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Habitat Assessment of the Indian Wild Ass, *Equus hemionus khur*, in the Little Rann of Kutch, Gujarat, India

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Abstract

The Indian wild ass, *Equus hemionus khur*, locally known as khur or ghudkhar, is an Asiatic wild ass subspecies now largely confined to the Little Rann of Kutch (LRK) in Gujarat, India. The LRK is a saline desert ecosystem with a mosaic of mudflats, grassland "bets", scrubland, and anthropogenically modified habitats. This study presents a habitat survey of *E. h. khur* in the LRK, with the objectives of (a) characterizing major habitat types used by the species, (b) assessing spatial patterns of habitat use across seasons, and (c) identifying key anthropogenic pressures influencing habitat quality. Using a combination of stratified habitat mapping, vehicle- and foot-based line transects, and indirect signs, we recorded the presence of khur and its relative abundance across major habitat classes, including saline mudflats, bets with grassland–scrub mosaics, agricultural fringes, and salt pan landscapes. Khur showed a strong affinity for open grassland and scrub habitats on bets and fringe areas, especially during the dry and pre-monsoon seasons, while seeking refuge on elevated bets during monsoon flooding. Open and partially open habitats supported higher encounter rates than closed vegetation. Major threats to habitat quality included expansion of salt panning, intensive livestock grazing, irrigated agriculture, and linear infrastructure within and around the Indian Wild Ass Sanctuary. The study underscores the importance of maintaining the integrity of grassland scrub systems on bets, regulating salt and grazing pressures, and managing landscape connectivity beyond the protected area boundary for the long-term conservation of *E. h. khur* in the LRK.

Keywords: *Equus hemionus khur*; Little Rann of Kutch; India

Introduction

The Indian wild ass, *Equus hemionus khur* is commonly called as khur, recognized as the southernmost subspecies of the Asiatic wild ass and is crucially significant as the last remaining population of its kind in India. Historically, this subspecies was widespread across a range that ranged from western India, southern Pakistan, Afghanistan, and southeastern Iran. However, its range has significantly diminished, and it is now confined to the Little Rann of Kutch (LRK) and the adjacent regions of Gujarat, representing a reduction of the species' range by >99% from its historical extent (Joshi et al., 2018). To protect this robust equid and its current habitat, the Indian Wild Ass Sanctuary was established. Sanctuary plays a vital role in the preservation of its natural environment and aids in the species' overall conservation efforts (Braman et al., 2021; Singh, 2000). Currently, the Indian wild ass is classified as Near Threatened on the IUCN Red List, reflecting the ongoing challenges it faces due to habitat loss and other environmental pressures, and is included in CITES Appendix II and protected under Schedule I of the Indian Wildlife (Protection) Act, 1972. Nonetheless, positive strides have been made: after decades of targeted protection and management interventions, the wild population has begun to show signs of recovery, highlighting the effectiveness of conservation measures (Mammals of India, 2025).

Conservationists continue to monitor the species' status to ensure its survival and to foster a thriving ecosystem in which it can live freely.

LRK constitutes a distinctive saline desert ecosystem characterized by extensive mudflats that are submerged during the southwest monsoon and subsequently desiccate into salt-encrusted plains throughout the dry season (Barman et al., 2021). Within this intriguing landscape are slightly elevated landforms, referred to locally as bets, which support grassland and scrub vegetation; these areas provide essential foraging and resting habitats for the Indian Wild Ass and numerous other species (Barman et al., 2021). The LRK has garnered recognition for its high biodiversity value and is proposed as a biosphere reserve, exemplifying a model of harmonious human-wildlife coexistence.

The Indian wild ass has shown a significant population recovery, with recent estimates indicating more than 7,000 individuals in its broader range in Gujarat (Pandya, 2024). However, this species faces considerable challenges as its habitat is increasingly threatened by various human activities, including salt production, irrigated agriculture, intensive livestock grazing, and the development of linear infrastructure such as roads and canals (Dave, 2010; Goyal et al., 1999). Additionally, changes in land use around the LRK have allowed for the expansion of the species' range into neighboring areas, which presents both new conservation challenges and opportunities (Dave, 2010). Comprehensive information regarding habitat utilization, seasonal variations in species distribution, and the relative significance of various habitat types within the landscape of the LRK is essential for effective wildlife management strategies. Previous studies have underscored the critical role of open and partially open habitats, as they appear to be favored by wildlife, with notable concentrations of animals often found along the edges of these habitats, known as bets, and their surrounding fringes (Shah et al., 2008). Despite these valuable insights, there is an ongoing need for continuous habitat monitoring.

The LRK is situated within the semi-arid biogeographic zone 4B, specifically designated as Semi-Arid Gujarat-Rajputana (Chandra et al., 2021). The climate of this region is characterized by hot summers, a brief monsoon season extending from June to September, and cool, dry winters. The annual rainfall is both low and highly variable, typically ranging from 250 to 500 mm, with the majority of precipitation occurring during the southwest monsoon (Chandra et al., 2021). Summer temperatures frequently exceed 40°C, while winter nights can be comparatively cool. From a physiographic perspective, the LRK is distinguished as a vast saline mudflat featuring dark silt soils and extensive salt encrustation (Oldham, 1898; Platt, 1962). During the monsoon season, the area experiences inundation due to a combination of direct rainfall, riverine inflows, and tidal influences, resulting in the formation of a shallow, temporary wetland. As the waters recede, the mudflats dry and crack, leaving behind hypersaline crusts. Scattered throughout this expanse are more than 70 elevated islands, referred to as bets, which remain either unsubmerged or only marginally inundated during floods, thereby serving as refugia for terrestrial fauna (Barman et al., 2021; Goyal et al., 1999; Shah and Qureshi, 2007). The flora of the LRK can be generally categorized into desert and grassland ecosystems that are primarily characterized by halophytic and xerophytic species (Dash et al., 2022). Different habitat types of the Indian wild ass include saline mudflats and open salt desert, bets with grassland and scrub Shah et al., 2008), fringe grasslands and scrublands, agricultural lands and fallows (Parasharya and Teli, 2015), salt pan landscapes and industrial areas.

The present study aims to (a) classify and describe the major habitat types available to the Indian wild ass within the LRK, (b) document spatial and seasonal patterns of habitat use, and (c) identify key threats and management implications related to habitat quality and connectivity. By synthesizing field survey data with existing knowledge, we seek to provide a habitat-focused perspective to inform conservation planning for the Indian wild ass in the LRK.

Material and methods

Study Area

The LRK is located in western Gujarat, India, and spans the coordinates of approximately 22°30′–24°00′ N and 70°30′–72°30′ E. This remarkable area includes the Indian Wild Ass Sanctuary, also referred to as the Wild Ass Wildlife Sanctuary, which encompasses around 4,954 square kilometres. This sanctuary is crucial for the conservation of the endangered Indian wild ass, providing a protected habitat essential for its survival (Fig. 1). The LRK is framed by the mainland of Gujarat to the east and south, with the Gulf of Kutch to the southwest, and the Great Rann of Kutch to the north and northwest, creating a diverse and vibrant ecosystem worth preserving (Singh, 2000).

Study design and sampling framework

The habitat survey was carried out to investigate the spatial distribution and habitat occupancy of the Indian wild ass across the LRK. To conduct the survey, we selected three sampling stations, i.e., Jogad, Zinjuwada, and Bajana in the LRK. We explore the Indian wild ass-dominated regions from these three sampling stations. During this study, we explored terrains like grassland-scrub mosaics, fringe grassland and scrub, agricultural lands, salt pan, and

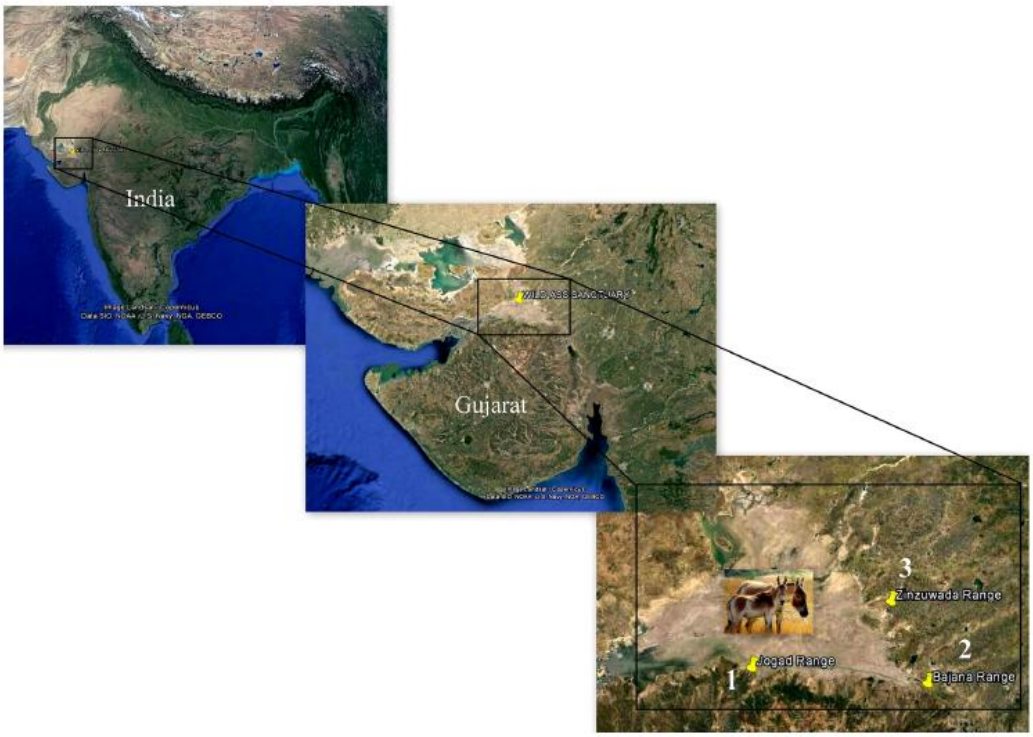
industrial regions, etc. Survey and sampling were carried out during pre-monsoon (hot, dry season), monsoon, and immediate post-monsoon (flooded and early recession phase), and late post-monsoon and winter (dry, cooler season). This methodological approach facilitated the examination of seasonal shifts in habitat use in relation to inundation patterns, availability of forage, and anthropogenic activities (Shah et al., 2008). The survey was carried out using photographic documentation from a suitable distance, without disturbing the animal. Additionally, we also collected indirect signs like dung and evidence of grazing, and habitat characteristics were also recorded.

Result

Habitat availability and composition

Saline mudflats and vast salt desert areas make up the largest portion of the sanctuary's overall terrain. Our observation reveals the unique ecological role of saline mudflats in this landscape, essential for assorted wildlife, including the endangered Indian wild ass. In addition to these mudflats, there are sparse yet ecologically significant zones of grassland-scrub ecosystems known as bets and fringe areas. Though these landscapes occupy a relatively smaller area compared to the expansive mudflats, they play a pivotal role in the ecology of the wild ass, providing foraging and resting needs of the Indian wild ass, making them disproportionately important in terms of diversity and conservation. Agricultural lands, primarily represented through irrigated fields and fallow lands, are found on the outskirts of the sanctuary. These cultivable land and agricultural fields, along with human activities, creates a transitional zone between the wilderness of the sanctuary and developed agricultural regions.

Fig. 1. Distribution range and major khur-dominated pockets in the Wild ass sanctuary, Little Rann of Kutch, Gujarat



Moreover, the salt pans and related infrastructure are located within saline zones, where the specific environmental conditions allow for salt extraction and other related activities. This interplay between natural habitats and agricultural land use reflects the complex dynamics within the Indian wild ass sanctuary, highlighting the importance of preserving these diverse ecosystems to sustain both wildlife and human needs. The structure of vegetation differed significantly across various habitat types. Saline mudflats primarily featured sparse, low-growing halophytic plants in an open setting. Bogs showcased a mixture of grasses and shrubs, typically with open to partially open coverage, while fringe areas exhibited more diverse and occasionally denser shrub growth. Agricultural fields offered thick seasonal crop cover, and salt pan regions were generally open and severely disturbed.

Through this study, we confirmed that habitat destruction is one of the omnipotent threats to the wild ass population of LRK. Despite habitat destruction and human encroachment in their natural home, they are experiencing competition for resources because of the high number of wild herbivores in the sanctuary, including Blue Bull (*Boselaphus tragocamelus*) (Fig. 2). The activities of the desert fox (*Vulpes vulpes pusilla*), golden jackal (*Canis aureus*), stripped hyena (*Hyaena hyaena*), both domestic and feral dogs in the sanctuary further contributes predation pressure on Khur (Fig. 2).

Spatial patterns of habitat use

Throughout various seasons, the Indian wild ass demonstrated a distinct preference for open and partially open habitats, particularly favoring bet grasslands and scrublands, as well as fringe zones between grasslands and scrubs. Encounter rates (individuals/km) in these habitats were consistently higher than those in closed or densely vegetated areas, supporting previous conclusions that open forests and partially open environments facilitate higher encounter rates of wild ungulates. Indian wild asses were frequently observed in larger bet areas, utilizing gentle slopes and plateaus for grazing and resting. Smaller bet habitats served as essential refuges during periods of monsoonal inundation, with the animals congregating on elevated terrain while adjacent mudflats experienced flooding. During the dry season, groups were observed transitioning between bet habitats and fringe grasslands, occasionally traversing bare saline expanses. The use of saline mudflats was primarily for movement purposes, and to a lesser extent, for foraging on ephemeral vegetation that emerged after the monsoon. Occurrences of Indian wild ass in salt pans and industrial landscapes were minimal; however, individuals occasionally crossed these areas to reach more favorable habitats. Agricultural lands were utilized opportunistically, particularly during the late post-monsoon and winter seasons when crops and stubble were available. This behaviour has the potential to create conflicts with agricultural stakeholders.

Fig. 2. Potential threats to the Indian wild Ass (*E. h. khur*) in the Little Rann of Kutch: Forage competition, predatory pressure, and habitat degradation

Seasonal shifts in habitat use

Habitat use patterns in the LRK exhibit significant seasonal variation, closely tied to the flooding regime and forage availability. During the monsoon and early post-monsoon periods, when extensive mudflats are submerged, Indian wild ass tend to congregate in higher ground areas known as bets and along the fringe zones. As the floodwaters recede, these animals disperse more broadly, utilizing peripheral grasslands, fallow fields, and occasionally entering agricultural croplands. Pre-monsoon surveys reveal a contraction in their activity, with Indian wild ass retreating to areas that still offer adequate forage and accessible water sources. This includes some fringe zones and permanent water features associated with canals and wells. The significance of bets as multi-season refuges becomes particularly clear, as they provide elevated terrain, less saline soils, and patches of perennial vegetation, which are crucial for sustaining wildlife.

Group size and distribution

Group sizes varied from single animals to clusters of several dozen, with the average group size generally greater on larger bets and in open grassland scrub mosaics (Fig. 3). Family groups and mixed herds were commonly seen (Fig. 3). The spatial distribution within the LRK was not uniform. Specific bets and fringes consistently supported

higher populations of Indian wild ass, likely attributable to a mix of better forage, reduced disturbance, and proximity to water resources. These areas may be viewed as core habitat patches within the larger LRK landscape.

Fig. 3. The Indian Wild Ass (*E. h. khur*) in the Wild Ass Sanctuary, LRK: Herds of varying sizes

Discussion

The observed preference of the Indian wild ass for open and partially open habitats in the LRK is consistent with its evolutionary history as a cursorial ungulate adapted to arid grasslands and shrublands (Barman et al., 2021; Pokharel, 2019). Open vistas likely facilitate predator detection and social cohesion, while grass shrub mosaics provide a balance of forage and cover. The reliance on bets and fringe grassland shrub systems underscores the importance of microtopographic and edaphic variation in an otherwise relatively homogeneous saline desert. Bets offer comparatively deeper, less saline soils that support higher biomass and diversity of grasses and forbs, making them key resource patches throughout the year Barman et al., 2021; Shah et al., 2008).

The LRK faces considerable anthropogenic pressures despite having legal protections in place. One of the primary economic activities in the area is salt panning, which accounts for approximately 25% of India's salt supply (Barman et al., 2021). The expansion of salt pans, along with the development of associated roads and worker settlements, leads to habitat fragmentation, disrupts wildlife, and modifies hydrological and soil salinity conditions (Fig. 2). These alterations can adversely affect forage availability and the movement patterns of various species. In addition, extensive livestock grazing by cattle, buffalo, sheep, and goats in the fringe grasslands and bets further exaggerates the competition for forage and risks degrading vegetation structure unless managed sustainably (Roy and Singh, 2013). The introduction of irrigation canals that supply water to the southern and eastern boundaries of the LRK has contributed to agricultural expansion while simultaneously altering soil salinity and drainage patterns (Gupta, 2015). These changes complicate habitat management and may impact the distribution of the Indian wild ass, as these animals are drawn to crop fields but may encounter increased human-wildlife conflicts (Parasharya and Teli, 2015). Furthermore, linear infrastructure such as roads, power lines, and canals can function as barriers or partial impediments to wildlife movement, fragmenting the LRK landscape and obstructing dispersal routes to the Great Rann of Kutch and parts of Rajasthan (Barman et al., 2021). It is crucial to maintain the permeability of these structures to support long-term metapopulation dynamics and ensure genetic connectivity among species. A similar study carried out by (Ali et al., 2023) on a related species of Indian wild ass, the Tibetan wild ass (*Equus kiang*) in the Changthang Wildlife Sanctuary, Ladakh, also describes changes in habitat resource use and conflicts of the

wild ass and the livestock for forage, as well as residents becoming intolerant towards them as a potential threat to these species.

Recent assessments of the Indian wild ass population show a significant recovery, with estimates exceeding 7,600 individuals in 2024, rising from around 6,000 in 2020 (Pandya, 2024). Previous studies indicated that the population within the LRK and nearby areas was nearing or had surpassed the carrying capacity of the current protected region, which has led to the expansion of their range into neighboring areas (Singh, 2000; Parasharya and Teli, 2015). While the growth of the population is an important conservation success, it also emphasizes the significance of habitat quality and availability. Continued habitat degradation within the LRK due to factors like overgrazing, the expansion of salt pans, or unplanned infrastructure could undermine the ecological foundation necessary to support high densities of Indian wild ass. On the other hand, effectively managed expansion of suitable habitats into surrounding regions could serve as a buffer, facilitating natural dispersal and alleviating concentration pressures within the sanctuary. Despite a significant increase in population numbers, research conducted by (Khaire et al., 2016; Khaire et al., 2017) revealed a concerning lack of genetic diversity in mitochondrial DNA (mtDNA). This finding suggests a potential population bottleneck in recent times, which may be linked to the outbreak of the protozoan disease known as Surra. These studies highlight that, although the population appears to be large, it remains genetically susceptible to parasitic and pathogenic infections, raising important concerns regarding its long-term viability and health, emphasizing the importance of such studies for the proper conservation measures.

The findings from the habitat survey indicate several key management implications. Protecting and restoring bets and fringe grassland–scrub systems is crucial. Due to their significant role as foraging and refuge habitats, these areas should be prioritized for safeguarding against intensive salt panning, quarrying, and unregulated grazing. Restoration initiatives could involve implementing controlled grazing practices, reseeding native grasses, and managing or removing invasive shrubs that hinder habitat openness. Regulation of salt production and its infrastructure is necessary. Implementing zoning for salt pan activities away from essential Indian wild ass habitats and vital movement corridors, as well as rehabilitating unused pans, would support habitat connectivity and lessen disturbances. Grazing management needs to be sustainable. Developing participatory grazing plans in collaboration with local communities can help reconcile livestock requirements with wildlife habitat needs, incorporating practices such as rotational grazing, stocking limits, and protection of crucial dry-season refuges on bets. Addressing human–wildlife conflict in agricultural borders is important. Utilizing incentive and insurance-based strategies along with community involvement can help mitigate conflicts stemming from khur interactions with croplands. Encouraging the adoption of wildlife-friendly agricultural practices in proximity to core habitats may mitigate damage to ecosystems while simultaneously providing seasonal forage for wildlife. Ensuring landscape connectivity is vital. Careful planning of roads, canals, and power lines, including the incorporation of wildlife crossings and avoiding critical bottlenecks, is essential for maintaining movement corridors between LRK and surrounding habitats in the Great Rann of Kutch and Rajasthan (Bindra, 2017). Conducting long-term monitoring and research is important. Ongoing assessment of habitat conditions, population dynamics, and movement patterns through methodologies such as line transects, camera trapping, telemetry, and remote sensing will be essential for evaluating the success of management efforts and adjusting strategies as needed over time (Shah et al., 2008).

Conclusion

Current study highlights the importance of bets and fringe grassland-scrub systems as essential habitats, the critical role of elevated refugia during monsoon flooding, and the Indian wild ass's strong preference for open and semi-open vegetation. However, factors such as expanding salt production, intensive livestock grazing, irrigated agriculture, and infrastructure development are posing significant threats to habitat quality and connectivity. Thus, conservation efforts should not only aim to protect the existing sanctuary but also focus on managing the larger LRK landscape and its surroundings as a cohesive socio-ecological system. By aligning habitat management strategies with community livelihoods, controlling industrial and infrastructural growth, and ensuring ecological connectivity, we can work towards securing the long-term future of the Indian wild ass while preserving the ecological and cultural significance of the LRK. Ongoing, detailed habitat monitoring and adaptive management will be essential in addressing the emerging challenges like climate variability, changes in land use, and increasing human pressures.

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