. *aznavourii* Gand. ex Aznav.		CR
2. *Allium efeae* Özhatay & İ.Genç		EN
3. *Tripleurospermum rosellum* var. *album* E.Hossain		VU
4. *Isatis cappadocica* subsp. *alyssifolia* (Boiss.) P.H.Davis		NT
5. *Noccaea phrygia* (Borm) F.K.Mey.		NT
6. *Barbarea trichopoda* Hausskn. ex Bornm.		NT
7. *Verbascum armenum* var. *occidentale* Hub.-Mor.		NT
8. *Erysimum lazistanicum* (Rupr.) Lipsky		LC

G3.5 Black pine (*Pinus nigra*) woodland: The other two forest communities in the study area, *Querco-Pinetum nigrae* and *Junipero-Pinetum nigrae*, fall under the habitat type G3.564 Anatolian Pallas' pine forests. These forests, dominated by *Pinus nigra*, occur at elevations of 1,200–1,800 m in the interior of northwestern, southwestern, and southern Anatolia and remain under snow cover for only a few months. They are characterized by low precipitation and more than six months of summer drought. The diagnostic, constant, and dominant species are such as *Quercus pubescens*, *Berberis crataegina* DC., *Juniperus oxycedrus*, *Koeleria nitidula* Velen., *Festuca lachenalii* (C.C.Gmel.) Spenn., *Salvia tomentosa* Mill., *Festuca valesiaca*, *Galium aparine* L., and *Verbascum flavidum* (Boiss.) Freyn & Bornm. (Figure 4). In the research area, one endemic taxon in the high-threat category is distributed in this habitat type (Table 3).

Figure 4. *Querco-Pinetum nigrae* community representing Anatolian Pallas' pine forests in the study area
Şekil 4. Çalışma alanındaki Anadolu karaçamı ormanlarını temsil eden Querco-Pinetum nigrae topluluğu

Table 3. Habitat class and endemic taxa of black pine forests in the study area
Çizelge 3. Çalışma alanındaki karaçam ormanlarının habitat sınıfı ve endemik taksonları

EUNIS Code	Habitat Class	Community
G3.564	Anatolian Pallas' pine forests	*Querco-Pinetum nigrae* *Junipero-Pinetum nigrae*
Endangered Endemic Taxa		IUCN Category
Sideritis galatica Bornm.		NT

G3.9 Coniferous woodland dominated by [Cupressaceae] or [Taxaceae]: The shrub community *Junipero-Palieretum spinae-christi* falls under the habitat type G3.935 Anatolian-Greek juniper forest according to EUNIS. This habitat type refers to *Juniperus excelsa* forests in the pre-steppe, central Mediterranean, and subalpine regions of Anatolia. The diagnostic, constant, and dominant species are such as *Paliurus spina-christi*, *Juniperus oxycedrus*, *Rhamnus thymifolia* Bornm., *Chrysojasminum fruticans* (L.) Banfi, *Anthoxanthum odoratum* L., *Taeniatherum caput-medusae* (L.) Nevski, *Xeranthemum annuum* L., *Poa bulbosa* L., *Koeleria pyramidata* (Lam.) P.Beauv., *Bromus japonicus* Houtt., and *Aegilops triuncialis* L. (Figure 5). This habitat type is home to three endemic taxa with a high-threat category (Table 4).

Figure 5. *Junipero-Palieretum spinae-christi* community representing Anatolian-Greek juniper forests in the study area

Şekil 5. Çalışma alanındaki Anadolu-Yunan ardıç ormanlarını temsil eden Junipero-Palieretum spinae-christi toplumu

Table 4. Habitat class and endemic taxa of juniper forests in the study area

Çizelge 4. Çalışma alanındaki ardıç ormanlarının habitat sınıfı ve endemik taksonları

EUNIS Code	Habitat Class	Community
G3.935	Anatolian Grecian juniper woods	*Junipero-Palieretum spinae-christi*
	Endangered Endemic Taxa	IUCN Category
1. *Allium efeae* Özhatay & İ.Genç		EN
2. *Tripleurospermum rosellum* var. *album* E.Hossain		VU
3. *Alkanna tinctoria* subsp. *glandulosa* Hub. Mor.		NT

G4.B Mixed Mediterranean pine - thermophilous oak woodland: The *Junipero oxycedri-Quercetum pubescentis* community may fall under the G4.B Mediterranean pine and thermophilous oak mixed forests habitat type. This habitat type consists of a mixture of thermophilous pines and deciduous or semi-evergreen oaks, along with species such as *Carpinus orientalis* Mill., *Castanea sativa* Mill., and *Ostrya carpinifolia* Scop. The dominant tree species in the study area is *Quercus pubescens*. Some of the diagnostic, constant, and dominant species *are Paliurus spina-christi*, *Juniperus oxycedrus*, and *Rhamnus thymifolia*, while the grass layer consists of *Geranium lucidum* L., *Stipa holosericea* Trin., *Prunus cocomilia* Ten., *Avenula pubescens* (Huds.) Dumort., *Trifolium hybridum* L., *Teucrium chamaedrys* L., and *Dactylis glomerata* L. (Figure 6). Two endemic taxa with a high-threat category are distributed in this habitat (Table 5).

Although Mediterranean flora from the southern Sakarya basin is present in the study area, it generally penetrates into the Central Anatolia Region via valleys and slopes. Therefore, it is thought to represent temperate oak forests of Mediterranean origin introduced into the Central Anatolian region from the Black Sea region, distinct from the pseudomaquis (such as diagnostic species *Quercus pubescens*, *Juniperus ocycedrus*, *Prunus cocomilia*, and *Teucrium chamaedrys*) that are distributed here. It forms a contact with the mixed forests of red pine and oak along the Seben-Nallıhan line, which adjacent the area.

Figure 6. *Junipero oxycedri-Quercetum pubescentis* community representing mixed mediterranean pine - thermophilous oak woodland in the study area

Şekil 6. Çalışma alanındaki Akdeniz çam- termofil meşe ormanlarını temsil eden Junipero oxycedri-Quercetum pubescentis toplumu

Table 5. Habitat class and endemic taxa of oak forests in the study area
Çizelge 5. Çalışma alanındaki meşe ormanlarının habitat sınıfı ve endemik taksonları

EUNIS Code	Habitat Class	Community
G4.B	Mixed mediterranean pine - thermophilous oak woodland	*Junipero oxycedri-Quercetum pubescentis*
Endangered Endemic Taxa		IUCN Category
1. *Allium cyrilli* subsp. *asumaniae* Özhatay & İ.Genç		CR
2. *Tripleurospermum rosellum* var. *album* E.Hossain		VU

G1.11 Riverine Willow Woodland: The *Heracleo-Salicetum albae* community identified in the research area belongs to the habitat type G1.111 Middle European white willow forests, which are dominated by willow species in shrub or tree form and are part of the *Salicion albae* alliance. This habitat is classified as Level 3 within the riparian or gallery forest habitat (G1.1), which is primarily dominated by alder, birch, poplar, or narrow-leaved willow species. In the study area, the dominant species of this habitat is *Salix alba*. Some of the diagnostic, constant and dominant species are *Veronica gentianoides* Vahl, *Festuca muralis* Kunth, *Rumex acetosella* L., *Ranunculus reuterianus* Boiss., *Valeriana alliariifolia* Vahl, *Equisetum palustre* L., *Heracleum platytaenium*, and *Brachypodium sylvaticum* (Huds.) P.Beauv. (Figure 7). No endemic taxa were found in this habitat (Table 6).

Figure 7. *Heracleo-Salicetum albae* community representing the Middle European white willow forests in the study area
Şekil 7. Çalışma alanındaki Orta Avrupa aksöğüt ormanlarını temsil eden Heracleo-Salicetum albae toplumu

Table 6. Habitat class and endemic taxa of riparian communities in the study area
Çizelge 6. Çalışma alanındaki nehir kenarı topluluklarının habitat sınıfı ve endemik taksonları

EUNIS Code	Habitat Class	Community
G1.111	Middle European white willow forests	*Heracleo-Salicetum albae*
Endangered Endemic Taxa		IUCN Category
-		-

E4.4 Calcareous Alpine and Subalpine Grassland: The *Hordeo-Alopecuretum arundinacei* community, one of the high mountain steppe communities identified in the research area, belongs to E4.41 Closed Calciphile Alpine Grassland, which is classified within the *Daphno-Festucetea* class according to EUNIS. This habitat is generally mesophyllous, typically closed, strongly structured, and frequently grazed or mowed, occurring on deep soils in the Alps, Pyrenees, Balkan Peninsula mountains, and locally in the Apennines. Diagnostic, constant and dominant species are *Alopecurus arundinaceus*, *Hordeum bulbosum*, *Euphorbia stricta* L., *Lotus corniculatus* L., *Luzula spicata* (L.) DC., *Centaurea triumfettii* All., *Urtica dioica* L., *Poa nemoralis* L., *Veronica bozakmanii* M.A.Fisch., *Dactylis glomerata*, and *Milium vernale* M.Bieb. (Figure 8). In the study area, this habitat supports six endemic taxa classified under high threat categories (Table 7).

E4.3 Acid Alpine and Subalpine Grassland: Another high mountain steppe community in the study area is *Astragalo-Festucetum cyllenica*. This community is classified as E4.3922 Balkan [*Festuca balcanica*] grasslands at Level 6 according to EUNIS. Alpine and subalpine grasslands develop on crystalline rocks, lime-poor surfaces, or decalcified mountain soils. Species such as *Festuca cyllenica*, *Astragalus amoenus*, *Verbascum armenum* Boiss. & Kotschy, *Avenula pubescens*, *Festuca airoides* Lam., *Hordeum bulbosum*, *Helichrysum plicatum* DC., *Thymus praecox* Opiz, and *Alyssum dasycarpum* Stephan ex Willd. are diagnostic, constant and dominant species. (Figure 9). Seven endemic taxa classified under a high threat category are present in this habitat type (Table 8).

Figure 8. *Hordeo-Alopecuretum arundinacei* community representing a closed calciphile alpine grassland in the study area

Şekil 8. Çalışma alanındaki kapalı kalsifil alpin otlakları temsil eden Hordeo-Alopecuretum arundinacei toplumu

Table 7. Habitat class and endemic taxa of high mountain communities in the study area

Çizelge 7. Çalışma alanındaki yüksek dağ topluluklarının habitat sınıfı ve endemik taksonları

EUNIS Code	Habitat Class	Community
E4.41	Closed calciphile alpine grassland	*Hordeo-Alopecuretum arundinacei*
Endangered Endemic Taxa		IUCN Category
1. *Lamium purpureum* var. *aznavourii* Gand. ex Aznav.		CR
2. *Tripleurospermum rosellum* var. *album* E.Hossain		VU
3. *Crocus biflorus* subsp. *pulchricolor* (Herbert) Maw.		NT
4. *Noccaea phrygia* (Borm) F.K.Mey.		NT
5. *Verbascum armenum* var. *occidentale* Hub.-Mor.		NT
6. *Erysimum lazistanicum* (Rupr.) Lipsky		LC

Figure 9. *Astragalo-Festucetum cyllenica* community representing the Balkan [*Festuca balcanica*] grasslands in the study area

Şekil 9. Çalışma alanındaki Balkan [Festuca balcanica] otlaklarını temsil eden Astragalo-Festucetum cyllenica toplumu

Table 8. Habitat class and endemic taxa of high mountain communities in the study area

Çizelge 8. Çalışma alanındaki yüksek dağ toplumlarının habitat sınıfı ve endemik taksonları

EUNIS Code	Habitat Class	Community
E4.3922	Balkan [Festuca balcanica] grasslands	*Astragalo-Festucetum cyllenica*
Endangered Endemic Taxa		IUCN Category
1. *Lamium purpureum* var. *aznavourii* Gand. ex Aznav.		CR
2. *Secale cereale* var. *ancestrale* (Zhuk.) Kit Tan		VU
3. *Jasione supina* subsp. *akmanii* Damboldt		VU
4. *Festuca cyllenica* subsp. *uluana* Markgr.-Dann.		NT
5. *Senecio olympicus* Boiss.		NT
6. *Cirsium sintenisii* Freyn		NT
7. *Verbascum armenum* var. *occidentale* Hub.-Mor.		NT

E5.4 Moist or Wet Tall-Herb and Fern Fringes and Meadows: The moist meadow community identified in the study area is *Mentho-Caricetum nigrae*, classified under the E5.41 *Screens or veils of perennial tall herbs lining watercourses* habitat type. This vegetation consists of tall grasses and ferns characteristic of the nemoral and boreal zones, occurring on hills and mountains below the montane level. Tall grasses generally dominate along waterways, in wet meadows, and at forest shade edges. Diagnostic, constant and dominant species characterizing this habitat are *Mentha longifolia*, *Hypericum venustum* Fenzl., *Agrostis stolonifera* L., *Juncus conglomeratus* L., *Carex nigra*, *Alchemilla compactilis* Juz., and *Poa nemoralis* (Figure 10). This habitat supports one threatened taxon within the research area (Table 9).

Figure 10. *Mentho-Caricetum nigrae* community representing the habitat of screens or veils of perennial tall herbs lining watercourses in the study area
Şekil 10. Çalışma alanındaki suyollarını kaplayan çok yıllık uzun bitkilerden oluşan perdeler habitatını temsil eden Mentho -Caricetum nigrae toplumu

Table 9. Habitat class and endemic taxa of moist meadow communities in the study area
Çizelge 9. Çalışma alanındaki nemli çayır toplumlarının habitat sınıfı ve endemik taksonları

EUNIS Code	Habitat Class	Community
E5.41	Screens or veils of perennial tall herbs lining watercourses	*Mentho-Caricetum nigrae*
Endangered Endemic Taxa		IUCN Category
Doronicum bithynicum J.R.Edm. subsp. *bithynicum*		NT

E1.2 Perennial Calcareous Grassland and Basic Steppes: *Sileno-Daphnetum oleoidis*, one of the rock communities in the research area, belongs to the E1.2E *Irano-Anatolian steppes* habitat type according to EUNIS. This habitat type is found across the Anatolian and Iranian plateaus, Transcaucasia, the Caucasus-facing hills of Dagestan, the Terek Basin, and northern Mesopotamia. Diagnostic, constant and dominant species are *Daphne oleoides*, *Silene supina* M.Bieb., *Astragalus amoenus*, *Festuca valesiaca*, *Bromus tomentellus* Boiss., *Marrubium astracanicum* Jacq., *Astragalus plumosus* Willd., *Koeleria pyramidata*, *Stipa holosericea*, *Eremurus spectabilis* M.Bieb., and *Rosa pulverulenta* M.Bieb. (Figure 11). In the research area, this habitat supports two endemic taxa that may be at risk of extinction (Table 10).

Figure 11. *Sileno-Daphnetum oleoidis* community representing the Irano-Anatolian steppes in the research area
Şekil 11. Araştırma alanındaki İran-Anadolu bozkırlarını temsil eden Sileno-Daphnetum oleoidis toplumu

Table 10. Habitat class and endemic taxa of steppe communities in the research area
Çizelge 10. Araştırma alanındaki bozkır toplumlarının habitat sınıfı ve endemik taksonları

EUNIS Code	Habitat Class	Community
E1.2E	Irano-Anatolian steppes	*Sileno-Daphnetum oleoidis*
Endangered Endemic Taxa		IUCN Category
1. *Festuca cyllenica* subsp. *uluana* Markgr.-Dann.		NT
2. *Verbascum armenum* var. *occidentale* Hub.-Mor.		NT

Centaureo-Sedetum confertiflorae, another rocky vegetation in the research area, belongs to the E1.21 *Helleno-Balkanic savory steppes* habitat type according to EUNIS. This habitat type is generally found in Greece, Serbia, and western Bulgaria. Some of the diagnostic, constant, and dominant species are *Festuca valesiaca*, *Stipa* sp., *Poa bulbosa*, *Melica ciliata* L., and *Teucrium chamaedrys* (Figure 12). There are four endemic taxa, whose conservation status ranges from critical to threatened, in this habitat (Table 11).

Figure 12. *Centaureo-Sedetum confertiflorae* community representing Helleno-Balkanic savory steppes in the research area
Şekil 12. Araştırma alanındaki Helleno-Balkanik tuzlu bozkırları temsil eden Centaureo-Sedetum confertiflorae toplumu

Table 11. Habitat class and endemic taxa of rock communities in the research area
Çizelge 11. Araştırma alanındaki kaya toplumlarının habitat sınıfı ve endemik taksonları

EUNIS Code	Habitat Class	Community
E1.21	Helleno-Balkanic savory steppes	*Centaureo-Sedetum confertiflorae*
Endangered Endemic Taxa		IUCN Category
1. *Lamium purpureum* var. *aznavourii* Gand. ex Aznav.		CR
2. *Velezia pseudorigida* Hub.-Mor.		VU
3. *Tripleurospermum rosellum* var. *album* E.Hossain		VU
4. *Melilotus bicolor* Boiss. & Balansa		NT

It was concluded that *Saxifrago-Sedetum albae*, one of the rock communities in the research area, can be classified within the E1.11 Euro-Siberian rock debris swards class according to EUNIS. Diagnostic, constant, and dominant species are *Sedum album*, *Poa bulbosa*, *Sedum litoreum* Guss., *Saxifraga exarata*, and *Asplenium septentrionale* (L.) Hoffm., and *Sabulina juniperina* (L.) Dillenb. & Kadereit (Figure 13). One endemic taxon with a high endangerment category is found in this habitat (Table 12).

Table 12. Habitat class and endemic taxa of rock communities in the research area
Çizelge 12. Araştırma alanındaki kaya toplumlarının habitat sınıfı ve endemik taksonları

EUNIS Code	Habitat Class	Community
E1.11	Euro-Siberian rock debris swards	*Saxifrago-Sedetum albae*
Endangered Endemic Taxa		IUCN Category
Tripleurospermum rosellum var. *album* E.Hossain		VU

Figure 13. *Saxifrago-Sedetum albae* confertiflorae community representing the Euro-Siberian rock debris swards in the study area

Şekil 13. Çalışma alanındaki Avrupa-Sibirya kaya enkazı habitatını temsil eden Saxifrago-Sedetum albae confertiflorae toplumu

CONCLUSION

Argözü Valley is home to a remarkable diversity of habitats and species, which in turn supports a significant number of endangered endemic plant species. Of the 11 habitats identified within the study area, 10 are inhabited by endemic taxa with conservation statuses ranging from "Critical" (CR) to "Near Threatened" (NT). The habitats with the highest number of endemic taxa, classified between CR and NT, include the Ponto-Caucasian Scots pine forests (8 taxa), Balkan *Festuca balcanica* grasslands (7 taxa), Closed calciphile alpine grasslands (6 taxa), and Helleno-Balkanic savory steppes (4 taxa). Notably, *Tripleurospermum rosellum* var. *album*, categorized as "Endangered" (EN), is found across six different habitats, while *Verbascum armenum* var. *occidentale*, classified as "Threatened" (NT), occurs in five distinct habitats. The critically endangered (CR) taxon *Allium cyrilli* subsp. *Asumaniae* is confined to the Mixed Mediterranean pine-thermophilous oak woodland habitat.

Among the study area's habitats, the Anatolian Grecian juniper woods and Mixed Mediterranean pine-thermophilous oak woodland stand out for their high species diversity. These shrub-dominated habitats provide critical shelter and food resources for fauna, and their protection would indirectly benefit the region's wildlife (Özkan, 2016). Additionally, the Helleno-Balkanic savory steppes (*Centaureo-Sedetum confertiflorae* community) and Euro-Siberian rock debris swards (*Saxifrago-Sedetum albae* community) habitats, which feature rock vegetation types, are particularly localized in the area and may represent endemic vegetation types. According to Natura 2000 and Aksoy (2006), these vegetation types are considered pioneer communities of *Sedo-Scleranthion* and *Sedo albi-Veronocion dillenii* alliances, associated with habitats on siliceous rocks that support chasmophytic vegetation. These drought-resistant communities are typically dominated by mosses, lichens, and members of the Crassulaceae family (Natura 2000; Aksoy, 2006). The *Centaureo-Sedetum confertiflorae* and *Saxifrago-Sedetum albae* communities found in the study area are representative of this habitat type (Natura 2000, Code: 8230) and should be prioritized for conservation efforts.

In the study titled Turkey Status Evaluation of EUNIS Habitat Classification, compiled by Çakmak and Aytaç (2021) from studies published between 2001 and 2020, the EUNIS habitat types present in Turkey were documented. Based on 22 literature reviews on the subject, the most common EUNIS habitat types at level 3 in Turkey were determined to be E1.2, G3.5, and G1.7, respectively. All habitat types identified in the Argözü Valley overlap with the habitat classification specified in this study (Çakmak & Aytaç, 2021). According to the Turkish National Action Programme for Combating Desertification, the region surrounding Kıbrıscık (Bolu), where the study area is located, exhibits significant diversity in terms of climate, landform development, and plant communities. These areas, however, are also highly susceptible to erosion, with climatic conditions at the threshold of sensitivity in terms of temperature and precipitation. Additionally, they host pure steppe and steppe-edge vegetation. The programme emphasizes the need for measures to protect, develop, and maintain the existing and potential vegetation cover in such regions (Anonymous, 2021).

Furthermore, the area encompassing the study region and the broader Köroğlu Mountains was designated as the Bolu Köroğlu Mountain, Culture, Tourism, Protection, and Development Region in 2015 (Anonymous, 2015c). The promotion of nature tourism, including flora tours, has contributed positively to the socio-economic development of the local community. However, the intensity of forestry and ecotourism activities poses significant threats to the region's forest, subalpine, and alpine habitats, as well as to the endemic and rare plant taxa present. Especially the E4.3 Acid Alpine and Subalpine Grassland, E4.4 Calcareous Alpine and Subalpine Grassland, E1.2E Irano-

Anatolian steppes, E1.21 Helleno-Balkanic savory steppes, and E1.11 Euro-Siberian rock debris swards habitats located within the high mountain vegetation are vulnerable to these threats. Therefore, it is essential that investment plans be informed by comprehensive vegetation, habitat, and biotope studies at the regional level to ensure sustainable development.

In the context of this study, habitat types, including the various vegetation units within the research area, were identified. This classification provides an essential framework for developing nature conservation and management strategies that align with the protection statuses and threat categories of these habitats. High mountain meadows in Turkey are generally used for transhumance, which subjects them to significant human pressure. The ecosystems in these high-altitude areas are particularly fragile, with damage that may take many years to repair. Additionally, grazing in rocky mountain areas exacerbates erosion (Sarı, 2010). Within the study area, habitats supporting high mountain ecosystems are under considerable grazing pressure (Figure 14), and many endemic plant species are found in these grazed areas. Given the sensitivity of these ecosystems, efforts to minimize damage should focus on reducing or managing human activities.

Figure 14. Grazing on high mountain steppe.
Şekil 14. Yüksek dağ bozkırlarında otlatma.

Alpine and subalpine regions are increasingly threatened by the expansion of tourism, agriculture, and forestry activities. In particular, human interventions, including recreational activities, mountain and winter sports, and animal husbandry, have significant impacts on alpine areas at both local and regional scales (Sarı, 2010). The study area supports various recreational activities, such as mountaineering and hiking (Figure 15). Given that these activities tend to peak during the spring, they pose a risk to endemic species, particularly during their flowering periods. To mitigate potential harm, such activities must be restricted or managed to avoid overlapping with the flowering and seed-setting periods of endangered species.

Figure 15. Ecotourism activities such as mountaineering and trekking in the research area
Photo: Çetin Oğuz (Anonymus, 2015a)
Şekil 15. Araştırma alanında dağcılık ve trekking gibi ekoturizm faaliyetleri
Fotoğraf: Çetin Oğuz (Anonymous, 2015a)

High mountain ecosystems are characterized by brief growing seasons, low air and soil temperatures, and limited nitrogen availability. These ecosystems are also subject to strong wind influences, which affect both air and plant temperatures. Due to the lack of shielding effects, radiation levels are high, leading to rapid heating and cooling of these areas (Blisst, 1962; Atay et al., 2009). As a result, only a limited number of species capable of adapting to these extreme conditions can thrive in such environments, contributing to a high rate of endemism. The same holds true for rock communities. Within the study area, high mountain steppes are exposed to intensive grazing,

particularly through transhumance activities, which are believed to be a significant factor contributing to the decline in species diversity. Given their sensitivity, high mountain ecosystems are particularly vulnerable to climate change. As a result of increasing temperatures, plant species adapted to these challenging conditions are being forced to migrate to higher elevations, posing a direct threat to their survival. Consequently, the conservation of alpine and subalpine regions should be prioritized to safeguard these delicate ecosystems.

The EUNIS habitat classification is based on phytosociological studies conducted at the European scale. It is seen that the phytosociological studies conducted in Türkiye are not included in the EUNIS system updated in 2019 (Schaminée et al., 2019). Therefore, habitat types may not fully overlap. In order to clearly demonstrate the compatibility of plant communities determined by phytosociological studies conducted in Türkiye with the habitat types in question, a habitat classification should be made at the Turkish scale

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Authors' Contribution Statement

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

Conflict of Interest and Ethical Statement

The authors declare that they have no conflict of interest. An ethics committee decision is not required for the article.

REFERENCES

Aedo, C., Fiz, O., Alarcón, M. L., Navarro, C., & Aldasoro, J. J. (2005). Taxonomic revision of Geranium Sect. Dissecta (Geraniaceae). *Systematic Botany*, *30* (3), 533-558. https://doi.org/10.1600/0363644054782260

Aichele, R. & Schwegler, A., (1996). *Der Kosmos-Pflanzenführer*, Franckh-Kosmos Verlags-GmbH & Co. Stuttgart.

Aksoy, N. (2006). *Elmacık Dağı (Düzce) vejetasyonu. (Tez no 182514).* [Doktora tezi, İstanbul Üniversitesi Fen Bilimleri Enstitüsü].Yükseköğretim Kurulu Ulusal Tez Merkezi.

Anonymous, (2005a). Bolu Orman Bölge Müdürlüğü. (2005). *Bolu Orman İşletme Müdürlüğü, Kıbrıscık Orman İşletme Şefliği Fonksiyonel Orman Amenajman Planı* (2005-2024).

Anonymous, (2005b). *Çölleşmeyle mücadele Türkiye ulusal eylem programı*. (2005). Çevre ve Orman Bakanlığı Yayınları No: 250 ISBN 975-7347-51-5, Ankara.

Anonymous, (2012). TC. Kıbrıscık Kaymakamlığı,. [Çevrimiçi]. Erişim: http://www.kibriscik.gov.tr/genel-bilgiler (Alınma Tarihi: 20.03.2012).

Anonymous, (2015a). Facebook. [Çevrimiçi]. Erişim: https://www.facebook.com/cetinoguzz. (Alınma Tarihi 24.11.2015 izin alınmıştır).

Anonymous, (2015b). IUCN Red List. http://www.iucnredlist.org/static/categories_criteria_3_1#categories. (Alınma Tarihi: 09.08.2015)

Anonymous, (2015c). Resmi Gazete. (2015, Ağustos 22). https://www.resmigazete.gov.tr/eskiler/2015/08/20150822-9.htm

Anonymous, (2021). MTA. Maden Tetkik Arama Genel Müdürlüğü. https://www.mta.gov.tr/v3.0/sayfalar/hizmetler/maden-haritalari/bolu.pdf. (Alınma Tarihi: 05.07.2015).

Anonymous, (2025). EEA. European Environment Agency. https://eunis.eea.europa.eu/habitats. (Alınma Tarihi: 15.06.2015).

Arslan, M., Bingöl, M.Ü., & Erdoğan, N. (2012). Avrupa Doğa Bilgi Sistemi (EUNIS) Habitat Sınıflandırması ve Türkiye Batı Öksin Alanındaki Doğu Kayını (Fagus orientalis Lipsky) Ormanları Örneği. *Artvin Çoruh Üniversitesi Orman Fakültesi Dergisi*, *13* (2), 278-290.

Atay, S., Güleryüz, G., Orhun, C., Seçmen, Ö., & Vural, C. (2009). *Dağlarımızdaki Zenginlik Türkiye'nin 120 Alpin Bitkisi. Rubicon Vakfı, Dönence Basım ve Yayın Hizmetleri*. İstanbul, 100 sy. ISBN/EAN : 978-90-814408-1-3

Baytop, A. (1998). *İngilizce-Türkçe Botanik Klavuzu, İstanbul Üniversitesi Yayın No: 4058, Eczacilik Fak. Yayın No: 70.* İstanbul.

Blisst, L.C. (1962). *Adaptations of Arctic and Alpine Plants to Environmental Conditions*. *AAAS Symposium Life University of Illinois,* New York City, 117-144.

Çakmak, M. H. & Aytaç, Z. (2020). Determination and mapping of EUNIS habitat types of Mamak District (Ankara), Turkey. *Acta Biologica Turcica*, *33*(4), 227-236.

Çakmak, M.H. (2017). *Avrupa Doğa Bilgi Sistemi (EUNIS) Habitat Sınıflandırması ve Soğuksu Milli Parkı Pilot Alanında Uygulanması (Uzmanlık Tezi). T. C. Orman ve Su İşleri Bakanlığı*, Ankara, Türkiye.

Çakmak, M.H. & Aytaç, Z. (2021). EUNIS Habitat Sınıflandırmasının Türkiye Durum Değerlendirmesi. *Bilge International Journal of Science and Technology Research*, *5* (2), 157-163.

Çolak, A. H. & Sorger, F. (2005). *Türkiye Çiçekleri, Lazer Ofset Matbaa*, Ankara.

Crosswalk EUNIS 2007 and Annex I 2008 (Microsoft Excel Spreadsheet). www.eea.europa.eu/themes/biodiversity/eunis/eunis-habitat-classification#tab-documents. (Alınma Tarihi: 11.02.2016).

Davies, C.E., Moss, D., & Hill, M.O. (2004). EUNIS Habitat Classification Revised. www.eea.europa.eu/themes/biodiversity/eunis/eunis-habitat-classification#tab-documents. (Alınma Tarihi: 09.03. 2016).

Davis, P. H. (ed.) (1965-1985). *Flora of Turkey and the East Aegean Islands*, Volume: 1-9, Edinburg University Press,

Davis, P. H., Mill, R. R., Tan, K. (ed.) (1988). *Flora of Turkey and the East Aegean Islands*, Volume: 10 (Supplement), Edinburg University Press.

Demir, O., Kızılırmaklı, A., Bozdağ, C. M., & Cabi, E. (2022). Determination of terrestrial EUNIS habitat types of Mount Ganos (Işıklar), Tekirdağ, Türkiye. *Frontiers in Life Sciences and Related Technologies*, *3*(2), 69-74. https://doi.org/10.51753/flsrt.1109635

Ekici, M., Ekim, M. (2004). Revision of the section Hololeuce bunge of the genus *Astragalus* L. (Leguminosae) in Turkey, *Turkish Journal of Botany*, *28* (3), 307-347.

Ekim, T., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z., & Adıgüzel, N. (2000). *Türkiye Bitkileri Kırmızı Kitabı*. TTKD&YYÜ No:18, Ankara.

Erik, S., Akaydin G., Göktaş A., (1998) Başkentin Doğal Bitkileri, Ankara Valiliği Çevre Vakfı Başkanlığı, Ankara.

Eröz Poyraz, İ. (2008). *Türkiye Velezia L. (Caryophyllaceae) cinsi revizyonu*, (Tez no 178941). [Yüksek Lisans Tezi, Eskişehir Osmangazi Üniversitesi Fen Bilimleri Enstitüsü, Biyoloji ABD]. Yükseköğretim Kurulu Ulusal Tez Merkezi.

Fiori, A. (1993). *Flora Italiana illustrata, Iconographia florae Italicae*.

Fitter, A. (1987). *Blumen, Wildblühende Pflanzen, Verlag Paul Parey,* Hamburg-Berlin.

Geven, F., Özdeniz, E., Kurt, L., Bölükbaşı, A., Özbey, B.G., Özcan, A.U., & Turan, U. (2016). Habitat Classification and Evaluation of the Köyceğiz Dalyan Special Protected Area (Muğla/Türkiye). *Rend. Fis. Acc. Lincei*, *27*, 509–519. https://doi.org/10.1007/s12210-016-0510-1

Güner, A., Aslan, S., Ekim, T., Vural, M, Babaç, M T. (ed.), (2012). *Türkiye Bitkileri Listesi (Damarlı Bitkiler), Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını*, İstanbul.

Güner, A., Özhatay, N., Ekim, T., Başer, K.H.C. (ed.), (2000). *Flora of Turkey and the East Aegean Islands, Volume:11(Supp. 2), Edinburgh University Press*, Edinburgh.

Güneş Özkan, N. (2016). *Argözü Vadisi'nin (Kıbrıscık-Bolu) Flora ve Vejetasyonu* (Tez no 430800). [Doktora tezi, Düzce Üniversitesi Fen Bilimleri Enstitüsü]. Yükseköğretim Kurulu Ulusal Tez Merkezi.

Hamzaoğlu, E., Aksoy, A., Budak, Ü. (2009). *Türkiye Senecio L. (Asteraceae) Türlerinin Taksonomik Revizyonu*, TBAG Proje No: 106T240.

Irkeç, T., & Ünlü, T. (1993). Volkanik kuşaklarda hidrotermal sepiyolit oluşumuna bir örnek: Kıbrıscık (Bolu) sepiyoliti. *MTA Dergisi, 115*, 99-118.

Işık, K. & Kurt, Y. (2005). Habitat Fragmentasyonu ve Biyoçeşitliliğe Etkileri. Türk Ormancılığında, Uluslararası Süreçte Acilen Eyleme Dönüştürülmesi Gereken Konular, Mevzuat ve Yapılanmaya Yansımaları Sempozyumu, Antalya, Türkiye, 22-24 Aralık 2005.

Kara, N., & Işık, K. (2008). *Populasyon Ekolojisi. Ekolojinin Temel İlkeleri içinde* (ss. 224-282). Çev. ve Ed.: K. Işık. Palme Yayıncılık.

Karaköse, M. & Terzioğlu, S. (2020). Finike (Antalya) orman planlama biriminin vasküler bitki florası. *Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi, 23* (5), 1144-1162. https://doi.org/10.18016/ksutarimdoga.vi.681247

Kavgacı, A. & Özalp, G. (2006). Ekosistem yönetiminde bitki sosyolojisinin yeri ve önemi. *Batı Akdeniz Ormancılık Araştırma Müdürlüğü Dergisi, 7* (1), 3-22.

Kaynak, G., Daşkın, R. & Yılmaz, Ö. (2007). *Bursa Bitkileri, T.C. Uludağ Üniversitesi Rektörlüğü* Yayın No: 08-029-0476, Bursa.

Kent, M. & Coker, P. (1996). *Vegetation Description and Analysis. Wiley*, Australia.

Khaddari, A., Bouziani, M., Moussa, K., Sammar, C., Chakiri, S., Hadi, H. E., ... & Titafi, A. (2022). Evaluation of Precipitation Spatial Interpolation Techniques using GIS for Better Prevention of Extreme Events: Case of the Assaka Watershed (Southern Morocco). *Eco. Env. & Cons*, 28, 1-10. http://doi.org/10.53550/ EEC.2022. v28i08s.001.

Kılınç, M. (2005). *Bitki Sosyolojisi (Vejetasyon Bilimi). Palme Yayınları*, Ankara.

Kılınç, M., Kutbay, H. G., Yalçın, E., & Bilgin, A. (2006). *Bitki Ekolojisi ve Bitki Sosyolojisi Uygulamaları. Palme Yayıncılık*, Ankara.

Koca, A. (2003). *Akçakoca (Düzce) ilçesinin florası ve etnobotanik özellikleri* (Tez no 130987). [Yüksek Lisans Tezi, Hacettepe Üniversitesi Fen Bilimleri Enstitüsü, Biyoloji ABD]. Yükseköğretim Kurulu Ulusal Tez Merkezi.

Kreutz, K. (C.A.J.) (2003). *Feldführer der Türkischen Orchideen*, Deutsch.

Kreutz, K. (C.A.J.), Çolak, A. H. (2009). *Türkiye Orkideleri, Rota Yayınları*, İstanbul.

Lidén, M. & Zetterlund, H. (1997). *Corydalis, A gardener's guide and monograph of the tuberous species*, Alpine Garden Society.

Mergen, O. & Karacaoğlu, C. (2015). Tuz Lake Special Environment Protection Area, Central Anatolia, Turkey: The EUNIS Habitat Classification and Habitat Change Detection between 1987 and 2007. *Ekoloji Dergisi*, *24*(95), 1-9.

Moss, D. (2008). *EUNIS Habitat Classification- A Guide for Users*. [Çevrimiçi]. Erişim: www.eea.europa.eu/ themes/biodiversity /eunis/eunis-habitat-classification#tab-documents, 2016.

Natura 2000. (2003). *Interpretation Manual of European Union Habitats*. European Commission DG Environment, Nature and Biodiversity-EUR 15.

Özen, A. & Ürker, O. (2020). Avrupa Doğa Bilgi Sistemi (EUNIS) habitat sınıflandırmasını kullanarak Işıklı Gölü ve Gökgöl sulak alanlarında habitat değişimlerinin belirlenmesi. *Erzincan Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, *13*(2), 518-531. http://doi.org/10.18185/erzifbed.646077.

Palabaş Uzun, S., Uzun, A., & Terzioğlu, S. (2012). Orman Ekosistemlerinde Habitat Parçalanmaları ve Biyolojik Çeşitlilik Üzerine Etkileri. *KSÜ Doğa Bil. Dergisi*. Özel Sayı,(Ulusal Akdeniz Orman ve Çevre Sempozyumu, 26-28 Ekim 2011, Kahramanmaraş), 136-144.

Rose, F. (1981). *The Wild Flower Key British Isles-N.W. Europe*, England.

Rothmaler, W. (1991). *Exkursionsflora*, *Volk und Wissen Verlag GmbH,* Berlin.

Şahin, C. (1984). *Aladağ Çayı Havzasında Abiyotik Çevre Koşulları ve Bunlarla İlgili Bozulmuş Doğal Dengenin Yeniden Kurulmasına İlişkin Sorunlar ve Çözüm Yolları.* TÜBİTAK Çevre Araştırmaları Grubu, ÇAĞ-55 No'lu Proje.

Sarı, D. (2010). Biyolojik çeşitlilik ve Floristik Çeşitlilik Açısından Alpin Alanların Önemi. III. Ulusal Karadeniz Ormancılık Kongresi, Artvin, Türkiye, 20-22 Mayıs 2010, ss. 1447-1455.

Satıl, F., Selvi, S., & Tümen, G. (2020). Balıkesir florasında istilacı karaktere sahip yerli bitki taksonları üzerine bir araştırma. *Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi, 23*(4), 928-946. https://doi.org/10.18016/ksutarimdoga.vi.692964.

Savran, A., Bağcı, Y., & Martin, E. (2009). *Türkiye Barbarea R. Br. (Brassicaceae) cinsinin revizyonu*, TÜBİTAK Bilimsel Araştırmalar Grubu, TBAG-106T179 No'lu Proje.

Schaminée, J. H., Chytrý, M., Hájek, M., Hennekens, S. M., Janssen, J. A., Knollová, I., & Tichý, L. (2019). Updated crosswalks of the revised EUNIS Habitat Classification with the European Vegetation Classification and the European Red List Habitats for EUNIS coastal habitats and mires. Wageningen Environmental Research, Wageningen, 541.

Schonfelder, P. & Schonfelder, I. (1990). *Was Blühtam Mittelmeer?*, Kosmos, Naturführer

Seçmen, Ö. & Leblebici, E. (1996). *Türkiye Sulak Alan Bitkileri ve Bitki Örtüsü, Ege Üniversitesi Fen Fakültesi Yayınları,* No:158-İzmir.

Serin, Y., Zengin, H., Tan, M., Koç, A., Erkovan, H.İ., Avcıoğlu, R., Soya, H., Geren, H., Gemici, Y., Kendir, H., Sancak, C. Özaslan-Parlak, A. Öztekin, M. (2005). *Çayır ve Mera Bitkileri Kılavuzu. T.C. Tarım ve Köyişleri Bakanlığı Yayınları*, Ankara, 317 sy.

Tekeli, Z. & Aslan, H. (2024). Identification of benthic habitat types of the Çanakkale Strait coast using the European Nature Information System and the Barcelona Convention habitat classification schemes. *Trakya University Journal of Natural Sciences*, *25*(2) 133-150. https://doi.org/10.23902/trkjnat.1471425.

Tekin, E., (2005). *Türkiye'nin En Güzel Yaban Çiçekleri, Türkiye İş Bankası Kültür Yayınları*, İstanbul.

Tel, A. Z., Ortaç, İ., Özuslu, E., & İlçim, A. (2025a). Akdeniz, Tarsus ve Erdemli (Mersin-Türkiye) ilçelerindeki bazı doğal sit alanlarının flora, genel vejetasyon yapısı ve EUNIS habitat tiplerinin incelenmesi. *Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi*, *28*(2), 403-422. https://doi.org/10.18016/ ksutarimdoga.vi.1592127.

Tel, A. Z., Ortaç, İ., Özuslu, E., & İlçim, A. (2025b). Investigation of the Flora, General Vegetation Structure and EUNIS Habitat Types of Some Natural Protected Areas in Gülnar and Silifke (Mersin-Turkey). *Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi*, *28*(3), 690-711. https://doi.org/10.18016/ksutarimdoga.vi.1592203.

Tüfekcioğlu, İ., Çakmak, M. H., & Hepcan, Ç. C. (2024). The use of EUNIS habitat classification to assess ecosystem services capacity: the case of Mamak district (Ankara, Türkiye). *Ege Üniversitesi Ziraat Fakültesi*

Dergisi, *61*(1), 31-45. https://doi.org/10.20289/zfdergi.1342347.

Tutin, T. G., Burges, N. A., Chater, A. O., Edmondson, J. R., Heywood, V.H., Moore, D. M, Valentine, D. H., Walters, S. M, Webb, D. A. (1964-1980). *Flora Europaea,* Volumes 1-5, Cambridge University Press.

Uluocak, N. (1984). *Toprak Koruması ve Yem Niteliği Bakımından Türkiye'nin Önemli Doğal Otlak Bitkileri II: Baklagiller*, İ.Ü. Yayın No: 3198 O.F. Yayın No: 358, İstanbul.

Uzunhisarcıklı, M E., Vural, M. (2012). The taxonomic revision of Alcea and Althaea (Malvaceae) in Turkey, *Turkish Journal of Botany*, *36*, 603-636. https://doi.org/10.3906/bot-1108-11.

Wilkin, T. A., Perrins, C. M., & Sheldon, B. C. (2007). The use of GIS in estimating spatial variation in habitat quality: a case study of lay-date in the Great Tit Parus major. *Ibis*, 149, 110-118. https://doi.org/10.1111/j.1474-919X.2007.00757.x.

Yıldırım, C., Yalçın, E., Cansaran, A., & Korkmaz, H. (2019). Syntaxonomic Analysis of Forests, Shrubs, and Steppes of Tavşan Mountain (Amasya, Türkiye). *Turk J Bot, 43*, 409-419. https://doi.org/10.3906/bot-1809-18.

Yıldırımlı, Ş. (1988). Türkiye'nin batı yarısı ve kuzeyindeki *Isatis* L. (Cruciferae) cinsinin revizyonu, *Doğa Botanik Dergisi*, *12*(3), 332-400.

Yıldız, B., Aktoklu, E. (1997). *Türkiye'nin Hedysarum ve Onobrychis Miller (Fabaceae) cinslerine ait türlerin revizyonu*, Tübitak Bilimsel Araştırmalar Grubu, TBAG-1147 No'lu Proje.

Yıldız, B., Tümen, G., Demirkuş, N., Adıgüzel, N., Akyalçın, H., Bahçecioğlu, Z. (2004). *Türkiye'de yetişen Thymus L. (Lamiaceae) türlerinin revizyonu ve türler üzerinde palinolojik ve kimyasal araştırmalar*, Tübitak Bilimsel Araştırmalar Grubu, TBAG-1715 No'lu Proje.