


## Distribution and conservation of the Red panda *Ailurus fulgens* F. Cuvier in the Rara National Park, Nepal

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### Abstract

The Red panda is an Endangered species in the IUCN Red List of Threatened Species. It is also listed as a protected mammal by Nepal's National Park and Wildlife Conservation Act of 1973. The present study was conducted in the Rara National Park (RNP), in mid-western Nepal (the Himalayas of Karnali Region). To determine the current distributional and conservation status of the red panda, we conducted visual surveys between September to December, 2023 along line transects (n= 13) to record species presence. We also measured habitat variables (vegetation types, waterholes, slopes/aspects, etc.) in 10x10 m<sup>2</sup> quadrat around the species sign to characterize habitat associations and interviewed 16 key informants to assess the conservation threats. We recorded 5 red panda signs, mostly fecal pellets, within an encounter rate of 1 sign per km. The majority of signs were associated with upper temperate mixed broad-leaf forest with bamboo cover >20%, tree stump presence, and fallen logs of birch trees. Himalayan Birch *Betula utilis* and Brown Oak *Quercus semecarpifolia* are the two most common tree species near red panda signs. The distribution ranged from 2988 m to 3291 meters above mean sea level. Interviews with key informants revealed that the main conservation threats to red pandas include excessive livestock grazing and the unsustainable extraction of bamboo by local communities. Overall, our results corroborate the presence of red pandas in this national park and highlight the immediate need for further research on its population abundance and conservation actions to conserve its prime habitat.

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### Introduction

The Red panda *Ailurus fulgens* F. Cuvier is an herbivorous mammal of the order Carnivora belonging to its own family Ailuridae. Two subspecies are recognized: *Ailurus fulgens fulgens* (the Indian Red panda) and *Ailurus fulgens styani* (the Red panda of China) (Glatston et al., 2015). It is native to the eastern Himalayan broadleaf and coniferous forests of Nepal, India, Bhutan, northern Myanmar, and China (Choudhury, 2001; Bista and

Poudel, 2014; Dendup et al., 2023). Fewer than 10,000 individuals remain in the wild, and thus, the IUCN Red List of Threatened Species has classified it as an “endangered” species (Glatston et al., 2015; Thapa et al., 2018a). The primary threats to red pandas are habitat loss, fragmentation, and degradation, exacerbated by human activities such as grazing, resource collection, and development (Yonzon and Hunter, 1991; Dorji et al., 2012; Acharya et al., 2018; Thapa et al., 2018b). Red panda habitat includes various forest types with bamboo

understories, and pandas prefer areas with steeper slopes, abundant fallen logs, tree stumps, shrubs, bamboo, canopy cover, and proximity to water sources (Choudhury, 2001; Pradhan et al., 2001; Panthi et al., 2017).

In Nepal, red pandas are found inside protected areas Annapurna Conservation Area, Dhorpatan Hunting Reserve, Kanchenjunga Conservation Area, Makalu-Barun National Park, Manaslu Conservation Area, Rara National Park, Sagarmatha National Park and Langtang National Park, and also outside protected areas in Jumla, Jajarkot, Illam and many other districts (Jnawali et al., 2011; Bishta et al., 2017; Thapa et al., 2020). The subspecies found in Nepal is the Indian Red panda (*Ailurus fulgens fulgens*). It is commonly known as “Kundo” or “Habre” in Nepali (Yonzon, 1989). The National Park and Wildlife Conservation Act, 1973 of Nepal gave the species the highest protection status by listing it in schedule I of the protected species list, which prohibits killing or capture, dead or alive (Glatston et al., 2015). In Nepal, red pandas are found in temperate forests at elevations between 2200 and 4800 meters above sea level, where there is a thick bamboo understory; they inhabit an area of moderate temperature between 10 and 25 °C with little annual change (Yonzon, 2000). The Red panda prefers habitats near water sources (within 100–200 m). It prefers mountainous mixed deciduous and conifer forests, especially with old trees and dense understories of bamboo (Chakraborty, 1999; Wei et al., 2022).

Over the last three decades, there have been multiple studies on red panda in Nepal, focusing on distribution and conservation status, ecology, dietary habitat, habitat suitability mapping, and health assessment (Yonzon, 1989; Yonzon and Hunter, 1991; Panthi et al., 2012; Bista and Poudel, 2014; Panthi et al., 2019; Shrestha et al., 2021). A recent review paper on red pandas indicated that despite the increasing number of publications on red pandas, most of the research on captive and wild populations of *Ailurus fulgens* focuses on their biology, including anatomy, behavior, reproduction, nutrition, and habitat use, and there is limited information on the species' genetics, particularly outside of China. Studies on diseases, the effects of anthropogenic activities (such as tourism and infrastructure development), movement ecology, interactions with other species, and the impact of climate change on red pandas are scarce (Dhami et al., 2023). Some recent studies include the assessment of payment of ecosystem services in red panda habitat (Koju et al., 2013), spatial and movement ecology of red panda (Bista et al., 2021; Bista et al., 2022), and health status (Bista et al., 2017; Sharma and Achhami, 2022). These studies have helped improve understanding of the ecology and behavior of the species, facilitating the implementation of conservation activities (Sherpa et

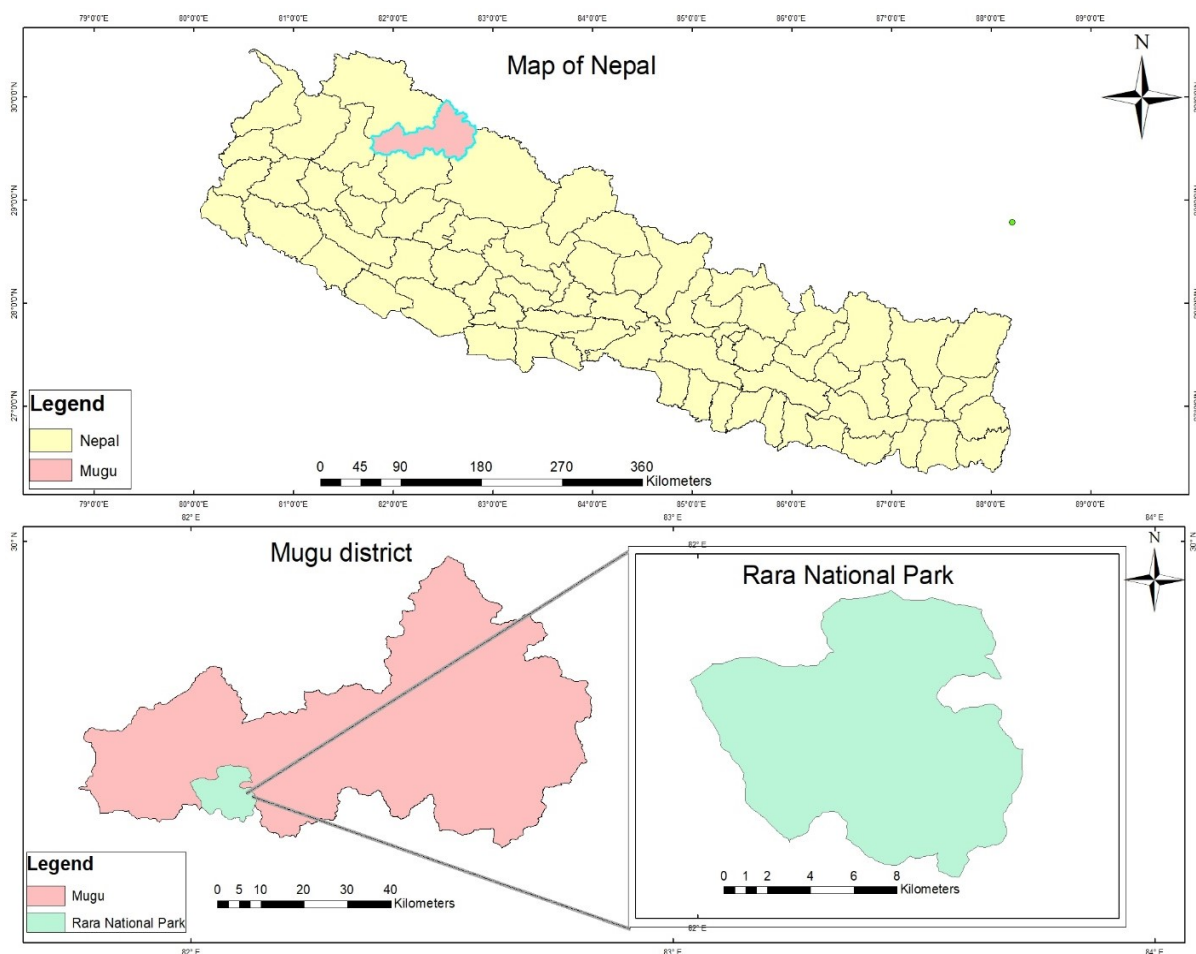
al., 2022). Rara National Park, which lies in western Nepal, has been identified as potential habitat for red panda in Nepal. While previous studies have corroborated the presence of red pandas in this national park (Sharma et al., 2014a, b; Sharma et al., 2019), further studies of red pandas in this habitat are needed. Studies focusing on assessing distribution, habitat quality, and conservation threats are essential to inform conservation and management decisions.

In this study, we aimed to determine red panda's distribution and conservation status in Rara National Park. In particular, we conducted line transect surveys and key informant interviews to identify the status of the red panda. Based on literature on the ecology of red panda (Yonzon and Hunter, 1991; Wei et al., 2022), we hypothesized that red panda presence will be associated with low levels of human disturbance, habitats with high bamboo cover, and near water resources. Our findings will further enhance research and conservation of red panda in this national park.

## Material and Methods

### Study area

The study area is in the Rara National Park (RNP) (Fig. 1), which covers 106 km<sup>2</sup> in Karnali Province (81°59'54" to 82°08'27" E, 29°26'28" to 29°33'11" N), with elevations ranging from 2754 to 4097 m above mean sea level. It was established and gazetted in 1976 to conserve its biodiversity and the natural beauty of the Rara Lake (10.8 km<sup>2</sup>), also known as Mahendra Tal (DNPWC, 2002). The park contains mainly coniferous forest, and the area around the lake is dominated by *Pinus wallichiana* (Blue Pine) up to 3200 m above mean sea level. Other tree species include rhododendron (*Rhododendron arboretum*), Black Juniper (*Juniperus indica*), West Himalayan Spruce (*Picea smithiana*), Brown Oak (*Quercus semecarpifolia*), and Himalayan Cypress (*Cupressus torulosa*). Fauna in the park include the Himalayan Black Bear (*Ursus thibetanus*), Leopard (*Panthera pardus*), Musk Deer (*Moschus moschiferus*), Goral (*Nemorhaedus goral*), Golden Jackal (*Canis aureus*), Himalayan Tahr (*Hemitragus jemlahicus*), Yellow-throated Marten (*Martes flavigula*), and Dhole (*Cuon alpinus*) (DNPWC, 2002). The park is surrounded by nine rural municipalities within Jumla and Mugu districts, of which some have been declared buffer zones and comprise 198 km<sup>2</sup> (Sharma et al., 2014a). The population of the red panda in Rara faces threats predominantly from livestock grazing and other human-induced activities such as the collection of fuel wood, timber, mushrooms, Jhapra shoots, and other non-timber forest products (NTFPs) by local herders, hotel operators, pilgrims, etc. (Sharma et al., 2014a).



**Figure 1:** Map of study sites showing the Rara National Park in Nepal. Source: Open Data Nepal.

### Methods of data collection

The survey was conducted in Trilokkhola, Milikhola, and Jarkhoreli in Rara National Park. Our major effort was devoted to the highest elevation, the main range of red pandas. Some localities of its former distribution were also visited. The main methods used to gather information on the distribution and status of red pandas are explained below.

### Reconnaissance survey

First, a preliminary field survey was conducted to identify the potential habitat of the red panda in the proposed study area between September to December, 2023. This survey included interviews with park people, local leaders, and other residents to gather knowledge about red panda presence and habitat distribution in the National Park area. A survey of the study area was carried out to reveal the potential and less suitable habitats of the red panda and to design the data collection process based on the knowledge of field assistants, game scouts, and local forest guides in the National Park.

### Altitudinal line transects survey

After selecting potential areas of the red panda in different sites of the study area, an altitudinal line transect survey was conducted between September to

December, 2023 to record the presence or absence of the red panda in that habitat (Williams, 2004). The presence of indirect evidence, such as for sign of red panda (fecal pellet and pugmark), was considered as presence of the red panda based on the recommendation of occupancy surveys of red panda (Panthi et al., 2017). A single transect line was made at each site in the potential area, and we walked. A field survey was conducted using several altitudinal line transects of variable length (approximately 200 m) in a certain interval of distance (approximately 400 m) between the altitudes of 2800 m and 3800 m above mean sea level. Each altitudinal line transect was surveyed once in each session (working day) to determine presence of red panda. A count of the animal signs within a 200-meter distance of each transect line was conducted. After reaching the end of the transect, the next transect along the next contour was followed 100 m up or down in elevation.

The time of walking along the transect coincided with the active period of the day from 7 AM to 5 PM in the evening. Measurement of the track such as paws or pugmarks (mostly found in wet ground or snow) and recording of pellets and groups were conducted to determine the age group of the animal, as there was a significant difference between the size of the track print and the diameter of the pellets among the adults and

cubs. The observed species was photographed with a digital camera. Panda sign (panda's paw print and scat) presence and the location of encountered species were measured by recording the latitude and longitude of the area with GPS.

### Habitat survey

Whenever a direct or indirect sighting (e.g., tracks, fecal pellets, or footprint) of a red panda was encountered, we established a 10x10 m<sup>2</sup> square plot around that sign or sighting location to measure the panda's habitat association. In particular, we measured habitat characteristics such as vegetation types, presence of waterholes, slopes and, and any other evidence of human disturbance such as livestock grazing, and lopping for fodder or bamboo collection.

### Key informants' interview

We selected 16 key people in and around the National Park to assess the distribution, long-term threats, and perceptions of people towards the conservation of the Red panda. Key informants (Appendix) include the park chief warden, game scouts, and other outsiders of the national park, such as the local leader, herders, Buffer Zone Management Committee (BZMC), and NGO representative.

### Data analysis

To determine the distribution of the red panda in Rara National Park, we prepared a distribution map. This map was prepared in ArcGIS 10.2.1 software, and GPS locations of red panda signs, such as pugmarks and scat, encountered during transect surveys were plotted on the map. Similarly, we conducted descriptive statistical analysis to summarize the total number of red panda signs, and identify their habitat associations. The habitat association of red pandas reflects the habitat characteristics occupied by red pandas. In this analysis, the total number of transects, the total number of red panda signs, their pugmarks, and scats (fresh vs. old) with respect to elevation, slope, forest type, distance to human settlement, distance to water, etc., were also summarized. Similarly, a descriptive analysis was conducted to assess key informants' perceptions toward red panda conservation using SPSS v 23.0 and Microsoft Excel.

## Results

### Description of survey effort and findings

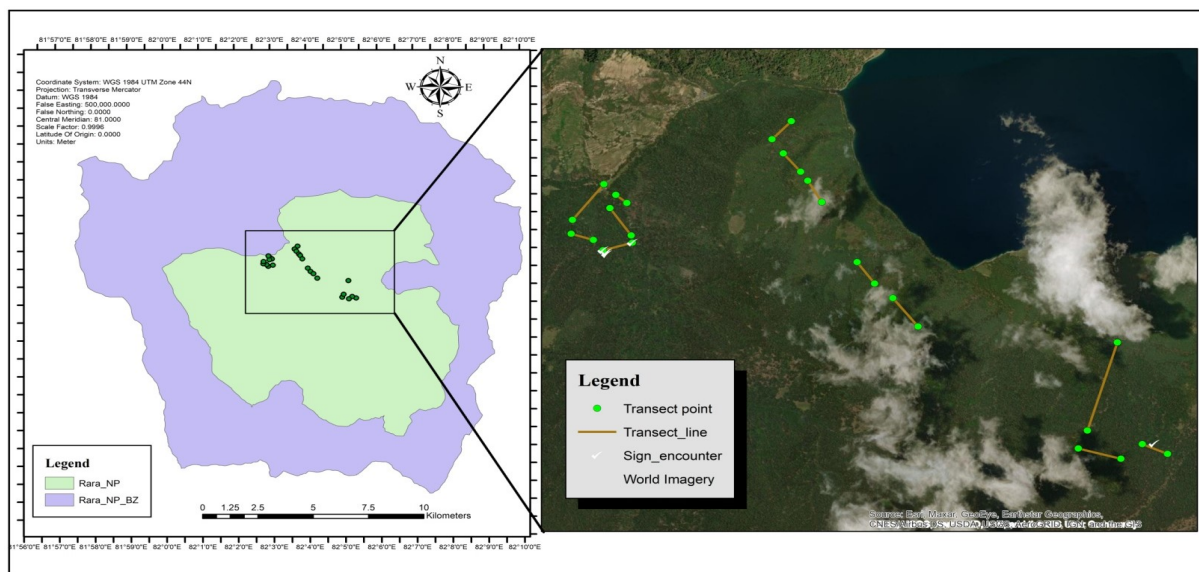
A total of 13 transects (mostly forest trails) were surveyed (Fig. 2). These transects represented an elevational distribution of red panda habitat in Nepal and were well distributed across the national park habitat to capture its heterogeneity. Transect lengths ranged from 200 to 400 m and ranged between 2912 m

and 3293 m above mean sea level in elevation. This elevation range broadly captures the documented elevation distribution of the red panda elsewhere in its range. These transects were distributed in the potential areas, i.e., TrilokKhola (29.516953° N, 82.048639° E, Elevation: 3080 m), Milikhola (29.50289° N, 82.088264° E, Elevation: 3291 m) and Jarkhoreli (29.517768° N, 82.050526° E, Elevation: 2988 m) of Rara National Park. The distribution map of the transect, along with panda sign we encountered, was prepared (Fig. 2). We recorded 5 red panda signs (Fig. 3), of which 3 were fecal pellets, 1 urine mark, and 1 footprint. These signs were encountered mostly in three areas of the national park: TrilokKhola, Milikhola, and Jarkhoreli.

Signs of red panda were associated with temperate and bamboo-dominated forests. *Betula utilis* and *Quercus semecarpifolia* were the two most common tree species in the 10x10 square plot near red panda signs. On average, there was high bamboo cover wherever we encountered the red panda sign (85% cover). We also detected evidence of human disturbance in those locations. We observed humans using those trails to collect and transport fodder, bamboo extraction as fodder, and some logging of timber. Out of 5 signs, most had a water source within ~200 to 500 m. Bamboo species such as *Arundinaria* and *Nigalo* were particularly available for their sustenance. They prefer mature forests with a mix of deciduous and coniferous trees, where the canopy provides ample cover. These forests contained broken trees, hollow logs, and tree cavities that offer shelter and nesting sites.

### Descriptive Analysis

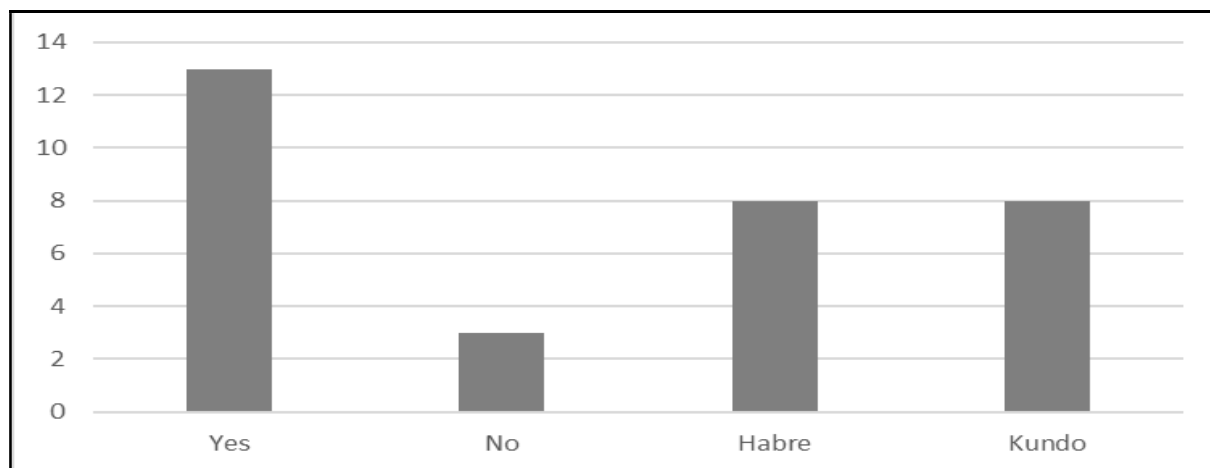
Of the interviewed local respondents, 13 people inside the buffer zone have seen the red panda (habre in Nepali language) in Rara National Park. Only three key informants have not seen this species in their entire lives (Fig. 4). All the people whom we questioned are natives of the Rara National Park. The locals used to call this species by its local names, such as "Habre" and "Kundo". 50% of the people answering survey questions called the Red panda *Habre* and 50% called it *Kundo* (Fig. 4). When asked about which tree species the red panda prefers to build its nest in, 5 respondents indicated that they had seen the red panda building its nest mostly in the Bhojpatra (*Betula utilis*), followed by bamboo species (Fig. 5). Most key informants believed that the total number of red pandas in Rara National Park is not decreasing. However, some people indicated that the population might be decreasing due to human disturbance, livestock grazing, and other anthropogenic threats, such as fodder extraction from red panda habitat.



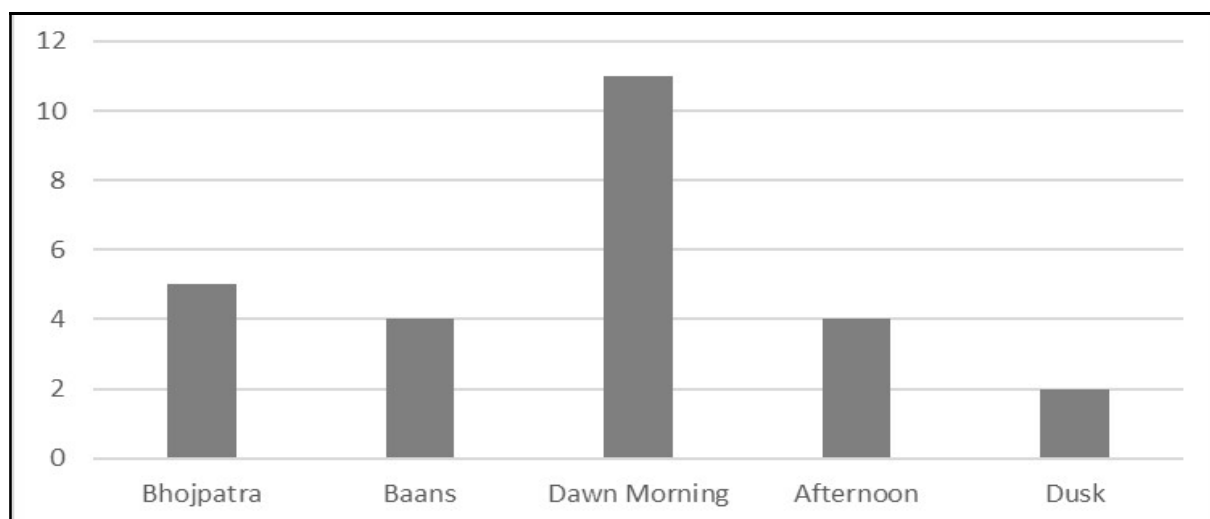
**Figure 2:** Transect distribution and sign encounter for red panda in Rara National Park. The white check mark represents the red panda sign encountered during the survey.



**Figure 3:** Different types of the red panda signs and associated habitat feature encountered during field survey, (A) Red panda scat, (B) red panda urine, (C) pugmark of red panda, and (D) Himalayan Bamboo; an important understory plant species.



**Figure 4:** Number of red pandas seen by people in the Rara National Park and their local names. Y axis represent the number of people indicating particular response.



**Figure 5:** Number of people indicating whether they have seen red panda nesting in particular tree species and their appearance time. Y axis represents the number of people indicating a particular response.

## Discussion

This study was conducted to assess the conservation and distribution status of red pandas in Rara National Park. Our results confirm the presence of red pandas in this national park and show that red pandas are found in limited areas of the national park, suggesting that such key sites of red pandas require immediate protection. Our distribution mapping shows that TrilokKholra and Milikhola are the main red panda habitat sites in the national park. These sites are characterized by upper temperate mixed broad-leaved forests dominated by fir, oak, and birch trees. The understory cover of bamboo thickets was visible across these habitats, and these bamboo thickets likely form the main diets of the red pandas, as shown by previous studies (Sharma et al., 2014b; Wei et al., 2022).

Importantly, our habitat characteristics assessment around the red panda signs revealed that these important red panda habitats are also exposed to

human disturbance. We found evidence of livestock grazing, logging and lopping, and bamboo extraction to meet household needs by local communities residing in the national park's buffer zone. A previous study conducted in 2014 showed that livestock grazing impacted red panda distribution in the National Park (Sharma et al., 2014). Livestock grazing reduces bamboo abundance, and the activity is generally accompanied by herders and dogs, causing disturbance to red pandas. Multiple previous studies conducted elsewhere in red panda habitats have shown the impact of livestock grazing on red panda occurrence (Panthi et al., 2017; Lama et al., 2020; Thapa et al., 2020). While livestock grazing is illegal inside national parks, local communities depend on national park areas for their livestock. Thus, this situation requires a balanced approach to meet the local communities' needs while reducing the impact on the red panda habitat.

During our survey, we observed people illegally collecting bamboo in the park for fodder and building

materials, similar to activities reported in other protected areas of Nepal (Yonzon and Hunter, 1991) and Bhutan (Dorji et al., 2012). These actions may reduce bamboo availability for red pandas. We also found logging of tree species like Himalayan Fir (*Abies spectalibis*), Rhododendron (*Rhododendron arboretum*), Maple (*Acer species*), Bhojpatra (*Betula species*), and Khasru (*Quercus species*). These tree species serve as nest sites and contribute to red panda's availability and connectivity between habitat patches (Panthi et al., 2017). Thus, there is a need to

regulate the logging of tree species inside national parks. While we did not directly observe poaching of red pandas, our interaction with key informants and local communities during informal interactions revealed that red pandas are poached for their skin in this national park. Previous studies in Nepal have shown that poaching continues to be among the prime threats to red pandas across their habitat in Nepal (Paudel et al., 2020; Paudel et al., 2022). A recent study on factors driving the demand for red panda skin or pelt suggested that the increasing supply of red panda pelts may be driven by factors such as insufficient knowledge about wildlife crime, miscommunication during awareness campaigns, the influence of investigators indicating a high demand for pelts, and poverty-driven motives for easy money-making (Bista et al., 2020). We therefore suggest that further research should be carried out to identify the main drivers and motivations of people involved in red panda poaching.

Water is an important habitat requirement for red pandas (Wei et al., 2022). Given their small home range, it is important that water is available within reachable distance from their nesting site. We also found that red panda signs were near water resources, such as small rivers and water springs. Multiple previous studies have demonstrated the importance of water resources for red panda habitats (Yonzon and Hunter, 1991; Dorji et al., 2011; Bista et al., 2019). However, local communities also use water resources during livestock grazing, and this has the potential to disturb red pandas.

Overall, we found that human disturbance is an important factor in determining the status of red pandas. Previous studies have shown pervasive human use of red panda habitat for resource extraction and livestock grazing (Panthi et al., 2017; Acharya et al., 2018). Our key informant interviews show that while the majority of these respondents do not agree that the number of red pandas is decreasing in the park, they cautioned that the pervasive impacts of human activities could threaten the red panda habitat and population. Some respondents said that livestock grazing has led to the degradation of tree species and fruiting plants, impacting the red panda's habitat. The study emphasizes the need for legal protection for additional forest habitat areas and strict

enforcement in existing conservation areas. Establishing suitable infrastructure for protected areas and effectively managing issues such as poaching and tree-cutting are deemed essential for the long-term survival of the red panda. In conclusion, a multi-faceted approach encompassing habitat management, community engagement, and stringent conservation measures is imperative to safeguard the red panda and address the complex challenges it faces.

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## Author contributions

Conceptualization: AS, KR; Funding acquisition: AS; Investigation: AS, KR; Methodology: AS, KA; Supervision: KR, KA; Writing-original draft: AS, KR; Writing- review and editing: AS, KA, KR.

## Conflict of interest

The authors declare that there are no conflicting issues related to this research article.

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## Appendix

### A. Personal information of the respondent:

Form no:	GPS coordinate of the village:	Date:	Time:			
Name of respondent					Age:	
Address:			Gender of respondent:			
Ethnicity:	Rai= 1 Bhotey= 2 Sherpa= 3 B/C/T= 4 Others (Specify).....					
Education	Gender	Illiterate	Primary level	Secondary	Higher secondary	Bachelors and masters
	Respondent					
Duration of stay in this village	<5 years=1		5–10 years= 2	>10 years= 3		
Well-being status	Which of the following status your family categorized? 1. Better off (Well off) 2. Medium 3. Poor 4. Ultra-Poor 5. Don't Know					
Annual income:			Earning members:			
Occupation:						

### B. Information of Red Panda:

1) Have you seen Red Panda species around?

Yes                      B) No                      C) Don't know

2) What do you call them locally?

3) At which time of the day have you seen them?

Dawn Morning    B) Afternoon    C) Dusk Evening    D) All time the day.

4) What is the name of tree species where they make nest or they live?

5) Do you know the potential hotspots (high population concentrated area) for Red Panda in this area?

Yes    B) No

If yes, where?

6) What is the name of the tree species where they make nest or they live?

7) Do you know about their food? If yes, then what are they?

Yes    B) No

8) How many species of bamboo are found in this place?

9) Mostly, which species of bamboo, they prefer?

10) Do they live near water resources?

Yes    B) No    C) Don't know

11) Have you seen them near water resources?

Yes    B) No

- 12) How can you manage water sources of your locality?
- 13) Do you agree that the no. of Red Panda is decreasing?  
Strongly disagree      B) Disagree      C) Don't know  
D) Agree      E) Strongly Agree
- 14) In your opinion what are the cause of Red Panda Population decreasing in your locality?  
Forest Harvest    B) Poaching    C) Human Influence    D) Grazing
- 15) Do you agree that conservation awareness to local people will help conservation of Red Panda?  
A) Strongly disagree      B) Disagree      C) Don't know  
D) Agree      E) Strongly agree
- 16) Can you estimate the number of Red Panda in this forest?
- 17) What do you think about importance of Panda?
- 18) How much timber, firewood would you collect from the forest?
- 19) What will you do, if you saw injured, dead panda or poachers trying to kill while you are at forest?