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ECOLOGICAL NICHE AND CONSERVATION STATUS OF *URSUS ARCTOS ISABELLINUS* IN PAKISTAN

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Abstract

The Himalayan brown bear (Ursus arctos isabellinus) is a rare and important subspecies that lives in the high altitude environments of northern Pakistan. The taxonomy, geographic range, habitat ecology, feeding habits, seasonal dynamics, and conservation status of the species are all summarized in this article. The species is mostly found in alpine and subalpine regions of Pakistan, such as Deosai National Park, Khunjerab National Park, and portions of Azad Jammu and Kashmir, Khyber Pakhtunkhwa, and Gilgit Baltistan. The bear's adaptable omnivorous diet, which is primarily composed of graminoids and forbs but also includes invertebrates and small mammals like marmots, reflects its adaptation to the highly seasonal availability of resources. Environmental variability is closely associated with seasonal behaviors, such as hibernation, timing of reproduction, and resource driven movement patterns. Small, dispersed, and remote subpopulation are at risk from genetic and demographic factors, according to population assessments. Human bear conflict, livestock competition, habitat fragmentation, disturbance from tourism, and climate change are among the main threats. Targeted conservation efforts can stabilize and restore local populations, according to data from protected areas, especially Deosai National Park. However, landscape level management that prioritizes habitat connectivity, ongoing ecological monitoring, conflict resolution, and climate adaptive tactics is necessary for long term viability. Effective conservation planning still depends on filling in research gaps in genetic diversity, movement ecology, and population dynamics.

INTRODUCTION

A unique subspecies of the brown bear (*Ursus arctos*), which is found throughout North America, Europe, and Asia, is the Himalayan brown bear (*Ursus arctos isabellinus*). This subspecies has ecological and morphological characteristics appropriate for mountainous habitats and is acclimated to high altitude ecosystems (Habib 2004; Nawaz 2007).In terms taxonomy *isabellinus* is a member of the *Ursidae* family and is distinguished by its smaller body size, lighter pelage, and behavioral adaptations to alpine and subalpine environments. Its separation from other brown bear populations is confirmed by genetic and morphological research (Nawaz et al., 2008; McLellan et al., 2017).

Because regional populations frequently encounter distinct ecological pressures, the subspecies status is crucial for conservation. Himalayan brown bears live in isolated,

fragmented habitats, in contrast to many other brown bear populations that are stable throughout the world (IUCN 2023).

Conservation Status

The IUCN Red List has classified *Ursus arctos* as Least Concern at the species level. However, habitat loss and human pressures are causing regional declines for a number of subspecies, including *Ursus arctos isabellinus* (IUCN 2023). In some areas of its range, the Himalayan brown bear is classified as endangered or critically endangered. Demographic instability is especially dangerous for small, remote populations (Aryal 2012).

The Himalayan brown bear is classified as a threatened species with a small population in Pakistan. Declining trends caused by habitat degradation, conflict between humans and wildlife, and climate related changes are highlighted in conservation assessments (WWF Pakistan 2022; Nawaz et al., 2008). Local population stabilization has been greatly aided by protected areas like Deosai National Park. However, without thorough ecological monitoring, long term viability is still uncertain (Nawaz 2007).

Importance as a Keystone Species

The Himalayan brown bear and other large carnivores and omnivores frequently serve as umbrella species. Many different types of coexisting plants and animals are indirectly protected by their conservation (Ripple 2014).

Brown bears have an impact on ecosystem functions through seed dispersal, nutrient cycling, scavenging, and predation. Trophic dynamics and ecosystem stability are supported by these ecological processes (McLellan 2017). In alpine ecosystems, the Himalayan brown bear aids in nutrient redistribution and prey population control. These functions underscore its ecological significance beyond its conservation value (Nawaz 2007).

Importance in Pakistan

Pakistan has relatively little ecological research on the Himalayan brown bear when compared to other regions. There are still gaps in our understanding of behavioral ecology, habitat use, and population dynamics (Nawaz 2008). The northern mountain ecosystems of Pakistan are experiencing fast environmental changes as a result of growing human activity, infrastructure development, and climate change. These variables change the distribution of resources and the availability of habitat (Pakistan WWF 2022).

Designing successful conservation plans, reducing conflict between people and wildlife, and maintaining habitat connectivity all depend on an understanding of species ecology. Decisions about protected area management are directly influenced by ecological data (Ripple 2014). Furthermore, maintaining genetic diversity, forecasting changes in distribution, and evaluating climate vulnerability all depend on precise ecological data. Conservation efforts run the risk of being reactive rather than proactive in the absence of such data (IUCN 2023).

Geographical Distribution

A large portion of Europe, Asia, North America, the Middle East, and some areas of North Africa are home to brown bears (*Ursus arctos isabellinus*) (Swenson et al., 2000; Servheen et al., 1999). According to Nawaz (2007) and Sathyakumar (2001), brown bears can be found in Asia along the Himalayas (from Pakistan to Bhutan), Afghanistan, Turkey, Iran, Central Asian mountains, Mongolia to Russia, and northern China (Fig. 1). While poorly defined populations of Himalayan brown bears spread across the northeast and west areas of China (Gong and Harris, 2006), the bears are distributed over Jammu and Kashmir and northern Indian states, like Uttaranchal and Himachal Pradesh (Sathyakumar, 2006). Because of their wide geographic range, brown bears (*Ursus arctos*) are categorized as a species of Least Concern worldwide. But the Himalayan brown bear subspecies is mostly found in South and Central Asia's mountainous areas (IUCN 2023).

Parts of India, Nepal, Bhutan, and Pakistan are among the Himalayan regions where the subspecies is found. Usually, these populations are restricted to cold desert ecosystems, alpine

meadows, and subalpine forests (Nawaz 2007; Aryal *et al.*, 2012).

The Himalayan brown bear is mostly found in Pakistan's northern mountainous areas; notable populations have been found in Deosai National Park, Khunjerab National Park, and the nearby alpine regions. Elevation, vegetation cover, and human disturbance are all closely related to habitat distribution (WWF Pakistan 2022; Nawwaz et al., 2008). Geographic isolation makes the Pakistani population more susceptible to localized threats and genetic bottlenecks. Movement between subpopulations is further limited by habitat fragmentation (Nawaz 2007).

Despite there aren't many reliable counts, Japan has a dense population when compared (Mano 2006). Seven healthy populations of brown bears can be found in Pakistan's Alpine, Karakoram, and Hindu Kush mountain ranges, including Gilgit Baltistan, Azad Jammu and Kashmir, and Khyber Pakhtunkhwa (KPK) (Nawaz 2007). Whereas the bear population is sparsely distributed throughout the alpine meadows and sub alpine zone of the Deosai Plateau, Khunjrab National Park, Nanga Parbat, and Astore (Virk et al., 2003), only the Deosai Plateau has a stable population in the western Himalaya (Nawaz, 2007). Kalam (Kohistan), Pallas Valley (Indus Kohistan), Kaghan Valley, and Chitral are the main habitats of this species in KPK (Nawaz, 2007; Akbar 2003; Arshad 2003; Roberts 1997). Pakistan's population strongholds and geographic distribution are displayed in the following table.

Table 01: Geographic Distribution Population dynamics of Brown bear in Pakistan

Locality	State	Habitat	Altitude	Population Pattern
Gilgit Region	Gilgit Baltistan	Subalpine Forest	3,000 4,500	Declining
Deosai Plateau	Gilgit Baltistan	Alpine Meadow	2,500 4,000	Stable/Increasing
AJK	Azad Kashmir	Temperate Forest	2,000 3,500	Fragmented

The distribution range of brown bears in Pakistan which comprises three main administrative divisions, acts as the study area. Through the Ministry of Kashmir Affairs and Northern Areas, States, and Frontier Regions (MoKANA), the federal government controls the Northern Areas (NAs). A Line of Control (LOC) splits the eastern portion of the state of Azad Jammu and Kashmir (AJK) from Indian Kashmir. The southern and western portions of the bear range are governed by the Khyber Pakhtunkhwa. The region is harsh, with one of the world's most mountainous landscapes dominant. In the south, elevations start at 1,000 meters, but in the north, they reach 6,000 meters. Over sixty percent of the region is above than 3,000 meters. Three major mountain ranges; the Western Himalaya, Karakoram, and Hindu Kush; as well as four intermountain highlands that are oriented north south the Hindu Raj, Swat Kohistan, Indus Kohistan, and Kaghan Neelam define the geography (Woods; Kalpatrick 1997).

The research area has a wide range of conditions, from the monsoon influenced moist temperate zone in the east to the arid and semiarid cold desert in the west. Valley temperatures can range from 10°C to 40°C per year. The various vegetational zones are dominated by coniferous woods, alpine meadows and scrub, and alpine desert. There is a distinctive altitude pattern to the way human land is used. Along the valley bottoms, there are a lot of highways, irrigated farms, and human settlements. Summer towns with summer pastures and crops are found between 2000 and 3000 meters above the waves. Starting at around 3,000 meters, alpine pastures continue to the snow line, usually at 5,000 meters (Ehlers and Kreutzmann 2000; GoP and IUCN 2003).

Present population status

Brown bears are now only found in a few remote regions of Pakistan, having been eliminated from much of their initial range. There may be between 150 and 200 bears left in Pakistan now, distributed across seven communities. Some of

these groups are totally isolated, and there is little connectivity between them (Zedrosser et al., 2001).

Northern Areas:

In northern areas (NAs) in Pakistan, three populations and five subpopulations can be recognized. The Hindu Kush has a pretty tiny population, while the Himalayan region has the most people, followed by Karakoram. Three groups; referred as the DNP, Minimerg, and Nanaga Parbat are found in the western Himalaya in NAs. The largest subpopulation, with around forty members, is the DNP. The main Deosai Plateau and the six adjacent valleys Karabosh, Dhappa, Shilla, Shagarthang, Bubind, and Chillam are native to this subpopulation. Along the line of control (LOC), east of the Deosai, is the tiny subpopulation.

Burzil Pass, Shaban Top, Gultari, Minimerg, and Kamri are among the places it covers. Narrow valleys, steep hills, and some decent forest stands are characteristics of this location. In the last six years, HWF staff have regularly observed bear signs in the Gultari area, a bear was shot on Shaban Top in 2000, a bear was sighted in early spring of 2031, a female with a cub was found in the Minimerg Valley during the September 2005 survey, and HWF staff have frequently noticed bear signs in the Dudgai and Kamri areas. Many bears were reported by the local people, and in 2004, a Pakistan Army officer stated spotting a bear cross the line of control between Indian Kashmir and Pakistan's NAs.

Azad Jammu Kashmir:

Only the northern parts of Azad Jammu Kashmir, like Machiara National Park, Gumote National Park, Shonther Valley, and Kel areas, are home to brown bears (Nawaz, 2007; Iftikhar, 2006). Good biological conditions and a dense bear population are found in the Gurez Valley, mostly in Musk Deer National Park (Nawaz, 2007). In along with Neelum Valley, they can also be found in the districts of Haji Pir (district Bagh) and Leepa Valley (Jhelum Valley) (Iftikhar, 2006). Brown bears belong to specific sections of the Neelum Valley, mainly protected areas, despite the fact that the Valley has a sizable area with potential habitat. Important factors that lower bear populations along with their distribution include habitat fragmentation (Nielsen et al., 2006; 2004), human bear conflict, and hunting pressure (Qamar et al., 2005).

Habitat Ecology

Brown bears live mostly in sub alpine and alpine regions between 2,600 and 5,000 meters in the Himalaya (Schaller 1977; Roberts 1997; Sathyakumar 1999). Their major habitats are alpine meadows in the summer and blue pine (*Pinus wallichiana*) forests in the spring and fall. Bears cannot live in areas above these heights since they are typically continuously covered in snow. The southern portion of Pakistan's brown bear habitat has less alpine meadows, but there are more woods there, such as in the Neelam and the Kaghan valleys, where brown bears are associated with Asiatic black bears.

Blue pine, spruce (*Picea smithiana*), silver fir (*Abies pindrow*), and *deodar* (*Cedrus deodara*) are the most common tree species. Particularly in the riparian zones, broadleaved trees such as *Prunus cornuta*, *Quercus floribunda*, *Juglans regia*, *Aesculus indica*, *Ulmus wallichiana*, and Acer caesium are intermingled with conifers. In Pakistan, the blue wood zone (2,600–3,000 m) comprises over 19,000 km², whereas the alpine meadows (in the range of 3,000 and 4,600 m) occupy roughly 51,000 km². Consequently, I deduce that there is roughly 70,000 km² of possible brown bear habitat in Pakistan. Given how arid and little forested the western portion of the range is, this could be an overestimate.

Habitat threats:

Pakistan has one of the greatest rates of population increase in the world, growing from 9.1% in 1994 to 2.1% annually in 1998 (Population Census Organization 2001). From 16.6 million in 1901 to 142.5 million today, the population will nearly double by 2035 (Faizunnisa and Ikram 2002). Even in NAs, where the population has doubled since the state's founding in 1947 (Ehlers; Kreutzmann 2000) and the population growth

rate has been calculated at 2.47% year (GoP; IUCN 2003), this human pressure remains evident. Rapid population growth has widespread negative effects on the environment, and bears and other species are affected in several ways by increasing demands for earth's resources and their consequent depletion.

Alpine meadows, which make up almost half of the available territory, are the vegetational zone that bears in NAs use the most. But throughout the past 20 years, these meadows have undergone a rapid metamorphosis (Kreutzmann 1991; 1995). An estimated 3.6 million hectares of natural grazing land existed in 1950, which was more than enough to support 1.12 million animal units of livestock

Feeding Ecology and Trophic Role

Himalayan brown bear (*Ursus arctos isabellinus*) has a versatile trogloecosystem, which has been accommodating both vegetarian and carnivorous foods to meet its subsistence needs to endure the resource limiting high altitude conditions in Pakistan (Nawaz *et al.,* 2019). The scat analyses demonstrated that there was a great diversity of the type of herbs with graminoids and forbs as the most common during the active period, which indicates that the trend of herbivory was high (Dar *et al.*, 2022). Invertebrates and small vertebrates had a minor role in the total digester energy but were large in energy value when there was a good source of proteins (van Dam *et al.,* 2021). The opportunistic foraging is manifested in seasonal change in diet, where animal foods including rodents are consumed more in late summer and autumn when body fat buildup is intensive (Ordiz *et al.,* 2018). Marmots were listed among the main sources of mammalian food in such instances, which is a significant addition to the plant foods in the alpine environment (Steyaert *et al.*, 2016). The omnivorous feeding habit of the bear relates lower trophic levels (plants) to higher carnivorous, which is why the bear is described as a primary and secondary consumer (García Rodríguez et al., 2021). The scavenging behavior also helps in cycling nutrients by removing the carrion and reallocating the organic matter within the ecosystems (Selva *et al.*, 2014).This ecological resilience of such trophic generalism to the changing resource supply is essential during climatic change prone alpine environments (Torretta *et al.,* 2023). This is an integrated feeding ecology that is critical to conservation planning because seasonal diversity in food resources sustains bear populations in the high mountains of Pakistan (van Dam *et al.,* 2021). The trophic structure of Himalayan brown bear is shown in the figure 01.

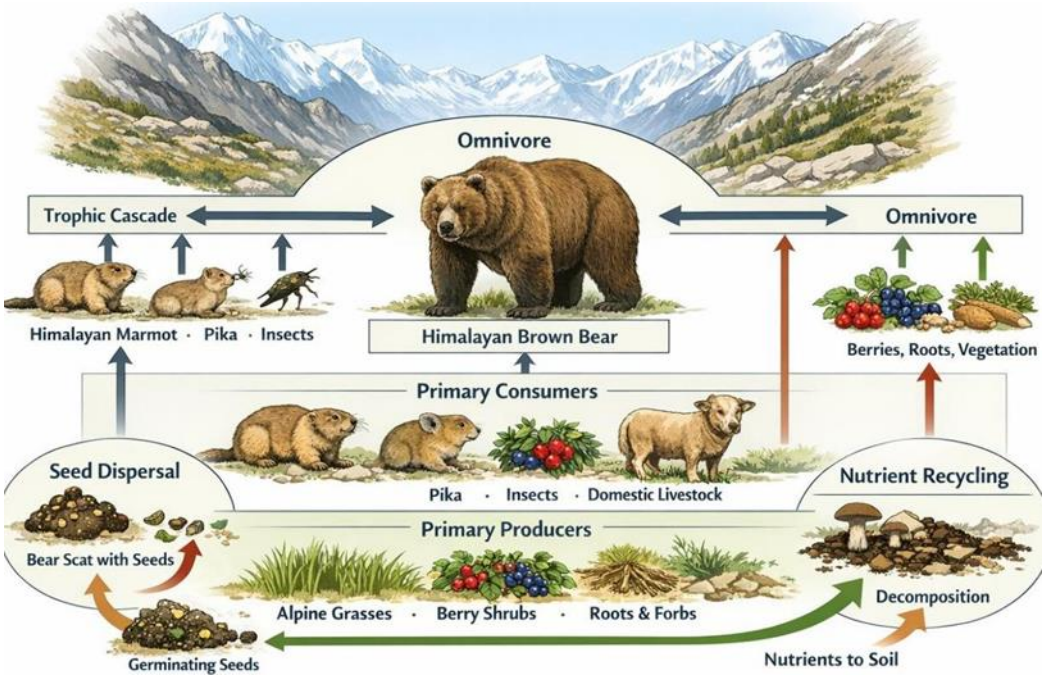


Fig. 01. Trophic Structure of Himalayan Brown Bear

Omnivorous diet composition

The Himalayan brown bear (*Ursus arctos isabellinus*) of Pakistan has a very omnivorous diet and subsists on a variety of vegetable and animal food. They mainly feed on graminoids, herbs and fruits, invertebrates, and rodents, and occasionally larger prey contribute greatly to the diet of the animals (Bosso 2024). Seasonal changes have a very strong impact on the composition of the diet, and bears lean more towards animal protein in early spring when food is scarce (BioOne 2024). In Deosai National Park, it has been studied that bears feed on more than 50 types of plants, which means their high adaptability to high nature (Ahmad *et al.*, 2019). Omnivory helps them to adapt in harsh climatic conditions where the amount of food changes monthly. Insects and larvae are invertebrates that are especially significant in the summer, so they complement the mostly herbivorous diet (Khan *et al.*, 2020). Comprehensively, the knowledge of Himalayan brown bear diet is important in conservation and management planning, particularly in anthropomorphic habitats (Raza *et al.*, 2022).

Seasonal diet variation

The Himalayan brown bear is a seasonal eater depending on the availability of food resources in the high altitude ecosystems. In spring, bears become more active in feeding on an animal, insects, rodents, and marmots as they are required to meet protein needs because of limited plants (Singh et al., 2021; Rehman et al., 2022). The main part of the summer period diet consists of graminoids, berries, and herbs, which indicates the best vegetation growth at the Alpine meadows (Khan *et al.*, 2020; Dawa *et al.*, 2026). During late summer and autumn, roots and tubers are overused to store fat to use during the winter (Sharma; Thapa 2019). Omnivory also enables bears to survive in difficult, variable habitats and their adaptable diet also influences seed propagation and prey counts. The scat analysis has indicated over 50 types of consumed flora that were consumed across the year, and over 36 percent the food consumed by the animals in the spring was also animal food . These seasonal patterns of dieting are vital in the successful conservation and management of populations of the Himalayan brown bears (Bosso *et al.*, 2024).

Role of Marmots and other prey

The alpine and subalpine ecosystems are an important source of animal prey in large omnivores such as brown bears, and the concentration of protein and fat provided by marmots are needed in the absence of vegetation growth. As it was established, the Himalayan marmot (*Marmota himalayana*) inhabits elevated areas, which is proven by photo evidence, which demonstrates that the rodents are available to the native predators .On Eurasia, meta-analysis indicates that brown bears tend to feed on medium sized ungulates and young when it is available in the diet, establishing the predator and the opportunistic feeder roles (Nied zonakowska *et al.*, 2018). Although the in summer season Montana and coastal brown bears feed on salmon, small mammals and insects are also consumed opportunistically in other areas. The movement behavior of bears can be influenced by the availability of marmots and other similar prey as they follow their prey concentration to the greatest extent they can get maximum energy. It is also possible that predation on marmots might decrease the grazing intensity on tundra vegetation by regulating the population of rodents. Ground birds and invertebrates are other small prey that increase the diversity of the animal component of the diet (Poudel *et al.*, 2024).

Ecological Role (Seed Dispersal, Scavenging, Trophic Balance)

Brown bears serve as an important seed dispersal vector because, unlike for many of the seeds they consume such as berries and fleshy fruits, almost all passes through gut entry enable germination allowing regeneration of the plants in the landscape. In southeastern Alaska, research indicates that thousands of seeds of several plant species are deposited in bear scat annually and this evidence indicates a major connection between foraging activity and plant communities (Willson & Gende, 2018). Experiments of the same nature in the Hokkaido Island reveal that the seeds of dominant berry species that pass through the gut germinate effectively, which points to the role of bears playing a functional role in the process of forest regeneration (Seed dispersal function of brown bears on Hokkaido Island 2022). Bears also recycle nutrients into food webs in the soil they scavenge and mitigate the chances of disease caused by rotting corpses. These interconnections ensure the trophic equilibrium because plants (primary producers) are interconnected to higher trophic levels. Moreover, the predator prey relationships along with nutrient recycling also enhance the resilience of the ecosystem particularly in hilly areas (Roberts O. Paine, 1966).

Seasonal and Behavioral Ecology

Hibernation patterns

Brown bear hibernation, a multifaceted seasonal phenomenon, is the means for survival during winter, when food supply is scarce; it permits a deceleration of metabolic activity to minimal levels and leads to minimized energy expenditures (Kuiker *et al.*, 2018).The bears enter a den and the safe insulated place that spend most of its time in sleep and live under fat storage. The physiological functions in a hibernation are the low heart rate, the low temperature maintained in the organism and nitrogen recycling that weeds out, muscle wasting (Tøien *et al.*, 2019). Such adaptations enable the bears to preserve lean tissues and other bodily functions that are critical even after extended starvation. Such adaptations allow the bears to retain lean tissues and other body processes that are crucial even following prolonged starvation. Photoperiod, snow depth, and depleting food resources are some of the examples of environmental cues that have a strong impact on den entry and emergence timing across populations (Støen *et al.*, 2020). Hibernation is another behavior consistent with the timing of reproduction, as animals cannot successfully mate and produce cubs because of limited resources after hibernation (Gleason *et al.*, 2022). The dens are typically located in locations with a stable microclimate and limited perturbations, which reduces the cost of energy as well as the death probability during wintertime (Manchi; Swenson 2016).

Seasonal Movement

Brown bears are also very mobile and have distinct temporal patterns in their motion and distribution that are directly associated with the availability of the resources and signs of reproductive activity, and increased distance of movement when food is abundant and mating is occurring. Bears greatly increase their daily range during the hyperphagia period in order to get as much energy as possible before winter dormancy (PMC 2021).The movement seasonally also depends on the topography and the distribution of food in the seasons, and people tend to change the route of travel to reach the high quality foraging regions and meet the costs of energy. Such flows are more restricted at the beginning of spring and in the late fall when food is scarce (Penteriani *et al.*, 2022).Male brown bears especially might enhance long distance dispersal in the mating season in order to meet multiple estrous females, but females with cubs are more localized in their movements in order to reduce risks and safeguard offspring. Snow depth and temperature are also examples of seasonal weather conditions that also affect the movement rates by changing the accessibility of habitats and energy spent (PMC 2021).

Activity rhythm

The daily and seasonal rhythm of activities of brown bears significantly depends on the environment and their biological clocks (Anno 2024).Ursus arctos in Deosai National Park, camera traps recorded a bimodal pattern of diel activity with high activity levels at midday and sunset, meaning that bears were crepuscular in their movement patterns, and activity patterns were consistent with the photooxidation cycle despite metabolic patterns that exhibited longer cycles (some cycles were diel).Bears change their rhythmicity to seasonal extremes, and diel activity patterns can persist in their activity patterns even when metabolic rhythms have longer periods though activity patterns can be diel (Thiel *et al.*, 2022).

Reproductive Ecology

Brown bears (*Ursus arctos*), have very seasonal reproductive timing, where copulation has been reported to occur between April and November, but the highest numbers of copulation occur between May and July across study areas in North America and Eurasia (García Rodríguez et al., 2020). This broad breeding dispersion was differing by latitude, and the bears at lower latitudes started to mate earlier in spring than those at higher latitudes. The onset of mating was associated with photoperiod more than with altitude or region, which could be attributed to the role of the day length on the reproductive physiology. Bears are implanted successfully, however, in a state of delayed implantation the blastocyst remains dormant until the female hibernates at the end of the fall.

Gestation period is about 5660 days and the process of implantation is normally initiated in November December and the cubs are normally born in January and February when mother is hiding in her den (Laake et al., 2022). This approach matches the cub birth and early spring when food quality is elevated to increase cub survival and maternal care and is a crucial energetic expenditure on the female who loses much body mass to support gestation and milk production during fasting in hibernation (Frontiers in Ecology and Evolution 2022). These are seasonal mating, delayed implantation, and winter birthing and important aspects of the *Ursus arctos* life history as well as significant consequences to demographic patterns and conservation management. The following figure shows the breeding cycle of Himalayan Brown Bear.

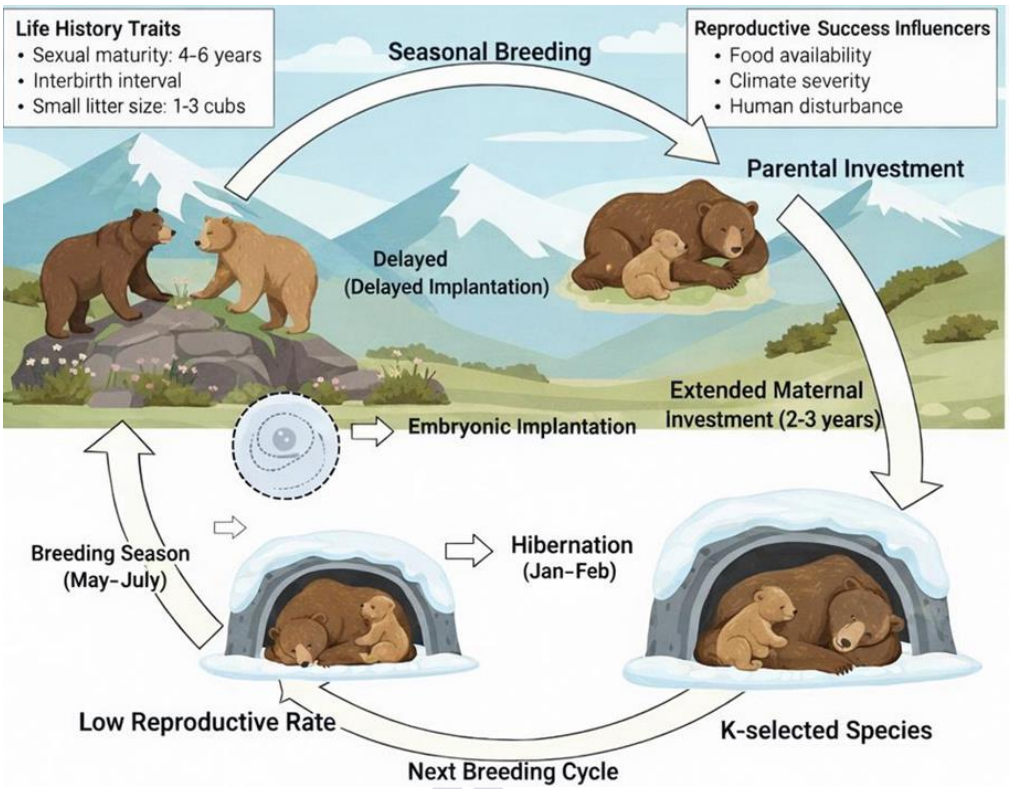


Fig. 02. Breeding Cycle of Himalayan Brown Bear

Population ecology

In Afghanistan, China, India, Iran, Iraq, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, Turkey, Turkmenistan, and Tajikistan, the Himalayan brown bear (*Ursus arctos isabellinus*) is widely distributed (Nawaz *et al.,* 2007).Brown bear populations have been found in 15 locations in Pakistan, with the Deosai Plateau and the Khujarab nationwide park having the largest populations due to conservation efforts. However, it is thought that some populations are dwindling. It used to be present in all of northern Pakistan's mountainous areas, but within the last forty to fifty years, it has experienced a sharp reduction (Sheikh & Molur, 2004).

Population Size and Demographic Status

A subspecies of brown bears that represents a long standing ancestry is the Himalayan brown bear. It is classified as a significantly endangered species in Pakistan and has a patchy distribution, existing in isolated groups throughout an area of roughly 150,000 km². There aren't many facts about the brown bear's habitat needs in Asia. This looks at the objectives of creating a comprehensive map of habitat appropriateness for the United States and learning about migration corridors to help guide policies that make patches more connected. In Pakistan, 31,000 km² of the species' old range have been covered by empirical evidence. Using an ensemble approach, a habitat suitability map was transformed into a produced one (Bista *et al.*, 2018).

Nonetheless, some suitable regions remain unprotected or receive just minimal protection. The population in the Hindu Kush range is remote, according to the connectivity model. The brown bear populations in the Pamir Karakoram type appear to be related to those in Afghanistan and China, whereas the Himalayan population is more closely related to the Indian population. We propose using the resource of tracking individuals via telemetry or genetic methods to validate migration corridors. The future of Himalayan brown bears in Pakistan depends on the green

management of gift blanketed regions and the expansion of protection to include unprotected habitats identified in this assessment (Nawaz *et al.*, 2008).

Identifying and locating Himalayan brown bears in Deosai National Park

The closest habitat in Pakistan to the last remaining stronghold of Himalayan brown bears (*Ursus arctos isabellinus*) is Deosai National Park (DNP). Despite having the best brown bear stronghold, the population of brown bears began to decline and was on the danger of extinction until DNP was informed in 1993 (Nawaz *et al.*, 2008). Brown bears were then able to improve their population thanks to conservation initiatives. The Himalayan brown bears dwell in alpine plateaus, which may not have extensive vegetation like the brown bears that inhabit Europe and the United States. This makes it possible to count brown bears directly or visually. The double observer survey method, which is entirely based on the capture mark recapture (CMR) version, was employed. It is possible to become acquainted with groups of brown bears due to the white spots on adult males and the length and color of brown bears' pelage (Bista et al., 2018).

Density of population

There are sixty six Himalayan brown bears in a 4,000 km² area that comprises DNP and its buffer valleys. At +90 five self-assurance C programming language, the population of Himalayan brown bears may be between fifty eight and seventy seven. The occupancy of brown bears varied between 0.00 and 0.04 animals/km². Nineteen tenting websites, each established by transhumance tribes to help themselves, their farm animals, or locals run distinct agencies, were positioned by the survey group. There were about 244 people living on such camping websites. Approximately 4,834 farm animal heads have also been found in DNP and the regions that surround it (zakir *et al.*, 2008).

Habitat fragmentation

This poses a significant genetic and demographic risk to isolated groups (Proctor et al., 2004). Population growth increases this danger and accelerates the rate of habitat destruction in their immediate surroundings (Nawaz, 2007; Can and Togan 2004; USFWS 2005) However, small populations could be successfully recovered if protection is provided. Numbers and geographic variation have been recovered in a number of locations in the United States and Western Europe by the crucial technique of reintroduction (Clark et al., 2002; Servheen et al., 1994). The large human settlements are likely the main reason why the brown bear population in the area was unable to increase.

The main factors that negatively impact the brown skinned population include rapid population expansion, the type of settlements, and the use of natural resources (Nawaz 2007). These activities, which include grazing, agriculture, gasoline timber series, hydroelectric tendencies, and so forth, are nicely described in literature as disturbing habitats. The main problems in the Neelum Valley are overgrazing, illegal logging, illegal collection of medicinal flora, and the extraction of timber and gas wood. There is an undue risk to the local animals due to the great demand for its fat for medical purposes (Qamar et al., 2005).

Human bear warfare

Many countries have proposed human bear warfare, which is becoming a global problem (Madden 2004; Ambarli; Bilgin 2008; Liu et al., 2011; Penjor Dorji, 2020). Due to regular interactions with rural communities (Abbas et al., 2015; Naeem et al., 2016), black bears in Asia, especially in Pakistan, are more of a public concern than any other carnivore (Ali et al., 2018; Ullah et al., 2020). This may be due to changes in the ways that forested land is used, such as the expansion of agricultural land, human reliance on properties in wooded areas, infrastructural development, an increase in the number of people living in spherical bear habitats, and disturbance of subterranean habitats (Woodroffe 2000; Sathyakumar 2001; Can et al., 2014). Black

undergrowth typically competes with humans for proximity, food, cover, and protection. The primary factor driving bears into the path of a human settlement is anthropogenic food. Conflict between humans and brown bears increases throughout their range as a result (Bargali et al., 2005; Escobar et al., 2015). Brown bears also seriously damage animals, fish farms, beehives, agricultural plants, and people that are near their habitat (Chauhan 2003; Bargali et al., 2005; Khan et al., 2021).

In certain places, like as Katmai National Park and Preserve, the herbal food resources are so abundant and consistent that visitors can visit the bear feeding areas to get up close and personal with the bears.

The dangers posed by human waste

A rapidly expanding threat to the long term population in the Indian Himalayan region is the consumption and reliance on human waste, which is generally caused by increased tourism and insufficient solid waste management. (Penjor & Dorji 2020)

Scavenged trash from human sell off sites now accounts for up to 75% of the Himalayan brown bear's diet, according to state of the art ecological study. The loss of natural alpine habitat and the increased accessibility of garbage, which leads to a hazardous overlap between human and wildlife habitats, particularly near protected regions like the Kugti Natural World Sanctuary, are the main causes of this dietary shift. (Ullah *et al.,* 2021).There are various fitness risks associated with scavenging garbage, including Consumption of nutrients was lower than that of their natural diet, Consumption of harmful chemicals, such as BPA, which may have an adverse effect on mortality rates, brain structures, and reproduction. Physical harm from consuming plastic that could result in intestinal blockage, ulceration, or perforation, which would probably cause hunger or even death. Exposure to zoonotic diseases and pathogens typically seen in waste disposal sites. The issue is made worse by challenging geography and harsh weather in remote mountain regions, which make efficient waste management challenging and result in incorrect disposal techniques like burning and dumping. (Khan *et al.,* 2021)

To lessen this risk, conservation initiatives, including those carried out by activist companies should concentrate on enhancing trash management facilities and working with neighborhood associations and governmental organizations.

Bear beating

Bear baiting has been occurring in the Punjab and Sindh provinces of Pakistan, since 2004. The local mafia, who host the competitions, own the battle dogs. In rural Pakistan, people swarm to watch bears fight groups of trained dogs. The bears are captured and tortured horrifically before they fight; their muzzles are viciously punctured with nose rings, their canines are damaged, and their claws are often severed. Because of their terrible injuries, bears seldom live past the age of eight. After one bear dies, the cycle repeats, forcing other young wild bears to suffer through captivity. You may help us put an end to the needless, agonizing suffering caused by the illegal practice of using dogs for bear baiting (IUCN Pakistan, 2004).

In Pakistan, bear baiting was prohibited by the Prevention of Cruelty to Animals Act (1890). Pakistan's wildlife authorities are working with animal welfare groups to put a halt to the incidents, with differing degrees of success. (Khan *et al.*, 2014)Mosques in bear baiting areas are encouraged to add an anticruelty message in their Friday Khuṭbah by the Bioresource Research Centre, a Pakistani wildlife organization committed to putting an end to bear baiting, using Islamic teachings. Animal baiting is forbidden in certain hadiths and lays restrictions on how people might treat animals, even though the Quran does not expressly condemn it (BRC 2018).

Conservation and Management in Pakistan

Conservation strategies:

With the possible exception of the entire Deosai National Park, the bear species in Pakistan has significantly decreased and is still declining throughout the majority of its range (Nawaz 2007;

Roberts 1997). Its long term survival depends on immediate action, which will be most successful if government agencies, non-governmental organizations, scientific institutions, and regions work together (WWF Pakistan 2012; IUCN 2000).

Establishing new reserves might not be required in the near future because the majority of surviving bear populations are currently contained within designated regions or conservancies. However, the efficacy of current protected areas is diminished by poor management practices, a lack of financing, and insufficient enforcement (IUCN 2000). Priorities for bolstering Pakistan's protected area system, establishing quantifiable conservation targets, and integrating are outlined in a national action plan created after extensive discussions (Ghazali & Khairi 1994).Priorities for bolstering Pakistan's protected area system, establishing quantifiable conservation objectives, and incorporating protecting biodiversity into long term policy are outlined in a national action framework that was created after thorough discussions (Ghazali & Khairi, 1994). Implementation by the appropriate authorities continues to be the key obstacle.

Local populations frequently have an unfavorable opinion of large carnivores, which makes it challenging to garner support for conservation. Carnivores, in contrast to ungulates, are seen to pose a threat to people and cattle because they do not directly produce meat (Treves & Karanth 2003). As a result, environmental education is a crucial instrument for influencing public opinion. Programs for raising awareness among visitors, workers at protected areas, local communities, and the general public can close knowledge gaps and foster collaboration in conservation efforts (Jacobson et al., 2015).Through community based revenue sharing, trophy hunting has grown in popularity as a conservation technique in Pakistan.

Despite its primary concentration on wildlife species, it has helped some prey species' populations rebound and produced substantial revenue for nearby communities (Shackleton 2001). It appears to have little effect on bears, but it may have a detrimental effect on other predators like wolves and winter leopards. Its wider contribution to biodiversity protection is still minimal (Hussain 2003). The ecological efficacy of trophy hunting regulations could be enhanced by incorporating carnivore conservation, for example by tying quotas to changes in predator populations (Leader Williams et al., 2005).

Bear habitats are still under threat from growing human populations, expanding infrastructure, depleting forests, and raising more livestock. In many areas, increasing reliance on alpine meadows may determine the species' continued existence and exacerbate human bear conflict (Woodroffe et al., 2005).

The continual protection of the Mountain brown bears also depends on international cooperation. Two important locations for cross border conservation efforts are the Pamir Knot and the Neelam Valley. It is possible to maintain habitat continuity and permit population dispersal through proposed preserves and mutually beneficial leadership across political boundaries (Schaller 2007).

Deosai should continue to be the main focus of conservation efforts in Pakistan since the integrity of this environment is crucial to the bear population in the nation. In a metapopulation paradigm, the Deosai population serves as a source population, highlighting the necessity of maintaining dispersal corridors connecting nearby populations and enhancing habitat quality. Recolonization potential throughout the Himalaya will be improved and the risk of inbreeding depression will be decreased by strengthening landscape connectivity (Frankham et al., 2010). For the Himalayan brown bear's long term survival, finding and safeguarding appropriate corridors ought to be a top management priority.

Framework for Management

Following its ratification of the Convention on the Protection of Biological Diversity (CBD), Pakistan created the National Conservancy Strategies (NCS) and Diversity Action Plan (BAP) to direct efforts to conserve biodiversity and protect the

environment (GoP 2000; IUCN Pakistan2003). Pakistan's wildlife protection is mostly the province's duty, with each province enforcing its own laws through forest or wildlife agencies (Nawaz 2007).

The northern regions forests, Wildlife and Parks Agency, the NWFP Wildlife Agency, and the AJK Division of Fisheries and Animals are the three provincial organizations responsible for overseeing the brown bear territory in northern Pakistan (Roberts 1997).The National Council for Preservation of Animals (NCCW), which is a federal agency, is in charge of overseeing provincial program coordination at the national level to make sure Pakistan complies with its international conservation obligations (GoP 2005).

Northern Pakistan is governed by three main wildlife laws: the Northwest Frontier Province Biodiversity Law (1974), the Azad Jammu and Kashmir Wildlife Act (1975), and the Northern Region of Pakistan Wildlife Preservation Act (1975). The legal foundation for creating protected places in three main categories as national parks, animal sanctuaries, and game reserves is provided by these statutes (IUCN 2000).Significant progress has been made in the designation of protected areas throughout the brown bear range.

Currently, a large portion of the remaining bear habitat is legally protected by seven national parks, 8 wildlife sanctuaries, and 10 game reserves (Nawaz 2007). Many of these regions cover core bear populations and offer defense against hunting or habitat degradation, but only a few sites like Deosai National Park or Khunjerab National Park are managed efficiently (WWF Pakistan 2012).Therefore, instead of serving as effective conservation units, many just exist on paper (IUCN 2000). The bulk of the roughly twenty five preserves in northern Pakistan lack official management plans, baseline ecological data, or basic management infrastructure critical omissions that compromise the efficiency of their conservation (GoP 2005; Nawaz 2007).

Conclusion

The Deosai brown bears population in Deosai National Park exhibits modest levels of genetic variety, according to our documentation, and is not currently in danger of interbreeding (Khan et al., 2014; Nawaz & Smith 2017). When the population shrank from a single, sizable population spread across northern Pakistan around 1000 years ago, it most likely started to lose genetic variety (Roberts 1997). As a result, the population was divided into smaller groups, each of which gradually lost contectedness (Frankham et al., 2010). After more protection measures were implemented, the population reduction in Deosai seems to have stabilized some 15 years ago (WWF Pakistan 2012). The population would probably be inbreeding now if there had been an extended period of isolation. Thus, we deduce that gene exchange with neighboring populations in Pakistan and India has preserved the moderate diversity in genes now found (Bellemain et al., 2007). However, compared to healthy brown black bear populations within Europe or North America, this degree of variety is still lower (Taberlet & Bouvet, 1994). Therefore, maintaining and enhancing connectivity with nearby populations will be essential to this small population's long term survival. We advise further research to maintain careful observation using both genetic analyses and field surveys (Waits & Paetkau 2005). In order to preserve or enhance genetic variety, management efforts should place a high priority on preserving and reestablishing contentedness with other populations; if not, the population will gradually lose diversity. In addition to improving population size estimates, extending the geographic reach of fecal samples would also shed more light on the magnitude of incoming transfer of genes (Kendall et al., 2009).

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