Assessment of the Conservation Status of the Rare Woody Plant Species of Karak, Northwestern Pakistan

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Abstract

This study seeks to evaluate the conservation status of 14 rare woody plant species in the Karak region. Population estimations for 14 chosen species are carried out based on data available in the last 3 generations using IUCN red list categories and criteria.. Furthermore, surveys (2022-2024) are conducted in surrounding areas with respondents aged 60 years and above to gain a deeper understanding of the local community's view on the population trends of these species. Extent of Occurrence (EOO) and Area of Occupancy (AOO) are caculated for the top threatened species. Results of the investigation shows that the Salvadora oleoides is Critically Endangered (CR) in the study region, under the criteria "A2abcd; A3bc, B1B2bc (i, ii, iii)' D1", Tamarix aphylla CR "A2acd; A3bc, B1B2bc (i, ii, iii)", Calligonum polygonoides CR "A2abcd; A3bc, B1bc (i, ii, iii)" D1", Capparis decidua EN "A2acd; A3bc, B1B2bc (i, ii, iii)", Acacia modesta Endangered (EN) "A2abcd; A3bc, B1B2bc (i, ii, iii)", Albizia lebbeck EN"A2abd; A3bc, B1B2bc (i, ii, iii)", Vitex negundo EN "A2abd; A3bc, B1B2bc (i, ii, iii)", Gymnosporia royleana EN "A2abd; A3bc, B1B2bc (i, ii, iii)", Periploca aphylla EN "A2abd; A3bc, B1B2bc (ii, iii)", Alhagi maurorum EN "A2abd; B1B2bc (i, ii, iii)", Olea ferruginea Vulnerable (VU) "A2abcd; A3bc", Ziziphus mauritiana VU "A2abcd; A3bc", Rhazya stricta VU "A2abcd; A3bc", and Monotheca buxifolia VU "A2acd; A3bc". The proposed study clearly emphasize the necessity of conservation endeavors to prevent further losses in woody plant populations in the Karak area. Conservation strategies are needed to focus on habitat restoration, sustainable land management, and community involvement.

Keywords: Woody Plants; Conservation; IUCN; Critically Endangered; Endangered; Vulnerable; Karak Region.

Introduction

The evaluation of plant conservation status involves the assessment of conservation measures efficiency, past and future

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conservation status, and the identification of species that require conservation and management. Some different approaches and tools can be applied to the evaluation process. The Green Status of Species delineates a method for assessing species' recovery. The impact of conservation tools on plant species recovery is monitored and evaluated, which helps shape conservation strategies regarding their effectiveness. The loss of biodiversity is mainly due to overexploitation, habitat loss and restricted range of distribution (Sing et al., 2024; Gonçalves et al., 2024). However, the escalation in the rate of biodiversity diminishing even in the aftermath of international conservation interventions continues (Pollock et al., 2020). The human interference with the ecosystems endangers the diversity of plants about which research study finds a considerable conservation problem (Mi et al., 2021). The current statistics explicitly highlight this fact, which states that almost 39% of plants might soon become extinct (Willis, 2017; Wiens et al., 2024). Agriculture, resource extraction, ecological system modifications, and urban development are identified as the fundamental causes of global plant extinction (Nic Lughadha et al., 2020). No definitive link exists between species decline or extinction risk and specific less conspicuous threats, such as climate change and invasive species (Gregory et al., 2024; Newsomes et al., 2024; Anderson et al., 2024). There is a lack of linkage between these factors and ecological processes and unreliable methods for assessing extinction risks (Kumschick et al., 2015; Naujokaitis-Lewis, Endicott, & Guezen, 2021). A small fraction of extinction risk assessments incorporate quantitative evaluations of climate change despite mounting evidence that it influences species survival (Cowie et al., 2022; Wiens et al., 2024).

Karak is an area used to safeguard plant diversity because of its geographical position. Despite its size, this locality is renowned for its assortment of plants, comprising just 0.002% of the Earth's surface but hosting around 0.07% of global plant species. This area is a hub for various plant species (Rehman et al., 2023). Throughout history, various important civilizations have emerged in the Karak region, causing environmental alterations due to activities over almost four thousand years. This has impacted plants' abundance, distribution, and dynamics and even contributed to extinctions (Jones, Bourn, Maclean, & Wilson, 2023; Zenni et al., 2024). This area is highly susceptible to the impacts of climate change (Mahmood et al., 2023; Noor & Shafi, 2023). With its intricacy, the Karak remains a focal point for preserving plant diversity (Majeed et al., 2024).

The main goal of conservation work is to save species from extinction and slow down the decline of their populations. To decide which species and areas need attention for conservation efforts, it is crucial

to evaluate how likely a species go extinct and match that with the resources available for conservation (Mesaglio et al., 2023; Zhang et al., 2023; Terpstra et al., 2024). The IUCN Red List of Endangered Species (IRLE) is a common reference for informing the probability for species escalating to the extinction. We receive a lot of appreciation going by the criteria that enables it to access the conservation status and the problems encountered by species, and both at global and local scale (Fenu et al., 2023; Vitt et al., 2023; Fa & Luiselli, 2024). IUCN Red List's criteria is widely applied to classify species' conservation status as well as hazards to extinction (Palacio et al., 2023; Van Huynh, 2023; Chen et al., 2024). Despite the fact that this act is involved in the initiation of conservation courses and assisting in the definition of shifts in the status of species conservation, the main purpose of this act is to categorize the species according to their levels of risk rather than directly suggesting conservation priorities (Ridley et al., 2024; Bachman et al., 2024). Conservation may rely on sources of information that can prompt management techniques with the same aim, including species action plans and other policies aimed at those areas that need protection (New et al., 2024; Almarri et al., 2024).

This study was conducted to evaluate the conservation status of the rare woody plants in the study region, and adopt conservation measures in the study region to prevent plants from extinction.

Martial and methods

Study Area

The research area is located at 32˚.47′ - 33˚ 28′ north latitude and 70˚. 30' to 71˚. 30' east longitudes. It is bounded on the north by Tehsil Banda Daud Shah, on the southeast and southwest by Tehsil Takhte Nasrati and Bannu (Fig.1). According to Javed et al. (2019), the climatic conditions of the study area are very harsh as hot in summer and very cold in winter. Highest recorded temperature range in June is 38˚C to 44˚C, while the lowest recorded temperature range in January is 5˚C to 10˚C. The winter rains durations are of weeks whilst the summer rains are characterized by thunderstorms creating flashfloods in the streams. The soil is generally clay, sandy or stony with rare fertile loamy soil (Khan et al., 2013). Some ecological problems of the area are deforestation, over grazing, soil erosion, wind erosion, soil salinity and shortage of water. The present research study is carried out using the following specific methodology.

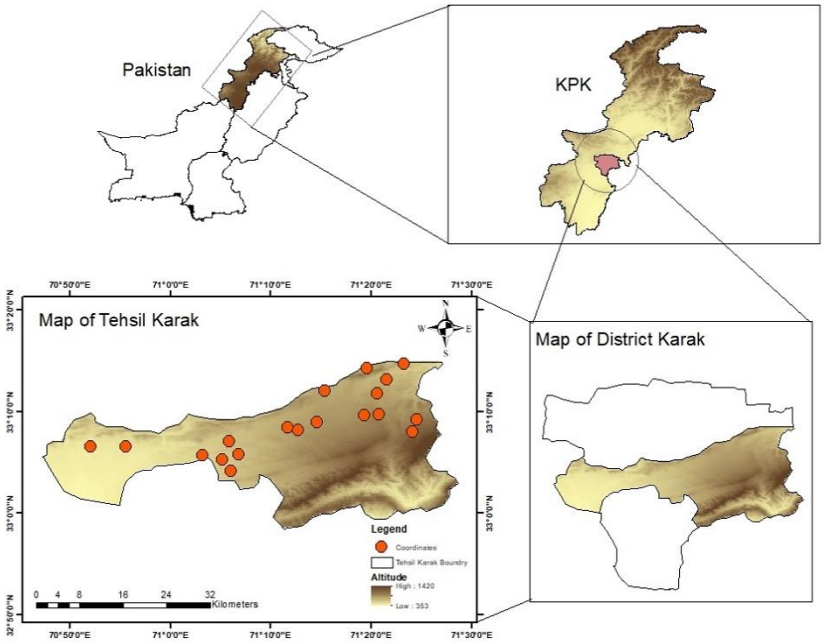

Figure 1: Study area map.

Field Survey

We conducted field surveys (2022-2024) to gather information on the specific plant species' location and how plentiful they are. We made sure to note down GPS coordinates during these surveys to plot the spatial distribution of each species accurately.

Data Collection

Two hundred questionnaire are filled from the local inhabitants having the age beyond 60 years, and the plants population decline is noted according to the respondent's views. The current situation of the concern plants population is also observed.

Calculation of Extent of Occurrence and Area of Occupancy

We used ArcView 9.2 (Google Earth, 2018), geographical coordinates are plotted on Google Earth to obtain a geo-referenced map. A polygon is drawn by connecting lines around all known locations of the taxon, excluding those within the polygon boundary, to show the extent of occurrence (EOO) of the endemic taxon. For determining the presence of endemics, a grid size of 2 km × 2 km (with each cell covering an area of 4

km²) is used. Similarly, the area of occupancy (AOO) is calculated by placing a uniform grid over the entire habitat range of the taxon and counting the number of occupied grid cells, in accordance with IUCN guidelines (2010).

Classification of Species into Threatened Categories

For the classification of various plant species into threatened categories, we followed the guidelines established by the International Union for Conservation of Nature (IUCN) for evaluating the conservation status of species. After evaluating these factors, we classified the species under investigation into threatened categories (Critically Endangered, Endangered and Vulnerable). Our comprehensive method enhanced how we analyzed and understood the collected data. The results of this research add to what we know about the variety of plant life in Karak and offer perspectives for conservation efforts and planning in the area. This study helps make decisions for preserving biodiversity and promoting development in places like Tahsil Karak by examining how native plant species are distributed and their conservation status.

Results

Population estimation

We estimated the population reduction of 14 rare woody plants in the study region. The population estimation of these rare woody plants revealed that different plant species have different population reductions over the past 10 years or 3 generations. More than 75 % of respondents of 60 years of age said that over the last three generations, the population of the given species has considerably declined in the area, i.e., *Salvadora oleoides* population size declined by more than (>93 %), *Tamarix aphylla* (>90 %), *Capparis decidua* (>50 %), *Acacia modesta* (>60 %), *Olea ferruginea* (>45 %), *Albizia lebbeck* (>50 %), *Ziziphus mauritiana* (>43 %), *Calligonum polygonoides* (>90 %), *Vitex negundo* (>60 %), *Rhazya stricta* (>35 %), *Gymnosporia royleana* (>58 %), *Monotheca buxifolia* (>40 %), *Periploca aphylla* (> 60 %), and *Alhagi maurorum* (> 70 %) (Table 1). Besides other detrimental factors, the annual use of these woody species for fuel is greater than its total germination. Therefore, its habitat has receded over the years. This decline satisfies the IUCN Red List Category and criteria (IUCN, 2010).

Geographic range

Among 14 rare woody plants, 10 species are assessed for their geographic range. The EOO and AOO of *Salvadora oleoides* is 80 km^2

and 2 km^2, *Tamarix aphylla* 93 km^2 and 4 km^2, *Calligonum polygonoides* 75 km2 and 12 km2, *Capparis decidua* 970 km2 and 170 km2, *Acacia modesta* 1098 km^2 and 212 km^2, *Albizia lebbeck* 660 km^2 and 185 km^2, *Vitex negundo* 805 km^2 and 45 km^2, *Gymnosporia royleana* 850 km^2, 45 km^2, *Periploca aphylla* 915 km^2 and 48 km^2, *Alhagi maurorum* 724 km^2 and 75 km^2 (Table 1).

Table 1: Population estimation and geographic range of rare woody plants in the study region.

S.No.	Plant species	Population reduction	EOO Km2	AOO Km2	Threatened Criteria	Threatened category
1	*Salvadora oleoides*	>93 %	80	2	"A2abcd; A3bc, B1B2bc (i, ii, iii)' D1"	CR
2	*Tamarix aphylla*	>90 %	93	4	"A2acd; A3bc, B1B2bc (i, ii, iii)"	CR
3	*Capparis decidua*	>55 %	970	170	"A2acd; A3bc, B1B2bc (i, ii, iii)"	EN
4	*Acacia modesta*	>60 %	1098	212	"A2abcd; A3bc, B1B2bc (i, ii, iii)"	EN
5	*Olea ferruginea*	>45 %	-	-	"VU A2abcd; A3bc"	VU
6	*Albizia lebbeck*	>50 %	660	185	"A2abd; A3bc, B1B2bc (i, ii, iii)"	EN
7	*Ziziphus mauritiana*	>43 %	-	-	"A2abcd; A3bc"	VU
8	*Calligonum polygonoides*	>90 %	75	-	"A2abcd; A3bc, B1bc (i, ii, iii)" D1"	CR
9	Vitex negundo	>60 %	805	30	"A2abd; A3bc, B1B2bc (i, ii, iii)"	EN
10	*Rhazya stricta*	>35 %	-	-	"A2abcd; A3bc"	VU
11	*Gymnosporia royleana*	>58 %	850	45	"A2abd; A3bc, B1B2bc (i, ii, iii)"	EN
12	*Monotheca buxifolia*	>40 %	-	-	"A2acd; A3bc"	VU
13	*Periploca aphylla*	> 60 %	915	48	"A2abd; A3bc, B1B2bc (ii, iii)"	EN
14	*Alhagi maurorum*	> 70 %	724	75	"A2abd; B1B2bc (i, ii, iii)"	EN

Very small or restricted population

Two species *Salvadora oleoides*, and *Calligonum polygonoides* are identified as having very small or restricted population. The matured individuals of *Salvadora oleoides* are 25(<50) and that of *Calligonum polygonoides* are 32 (<50) in the study region (Table 1).

Status summation

The total hierarchical alphanumeric numbering system of the criteria and sub-criteria, combined with population estimation and geographic range, revealed the conservation status of the 14 rare woody plants in the area, summarized as follows. *Salvadora oleoides* "A2abcd; A3bc, B1B2bc (i, ii, iii)' D1", *Tamarix aphylla* "A2acd; A3bc, B1B2bc (i, ii, iii)", *Calligonum polygonoides* "A2abcd; A3bc, B1bc (i, ii, iii)" D1", *Capparis decidua* "A2acd; A3bc, B1B2bc (i, ii, iii)", *Acacia modesta* "A2abcd; A3bc, B1B2bc (i, ii, iii)", *Albizia lebbeck* "A2abd; A3bc, B1B2bc (i, ii, iii)", *Vitex negundo* "A2abd; A3bc, B1B2bc (i, ii, iii)", *Gymnosporia royleana* "A2abd; A3bc, B1B2bc (i, ii, iii)", *Periploca aphylla* "A2abd; A3bc, B1B2bc (ii, iii)", *Alhagi maurorum* "A2abd;

B1B2bc (i, ii, iii)", Olea ferruginea "VU A2abcd; A3bc", *Ziziphus mauritiana* "A2abcd; A3bc", *Rhazya stricta* "A2abcd; A3bc", and *Monotheca buxifolia* "A2acd; A3bc" (Table 1).

Status Declaration

In the given 14 rare woody plants 3 (21.42 %) are declared as Critically Endangered, i.e., *Salvadora oleoides*, *Tamarix aphylla*, *Calligonum polygonoides*, 7 (50 %) are declared as Endangered i.e., *Capparis decidua, Acacia modesta, Albizia lebbeck,* Vitex negundo, *Gymnosporia royleana, Periploca aphylla,* and *Alhagi maurorum,* and 4 (28.57 %) are declared as Vulnerable i.e., *Olea ferruginea, Ziziphus mauritiana, Rhazya stricta, Monotheca buxifolia* (Table 1).

Discussion

Rare woody plants play a crucial role in ecosystems by supporting biodiversity and contributing to stability. This study examines the conservation status, challenges, and strategies for preserving rare woody plants in Karak.i.e., (*Salvadora oleoides, Tamarix aphylla*, *Capparis decidua*, *Acacia modesta*, *Olea ferruginea*, *Albizia lebbeck*, *Ziziphus mauritiana*, *Calligonum polygonoides*, *Vitex negundo*, *Rhazya stricta*, *Gymnosporia royleana*, *Monotheca buxifolia*, *Periploca aphylla,* and *Alhagi maurorum*. These plants population is rapidly declining in the study region due to over exploitation for multiple purposes like trade on local basis, as fuels, medicinal, and habitat loss. In the given study are top rarest woody plants are assessed for their conservation status. The results reflected that among these 14 top rare plants 3 plants are critically endangered, 7 are endangered and 4 are vulnerable. Our results are supported by previous studies in which conservation status is assessed for the *Salvadora oleoides* and *Tamarix aphylla* which support our findings (Alhourani, Kasabri, Bustanji, Abbassi, & Hudaib, 2018). Other researchers found that, habitat loss in terms of agricultural expansion is a significant threat to the plants of a specific area, which gradually contribute to the extinction of the given species (Amenu, 2016; Miara, Teixidor-Toneu, Sahnoun, Bendif, & Hammou, 2019; Olalekan, Omidiji, Williams, Christianah, & Modupe, 2019). The studies of (Kramer & Havens, 2009) showed the necessity for conservation initiatives to prevent additional reductions and maintain genetic variety. Field firsthand observations have proven essential in evaluating the population's status and gaining insights into their habitat preferences. Another study assessed the conservation priorities for species such as *Capparis decidua, Acacia modesta, Olea ferruginea, Albizia lebbeck*, and *Ziziphus mauritiana*. The findings emphasize the importance of continuous field monitoring to

understand the changing dynamics of these populations and to identify threats to endangered woody plants. (Rahman, 2011; Leakey et al., 2022) The study of (Tabassum, Rahman, & Haq, 2014) highlights the significance of integrating, on-site research into conservation plans to guide decision making. Various research projects offer targeted conservation suggestions customized to address the obstacles encountered by the threatened plant species (Khan et al., 2021; Tabassum et al., 2014). Our results also support by the studies of (Belsare, 2007; Narwade et al., 2021; Rajeswara Rao, 2016; Sarlak, 2020) on *Calligonum polygonoides*, *Vitex negundo*, *Rhazya stricta*, *Gymnosporia royleana*, *Monotheca buxifolia*, *Periploca aphylla*, and *Alhagi maurorum* emphasized the importance of conservation efforts outside habitats because of habitat destruction and the absence of conservation strategies, on privately owned properties. According to (Biharee et al., 2024), *Vitex negundo* and *Rhazya stricta* populations are decreeing rapidly, so conservation measures of these species are necessary. Variations in population estimates across studies highlight the difficulties in determining conservation status. This underscores the significance of using methodologies and thorough surveys to gather data for conservation strategies (Biharee et al., 2024).

Although efforts to protect native plants on privately owned properties, research on the rare woody plant species of Karak has led to several recommendations for improving or establishing conservation measures to protect vital habitats. Ecological impact evaluations are considered crucial for mitigating these effects. Conservation efforts are more likely to succeed when the community is involved. Local people often possess valuable knowledge about rare woody vegetation and its environmental significance. Engaging these communities in preservation initiatives fosters a sense of responsibility, contributing to the establishment of sustainable methods that support both biodiversity conservation and residents' well-being. While these studies provide valuable insights, some gaps remain. Future research must investigate the causes of habitat loss and fragmentation and evaluate the resilience of rare woody plant populations to various challenges. Additionally, conducting surveys across different geographical regions is essential for more accurately assessing population conditions and changes.

To sum up, the conservation of rare woody plants need a multifaceted strategy combining research, policy formulation, community involvement and awareness raising initiatives. By combining insights from research projects and catering to different species' conservation requirements, we can strive towards protecting these important plant species and maintaining biodiversity for the benefit of future generations. By uniting our efforts and implementing conservation plans, we can secure

the enduring existence of woody plants amidst the persisting environmental challenges.

Conclusion

From the current study it is concluded that Karak region has a semi-arid type of habitat having rare woody species. The given species faces multiple threats and their population is continuously declining. The conservation status of 14 rare plants species is assessed and it is found that these species belongs to threatened categories. These plants species must be conserved and special conservation actions are needed to conserve it in its natural habitat. This study provides a base line for the further species conservation studies. Further, research is needed to address the challenges faced by the local flora.

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