

# Conservation Assessment of a critically endangered endemic *Polygonum samsunicum* (Polygonaceae) with emended description from Turkey

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**Key words:** endemic, IUCN assessment, *Polygonum samsunicum*, species conservation action plan, Turkey.

**Ključne besede:** endemiti, IUCN ocena, *Polygonum samsunicum*, akcijski načrt ohranjanja vrste, Turčija.

## Abstract

*Polygonum samsunicum* is one of the endemic species from Turkey. Up to now, it has been only known from the type locality (Samsun /Ladik). This research intends to define the global conservation status and strategies of locally distributed endemic *P. samsunicum* which has been confronted with the danger of extinction due to anthropogenic effects in recent years. In this research, we did extensive field studies and collected all needed data for determining the precise conservation status of *P. samsunicum*. We reported nine additional populations from Upper Tersakan valley, where the Mediterranean climate is dominant, and the size of populations, altitude, coordinates, habitat types, and the threats it faces in each locality were given. GeoCAT analyses at global levels indicate the grade of occurrence 21.609 km<sup>2</sup> and area of occupancy 10.094 km<sup>2</sup> and there could be an inferred decline due to habitat loss and fragmentation of the original population, suggesting local endemic species might be classified as CR, based on criteria B1ab (i, ii, iii) + 2ab (i, ii, iii) in the Red List categorization. Its parts are also consumed by local people due to its medicinal features. For in-situ conservation, phenological life history and detailed ecological studies, as well as population monitoring and ex-situ conservation studies should be continued together. Establishing cooperation between universities, research institutes, and local management authorities is strongly needed for long-term monitoring of population size, distribution, overgrazing, and public awareness.

## Izveleček

*Polygonum samsunicum* je ena od endemičnih vrst Turčije. Do sedaj je bila znana samo s tipske lokacije (Samsun /Ladik). V članku smo opredelili globalni varstveni status in strategije lokalno razširjene endemične vrste *P. samsunicum*, ki ji v zadnjem času grozi izumrtje zaradi antropogenih vplivov. Izvedli smo obsežne terenske raziskave in zbrali vse potrebne podatke za natančno oceno varstvenega statusa. Poročamo o devetih dodatnih populacijah iz zgornje doline Tersakan s prevladujočim sredozemskim podnebjem in njihovi velikosti, nadmorski višini, koordinatah, habitatnih tipih in grožnjah. Analiza GeoCAT na globalnem nivoju je pokazala, da se vrsta pojavlja na 21,609 km<sup>2</sup> in območju zasedenosti 10,094 km<sup>2</sup> ter bi lahko prišlo do upadanja populacije zaradi izgube habitata in razdrobljenosti prvotne populacije. Zato lahko lokalno endemično vrsto uvrstimo kot CR na osnovi kriterijev B1ab (i, ii, iii) + 2ab (i, ii, iii) v klasifikaciji rdečega seznama. Rastline lokalni prebivalci nabirajo zaradi zdravilnih lastnosti. Za in-situ varovanje so potrebne fenološke in podrobne ekološke raziskave ter monitoring populacij, prav tako pa tudi raziskave ex-situ varovanja. Sodelovanje med univerzami, raziskovalnimi inštituti in lokalnimi institucijami je za dolgoročni monitoring velikosti populacij, razširjenosti, prekomerne paše in ozaveščanja javnosti nujno potrebno.

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## Introduction

Natural ecosystems degraded and decline rapidly because of the human populations increase. The demolition of habitat through human detriment seems to be the principal cause of the loss of biodiversity (López-Pujol et al., 2006). Turkey has a great variety of biotic and abiotic diversity, i.e., climatic, edaphic, geographic & geologic, and pollinator diversity. These factors lead to Turkey is one of the most important plant biodiversity centres in the world with about 11707 plant species and ca. 35% endemism ratio (Davis et al., 1965; Güner et al., 2012). In addition, three different phytogeographic regions are come together in Turkey, as Mediterranean, Iran-Turanian, and Euro-Siberian (Circumboreal) phytogeographic regions (Zohary, 1973; Thomson, 2020). Due to the rapid population increase in Turkey, many natural habitats have been fragmented and reduced in size or degraded (Kaya & Raynal, 2001).

Particularly the effects of overgrazing, illegal cuttings, population increase, unconscious agricultural practices, unplanned urbanization, road, dam, and hydroelectric power plant constructions have led to the large-scale destruction of important habitats for many species in Turkey (Celep et al., 2010; Subaşı et al., 2020). Rapid degradation of natural ecosystems causes the extinction of plant species. It is estimated that 12 endemic species have been extinct in Turkey in the last few decades (Ekim et al., 2000).

Many studies show that narrow endemic species are vulnerable to extinction and one of the most important being the demolition of their habitats. Because of that, endemic species are the first to experience the negative effect of habitat demolition or fragmentation. The precise evaluation of the preservation status of especially rare endemic species is a necessary most essential condition in order to prevent its extinction (Bernardos et al., 2006). In this context, The IUCN Red List is globally known as a standard not only serving to highlight extinction risk levels of species but also providing guidance to species conservation responses, identifying priority (IUCN, 2012a; IUCN, 2012b; IUCN, 2012c; IUCN, 2019).

Current conservation strategies on plant diversity are not sufficient enough to prevent a continuous decline in biodiversity. Mediterranean-type ecosystems (MTEs) are suffering from high habitat loss because of human impact (Myers et al., 2000; Le Roux et al., 2019; Thompson, 2020). Moreover, nowadays, MTEs are among the most vulnerable due to global warming (or climate change) worldwide (Spampinato et al., 2019).

The genus *Polygonum* L. has 39 species (45 taxa) in Turkey. Eleven taxa of them are endemic (24.44%), 2 of which are doubtful records (Keskin, 2012). *Polygonum*

*samsunicum* was firstly described by Yıldırım & Leblebici (1989) as one of the local endemic species only known from Ladik-Samsun County in Turkey. *P. samsunicum* has a very restricted distribution areas, limit of its distribution, population dimension, and potential threats of the populations are not well known. So far, the first author has proposed the IUCN category as CR (Critically Endangered) for *P. samsunicum*, with only an estimate of the distribution area in the Turkish Red Data Book (Ekim et al., 2000).

Based on extensive field studies and observations supported by the Republic of Turkey Ministry of Agriculture and Forestry, this research aims to determine the extinction risk of rare endemic *P. samsunicum*, on a global scale and its conservation strategies in consideration of the urgency of deficiencies. For this purpose, the distribution, population size, habitat characteristics of *P. samsunicum*, and threats on the species are determined and the protection acts are recommended.

## Material and Methods

The type location of *P. samsunicum* was affirmed by the field studies. After that, we did extensive field surveys to determine the distribution areas of the species between May and October 2015. All the consisting information appropriate to the ecological, phenological, taxonomic and distribution of *P. samsunicum* were collected from natural habitats and the other possible distribution areas (Davis et al., 1988; Yıldırım & Leblebici, 1989; Güner et al., 2000; Karaer, 2003; Karaer, 2013). In addition, the species that attendant with *P. samsunicum* was collected and identified. The nomenclature from the International Plant Names Index (IPNI) and The Plant List (TPL) was accepted.

The holotype in the HUB herbarium and the isotype specimens in the EGE (İzmir) herbarium were obtained. Isotype specimens in herbarium B (Berlin), and E (RBG Edinburgh) are available online.

For all localities, coordinates, number of the individuals (population size), elevation, habitat type (following the IUCN habitats classification scheme version 3.1), and the threats (following the IUCN threats classification scheme version 3.2.) were recorded (IUCN, 2012a; IUCN, 2012b; Akçakaya, 2016). All coordinates were defined by using the Global Positioning System (GPS). Habitat and threat types of each locality were provided from field observations.

The numbers of individuals in the population were forecasted using the following formula by sampling 10 quadrats haphazard from each locality, the quadrat dimensions were 5 × 5 m (Guidi, 2010).

Wherein,  $N_s$  is the number of individuals of a species,  $\mu_i$  is the mean number of individuals in a locality  $i$ , and  $S_i$  is the total area of locality  $i$ ;  $\mu_i / 25$  is the density per  $m^2$  (Guidi, 2010).

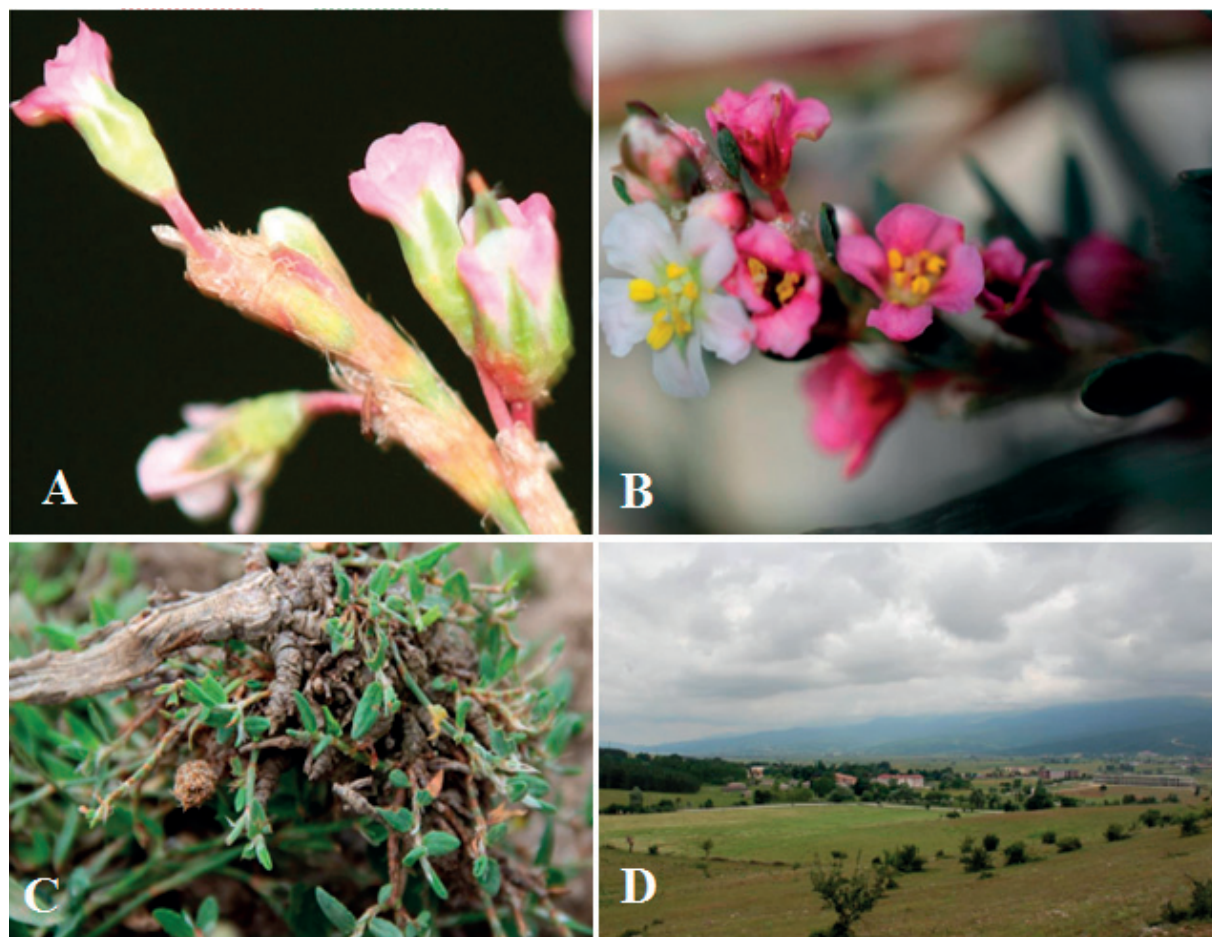
Calculation of the Grade of Occurrence (GOO,  $km^2$ ) and Area of Occupancy (AOO,  $km^2$ ) was carried out by using Geo-Cat (Bachman et al., 2011). Due to the narrow and local distributions of the species and the details on spatial data, which are available in the AOO, by using a grid of  $1 km^2$  has been calculated. A  $1 km^2$  grid can be used for assessment when high precision data are available (IUCN, 2012a; IUCN, 2012b). AOO and GOO population numbers and field observations were used to reassessment the conservation status of this species implementing the IUCN (2012c) Categories and Criteria (ver 3.1).

## Results

After extensive field studies, we found that *P. samsunicum* is distributed in Ladik, Kavak, and Havza counties about 70–80 km south of Samsun city (Figure 1). The altitude of the areas varies between 600 and 1200 m.

## Taxonomic Situation

Although *P. samsunicum* was first collected by Yıldırımli in 1978, in Samsun-Turkey, Ladik Region, near Aslantaş village road, it was described 11 years later (Yıldırımli & Lelebici 1989). According to Yıldırımli & Lelebici (1989), *P. samsunicum* is similar to *P. salebrosum* Coode & Cullen, endemic in Muğla and Antalya (western Mediterranean region of Turkey). *Polygonum samsunicum* differs from *P. salebrosum* by its flower size (3 mm), flower color (rose red, white and banded), and shorter tepals (Coode



**Figure 1:** The general appearance of *Polygonum samsunicum*, A: Inflorescence, B: Flower, C: Root, stem & leaves, D: Ladik is type location in its natural habitat (Photos F Karaer).

**Slika 1:** Izgled vrste *Polygonum samsunicum*, A: socvetje, B: cvet, C: korenina, steblo in listi, D: značilna lokacija Ladik z naravnim rastiščem vrste (Foto F Karaer).

& Cullen, 1967; Yıldırım & Leblebici, 1989; Güner et al., 2000). In addition, Keskin (2009) reported that *P. istanbulicum* differs from *P. samsunicum* by its indumentum (pustulate) and nutlet size (6 mm, not 1.8–2.5 mm) and habitat and altitude (only 69 m above the sea level).

## Expanded and Amended New Description

We provide here an emended description based on our observations of living plants and add photographs of them (Figure 1). Characteristics for which the *P. samsunicum* was first identified are given in bold and our investigation is reported in light. Also, we describe here raw stamen, nectareous, ovary, and fruits characteristics.

*Polygonum samsunicum* Yild. & Leblebici, Willdenowia 19(1): 87–89 (1989). Figure 1

**Tip: A6 Samsun:** Lâdik, on the road of Aslantaş Village, open *Quercus* sp., limestone areas, 900 m, 22.vii.1978, Ş. Yıldırım 1224! (Holotip HUB! isotypes B! E! EGE!)

**Suffrutescent with hardy woody stocks, perennial herbs**, bark grey brown. **STEMS** much branched, erect, **decumbent, or prostrate up to (5–) 30–90 cm tall**, glabrous, branches curved; branchlets papillate, striate, grooved, **internodes 5–10 (20–30) mm**. **LEAVES** simple, alternate, **shortly petiolate** or sessile 2–4 mm, clawed, base articulate; stipules often united to a sheath **ochrea brown, hyaline tapering to apex conspicuous white or silver-coloured and 10–18 veins** oblique, acute; leaf blade grey-green abaxially, green adaxially grey, **elliptic**, oblong-elliptic, lanceolate, linear (8–)9–12(15–30) × (2–)3–4.5 (–6) mm, sub leathery, abaxially with prominent midvein and conspicuous lateral veins, adaxially with conspicuous midvein, base broadly cuneate or rounded, **margin revolute**, straight, crisped or sub undulate, **acute** or obtuse **at apex**. **INFLORESCENCE** lax, axillary, terminal, **elongate spicate**, racemose or **some flowers fascicle**, 6–10 cm; bracts **similar to leaves but smaller than the leaves** 4–10 mm, blade green elliptic, oblong-elliptic, margin straight, crisped or sub undulate, apex obtuse, 2–3(–4) flowered, peduncle absent. **Pedicel** (2–)3–4.2 (–5) mm occasionally articulate at the base, red-pink, buds pink-rose or red-pink. **FLOWERS** small, actinomorphic, sometimes monoecious, usually hermaphrodite. **Perianth** (tepals) not enlarged in fruit, **pink to red with black spots** early period red or pinkish soon pinkish or white, 5-parted; tepals obovate apex obtuse, ca. (2–)2.5–3.5 (–4) mm, fused base, lobes longer than the tube, red or green veined. **Stamen** 8 (–9) rarely sterile stamen 1, filaments free, dilated at the base, triangular, glabrous, dorsifixed, anthers 2-loculed, opening lengthwise exteriors whitish, yellow, elliptical-rectangu-

lar. Nectareous, bright, indistinctly disc-shaped, gland swollen base. **OVARIUM** superior, stylus short 3, ovary 1-placenta, placentation basal, stigma capitate. **FRUIT** trigonous, biconvex, or biconcave nut/achene. **Achenes (Nuts)** included in persistent shorter than or rarely longer than persistent perianth, black-brown, shining, broadly ovoid, **trigonous, 1.8–2.5 (–4) mm**, densely granular punctulate. Seed 1 with straight embryo and conspicuous endosperm.

**Etymology:** The species epithet comes from Samsun city in Turkey.

## Distribution, habitat, and ecology

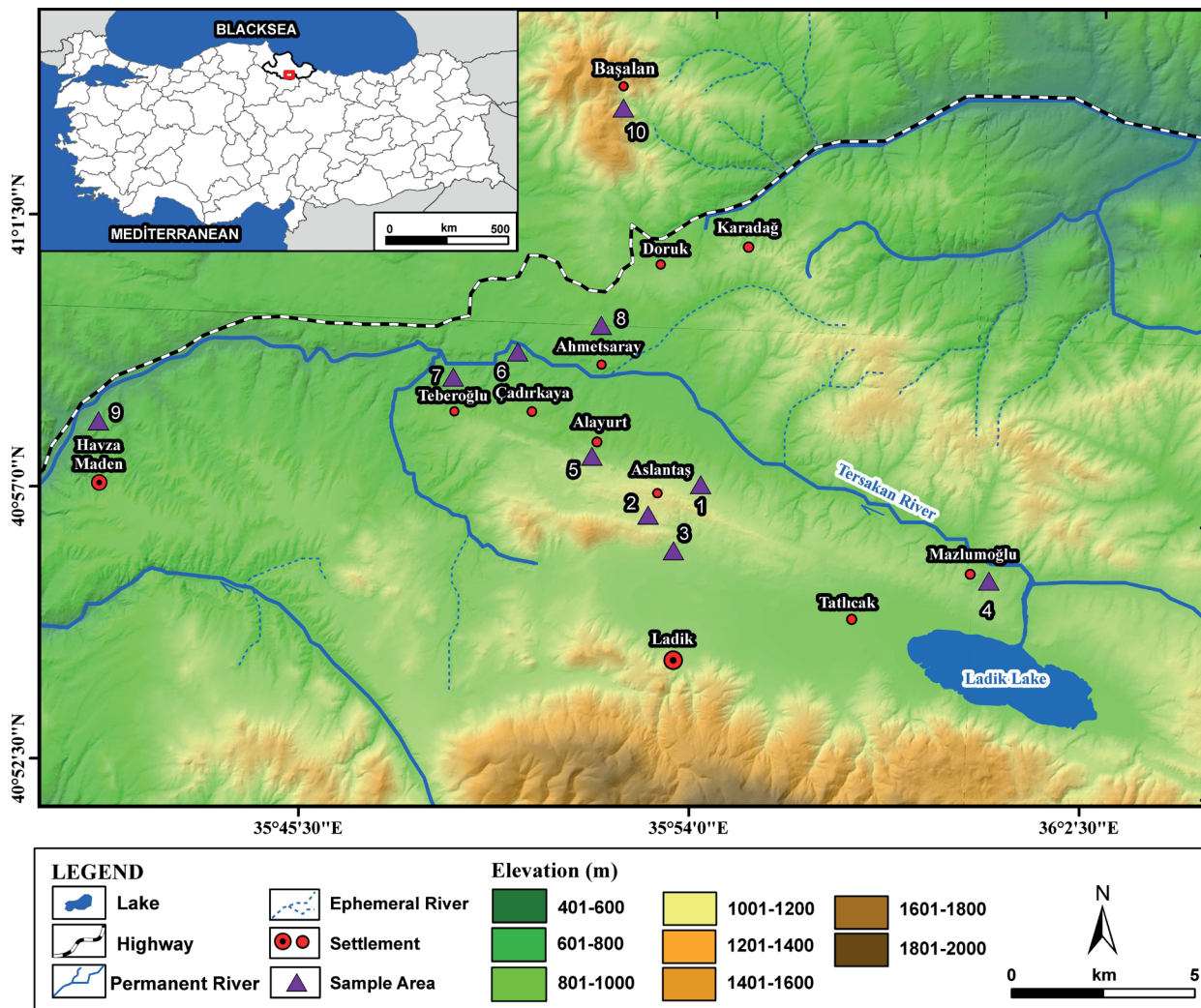
*Polygonum samsunicum* has been known only from its type locality since 1989 (Yıldırım & Leblebici, 1989). We recently identified nine new localities seven in Ladik (Ladik 1 Cement, Ladik 2, Mazlumoğlu, Alayurt, Çadırkaya, Teberoğlu, Ahmetsaray Villages), one in Maden (Havza), and one in Başalan (Kavak) during our conservation planning studies for the species (Table 1). Upper Tersakan Valley where the Mediterranean climate dominant was determined as the main distribution area of the species (Figure 2). While flowering is between June and July, fruiting is between July and August. It grows in an open diverse *Quercus* forest and roadsides in the south facing of valleys.

The distribution area of the species is located at the transition zone of the Central Canik Mountains and the Central Anatolian region (CAR) caused rich plant biodiversity. Like lower Tersakan valley (Celep et al., 2006), the plants of the degraded maquis vegetation of Mediterranean elements are distributed in the area.

Black Sea region (BSR) is situated in the northern part of Turkey and it has a relatively Euro-Siberian type homogeneous vegetation and there were different communities especially around river valleys. Mediterranean enclaves are very widespread in coastal regions and around stream valleys of BSR. The main cause of the penetrance of Mediterranean enclaves into the BSR is climatic and geomorphological changes during Quaternary (Karaer et al., 1995; Karaer et al., 1999; Karaer et al., 2010; Kilinc & Karaer, 1995).

Thus, *P. samsunicum* shares its habitat with plants belonging to the forest and degraded forest vegetations together with the plants of the steppe vegetation and Mediterranean elements. According to the field observations, Mediterranean floristic elements and the Euro-Siberian floristic elements are the most common in the habitats of *P. samsunicum*. Because these areas are located on the south-facing slopes of the valley. This area is in the A6 square in the grid scheme of Davis et al. (1965).





**Figure 2:** The location of the *Polygonum samsunicum* population studied (red triangle and number).  
**Slika 2:** Lokacije obravnanih populacij vrste *Polygonum samsunicum* (rdeči trikotniki in številke).

The species is distributed between elevations of 645–1188 m east, north, northeast slopes of Karadağ Mountain in the Kavak (Samsun) and along with the southern part of the Tersakan valley between elevations of 645–1005 m on rocky substrates rich in the limestone where is not very inclined. Ladik is located between the BSR and CAR. Semiarid Mediterranean bioclimate and the Cold Winter Mediterranean subsection of bioclimate are seen in Ladik according to the method of Emberger (1952). The precipitation regime in the research area is East Mediterranean Type 2 (Sp.W.A.S/ Spring, Winter, Autumn, Summer). For these reasons, “transition climate” is seen locally. According to this, summers are dry and hot, winters cold and rainy in Ladik (Akman, 1999). The mean annual average temperature is 9.4 °C and precipitation is 602 mm average in a year. It can be seen that

severe rainfall is received in April to May and October and November, while the dry period extends from the beginning of June until the end of September (Anonymous, 2020).

There are two large soil groups in the research area. These are brown forest soils and chestnut soils. The species mainly grows in brown forest soils with high lime content and lime-rich volcanic material. These soils can easily be eroded by the destruction of the vegetation cover formed by widespread grass, bushes, or sparse trees (Anonymous, 1984).

*P. samsunicum* prefers calcareous habitats in the open areas of damaged *Quercus pubescens* Willd., *Q. cerris* L. var. *cerris*, *Q. infectoria* G. Olivier, and *Q. petraea* (Mattuschka) Liebl. subsp. *iberica* (Steven ex M. Bieb.) Krassiln. The species is also found in field borders (Figure 3).



*Quercus cerris* var. *cerris*, *Fagus orientalis* Lipsky, *Carpinus betulus* L. mixed forests are common in the upper Mediterranean euxinic province of the distribution areas of *P. samsunicum*. On the other hand, while there are *F. orientalis* forests in the less mountainous Euxine province, there are pure and mixed forests of *F. orientalis* and *Pinus sylvestris* in the mountainous regions. In addition, *P. nigra* J. F. Arnold subsp. *pallasiana* (Lamb.) Holmboe forests can be seen in narrow areas on the western slopes of the transition areas under the effect of the Black Sea climate. At the bottom of Tersakan valley, *Salix triandra* L., *Fraxinus angustifolia* Vahl. subsp. *oxycarpa* (Willd.) Franco & Rocha Alfonso etc. are also found.

**Figure 3:** Habitats of *Polygonum samsunicum*. *Quercus cerris* destruction area, field edge and road widening (Top), Yukarı Tersakan valley (Ahmetsaray village, Bottom) (Photos F. Karaer)

**Slika 3:** Rastišča vrste *Polygonum samsunicum*. Degradiran gozdni otok s cerom (*Quercus cerris*), rob njive in razširitev ceste (zgoraj), dolina Yukarı Tersakan (vas Ahmetsaray, spodaj) (Foto F. Karaer).

*Polygonum samsunicum* also grows in broadleaf and sclerophyllous Oak and broadleaf forests, and conifer forest communities in *Carpino-Quercetum cerridis* Kutbay & Kılınç 1995 association and it forms ecotone zone of the *Bunio-Quercetum pubescentis* Karaer (unpublished data) degraded forest association. The associated species of the association are *Q. cerris* var. *cerris*, *Q. pubescens*, *P. nigra* subsp. *pallasiana*, *C. betulus* L., *C. orientalis* Mill, *Acer campestre* L. subsp. *campestre*, *Ulmus glabra* Mill, *Euonymus latifolius* (L.) Mill. subsp. *latifolius*, *Crataegus monogyna* Jacq. subsp. *monogyna*, *Genista tinctoria* L., *Cornus sanguinea* L. subsp. *australis* (C. A. Mey.) Jáv., *C. mas* L., *Rhododendron luteum* Sweet, *Rubus canescens* DC. var. *canescens*, *R. hirtus* Waldst. et Kit., *Rosa canina* L., *Clematis vitalba* L.

The main accompanying plants of the *P. samsunicum* are *Sambucus ebulus* L., *Bunium microcarpum* (Boiss.) Freyn & Bornm., *Helianthemum nummularium* (L.) Mill. subsp. *tomentosum* (Scop.) Schinz et Thellung, *Silene vulgaris* (Moench) Garcke subsp. *vulgaris*, *Geum urbanum* L., *Hy-*

*pericum perforatum* L., *Achillea arabica* Kotschy, *Teucrium polium* L., *Astragalus microcephalus* Willd. subsp. *microcephalus* and *Dactylis glomerata* L. subsp. *lobata* (Drejer) H. Lindb.

In addition, shrub and herbaceous taxa belonging to the maquis vegetation are scattered in the area. These taxa are *Phyllrea latifolia* L., *Cistus laurifolius* L., *Jasminum fruticans* L., *Clematis flammula* L., *Origanum vulgare* L., *Fumana arabica* (L.) Spach, *Micromeria myrtifolia* Boiss. & Hohen, *Aira elangatissima* Schur. (Figure 3).

## Recommended threatened category

It was first determined that *P. samsunicum* is mainly distributed in Ladik, Havza, and Kavak (Karadağ) regions in the Upper Tersakan Valley. During our studies, we increased it to ten populations (Table 1). The distribution area of *P. samsunicum* varies between 0.002 km<sup>2</sup> and 4.6 km<sup>2</sup>. The current total estimated population size is calculated here to be 2960 individuals: 150 in Aslantaş



Village (AK1)/Ladik, 38 in Ladik 1 Cement (LDK1)/Ladik, 62 in Ladik 2 (LDK2), 280 in Mazlumoğlu Village (MO)/Ladik, 12 in Alayurt Village (AK)/Lâdik, 1723 in Çadırkaya Village (ÇK)/Lâdik, 345 in Teberoğlu Village (TK)/Ladik, 20 in Ahmetsaray.

Village (ASK)/Ladik, 75 in Maden location (MH)/Havza and 255 in Başalan Village - Karadağ (BK)/Kavak; the estimated population size of each locality ranges between 12 and 1723 individuals. GeoCAT analyses at the global level calculate GOO values 21,609 (ca. 22) km<sup>2</sup> and AOO values 10,094 (ca. 10.1) km<sup>2</sup>, and that there is a concluded decrease due to habitat loss and fragmentation of the original population suggesting that this species might be classified as CR; we obtained the Red List categorization of CR for *P. samsunicum*, based on criteria B1ab (i, ii, iii) + 2ab (i, ii, iii).

Agricultural activities, various orchards, and wide herbicide use are the common threats to the population of the taxon. In addition, opening new agricultural fields, and activities for road renovation and widening, and forest destruction are creating a risk of destroying the habitat of this species (Table 1). Extensive grazing pressure and obtaining the necessary soil for the Cement factory are observed in particular, at Aslantaş Village locality. The individuals of the species are shorter stature, particularly in the overgrazed areas.

## Discussion

Habitat loss and fragmentation due to agricultural activities and grazing (sheep) are the greatest threats to the whole population of *P. samsunicum*. Deforestation and other activities i.e., roads widening, are also creating a risk of destroying the habitat and individuals of the species. Whereas, the effects of grazing on the population are not fully known. Some studies show that overgrazing causes a decrease in plant biomass, reduced plant cover, contributes to the change of plant communities with declined plant height, and threatens vegetation and endemic plants (Cui et al., 2005; Teague et al., 2011; Hanke et al., 2014; Su, 2017).

In our research, it was observed that *P. samsunicum* individuals were shorter and more glaucous grey in Ladik 1 locality where grazing pressure was found. When habitats of a rare and endemic species are damaged and degraded by misuse and other various human activities, species' distribution areas, population sizes, and genetic variability will be reduced, and the members thereof will become vulnerable to extinction more extensively than other species (Heywood & Iriondo, 2003; Işık, 2011).

Fragmentation of habitats may also cause an indirect adverse impact on plants due to the fact that pollinators

or seed dispersers may have difficulty in finding their host plants (Mullu, 2016). It was suggested that agricultural activities and causing habitat fragmentation which is major threats to ecosystems (Subaşı et al., 2020).

The knowledge of the reproductive biology of *P. samsunicum* is incomplete. However, the rise fragmentation due to continuing serious agricultural activities in the distribution area was highlighted to be a plausible threat for this species, suggesting difficulty with gene transfer among subpopulations, which might contribute to population fragmentation.

Particularly in areas close to the roadside, it has been observed that the plants can carry the parasitic pathogen fungus, which rarely gives a whitish appearance to the leaves.

While the biggest population size was defined in Çadırkaya Village, the smallest population size was calculated in Alayurt village (Table 1). The current population size of *P. samsunicum* is conjectural to be ca. 22 km<sup>2</sup> and anticipated to decrease in the number of individuals and the number of localities due to habitat losses. According to IUCN (2019), the current status of the *P. samsunicum* can be appraised as CR based on the B criteria in terms of GOO value <100 km<sup>2</sup> (ca. 22 km<sup>2</sup>) B1b (i, ii), AOO value <10 km<sup>2</sup> B2b (i, ii). However, Section 4.11 in the IUCN guidelines (IUCN 2019) suggests that “The term ‘location’ defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present”.

All subpopulations of the species were forethought a single location due to the presence of a single major threat in the habitats (status (a) under Criteria B1 and B2). Besides, continuing reduction area, extent, and quality of the habitat fulfill condition (iii) under Criteria B1b and B2b.

As result of all these valuations, we evaluated the global conservation status of CR for *P. samsunicum*, based on the new IUCN Red List criteria (IUCN, 2019), B1ab (i, ii, iii) + 2ab (i, ii, iii). IUCN Red List proposes necessary protection measures and studies for *P. samsunicum* (Table 2).

To establish a long-term protection measure for *P. samsunicum*, it is necessary to complete the deficient data on the phenological features of the species as precedence. Understanding the reproductive biology (reproductive success, pollination, seed germination, and seedling, etc.) of the taxon besides the genetic structure of the population is important. However, as such studies request long-term researches, we propose an integrated protection plan for *P. samsunicum* through in-situ protection, population monitoring, and ex-situ protection in order to prevent the destruction of the existing gene pool.

Local people and institutions could work with the government for limiting the cultivated areas, or preventing habitat loss and fragmentation by restricting the opening of new crop fields and road renewal – expansion works, grazing pressure within the distribution area in the future. Besides, the naturalization of farmlands could constitute a new habitat for the reintroduction of the species.

## Conclusion

*Polygonum samsunicum* (Polygonaceae) is one of the local endemic species which has been confronted with the danger of extinction due to anthropogenic effects in recent years from Turkey. In this research, we reported a total of ten populations from Upper Tersakan valley (N Anatolia), where the Mediterranean climate is dominant, and the size of populations, altitude, coordinates, habitat types and the threats it faces in each locality was given. GeoCAT analyses at global levels indicate the grade of occurrence 21,609 (ca 22) km<sup>2</sup> and area of occupancy 10,094 (10.1) km<sup>2</sup> and there could be an inferred decline due to habitat loss and fragmentation of the original population, suggesting local endemic species might be classified as CR, based on criteria B1ab (i, ii, iii) + 2ab (i, ii, iii) in the Red List categorization. For in-situ conservation of the species, phenological life history and detailed ecological studies, as well as population monitoring and ex-situ conservation studies should be continued together. Establishing collaboration between research institutes and local government authorities is sorely needed for long-term monitoring of population size, distribution, overgrazing, and public awareness.

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**Table 1:** The 10 sites *Polygonum samsunicum* has been located, with altitude range, habitats classification scheme coded and identified threats (IUCN, 2012a, IUCN, 2012b).  
**Tabela 1:** Deset lokacij vrste *Polygonum samsunicum* z razponom nadmorske višine, klasifikacija v habitatne tipe in ocena groženj (IUCN, 2012a; IUCN, 2012b).

No. / %	Locality	Estimated Population Size	Individual	Area of sites (km <sup>2</sup> )	Elevation (m)	Habitat (IUCN habitats classification scheme)	Assessed threats (IUCN threat classification scheme)
1	Aslantaş village (AK1)	0,400	150	0,845	947–1005	1.4 Forest –Temperate 3.8 Scrubland – Mediterranean -type shrubby vegetation 14.1 Arable Land 14.2 Pastureland 14.3 Plantations Pinus nigra forest, calcareous substrate 14.4 Rural Gardens	2.1.2 Small-holder farming 2.3.2 Small-holder grazing, ranching, or farming 3.2 Mining & quarrying 4.1 Roads & railroads 5.3.1 Intentional use: subsistence/small scale (species being assessed is the target [harvest]) 9.1 Domestic & urban wastewater 9.3.2 Soil erosion, sedimentation 9.4 Garbage & solid waste
2	Ladik 1 (LDK1), Çimento	0,107	38	0,215	940–950	3.8 Scrubland – Mediterranean-type shrubby vegetation 14.1 Arable Land 14.2 Pastureland 14.3 Plantations Pinus nigra forest, calcareous substrate 14.4 Rural Gardens 14.5 Urban Areas	1.1 Housing & urban areas 2.1.1 Shifting agriculture 2.1.2 Small-holder farming 2.1.3 Agro-industry farming 2.3.2 Small-holder grazing, ranching, or farming 3.2 Mining & quarrying 4.1 Roads & railroads 5.3.1 Intentional use: subsistence/small scale (species being assessed is the target [harvest]) 9.1 Domestic & urban wastewater 9.3.2 Soil erosion, sedimentation 9.3.3 Herbicides & pesticides 9.4 Garbage & solid waste
3	Ladik 2 (LDK2),	0,387	62	0,774;	925–932	3.8 Scrubland – Mediterranean-type shrubby vegetation 14.1 Arable Land 14.2 Pastureland 14.3 Plantations Pinus nigra forest, calcareous substrate 14.4 Rural Gardens 14.5 Urban Areas	1.1 Housing & urban areas 2.1.1 Shifting agriculture 2.1.2 Small-holder farming 2.1.3 Agro-industry farming 2.3.1 Nomadic grazing 2.3.2 Small-holder grazing, ranching, or farming 3.2 Mining & quarrying 4.1 Roads & railroads 5.3.1 Intentional use: subsistence/small scale (species being assessed is the target [harvest]) 9.1 Domestic & urban wastewater 9.3.2 Soil erosion, sedimentation 9.3.3 Herbicides & pesticides 9.4 Garbage & solid waste
%		3,836	2,09	3,584			

4	Mazlumoğlu (MO) village ( <b>Lâdik</b> )	1,273	280	0,443	876–891	3.8	Scrubland – Mediterranean-type shrubby vegetation 14.1 Arable Land 14.2 Pastureland 14.3 Plantations Pinus nigra forest, calcareous substrate 14.4 Rural Gardens	2.1.1 Shifting agriculture 2.1.2 Small-holder farming 2.1.3 Agro-industry farming 2.3.2 Small-holder grazing, ranching, or farming 2.3.3 Agro-industry grazing, ranching, or farming 4.1 Roads & railroads 5.3.1 Intentional use: subsistence/small scale (species being assessed is the target [harvest]) 9.1 Domestic & urban wastewater 9.3.2 Soil erosion, sedimentation 9.3.3 Herbicides & pesticides
%		12,606	9,46	2,051				
5	Alayurt village (AK) ( <b>Lâdik</b> )	0,010	12	0,002	835–872	1.4 3.8	Forest –Temperate Scrubland – Mediterranean-type shrubby vegetation 14.1 Arable Land 14.2 Pastureland 14.3 Plantations Pinus nigra forest, calcareous substrate 14.4 Rural Gardens	2.1.1 Shifting agriculture 2.1.2 Small-holder farming 2.1.3 Agro-industry farming 2.3.2 Small-holder grazing, ranching, or farming 4.1 Roads & railroads 5.3.1 Intentional use: subsistence/small scale (species being assessed is the target [harvest]) 9.1 Domestic & urban wastewater 9.3.2 Soil erosion, sedimentation
%		0,099	0,41	0,010				
6	Çadinkaya village (ÇK) ( <b>Lâdik</b> )	4,600	1723	9,814	745–768	3.8	Scrubland – Mediterranean-type shrubby vegetation 14.1 Arable Land 14.2 Pastureland 14.3 Plantations Pinus nigra forest, calcareous substrate 14.4 Rural Gardens	2.1.1 Shifting agriculture 2.1.2 Small-holder farming 2.1.3 Agro-industry farming 2.3.2 Small-holder grazing, ranching, or farming 2.3.3 Agro-industry grazing, ranching, or farming 3.2 Mining & quarrying 4.1 Roads & railroads 5.3.1 Intentional use: subsistence/small scale (species being assessed is the target [harvest]) 9.1 Domestic & urban wastewater 9.3.2 Soil erosion, sedimentation
%		45,569	58,21	45,417				
7	Teberoğlu village (TK) ( <b>Ladik</b> )	1,818	345	3,293	730–748	3.8	Scrubland – Mediterranean-type shrubby vegetation 14.1 Arable Land 14.2 Pastureland 14.3 Plantations Pinus nigra forest, calcareous substrate 14.4 Rural Gardens	2.1.1 Shifting agriculture 2.1.2 Small-holder farming 2.1.3 Agro-industry farming 2.3.1 Nomadic grazing 2.3.2 Small-holder grazing, ranching, or farming 2.3.3 Agro-industry grazing, ranching, or farming 4.1 Roads & railroads 5.3 Logging & wood harvesting 5.3.1 Intentional use: subsistence/small scale (species being assessed is the target [harvest]) 9.3.3 Herbicides & pesticides
%		18,005	11,66	15,237				

No. / %	Locality	Estimated Population Size	Individual	Area of sites (km <sup>2</sup> )	Elevation (m)	Habitat (IUCN habitats classification scheme)	Assessed threats (IUCN threat classification scheme)
8	Ahmetsaray Village (ASK)	0,200	20;	0,445;	773–785	1.4 Forest – Temperate 3.8 Scrubland – Mediterranean-type shrubby vegetation 14.1 Arable Land 14.2 Pastureland 14.3 Plantations Pinus nigra forest, calcareous substrate 14.4 Rural Gardens	2.1.2 Small-holder farming 2.1.3 Agro-industry farming 2.3.2 Small-holder grazing, ranching, or farming 2.3.3 Agro-industry grazing, ranching, or farming 4.1 Roads & railroads 5.3.1 Intentional use: subsistence/small scale (species being assessed is the target [harvest]) 9.1 Domestic & urban wastewater 9.3 Agricultural & forestry effluents 9.3.2 Soil erosion, sedimentation 9.3.3 Herbicides & pesticides 9.4 Garbage & solid waste
9	Maden district (MH) (Havza)	0,300	75;	3,654	645–664	3.8 Scrubland – Mediterranean-type shrubby vegetation 14.1 Arable Land 14.2 Pastureland 14.3 Plantations Pinus nigra forest, calcareous substrate 14.4 Rural Gardens 14.5 Urban Areas	1.1 Housing & urban areas 2.1.1 Shifting agriculture 2.1.2 Small-holder farming 2.3.2 Small-holder grazing, ranching, or farming 3.2 Mining & quarrying 4.1 Roads & railroads 5.3.1 Intentional use: subsistence/small scale (species being assessed is the target [harvest]) 9.1 Domestic & urban wastewater 9.3.2 Soil erosion, sedimentation 9.3.3 Herbicides & pesticides 9.4 Garbage & solid waste
10	Başalan village (BA) (Kavak)	1,000	255	2,124	1101–1188	3.8 Scrubland – Mediterranean-type shrubby vegetation 14.1 Arable Land 14.2 Pastureland 14.4 Rural Gardens	2.1 Annual & perennial non-timber crops 2.3.2 Small-holder grazing, ranching, or farming 4.1 Roads & railroads 5.3 Logging & wood harvesting 5.3.1 Intentional use: subsistence/small scale (species being assessed is the target [harvest])
	<b>Total</b>	<b>10,094</b>	<b>2960</b>	<b>21,609</b>			



**Table 2:** Protection measures needed and research needed proposing and carried out, for *Polygonum samsunicum* and coded according to IUCN (2012a, 2012b, 2012c).

**Tabela 2:** Predlagane in izvedene mere varovanja in raziskave za vrsto *Polygonum samsunicum* in šifre v skladu z IUCN (2012a, 2012b, 2012c).

Conservation action	Proposed	Research needed	Adopted
2-Species management	2.4 Ex-situ conservation	Practices should be continued, ecological and phenological features should be checked.	1.2 Population size, distribution & trends
3-Species management	3.4 Ex-situ conservation	Five individuals were ex-situ to the Vezirköprü (Samsun) district, which has a similar habitat. Can be ex-situ to different similar areas	1.2 Population size, distribution & trends
4-Education and awareness	4.2 Training 4.3 Awareness & communications	Awareness trainings continue. First of all, the communication network can be expanded by giving awareness trainings to the teachers.	1.3 Life history and ecology