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Identifying key habitats to conserve the threatened brown bear in the Himalaya

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ABSTRACT

The threatened Himalayan brown bear has a fragmented range in the Himalayas. However, its habitat has never been documented, which hinders conservation efforts. The Deosai Plateau in northern Pakistan has long been recognized as the core area for this subspecies in the country. To provide knowledge to help conserve the remnant populations in the Himalayan region, and especially in protected areas, we investigated habitat selection of brown bears and the influence of human presence on brown bear distribution in Deosai National Park, Pakistan.

We used an Ecological Niche Factor Analysis to assess brown bear habitat selection, using scats sampled along transect routes throughout the park as location data. Habitat use based on 137 observations of brown bears during monitoring confirmed that differential scat detectability did not bias our results. Only 65% of the park area had productive vegetation. Our analyses indicated that brown bears avoided higher elevations and steeper slopes and selected more productive parts of the park (marshy, grassy, and stony vegetation types). The marshy vegetation was the most preferred habitat, probably because it had the highest forage production and density of golden marmots. Brown bears tolerated human infrastructures, like roads and camps, but strongly avoided grazing areas with high livestock density. The habitat suitability map generally followed the biomass productivity patterns of the park. It indicated the central part as suitable, and classified half of the park, mainly peripheral areas, as unsuitable for brown bears.

The vegetation and habitat suitability maps also provide an objective criterion for evaluating present and future developments in the park. Until recently, communities seem to have used the park's resources without significantly affecting the brown bear population. However, in recent years a large influx of nomadic communities with their livestock has become a challenge, which needs urgent attention to continue the present brown bear population recovery and to secure its habitat. We recommend monitoring the livestock and conducting a detailed inventory of the rangeland to understand grazing dynamics in the park and to maintain sustainable stocking rates.

1. Introduction

Human persecution, increasing human populations and their activities, and habitat degradation and fragmentation have reduced populations of large carnivores in much of the world (Weber and Rabinowitz, 1996; Woodroffe, 2000). Large carnivore conservation is particularly challenging, because these animals typically need large areas to meet their requirements, which necessitates landscape-level management. Protected areas can provide an important sanctuary for sensitive species, such as large carnivores, but they are often too small to ensure population viability (Newmark, 1995; Woodroffe and Ginsberg, 1998). Nevertheless, protected areas often constitute important, core habitats that better enable large carnivores to exist compared with mostly human-dominated landscapes (Schwartz et al., 2006). Zoning is an increasingly popular approach in wildlife conservation that results in distributing the resources within a protected area among various competing interests, such as human uses and wildlife

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(Hepcan, 2000; Kothari et al., 1996). However, reserving suitable areas for wildlife requires specialized knowledge, which is generally unavailable in many areas of the world and managers often select areas on an ad hoc basis, without a clear understanding of the ecological needs of the species they manage.

Brown bears (*Ursus arctos*) are endangered in Southern Asia, where mostly small, isolated populations exist in remote and rugged mountainous areas (Servheen, 1990). Although brown bears are generally well studied in North America and Europe, very little is known about their status and requirements for survival in Asia (Servheen et al., 1999), which hinders conservation efforts. The Himalayan brown bear (*U. a. isabellinus*) is a subspecies that represents an ancient lineage of the brown bear (Galbreath et al., 2007) and is distributed over the Great Himalaya region. This subspecies is threatened and its population is fragmented in Pakistan (Nawaz, 2007; Sathyakumar, 2001; Aryal et al., 2012). To date, almost no research has been conducted on the habitat requirements of brown bears in the Himalayan region, where they occur at low densities, usually in alpine meadows above timberline, between 3000 and 5500 m a.s.l. (Sathyakumar, 2001; Aryal et al., 2012). Most brown bears in Pakistan occur on the Deosai Plateau (Rasool, 1991; Roberts, 1997; Nawaz, 2007), but there were only about 20 individuals (Nawaz et al., 2008). This raised concerns for their survival and lead to the declaration of the area as a national park in 1993.

One of the goals of the Deosai National Park (DNP) was the conservation of the remnant bear population (HWF, 1999). A zoning plan was created to accommodate the resource needs of local and nomadic herding communities (HWF, 1999). Although people were allowed to use resources in consumptive zones, a "core area" was designated for brown bears, where public entry was prohibited. The ecological needs of brown bears were unknown at that time, so the demarcation of the core area was based on sightings of brown bears and subjective assessments. These conservation efforts seem to have been successful, because the brown bear population in the park grew by about 5% annually between 1993 and 2006 (Nawaz et al., 2008). Nevertheless, livestock numbers in the park also are increasing and there have been unsuccessful attempts by the livestock herders to encroach into the core area. However, new developments have been proposed for the park, including new roads, hotels, and sport facilities. Brown bears will not necessarily avoid livestock, as depredation losses on unguarded livestock can be high (Sagør et al., 1997), but brown bears do avoid human activities, settlements, and tourist developments at several levels of spatial scale (Nellemann et al., 2007; Martin et al., 2010). A better understanding of the park resources and how brown bears respond to human activities is required to understand how these issues might affect the bear population and also would provide important information to assist in the successful conservation of the remnant populations throughout the Himalayan region.

Our goal was to document the Himalayan brown bear's spatial ecology and use this knowledge to help improve park conservation efforts. Our objectives were to (1) assess habitat selection of brown bears, (2) assess the influence of human presence on bear distribution, and (3) provide a habitat suitability map for the brown bear as a tool for further conservation actions within this park.

2. Materials and methods

2.1. Study area

DNP occupies about 1800 km^2 of an alpine plateau in the western Himalaya and is managed administratively by the Gilgit-Baltistan Forest and Wildlife Department, Gilgit-Baltistan, Pakistan. It is a typical high-altitude ecosystem, with mean daily temperatures ranging from −20 °C to 12 °C, and annual precipitation varying between 510 and 750 mm. The vegetation is predominately herbaceous perennials, grasses, and sedges.

The alpine pastures of the park are an essential resource for wildlife, particularly brown bears (Nawaz, 2007). These rangelands also contribute substantially to the livelihood of local communities and nomadic groups (*Gujjars*). About 9000 livestock, mainly goats and sheep, grazed within the DNP in 2004. According to the zoning plan (HWF, 1999), the southeastern half of the park was designated as the core area for brown bears; local communities and Gujjars were allowed to graze alpine grasslands in the rest of the park.

2.2. Data collection

The locations of brown bear feces (hereafter referred to as sign) were used to indicate areas of use. Other brown bear sign (e.g. hairs, tracks) were not easy to find along the transect routes. We therefore only used scats as location of brown bear presence. We believe scats were representative of important habitats used by brown bears in the study area, because brown bears are not known to defecate in particular areas, except for concentrations at bed sites (Menges, 2011), which could bias our results. Therefore, they were adequate for assessing habitat suitability at the population level. Feces are commonly used in wildlife investigations to estimate abundance, species richness, and detection of prey in the diet (Wilson and Delahay, 2001; Bellemain et al., 2007), and recent advancement in molecular tools has enhanced precision and efficiency in these techniques (Valentini et al., 2009; Shehzad et al., 2012). Particularly for detection of carnivores at large spatial scales, sign surveys are known to be the most efficient methods both in economic and logistic terms (Barea-Azcon et al., 2007). However factors like seasonality and habitat type may influence detection and count of feces (Wilson and Delahay, 2001).

We divided DNP into five blocks, delineated by major rivers, and each block was searched for brown bear feces. Transects, 40 m wide and 40–60 km long, were placed in each block, and walked by a team of 2–3 people. The transect routes were located throughout most of the block, and included all elevation ranges and habitat types. Transect routes resembled a loop, starting from the central road, progressing towards the periphery of the park, and ended at the starting point. Each transect was completed in 2–3 days, with night stays made in portable tents. Sampling was done in September–October each year, towards end of the summer season, and scats of all age classes included. Age of scats was categorized into six classes, based on freshness (see details in Bellemain et al., 2007), however all age classes were included in collection to cover the entire summer season. Scats detectability was similar in each vegetation type, as the vegetation in the study area is not dense or tall enough to induce variability in detection rates.

2.3. Vegetation classification

We used the 28 July 1998 LANDSAT Thematic Mapper (TM) satellite image (Scene ID: LT5149036009820910) for habitat classification. There is snow cover in Deosai from October to May/June and cloud cover is dense and frequent. Although more recent images were available, the 28 July 1998 LANDSAT gave the best unobstructed view of the vegetation. We used a combination of supervised and unsupervised classification tools and ground control points in the ERDAS Imagine Program (Leica Geosystems, Inc.) to classify DNP into six classes; marshy vegetation, grassy vegetation, stony vegetation, rocky, water, and snow (Table 1). The cloud-covered areas in the 28 July 1998 LANDSAT image, about 8%, were replaced using the 30 September 2001 LANDSAT Enhanced Thematic Mapper (ETM) image (Scene ID: p149r036_7t20010930).