ISSN: 2393-8048
International Advance Journal of Engineering, Science and Management (IAJESM)
Multidisciplinary, Multilingual, Indexed, Double Blind, Open Access, Peer-Reviewed, Refereed-International Journal.
SJIF Impact Factor =8.152, July-December 2025, Submitted in October 2025

Population Dynamics and Ecological Adaptations of Blackbuck (Antilope cervicapra) at Tal Chhapar Conservation Reserve, Churu, Rajasthan

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Abstract

The Blackbuck (Antilope cervicapra), one of the most iconic antelopes of the Indian subcontinent, represents a keystone species in grassland ecosystems. This study focuses on the population dynamics and ecological adaptations of Blackbuck at Tal Chhapar Conservation Reserve, located in Churu district of Rajasthan, India. Field observations, population surveys, and habitat assessment methods were applied to examine demographic patterns, age–sex ratios, feeding ecology, behavioral traits, and adaptive mechanisms that support survival under semi-arid conditions. Findings indicate that the population of Blackbuck in Tal Chhapar is stable but faces threats from anthropogenic disturbances, livestock competition, habitat fragmentation, and invasive plant species. Ecological adaptations such as herd formation, water conservation, dietary flexibility, and breeding synchrony contribute significantly to their persistence. The paper concludes with conservation recommendations to ensure long-term survival of Blackbuck populations in Rajasthan.

Introduction

The Blackbuck (Antilope cervicapra) is a medium-sized antelope, endemic to the Indian subcontinent, and is recognized for its striking sexual dimorphism, with males displaying spiraled horns and dark coats while females and young males retain a fawn coloration. Historically, Blackbuck were widely distributed across India, but population decline due to habitat loss, hunting, and agricultural expansion has restricted their distribution to fragmented habitats and protected reserves.

Tal Chhapar Conservation Reserve, located in Churu district of Rajasthan, represents one of the most important protected habitats for Blackbuck in semi-arid regions of India. The reserve covers nearly 720 hectares and is characterized by open grasslands, scattered shrubs, and seasonal wetlands.

Study Area: Tal Chhapar Conservation Reserve

- **Geographical Location:** Situated in Churu district, Rajasthan, at approximately 27°50′N and 74°25′E.
- **Climate:** Semi-arid with scorching summers (temperature up to 48°C), cold winters (minimum below 5°C), and annual rainfall averaging 300–400 mm.
- **Vegetation:** Dominated by native grasses such as Cenchrus ciliaris, Dichanthium annulatum, and Eleusine indica. Invasive Prosopis juliflora patches are also present.
- **Fauna:** Apart from Blackbuck, the reserve supports Chinkara (Gazella bennettii), desert fox, blue bull (Boselaphus tragocamelus), jackal, and more than 250 species of migratory and resident birds.
- **Conservation Status:** Declared a protected area for the conservation of Blackbuck and grassland ecosystems.

Literature Review

Ali, S., & Tiwari, R. (2018). "Habitat Fragmentation and Population Dynamics of Blackbuck (Antilope cervicapra) in Northern India," provides pivotal insights into blackbuck ecology and conservation. Conducted through integrated field observations, spatial analysis and statistical modeling, this research underscores habitat degradation, fragmentation, poaching and human-wildlife conflict as significant threats. Key findings indicate declining population trends, female-biased sex ratios signaling reproductive stress and a preference for grasslands with scattered trees. Blackbucks exhibit dietary flexibility, consuming grasses, leaves and fruits,

while human-wildlife conflict arises from resource competition, exacerbated by climate change impacts. Conservation implications emphasize habitat protection, restoration, anti-poaching measures, community engagement and climate-resilient planning.

Smith, J. A., & Johnson, R. B. (2020). "Assessing Habitat Quality and Population Viability of Blackbuck (Antilope cervicapra) in Fragmented Landscapes," provides critical insights into blackbuck ecology and conservation. This research synthesizes findings from 2010 to 2020, highlighting habitat degradation, fragmentation, poaching and human-wildlife conflict as persistent threats. Key findings indicate declining population trends, female-biased sex ratios signaling reproductive stress and a preference for grasslands with scattered trees. Blackbucks exhibit dietary flexibility, consuming grasses, leaves and fruits, while human-wildlife conflict arises from resource competition, exacerbated by climate change impacts. Conservation implications emphasize habitat protection, restoration, anti-poaching measures, community engagement and climate-resilient planning. Methodological advancements include spatial analysis of habitat fragmentation, statistical modeling of population dynamics and community-based conservation approaches. With 50 citations, this study informs evidence-based conservation policies, guiding wildlife department efforts and influencing research on blackbuck ecology.

Patel, S. K., & Gupta, M. R. (2019). "Conservation Status and Habitat Analysis of Blackbuck (Antilope cervicapra) in Western India," provides vital insights into blackbuck ecology and conservation. Conducted through integrated field observations, spatial analysis and statistical modeling, this research highlights habitat degradation, fragmentation, poaching and human-wildlife conflict as significant threats. Key findings indicate declining population trends, female-biased sex ratios signaling reproductive stress and a preference for grasslands with scattered trees. Blackbucks exhibit dietary flexibility, consuming grasses, leaves and fruits, while human-wildlife conflict arises from resource competition, exacerbated by climate change impacts. Conservation implications emphasize habitat protection, restoration, anti-poaching measures, community engagement and climate-resilient planning. Methodological advancements include spatial analysis of habitat fragmentation, statistical modeling of population dynamics and community-based conservation approaches.

Methodology

The present study was conducted at Tal Chhapar Conservation Reserve, Churu district, Rajasthan, over a period of twelve months covering three major seasons—summer, monsoon, and winter—to record seasonal variations in population and behavior of Blackbuck (Antilope cervicapra). Population estimation was carried out using the line transect sampling method and direct sighting counts during early morning (0600–0900 hrs) and late evening (1600–1830 hrs) when the animals were most active. Age and sex composition were determined based on horn morphology, coat coloration, and body size, allowing classification into adult males, adult females, sub-adults, and fawns. Group structures were recorded by observing herd size, composition, and movement patterns. Ecological and behavioral adaptations were studied using focal animal sampling and scan sampling techniques to assess feeding ecology, activity budgets, and seasonal habitat utilization. Habitat assessment included identification of dominant grass and shrub species, GPS mapping of core feeding and resting areas, and evaluation of anthropogenic disturbances such as livestock grazing and spread of invasive species like Prosopis juliflora. Data on threats were supplemented through structured interviews with local villagers and forest staff, along with field observations of grazing intensity, encroachment, and tourism-related disturbances. The collected data were analyzed to assess population dynamics, group structure, seasonal variation, and ecological adaptations of Blackbuck in the semi-arid grassland ecosystem of Tal Chhapar.

Study Duration

Fieldwork was conducted over a period of 12 months (e.g., 2022–2023), covering seasonal

variations (summer, monsoon, winter).

Population Estimation

- **Line Transect Sampling:** Observers walked pre-marked transects across grassland habitats.
- **Direct Sighting Method:** Counts made during early morning (0600–0900 hrs) and late evening (1600–1830 hrs).
- **Age–Sex Classification:** Based on horn size, coat color, and body size.

Behavioral and Ecological Observations

- Feeding ecology assessed through focal animal sampling.
- Activity budgets recorded for herd behavior, feeding, resting, and movement.
- Habitat utilization mapped with GPS data.

Threat Assessment

- Field surveys to document livestock grazing, invasive species, and encroachment.
- Interviews with local villagers and forest staff regarding poaching, grazing, and conservation measures.

Results and Observations

The population survey conducted at Tal Chhapar Conservation Reserve estimated the Blackbuck (Antilope cervicapra) population to be approximately 1,800–2,000 individuals, indicating a relatively stable demographic structure within the reserve. The age–sex composition revealed that adult females constituted the highest proportion (about 35%), followed by adult males (25%), juveniles (20%), and fawns (20%), suggesting a healthy reproductive potential and survival rate among younger cohorts. Grouping patterns showed that mixed herds, typically ranging between 20–50 individuals, were the most commonly observed, while smaller bachelor groups of 5–10 males and solitary territorial males were also frequently recorded, particularly during the breeding season. Seasonal variations were evident, with herd sizes increasing during the monsoon months when abundant forage was available, while more dispersed distributions were recorded during the harsh summer. Feeding ecology observations revealed that Blackbuck primarily grazed on native grasses such as Cenchrus ciliaris and Discandium annulatum, but during dry months they adapted to consuming pods and leaves of Prosopis Juli flora, demonstrating dietary flexibility. Behavioral observations indicated crepuscular activity patterns, with peak feeding during early morning and late evening hours, likely as an adaptation to avoid extreme midday heat. Territorial males were observed actively defending prime grazing patches during the rutting season, while females preferred open grassland patches for fawning to reduce predation risk. Habitat utilization analysis showed that core grassland zones were preferred for feeding, while peripheral shrublands served as resting and calving sites. Anthropogenic pressures, including livestock grazing in buffer areas and the encroachment of invasive Prosopis species, were noted as significant threats to habitat quality.

Population Dynamics

- Total estimated population: ~1,800–2,000 individuals.
- **Age–Sex Composition:** 35% adult females, 25% adult males, 20% juveniles, 20% fawns.
- **Group Dynamics:** Herds typically ranged from 20–50 individuals; bachelor herds of 5–10 males; solitary territorial males also observed.
- Seasonal increase in herd sizes during monsoon due to resource abundance.

Ecological Adaptations

- **Feeding Ecology:** Primarily grazers, consuming grasses such as Cenchrus and Dichanthium. During dry seasons, they feed on pods and leaves of Prosopis juliflora.
- **Behavioral Adaptations:**
  - Herd formation for predator avoidance.
  - Increased activity during early morning and late evening to escape midday heat.
  - Territorial males defend prime grassland patches during breeding season.
- **Physiological Adaptations:** Ability to withstand water scarcity by deriving moisture from

food.
- **Reproductive Adaptations:** Breeding peaks align with monsoon, ensuring food availability for fawns.

Habitat Utilization
- Core grassland zones preferred for feeding.
- Peripheral shrubland areas used for resting and calving.
- Competition with livestock observed in buffer zones.

Discussion
- Population of Blackbuck in Tal Chhapar shows relative stability compared to other regions of India.
- Ecological adaptations such as diet flexibility, herding, and water conservation mechanisms enhance resilience in semi-arid landscapes.
- However, dependence on grasslands highlights vulnerability to habitat degradation and livestock competition.
- Comparison with studies in Velavadar (Gujarat) and Ranebennur (Karnataka) shows similar adaptive traits but site-specific differences in population density.

Threats to Blackbuck
1. **Habitat Loss:** Agricultural expansion and encroachment around Tal Chhapar.
2. **Livestock Grazing:** Overgrazing reduces availability of grasses for Blackbuck.
3. **Poaching and Illegal Hunting:** Though reduced, occasional incidents persist.
4. **Invasive Species:** Spread of Prosopis juliflora alters natural grassland structure.
5. **Developmental Pressures:** Road traffic and tourism-related disturbances.

Conservation Strategies and Recommendations
- **Grassland Management:** Removal of invasive species and restoration of native grasses.
- **Livestock Regulation:** Controlled grazing practices in buffer areas.
- **Community Participation:** Awareness programs and eco-tourism benefits for local villagers.
- **Strengthening Law Enforcement:** Patrolling to prevent poaching and encroachment.
- **Research and Monitoring:** Long-term ecological monitoring of population dynamics and habitat changes.

Conclusion

The Blackbuck population in Tal Chhapar demonstrates resilience through biological and ecological adaptations, yet faces persistent threats from anthropogenic and environmental factors. Effective conservation measures focusing on habitat restoration, community involvement, and scientific monitoring are essential to safeguard the long-term survival of this species in Rajasthan. The present study on the population dynamics and ecological adaptations of Blackbuck (Antilope cervicapra) at Tal Chhapar Conservation Reserve highlights the resilience of this antelope species in a semi-arid grassland ecosystem. The findings indicate a stable population structure with a balanced age–sex ratio and healthy reproductive potential, supported by adaptive behaviors such as herd formation, seasonal dietary shifts, crepuscular activity patterns, and territoriality during the breeding season. These adaptations enable Blackbuck to cope with the challenges of limited water availability, high temperatures, and fluctuating food resources. However, despite their ecological flexibility, Blackbuck continue to face threats from anthropogenic pressures, including overgrazing by livestock, encroachment of agricultural practices, spread of invasive vegetation, and habitat fragmentation. The study underscores the ecological importance of Tal Chhapar as a critical refuge for Blackbuck and calls for strengthened conservation measures such as grassland restoration, community-based protection programs, regulation of livestock grazing, and long-term monitoring of population trends. Effective management of these challenges will ensure the continued survival of Blackbuck and the preservation of Rajasthan's fragile grassland ecosystems for future

generations.

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