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RESEARCH ARTICLE

PRELIMINARY EVALUATION OF THE STATUS OF ALOE DHUFARENSIS LAVRANOS (ASPHODELACEAE JUSS.) IN THE ARABIAN PENINSULA

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Abstract

Assessment of plant species in particular rare and endemic is essential for monitoring and conservation planning. I aimed to support conservation activities by addressing knowledge of the status of *Aloe dhufarensis* Lavranos, one of the endemic plants in the Arabian Peninsula. Information on the status and distribution range of *A. dhufarensis in the Arabian Peninsula* is almost absent. To Assess *A. dhufarensis* according to IUCN categories, Extent of Occurrence (EOO) and Area of Occupancy (AOO) were created and measured using ArcMap 10.8. The species is described and illustrated; the distribution of the species was mapped. The evaluation and the conservation status of this plant species are reported according to the context of IUCN Red List guidelines and criteria.

Keywords: *Aloe dhufarensis*, Arabian Peninsula, Conservation, Evaluation, IUCN.

Introduction:

The International Union for Conservation of Nature (IUCN) Red List is one of the most well-known objective assessment systems for classifying the status of plants animals, and other organisms threatened with extinction [1] Still, each year plant scientists around the world assess or reassess names of species. Conservation assessments for rare, endemic, and endangered plant species have become increasingly essential tools to provide a framework for conservation planning, management, monitoring, and decision-making [2,3]

Aloe species play an important role in supporting local incomes across their distribution areas, they are mainly used for medicine, foods, and as ornamental plants [4-6]. The genus comprises approximately. 548624 taxa, including subspecies and varieties [7,5]. *Aloe* naturally occurs throughout Eastern and Southern Africa, the Arabian Peninsula, Socotra, Madagascar, and several islands in the Indian Ocean [8,5]. The highest species density of aloes is found in Southern, Eastern, and Northeastern Africa, Arabia, and Madagascar, with very few species in the Western African countries. The major center of diversity is in South Africa and Madagascar [9-13].

In 2016, IUCN listed 1851 near threatened plant species, among them 51 subspecies and 73 varieties. Of the 88 species of *Aloe* reported in the Horn of Africa, 39% are threatened with extinction. Moreover, of the 128 *Aloe* taxa assessed for the Red List of the plants of South African, 20% were listed as threatened and a further 8% were listed as either rare or declining [4]. In Madagascar, a preliminary assessment using the latest IUCN categories and criteria classified 39% of species as being threatened with extinction, although half were regarded as having insufficient data to assess [15]. In a preliminary Red List assessment of 25 endemics of Kenyan *Aloe* taxa, 80% were shown as threatened [16].

In Yemen, 33 species of *Aloe* were recorded [17,18], of which 27 are endemics to the Arabian Peninsula, and most of them are threatened and unrepresented in seed banks or Botanic gardens. A preliminary IUCN Red List assessments for few species have been compiled for Yemen and the Socotra Archipelago in the unpublished report to Plant Specialist Group (APSG), Kuwait, 2007 submitted by Abdul Wali Al Khulaidi and Anthony Miller and of these 23 were *Aloe* species [19].

This study aims to evaluate *Aloe dhufarensis* using IUCN categories. The results of this study will inform priorities in conservation projects concerning *Aloe* and the areas where they occur.

Materials and Methods:

Intensive fieldwork was done in Hat district, South Sanau of Al-Mahara Governorate, Yemen, only 45 km from the Oman border at its nearest point to evaluate and record the occurrence of a near-endemic plant *A. dhufarensis* (Fig. 2)**.** Localities of this plant in Oman were also obtained from different sources [20-22]. To assess this plant according to IUCN categories**,** Extent of Occurrence (EOO) and (Area of Occupancy (AOO) were created and measured using ArcMap 10.8. *Area of occupancy [AOO] is defined as the area within its extent of occurrence which is occupied by a taxon. The extent of occurrence [EOO] is defined as the area contained within the shortest continuous imaginary boundary which can be drawn to include all the known sites of present occurrence of a taxon [23]*. The width of the AOO cell is reported in kilometers. *The grid size of the area of occupancy was calculated as four square km using ArcMap and* is placed over all selected taxon records *(Fig.1)*. The calculation of AOO made using the following formula [24]:

AOO = number of occupied cells × area of the individual cell.

AOO rating as for EOO, the AOO rating is based on the values listed under the IUCN Categories and Criteria Version 3.1 [24]. The area value for AOO is compared with the thresholds set in Criterion B2 and the relevant rating is returned. The threshold values are as follows [25]:

AOO (km^2) Rating	Rating
>10	CRITICALLY ENDANGERED
>500	ENDANGERED
>2,000	VULNERABLE
>4,500	NEAR THREATENED

EOO rating The EOO rating is based on the values as listed under the IUCN Categories and Criteria Version 3.1 [24]. The area value for EOO calculated above is compared with the thresholds set in Criterion B1 and the relevant rating is returned. The threshold values are as follows [25]:

EOO (km^2)	Rating
< 100	CRITICALLY ENDANGERED
<5000	ENDANGERED
<20,000	VULNERABLE
<45,000	NEAR THREATENED

AOO Density**:** AOO Density = 1 - (AOO Subpopulations/AOO Number of cells) is a measure to describe the density of the point distribution [23,26].

Specimens Examined:

The specimen was collected from a wadi bed, Al Mahara, Yemen and planted in the genetic farm of Agricultural research & Extension Authority, regional Station, Taiz, Yemen. Locality: wadi bed, wp 16, west of Hat (Al Mahara), 16 Nov. 2010, between lat. 17.201334 and long. 51.766396, at an altitude of 865 m. Collector: Abdul Wali Al-Khulaidi.

Type specimen:

Aloe dhufarensis grows in southern Arabia, on a dissected plateau southeast of the entrance to Wadi Urzuq on the Dhufar coast of Oman, Lat. 17.102251 and long. 54.698158; 250m (800 feet), coll. 13 January 1966, Pretoria, South Africa, 24 February 1967, *Lavranos 4337*, holotype PRE (herbarium acronym is according to [27].

Etymology:

The epithet *dhufarensis* is an illustration of the origin of the species in the Dhofar Governorate, Oman. The suffix *–ensis* indicates the place of origin [28].

Habitat and Ecology

Aloe dhufarensis forms a community in Hat, South Sanau in the Mahara Governorate, Republic of Yemen [29]. The community is rare and found on depressions at the foothills and the rocky dry plateau south, between 860 and 960 m, with a frequency of 3% and a density of 30 individuals per hectare (Plate 1).

Associated species:

Senegalia hamulosa (=Acacia hamulosa), **Vachellia tortilis** (=Acacia tortilis), Blepharis edulis, Chrysopogon plumulosus, Euphorbia rubriseminalis, Heliotropium fartakense, Kohautia retrorsa, Pluchea arabica, Rhazya stricta, Senna holosericea, Tephrosia purpurea subsp. apollinea, and Tetraena decumbens (=Zygophyllum decumbens)

The plant was also recorded from Oman in dry wadis, rocky coastal plain, wadi banks, and gravel banks in poor alkaline soils and dry stony places, especially on drier plateaus as well as stony and gravelly places in valleys, rocky slopes, and cliffs with an open *Dracaena* woodland. These areas receive *monsoon* rainfalls from May until September. The occurrence range of *A. dhufarensis is* from an altitude of 50–1400 m, and are usually found in shrubland habitats in Jabal Al Qamar while it is absent in Jabal Al Qara and Jabal Samhan [20,21] Rainfall in the habitat of *A. dhufarensis* would be less than 150mm annually. Temperatures range from 18-33˚C [22]

Plate 1: *Aloe dhufarensis* in its habitat, South Sanau in the Mahara Governorate, Yemen (Photo by Abdul Wali Al-Khulaidi)

Geographic Range:

Yemen is the native range of *Aloe dhufarensis* (Al-Mahara: Hawf, Hat, Rumahh districts, and Jabal Fartak mountain), between 180 and 500 m. Oman: Wadi Darbat, between Mirbat and Sadh, Dhofar, Jabal Qamar, Jabal Al Qara, and Jabal Samhan, between 4 and 1500 m.

Phenology:

Spring, late April to May is generally the peak of the flowering season, however, sporadic flowering can be seen throughout the year.

Uses:

A. dhufarensis is one of the most important and useful medicinal plants in Both Yemen and Oman. It is used for a variety of different medicinal conditions from eye, skin, and digestive ailments [30-32]. The juice extracted from the fleshy leaves was and continues to be a significant element of traditional medicine practiced by the Jibali communities of southern Oman [33]. Also, it is used to wound healing and as a purgative [34]. Dried juice of A. dhufarensis is used in Dhofar as a yellow-orange dye for the decoration of pottery and as a cosmetic dye used to colour the neck, arms, and legs. (https://planetdesert.com/products/aloe-dhufarensis#)

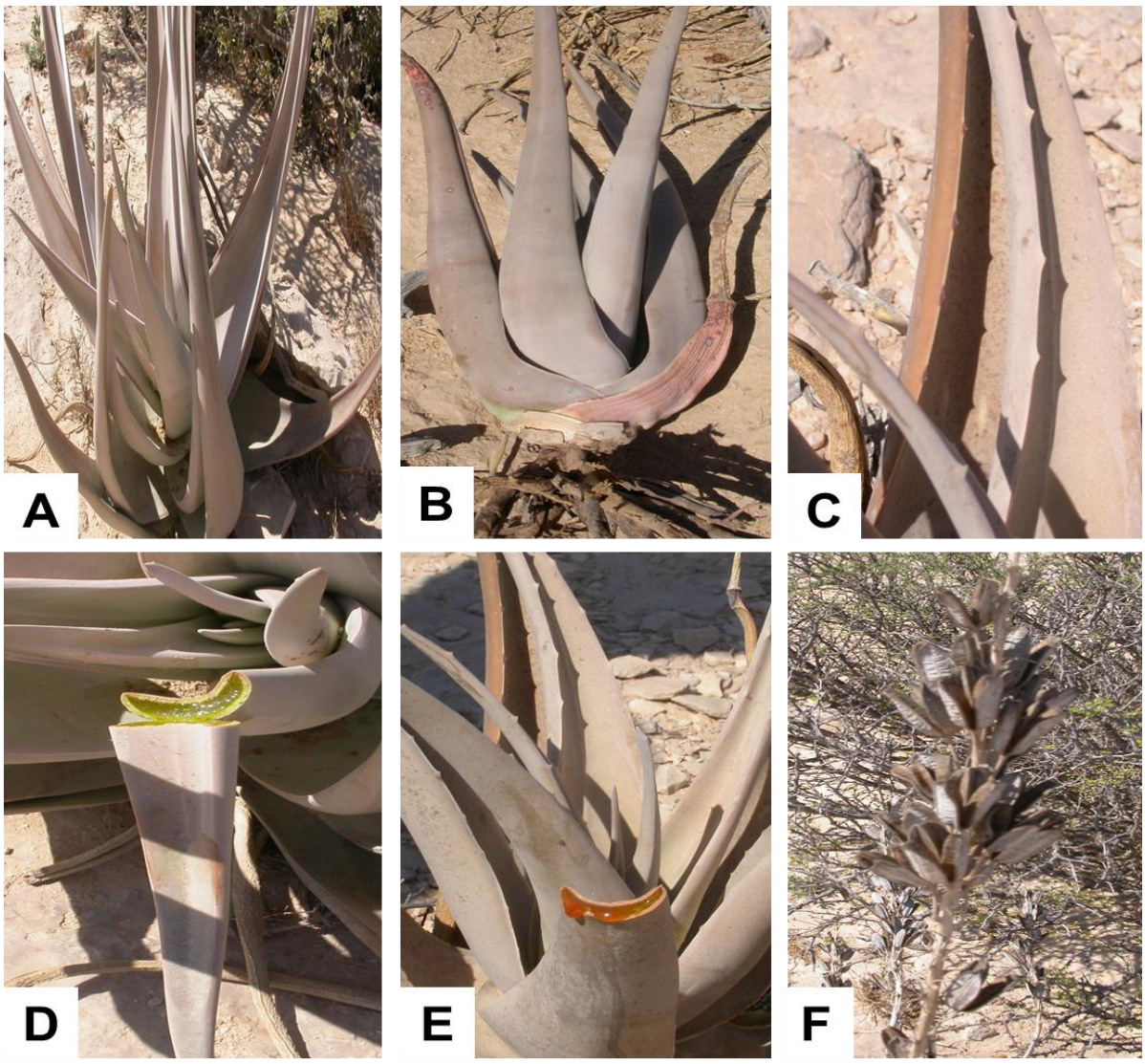

Plate 2: *Aloe dhufarensis* collected from Al-Mahra, Yemen on 14 October 2010 by Dr. Abdul Wali Al-Khulaidi. **A**. Plant leaves arrangement; **B.** Decumbent offset, showing roots from some nodes and the plant base (rosulate); **C.** Tiny teeth on the leaf's margins; **D.** Leaves freshly cut showing colour of sap when fresh; **E.** Sap, showing colour after 10–15 minutes; **F.** Whole inflorescence, flowers arranged from top to bottom of the branch including peduncle after maturation. (Photos by Dr. Abdul Wali Al-Khulaidi).

Threats:

The main threats to the species are the expansion of cultivated fields, collection for medicinal and cosmetic purposes, livestock farming, effects of logging, and wood harvesting.

Results

Plant Description:

Succulent perennial stemless plant, up to 1.5 m high, usually unbranched. Leaves**:** 10-20 in number, forming a dense rosette, ascending or erect, up to 45cm long, flat above, convex and smooth beneath, with some spines on the margins, very pale, to nearly white**,** covered in a heavy waxy coating; marginal teeth are absent except in some young plants. Inflorescence cylindrical-acuminate, slightly branched, lax raceme up to 1.5 m tall. Flowers coral red to yellow, up to 30 mm long, 9 mm diameter; tepals free; stamens 6, together with the scar protruding up to 8 mm from the flower; pedicel 12-15 mm long.

Plant Classification according to a catalogue of life website (https://www.catalogueoflife.org/data/taxon/C3KN):

Name: Aloe dhufarensis Lavranos

Published in: Lavranos. In: Cact. Succ. J. (Los Angeles) 39: 167. (1967).

Classification:

Kingdom: Plantae

Phylum: Tracheophyta

Class: Liliopsida

Order: Asparagales

Family: Asphodelaceae

Genus: *Aloe* L.

Species: *Aloe dhufarensis* Lavranos

Common names:

Dhofar Aloe or Dhofari Aloe

Plant assessment

To assess this plant according to IUCN categories. According to the following map (Fig. 2); the blue line that joins the points represents the Extent Of Occurrence (EOO), The value reported for EOO is the area within the blue line and is measured in km^2 using ArcMap, this estimated to be about 22500km^2.

B1- EOO rating

The area value for EOO calculated above is compared with the thresholds set in Criterion B1. The threshold value is NEAR THREATENED (NT).

B2-AOO Area

The red circles represent 10 geographical zones, the red squares represent Area Of Occupancy (AOO). AOO Number of squares that contain at least one point were 13. The red occupied cells showed in a square grid (Fig. 1) and is each one 4 km^2. (2 ×2 km.)

AOO = number of occupied cells × area of individual cell = 13 × 4 = 52 km^2, so the threshold value according to in the Criterion B2 is Critical ENDANGERED (EN).

AOO density is calculated as the number of 1- AOO subpopulations divided by the number of AOO cells, in this case, the AOO density is: 1- 10/13 = 0.231 (less than one), which is sparsely occupied [23].

(b) The main threat can be the collection of the plant for its sap, which is used for a variety of different medicinal and cosmetic conditions.

The Blue solid line is the Extent Of Occurrence (EOO). The red rectangles represent the Area Of Occupancy (AOO). The red circles represent the subpopulations (Ecological Zones). The red arrow shows the survey area, Hat district, South Sanau of Al-Mahara Governorate.

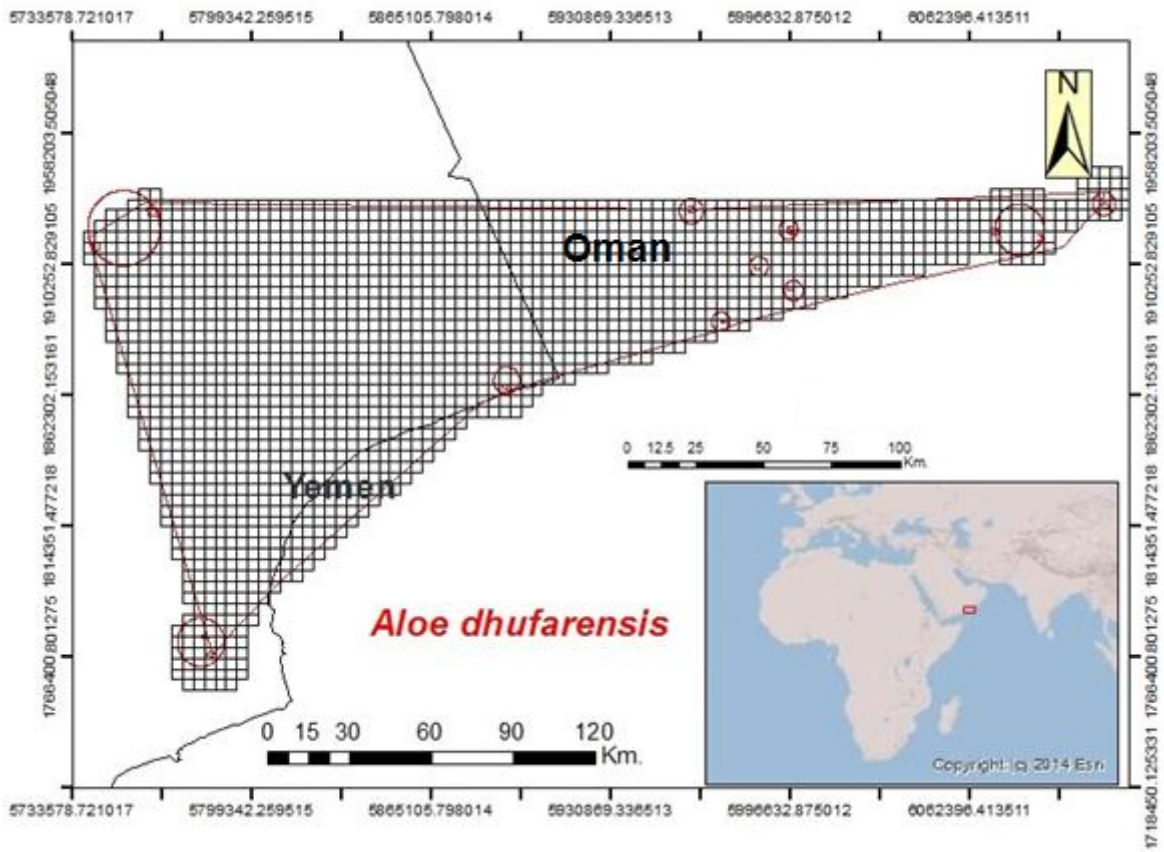

Figure 1. A grid map, each with 4 km^2. (2 × 2 km grid cell).

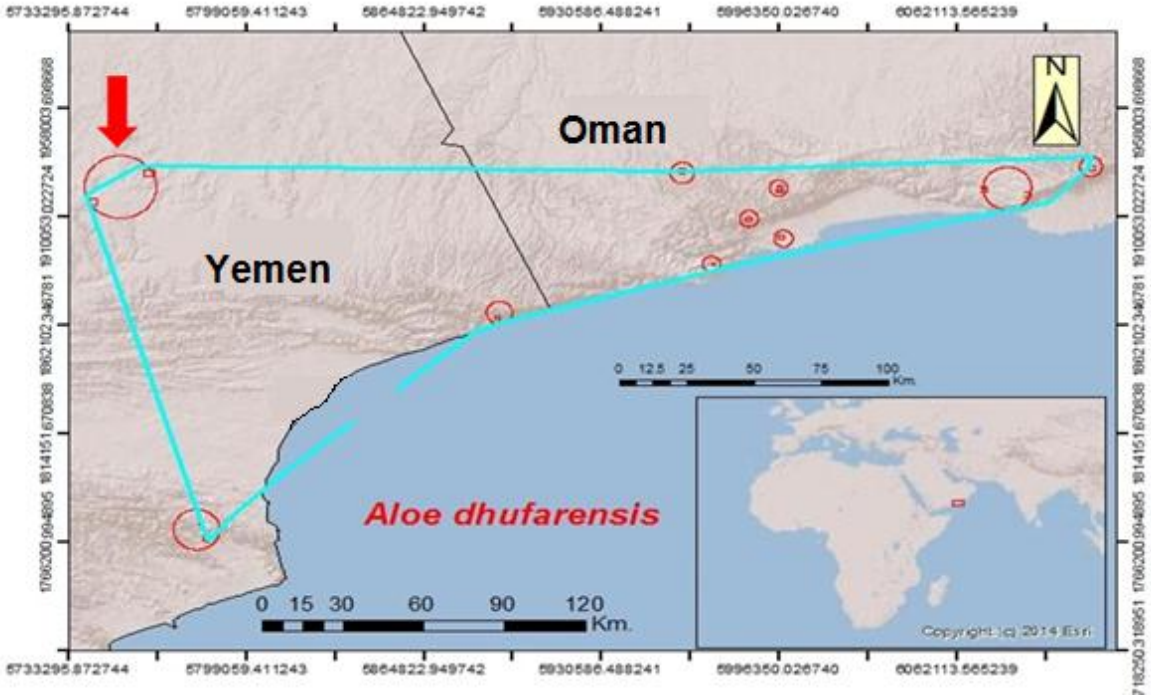

Figure 2. Conservation Assessment of *Aloe dhufarensis* in Arabian Peninsula.

Discussion and Conclusion:

The assessment results presented here are obtained from AOO and EOO values, except for a few recently described taxa where a conservation status has already been determined by their authors. These results are based largely on fieldwork in the Al-Mahara region an assessment of herbarium collections that provide coordinates and population-level data, which is an important parameter for assessing conservation status. For this reason, these results may change during the full conservation assessment that will be conducted.

Such a comprehensive assessment will require extensive research concerning the populations and threats of each *Aloe* before assigning a final status. At that stage, software (ArcMap Version: 10.8) will be used for predictive mapping to assist in the search for additional unknown populations and in producing conservation plans for a species. Nonetheless, the preliminary assessment already provides a realistic view of the conservation status of *A. dhufarensis* in Yemen and Oman. Besides, it highlights the need to urgently update the full conservation status assessments for other Arabian Peninsula Aloes, which will contribute towards reaching Target 2 of the GSPC [35]. This is especially important since *A. dhufarensis* is evaluated for the first time

The information presented here further enables prioritizing actions in conservation projects concerning other species of Aloes. At present several Aloes sites in the Arabian Peninsula are subject to destruction because of human activities such as establishing houses, parks, roads, and clearing of land for agricultural purposes. Most of the Arabian Peninsula Aloes are in the category of Data Deficient (DD). These species deserve special attention as it is suspected that a large majority of the DD Aloes could be threatened.

Oman Botanic Garden has collected and banked a near-endemic *A. dhufarensis*, the plant is restricted in its distribution to the drier areas in Dhofar, southern Oman. Such as the high plateau of Jabal Qamar. To the east, it also occurs at low altitudes in gravelly wadis and slopes. It is considered locally as Vulnerable (VU B1b (ii, iii)) because it is under threat from development and road construction [36].

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مقالة بحثية

تقييم أولي لحالة الصبر الظفاري ALOE DHUFARENSIS LAVRANOS في شبه الجزيرة العربية (ASPHODELACEAE JUSS.)

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استلم في: 20 ديسمبر 2020/ قبل في: 21 يناير 2021 / نشر في: 31 مارس 2021

المُلخّص

تقييم الأنواع النباتية على وجه الخصوص النادرة والمتوطنة أمر ضروري للمتابعة والتخطيط لحفظها. اهدف من هذه الدراسة إلى دعم أنشطة الحفظ من خلال ابراز وتحديد حالة أحد النباتات المتوطنة في شبه الجزيرة العربية وهو الصبار الظفاري *Aloe dhufarensis* Lavranos. تكاد المعلومات عن حالة ونطاق انتشار هذا النبات في شبه الجزيرة العربية غائبة. لتقييم النبات وفقا لمعايير منظمة صون الطبيعة (IUCN) تم إنشاء وقياس مدى تواجد النبات (EOO) والمنطقة الجغرافية الذي يشغلها وذلك (AOO) باستخدام برنامج ArcMap 10.8. تم وصف وتوضيح شكل النبات؛ تم رسم خريطة توضح توزيع النبات. تقيم حالة النبات تم الإبلاغ عن حالة هذا النوع النباتي وفقًا لمعايير القائمة الحمراء للاتحاد الدولي لصون الطبيعة.

الكلمات الرئيسية: نبات الصبر الظفاري، شبه الجزيرة العربية، الحفظ، التقييم، منظمة صون الطبيعة.

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