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| RESEARCH ARTICLE

Current Status of Marco Polo Sheep (*Ovis ammon polii*) in the Pamir Mountains of Badakhshan Province, Afghanistan

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| ABSTRACT
The present survey was conducted to determine the abundance and population density of Marco Polo sheep in the Pamir Mountains of Badakhshan Province, Afghanistan. Marco Polo sheep inhabitants in very high mountain regions experience extremely cold winds and arid climatic conditions throughout the year. The Marco Polo sheep is listed as a critically endangered species on the IUCN Red List. Field surveys and interviews were carried out from 2022 to 2023 by using semi-structured questionnaires. 98 respondents were interviewed, and line transect walks in the field were used to observe the Marco Polo Sheep in the study region. As a result, a total of 1304 Marco Polo Sheep individual were recorded in the Pamir regions. The highest number of Marco Polo Sheep observations is related to the Tollaboy region, with 452 individuals (34.6%), and the lowest number of observations is in the Angelic region, 93(7.1%). According to the study area's locality, the population density of the Marco Polo Sheep differs in each season of the year. In conclusion, the highest density was in the Tollaboy region with 125.5± 3.5 per km^2, and the lowest density was in the Angelic region10.7±1.6 per km^2 ware observed.

| KEYWORDS

Badakhshan, Pamir, Marco Polo Sheep, abundance, and population density.

| ARTICLE INFORMATION

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1. Introduction

The Marco polo sheep, also known [*Ovis ammon polii* (Blyth 1841)], is a subspecies of argali sheep that belongs to the Bovidae family. Marco Polo sheep is considered a near-threatened species on the IUCN Red List and distributed in the Pamir Mountains of Afghanistan, Tajikistan, Kyrgyzstan, Pakistan, and China(Ariel et al. 2017; Schaller and Kang 2008; Valdez et al. 2016). The historic range of these species (O. a. polii) includes several countries in Asia. Marco Polo sheep inhabit the highlands and broad alpine valleys of the Pamir Mountains, which are located at elevations of up to 5000 meters. The Pamirs are a high plateau known for their rugged terrain and are the primary habitat for this species(Zhuo et al. 2024). Overall Marco Polo sheep population has decreased significantly due to uncontrolled hunting(Habib 2014; Khan, Ablimit, Khan, Jasra, et al. 2016; Salas et al. 2018; Schaller and Kang 2008).

In Afghanistan, territory found only one subspecies of argali. It is known for its long, outward curving horns in males. Marco Polo sheep are taller and larger than most other domestic and wild sheep. But these species are not as large as the Tibetan argali. Adult rams can reach a height of around 1.2 meters at the shoulder and weigh up to 113.5 kg to 140 kg.(Habib 2014; Schaller 1975). Adult females of O. a. polii have horns that can reach up to 13 cm in length, with slight annulations or wrinkles close to the base. The color of Marco Polo sheep varies throughout the year. During the summer, it is sandy-reddish with gray and white hairs on the breast and face, and during the winter appears heavier and somewhat gray, with more around the neck and chest(Habib 2014; Salas et al. 2018; Zhuo et al. 2024).

Badakhshan province of Afghanistan has a cold climate with extremely cold winters reaching temperatures as low as -40°C. The winter season is characterized by heavy snowfall and precipitation ranging from 81 to 255 millimeters. Summer in Badakhshan regions is warm, with temperatures ranging from 28 to 37, 5 °C, and experiences dry conditions with precipitation ranging from 24 to 100 millimeters. Despite the existence of good vegetation in the region, various pressures such as farming, animal grazing, deforestation, and the uprooting of shrubs for fuel caused the reduction of much of the original natural vegetation in the area (Smallwood et al., 2011 Majidi and Mansoor 2023). Marco Polo Sheep is one of the wild mammals that adapted to cold climates Pamir Mountains. Without touristic importance, this species has a significant role in the deaths of several endangered carnivores such as the wolf, Canis lupus (Linnaeus, 1758), and snow leopard, panther uncia etc. (Majidi et al. 2022). Decades of conflict and power struggles in this country resulted in the degradation of land and the decline of wildlife populations. Hunting, wildlife trade, dryland forming, overgrazing, and deforestation are major factors contributing to the decline in wildlife populations and overall biodiversity in Afghanistan(Mishra and Fitzherbert 2004b, 2004a).

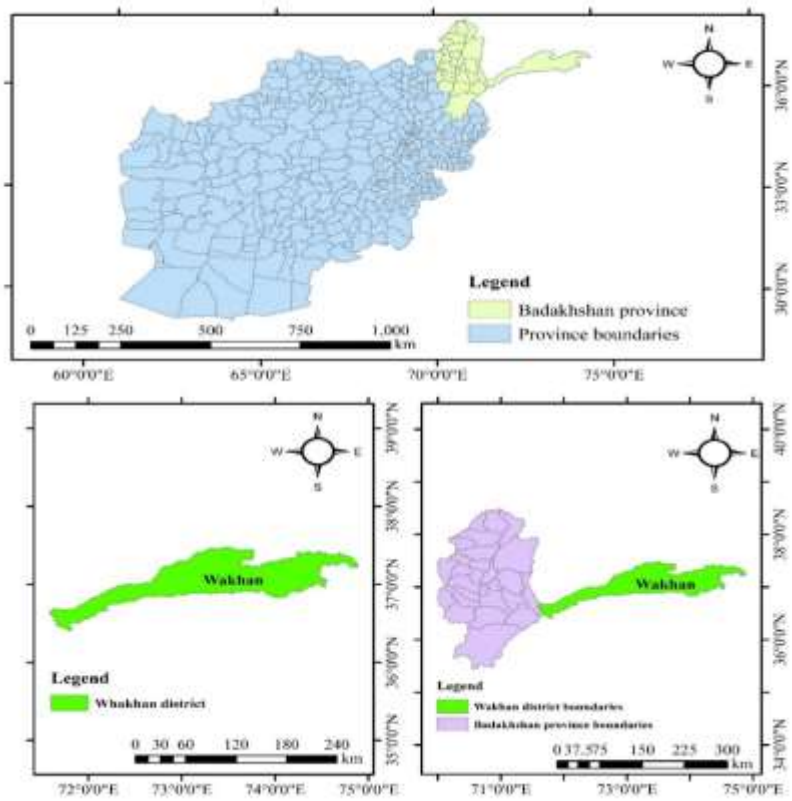
The Pamir Mountains, located in central Asia, provide a significant habitat for wildlife. Pamir Mountains of Afghanistan are renowned for their unique fauna and flora and are also known as the "Roof of the World" This region is characterized by its high-altitude landscapes and extreme climatic situations(Ariel et al. 2017; Habib 2014; Salas et al. 2018, Majidi 2022). The Pamir region of Afghanistan faces different environmental challenges, such as climate change, habitat loss, overgrazing, and uprooting of shrubs. Conservation efforts are important for protecting the unique biodiversity of the Pamir region ensuring its sustainability for future generations. This survey aims to document Marco Polo sheep abundance and population density in the Pamir Mountains of Badakhshan Province, Afghanistan.

2. Material and methods

2.1 Study area

The current survey was conducted in Wakhan district (Big and Small Pamirs) located in the Badakhshan Province (BP) in northeastern Afghanistan. Wakhan district is one of 28 districts of BP, and it covers an area of 11258 km2 (figure 1). Its geographical coordinates are 36° 23' 58" to 37° 28' 30" N and 71° 35' to 74° 53' 22" E. This region is home to different wildlife, including iconic species like Marco Polo Sheep. This region is bordered by Tajikistan to the north, Pakistan to the east, China to the northeast, and south to the Hindu Kush Mountains. Wakhan River flows along the corridor, providing a water source for the local communities and contributing to the unique ecosystem of the area(Khan et al. 2016; UNEP 2008). The Kyrgyz people residing in the region have a rich and distinct culture that is deeply rooted in their nomadic traditions and heritage (Shaurani 2002).

Figure 1 illustrates the study area in the map of Afghanistan.



The study area is comprised of two regions, Big Pamir and Small Pamir: The Big Pamir is a vast, awe-inspiring mountainous region situated in the east of BP, Afghanistan. The area stretches across the corridor, a narrow strip of land that separates Pakistan from Tajikistan and China. The Big Pamir is a habitat for different wildlife, and extreme conditions like high altitudes have shaped a particular range of fauna and flora that have adapted to survive in this challenging ecosystem. The Small Pamir is also a mountainous area situated in the Wakhan corridor. It is a section of the Big Pamir, which is often denoted as the Roof of the World because of its high altitudes and majestic peaks. This area is characterized by its rocky and remote landscapes featuring towering peaks, deep valleys, alpine meadows, and glaciers. This region is the habitat of different wildlife species that have adapted to the harsh and sparse vegetation. Pamir is famous for its unique wildlife, such as Marco polo sheep, Snow Leopard, Siberian Ibex, Brown Bear, and long-tailed marmot(Habib 2014; Kanderian, Lawson, and Zahler 2011; Saidajan 2012; Smallwood et al. 2011). Pamir regions of Afghanistan face environmental challenges like climate change, overgrazing, habitat loss, and unsustainable resource extraction(UNEP 2017). Conservation efforts are important to protect this extraordinary area, ensuring its sustainability for future generations.

2.2 Methods

Interviews and transect-line methods were used to collect data on the abundance and population density of the Marco Polo Sheep (*Ovis ammon polii)* from June 2022 to September 2023 in Wakhan district (Big and Small Pamirs) of the BP, Afghanistan. 98 informants from both regions (B & S) Pamirs were interviewed. The authors directly interviewed Kyrgyz people living in the Pamirs in their native language, Kyrgyz-Uzbek languages, by using semi-structured questionnaires, and the authors wrote Kyrgyz names for the study areas. According to local people (Kyrgyz), the abundance and population density of the Marco Polo Sheep are not the same in all seasons of the year, and as well as we interviewed provincial wildlife conservation officials in Fayzabad city about the status of Marco Polo Sheep in the Pamir mountains. The transect-line method was applied to collect data on the abundance and Population density of the Marco Polo Sheep Pamir Mountains. A total of 16 transects (each site 2-3 transects) between 3000 to 7495 m were taken during the summer seasons of 2022 to 2023. Each transect line was 400m wide and 3km long, and the length of the transect-line was adjusted according to the land region (Majidi et al., 2022).

3. Results

In the present survey, data was collected from seven regions of Pamir mountain of BP from 2022 to 2023. Marco Polo Sheep (*Ovis ammon polii)* has been distributed all over the Big and Small Pamirs of Afghanistan. This species is characterized by its distinctive long, outward curving horns, particularly in mature males. A total of 1304 individuals of Marco Polo Sheep (*O.a polii)* were observed in the study area (table 1; Figure 2). The abundance and population density of Marco Polo Sheep in each region were recorded separately. The highest number of Marco Polo Sheep observations is related to the Tollaboy region with 452 individuals (34.6% of all observations), and the minimum number of observations is in the Angelic region 93(7.1%), and according to the respondents," population density of Marco Polo Sheep in the Pamir mountains of Afghanistan differs in each season of the year, and respondents show the higher number in the spring and summer seasons and authors respectably recorded according to respondents(Habib 2014).

Table 1. Abundance and population density of Marco Polo Sheep (*Ovis ammon polii*) in the Pamir Mountains of Afghanistan

No	Region	Number of Marco Polo observed	Abundance (%)	Number of Transect	Density (per Km^2) (Mean±SE)
1	Tollaboy	452	34.6	3	125.5± 3.5
2	Condatour	193	14.8	2	80.4± 2.8
3	Elisu	103	7.8	3	10.7±1.6
4	Angelic	93	7.1	2	38.7±1.3
5	Tegirmonsu	253	19.4	2	105.4±3.5
6	Barsu	113	8.6	2	47.08±1.3
7	Wakhchir	97	7.4	2	40.4±1.2
Total	**7**	**1304**	**100%**	**16**	

Abundance and Population density of Marco Polo sheep (*Ovis ammon polii*) was highest in the Tollaboy with 125.5± 3.5 per km^2, followed by Tegirmonsu with 105.4±3.5, Condatour with 80.4± 2.8, Barsu with 47.08±1.3, and Wakhchir with 40.4±1.2 respectively. The lowest density per km^2 was in Angelic and Elisu (38.7±1.3 and 10.7±1.6), respectively. The Population density of Marco Polo sheep was significantly different in all surveyed areas ($p<0.05$). In the current survey, the highest density was observed in the Tollaboy region of Big Pamir, followed by the Tegirmonsu region of Small Pamir of Afghanistan (Majidi et al., 2022).

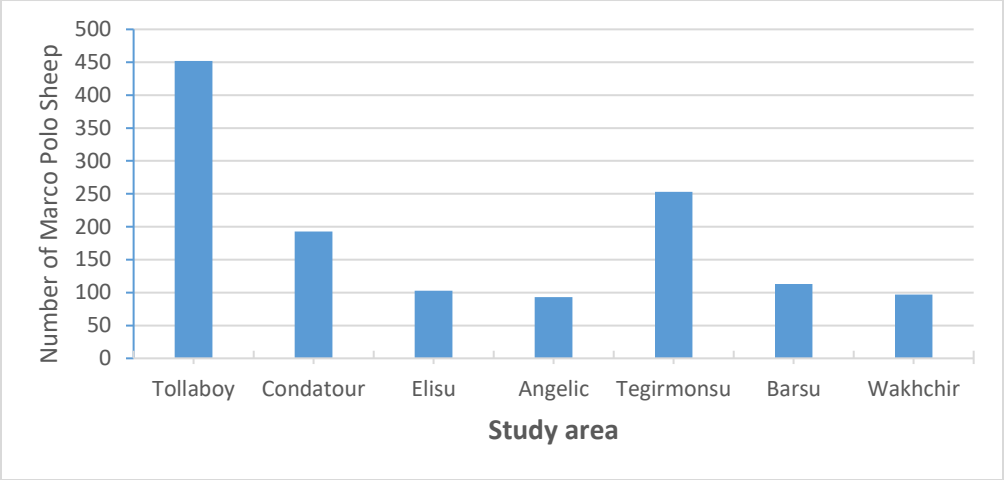


Figure 2: the number of Marco Polo Sheep in each region of the Pamir Mountains of Afghanistan

The Pamir Mountains offer suitable habitats for wildlife due to the high altitude, grasslands, and steep rocky slopes (figure 3); Marco Polo is adapted to these mountains' terrain and is known for its ability to navigate rocky cliffs and steep slopes. The Pamir is characterized by rugged landscapes, deep valleys, and high peaks such as Noshakh, with altitudes ranging from 3000 to 7495 m.

Figure 3 shows Marco Polo sheep in the Pamir Mountains of Badakhshan, Afghanistan.

The species is the only subspecies of sheep that can be found in various habitats of the Pamir Mountains of Afghanistan (figure 4). Pamir Mountain is a suitable habitat for this species, which is adapted to live in high environments (Habib 2014, WCS. A 2022). The vegetation of the area consists of grasslands, alpine meadows, and sparse shrubs, providing food and habitat for this species. These species migrate seasonally, during warm seasons, moving to higher elevations, and during the cold seasons, moving to lower regions of Pamir, and this migration allows them to access different food sources and find suitable habitats throughout the year(Zhuo et al. 2024). During the current survey, we documented four main threats to Marco Polo sheep in the Pamir Mountains:

habitat degradation, climate change, human disturbance, and illegal hunting, which have affected the flora and fauna of the area, figure 5 (WCS. A 2022). According to the local office of wildlife management, their efforts to conserve this iconic species and protect its habitat in this region through conservation initiatives and wildlife management strategies.

Figure 4 shows Marco polo sheep in the grassland habitat of the Pamir Mountains.

Figure 5 shows hunted Marco polo sheep in the study area.

4. Discussion

The present survey was performed to document the abundance and population density of Marco Polo sheep (*Ovis ammon polii*) in the Pamir Mountains of Badakhshan Province, Afghanistan. Our results correspond with Habib. (2014) from Nakchrishitk Valley of Pamir reported 211 Marco polo sheep and as well as he documented some other wild animals during the survey are Brown Bear (*Ursus arctos*), Wolf (*Canis lupus*), red fox (*Vulpes vulpes*), Siberian Ibex (*Capra ibex siberica*) and Himalayan stoat (*Mustela ermine*), etc. another study reported a drastic decrease of Marco polo sheep abundance and population in Khunijerab region of Pakistan over of 20 years skewed sex ratio towards females and th decrease number of migrating animals indicating a critical conservation concern(Khan et al. 2016). Another study in Tajikistan reported that the abundance and population of Marco polo sheep in Pamirs have significantly enhanced due to factors such as minimum number of domestic livestock, Haman population density, the exist of suitable habitats, and Tajikistan has a high population of Marco polo sheep compared to china and other neighboring country(Valdez et al. 2016). Another study in Wakhan reported that eight species of large mammals are generally threatened, such as Marco Polo sheep and snow leopards (Mishra and Fitzherbert 2004b)2015), reported that the population of Marco Polo sheep decreased due to habitat and vegetation conditions. Other research reported the same results(Khan et al. 2016; Saidov and Karimov 2016). Salas et al. (2018) reported that annual temperature powerfully correlated with Marco polo distribution, decrease of suitable habitat at lower altitudes(3300-4300m) averaged habitat increases at much greater altitudes (4500-6900m), and potential elevational shifts in habitat use. Ariel et al. (2017) reported that in a successfully modeled winter and summer habitat, the

suitability of this species in the Pamir Mountains was assessed using statistic algorithms and recognized important predictors for each season.

Afghanistan's biodiversity and natural resources play an important role in the livelihoods of a great portion of the population, with horticulture, agriculture, animal husbandry, and forestry as the main contributors to the economy (Majidi, 2023; Omari et al., 2023). However, the loss of biodiversity and habitat destruction have direct consequences on farming and agriculture, highlighting the important link between sustainable agriculture and biodiversity conservation. Afghanistan faces significant threats to its natural resources, like illegal hunting, desertification trade, deforestation, and lack of law enforcement(Mishra and Fitzherbert 2004b; Mjidi et al. 2024); the natural landscape of Afghanistan has suffered greatly due to decades of discord and power struggles, leading to degradation and suffering of wildlife population(Kanderian, Lawson, and Zahler 2011). The movement of Marco Polo sheep across borders offers an international peace park to protect wildlife and rangelands, and the potential benefits of such parks include the promotion of cooperation and conservation (Schaller 2007).

In general, authors surmised that Marco Polo sheep (*Ovis ammon polii*) were abundant in suitable zones of the Pamir Mountains of Badakhshan province. In addition, the occurrence of human and livestock overgrazing affects Marco polo distribution. In addition, during this study, four main threats to Marco Polo sheep were recorded: habitat degradation, climate change, human disturbance, and illegal hunting. Currently, there are no previous reports on the population density of Marco Polo sheep in the study area. Therefore, these findings are important for the conservation of Marco Polo sheep and future studies on wildlife.

5. Conclusions

The present survey was conducted in the Pamir Mountains of Afghanistan. The region was surveyed for the abundance and population density of Marco Polo sheep (*Ovis ammon polii*) in the years 2022 to 2023. Marco Polo Sheep has been distributed all over the Big and Small Pamirs of Afghanistan. A total of 1304 individuals of these species were observed in the study area. The abundance and population density of Marco Polo Sheep in each region differed. The highest number of Marco Polo Sheep observations is in the Tollaboy with 452 individuals (34.6%), and the lowest number of observations is in the Angelic region 93(7.1%). According to the study area's locality, the population density of the Marco Polo Sheep differs in each season of the year. During this study, four main threats to Marco Polo sheep were recorded: habitat degradation, climate change, human disturbance, and illegal hunting.

5.1 Highlights

1. The Pamir Mountains, located in central Asia, provide a significant habitat for wildlife.
2. Marco Polo Sheep has been distributed all over the Big and Small Pamirs of Afghanistan.
3. The population density of the Marco Polo Sheep differs in each season of the year.
4. Four main threats to Marco Polo sheep were recorded: habitat degradation, climate change, human disturbance, and illegal hunting.

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