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Current Population Sizes, Distribution Areas and Re-Evaluated IUCN Categories of Rare and Endemic Species from Central Anatolia, Turkey: *Salsola grandis, Scutellaria yildirimlii* and *Sideritis gulendamii*

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Abstract

Salsola grandis, *Scutellaria yildirimlii* and *Sideritis gulendamii* are rare and edaphic endemic species, which grow on marly-gypseous soils. The reason that there exists discontinuous distribution for these species is because they need special habitat type. In this study, it is aimed to determine the current population size, distribution area and threat factors for these endemic species. It is also aimed to re-evaluate the IUCN threat category according to 2012 IUCN Red List Category and Criteria because an increase in the population size and the distribution areas were determined by the discovery of the new localities. For small populations, the population size was assessed by counting mature individuals one by one. For relatively larger populations, the number of mature individuals were estimated via randomly chosen sampling areas with the size of 25 m^2. Including the new localities, 4 localities of *Sa. grandis* have the occupancy area of 16 km^2 and the extent of occurrence area of 3529 km^2. The estimated value of total number of mature individuals is 6067. Although the re-evaluation of collected data suggests that this species belongs to EN category, it is considered that CR category is the most suitable category for *Sa. grandis* regarding the risk of extinction in the near future. *Sc. yildirimilii* is distributed through 6 localities with the area of occupancy of 24 km^2 and the extent of occurrence of 1305 km^2. The estimated value of total number of individuals is 92934. Obtained results suggests that *Sc. yildirimlii* belongs to the category EN in terms of the extent of occurrence and the area of occupancy whereas it is categorized under VU in terms of number of locations according to 2012 IUCN criteria. However, it is believed that EN category is much more suitable for this species. *Si. gulendamii*, whose area of occupancy and extent of occurrence are 28 km^2 and 5997 km^2, respectively, has 7 localities. The estimated value of total number of mature individuals is 20563. Therefore, *Si. gulendamii* is re-evaluated in EN category according to 2012 IUCN Red List Categories and Criteria taking into account the extent of occurrence, number of locations and threat factors.

Key words: *Salsola grandis*, *Scutellaria yildirimlii*, *Sideritis gulendamii*, endemic, IUCN, conservation

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İç Anadolu'nun Nadir ve Endemik Türlerlerinin Mevcut Populasyon Büyüklüğü, Yayılış alanı ve IUCN Kategorilerinin Tekrar Değerlendirilmesi: *Salsola grandis, Scutellaria yildirimlii* ve *Sideritis gulendamii*

Özet

Salsola grandis, *Scutellaria yildirimlii* and *Sideritis gulendamii* marnlı-jipsli topraklarda yetişen nadir ve endemik türlerdir. Bu türlerin parçalı yayılış göstermelerinin nedeni özel habitat tiplerine ihtiyaç duymalarıdır. Bu çalışmanın amacı, bu endemik türler için mevcut popülasyon büyüklüğü, yayılış alanı ve tehdit faktörlerini belirlemek ve yeni lokalitelerin keşfedilmesinin bir sonucu olarak artan popülasyon büyüklüğü ve yayılış alanlarından dolayı 2012 IUCN Kırmızı Liste Sınıfları ve Ölçütlerine göre tehlike kategorisini tekrar değerlendirmektir. Küçük popülasyonların mevcut popülasyon büyüklüğünü belirlemek için olgun bireyler tek tek sayılmıştır. Nispeten daha büyük popülasyonlar için olgun bireylerin sayısı 25 m^2 büyüklüğünde rastgele seçilen örneklik alanlar ile tahmin edilmiştir. Yeni lokaliteleri dahil olmak üzere toplam 4 lokaliteye sahip olan *Sa. grandis*'in yaşam alanı 16 km^2 ve yayılış alanı 3529 km^2'dir. Tahmin edilen toplam birey sayısı 6067'dir. Toplanan veriler yeniden değerlendirildiğinde bu türün EN kategorisine ait olmasına

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rağmen yakın gelecekte yok olma riskine ilişkin olarak en uygun kategorinin CR olduğu düşünülmektedir. *Sc. yildirimilii* 24 km^2 yaşam alanı ve 1305 km^2'lik yayılış alanı ile 6 lokalitede yayılış göstermektedir. Tahmin edilen toplam birey sayısı 92934'tür. Elde edilen sonuçlar göz önüne alındığında *Sc. yildirimlii* 2012 IUCN kriterlerine göre yayılış alanı ve yaşam alanı bakımından EN kategorisine girerken lokalite sayısı bakımından VU altında sınıflandırılmıştır. Bununla birlikte EN kategorisinin bu tür için çok daha uygun olduğuna inanılmaktadır. Yaşam alanı ve yayılış alanı sırasıyla 28 km^2, 5997 km^2 olan *Si. gulendamii* 7 lokaliteye sahiptir. Tahmin edilen toplam olgun birey sayısı 20563'tür. Yayılış alanı, lokalite sayısı ve tehdit faktörleri tekrar göz önüne alındığında 2012 IUCN Kırmızı Liste Sınıfları ve Ölçütlerine göre EN kategorisinde yeniden değerlendirilmektedir.

Anahtar kelimeler: *Salsola grandis*, *Scutellaria yildirimlii*, *Sideritis gulendamii*, endemik, IUCN, koruma

1. Introduction

Global changes influence all the living creatures on Earth from humans and plants to microorganisms that are closely related with each other. Some species are much more vulnerable than others, like the ones that need very special habitats and have restricted distribution areas. Turkey takes great attention with its high biodiversity and endemism ratio especially for plants. Nevertheless, this natural richness is threatened by global changes, expansion of agricultural and urban areas, overgrazing, mining and erosion. Furthermore, Turkey is known for its many rare, endemic and threatened plant species in Central Anatolia. This study focuses on three of these species mentioned below.

Salsola grandis Freitag, Vural & N. Adıgüzel was known from three provinces Ankara, Çorum and Kırıkkale. It is an annual species distributed over marly-gypseous soils [1, 2, 3] (Figure 1). *Scutellaria yildirimlii* M. Çiçek & Yaprak was known from four localities at marly-gypseous soils from Ankara and Eskişehir [4] but two more new localities were found during the field surveys (Figure 4). It is relatively newly defined species therefore IUCN threat category was not evaluated before. *Sideritis gulendamii* H. Duman & Karavelioğulları, which prefers marly-gypseous soils, had two localities in Ankara and Eskişehir [5, 6] (Figure 7). However, the distribution area is increased since the total number of localities is increased to 7 with the discovery of 5 new localities during field survey.

All these three taxa have distribution areas mainly in Ankara, Eskişehir, Kırıkkale and Çorum provinces and all have the same soil preference that restricts their distribution area. Despite the existing knowledge of these three taxa, there is still a need for detailed information for the protection of natural sources. Therefore, the population sizes, distribution areas and IUCN threat categories (which were reevaluated) of these three rare and edaphic endemic species were determined.

2. Materials and methods

The distribution areas of the species were determined by literature review and visits to major herbaria of Turkey (ANK, GAZI, HUB, ESSE). Depending on the knowledge of known distribution areas, potential distribution areas were estimated and field studies were made for new populations around these potential areas between the years of 2015 and 2018. Population size of small populations was determined by counting all of the mature individuals in the area whereas that of large populations was estimated by extracting a mean number for mature individuals using the number of individuals in grid areas of 25 m^2 that were separated from each other with 10 m gaps. Minimum convex polygons were formed by entering GPS coordinates for each species in the IUCN mapping programme; i.e. Geospatial Conservation Assessment Tool programme (GeoCAT- http://geocat.kew.org). Thus, extent of occurrence (EOO) and area of occupancy (AOO) were obtained for each species. Later, the threat category of each species was reevaluated according to IUCN Red List Categories and Criteria [7].

3. Results

It was known from only one locality in Ankara [1, 2] but the number of locations was revised as 4 after field studies [3]. In this study, the population size was determined as 6067 (Table 1). AOO and EOO were calculated as 16 km^2 and ~3529 km^2, respectively (Figure 2). The population sizes (Figure 3) and the threat factors for each population were summarized in Table 1. After the evaluation of this information, the IUCN threat category is determined as EN [7].

Figure 1. Locations of the four populations of *Sa. grandis*

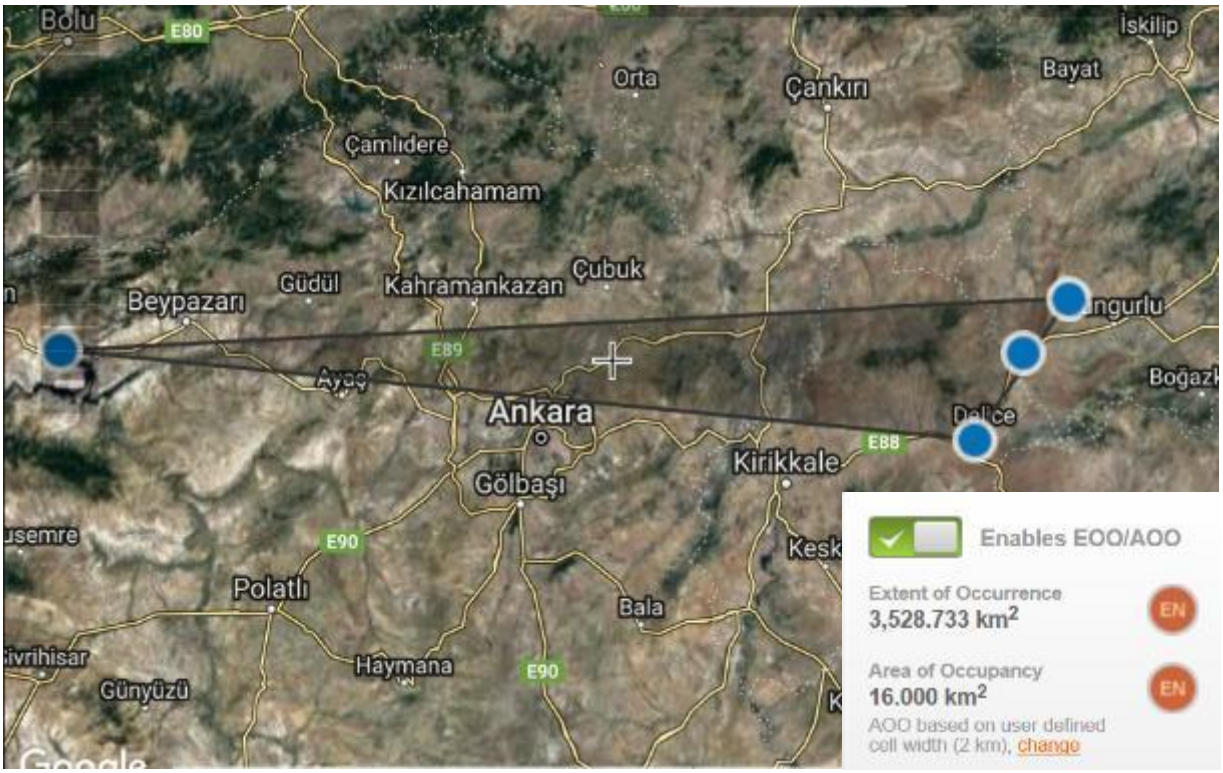


Figure 2. The extent of occurence and area of occupancy of *Sa. grandis*

Figure 3 Populations of *Sa. grandis*

Table 1. Number of mature individuals, area and threat factors of *Sa. grandis* (mature individuals were counted one by one)

Pop*	**Locations**	**Number of Mature Individuals**	**Area**	**Threat factors**
A	A3 Ankara: Between Beypazarı and Nallıhan, 28 km to Nallıhan Bird Paradise, 480 m	2063	1.5 ha	Proximity to agricultural areas, small size of the area, easy to reach, erosion at clayey hills
B	A5 Çorum, Sungurlu, Sungurlu-Çankırı route 12th km, 2-3 km to Village Karaçay, roadside and hillside, 794 m	188	1 ha	Expansion of agricultural areas, proximity to highway, small size of the area
C	A5 Çorum, Kırıkkale-Çorum route, 20 km to Sungurlu, near Village Bahşili, field and roadside	328	2 ha	Agricultural activities, proximity to highway, small size of the area
D	B5 Kırıkkale, Delice, 2-3 km to Delice, roadside and hillside, 657 m.	3488	4.5 ha	Proximity to tire recycling facility
Total Number of Individuals		6067		

*Population

3.2. *Scutellaria yildirimlii*

This species is known from 6 known localities. Field studies at these localities revealed 92943 mature individuals in total (Table 2). AOO and EOO were obtained as 24 km^2 and ~1305 km^2, respectively (Figure 5). The population sizes (Figure 6) and threat factors of each population were summarized in Table 2. The evaluation of this information suggests that IUCN threat category for this species is EN [7].

Figure 4. Locations of the six populations of *Sc. yildirimlii*

Figure 5. The extent of occurence and area of occupancy of *Sc. yildirimlii*

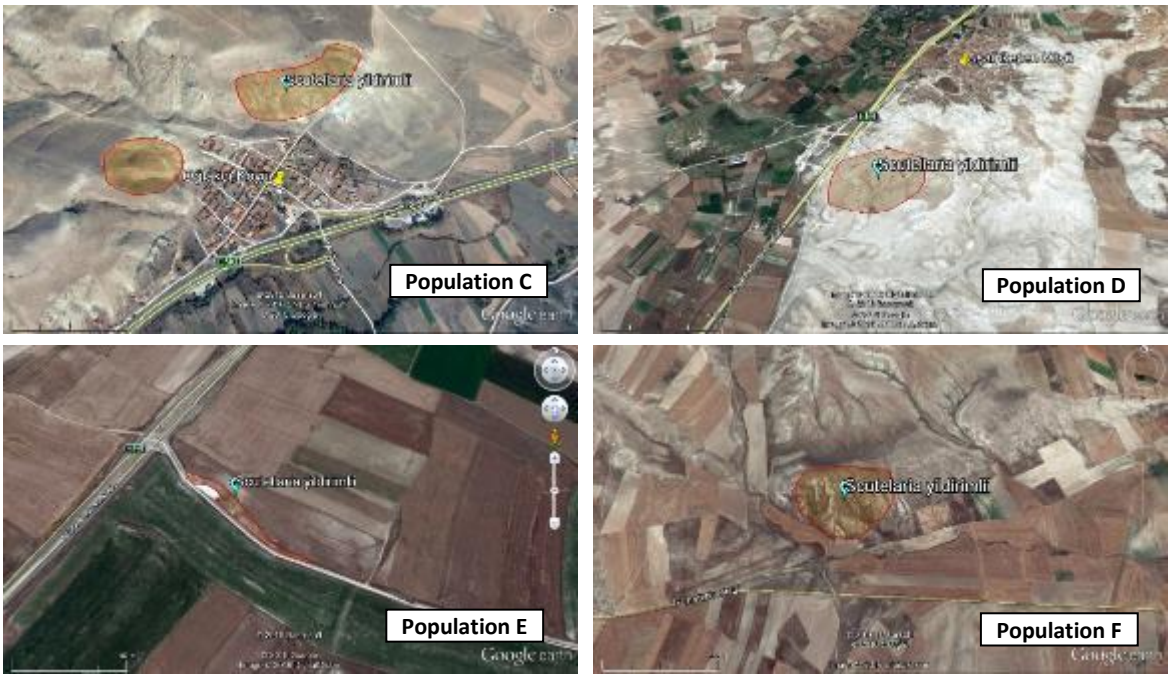


Figure 6. Populations of *Sc. yildirimlii*

Table 2. Number of mature individuals, area and threat factors of *Sc. yildirimlii* (populations marked with * were counted one by one whereas number of quadrates were given for others)

Pop*	**Locations**	**Number of Mature Individuals**	**Area**	**Threat factors**
A	A4 16th km of the Ayaş-Ankara route, Aysantı pass, 1190 m, gypseous soils	587*	8.3 ha	Expansion of agricultural areas, reforestation activities
B	B4 Ankara, Polatlı-Kızlarkayası, 755-800 m.	48000 (46 quadrates)	35 ha	Expansion of agricultural areas
C	B3 24th km of Sivrihisar-Polatlı route, near Oğlakçı, Eskişehir, 870 m, clayish hillsides	2804*	11 ha	Proximity to urban areas, overgrazing, re-forestation
D	B3 Near Aşağıkepen village in Sivrihisar, Eskişehir, 950-1000 m, gypseous soils	27317 (82 quadrates)	28 ha	Terracing, erosion, overgrazing
E	B3 At the intersection of Yeşilköy road and Afyon-Sivrihisar route, near Aşağıkepen village Eskişehir, 872 m, gypseous hillsides	146*	0.5 ha	Expansion of agricultural areas, small size of the areas
F	A3 North-East of Kavuncu village in Günyüzü, Eskişehir, gypseous step	14080 (46 quadrates)	16 ha	Expansion of agricultural areas
Total Number of Individuals		92943		

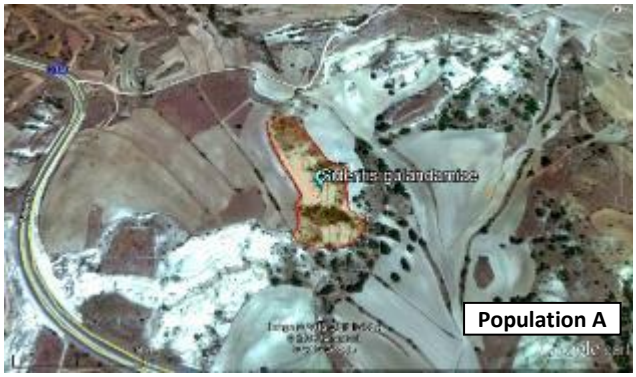
*Population

3.3. *Sideritis gulendamii*

It is known from 7 localities with population size of 20563 mature individuals (Table 3). AOO and EOO were calculated as 28 km^2 and ~ 5997 km^2, respectively (Figure 8). The population sizes (Figure 9) and threat factors of each population were summarized in Table 3. Thus, the IUCN threat category was determined as EN according to IUCN Red List Categories and Criteria [7].

Figure 7. Locations of seven populations of *Si. gulendamii*

Figure 8. The extent of occurence and area of occupancy of *Si. gulendamii*



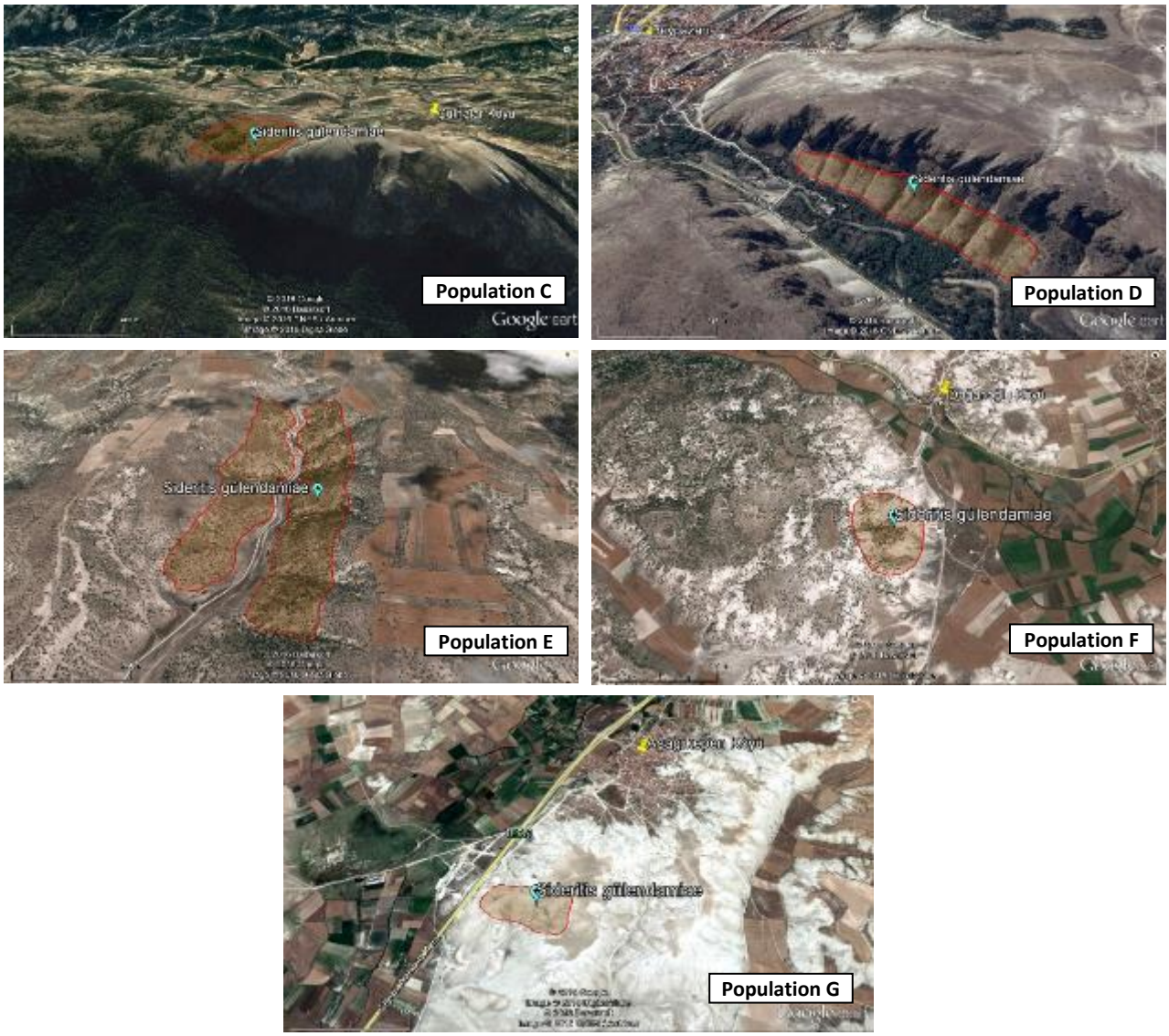


Figure 9. Populations of *Si. gulendamii*

Table 3. Number of mature individuals, area and threat factors of *Si. gulendamii* (populations marked with * were counted one by one whereas number of quadrates were given for others)

Pop*	Locations	Number of Mature Indıviduals	Area	Threat factors
A	A4 16th km of the Ayaş-Ankara route, Aysantı pass, 1190 m, gypseous soils	510*	2.2 ha	Expansion of agricultural areas, reforestation
B	A3 Ankara, 2 thof Beypazarı-Başören village, 700-800 m, marly steppe	1285*	10 ha	Proximity to highway and urban areas
C	A3 Ankara, Nallıhan, Çulhalar village, Sarıçalı Mountain	3559 (59 quadrates)	15 ha	No threat because of isolation
D	A3 Ankara, Beypazarı İnözü valley	4244*	4.8 ha	Proximity to urban and industrial areas
E	B3 Eskişehir: on the route of Çatacık National Park, high hillsides of Çırçır, Ağıllar	1743*	62 ha	Proximity to urban areas, overgrazing
F	B3 Eskişehir, Beylikova, Yukarıdoğanoğlu village	884*	17 ha	Terracing, reforestation
G	B3 Near Aşağıkepen village in Sivrihisar, Eskişehir, 950-1000 m, gypseous soils	8338 (59 quadrates)	15 ha	Terracing, erosion, overgrazing
Total Number of Individuals		20563		

*Population

4. Conclusions and discussion

EOO, AOO, number of mature individuals (population size), number of localities and IUCN Red List Categories were determined using the data gathered by field studies and these were summarized in Table 4.

Table 4. EOO, AOO, number of mature individuals, number of locations and IUCN (2012) Red List Categories of each species.

Species	EOO (km^2)	AOO (km^2)	Number of mature individuals	Number of locations	Categories cited in Red Data Book of Turkish Plants	IUCN (2012) Red list Category
Salsola grandis	~ 3443	16	6067	4	CR	CR
Scutellaria yildirimlii	~ 1320	24	92943	6	-	EN
Sideritis gulendamii	~ 6539	28	20563	7	EN	EN

CR: Critically, EN: Endangered

Sa. grandis is known from 4 localities in Ankara, Çorum and Kırıkkale and total number of individuals is 6067 (Table 1). EOO and AOO were calculated as 3529 km^2 and 16 km^2, respectively. In Red Data Book of Turkish Plant [8] threat category for this species was given as CR. According to IUCN (2012), obtained values of EOO and AOO along with the number of locations indicate category EN [EN B1ab(ii,iii)+2ab(ii,iii)]. However, as given in Table 1 in detail, the extinction risk is very high particularly for Populations B and C in the near future due to the small number of individuals in populations, very small sizes of EOO and further expansion of agricultural areas. Hence, it is believed that category CR is the most suitable category for this species.

Sc. yildirimlii is known from 6 localites in Ankara & Eskişehir provinces and total number of individuals is 92943 (Table 2). EOO and AOO were calculated as 1305 km^2 and 24 km^2, respectively. This is a relatively new species which was determined in 2013. For this reason, the threat category was not defined in Red Data Book of Turkish Plants. This taxon belongs to the category EN [EN B1ab(ii,iii)+2ab(ii,iii)] in terms of EOO and AOO whereas it is categorized under VU [VU D2] in terms of the number of locations. Despite its relatively high number of individuals, EN category is considered to be much more suitable for this species because of discontinuous distribution and human impacts such as agricultural activities, overgrazing and proximity to both roads and settled areas.

Si. gulendamii is known from 7 localities in Ankara and Eskişehir and total number of individuals is 20563 (Table 3). EOO and AOO were calculated as 6539 km^2 and 28 km^2, respectively. Even though the number of individuals appears to be high, this species belongs to VU category considering the total number of locations and EOO whereas this species belongs EN category according to AOO. As summarized in Table 3, expansion of agricultural areas, proximity to both highway and urban areas, overgrazing, erosion, terracing and stone quarries poses great threat over fragmented and discontinuous populations of this species. After the evaluation of this information, according to IUCN (2012) (criteria B2) *Si. gulendamii* belongs to the category EN [EN B2ab(ii,iii)] as already given in Red Data Book of Turkish Plants because AOO is less than 500 km^2 and EOO is highly fragmented (a), as well as because the expected decrease in (ii) AOO, (iii) EOO, distribution or their quality in near future (Table 4).

As mentioned before, these three taxa need priority for in-situ and ex-situ conservation. For this purpose, our suggestion for the protection of these species are as follows: (a) seeds of these taxa should be preserved in gene banks and botanical gardens, (b) activities that cause habitat fragmentation; such as road construction, expansion of agricultural areas and etc., should be controlled by authorities, (c) overgrazing and uncontrolled grazing should be avoided, (d) informative sign-boards and educational programs should be prepared by both local and national levels, and (e) coordinated studies need to be undertaken by all parties, local people, press, universities, NGO's and governmental agencies.

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