Himalayan Wolf Research and Conservation Working Strategy

Produced by Geraldine Werhahn & Naresh Kusi / Himalayan Wolves Project (HWP)

Common name: Himalayan wolf, Tibetan wolf, Woolly wolf

Scientific name: *Canis lupus chanco*

Population status and trend: 2,275–3,792 mature individuals and decreasing population trend estimated (Werhahn et al. 2023)

Protection Status

- **Vulnerable** in the global IUCN Red List (Werhahn et al. 2023)
- **CITES Appendix I** for grey wolf populations in Nepal, Bhutan, India and Pakistan which renders all trade of wild specimens or their parts illegal (CITES 2023).
- **Critically Endangered** in the Nepal's National Red List Series based on assumed low population numbers and declining population trends (Jnawali et al. 2011, refers to grey wolves *Canis lupus*)
- **Protection status in Nepal:** The grey wolf *C. lupus* is protected under Nepal's National Parks and Wildlife Conservation Act 2029 (1973) as a **priority species**.
- **Protection status in India:** The Tibetan wolf *C. lupus chanco* and the Indian wolf *C. lupus pallipes* are **protected under Schedule I** of the Wildlife Protection Act 1972.
- **Protection status in Bhutan:** Wolves *Canis lupus* are **legally protected under Schedule 1** of the Forest and Nature Conservation Act of Bhutan, 1995 (Amended up to 2020).

Figure 1. A pack of Himalayan wolves in northwestern Nepal camouflaged by their colouration blending into the landscape (© Himalayan Wolves Project).

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Conservation Threats

- Human wildlife conflict due to livestock depredation
- Habitat modification and encroachment
- Depletion of wild prey populations
- Poaching to prevent or retaliate depredation conflict
- Poaching for the illegal wildlife trade

Conservation Needs

- **Raising awareness** from the local to the global level about the need for protection of Himalayan wolf populations and spreading information that they are legally protected in the range countries and globally assessed as Vulnerable on the IUCN Red List
- **Prey population protection**
- **Habitat protection & wildlife refuges** (areas without livestock herding or other anthropogenic disturbances)
- **Sustainable livestock herding** to protect habitat and prey populations (including reduced livestock loads, and holistic herding strategies which combine the latest knowledge with traditional methods)
- **Improving livestock guarding methods** (e.g. predator-proof livestock corrals, use of sound and light deterrents, and livestock guarding dogs)

Conservation Actions

The following conservation actions, tested and found effective by the HWP team, mitigate depredation conflict and advance carnivore conservation in the high Himalayas.

- **Sound and light devices to deter carnivores.** Solar-powered Fox Lights, which mimic a person patrolling the area with a flashlight in an erratic manner, have proven effective. Combining the lights with sound-emitting devices enhances the effectiveness. It's important to change the setup at regular intervals to prevent carnivores habituating to the devices.
- Communal **predator-proof livestock corrals** are effective to safely keep livestock (particularly yak calves) in the winter months and can be shared by the community.
- **Conservation education** using films (preferably narrated in the local language), books, and other Information, Education and Conservation (IEC) materials like posters, group activities, game-based activities (especially for school children), classroom sessions and field trainings tailored to the local customs are effective at raising conservation awareness among local communities.
- **Improving conservation policy and enforcement** on the ground through raising awareness about the laws and illegal activities in local communities and government officials.

The following conservation actions have not been tested by our team as the local communities in our study area did not favour these approaches. However, they might be welcomed by traditional communities elsewhere but such demand has to be carefully assessed beforehand.

- **Livestock guarding dogs** can be a useful strategy to protect grazing livestock. But they must be explicitly welcomed by the target communities and adequately raised and trained. Awareness of dog and handler training needs and responsibilities in dog ownership are important to ensure the dogs don't end up roaming around feral and are cared for appropriately.

- **Electric fences** are a movable and effective tool to keep large carnivores out of livestock herding areas. But technical support might be lacking in some remote areas, and this needs to be carefully addressed with the target community.

Research Needs

- Understanding and monitoring the population status and trends across the range
- Detailed understanding of the distribution range (especially northwestern and southeastern distribution boundaries remain little researched)
- Understanding the wolves' habitat and connectivity needs
- Trophic ecology and predator-prey dynamics
- Impact of climate change on the wolves, prey and habitat
- Effective conservation measures
- and more

Distribution

The Himalayan wolf is found in the Himalayas of Nepal, India and likely Bhutan and across the Tibetan Plateau of western China.

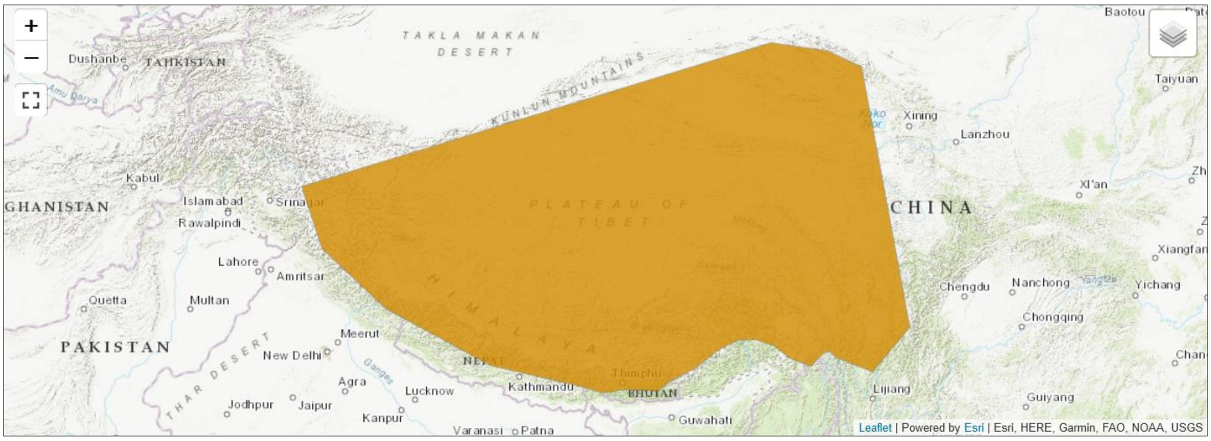

Figure 2. Map showing the distribution range of the Himalayan wolf based on the IUCN Red List assessment (Werhahn et al. 2023)

Ecology

Habitat

The Himalayan wolf is a high-altitude specialist wolf found in alpine steppe, high-altitude grassland and tundra habitats at elevations above 3900m asl in Central Asia.

Prey species

Prey species include woolly hare (*Lepus oiostolus*), marmots (*Marmota* spp.), pikas (*Ochotona* spp), Tibetan gazelle (*Procapra picticaudata)*, blue sheep (*Pseudois nayaur)*, Tibetan argali

(*Ovis ammon hodgsoni)*, Kiang (*Equus kiang)*, as well as livestock such as domestic yaks (*Bos grunniens*) and goats (*Capra aegagrus hircus*) (Werhahn et al. 2023). The Himalayan wolf prefers wild prey over domestic species when wild prey species are available, but domestic prey can make up a large part of its diet in some areas (Werhahn et al. 2019; Shrotriya et al. 2022).

Social structure

Himalayan wolf packs centre around a family group and are dynamic. Himalayan wolf pups are born around mid-April to May in a denning cave. Den sites were found in high-altitude shrubland patches within alpine grasslands at elevations ranging from 4270 to 4940 m asl (Werhahn et al. 2017). The pack is spatially bound to the den area in spring when the pups are born and until the pups have grown stronger to be increasingly mobile. By the end of summer and autumn they are almost fully grown and move widely across their territories with the adult pack members. That is the reason why packs appear larger in autumn compared to spring as the pups have grown to almost adult size but mostly remain with their natal pack during the winter. Towards the end of winter many of the young wolves disperse to find their own territories and mates. Only some of the yearling wolves remain with their natal pack for another season or two to help their parents raise a new litter of pups.

Evolution, Genetics, and high-altitude Adaptation

The Himalayan wolf is an evolutionarily basal wolf endemic to Central Asia and basal to all other grey wolf populations (Hennelly et al. 2021). It is genetically adapted to cope with the high-altitude environment where hypoxic conditions challenge mammalian life (Werhahn et al 20218, Wang et al 2020).

The Himalayan wolf lineage is supported by whole genome data (Hennelly et al., 2021) as well as mitogenomic data (Hennelly et al. 2021, Werhahn et al. 2018, 2020). It shows divergent genomes, mitogenomes, zinc finger protein coding genes on the sex chromosomes, and diverged alleles on gene SNPs that are related to cope with the hypoxic stress in high altitudes (Werhahn et al. 2018, 2020; Wang et al. 2020; Hennelly et al. 2021). This wolf's specific high-altitude adaptation is evidenced to date by differentiated alleles on functional nuclear genes: EPAS1, ANGPT1 and RYR2 (Werhahn et al. 2018; Wang et al. 2020; Hennelly et al. 2021). Further differentiated gene expression in 90 genes was found including genes important for physiological coping with high-altitude conditions (Liu et al., 2019).

Research Methods

Monitoring an elusive carnivore like the Himalayan wolf in harsh and remote high altitude habitats is resource intense in terms of time, human resources, logistics, and costs.

Below we will take a look at some of the common research methods and discuss their strengths and weaknesses. Both camera trapping and scat sampling offer practical non-invasive ways to learn more about the wolves and will be discussed in more detail.

Camera trapping yields reliable data about the target species as well as other passing wildlife (given the camera trap locations are appropriately selected). Camera trapping is a non-invasive method for studying wildlife, potentially offering intimate insights into the target species as well as other species. Species identification and presence data can be easily obtained from camera trapping data. Individual identification is possible, but it must be considered with care, as wolf individuals can change their appearance with the seasons due to changing fur and aging (independent individual identification assignment by two researchers with cross-validation is recommended). The various visual insights into the study area over time are a significant advantage of camera trapping in addition to the main data.

Non-invasive genetic sampling. Genetic samples non-invasively collected from scats, hairs and carcasses can provide valuable data for species identification and presence, individual identification, relatedness among individuals, population genetic diversity, and connectivity, etc. Genetic data can be widely used for various types of analyses, ranging from the individual to the population to the evolutionary level.

For more details on camera trapping and non-invasive genetic sampling please see Table 1.

Foraging ecology can be studied through dietary analysis (either genetic or microscopic) of non-invasively collected wolf scats. Prey estimates in the habitat can be obtained using herbivore population estimation methods such as distance sampling, double observer method, etc. Understanding what the wolves have eaten in relation to what and how much of prey species is available in the landscape is valuable to understand the wolves foraging ecology and inform human wildlife coexistence strategies.

Non-invasive behavioural studies. Non-invasive behavioural research based on observations will be valuable to improve the understanding of these wolves and inform human-wolf coexistence strategies. However such observational studies on Himalayan wolves can be challenging as the wolves roam over large territories and remain elusive, avoiding humans. With sufficient time and a respectful approach, fortunate observations may be made in the vast landscape, which in parts allows distant viewing. Wolves may be observed roaming and foraging in the landscape and in rare cases den sites may be observed (but ensure to keep a distance of >1km). Until more behavioural research is available, grey wolf behaviour can serve as guidance to what to expect in the Himalayan wolves. Studies involving captive animals or invasive methods are not recommended.

Table 1. Different aspects of non-invasive genetic sampling and camera trapping. Differences are indicated with green font.

	Non-invasive genetic sampling	Camera trapping
Summary	***Strengths*** non-invasive ***Advantages*** qualitative data ***Weaknesses/Challenges*** samples have to be handled effectively ***Effectiveness*** precise & effective ***Resource intensity*** field costs, lab costs ***Applicability*** straightforward if protocol is followed	***Strengths*** non-invasive ***Advantages*** visual, qualitative data ***Weaknesses/Challenges*** Camera traps can get stolen and misfunction at times resulting in data loss ***Effectiveness*** precise & effective ***Resource intensity*** field costs, equipment costs ***Applicability*** widely applicable, straightforward if systematic approach and appropriate locations are chosen
Research value		
Overall research value	-non-invasive -Precise for species ID and individual ID -spatial interaction among various species - data on other species present in the area -data useful for genetic and genomic analysis	-non-invasive -Precise for species ID and individual ID -spatial and temporal interaction among various species -data on other species present in the area
Occupancy analysis	Yes	Yes
Population estimation	Yes. Population modelling & minimum population estimate with individual ID. A variable percentage of collected samples will not yield data.	Yes. Population modelling & minimum population estimate with individual ID. Individual ID has to be done with care as the wolves' appearance may change over the seasons (cross-validation among two observers recommended)
Spatial Capture and Recapture analysis	Yes, but recaptures might be lower than ideal as not all scat samples can yield individual ID information due to degraded DNA quality	Yes, but comes with assumption that wolf individuals are accurately identified through photographs
Other research value	Insights into -evolutionary history & phylogeny -relatedness among individuals -population connectivity -genetic diversity	Insights into -other wildlife species' presence and daily habitat use -spatial and temporal interaction of various wildlife species present
Other values	-Phylogenetic trees for visualization	-Visual data on wildlife
Resources required		
Time	-A minimum of one field visit to collect samples -A minimum of two weeks in the field -Sample collection for as long as necessary to fulfil data requirement and study area coverage	-A minimum of two field visits (setting up of camera traps & recollecting camera traps and/or exchanging batteries and SD cards) -A minimum of two weeks in the field for each visit -Sample collection for as long as necessary to fulfil data requirement and study area coverage
Finances	Field costs; Lab costs are substantial depending on sample size and the types of analysis	Field costs; equipment cost for camera traps, batteries and SD cards are substantial; field costs to maintain camera traps
Human resources	Field team: minimum of two people; more human and logistic resources are required depending on remoteness of the study area	Field team: minimum of two people; more human and logistic resources are required depending on remoteness of the study area

Selected Literature

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Acknowledgments

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