

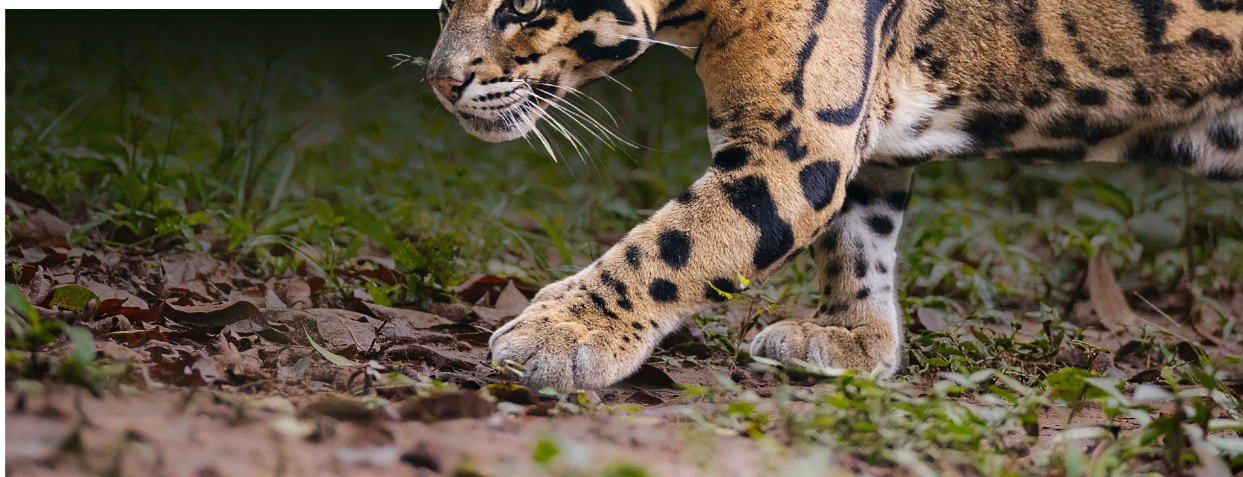


CONSERVATION ACTION PLAN

*For Caracal, Fishing
Cat & Clouded Leopard*

2026

Technical Report



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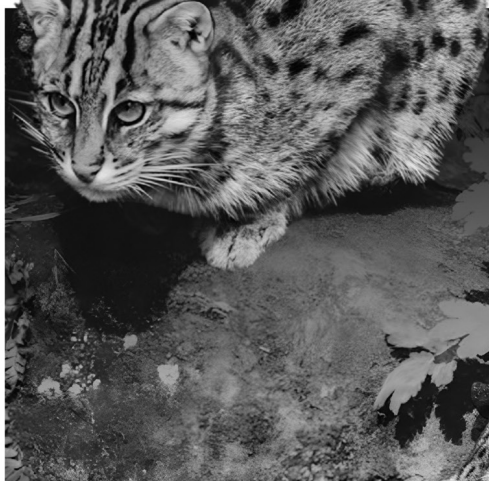
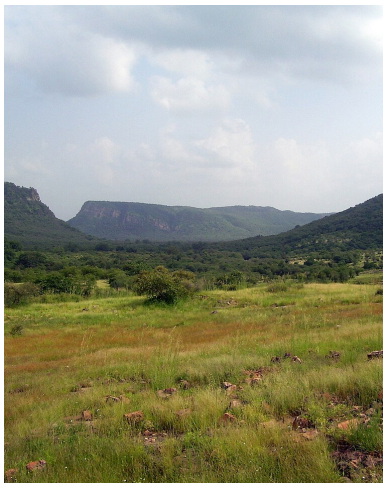


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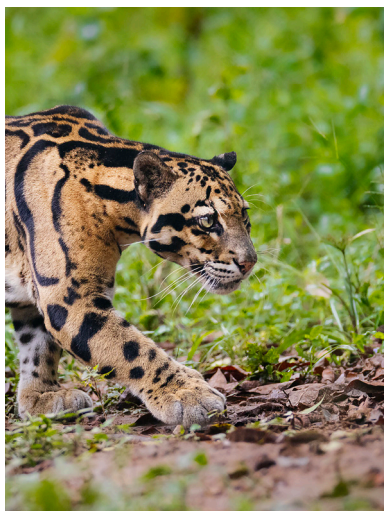
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List of Abbreviations

Abbreviation	Full Form	Abbreviation	Full Form
AI	Artificial Intelligence	M-STrIPES	Monitoring System for Tigers – Intensive Protection and Ecological Status
AMRUT	Atal Mission for Rejuvenation and Urban Transformation	mtDNA	Mitochondrial Deoxyribonucleic Acid
AOP	Annual Operating Plan	NBA	National Biodiversity Authority
APC	Anti-Poaching Camp	NCD	Nature Conservation Division
APCCF	Additional Principal Chief Conservator of Forests	NCTNC	National Trust for Nature Conservation
ASL	Above Sea Level	NDVI	Normalized Difference Vegetation Index
BNHS	Bombay Natural History Society	NDWI	Normalized Difference Water Index
BR	Biosphere Reserve	NGO	Non-Governmental Organisation
BSF	Border Security Force	NGS	Next Generation Sequencing
CA	Conservation Area	NGT	National Green Tribunal
CAMPA	Compensatory Afforestation Fund Management and Planning Authority	NH	National Highway
CAP	Conservation Action Plan	NMCG	National Mission for Clean Ganga
CEFP	Critical Ecosystem Partnership Fund	NP	National Park
CF	Community Forest	NPCA	National Plan for Conservation of Aquatic Ecosystems
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora	NPO	National Project Officer
CPCB	Central Pollution Control Board	NTCA	National Tiger Conservation Authority
CPUE	Catch Per Unit Effort	NTFP	Non-Timber Forest Product
CR	Community Reserve	PA	Protected Area
CRZ	Coastal Regulation Zone	PAWS	Protection Assistant for Wildlife Security
CSR	Corporate Social Responsibility	PES	Payments for Ecosystem Services
CTDS	Camera Trap Distance Sampling	PHVA	Population and Habitat Viability Analysis
CWC	Central Water Commission	PWD	Public Works Department
DNA	Deoxyribonucleic Acid	REDD+	Reducing Emissions from Deforestation and Forest Degradation Plus
DPR	Detailed Project Report	RF	Reserve Forest
DST	Department of Science and Technology	RRT	Rapid Response Team
EDC	Eco-Development Committee	RS	Remote Sensing
eDNA	Environmental Deoxyribonucleic Acid	RTR	Ranthambore TR

E-flow	Environmental Flow	SACON	Sálim Ali Centre for Ornithology and Natural History
EMP	Environmental Management Plan	SAPCC	State Action Plan on Climate Change
ER	Elephant Reserve	SAWEN	South Asia Wildlife Enforcement Network
ESZ	Eco-Sensitive Zone	SBSAP	State Biodiversity Strategy & Action Plan
FCCA	Fishing Cat Conservation Alliance	SCR	Spatial Capture–Recapture
FD	Forest Division	SE	Standard Error
GEF	Global Environment Facility	SECR	Spatially Explicit Capture–Recapture
GIS	Geographic Information System	SESA	Strategic Environmental and Social Assessment
GPS	Global Positioning System	SHG	Self-Help Group
HoFF	Head of Forest Force	SMART	Spatial Monitoring and Reporting Tool
IBCA	International Big Cat Alliance	SMS	Short Message Service
IBP	India Biodiversity Portal	SOP	Standard Operating Procedure
ICAR	Indian Council of Agricultural Research	SPCB	State Pollution Control Board
ICZM	Integrated Coastal Zone Management	SSC	Species Survival Commission
IDWH	Integrated Development of Wildlife Habitats	STF	Special Task Force
IEC	Information, Education and Communication	SWAP	State Wildlife Action Plan
IMD	India Meteorological Department	TR	Tiger Reserve
ISRO	Indian Space Research Organisation	UNDP	United Nations Development Programme
IUCN	International Union for Conservation of Nature	UNESCO	United Nations Educational, Scientific and Cultural Organization
JFMC	Joint Forest Management Committee	UNFCCC	United Nations Framework Convention on Climate Change
KBA	Key Biodiversity Area	WCCB	Wildlife Crime Control Bureau
LAC	Local Advisory Committee	WCS	Wildlife Conservation Society
LPG	Liquefied Petroleum Gas	WII	Wildlife Institute of India
MEE	Management Effectiveness Evaluation	WLS	Wildlife Sanctuary
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme	WPA	Wildlife (Protection) Act, 1972
MoEFCC	Ministry of Environment, Forest and Climate Change	WR	Wildlife Reserve
MoU	Memorandum of Understanding	WWF	World Wide Fund for Nature
MP	Madhya Pradesh	WTCL	Western Tiger Conservation Landscape



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We dedicate this work to the conservation of the Asiatic Caracal, Fishing Cat, and Clouded Leopard, and to all those working towards securing the future of these remarkable felids and the ecosystems upon which they depend.

INTRODUCTION



Background & Rationale

India supports a rich diversity of wild cat species, many of which are emblematic of the country's varied ecosystems. However, conservation attention and action have historically been skewed toward a few charismatic large cats, leaving several ecologically significant smaller felids inadequately represented in research, policy, and protection frameworks. Among these neglected species, the caracal (*Caracal caracal*), fishing cat (*Prionailurus viverrinus*), and clouded leopard (*Neofelis nebulosa*) are particularly vulnerable due to habitat fragmentation, prey depletion, increasing human pressures, and the absence of species-specific conservation strategies.

Each of these species plays a unique ecological role within its habitat. The caracal, an adapted mesopredator with high ecological tolerance, is restricted to the arid and semi-arid ecosystems of western and central India, where it faces intense anthropogenic pressures and localised extinctions (Kolipaka, 2011). The fishing cat, a specialist in wetland ecosystems, inhabits highly threatened aquatic habitats across South and Southeast Asia and is declining rapidly due to habitat conversion, pollution, and the expansion of aquaculture (Mukherjee *et al.*, 2025). The clouded leopard, often referred to as a modern-day sabre-toothed cat and the smallest of the big cats, is native to South and Southeast Asia and has adapted to an arboreal lifestyle; however, it faces widespread deforestation, poaching, and depletion of its prey base (Gray *et al.*, 2021).

Although all three species are listed under Schedule I of the Wildlife (Protection) Act (WPA), 1972, which provides the highest level of legal protection in India, their conservation status remains precarious. Caracals are known from only three states and occur at extremely low densities, with fewer than 50 individuals estimated in some populations (Singh *et al.* 2014). Fishing cats, although more widely distributed, number fewer than 8,000 mature individuals globally and face severe degradation of their wetland habitats (Mukherjee *et al.*, 2025). Clouded leopards, with an estimated global population of fewer than 10,000 mature individuals, have experienced population declines exceeding 30% over the last three generations and are increasingly threatened by habitat loss and illegal trade (Gray *et al.*, 2021).

Despite their protected status and ecological importance, these species have remained absent from national-level targeted recovery programmes. Conservation planning and implementation for these species have been fragmented, with available ecological data scattered and region-specific management responses often lacking coordination. Notably, the caracal and clouded leopards have been recognised as conservation priorities. Both are now included under the Species Recovery Programme of the Integrated Development of Wildlife Habitats (IDWH) scheme by the Ministry of Environment, Forest and Climate Change (MoEFCC), which aims to safeguard species of concern, particularly those found outside the PA network. However, these species inhabit landscapes across much of their range where local ecological conditions and socio-economic realities have not yet systematically integrated conservation interventions. This disconnect increases their vulnerability to continued decline and potential local extirpation, further emphasising the necessity of comprehensive and evidence-based recovery planning.

In light of these challenges, the GOI–UNDP–GEF-7 Project, under the overarching theme of “*Strengthening conservation and resilience of globally significant wild cat landscapes through a focus on small cat and leopard conservation*”, has recognised the urgent need for Conservation Action Plans (CAPs) for these three under-represented felids. The project requires the development of data-driven, participatory, and climate-resilient conservation strategies informed by a comprehensive review of scientific knowledge, socio-environmental evaluations, and stakeholder consulta-

tions and conducted through the Strategic Environmental and Social Assessment (SESA) framework.

The preparation of these CAPs is intended as a collaborative and systematic process that will (1) address critical knowledge gaps in the ecology, distribution, and threats to these species, (2) prioritise conservation actions in key landscapes, (3) incorporate stakeholder and community perspectives, and (4) integrate climate adaptation and resilience-building into conservation planning.

Ultimately, this initiative aims to contribute to a national database and atlas of these three small wild cats (caracal, fishing cat, and clouded leopard), offering a foundational tool for future conservation policy. The development of species-specific recovery plans is thus a critical step towards mainstreaming small cat conservation within India's broader biodiversity agenda and ensuring the long-term survival of these charismatic yet overlooked species.



By Tribhuwan Singh

Objectives of the Conservation Action Plan (CAP)

The primary goal is to develop science-based, participatory, and climate-resilient CAPs for the caracal, fishing cat, and clouded leopard, with the overarching purpose of guiding their long-term conservation and recovery across priority landscapes in India.

Recognising that each of these species occupies distinct ecological niches and faces unique conservation challenges, the action plan adopts a species-specific, yet landscape-level approach. It is designed to integrate ecological data, socio-environmental considerations, and stakeholder insights into cohesive conservation strategies.

The specific objectives of the CAP are as follows.

Review and synthesise existing knowledge:

To compile and evaluate existing scientific and grey literature—including published studies, field reports, camera trap data, and expert knowledge—on the distribution, habitat use, population trends, ecological requirements, and threats faced by each of the three species. This synthesis will be used to (i) assess the current conservation status of the caracal, fishing cat, and clouded leopard; (ii) identify critical data gaps; and (iii) determine priority areas for future research and conservation intervention.

Apply the SESA Framework:

To implement the SESA framework as a decision-support tool for assessing landscape-level ecological risks, social dynamics, and human-wildlife interactions; identifying community dependencies, conflict zones, and institutional constraints; and integrating social safeguards and climate adaptation measures into recovery planning to ensure resilience and long-term viability.

Develop species-specific CAPs and strengthen conservation data structure:

To formulate comprehensive and action-orientated CAPs for each target species, which will define conservation goals, prioritised interventions, timelines, and responsible institutions; include monitoring and evaluation frameworks and climate adaptation strategies; and feed into a national small wild cat database and spatial atlas, thereby supporting coordinated long-term conservation planning, policy development, and implementation at national and state levels.

Facilitate multi-stakeholder engagement and consultation:

To conduct structured discussions and consultations with key stakeholders, including state forest departments, researchers, NGOs, and local communities, to integrate field-based and experiential knowledge into the planning process; build consensus on species-specific conservation needs, risks, and management challenges; and co-develop context-sensitive recovery strategies aligned with local socio-ecological realities.

These objectives collectively aim to establish a robust foundation for the recovery of caracal, fishing cat, and clouded leopard populations across their respective ranges, while also contributing to the broader goal of mainstreaming small cat conservation in India's wildlife management and biodiversity strategies.

01

CARACAL

(Caracal caracal)



Summary

Caracals (*Caracal caracal*) are one of the most widespread medium-sized cats. However, among distinct subspecies, the Asiatic caracal (*Caracal caracal schmitzi*; Matschie, 1912) is thought to be declining across its limited range (Mallon & Budd, 2011; Kitchener *et al.*, 2017). The conservation status of this subspecies is precarious in most countries within its distribution range and lacks essential scientific information. Considering this, various countries have initiated status surveys using modern tools for preparing Conservation Action Plans (CAPs). Recently, Hassan-Beigi (2015) proposed a CAP in Iran, whereas Dunford *et al.* (2024) identified factors affecting occupancy in an arid landscape in Saudi Arabia.

The Asiatic caracal was historically widely distributed in India (Khandal *et al.*, 2020) but has declined sharply over the last two decades. The remaining populations are likely distributed across three states: Rajasthan, Gujarat, and Madhya Pradesh (MP). Asiatic caracals preferred dry deciduous forests dominated by scrub and grassland, which support their preferred prey, such as rodents, hares, ground-dwelling birds like partridges and quails, and reptiles. In India, the primary focus of population assessment has been on two PAs in Rajasthan and Gujarat, respectively, with the distribution status in other areas unknown. The current estimate of the subspecies is approximately 50 individuals, distributed in two isolated populations within the PAs of Rajasthan and Gujarat. Recent observations suggest that individuals of the Asiatic caracal are dispersing primarily in the north and south of the Ranthambore TR (RTR) via protected forests. This may be due to a lack of suitable dispersal habitat in surrounding areas, which are mainly agricultural, as well as to other anthropogenic factors, such as livestock grazing and habitat degradation. Therefore, concerted efforts are needed to understand the distribution, population status, and management of this subspecies' habitat, which are critical to minimising extinction vulnerability.

Considering this, the overall goal of the CAP is to follow multipronged conservation strategies to maintain and restore populations to favourable levels throughout the Asiatic caracal's distribution range in India. To achieve the goal, the objectives are to evolve targeted strategies for managing existing populations for long-term survival; identify threats causing the decline of the population; enhance the existing distribution range through habitat restoration; use state-of-the-art conservation strategies to minimise the extinction probability; involve the participation of local stakeholders; align with other ongoing conservation programmes; and effectively implement the CAP.

Kuno NP, MP, has potential Asiatic caracal habitat, and, given its proximity to RTR, we suggest translocating a few individuals and restoring habitat between these two PAs to enhance ecological connectivity.

For the establishment of a “Conservation Captive Breeding Centre” for the Asiatic caracal, a critical issue is to have an adequate founder population for rewilding the captive population. Given the small and isolated population in India, the founder population may not be sufficient for initiating conservation captive breeding, as indicated by the Population and Habitat Viability Analysis (PHVA). Therefore, we propose establishing a “Consortium of Asiatic Caracal Range Countries” to assess genetic diversity using a harmonised methodology and to share individuals to support the success of “Conservation Captive Breeding”. Such strategies would enhance the overall conservation status across the subspecies distribution range.

The roles of stakeholders and SESAs, as well as the effects of climate change, have been discussed. A summary of the report has been presented in the framework action plan.

Conservation Action Plan for Caracal in India:

1. Identification of potential habitat across Rajasthan, Gujarat, & Madhya Pradesh,
2. Population status across states by using different approaches, such as baited camera traps, Faecal & eDNA, track plots, etc.,
3. Determine factors influencing caracal distribution,
4. Habitat restoration & identifying potential dispersal corridors,
5. Assess Genetic Diversity,
6. Integrate Caracal Conservation with Cheetah Conservation & Tiger Conservation Plan in the Landscape with common distribution,
7. Stakeholder consultation, and
8. Develop a “Conservation Breeding Centre” if the species’ status continues to decline or remains low after establishing its status.

1.1

Conservation status of Caracal (*Caracal caracal*, Schreber, 1776)

Among several small- to medium-sized felids, the caracal (*Caracal caracal*, Schreber, 1776) is widely distributed across the world, ranging from throughout Africa, north to the Arabian Peninsula, the Middle East, and central and southwest Asia into India (Fig. 1.1a); its habitat includes arid woodlands, savanna, scrublands, hilly steppes, and arid mountainous regions. The species is distributed across at least 20 million km², including 42 African and 18 Asian countries (Avgan *et al.*, 2016).

It is slender with a short tail and long ear tufts. Buffon (1761) chose the name “Caracal” in reference to its Turkic name “Karrah-kulak” or “Kara-coulac”, meaning “cat with black ears”. In contrast, the species is also known by numerous other vernacular names, such as African lynx, caracal lynx, desert lynx, karakal, red cat, red lynx, and rooikat (Kenmuir & Williams, 1975; Stuart, 1982). Body weight ranged from 5.8 to 22 kg across its distribution. Adult males can weigh anywhere between 8 and 20 kg (average 12.7 kg), while females range between 6.2 and 15.9 kg (average 10.1 kg) (Veals *et al.*, 2020). Despite its wide distribution, Ray *et al.* (2005) estimate a 37.7% loss of its historical distribution in Africa, and it is now less common. It is patchily distributed in pockets of drier habitat (Nowell & Jackson, 1996). It is listed globally by the IUCN as “Least Concern” despite population trends being unknown across most of its geographic range. The CITES lists Asian populations under Appendix I and African populations under Appendix II.

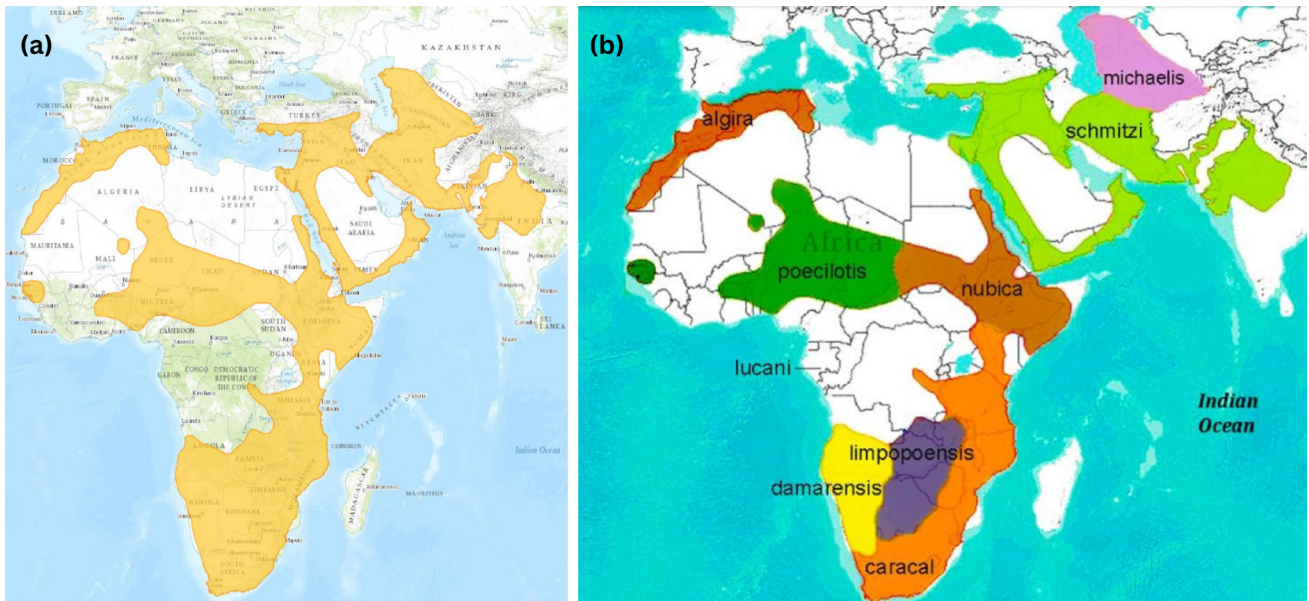


Figure 1.1.

(a) Global distribution of *Caracal caracal* (The IUCN Red List of Threatened Species 2015), and (b) Distribution of caracal subspecies in the world (adopted from Hassan-Beigi, 2015).

Different numbers of subspecies have been reported in the literature by various authors due to a lack of recent morphological and molecular studies across its distribution range (Kitchener *et al.*, 2017). Wozencraft (2005) recognised eight subspecies of caracal, whereas *C. c. michaelis* was later added (Fig. 1.1.b).

1. *C. caracal algira* (Wagner, 1841), northern Africa
2. *C. caracal caracal* (Schreber, 1776), eastern and southern Africa
3. *C. caracal damarensis* (Roberts, 1926), throughout Namibia
4. *C. caracal limpopoensis* (Roberts, 1926), north of the province Transvaal
5. *C. caracal lucani* (Rochebrune, 1885), grasslands of southeastern Gabon
6. *C. caracal nubica* (J. B. Fischer, 1829), eastern Cameroon and north to the Nubian Desert
7. *C. caracal poecilotis* (Thomas & Hinton, 1921), western Africa
8. *C. caracal schmitzi* (Matschie, 1912), Turkey, Palestine, Iran, Pakistan, Arabian Peninsula, and India
9. *C. caracal michaelis* Heptner, 1945; Turkmenistan

Subsequently, Kitchener *et al.* (2017) propose the possibility of three subspecies: *C. c. caracal*, *C. c. nubica*, and *C. c. schmitzi* and suggest a method for determining the geographical variation across its range.

1.1.1. Population characteristics

The average life span of the species is 10 years in the wild, whereas captive individuals can live up to 19 years (Nowell & Jackson, 1996; Livingston, 2009). Although male-to-female ratios and overall population density are influenced by factors such as prey availability, habitat type, and human persecution (Avenant, 1993), species exhibit a male-biased adult sex ratio (Anile & Devillard, 2018). Caracal occurs throughout South Africa, with the highest densities reported in the south and west (Stuart, 1981), of around 38.5 individuals/100 km² (Grobler, 1981). Avenant and Nel (1998) estimated a density of 23–47 individuals/100 km² (Grobler, 1981; Moolman, 1986; Avenant & Nel, 1998) with an estimated average annual population growth of 8–15% in southern Africa (Furstenburg, 2010).

1.1.2. Space use

Across the distribution range, species occurred in a wide variety of landscapes and habitat types at elevations ranging from sea level to 3,300 m, with the highest elevations reported in Ethiopia and Lesotho (Grobler, 1981; Sunquist & Sunquist, 2009). Most preferred habitats have been arid woodlands, savannas, scrublands, hilly steppes, and arid mountainous regions (Sunquist & Sunquist, 2009). Specifically, in arid or semiarid areas, species are most associated with thick brushes and vegetation on rocky slopes (Avenant & Nel, 1998) and in riverine habitat (Drouilly *et al.*, 2018a), where rodent abundance is high. Like other felids, caracals use vegetation cover while hunting, and shrubs provide thermal cover during the day.

Male *C. caracal* wandered 5–15 km daily, whereas females moved 2.5–10 km per day (Weisbein & Mendelssohn, 1990). Home-range size and population density of *C. caracal* were dependent on vegetation productivity, with high variation across its distribution. Large home ranges are thought to result from lower productivity and prey abundance in arid environments (van Heezik & Seddon, 1998). In the Western Cape Province of South Africa, male home ranges were about 26 km² (Avenant & Nel, 1998) to 65 km² (Norton & Lawson, 1985), and females patrolled home ranges of roughly 7 km² (Avenant & Nel, 1998). In contrast, a male in Saudi Arabia ranged over 1,116 km² during the winter months (van Heezik *et al.*, 1998). In contrast, the annual home range of males and females was 220 km² and 57 km², respectively, in Israel (Weisbein & Mendelssohn, 1990). Home ranges of males were larger than those of females in fragmented agricultural areas in South Africa (Ramesh *et al.*, 2017), and species prey on small livestock during low prey availability (Melville & Bothma, 2006).

1.1.3. Food habits and interspecific interactions

Food-habit studies were mainly conducted in Africa, and the diet of *C. caracal* is highly dependent on its distribution within its broader geographic range and on prey availability. Caracal preys on a variety of species, with small mammals, antelopes, and birds forming a majority of its diet (Smithers, 1971; Grobler, 1981; Skinner & Chimimba, 2006; Drouilly *et al.*, 2018b). Diet analysis showed that small mammals compose up to 89% of their diet in sub-Saharan Africa (Nowell & Jackson, 1996; Mukherjee *et al.*, 2004; Neils, 2018). In South Africa, 95% of prey species were lagomorphs, rock hyrax, and spring hares (Pohl, 2015). Rodents were identified as the most likely prey for *C. caracal* in Iran's Kavir NP (Mousavi, 2010) and Karoo NP, South Africa (Palmer & Fairall, 1988). Observed broad dietary niche breadth across varied landscapes suggests that species are less vulnerable to dietary competition and prey fluctuation (Drouilly *et al.*, 2018). A significant source of human conflict with Caracal stems from livestock depredation, which has been reported across its range, particularly in southern Africa (Nowell & Jackson, 1996; Ramesh *et al.*, 2017; Drouilly *et al.*, 2018b). Observed dietary niche overlap of 53–64% with black-backed jackals and leopards suggests competition with other carnivores for resources. Adult *C. caracal* can be killed by leopards and spotted hyenas *Crocuta crocuta* (Skinner, 1979), whereas kittens will be predated by these carnivores and jackals if found (Furstenburg, 2010; Bothma, 2012).

1.1.4. Reproduction

Kittens are born blind and open their eyes at 6–10 days. Cubs begin hunting with the mother 4–6 months after weaning, when their canines erupt (Sunquist & Sunquist, 2009). Juveniles may leave the natal range by 9–10 months or may remain with the mother for about a year (Sunquist & Sunquist, 2009). Caracal females reach sexual maturity between 7 and 12 months and males between 9 and 14 months (Bernard & Stuart, 1987). However, males likely do not begin mating until they are between 18 and 20 months old, as older, dominant males control higher-quality territories (Furstenburg, 2010). Females likely do not begin mating until 14 months of age and can remain reproductive until 18 years of age (Furstenburg, 2010). Females are polyoestrous, and oestrus cycles last anywhere from 1 to 6 days (Nowell & Jackson, 1996). Reproduction is timed to the phenology of prey species, peaking when vegetation and, therefore, prey production are highest. Thus, the timing of reproduction varies by geographic location, with usually only a single litter produced each year (Bernard & Stuart 1987). However, for captive *C. caracal*, births can occur throughout the year with a pronounced peak in the summer (Bernard & Stuart, 1987). Copulation is short, and the gestation period averages 78–81 days. Births are typically separated by 1 year (Bernard & Stuart, 1987), but consecutive litters can be spaced approximately 10 months apart (Furstenburg, 2010). Litters average 2–4 kittens (Bernard & Stuart, 1987), but up to six kittens may be born (Sunquist & Sunquist, 2009).

There has been growing awareness that many felid species are at risk of extinction, which has led to the exploration of assisted reproductive technologies for captive breeding programmes, resulting in a 33% pregnancy establishment rate in caracals (Pope *et al.*, 2006).

1.1.5. Behaviour

Limited behavioural observations are available due to the species' elusiveness and low density. It is solitary, and two adults are rarely observed moving together (Stuart, 1981; Schütze, 2002). Eight individuals were seen at a fishpond in Israel (Hoath, 2003). Females have been observed with their offspring. Additionally, home ranges overlap both within and between sexes, and males exhibit more territory-marking behaviour than females do. Both sexes use "scratching trees" to mark their territories (Stuart & Wilson, 1988). Caracal is promiscuous, and females often mate with more than one male. Males may fight each other for access to receptive females. In Israel, females copulate with multiple males in succession, with mating order determined by age and weight (Sunquist & Sunquist, 2009). Once a mate is chosen, males and females travel together for 3 or 4 days before separating, copulating multiple times (Bernard & Stuart, 1987). Males do not take part in any rearing of the young and are reported to kill young kittens (Stuart, 1981), likely to induce oestrus in females. Females nest in

old porcupine burrows, trees, brush, or rock crevices and line beds with feathers and hair (Schütze, 2002). Birth can occur year-round; however, the timing of birth depends on the female's nutritional status and is dependent on prey availability. In the Western Cape Province of South Africa, Caracal exhibits birth peaks between December and March (Avenant & Nel, 1998). In contrast, in the Eastern Cape Province, birth peaks occur between October and February (Bernard & Stuart, 1987). Males disperse 60–90 km away from natal ranges, whereas females remain and may occupy home ranges overlapping with their mother's (Weisbein & Mendelssohn, 1990). Caracal is known to exhibit a range of vocalisations, including purrs, growls, hisses, barks, chirrups, and meows (Guggisberg, 1975). Contact calls are primarily composed of barks, chirrups, and meows. It also communicates via chemical signals, including urine spraying and scent-marking. Caracal has cheek, chin, anal, and digital scent glands (Schütze, 2002) that enable individuals to mark territories and advertise receptivity.

Caracals exhibit typical feline hunting behaviour, including stalking and pouncing with a killing bite to the nape or throat, depending on prey size (Kenmuir & Williams, 1975; Pringle & Pringle, 1979; Stuart, 1981). Small- to mid-size prey are killed with a bite to the back of the neck, while larger prey items are killed with a bite to the throat. Caracal is said to be the fastest felid of its size and can run down prey for short distances (Skinner, 1979; Kingdon & Hoffmann, 2013). Caracals are highly admired for their precision in bird hunting, attributed to their remarkable ability to lunge up to 4 m into the air and catch birds with their forepaws, or to knock several out of the air at once (Heptner & Sludskii, 1992). Caracal was traditionally used by royalty in Iran, India, Egypt, and Syria for hunting (Heptner & Sludskii, 1992).

1.1.6. Genetics

A phylogenetic analysis indicated that the Caracal lineage (serval, caracal, and African golden cat) diverged from other felids about 8.5 million years ago (Janczewski *et al.*, 1995; Pecon-Slattery & O'Brien, 1998; O'Brien, 2008) (Fig. 1.2). The serval diverged about 5.6 million years ago, and the African golden cat and *C. caracal* bifurcated about 1.9 million years ago (Johnson *et al.*, 2006). The genetics of *C. caracal* at a local scale are poorly known; therefore, genetic profiles are largely lacking for the nine previously recognised subspecies. Hence, whether subspecies are genetically distinguishable from each other is unknown. Recently, mitochondrial and microsatellite markers revealed a high level of genetic diversity in *C. caracal*, with all individuals belonging to a single nuclear genetic cluster in the Karoo region of South Africa (Tensen *et al.*, 2018).

Though two proposed subspecies, *C. c. michaelis* and *C. c. schmitzi*, were thought to occur in Iran, a genetic analysis of 24 tissue samples taken throughout Iran showed minimal variation in mitochondrial DNA (Hassan-Beigi, 2015). Mountain chains and wide roads or highways may pose significant barriers to gene flow for the Caracal (Hassan-Beigi, 2015).

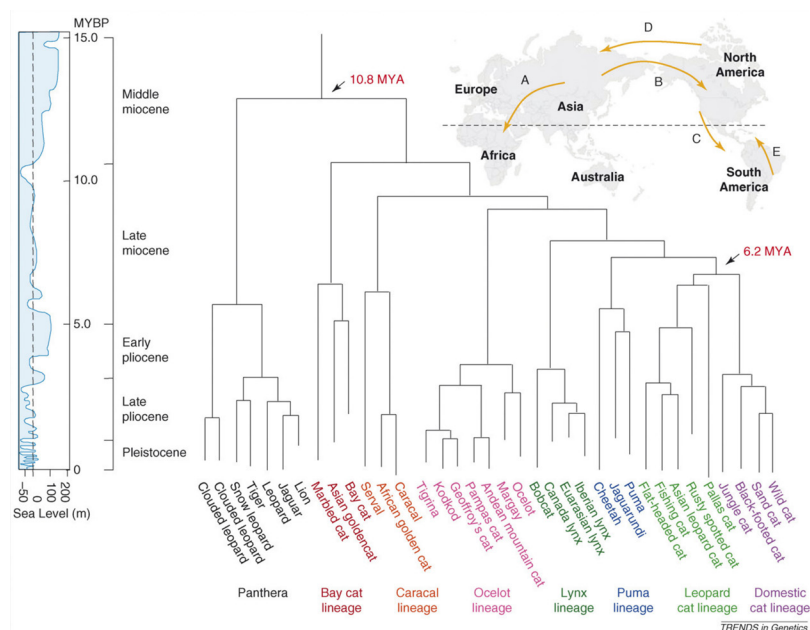
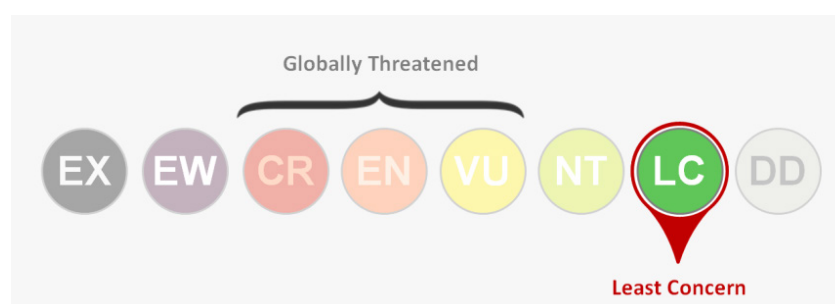


Figure 1.2.

Molecular phylogeny of Felidae and historical global sea levels; arrows A-E show the migration routes of felids (O'Brien, 2008).

1.1.7. Conservation status

Caracal caracal is globally listed as “Least Concern” by the IUCN because it is relatively common with a stable population across a broad distribution, particularly in southern and eastern Africa (Macdonald *et al.*, 2010), but there is a conservation concern in Asia because of a decrease in population and overexploitation for fur or meat (Sunquist & Sunquist, 2009; Hassan-Beigi, 2015; Avgan *et al.*, 2016). The status of *C. caracal* in individual countries varies, ranging from “common” to “extremely rare”. Although *C. caracal* is protected by law in countries across its geographic distribution, widespread habitat destruction for agricultural or road development, poaching for fur or meat, culls due to human–wildlife conflict, exotic pet trade, and road collisions threaten its populations (Habibi, 1977; Serez, 1992; Nowell & Jackson, 1996; Giannatos *et al.*, 2006; Ghoddousi *et al.*, 2009; Hassan Beigi, 2015). Livestock predation is another major conservation issue, with locals often leading to culling and poisoning (Grobler, 1981; Nowell & Jackson, 1996; Farhadinia *et al.*, 2007; Hassan-Beigi, 2015; Neils, 2018). In South Africa and Namibia, species are considered vermin and are heavily persecuted (Nowell & Jackson, 1996; Avenant & Nel, 1998; Avenant *et al.*, 2016). Besides this, the species is used as bushmeat and consumed by communities in South Africa and Namibia (Avenant *et al.*, 2016).



1.2

Conservation status of Asiatic caracal (*Caracal caracal schmitzi*; Matschie 1912) in India

Of the 45 felid species in the world, 15 inhabit the diverse ecosystems of India. Conservation efforts have focused primarily on large felids such as tigers, leopards, and snow leopards. Despite the significant role of small felids in India’s ecosystem, regulating prey populations, facilitating nutrient transfer, and safeguarding critical habitats, these species received inadequate conservation attention in comparison to large felids (Bandyopadhyay *et al.*, 2024). Empirical studies have shown that small carnivores influence the ‘middle-out’ ecosystem services (Marneweck *et al.*, 2022) by altering prey and plant populations (Nagy-Reis *et al.*, 2017). As secondary ecosystem consumers, small carnivores help sustain a healthy ecosystem by indirectly protecting critical habitat and ecotones, and they ensure economic well-being for agro-pastoral systems by controlling pest populations and reducing the risk of vector-borne disease transmission (Mukherjee *et al.*, 2004; Hofmeester *et al.*, 2017).

Nonetheless, India has not lost any terrestrial carnivore in the past 75 years, except for the Asiatic cheetah (*Acinonyx jubatus venaticus*) (Divyabhanush, 2023), which was exterminated by indiscriminate game hunting and habitat loss. Another sympatric species in the Asiatic cheetah landscape, the Asiatic caracal, is either thriving in small and isolated populations across its distribution range due to habitat loss and human disturbance (Bandyopadhyay *et al.*, 2024). Many of the vital habitats of smaller cats, including the caracal, have been lost due to habitat destruction, habitat fragmentation from land conversion, and agricultural modification (Sunquist & Sunquist, 2002). Such changes disrupt connectivity between cat populations, making movement difficult and limiting access to resources (Pusparini *et al.*, 2014). Besides, many small felid populations occur outside the ‘formal’ realm of PAs in multiple-use landscapes, making them vulnerable to human impact (Athreya *et al.*, 2013; Naha *et al.*, 2016).

1.2.1. Historical and current distribution of the Asiatic caracal in India

The Asiatic caracal has a long and unique history with humans in Asia, where it was valued for its litheness and ability to catch birds in flight (Vigne, 1842; Lydekker, 1907; Sunquist & Sunquist, 2002). However, in India, the caracal was also used as a coursing animal during the Delhi Sultanate in the late medieval period (Divyabhanusinh, 1993; Verma, 1994; Thapar *et al.*, 2013). In the 14th century, Firuz Shah Tughlaq was said to have established a facility called 'Siyah Goshdar Khana' dedicated solely to the maintenance of large numbers of coursing caracals (Verma, 1994). The Third Mughal Emperor, Akbar, furthered the reputation of the Caracal as a coursing animal and used it extensively for coursing (Blochmann, 1873). Centuries ago, when Maharajahs ruled the lands of Rajasthan, Delhi, Uttar Pradesh, Gujarat, Punjab, and Haryana, the caracal or siyagosh was tamed and used for hunting. In ancient Egypt, there was a practice to tame these wild cats, too. Hence, the caracal was widely used as a coursing animal in India from at least the 14th century until the mid-20th century. Multiple distinct vernacular names are known to ordinary people in India for the caracal. The caracal is well known by its Persian name, *Siyah-Gosh* (or "black-eared"). In Rajasthan, the caracal's reputation as a peafowl killer has led to multiple vernacular names reflecting this, such as Mor Todni and Mor Mar Bagheri.

A recently published book titled "*Caracal: An Intimate History of Mysterious Cat*" provides the first and definitive work exploring the caracal's biology and ecology, the fascinating history with humans, and the changes in its distribution over time in the country (Khandal & Dhar, 2024).

The oldest report of the Caracal in the Indian subcontinent is a fossil from the Indus Valley, dating to 3000–2000 BCE (Ghosh, 1982). The Caracal in India has been considered rare in the wild since at least 1671 (Foster, 1924, 1926), and remains so today. Several naturalists commented on its rarity (Hamilton, 1727; Blyth, 1842; Stoliczka, 1872; Jerdon, 1874; O'Malley, 1909; Allen, 1919; Sharma & Sankhala, 1984a). Changes in land use patterns resulting from economic growth may explain its rarity. Approximately 200,000 km² of grassland and shrubland, along with 260,000 km² of forests, are estimated to have been converted for agricultural use from 1880 to 2010 (Tian *et al.*, 2014; Vanak *et al.*, 2017).

Khandal *et al.* (2020) retrieved information on AC presence from an archive collection spanning from 1616 to 2020. They observed that historically, the subspecies was reported in 13 Indian states, viz. Rajasthan, Gujarat, MP, Uttar Pradesh, Punjab, Haryana, Delhi, Maharashtra, Jharkhand, Chhattisgarh, Odisha, Andhra Pradesh, and Telangana, and in nine biotic provinces (Fig. 1.3). Caracal's presence has been reported in only three states and four biotic provinces since 2001, with only two possible viable populations, *i.e.*, Rajasthan and Gujarat. Before 1947, Caracal was distributed over an area of 793,927 km², but decreased by 47.99% between 1948 and 2000, and is currently restricted to only 16,709 km² in India (Khandal *et al.*, 2020).

1.2.2. Ecological perspective

Though caracals (*Caracal caracal*) are one of the most widespread medium-sized cats, the population of one of the subspecies, the Asiatic caracal (*Caracal caracal schmitzi*; Matschie, 1912), is thought to be in decline throughout its limited range across Asia (Mallon & Budd, 2011; Kitchener *et al.*, 2017).

In Asia, the Asiatic caracal occurs in areas with forests, savannas, marshy lowlands, semideserts, and scrub forests but prefers dry areas with low rainfall and availability of cover across the Arabian Peninsula, Afghanistan, Algeria, Egypt, India, Iran, Israel, Jordan, Kazakhstan, Lebanon, Morocco, Pakistan, Syria, Tajikistan, Tunisia, Turkey, Turkmenistan, and Uzbekistan. The subspecies is protected through its distribution range. The Central Asian caracal population has been listed as Critically Endangered in Uzbekistan since 2009 and in Kazakhstan since 2010. In India, it is listed as Schedule I under the Wildlife (Protection) Act, 1972.

Across its distribution range, Caracal sightings have been reported in Dana in Jordan, Arabian Oryx Sanctuary and Jebel Samhan in Oman, Harrat Al Harrah, Rayda and Shada in Saudi Arabia, Jebel Bura'a, Hawf and Ota-mah in Yemen (Mallon & Budd, 2011, Khorozyan *et al.*, 2014), Termessos NP, Turkey (Giannatos *et al.*, 2006, Albayrak *et al.*, 2012) and in the Badkhyz State Nature Reserve, Turkmenistan (Kaczensky & Linnell 2014), Bahram'gur PA, Siah-kuh PA and Kavir NP, Iran (Ghoddousi *et al.*, 2009, Hassan-Beigi, 2015). In the Emirate of Abu Dhabi, a male caracal was photographed by camera traps in Jebel Hafeet NP in the Al-Ain Region (Abu Dhabi) in spring 2019, the first such record since the mid-1980s. In Uzbekistan, caracals were recorded only in the desert regions of the Ustyurt Plateau and Kyzylkum Desert. Between 2000 and 2017, 15 individuals were sighted alive, and herders killed at least 11.

The Caracal might still be present but underreported in states like Maharashtra, MP, Uttar Pradesh, and the eastern parts of India. Most recent sightings have been from RTR, Kailadevi WLS, Dholpur, Rajasthan, and Narayan Sarovar WLS, Kachchh, Gujarat. Recently, caracals have been recorded in the Sariska TR in 2004 and in a camera-trap photo from the Keoladeo Ghana NP in Bharatpur in 2017. Although the caracal was considered extinct in MP until recently, sightings have been reported from Gandhi Sagar WLS, MP, and a caracal has been spotted crossing the Chambal River from MP to Rajasthan. This indicates that they may be present in MP. Overall, there are two potential breeding populations, each in Rajasthan and Gujarat (Fig. 1.4). However, targeted surveys are needed to determine the current distribution range.

Caracals are smaller and paler than the nominate form, weighing 8–15 kg, and have an average body length of 1–1.2 m (Harrison & Bates, 1991), likely reflecting adaptations to the arid and semi-arid regions they inhabit. Caracals are thought to live in desert wadis (temporary river valleys), mountains, and basalt fields. However, because these habitats are fragmented across the Arabian Peninsula and the species' range, they are more vulnerable (Sunquist & Sunquist, 2002; Mallon & Budd, 2011). In Saudi Arabia, caracals historically inhabited the rugged mountains of the western coast, but they are currently considered rare in this country (Fisher, 1999; Mallon & Budd, 2011). In desert climates, many species rely upon large areas of connected habitat for resource acquisition and for population stability. In Saudi Arabia, caracals appear to maintain large home ranges, with one radio-tracked male ranging over 1116 km² (van Heezik *et al.*, 1998; Mallon & Budd, 2011).

Caracal persistence in desert landscapes may also be attributable to an adaptable diet; they do not show strong preferences for single prey species and often hunt wild prey species in proportion to their abundance. In Africa, they preferred to feed on birds, reptiles, invertebrates, fish, and small to medium-sized mammals such as rodents, rock hyrax, lagomorphs, and ungulates weighing less than 50 kg (Stuart & Stuart, 2007, 2013; Ghoddousi *et al.*, 2009; Mallon and Budd, 2011; Braczkowski *et al.*, 2012; Jansen *et al.*, 2019; Leighton *et al.*, 2020; Minnie *et al.*, 2018). The importance of rodents in Asiatic caracal diets has been highlighted in Iran and India, where they comprised up to 73% of caracals' metabolised energy (Mukherjee *et al.*, 2004; Farhadinia *et al.*, 2007). In Israel, males have territories averaging 220 km² (85 sq mi), while those of females average 57 km² (22 sq mi). Male territories in Saudi Arabia range from 270 to 1,116 km² (104 to 431 sq mi).

The caracal is typically nocturnal, though some activity may be observed during the day as well (Singh *et al.*, 2014). However, the cat is so secretive and difficult to observe that its daytime activity might easily go unnoticed.

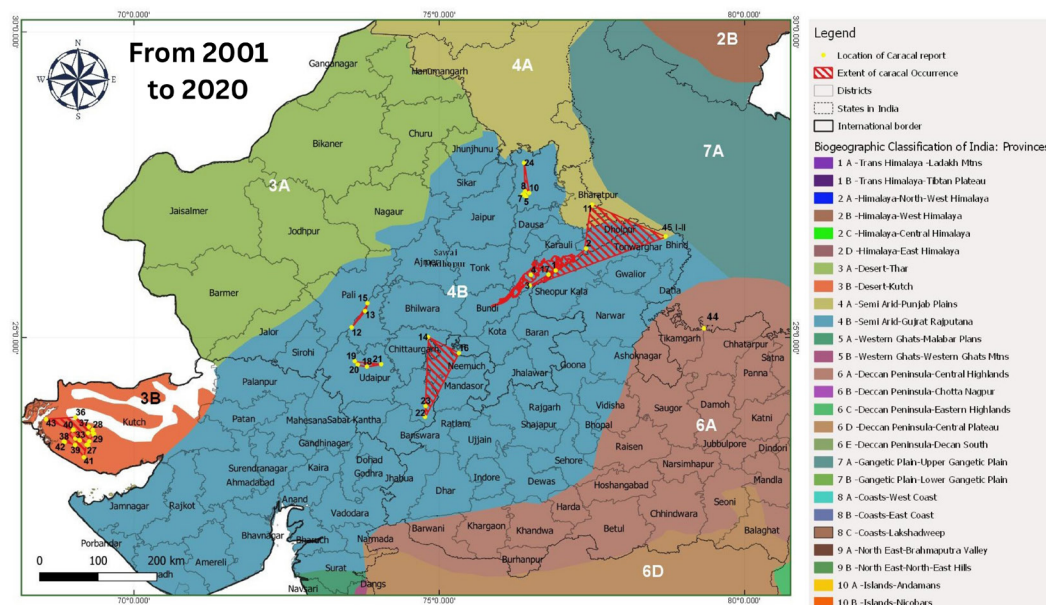
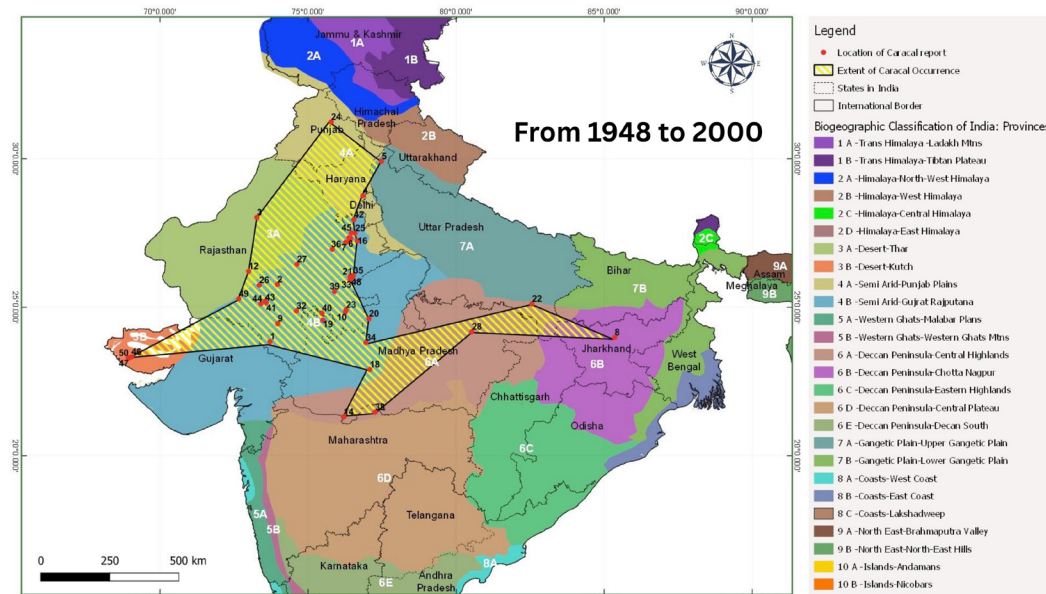
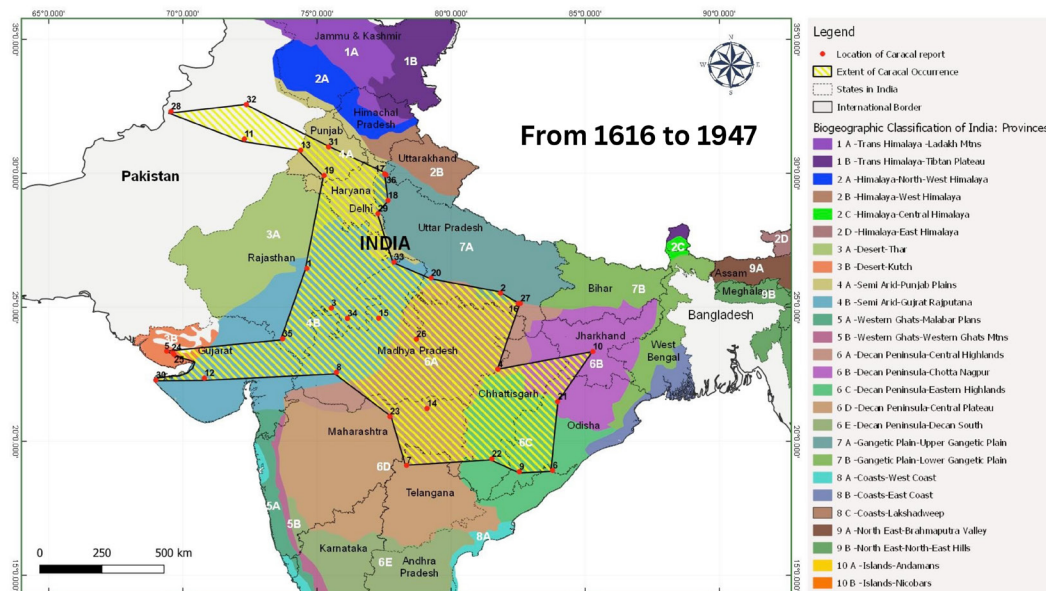


Figure 1.3.

Reported distribution of Asiatic Caracal from 1616 to 2020 in the adjoining area (adopted from Khandal *et al.*, 2020).

Singh *et al.* (2014) studied the population and ecological characteristics of the caracal using camera traps in RTR, western India, from 2006 to 2009. They obtained 37 caracal captures over 25,156 camera nights, with a capture success rate of 0.02–0.34 captures/100 trap nights or one caracal/679.9 trap nights over 4 years. Our results reveal that caracal presence was associated with forests and undulating terrain. Caracals were more active late at night and during crepuscular hours. There was a difference in their activity between dusk and dawn. Singh *et al.* (2014) provide baseline information on the ecological characteristics of the caracal, and it may be used to develop conservation and management plans for this species. We also suggest that the RTR and its surrounding areas could be highlighted as a global conservation region for caracals.

It is territorial and lives mainly alone or in pairs. The caracal is sexually dimorphic; the females are smaller than the males in most bodily parameters. Both sexes become sexually mature by the time they are one year old and breed throughout the year. Gestation lasts between two and three months, resulting in a litter of one to six kittens. Juveniles leave their mothers at the age of nine to ten months, though a few females stay with their mothers. The average lifespan of captive caracals is nearly 16 years.

Hassan-Beigi *et al.* (2023) is the only study to examine the phylogenetic status and haplotype diversity in the Asiatic caracal population of Iran, and observed low diversity and a lack of geographic structure. The haplotypes of the Arabian Peninsula were identical or closely related to those of Iran, suggesting that the historical demographic pattern may have been extended to Southwest Asia. They also found that divergence time between the Southwest Asian and South African lineages was about ~300–500 ka, *i.e.*, midway through the Middle Pleistocene.

Analysis of environmental factors affecting caracal distributions is necessary for conservation planning. Jangid *et al.* (2020) used ensemble models to identify potential habitats where the caracal population could occur and to assess its status (Fig. 1.5). Such information is beneficial for planning targeted, priority conservation actions in these regions. They examined an area of 346,726.8 km² and found that the highly suitable class has 1,207.83 km², followed by 7,453.65 km² under moderately suitable and 39,984.6 km² under least suitable habitats. Hence, a moderately to highly suitable habitat in the studied landscape may be approximately 8700 km². Their study showed that caracal presence was associated with forest and terrain ruggedness. This finding may be related to the suitability of the habitat for the caracal, which provides cover for hunting, shelter, and prey distribution (Farhadinia *et al.*, 2007; Heptner and Sludski, 1992; Illemin and Gürkan, 2010). Similarly, Avenant and Nel (1998) suggested caracals spend most of their time foraging in vegetation. These studies suggest that forest cover and ruggedness are critical environmental variables that had the strongest influence on caracal occupancy.

Bandyopadhyay *et al.* (2024) used ecological niche modelling to identify the environmental features that most influence the presence and distribution of small cats in India. They found that human disturbance was the most critical factor affecting the distribution of caracals, Asiatic golden cats, and rusty-spotted cats.

Assessment of the predictor variables regarding the distribution probability of caracals indicated that areas with a high range of temperatures and precipitation seasonality, highly rugged terrain, moderate-to-highly dense

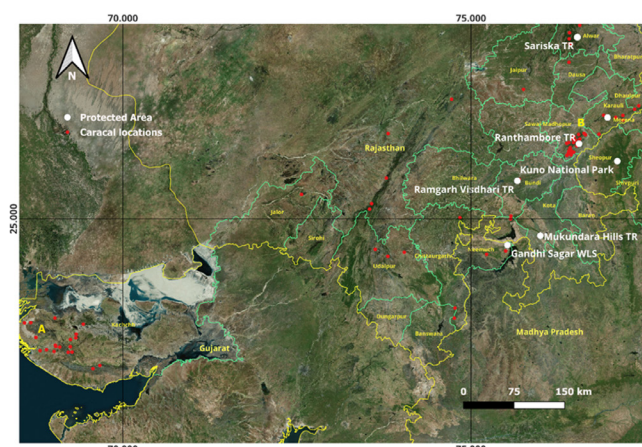


Figure 1.4.

Two breeding populations of Asiatic caracal (A) Gujarat and (B) Rajasthan.

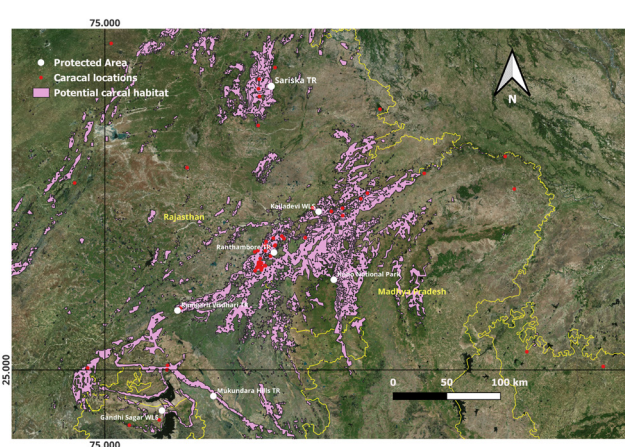


Figure 1.5.

Potential habitat of the Asiatic caracal across Rajasthan, Madhya Pradesh, and Gujarat.



forest types, and low-to-intermediate arid regions are climatically suitable for caracals (Jangid *et al.*, 2020). Studies from Iran presented the use of highly rugged areas with good vegetation cover by caracals (Adibi *et al.*, 2014; Hemami *et al.*, 2018).

Jangid *et al.* (2020) also demonstrated that Kuno holds high-potential habitats for caracals like RTR, where frequent sightings are recorded (Parashar, 2020; Khandal *et al.*, 2020; Tanwar *et al.*, 2021) and may probably have functional wildlife movement corridors between RTR and Kuno NP (Qureshi *et al.*, 2014). However, previous camera-trapping exercises in Panna TR and Kuno NP within the caracal's distributional range (Divyabhaskar, 1993) did not record the species (Jhala *et al.*, 2020; Khandal *et al.*, 2020). This may be due to low detection/inadequate sampling (Singh *et al.*, 2015) or seasonal migration (Adibi *et al.*, 2014).

Given the availability of suitable caracal habitat, the restoration of habitat between RTR and Kuno NP, and the translocation of individuals, these could be considered the best conservation options (Jangid *et al.*, 2020). However, caracal population density depends not only on prey availability but also on habitat type and the degree of anthropogenic pressure (Avenant & Nel, 2002).

While analysing global research on lesser cats, Bandyopadhyay *et al.* (2024) retrieved 938 publications between 1972 and 2024, with a notably low percentage (<15%) originating from India. Such data deficiency is the pivotal research challenge for conservation planning of small felids or mesopredators in India. Except for a handful of studies, there has been virtually no contribution to the knowledge of Asiatic caracal ecology in India in the 21st century. Persistent populations outside PAs remain either unknown or poorly monitored. The lack of a recent population assessment (Mallon & Budd, 2011) and an estimated population of approximately 50 necessitate a concerted effort to understand distribution and population status, and to manage habitat for this subspecies, which is of critical conservation importance.

Thus, studies critically needed to initiate are on population size, reproduction, mortality, home range sizes, and prey dynamics. Long-term studies focusing on caracal movement patterns to determine and establish wildlife corridors that connect the remaining fragmented population units are equally essential.

1.2.3. Conservation threats

Understanding the threats causing a decline in the population is most critical for strategic conservation planning to protect threatened species (Marcot & Flather, 2007; Rao *et al.*, 2007; IUCN-SSC, 2008), as it can formulate threat mitigation measures based on the potential habitats of the species. Assessment of conservation threats to species has included habitat loss from urbanisation and agricultural expansion, reduced prey availability, retaliatory killings by livestock farmers, illegal wildlife trade for the exotic pet industry, and habitat fragmentation from infrastructure projects. Some caracal potential prey species populations are also at risk from widespread use of poisons and rodenticides. Local people kill caracals to protect livestock or in retaliation for their predation on small livestock in Africa. Due to various threats, the caracal is believed to be close to extinction in North Africa, critically endangered in Pakistan, endangered in Jordan, but stable in central and southern Africa.

Caracals are highly sensitive to habitat modification and have a low tolerance to human interference. Therefore, fragmentation and habitat loss have occurred due to the conversion of most preferred habitats, such as scrubland and grassland, which were classified as “wasteland,” into agricultural land and urban areas over the last few decades. This appears to be the single most prominent threat to the Caracal in India. Most felids need vegetation cover for stalking prey and for moving between habitats. Loss of vegetation cover reduces the potential prey species of lesser felids (Mukherjee *et al.*, 2004). Caracals are long-ranging species, and due to changes in land use and loss of vegetation cover, they have lost most of their movement corridor. Moreover, the impact of other large felids, such as tigers and leopards, on caracal persistence is also unknown. Hence, changes in landscape matrices, prey loss, and interactions with other larger felids may have exacerbated the dramatic decline in caracal populations in India. These may be among the reasons why species are confined to PAs in India. The wildlife trade of caracals for exotic pets and their skin poses significant conservation threats in other parts of the world. However, five Caracals and a Serval (another member of the Caracal lineage exclusively occurring in Africa) were rescued while being smuggled through Mirzapur, U.P., in 2017; however, the probable origin remains unconfirmed. Caracal pelts are also in demand in the illegal wildlife trade, with skins previously being recovered from Rajasthan. Death by vehicular collision and mauling by feral dogs are the other threats reported for caracal in India, but their contribution to population decline is little known.

Narayan Sarovar WLS and its surrounding habitats in Gujarat are home to breeding populations of caracals. However, anthropogenic factors may impact species’ distribution patterns in this landscape.

The Asiatic caracal in other parts of its distribution range is threatened by hunting for the pet trade on the Arabian Peninsula. In Turkey and Iran, caracals are frequently killed in road accidents. In Uzbekistan, the primary threat to caracals is killing by herders in retaliation for livestock losses. Guarding techniques and sheds are inadequate to protect small livestock, such as goats and sheep, from predators.

Thus, we suggest continued monitoring, identification of threats causing population decline, habitat restoration, stakeholder involvement, and anti-poaching efforts as critical to preventing further decline.

1.3

Conservation Action Plan Strategies for Asian caracal (*Caracal caracal schmitzi*) to prevent extinction vortexes

20

The Asiatic caracal population is estimated at fewer than 100 individuals, with two core populations in Rajasthan and Gujarat (Khandal et al. 2020). However, most areas outside PAs have not been surveyed, leaving the species' status in these habitats poorly understood. The species has been seen dispersing from the RTR's core area to the north and south, but it has stayed in Gujarat's Kutch district. Changes in land-use patterns limit the long-range dispersal of the species across the landscape, as most of the land around the core Caracal habitat is under agriculture and other anthropogenic pressures.

Conserving small, threatened populations like the Asian caracal requires strategies to increase their numbers, create additional habitat for dispersal, and improve genetic diversity to prevent extinction vortexes. However, multifaceted approaches have been used to conserve species on the brink of extinction by addressing habitat loss, poaching, human-wildlife conflict, and the lack of awareness of their ecological importance. Considering these key aspects of conservation strategies, numerous examples of conservation success have been demonstrated globally, demonstrating that implementing targeted conservation strategies can help species survive and achieve long-term conservation goals.

Although there is no exact population estimate for the subspecies across its distribution range, most monitoring has been limited to PAs, suggesting a population of around 50, including areas in Rajasthan and Gujarat. In comparison, status in other areas is unknown due to a lack of systematic, intensive surveys. The current core population is in RTR, Rajasthan, and Narayan Sarovar Sanctuary in Gujarat. However, it is still not known why the population has declined and become locally extinct across its distribution range, especially in Central India and the Gangetic plain, despite the presence of many PAs and adequate prey species. Decline in subspecies has been attributed to large-scale hunting and illegal trade in the past. While the lack of sightings despite ongoing intensive camera trapping for tiger monitoring in PAs may be due to (i) sampling protocols used for monitoring tigers being inadequate for the lesser felids and may require entirely different strategies for surveying lesser felids of low density and (ii) most of the camera trapping is done in the forested areas, whereas the sub-species' preferred habitat is open forest, scrubland and grassland.

Thus, to minimise the risk of extinction, we suggest simultaneously implementing (i) continuous monitoring of the sub-species using various commonly deployed techniques for the status survey of the lesser felids of low density; (ii) determine the causative factors leading to the decline of the population; (iii) restore and improve the species' habitat quality and ecological connectivity; and (iv) conservation of captive breeding.

Hence, it is possible to prevent the extinction vortex of the Asiatic caracal by using effective conservation strategies such as habitat management and protection, research into their ecology and population dynamics, public awareness campaigns, genetic rescue, managing threats, metapopulation management, conservation breeding, mitigation of climate change impact, raising awareness and education among local communities, and coordination with other ongoing conservation plans (Fig. 1.6).

Goals and objectives: The overall goal of the CAP is to maintain and restore populations to favourable levels throughout the Asiatic caracal's distribution range in India. To achieve the goal, the objectives are to evolve targeted strategies for managing existing populations for long-term survival; identification of threats causing decline of the population; enhancement of the existing distribution range through habitat restoration; use of state-of-the-art conservation strategies to minimise the extinction probability; involvement of participation of local stakeholders; alignment with other ongoing conservation programmes; and effective implementation of the "Action Plan".

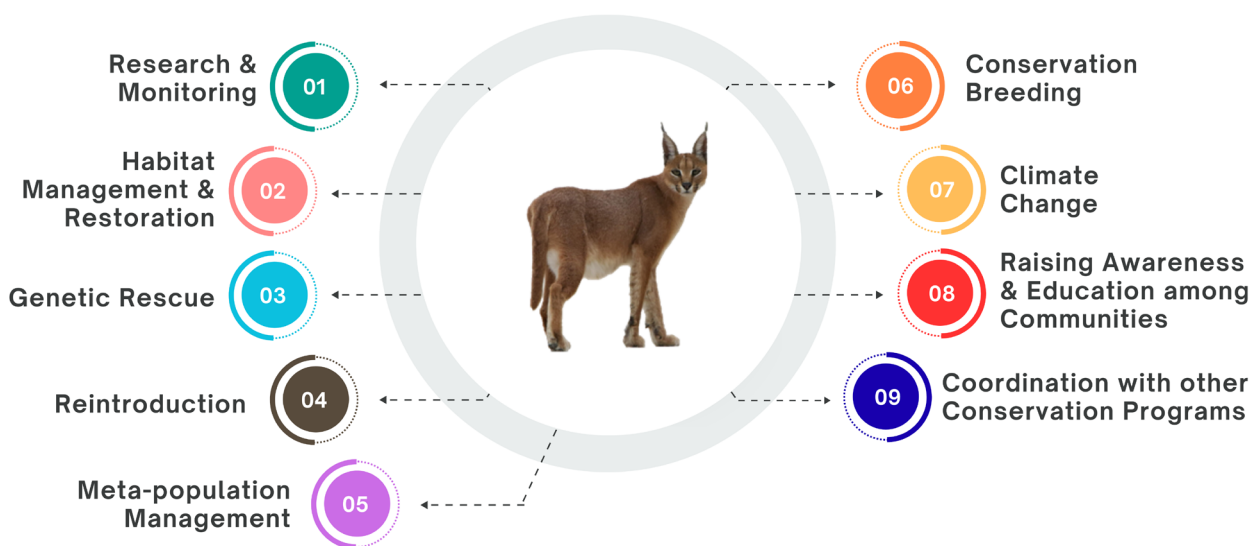


Figure 1.6.

Targeted conservation strategies for ensuring survival and achieving long-term conservation goals of the Asiatic caracal.

1.3.1. Research and Monitoring

Although the caracal has been intensively studied on the African continent, studies on the Asiatic caracal are scarce across its distribution range, including India. Most of the information available for the subspecies comes from ongoing studies on other carnivores, especially within the PAs; however, it lacks long-term studies and information on its status outside the PAs. Bandyopadhyay *et al.* (2024) highlighted the need for robust ecological data, particularly on demographic parameters, prey–predator relationships, and responses to human-induced habitat alterations, for planning conservation strategies.

Moreover, there are only a few recent studies for subspecies, mostly on determining the potential habitat, factors affecting distribution, conservation threats, *etc.* (Hassan-Beigi, 2015; Khandal *et al.*, 2020; Jangid *et al.*, 2022; Bandyopadhyay *et al.*, 2024; Dunford *et al.*, 2024; Thakar *et al.*, 2025). Hence, it is of utmost necessity to fill knowledge gaps and integrate ecological findings into the conservation framework of the Asiatic caracal. Considering two isolated populations of Asiatic caracal in Rajasthan and Gujarat and the scarcity of consolidated long-term research efforts, we suggest (a) determining the status of the Asiatic caracal in the potential habitats of Rajasthan, Gujarat, and MP, and (b) conducting long-term studies on the ecology and biology of the species.

1.3.1.1. Determine the status of the Asiatic caracal in the potential habitats of Rajasthan, Gujarat, and Madhya Pradesh

1.3.1.1.1. Delineation of potential area for the conservation of the Asiatic caracal

Information on habitat characteristics preferred by the Asiatic caracal originated mainly from the PAs of Bhuj, Gujarat, and RTR, Rajasthan. Moreover, information lacks its status in other areas, except for sporadic records of its presence. Considering this, it is critical to identify and delineate potential habitats to support effective landscape-level conservation planning. Published literature indicates that Caracal preferred arid woodlands, savanna, scrublands, hilly steppes, and arid mountainous regions. Therefore, we relied on the following for delineation of the potential habitat (Fig. 1.7): (a) delineation of the scrub habitats in the surrounding areas of the recent records of the Asiatic caracal presence and (b) potential habitat determined by the ensemble modelling by Jangid *et al.* (2022). Table 1.1 indicates the identified districts and the percentage forest cover for landscape-level conservation planning of the Asiatic caracal in Gujarat, MP, and Rajasthan.

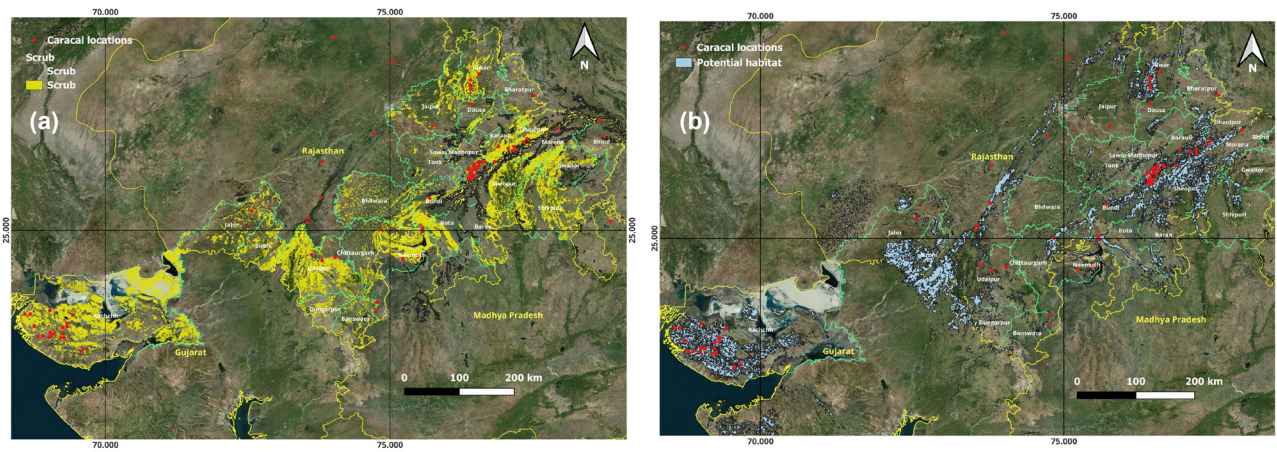


Figure 1.7.

Delineation of potential conservation areas for Asiatic caracal based on the distribution of (a) scrub and (b) potential habitat (Jangid *et al.*, 2022) in the states of Rajasthan, Madhya Pradesh, and Gujarat.

Table 1.1.

Landscape of conservation districts of importance to the Asiatic caracal in Rajasthan, Madhya Pradesh, and Gujarat

	States			
	Gujarat	Madhya Pradesh	Rajasthan	% Forest cover of geographic area**
District	Kachchh*	Bhind	Alwar*	14.28
		Gwalior	Banswara	5.94
		Morena	Baran	14.46
		Neemuch	Bharatpur*	4.55
		Sheopur	Bhilwara	2.14
		Shivpuri	Bundi	9.65
			Chittaurgarh*	12.64
			Dausa	3.41
			Dhaulpur*	13.81
			Dungarpur	8.02
			Jaipur	4.96
			Jalor	2.52
			Karauli*	15.75
			Kota	10.48
			Sawai Madhopur*	10.29
			Sirohi	17.76
			Tonk	2.29
			Udaipur*	23.51
* Caracal presence reported between 2001 and 2020 (Khandal <i>et al.</i> , 2020)				
** India State Forest Report 2019				

1.3.1.1.2. Assess the status of the Asiatic caracal in the potential habitats of Rajasthan, Gujarat, and Madhya Pradesh

Caracal has occurred frequently in the dryland habitats of the three states, viz., Gujarat, MP, and Rajasthan, until recently. Records of caracals have been reported from Rajasthan and Gujarat; however, they have sporadically appeared in MP. Therefore, the caracal was considered extinct in the state of MP, as the species was never photographed until recently, despite extensive and intensive camera trapping in tiger-bearing areas under the “All India Tiger Monitoring” exercise. This may have been due to the degradation of grasslands and scrub habitats, which have probably impacted the dryland wildlife species.

In March 2024, a caracal was photographed crossing the Chambal River from MP to Rajasthan by a wildlife enthusiast, Vaibhav Sanghvi (Fig. 1.8a and b). The observed crossing was near the Agra-Mumbai national highway bridge over the Chambal River (Fig. 1.8.c). The crossing site, located near Dholpur, is a frequent caracal habitat in Rajasthan. This individual may have originated in Morena, MP. The observation may suggest frequent movement of caracals between Rajasthan and MP. Still, it remained unnoticed in MP’s dryland habitat, as no planned survey was undertaken.

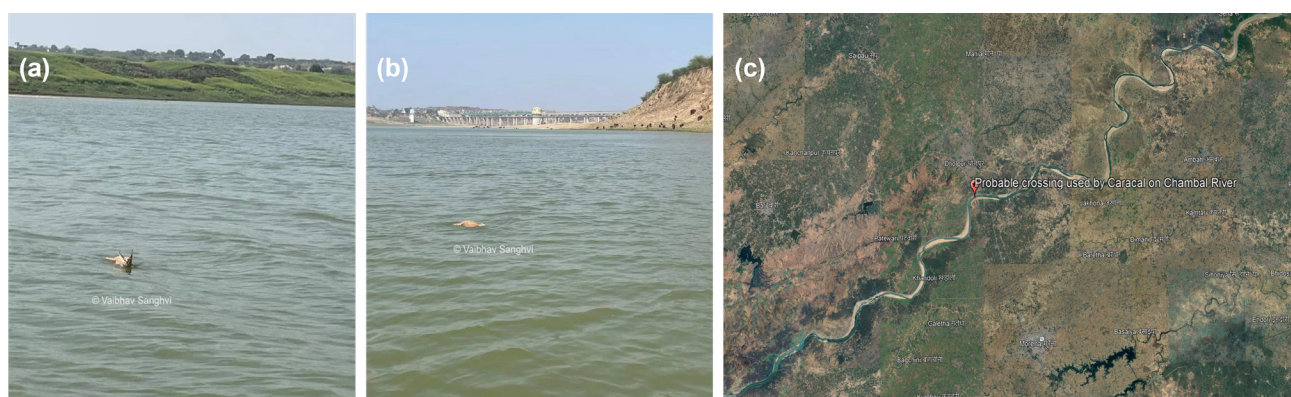


Figure 1.8.

An Asian caracal was recorded crossing the Chambal River on the Agra–Mumbai NH in March 2024.

During regular camera trapping at one of the cheetah’s conservation sites, the Gandhi Sagar WLS in MP, a caracal was captured several times on 1st July 2025.

Hence, the presence of caracal suggests suitable dryland habitat in MP; however, an intensive survey is required to determine the status of this species, as no detailed surveys have been conducted previously. Most of the PAs in MP are forested, whereas the caracal’s preferred habitat is dry grasslands, scrubland, rocky areas, and open woodland. Therefore, the dry regions of Panna, Sagar, Satna, Guna, Gwalior, Bhind, Morena, and Shivpuri, as well as Gandhi Sagar, may be potential caracal habitats and warrant systematic surveys.

In March 2025, a camera trap captured an image of a caracal in Mukundra Hills TR, Kota. Considering the species’ long-range behaviour, the individual might have been dispersed from the nearest source population within the Ranthambore landscape (RTR, Kailadevi, and Dholpur). Additionally, Rana Pratap Sagar and the Chambal basin in Rajasthan have confirmed caracal populations.

Hence, the sporadic recent sightings across Rajasthan and MP suggest the presence of suitable habitat. Still, the status is unknown due to a lack of intensive surveys outside the PAs. Therefore, we recommend undertaking an intensive survey using multiple non-invasive techniques simultaneously in the scrub and ravine habitats of potential districts in Rajasthan, MP, and Gujarat (Fig. 1.7; Table 1.1).

1.3.1.1.3. Proposed non-invasive survey techniques for assessing the status of the Asiatic caracal

Critical aspects in effective wildlife management require information on the distribution and abundance of species, especially carnivores, which are considered flagship species, in relation to anthropogenic factors. The majority of the breeding population of medium to large carnivores is within the PAs, though they use human-dominated landscape matrices for moving from one habitat to another (Athreya *et al.*, 2013; Chapron *et al.*, 2014; Chanchani *et al.*, 2016; Ghosh Harihar *et al.*, 2019; Bista *et al.*, 2021). Unfortunately, assessment of wildlife status in such areas has mostly been ignored. Kannan *et al.* (2022) surveyed multiple-use landscape matrices around RTR and in other regions, totalling 3,384 km², using sign surveys. Still, their findings were confined to the tiger, leopard, sloth bear, and hyena. Although the probability of detection in their study outside the PA was low, it highlights the use of such areas by carnivores. Additionally, crossing the Chambal River by an Asiatic caracal from MP to Rajasthan also underscores the importance and presence of carnivores in such a landscape. Hence, monitoring the status and trends of the Asiatic caracal is key to understanding how the species responds to natural and human-derived threats and to evaluating and improving conservation planning and management. Despite the wide range of available methods for surveying carnivores, employing efficient methods over large spatial scales is often resource-intensive (Llaneza *et al.*, 2014). Therefore, monitoring of large carnivores usually relies on a network of both professional and non-professional participants; hence, citizen science has become an increasingly important part of wildlife monitoring over large areas (Louvrier *et al.*, 2018; Molinari-Jobin *et al.*, 2018; Ražen *et al.*, 2020).

Use of scent lures and baits improves time to first detection and detection probability of elusive species:

Singh *et al.* (2014) studied population and ecological characteristics of caracal using camera traps in RTR, western India, from 2006 to 2009. They obtained 37 caracal captures over 25,156 camera-nights, with a capture success rate of 0.02–0.34 captures/100 trap-nights or one caracal/679.9 trap-nights over 4 years. Similarly, regular camera trapping in other PAs, such as Kuno NP and Panna TR, failed to capture the caracal. This may be due to either the absence of caracals or to inadequate sampling strategies for detecting them. Similarly, Kannan *et al.* (2022) conducted a sign survey in the surrounding areas of RTR, covering 3,384 km². The results showed that tigers and sloth bears had very low occurrence probabilities of 0.093–0.13, and no Caracal presence was found. Carnivores, which are usually scarce, elusive, and nocturnal, have multiple land uses outside the PAs; therefore, it is critical to increase the probability of detection during surveys. Numerous empirical studies have demonstrated that the use of bait (food attractants) and/or lure (scent attractants) improves detection of small carnivores (Buyaskas *et al.*, 2020; Holinda *et al.*, 2020; Randler *et al.*, 2020). Additionally, Mortelliti *et al.* (2024) found higher costs for studies conducted without bait or lure for mustelid species, as more sites were needed to achieve measurable results, thereby requiring additional time and resources. Hence, we may need to opt for active rather than passive monitoring with camera traps and propose the simultaneous use of several methods to detect caracal presence in India.

Carnivore survey methods: Non-invasive methods have been more cost-effective for surveying large landscapes than invasive methods. Based on the review of Goodenough and Perks (2025) and other empirical studies, most methods deployed for carnivore surveys are as follows (Fig. 1.9):

- **Camera trapping:** Placing cameras to capture images of animals, providing data on presence and activity patterns.
- **Scat analysis:** Identifying species through the collection and analysis of faecal samples (scats), often aided by DNA analysis.
- **Scent track stations:** Using lures and scent stations to attract and detect carnivores by their scent marks.
- **Sign surveys:** Looking for direct signs, such as tracks, or indirect signs, such as feeding sites.
- **Citizen science:** Utilising citizen science in areas where caracals persist.
- **DNA:** eDNA refers to DNA collected from an environmental sample, such as water or soil, rather than directly from an organism. These have now been used for mammals in conservation contexts (Pinakhina and Chekunova, 2020).

Sampling strategies to determine Asiatic caracal status: Considering the critical status of the Asiatic caracal, we propose the use of all possible methods to assess the status of the species outside the PAs within the identified potential habitat for conservation at the landscape level (Fig. 1.4).

- **Survey unit:** Use each taluka or tehsil as a sampling area and divide it into 25 km² grids for sampling, which is close to the reported home range of the caracal in dry deciduous habitat. We propose occupancy modelling to estimate the method-specific detection probability of the species across large-scale, grid-based (5 × 5 km²) surveys using different non-invasive sampling techniques.
- **Survey methods:** Carnivores frequently use human trails and paths to move through forests, scrubland,

and human-dominated areas, and therefore, sampling for animal signs on trails is an efficient method of surveying large areas for carnivores (Karanth & Srinquist, 2000; Wilson & Delahay, 2001; Thorn *et al.*, 2010). Geyle *et al.* (2020) reported that detectability was seven times higher for cats and three times higher for foxes on-road. Thus, targeting survey efforts on the road yielded the greatest power to detect declines in both species. Therefore, we suggest using human trails and paths for non-invasive techniques to assess the status of the Asiatic caracal within each grid's potential habitat.

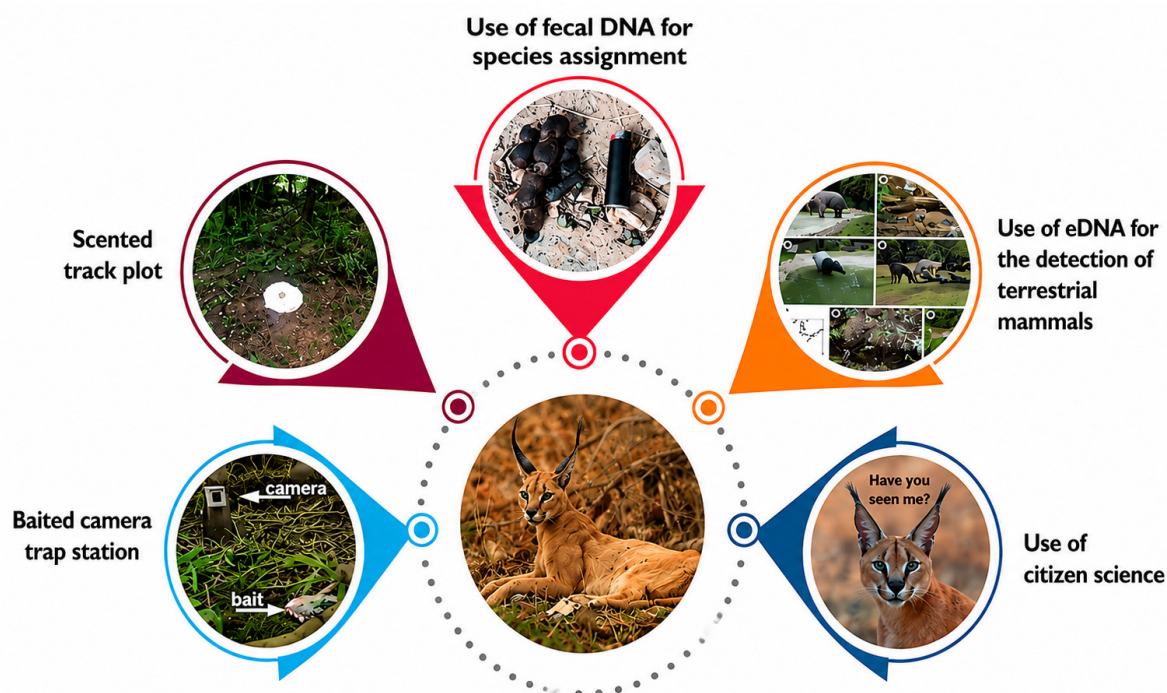


Figure 1.9.

Proposed use of simultaneously non-invasive survey techniques for assessing the status of the Asiatic caracal in the states of Rajasthan, Madhya Pradesh, and Gujarat.

Scented track stations: A scented track station consists of flour spread in a circular area on the ground. A “scent” or “bait” is placed in the middle of the region, attracting predators who leave their foot-prints in the flour, which helps you to identify the animals present in the area. Prepare an album of carnivore tracks by using several scented track stations coupled with camera traps in RTR. Select a location on the trail and path that appears frequently used by predators, characterised by low vegetation in each grid. Prepare at least four scent track stations in each grid, consisting of circular layers of chalk dust, fine sand, plaster of Paris, or natural soil or mud, each measuring 1.0 m in diameter and 2–4 cm thick. Place your bait in the middle of the circle (Fig. 1.10). This ensures that the animals will have to walk through the track plot to get to the bait. Leave your station overnight, then examine the next day to see what tracks are made. Please photograph the track with a scale and GPS coordinates, and compare it with known tracks of carnivore species.



Figure 1.10.

Scented track station placed on a path for a carnivore survey.

Baited camera-trap station: Camera trapping is a powerful tool for non-invasively surveying rare and elusive carnivores. However, unbaited camera-trapping is plagued by low capture rates or detection. While working on leopards, du Preez *et al.* (2014) demonstrated that baited camera trapping significantly increased leopard capture rates and recorded dependent cubs, whereas the unbaited method failed to detect them. Besides, the baited method is more cost-effective and has the potential to accurately survey unmonitored populations, including those with too low densities to be determined accurately via other means. Considering this, we proposed using baited camera trap stations and placing at least four in a grid at strategic locations along the trail or path to maximise detection probability within the preferred habitat. Each camera trap station should be at least 1 km apart within the grid.



Figure 1.11.

Placement of a baited camera trap station on a trail for carnivore survey.

Molecular-based species identification of scats: Faecal mini-barcoding of mitochondrial DNA (mtDNA) is a potential tool for wildlife monitoring (Pilot *et al.*, 2007). One such mini-barcode is a 126-base-pair section of the ATP synthase 6 (ATP6) gene, which has been shown to discriminate closely related, recently diverged carnivore species (Haag *et al.*, 2009; Chaves *et al.*, 2012). These ATP6 primers also failed to amplify any prey DNA present in the faecal sample (Chaves *et al.*, 2012). Successful use has been demonstrated in carnivores from different habitats, including tropical rainforests (Haag *et al.*, 2009; Michalski *et al.*, 2011; Chaves *et al.*, 2012; Alberts *et al.*, 2017; Souza *et al.*, 2017; Srbek-Araujo *et al.*, 2018; Gonçalves *et al.*, 2022; Wong *et al.*, 2025) and mountainous regions (Mazzolli *et al.*, 2017).

Therefore, it is suggested to cover all possible trails and paths in each grid that carnivores have used. Collect half of any scat encountered during the survey and store it over silica gel in a plastic vial (Wasser *et al.*, 1997), along with the GPS coordinate for further DNA analysis in the lab.

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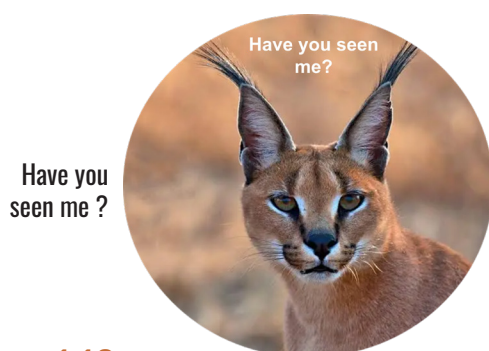


Figure 1.12.

A photo of the Asiatic caracal may be used during a citizen science survey.

Use of a citizen science survey to determine the presence of the species: Citizen science is a collaborative approach to scientific research that involves public participation. Citizen science has emerged as a powerful tool, bridging the gap between scientific research and society, with several projects having increased substantially over the last three decades (Davis *et al.* 2023). Hence, it is possible to survey the species, and citizen volunteers may be involved in village-based studies to determine whether they have seen this animal by showing a photo (Fig. 1.12) and by conducting other ecological surveys.

Use of such methods may help determine the current distribution range of caracals in India. Mukherjee *et al.* (2021) conducted a small survey of wild cats, involving 35 citizen volun-

teers, during 2017-2019 in Sanjay Gandhi NP, Mumbai, India. Karnataka-based NGO *Deccan Conservation Foundation* has initiated a similar survey in Koppal district, and the Forest Department at Gandhi Sagar WLS in M.P. has posted posters asking locals and visitors to report caracal sightings. Efforts to understand caracal distribution have also been undertaken in the Panna landscape in MP.

Use of eDNA: With recent advances in DNA technology, environmental DNA (eDNA) surveys have gained popularity (Ruppert *et al.* 2019) and have become a viable tool for detecting rare species (Leempoel *et al.* 2020, Sales *et al.* 2020). Mostly, samples of soil, water, or air are screened for mitochondrial DNA shed by animals to detect the presence of species (Thomsen & Willerslev, 2015). Various empirical studies have demonstrated successful use of eDNA in detecting the critically endangered European mink *Mustela lutreola* (Croose *et al.* 2023), least weasel, stoat (Broadhurst *et al.* 2021), European pine marten *Martes martes*, and Eurasian otter *Lutra lutra* (Sales *et al.* 2020). Jacjowski *et al.* (2024) reviewed state-of-the-art non-invasive methods for monitoring weasels and highlighted the potential of eDNA for carnivore surveys. Considering its potential, this approach may be used to determine the status of the Asiatic caracal by analysing soil or water samples from each grid.

1.3.1.2. Plan long-term research into two isolated populations of Asiatic caracal

Very little is known regarding factors affecting distribution patterns, species' ecology and biology, and interactions with other carnivore species. Therefore, we suggest initiating a long-term research study for the core population of the Asiatic caracal in RTR and Bhuj on the following points:

- *Understanding ecology and biology:* Further research is needed to understand the specific ecological requirements, including habitat preferences, prey availability, ranging behaviour, breeding biology, and interactions with other species.
- *Population monitoring:* Regular monitoring of populations using techniques such as camera trapping and genetic analysis will enable us to assess population status and track the effectiveness of conservation efforts.
- *Population genetic study:* Conduct genetic analyses using non-invasive samples to assess genetic diversity, population structure, gene flow, and connectivity among caracal populations. This will help identify isolated populations, evaluate the effects of habitat fragmentation, and inform conservation strategies for maintaining long-term population viability.
- *Movement ecology:* It is suggested that a few caracals of both sexes be collared in Rajasthan and Gujarat using GPS telemetry to understand their movement ecology in relation to habitat characteristics, the use of different landscape matrices, and the impact of anthropogenic factors.
- *Studying threats:* Assess the impact of anthropogenic factors on the species' ecology and biology to plan targeted conservation strategies.

1.3.2. Habitat management and restoration for establishing movement corridors and strengthening the existing distribution range of the Asiatic caracal

Loss of suitable habitat reduces the carrying capacity of the environment and can isolate populations, hinder gene flow, and increase vulnerability to extinction. Most caracal sightings have been in Rajasthan near RTR and in Bhuj, Gujarat. Recent sightings outside these areas have been reported, suggesting that animals are dispersing, likely from RTR to other PAs in the north and south, as the surrounding habitats are predominantly human-dominated and agricultural fields. In semi-arid habitats, many species rely on large areas of connected habitat to acquire resources and maintain population stability. Jangid *et al.* (2022) identified environmental factors influencing caracal distributions in India and indicated that areas with high temperatures and precipitation seasonality, rugged terrain, moderate-to-high forest density, and low-to-intermediate arid regions are climatically suitable for caracals. Studies from Iran also indicated that caracals use highly rugged areas with excellent vegetation cover (Adibi *et al.*, 2014; Hemami *et al.*, 2018). Dunford *et al.* (2024) identified factors influencing caracal distribution patterns and highlighted the importance of higher vegetation indices, elevations, and associated precipitation in maintaining caracal persistence in Saudi Arabia. Khandal *et al.* (2020) reported the importance of reviving grassland, scrub, and ravine habitats for ensuring long-term conservation planning. Due to anthropogenic factors, many preferred habitats are fragmented, leading to isolation because they lack suitable dispersal areas. Thus, strategic conservation planning has been suggested for protecting threatened species (Marcot & Flather, 2007; Rao *et al.*, 2007; IUCN-SSC, 2008), as it can formulate threat mitigation measures based on the potential habitats of the species.

The restricted distribution range and exclusive movement in the north and south of RTR, Rajasthan, despite the potential habitat in the adjoining state of MP, may be attributed to the lack of a movement corridor and habitat, as well as various anthropogenic activities, given the landscape's dominance by agriculture and livestock grazing. Different empirical studies elucidated that carnivores use vegetation cover for movement by navigating through areas of dense to moderate foliage to hide from humans and avoid detection, moving along linear features like roads and fences for efficient travel, and utilising the interface between habitat types, such as forests and pastures, for foraging. Hence, vegetation cover is essential for reducing exposure, finding prey, and safely traversing fragmented human-modified landscapes.

Key strategies focus on increasing their numbers and genetic diversity to prevent extinction vortexes and conserve small, isolated threatened populations. This can be achieved by increasing the extent of suitable habitats and connectivity. Various empirical studies have highlighted the need to consider habitat-specific characteristics when implementing conservation measures. Therefore, we analysed the potential habitats of Rajasthan and MP and proposed the management and restoration of scrub, grassland, and ravines, as well as the creation of wild edges along agricultural fields and the utilisation of dry river streams (Fig. 1.13) to increase the distribution range of the species.

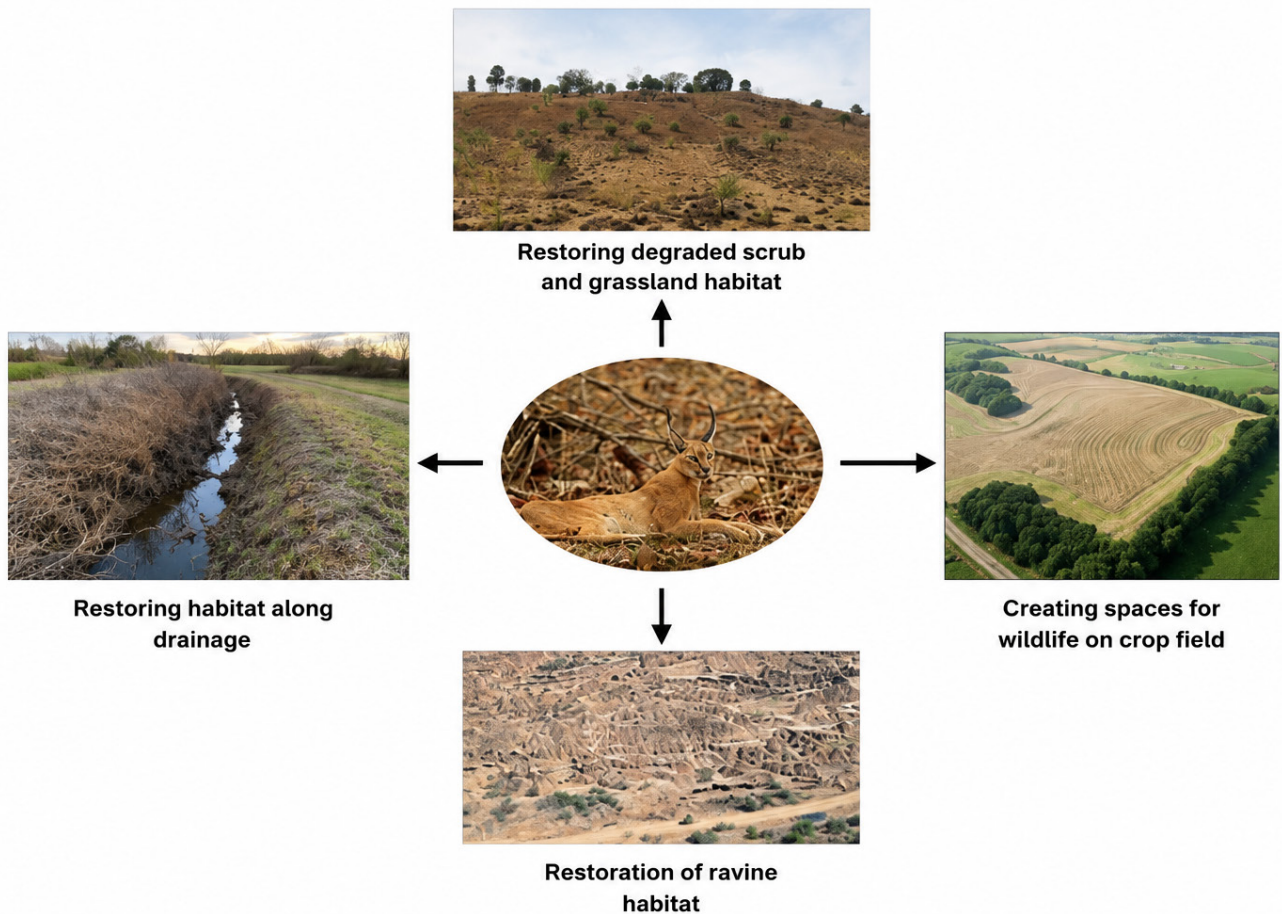


Figure 1.13.

Proposed strategies for habitat management and restoration for strengthening the existing distribution range of the Asiatic caracal in Rajasthan and Madhya Pradesh.

1.3.2.1. Restoration of Wasteland/Scrub habitat:

Rajasthan is a key habitat for the Asian caracal, but the conversion of scrub wasteland to cropland has impacted it. A decrease in dense scrub habitat by 3839.45 km², whereas an increase in open scrub by 1576.97 km², has been recorded between 2008-09 and 2015-16. Fig. 1.14 shows a decrease in wasteland habitats in key conservation districts important to the Asian caracal. However, Table 1.2 indicates that vast stretches of wasteland ranging from 375 to 4724 km² are available across all states identified as having potential Asiatic caracal habitat. Besides, our analysis of land-use patterns indicated that scrub habitat occurs across the potential distribution range, covering 7-59 per cent of the state area (Fig. 1.15). Such potential habitat may be improved through restoration with native plant species, thereby enhancing the preferred prey of rodents, birds, and other lizards for the Asiatic caracal.

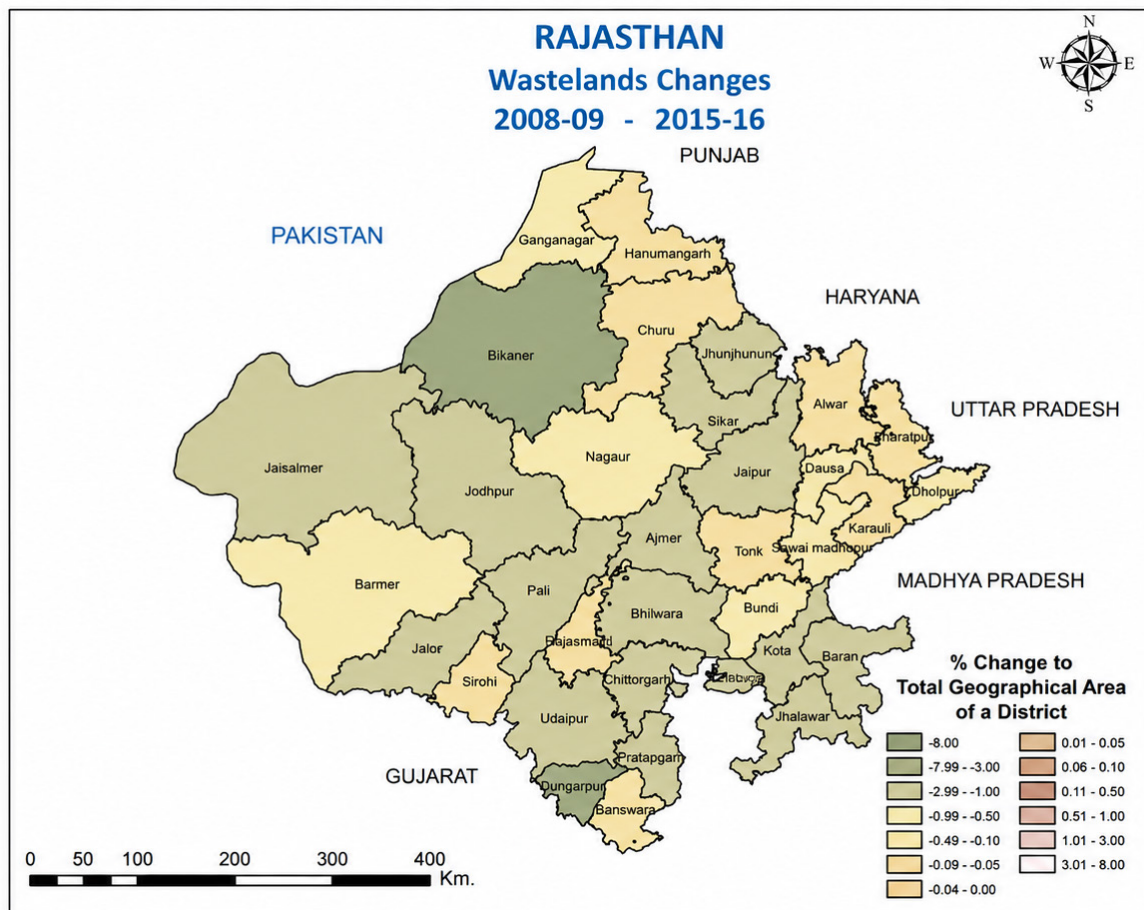


Figure 1.14.

Wasteland changes in Rajasthan during 2008-09 and 2015-16.

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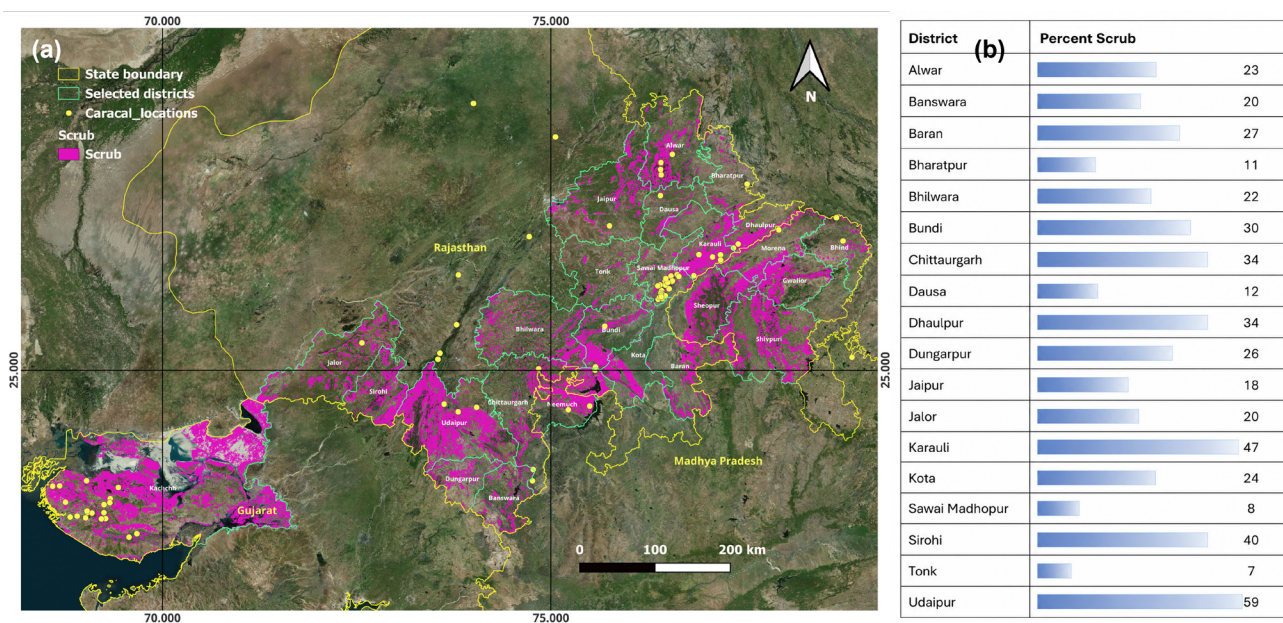


Figure 1.15.

(a) Distribution of scrub habitat across the proposed distribution range of the Asiatic caracal in Rajasthan, Madhya Pradesh, and Gujarat and (b) Per cent scrub area available in potential Asiatic caracal habitats in the districts of Rajasthan.

1.3.2.2. Enhancing landscape permeability of cropland for wildlife through best agro ecology practices

1.3.2.2.1. Status of croplands within the identified districts for the conservation importance of the Asian caracal

Based on the land-use pattern determined across the proposed potential Asiatic caracal habitat across three states, viz., Rajasthan, MP, and Gujarat, most of the area is under cropland, ranging from 26 to 93 per cent across different districts of Rajasthan (Fig. 1.16). However, empirical studies have shown that it is possible to create wildlife habitat within the agricultural matrix, enabling animals to move between potential habitats. Considering these findings, we examined ways to create wildlife habitat within an agricultural matrix and make it permeable for wildlife to move across the landscape.

Table 1.2.

Distribution of potential areas suitable for restoration of the Asiatic caracal habitat in the selected districts of Rajasthan.

District	Area, km ²	Population	Not available for cultivation ¹ , km ² (1)	Other uncultivated land excluding fallow land ² , km ² (2)	Fallow land ³ , km ² (3)	Total, km ² (1 to 3)
Ajmer	8481	1531974	1360.56	1358.45	518.76	3237.77
Alwar	8380	2015275	1272.45	301.85	477.35	2051.65
Banswara	5037	1798194	611.36	345.90	297.14	1254.40
Baran	6992	1223921	641.49	435.03	251.93	1328.45
Bharatpur	5066	1475707	448.37	101.33	194.21	743.91
Bhilwara	10455	1589543	2125.69	2182.70	839.32	5147.71
Bundi	5550	1113725	893.15	472.27	324.95	1690.37
Chittorgarh	7822	1544392	1173.77	1364.48	258.66	2796.91
Dausa	3432	1637226	375.11	299.81	193.17	868.09
Dholpur	3084	1207293	755.25	297.31	157.76	1210.32
Dungarpur	3770	1388906	901.41	598.27	435.26	1934.94
Jaipur	11152	6046835	1635.03	552.68	1050.01	3237.72
Karauli	5043	1458248	709.55	404.66	176.70	1290.91
Kota	5217	1951014	614.30	339.15	222.83	1176.28
Sawai Madhopur	10527	1335551	628.79	453.70	234.89	1296.38
Tonk	7194	1421326	762.71	763.34	460.72	1986.77
Udaipur	11724	2497645	4724.46	2005.61	664.28	7394.35
Total	118926	31236775	19633.54	12258.54	6757.94	38649.93

Source: Agriculture Statistics of Rajasthan 2021-2022. Directorate of economics and statistics, Department of Planning, Rajasthan, Jaipur

1. Area under non-agricultural uses, barren and unculturable wasteland
2. Permanent pasture and other grazing land, cultivable waste, and under miscellaneous tree crops and groves

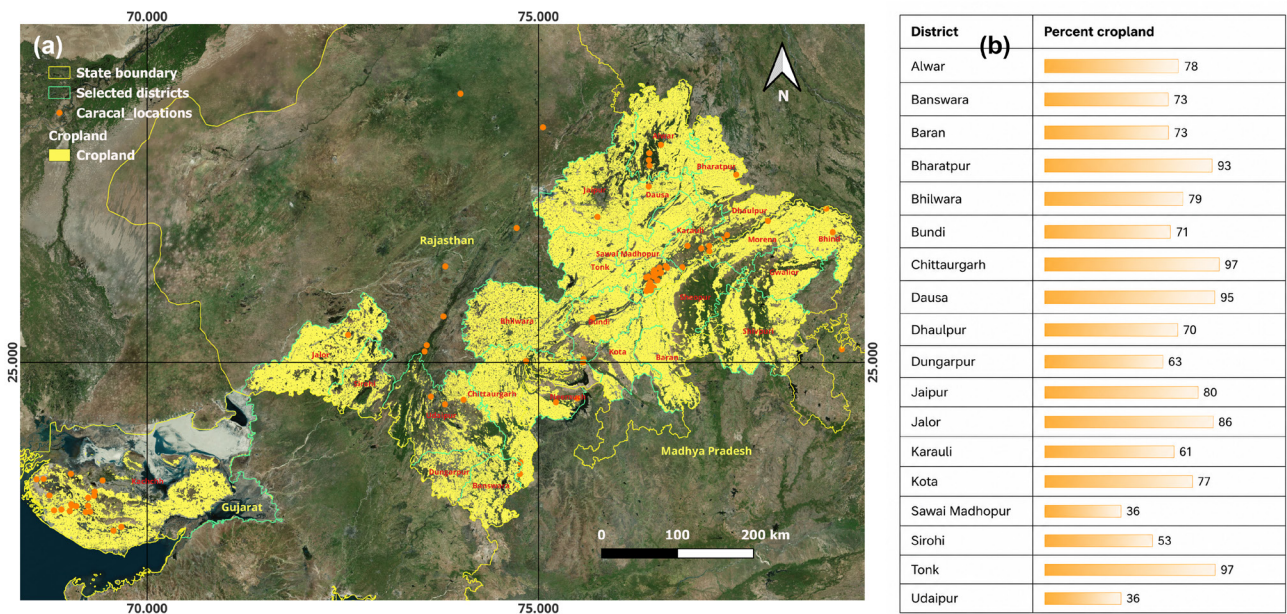


Figure 1.16.

(a) Distribution of cropland across the proposed distribution range of the Asiatic caracal in Rajasthan, Madhya Pradesh, and Gujarat and (b) Per cent scrub area available in potential Asiatic caracal habitats in districts of Rajasthan.

1.3.2.2.2. Create wild edges on agricultural fields

Agroecology enables enhancing crop field edges to attract wildlife by planting a diverse array of native grasses, forbs, legumes, and shrubs. These plants can provide food and cover to various wildlife species. Connecting these vegetated field borders with other natural areas, like woodlots and grasslands, can create a network of habitats, further enhancing wildlife diversity. Considering the significance of such agroecology practices, numerous empirical studies have demonstrated that creating wildlife-friendly habitat on low-yielding edges of agricultural fields (Fig. 1.17) increased overall crop yield by 25 to 35 per cent and wildlife numbers in comparison areas without wildlife-friendly habitats (Pywell *et al.*, 2015). The Extension department of the University of Missouri (<https://mdc.mo.gov/>), USA, enrolled approximately 1,160 fields in the Conservation Reserve Program (CRP) CP-33 Habitat Buffers for Upland Birds practice. This study demonstrated that field borders planted with recommended grass/forb mixtures can increase the local abundance of bird species by 50-100% compared to conventionally farmed fields. Other wildlife species also used such habitats. They concluded that agricultural landscapes could support key species of regional conservation concern when select conservation practices are strategically used to create native plant communities on farmlands. This study also suggested that wider field borders provide more available and diverse wildlife habitat and should be at least 10 metres wide.



Figure 1.17.

A wide vegetative zone between crop fields with native vegetation provides higher quality habitat for wildlife and crop pollinators (Source: <https://extension.missouri.edu/publications/g9421>).

Actions: Therefore, for enhancing the landscape connectivity of Asian caracals through crop fields in the selected districts, there is a need for a “conservation and habitat restoration on crop field scheme”, and consider the following points:

- (i) Identify potential croplands based on the suitable habitat and status survey undertaken outside the PAs within the selected districts.
- (ii) Provides financial incentives for landowners to remove field borders from crop production and manage cropland field borders for wildlife habitat. This economic incentive under the conservation scheme should offset the loss of future net revenue on the enrolled area for the life of the contract.
- (iii) Better engagement and training of farmers will be essential to deliver these more demanding and complex wildlife habitats.

Hence, wildlife conservation and commercial crop production can go hand in hand.

1.3.2.2.3. Habitat conservation and restoration of the “Badland” around the Chambal River: A potential unexplored Asiatic caracal habitat

Badland topographies are characterised by rugged, deep gullies and narrow ravines, covering approximately 5000 km² along the Chambal River and its tributaries in Rajasthan, MP, and Uttar Pradesh. The most prominent districts in Rajasthan are Kota, Bundi, Baran, Sawai Madhopur, Karauli, and Dholpur, whereas in MP, these are Gwalior, Bhind, Morena, and Sheopur.

The National Chambal Sanctuary provides adequate protection to habitats and wildlife species over an area of 5400 km² across three states: Rajasthan, MP, and Uttar Pradesh. Rajasthan, MP, and Uttar Pradesh. The majority of the habitat is a long, narrow strip along the river, with a width ranging from 2 to 6 km. Chambal's unique badland topography is characterised by steep slopes, gullies, and ravines within the sanctuary and adjoining areas (Fig. 1.18). The deep networks of gullies developed here are known for their ruggedness and high inaccessibility.



Figure 1.18.

Badlands characterise mazes of ravines and deep gullies around the Chambal River.

Vegetation of the Chambal region comprises mainly two types of forests: tropical dry deciduous forests and tropical ravine thorn forests. Tropical dry deciduous forest, primarily dominated by *Anogeissus latifolia*, *A. pendula*, *Boswellia serrata*, *Acacia* sp., *Ziziphus* sp., *Lannea coromandelica*, *Tectona grandis*, etc. In comparison, the tropical ravine thorn forest is mainly composed of *Acacia* sp., *Zizyphus* sp., *Prosopis cineraria*, *Mimosa* sp., *Flacourtia indica*, and *Commiphora wightii*, among others. Badlands are characterised by scrub vegetation, primarily native grasses and bushes of *Acacia* sp. and *Prosopis juliflora*. This habitat is suitable for numerous prey species of lesser to medium-sized carnivores (Fig. 1.19). Hence, Badlands, characterised by a labyrinth of winding gullies and hills, serve as critical, secluded habitats for various wildlife species, offering escape cover and potential hunting grounds for a wide range of predators.



Figure 1.19.

Presence of native grasses and bushes within the ravine habitat.

Fig. 1.20 indicates the distribution of badlands around reported caracal occurrences in Rajasthan and may occur in such habitats of MP. However, the species' status is poorly known, as no status survey has been conducted outside PAs. Tigers are thought to use these maze-like ravines when travelling from RTR to Kuno-Palpur WLS across the Chambal and Kailadevi WLS to the north, as the ravines provide access to either patch while avoiding human settlements. Leopards are known to traverse these ravines as well. Despite harshness, badland scrub habitats provide diverse niches for various wildlife species. They are also home to rodents in arid to semi-arid regions, as well as hares, jackals, wolves, sloth bears, and other ground-dwelling birds, such as partridges and sandgrouse. Dholpur and Karauli districts lie within the Chambal ravines, where the borders of Rajasthan, MP, and Uttar Pradesh meet. Close to Dholpur, a caracal was sighted crossing the Chambal River from MP to Rajasthan. This suggests the presence of the Asiatic caracal habitat in MP.

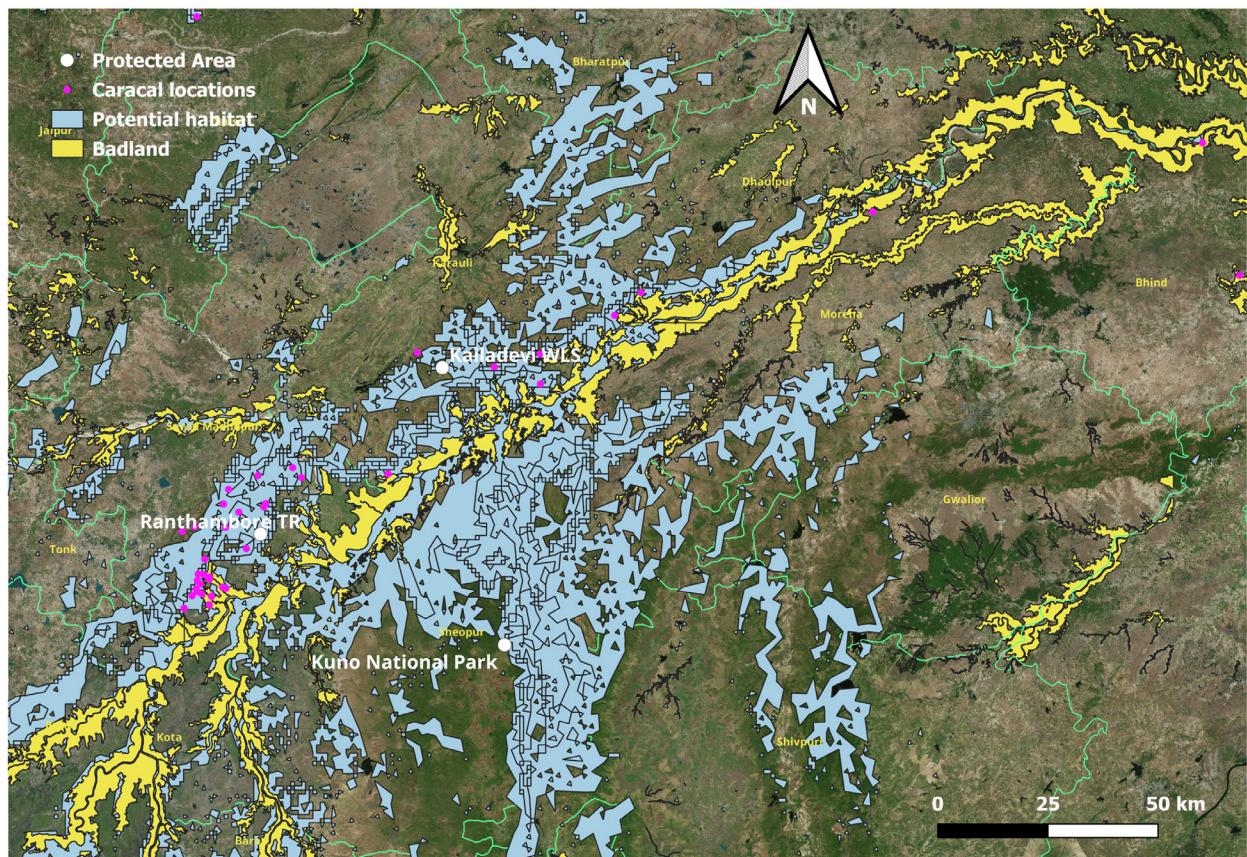


Figure 1.20.

Presence of “Badland” along the Chambal river of Rajasthan and Madhya Pradesh in relation to the recorded presence and potential habitat of the Asiatic Caracal.

Classification of Ravines

Based on depth: Table 1.3. describes the classification of ravines based on depth.

Table 1.3.

Classification of ravine based on depth (adopted from Verma *et al.*, 2018).

Class	Bhulyan (1967)	Seth <i>et al.</i> (1969)	Tejwani (1974_1975)	Gupta and Prajapati (1983)
Very shallow	-	Depth < 1.5 m and bed width up to 3 m	-	-
Shallow	Depth <1 m	Depth < 1.5 m and bed width up to >3 m	Depth <1m; bed width up to 18 m	Depth, 1.5 m
Medium	Depth < 1-5 m	Depth 1.5 to 5.0 m and bed width > 3.0 m	Depth 3 to 9 m; bed width 18 m; side slope 8 to 15%	Depth 1.5 to 5.0 m
Deep	Depth > 5 m	-	Depth 3.0 to 9.0 m and bed width > 18 m	Depth 5.0 to 10.0 m
Very Deep	-	-	Depth 9.0 m and side slope steep to vertical	Depth >10 m

Based on Reclaimability: Bali and Karale (1977) divided ravines into five classes (I–V), considering their depth, width, bed slope, hard pan or rock, especially on the inter-gully land, and groundwater level.

- Class I: Outstanding ravine land that can be reclaimed readily with minor reclamation measures. These include shallow ravines with a width of 30 m or more and no calcareous layer within 1.5 m of the surface.

- Class II: Good ravine land that can be reclaimed with minor operations requiring more dozing work than Class I. Bed slope 5–10%.
- Class III: Moderate land with medium-depth ravines, bed slope 10–15%, calcium carbonate hardpan or bedrock within 0.5–1.0 m depth from the surface.
- Class IV: Poor land with medium to deep gullies of narrow width, hard pan or bedrock within 0.5 m depth, very costly to reclaim, or may not be suitable for cultivation after reclamation.
- Class V: Land unsuitable for reclamation and can be developed for forestry/grassland.

Classification of ravines suggests that those that are medium to very deep and classified as Class III to V may be the potential habitat for the Asiatic caracal. These areas need to be identified within the designated districts to conserve and improve the species through afforestation.

Conservation threats to badlands

The Chambal Badlands are extremely dissected, difficult to cross, and agriculturally unfit. Despite these challenges, various attempts have been made under different schemes to bring the land under agriculture since independence (Verma *et al.*, 2018).

Currently, MP has nearly 18 lakh hectares of ravines with steep but shallow gullies. This area, primarily along the banks of the River Chambal and its tributaries, spans districts such as Bhind, Morena, Shivpuri, Gwalior, Ujjain, and Mandsaur. The region sought support from the Centre to utilise advanced technology to bring this land under agriculture. The Centre has worked with the World Bank to explore converting large areas of ravines into arable land, aiming to promote agricultural development and employment while integrating environmental considerations. The “Green-Ag: Transforming Indian Agriculture for Global Environmental Benefits and the Conservation of Critical Biodiversity and Forest” project, funded by the Global Environment Facility (GEF), aims to promote sustainable, agro-ecological approaches and community-based natural resource management to address ravine erosion and improve livelihoods. Despite these efforts, it has faced significant opposition and concerns about its environmental impact.

Under “Green-Ag Project”, the MP government has proposed the “Chambal Green Landscape of 97982 ha for enhancing sustainable livelihood and biodiversity conservation” (Table 1.4).

Table 1.4.

Land use details of the Chambal Green Landscape, Madhya Pradesh, India
(adopted from <https://greenag.nmsa.gov.in/pdfDoc/Summary/MP.pdf>).

Class	Description	Approximate area (ha)
Agriculture	Agricultural land near the Chambal River and the Morena and Sheopur districts	19,400
Forest (<i>Anogeissus pendula</i>)	<i>Anogeissus pendula</i> are available in small patches in the district of Sheopur within the project landscape	614
Forest (degraded)	Forest-degraded areas are available in Sheopur district, with the project site	4,399
Forest (Dry deciduous)	Dry deciduous trees are distributed in the southeast and southwest areas of the project site	26,048
Forest (Teak mixed moist deciduous)	The teak mixed moist deciduous is distributed in the south-east and southwest areas of the project site	7,710
Grassland (<i>Boswellia</i> , <i>Zizyphus</i>)	Grassland is distributed in the southeast and southwest areas of the project site	3,453
Scrub	Scrub area found almost the entire landscape	32,698
Settlement	Settlement is available in Morena and Sheopur districts	193
Water body	Major streams are available in the study site	3,468
Total area		97,982

Strategies for enhancing the landscape conservation value of Badland for the Asiatic caracal between Rajasthan and MP

Fig. 1.21 elucidates the importance of this landscape in providing connectivity between the Asiatic caracal-occupied area of Rajasthan and the MP landscape. Besides, the observed crossing of the Asiatic caracal from the Chambal River in MP to Rajasthan also signifies the importance of this area.

1. The Asiatic caracal's status is unknown in the Badlands of MP and Rajasthan, as no surveys have been conducted to date. Therefore, it is suggested to undertake systematic surveys using multiple approaches, such as pugmark-based monitoring with track plots, molecular-based species identification of scats, and baited camera traps.
2. Medium- to very-deep gullies in Badland habitats are not suitable for agriculture, and such areas are among the most promising habitats for the survival of lesser- to medium-sized carnivores, including the Asiatic caracal. Therefore, it is suggested to identify such areas using GIS and RS, and to minimise anthropogenic factors, especially livestock grazing, and restore the habitat with native bushes.
3. Establish stepping-stone scrub habitat patches: Presently, observed Asiatic caracal locations indicate that the species is dispersing only north and south, PAs from RTR (Fig. 1.20). Therefore, to ensure and enhance the dispersal capability of the species in the human-dominated landscape, it is suggested that several 1-ha scrub habitat patches be established as stepping-stone habitats across the Badlands of MP and Rajasthan and protected with livestock fencing.

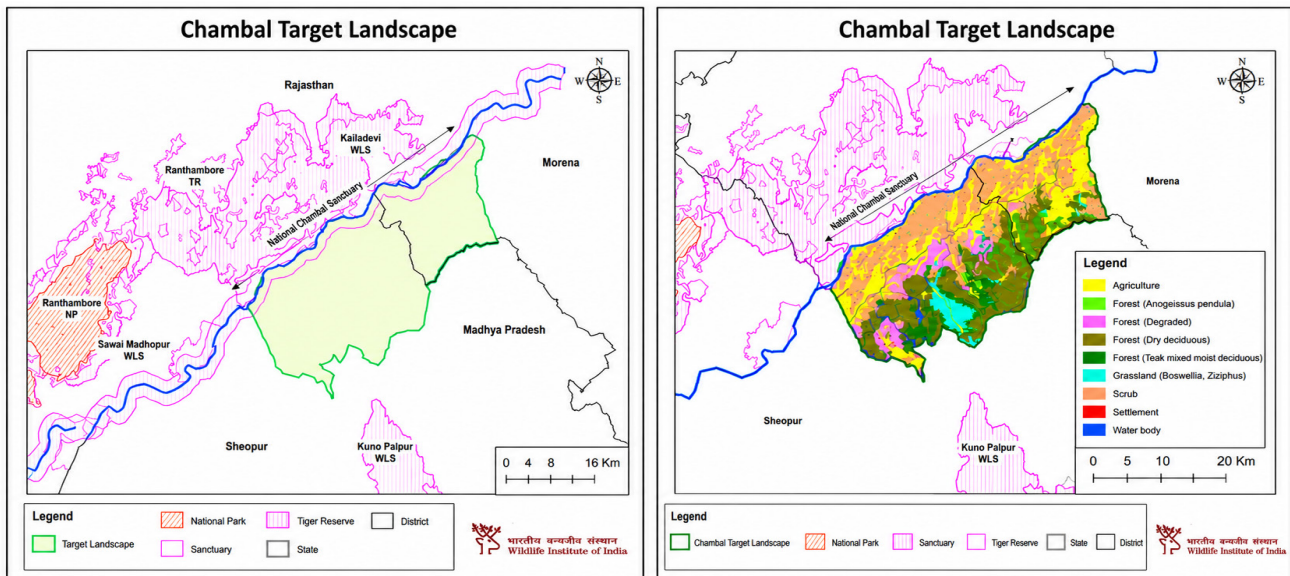


Figure 1.21.

Land use pattern of “Chambal Green Landscape” proposed under “Green-Ag Project” of Madhya Pradesh, India (adopted from <https://greenag.nmsa.gov.in/pdfDoc/Summary/MP.pdf>).

1.3.2.2.4. Strengthening movement corridor through habitat restoration around dry streams across the Asiatic caracal landscape

The significance of the riverscape has been primarily examined in terms of its role as a natural corridor for aquatic species and its contribution to biodiversity conservation. However, it has often been viewed as a barrier to various terrestrial vertebrates. However, over half the length of the global river network temporarily stops flowing at some point and may potentially act as a corridor for vertebrates. Still, studies addressing their function as movement corridors are scarce. Sanchez-Montoya *et al.* (2016) examine the role of dry riverbeds as movement corridors, and their results demonstrate that dry channels (Fig. 1.22) can act as highways for terrestrial vertebrates to access other habitats, thereby minimising the effects of landscape fragmentation. They also concluded that in areas with low connectivity, the inclusion of rivers and ephemeral streams increased total corridor length by 224%. Other studies have also demonstrated that dry river channels are vital corridors for carnivores, providing access to water, prey, and shelter, especially in arid and semi-arid regions, and that most carnivore movement is longitudinal (upstream-downstream) (Sánchez-Montoya *et al.*, 2016). Besides, they serve as crucial dispersal routes, connecting different habitats and enabling migration and movement across the landscape.

Carnivores utilise these channels for foraging, establishing territories, and avoiding human disturbances, making their conservation essential for maintaining ecosystem health and function. Hence, dry rivers or streams are becoming target ecosystems for conserving and protecting terrestrial species (Vidal-Abarca *et al.*, 2020; Sánchez-Montoya *et al.*, 2022).

Given the value of such habitats, we examine stream distribution using remote sensing and GIS data. The identified districts of the Asiatic caracal landscape (Fig. 1.23) widely distribute these habitats, which could serve as movement corridors. Different empirical studies elucidated that carnivores use vegetation cover for movement by navigating through areas of dense to moderate foliage to hide from humans and avoid detection, moving along linear features like roads and fences for efficient travel, and utilising the interface between habitat types, such as forests and pastures, for foraging. Hence, vegetation cover is essential for reducing exposure, finding prey, and safely traversing fragmented human-modified landscapes. Vegetation cover along such riverbeds in semi-arid areas is scarce due to anthropogenic factors such as livestock grazing and fodder collection.



Figure 1.22.

Dry riverbed as a potential habitat for movement corridors for terrestrial vertebrates.

Actions: Therefore, to increase the distribution range of the species in other potential habitats, we suggest habitat restoration on the edges of the dry streams/riverbeds using native plant species such as *Zizyphus nummularia*, *Capparis decidua*, *Prosopis cineraria*, *Maytenus emarginatus*, *Grewia sp.*, *Salvadora oleoides*, *Tephrosia purpurea*, *Capparis sepiaria*, *Aerva persica*, and others, including grasses.

1.3.2.3. Suggested plant species for the restoration of different types of habitats among the identified districts for Asiatic caracal conservation

Table 1.5. lists suggested native plant species that may be used to improve scrub and restore other habitats across the Asiatic caracal landscape

Table 1.5

Suggested native plant species for habitat improvement and restoration for enhancing the dispersal capability of the Asiatic caracal.

S. No.	Plant species
Grasses	
1	<i>Cenchrus ciliaris</i>
2	<i>Cenchrus setigerus</i>
3	<i>Dichanthium annulatum</i>
4	<i>Heteropogon contortus</i>
5	<i>Sehima nervosum</i>
Herb, shrub, and tree	
6	<i>Echinops echinatus</i>
7	<i>Solanum xanthocarpum</i>
8	<i>Argemone mexicana</i>
9	<i>Leptadenia pyrotechnica</i>
10	<i>Calotropis gigantea</i>
11	<i>Commelina diffusa</i>
12	<i>Tridax procumbens</i>
13	<i>Indigofera oblongifolia</i>
14	<i>Crotalaria burhia</i>
15	<i>Vachellia nilotica</i> or <i>Acacia nilotica</i>
16	<i>Capparis decidua</i>
17	<i>Balanites aegyptiaca</i>
18	<i>Ziziphus nummularia</i>
19	<i>Prosopis cineraria</i>
20	<i>Salvadora oleoides</i>
21	<i>Salvadora persica</i>

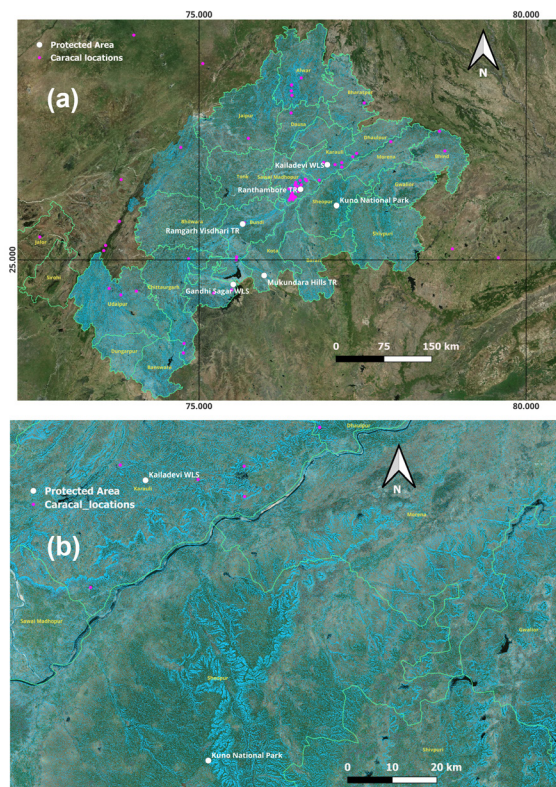


Figure 1.23.

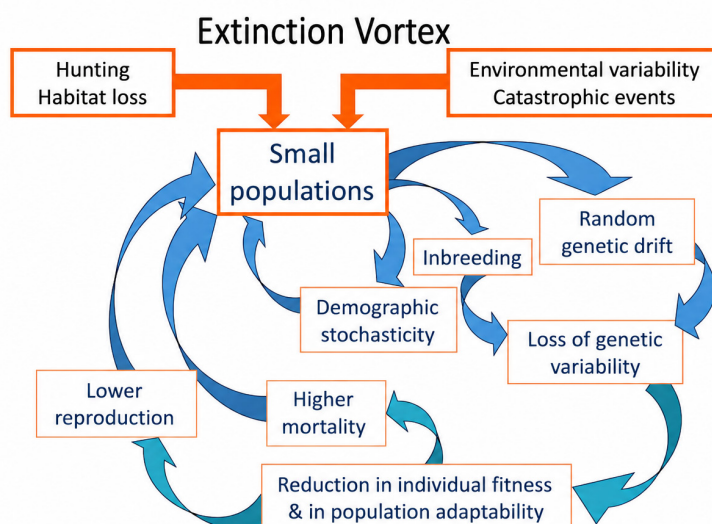
Distribution of stream network in the (a) selected habitats of the Asiatic caracal and (b) between Kailadevi WLS and Kuno NP.

1.3.3. Genetic rescue

Genetic rescue is a conservation strategy that reintroduces new genetic variation into small, isolated, and inbred populations by introducing individuals from external, genetically diverse populations. This facilitated gene flow aims to increase genetic diversity, reduce the risks of inbreeding depression, improve the population's health and fitness, and decrease extinction risk if the population is isolated.

Therefore, genetic rescue has often been suggested to minimise the risk of extinction for small and isolated populations, as they are prone to inbreeding and genetic drift (Fig. 1.24), which reduces genetic diversity and fitness, ultimately increasing the risk of extinction.

Thus, understanding current population genetic characteristics and how genetic variability is distributed across populations is critical for planning targeted conservation strategies to increase genetic diversity (Awise, 1989; Awise & Hamrick, 1996; Awise, 2000; Frankham, 2002) and, if needed, to implement genetic rescue. Such studies provide information on essential parameters critical for managing small populations, such as inbreeding, the optimal population size (N_e), and the ratio of the effective population size to the census size (N_c). Microsatellites have been widely used in wildlife conservation studies over the last few decades, providing estimates of contemporary genetic variation and informing recent population history, including demographic events such as population bottlenecks, inbreeding, hybridisation, reproductive behaviour, social structure, and dispersal (Beaumont & Bruford, 1999). Due to limitations in using microsatellites, NGS has become a popular tool in wildlife research over the last decade.



Drawn by Karen B. Strier, 2018b;
adapted from Gilpin & Soule, 1986.

Figure 1.24.

Factors responsible for the extinction vortex in a small population.

Although the caracal is widely distributed, population genetic studies are scarce (Hassan-Beigi, 2015; Tensen *et al.*, 2018; Kyriazis *et al.*, 2024). Caracal, which has a continuous distribution in South Africa, had relatively higher genetic diversity (average number of alleles per locus and observed heterozygosity = 0.76) than other felids, except leopards (Tensen *et al.*, 2018). In contrast, Kyriazis *et al.* (2024) reported elevated inbreeding levels in the isolated, small Caracal population of the Cape Peninsula. Hassan-Beigi (2015) studied the genetic diversity of the Asiatic caracal population of Iran and reported that the mean observed heterozygosity and number of alleles per locus were 0.53 and 5, respectively.

Actions: Considering the significance of genetic studies, we suggest using non-invasive genetic sampling of scats to undertake population and landscape genetics using microsatellites or NGS to develop targeted conservation strategies.

1.3.4. Translocation as conservation strategies

To minimise biodiversity loss, conservationists have restored connectivity among habitats to facilitate natural recolonisation in vacant areas or reintroduced organisms through translocation within their historical distribution range. Considering the IUCN guidelines (IUCN/SSC, 2013), tigers and Indian bison have been reintroduced in several PAs in India.

Despite intensive camera trapping, both within the historical distribution range of caracals (Divyabhanushin, 1993), caracals were not recorded (Jhala *et al.*, 2020; Khandal *et al.*, 2020). This may be due to either low detection/inadequate sampling or seasonal migration (Adibi *et al.*, 2014). However, Kuno NP holds high-potential habitats for caracals, such as RTR, where frequent sightings are recorded (in RTR; Parashar, 2020; Khandal *et al.*, 2020; Tanwar *et al.*, 2021) (Fig. 1.25). Therefore, it is suggested for undertaking intensive and extensive status survey across distribution range before planning for translocation as conservation strategies. Therefore, it is suggested for undertaking intensive and extensive status survey across distribution range before planning for translocation as conservation strategies.

Actions:

1. Once the status survey and genetic assessment of both Rajasthan and Gujarat populations is completed, a detailed proposal will be prepared for the reintroduction of the caracal based on the "PHVA", if needed.
2. Utilise the experiences gained from the wild-to-wild translocation of both Eurasian lynx and Canadian lynx.

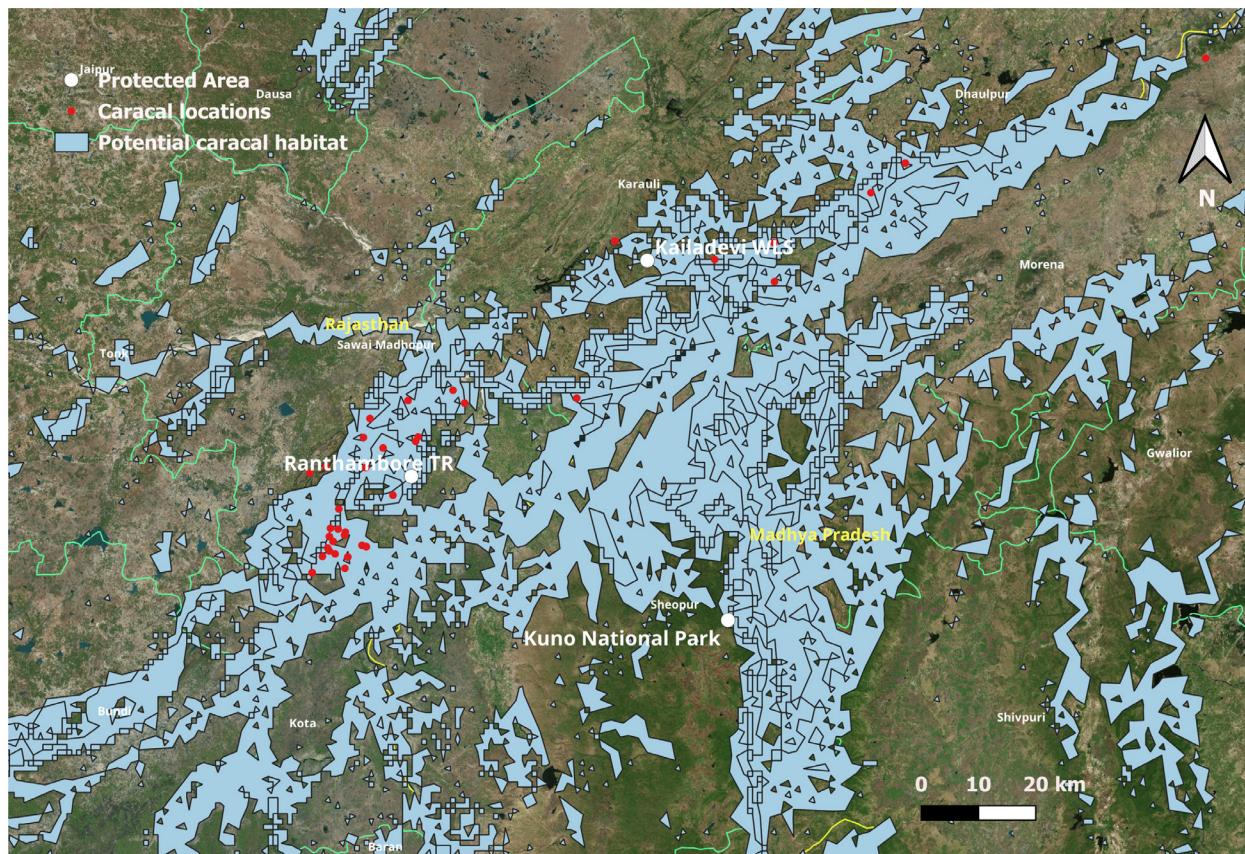


Figure 1.25.

Distribution of potential Caracal habitat (Jangid *et al.*, 2022) around Ranthambore TR and Kuno NP.

1.3.5. Management of the metapopulation of the Asiatic caracal

Metapopulation management usually focuses on the following key strategies:

- *Enhance habitat connectivity* by restoring several habitat patches in a mosaic pattern, ensuring each patch falls within Caracal's daily range. Additionally, connect these patches to facilitate movement between them.
- *Improve dispersal mechanisms*: Ensure ecological corridors are sufficiently large or numerous to support species dispersal between patches.
- *Increase habitat quality and extent*: Restore and expand existing habitat patches to improve their quality to support prey populations.
- *Create new habitat patches*: Develop new habitat areas within the landscape to provide additional colonisation sites.
- *Use source-sink dynamics*: Monitor source breeding populations that are productive enough to supply individuals to sink populations and manage these interactions to maintain metapopulation stability.
- *Implement adaptive management*: Use active and passive strategies to learn from past interventions and refine future management decisions.

Caracal occurrence data indicate the presence of two core breeding populations, one in Gujarat and one in Rajasthan (Fig. 1.25). However, these two populations are completely isolated from one another. There is no possibility of establishing connectivity between these two populations due to anthropogenic factors, and the connecting habitat is dominated by agricultural land (Fig. 1.26). Hence, it is not possible to establish natural gene flow through ecological corridors.

In such a scenario, assisted gene flow by translocating individuals as a management tool has been widely implemented as a targeted conservation strategy for small and isolated populations (Whiteley *et al.*, 2015; Ralls *et al.*, 2018; Bell *et al.*, 2019; Fitzpatrick *et al.*, 2023). Several empirical studies have demonstrated that genetic mixing in conservation translocation increases diversity (Nistelberger *et al.*, 2025).

Actions:

1. Since it is not possible to maintain natural gene flow between populations of Rajasthan and Gujarat, we suggest augmenting levels of migration by translocating male individuals intermittently from RTR, Rajasthan, to initiate genetic rescue, and
2. There are several PAs within the potential caracal habitat, and these may become a source population in the future. Therefore, it is recommended to initiate habitat management and restoration to establish ecological corridors connecting caracal populations across all these PAs and to facilitate natural gene flow among subpopulations in Rajasthan and Gujarat (Fig. 1.27).

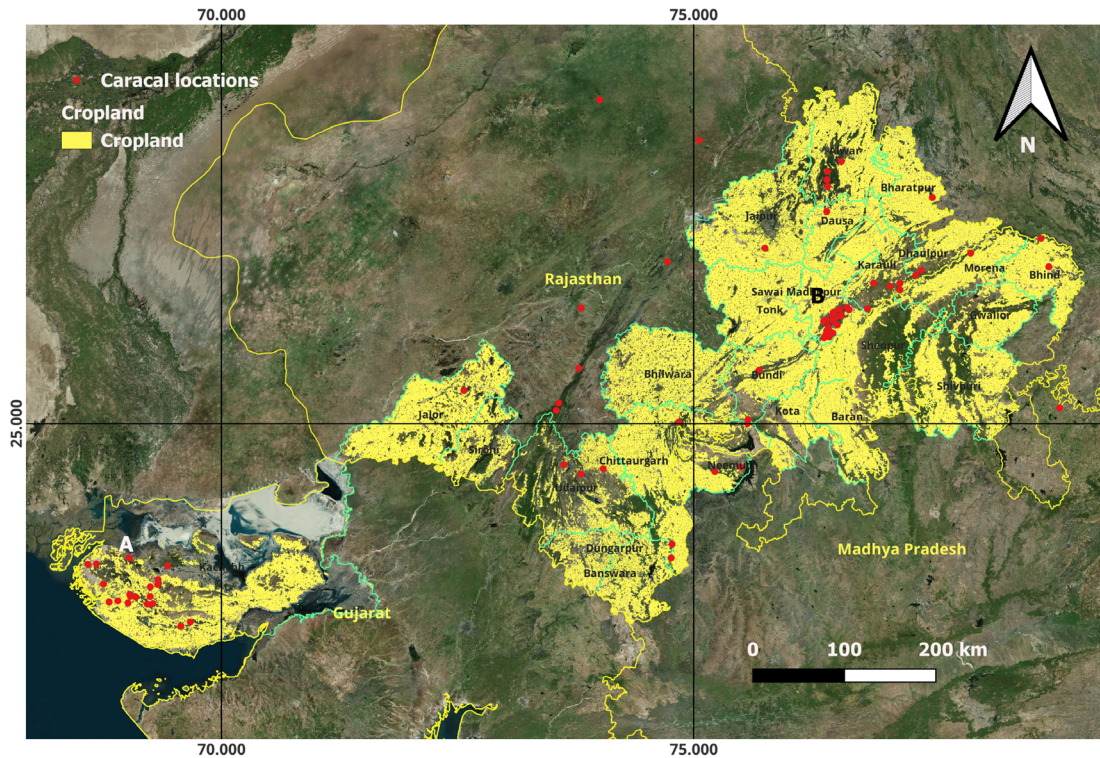


Figure 1.26.

Distribution of two core breeding populations in (A) Bhuj, Gujarat, and (B) Ranthambore TR, Rajasthan.

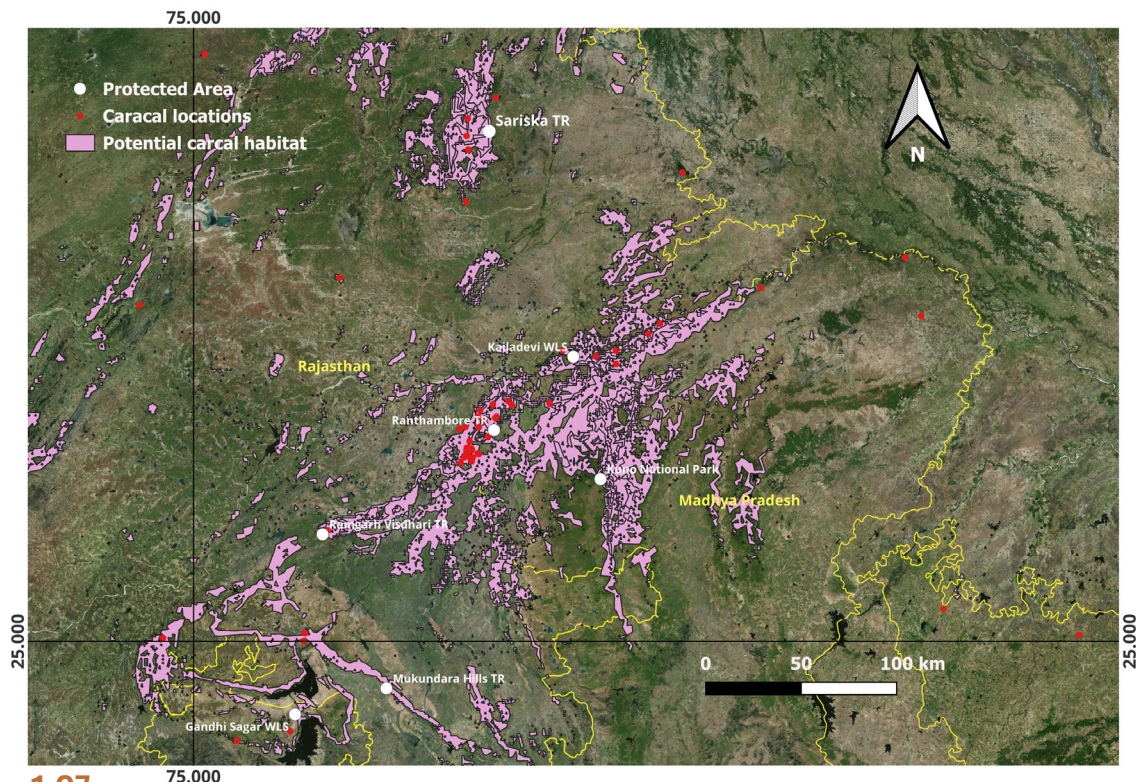


Figure 1.27.

Distribution of potential Caracal habitat in relation to the key PAs in Rajasthan and Madhya Pradesh.

1.3.6. Conservation captive breeding

“Conservation captive breeding” is one of the suggested multipronged conservation strategies for minimising the risk of Asiatic caracal extinction in India and across its distribution range. Captive breeding is one aspect of species conservation that involves breeding endangered animals in captivity or semi-wild environments, with the intention of releasing them back into the wild at some point in the future. Such programmes are critical for preventing species extinction and maintaining ecosystem function (McGowan *et al.*, 2010). Thus, a significant goal of captive breeding programmes is to establish a healthy, genetically diverse population that can survive and reproduce independently in its natural habitat, acting as an “insurance policy” against wild population loss. This entails applying principles of population genetics and demography to ensure long-term survival. Bandyopadhyay *et al.* (2024) suggested that the conservation of this critically endangered small cat is likely to be more beneficial with the implementation of a conservation breeding program in line with the Great Indian Bustard (*Ardeotis nigriceps*). Hence, this may be planned once the status of Asiatic caracal is assessed across its distribution range.

Actions:

1. It is suggested that a detailed feasibility report for the establishment of an “Asiatic caracal conservation and captive breeding centre” be based on “PHVA”, genetic consideration, and other aspects.
2. Initiate a population demography and genetics study on a priority basis to determine the demography and genetic diversity of both core populations of India, and
3. Building an “International Consortium of Asiatic Caracal Conservation”: One of the major concerns for the conservation breeding programme is ensuring that founder individuals are genetically divergent; relying on two isolated populations with only a few individuals may not be ideal. To retain genetic diversity across the subspecies range and to start with genetically diverse and adequate founder individuals, we suggest the following:
 - a) Build an “International Consortium of Asiatic Caracal Conservation” across range countries.
 - a) Assess population genetic characteristics using harmonised DNA methodology.
 - a) Identify genetically diverged populations and individuals for the selection of founder individuals for conservation and captive breeding.
 - a) Based on the success of captive breeding conservation, enhance the overall conservation status across the subspecies range through reintroduction.

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1.3.6.1. Learn from the experiences of ongoing captive breeding programs of the Caracal

Some zoos and captive breeding facilities worldwide have successfully bred caracals. Visiting these facilities and gaining experience would be beneficial for the planned conservation captive breeding programs in India. Some of the facilities are as follows:

- a) The Saudi National Centre for Wildlife (NCW) recorded the successful first birth of a female caracal at the Prince Saud Al-Faisal Wildlife Research Centre in Taif. They started breeding programmes in 2022 with a nucleus of 16 individuals. The research centre is the home to breeding programmes for different species.
- b) Zoos in the United States of America are breeding caracals at San Diego, Oregon, and
- c) Greens Zoological, Rescue and Rehabilitation Centre, Jamnagar, India

1.3.6.2. Use experiences of “Rewilding Iberian lynx (*Lynx pardinus*) through conservation captive breeding program

The best example of rewilding felids is the Iberian lynx (*Lynx pardinus*) through a conservation captive-breeding program, which has made a remarkable comeback in conservation history, growing from 100 individuals in 2000 to more than 2,000. The programme involves ex-situ and in-situ conservation and emphasises how results from multidisciplinary life science research can be integrated into an adaptive management approach to help recover the world’s most threatened felid species. A recent study by Cisneros-Araujo *et al.* (2024) reveals similarities in space use between captive-born and wild Iberian lynx.

1.3.7. Raising awareness and education among communities

Kannan *et al.* (2022) surveyed the broad socio-economic attributes of communities and their attitudes towards wildlife in 66 villages outside the PAs around RTR, Rajasthan. Most respondents expressed negative attitudes, while positive attitudes varied by education level, occupation, and landholding size. Observed negative attitudes towards wildlife conservation among people living in the agricultural matrix surrounding RTR may undermine the conservation success. Several empirical studies have demonstrated that public awareness programmes about the ecological significance of conservation among stakeholders can be strengthened to achieve success. Majić-Skrbinšek (2014) has shown that the active involvement of stakeholders and the public in wolf monitoring activities improved knowledge and attitudes towards wolves (at least in Slovenia). The inclusion of interested members of the public in field research activities proved beneficial; volunteers not only gained field experience through participation but also became more aware of the general ecological issues and more susceptible to scientific research (Bonney *et al.*, 2009; Jordan *et al.*, 2012). Besides verbal communication, they shared their improved knowledge and experiences with others through local and social media, as well as presentations in their environment (*e.g.*, schools).

Community-based conservation efforts, including incentives provided to the community and revenue-generating ecotourism through ongoing national conservation programmes such as “Project Cheetah”, “Project Tiger”, and the “Recovery of Indian Great Bustard” within the “Proposed Asiatic Caracal Conservation Landscape”, would help boost species to thrive in Rajasthan, MP, and Gujarat.

Actions:

Additionally, we suggest:

- *Educating the public:* Raising awareness of the importance of small felids and the threats they face is essential to garnering support for conservation efforts.
- *Engaging local communities:* Involving local communities in conservation initiatives can help build a sense of ownership and responsibility for protecting these animals.
- *Promoting sustainable livelihoods:* Supporting local communities’ livelihoods can reduce their dependence on activities that negatively impact small feline habitats and populations.

1.3.8. Align with other conservation programs

The Asiatic caracal thrives in most of the grassland and scrubland habitats, which are outside the realm of PAs. Thus, securing and conserving these habitats should be the utmost priority (Bandyopadhyay *et al.*, 2024). Most of the habitat of the Asiatic caracal proposed in several districts of Rajasthan, MP, and Gujarat are already part of the ongoing national conservation program, such as “Project Cheetah”, “Western Tiger Conservation Landscape” (Fig. 1.28), and improvement of grasslands and scrubland for “Recovery of Great Indian Bustard” in Kachchh district of Gujarat.

These ongoing programmes would strengthen the improvement of grassland and scrubland habitats, reduce further habitat fragmentation and degradation, minimise the impact of developmental projects, control poaching, and involve stakeholders in conservation efforts.

Ongoing “Small Wild Cat Conservation Programme” in India will further strengthen the overall conservation of the species. This program aims to secure the critical habitat corridors of small wild cats, prioritising northeastern, northern, and western India, as part of the United Nations Development Program (Bhattarai, 2020).

Actions:

1. Include a chapter in the Working or Management Plan for the conservation of habitats that meet the Asiatic caracal’s specific requirements.
2. Minimise the collection of palatable fodder species in identified patches of mosaic patterns.
3. Minimise livestock grazing in identified patches of habitat in mosaic patterns, and provide adequate protection through livestock-proof, wildlife-user-friendly fences.
4. Regularly monitor the occurrence of the Asiatic caracal in the proposed Caracal Conservation Landscape, Western Tiger Conservation Landscape, and Great Indian Bustard areas.

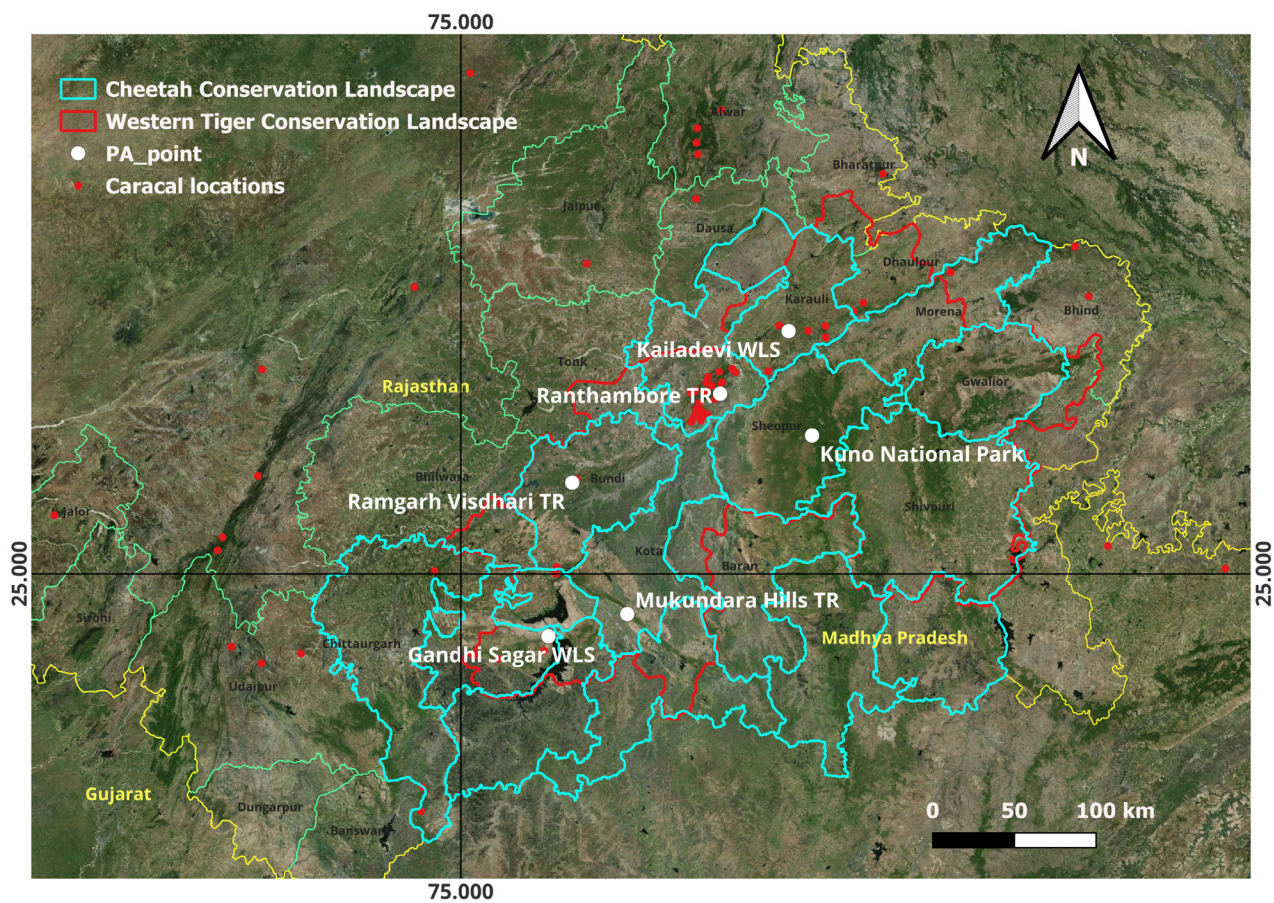


Figure 1.28.

Proposed Asiatic caracal conservation habitat in relation to "Cheetah Conservation Landscape" and "Western Tiger Conservation Landscape".

1.4

Strategic Environmental and Social Assessment

Strategic environmental and social assessment (SESA) is a systematic examination of ecological, social, and associated risks, impacts, and issues associated with a policy, plan, or programme, typically at the national level but also in smaller areas. Landscape-level conservation strategies proposed under this project may negatively impact farmers, as we intend to reserve a small area on the edges of agricultural fields for wildlife habitat. Because of this, they may incur small financial losses and suggest conservation incentives to compensate for them.

The project's implementation would have a positive environmental impact by proposing strategies to restore degraded areas of open forest, scrubland, and grassland. These strategies would enhance the various trophic levels, thereby restoring ecosystem function. Hence, as Schmitz *et al.* (2023) suggested, restoring trophic guilds is a natural climate solution that can enhance the ability to prevent climate warming beyond 1.5 °C.

Actions:

1. Several empirical studies have demonstrated that the presence of natural plant species in the agricultural landscape enhances pollinator diversity, thereby increasing overall crop productivity. Therefore, it is essential to sensitise stakeholders to the conservation significance of retaining natural plant diversity and restoring the carnivore community in agricultural landscapes.
2. Restoring habitat and corridors, as suggested, will enhance dispersal capabilities and enable ecosystem entities to occupy other habitats in response to climate change.
3. Based on the stakeholder sensitisation, explore "Community Reserve (CR)" and "Other Effective Area-Based Conservation Measures (OECM)" managed either by the government or the community.

Various mitigation measures have been proposed to reduce the impact of climate change. However, key strategies for conserving flagship species, such as carnivores, which play a vital role in ecosystem functioning, include retaining ecological functions and mitigating the impacts of climate change through terrestrial species, especially carnivores, which are considered flagship species of the ecosystem. Mitigation strategies for climate change in cat conservation involve (i) reducing human-caused pressures on wild cat populations and their habitats, (ii) protecting and restoring forests and ecosystems, (iii) establishing ecosystem connectivity across the landscape where ecosystems can function naturally, and (iv) nature-based solutions.

1.5

Impacts of Climate Change

Humans are causing declines in species abundance and functional diversity, and impeding large-scale movements, because these ecosystems are functionally highly compromised. Recently, Schmitz *et al.* (2023) discussed the need for new thinking that includes the restoration and conservation of wild animals and their ecosystem roles as a key component of natural climate solutions that can enhance the ability to prevent climate warming beyond 1.5 °C. Animals play a critical role in seed dispersal, supporting the germination of large-seeded trees with carbon-dense wood, reducing plant competition through herbivory, and enhancing soil nutrient supply and organic carbon storage. Thus, they emphasised the need for trophic rewilding as a natural climate solution.

Actions: Proposed restoration of degraded scrubland habitat and enhancement of ecological connectivity through native plant species in the agricultural landscape will help achieve the goals of different trophic levels and retain the functionality of the semi-arid ecosystem.

1.6

Framework For Action

Goals and objectives: The overall goal of the CAP is to maintain and restore populations to favourable levels throughout the Asiatic caracal's distribution range in India. To achieve the goal, the objectives are to evolve targeted strategies for managing existing populations for long-term survival; identify threats causing the decline of the population; enhance the existing distribution range through habitat restoration; use state-of-the-art conservation strategies to minimise the extinction probability; involve the participation of local stakeholders; align with other ongoing conservation programmes; and effectively implement the plan. We proposed action priorities as “high”, “medium” and “low”, whereas proposed time scales are as follows:

- Immediate: Need to complete within the next 2 years
- Short: Need to complete within the next 3 years
- Medium: Need to complete within the next 5 years
- Long: Need to complete within the next 10 years
- Ongoing: Ongoing should continue
- Completed: During preparation of CAP



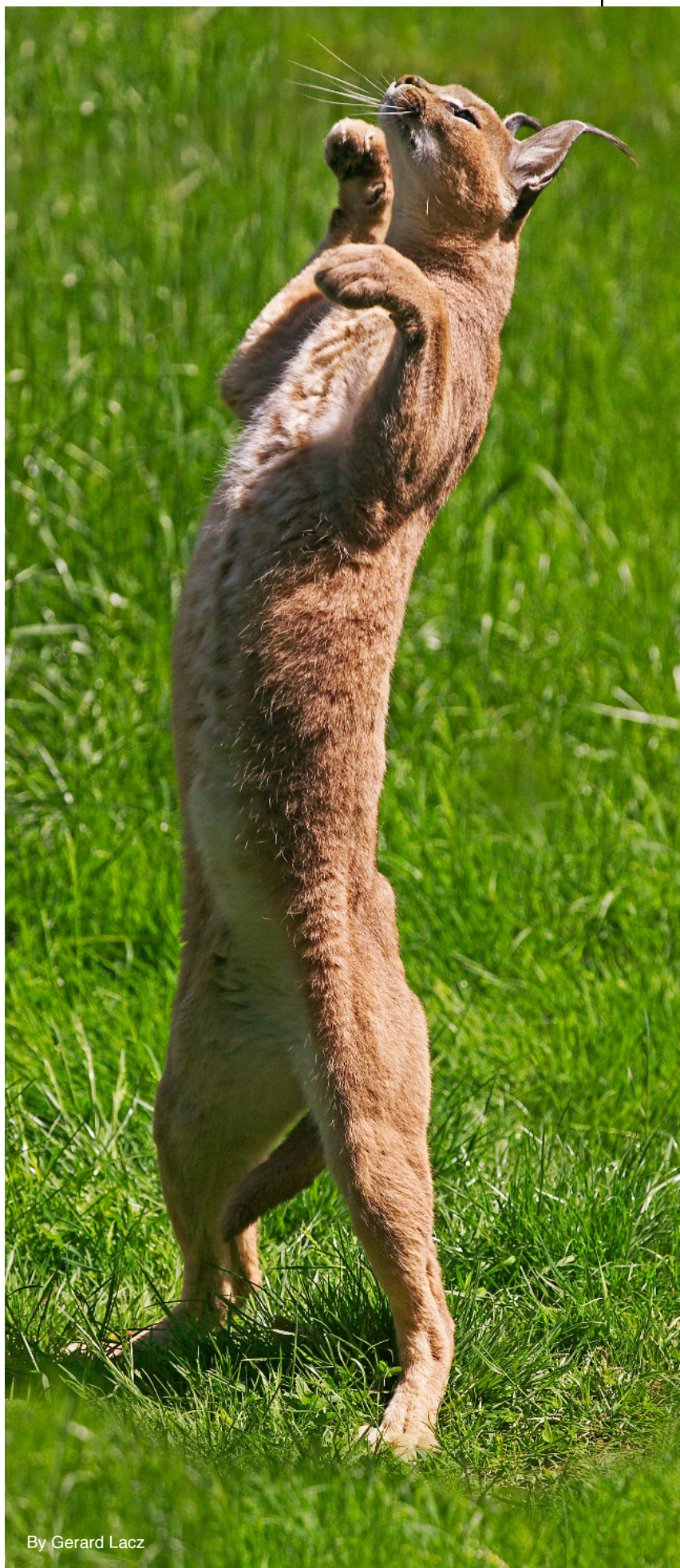
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Framework

S. No.	Tasks	Proposed strategies	Actions to be undertaken	Priority	Time scale	Organisations to be involved	Indicator
1	Research and Monitoring (See 1.3.1 for details)	Status assessment of species and habitat within PAs and outside the PAs	Identify potential districts of Asiatic caracal conservation in the states of Rajasthan, MP, and Gujarat for landscape conservation planning Assess fine-scale preferred habitat characteristics of the subspecies Deploy multiprong survey strategies used for elusive and low-density felids simultaneously, such as baited camera traps and track plots, faecal DNA, and eDNA within the potential habitats of the Asiatic caracal in three States Continuing ongoing population monitoring of the subspecies within the PAs of Rajasthan and Gujarat Determine the status of the Asiatic caracal and habitat across the identified potential habitat every five years Long-term research project to understand ecology, population status, demographics, reproductive biology, habitat use, ranging behaviour, and conservation threats in two cores each of Rajasthan and Gujarat Tag the Caracal individuals with a GPS transmitter in different areas to understand the ranging behaviour across the landscape	Essential	Completed	As a part of the CAP	Distribution of occurrence probabilities across the identified landscape
			Assess fine-scale preferred habitat characteristics of the subspecies	High	Immediate	Research Organisations, NGOs, Forest Departments	Distribution of preferred habitat
			Deploy multiprong survey strategies used for elusive and low-density felids simultaneously, such as baited camera traps and track plots, faecal DNA, and eDNA within the potential habitats of the Asiatic caracal in three States	High	Short		Provide detection probability in relation to habitat at the landscape level
			Continuing ongoing population monitoring of the subspecies within the PAs of Rajasthan and Gujarat	High	Ongoing	NTCA, NGOs, Forest Departments	Change in population status and demography
			Determine the status of the Asiatic caracal and habitat across the identified potential habitat every five years	Low	Medium	Research Organisations, NGOs, Forest Departments	Change in the probability of occurrence
			Long-term research project to understand ecology, population status, demographics, reproductive biology, habitat use, ranging behaviour, and conservation threats in two cores each of Rajasthan and Gujarat	Essential	Short	Research Organisations	Ecology of subspecies and factors affecting distribution
			Tag the Caracal individuals with a GPS transmitter in different areas to understand the ranging behaviour across the landscape	Medium	Medium		Ranging behaviour in a human-dominated landscape
			Create, restore, and protect mosaic patches in the open forest and scrub habitats across identified Asiatic caracal conservation areas	Medium	Long	Research Organisations, Forest Departments	Increase in the probability of the occurrence of biodiversity
			Restore habitat using native grasses and scrub species	Medium	Long		Increase in the probability of the occurrence of Caracal and prey species
			Protect mosaic habitat patches from livestock grazing using wildlife user-friendly fences or through trenches	Medium	Long	Forest Departments	Increase in the probability of occurrence of Caracal
			Identify medium to very deep "Badlands" in the Chambal ravine and provide adequate protection from livestock grazing	Medium	Long	Research Organisations, Forest Departments	Increase in the probability of occurrence of Caracal and prey species
			Identify and map critical areas for landscape permeability by creating wild edges using native plant species in an agricultural landscape	Medium	Long		
			Habitat restoration around the dry river stream	Medium	Long		

3	Genetic rescue (See 1.3.3. for details)	Assess population and landscape genetics	Assess the population and landscape genetics using state-of-the-art technology of the two core populations in Rajasthan and Gujarat, respectively	High	Short	Research Organisations	Genetic status and diversity
4	Translocation as a conservation strategy (See 1.3.4 for details)	Reintroduction of the Asiatic caracal to other PAs	Plan translocation of a few individuals to the Kuno NP, having potential Caracal habitat, after "PHVA"	Low	Long	Research Organisations, Forest Departments	Change in genetic diversity
5	Management of metapopulation (See 1.3.5 for details)	Management strategies for metapopulation management	Prepare a feasibility report of translocation to other PAs within the identified Asiatic caracal conservation landscape	Low	Long	Research Organisations, NGOs, Forest Departments	Plan future translocation
			Learn about the wild-to-wild translocation of Eurasian and Canadian lynx experiences	Low	Long	Research organisations, Forest Departments	Enhance translocation success
			The Gujarat population is isolated from Rajasthan, plan adaptive management and translocate a few individuals, if needed	Low	Long	Research organisations, Forest Departments	Increase in the genetic diversity of the Gujarat population
6	Conservation captive breeding (See 1.3.6 for details)	Use the Conservation captive breeding program as an "insurance policy" against wild population loss	Establish and create landscape corridors between other PAs envisaged for translocation in the future	Low	Long	Research Organisations, NGOs, Forest Departments	Increased landscape-level conservation
			Prepare a feasibility report and establish a "Conservation Captive Breeding Centre"	Medium	Medium	Research Organisations	Increased landscape-level conservation
			Building an "International Consortium of Asiatic caracal conservation" by involving range countries	High	Short	Government of India, Range Countries, Research Organisations, Forest Departments	Increased conservation status across range countries
			Assess the genetic and population demographics of the Asiatic caracal across the range countries	Low	Long		
			Identify genetically diverged populations for the selection of the founder population across the subspecies distribution range countries	Low	Long		
			Prepare a feasibility report for improving the status of the Asiatic caracal across its distribution range through reintroduction	Low	Long		
7	Raising awareness and education among communities (See 1.3.7 for details)	Organise a sensitisation program among communities	Learn about the experiences of breeding caracal from other Zoos in the world	Medium	Short	Research Organisations, Forest Departments	Change in attitude towards conservation among stakeholders
			Use experiences of "Rewilding Iberian lynx through conservation captive breeding program	Medium	Short		
			Obtain a positive attitude for conservation through the use of citizen science volunteers in the status survey, awareness, and education	Medium	Medium		
			Sensitise villagers to the idea of creating a wildlife habitat on agricultural fields to enhance crop productivity	Medium	Medium		

8	Align with other ongoing conservation programs (See 1.3.8 for details)	Enhancing overall conservation of the subspecies through other ongoing conservation programs in the landscape	Conservation landscapes of other projects, such as “Project Cheetah” and “Western Tiger Conservation Landscape”, Recovery of Great Indian Bustard” overlap with the Asiatic caracal conservation landscape. Write a chapter in these plans for the conservation of the subspecies	High	Short	NTCA, Research Organisation, NGOs, Forest Departments	Increase in the probability of occurrence of Caracal and other prey species
			Minimise habitat destruction of the Asiatic caracal by the collection of shrubs and grasses	High	Short		
			Minimise the livestock grazing	High	Short		
			Assess the regular population status in these landscapes	High	Short		
9	SESA (See 1.4 for details)	Assess the impact of the project on the community and climate change	Sensitise villagers about the significance and benefits of felid conservation	Essential	Short	Research Organisations, NGOs, Forest Departments	Change in stakeholders’ attitude and an increase in the diversity of species
			Monitor changes in species diversity through habitat restoration to retain ecological functionality	Essential	Short		
10	Climate change (See 1.5 for details)	Minimise the impact of climate change	Enhancing landscape permeability through habitat restoration would enable subspecies to move from one habitat to another due to the impact of climate change	Low	Long	Research Organisations	Resilience due to climate change



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02

FISHING CAT

(*Prionailurus viverrinus*)



Summary

The fishing cat (*Prionailurus viverrinus*) is a unique semi-aquatic felid strongly associated with wetlands, marshes, mangroves, floodplains, and riverine ecosystems across South and Southeast Asia. As a specialist predator dependent on healthy wetland systems, the species serves as an important indicator of freshwater ecosystem integrity. Despite their wide distribution, fishing cat populations have undergone substantial declines across much of their historical range due to extensive wetland loss, fragmentation, urbanisation, aquaculture expansion, pollution, and increased human disturbance. Consequently, the species is currently classified under Schedule I of the Wildlife (Protection) Act (WPA), 1972, in India.

India supports one of the largest remaining global populations of the fishing cat and represents a critical stronghold for its long-term conservation. The species occurs across a diverse network of wetlands extending from the Terai Arc and Gangetic floodplains to the Brahmaputra Valley, the Sundarbans, Chilika Lagoon, the Bhitarkanika mangroves, the Godavari–Krishna deltas, and several wetlands of northeastern India. However, its distribution is highly fragmented, with many populations persisting outside PAs in human-dominated landscapes. Population estimates available from selected sites indicate substantial variation in densities, reflecting differences in habitat quality, wetland productivity, and anthropogenic pressures. Many populations remain isolated and vulnerable to local extinction.

The principal threats to the species include degradation and conversion of wetlands for agriculture, aquaculture, infrastructure development, industrial expansion, and urban growth. Additional concerns include retaliatory killings arising from conflict around fish ponds and poultry, road mortality, poaching, pollution, invasive species, and the growing impacts of climate change, such as sea-level rise, altered hydrological regimes, salinity intrusion, and extreme weather events. These threats are particularly significant because the majority of important fishing cat habitats occur outside formally protected landscapes and often lack targeted conservation attention.

The Conservation Action Plan (CAP) aims to secure and sustain viable, interconnected populations of fishing cats across their current range in India while safeguarding the wetland ecosystems upon which they depend. The Action Plan proposes a national conservation framework built around nine thematic pillars:

- (1) wetland habitat protection and restoration,
- (2) landscape connectivity conservation,
- (3) monitoring and research,
- (4) climate change adaptation,
- (5) community engagement and participation,
- (6) human–wildlife conflict mitigation,
- (7) policy integration and legal protection,
- (8) capacity building, and
- (9) awareness, outreach, and education.

Particular emphasis is placed on recognising the fishing cat as a flagship species for wetland conservation and integrating its protection within broader frameworks for managing freshwater ecosystems.

Six major conservation landscapes

have been identified to represent the full ecological and geographic range of the fishing cat in India:

1. **Gangetic Plains: Terai Arc Landscape**, including Dudhwa, Pilibhit, Katarniaghat, Hastinapur, Patna wetlands, and Corbett landscapes.
2. **Central Indian Landscape: Panna and Bandhavgarh regions**, where recent records suggest possible range expansion or overlooked populations.
3. **Western India: Ranthambhore and Keoladeo landscapes** represent the westernmost occurrences of the species.
4. **Eastern Coastal Wetlands: The Sundarbans, Bhitarkanika, Chilika, and Tampara wetlands** constitute globally significant strongholds.
5. **Southern Coastal Wetlands: Godavari and Krishna deltas, Coringa mangroves, and associated coastal wetlands.**
6. **Northeastern Wetland Landscape: Kaziranga, Orang, Pobitora, Namdapha, D'Ering, and associated Brahmaputra floodplain wetlands.**

These landscapes encompass the most important remaining habitats and provide the basis for future monitoring and management interventions.

Across these landscapes, the plan recommends strengthening habitat protection, restoring wetland connectivity, enhancing ecological monitoring, improving understanding of population status and genetic diversity, addressing human–wildlife conflict, and fostering collaborative conservation involving government agencies, researchers, local communities, and civil society organisations. The action plan further emphasises the need for systematic surveys, standardised monitoring protocols, and climate-resilient management strategies to ensure the long-term persistence of fishing cat populations and the ecological integrity of India's wetland ecosystems. Ultimately, the fishing cat represents more than a threatened carnivore; it is a flagship for the conservation of India's rapidly declining wetlands. Effective implementation of the proposed conservation measures will not only secure the future of the species but will also contribute significantly to the protection, restoration, and sustainable management of freshwater and coastal ecosystems that support biodiversity, ecological services, and human livelihoods.

2.1

Species Profile

The fishing cat is the only wild felid whose common name directly reflects both its primary prey and hunting behaviour. It is uniquely associated with aquatic habitats and wetland ecosystems (Sunquist & Sunquist, 2002; Hunter, 2015). Although several other cat species may occasionally catch fish, the fishing cat's semi-aquatic adaptations and regular use of wetlands for foraging set it apart ecologically from other felids.

The species was formally described as *Prionailurus viverrinus* by Edward Turner Bennett in 1833. Early naturalists noted its superficial resemblance to civets, particularly the large Indian civet (*Viverra zibetha*), due to its coarse coat, sturdy build and facial markings. This resemblance led to the species epithet *viverrinus*, meaning “civet-like” (Nowell & Jackson, 1996). These similarities led to taxonomic confusion in the past, and the species was once placed in genera such as *Viverriceps* and even misclassified as *Leopardus* or *Serval* (Brongersma, 1935). Based on morphological and molecular evidence, contemporary taxonomy now firmly recognises the fishing cat within the genus *Prionailurus* (Johnson *et al.*, 2006; Kitchener *et al.*, 2016).

2.1.1. Description and Taxonomy

2.1.1.1. Description

The fishing cat is a member of the genus *Prionailurus*, which also includes the rusty-spotted cat, flat-headed cat and leopard cat. These species are characterised by distinct striping and spotting on the head and body (Sunquist & Sunquist, 2002). Immunological and genetic studies confirm the fishing cat's close evolutionary relationship with the leopard cat (*P. bengalensis*) (Collier & O'Brien, 1985). Both species share features such as spotted coats, long, narrow skulls, and small, rounded ears, with black backs and a central white spot (Sunquist & Sunquist, 2002). They differ clearly in body build. The leopard cat is slender and agile, while the fishing cat is notably muscular and robust, often compared to a shot-putter in contrast to a hurdler (Sunquist & Sunquist, 2002).

The species' morphology reflects its semi-aquatic lifestyle. It has a deep chest, short and sturdy limbs, and a broad, flat head (Nowell & Jackson, 1996). The coat is dense and coarse, olive grey to mouse brown in colour, and marked with rows of solid black spots that may elongate into stripes along the back and shoulders (Nowell & Jackson, 1996; Cheruvat *et al.*, 2006). The underside is pale with dark spotting, and the throat has two dark, collar-like bands (Pocock, 1939; Guggisberg, 1975). Facial markings include six to eight dark longitudinal lines that extend from the forehead to the neck. The tail is short, measuring less than half the head-body length, and is thick at the base, ringed with five to six black bands, and ending in a black tip (Sterndale, 1884; Roberts, 1977). Fishing cats are approximately twice the size of domestic cats. Males weigh between 11 and 12 kg and females between 6 and 7 kg (Nowell & Jackson, 1996). Head-body length ranges from 66 to 85 cm, and the tail measures between 23 and 31 cm (Nowell & Jackson, 1996). The ears are small and rounded, set low and wide apart, which contributes to a streamlined facial profile (Phillips, 1935).

Several anatomical features support the species' carnivorous and semi-aquatic habits. The front toes are partially webbed, which assists movement in wetlands, and the claws are incompletely retractile, remaining partly visible even when sheathed (Pocock, 1932; Nowell & Jackson, 1996). The short, muscular tail likely aids aquatic manoeuvrability by functioning as a rudder during swimming (Sterndale, 1884; Guggisberg, 1975; Roberts, 1977). Although the fishing cat is widely known for catching fish, its dentition is consistent with a generalist predator (Nowell & Jackson, 1996; Sunquist & Sunquist, 2002). For example, the second upper premolar is less developed than in the flat-headed cat (*P. planiceps*), which shows greater dental specialisation for fish consumption (Cheruvat *et al.*, 2006).

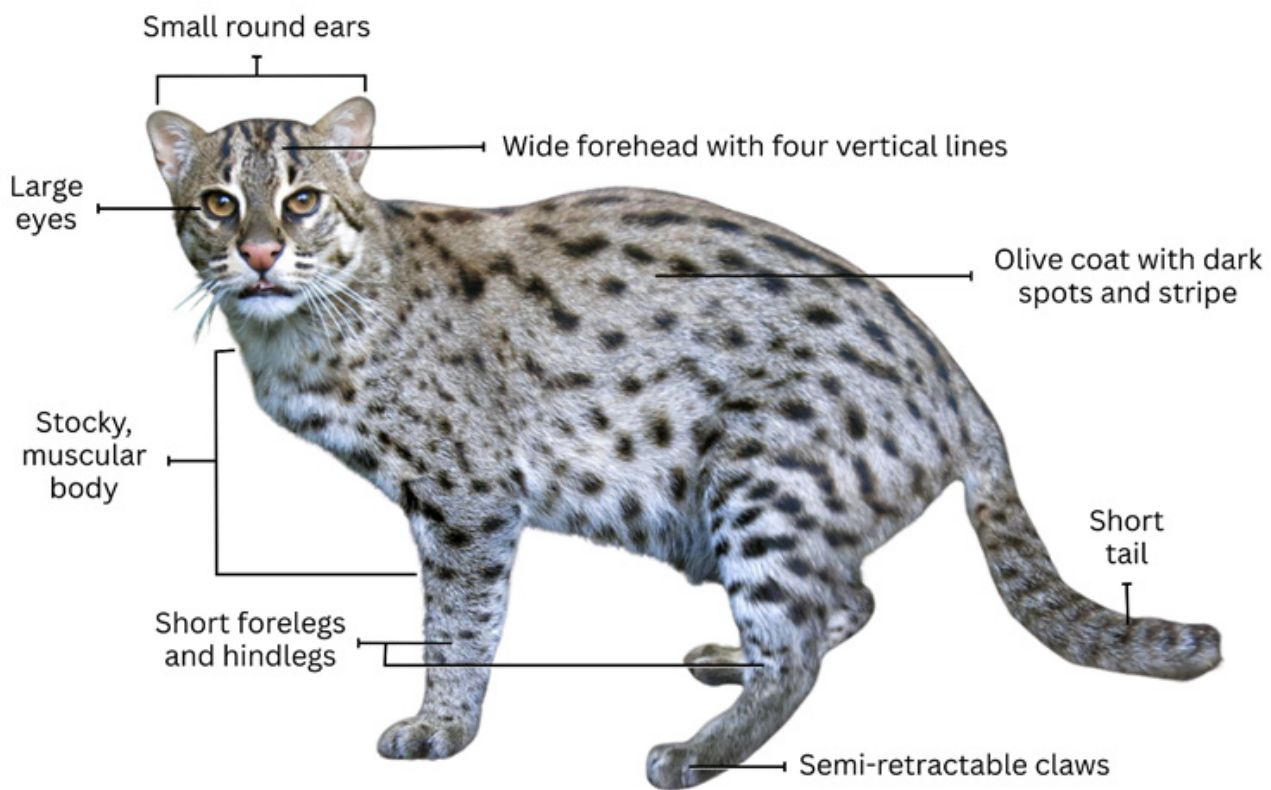


Figure 2.1.

Morphological adaptations of the fishing cat. Key physical traits of the fishing cat, highlighting its adaptations for wetland hunting, include a muscular build, short limbs, and semi-retractable claws (Source: Fishing Cat Conservation Alliance).

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Table 2.1.

Morphological characteristics of the fishing cat. The table summarises key morphological features of the fishing cat as described in the literature, highlighting characteristics associated with its semi-aquatic adaptations, general body measurements, and diagnostic external features. Data are drawn from multiple sources (provided in the main text).

Characteristic	Description
Build	Muscular, stocky (compared to the leopard cat’s slender build)
Skull	Long, narrow skull
Body Structure	Deep chest, short sturdy limbs, broad flat head
Fur	Olive-grey/mouse-brown; rows of black spots and stripes
Underside	Pale with dark spots; two dark collar bands on throat
Facial Markings	6–8 dark lines from forehead to neck
Tail	Short (23–31 cm), thick base, 5–6 black bands, black tip
Size and Weight	Males: 11–12 kg; Females: 6–7 kg; Length: 66–85 cm
Ears	Small, rounded with a black back and white spot; Set low, recessed
Webbed Toes	Front toes are partially webbed
Claws	Incompletely retractile (partially visible)
Tail Function	Acts as a rudder during swimming
Dentition	Generalist; underdeveloped second upper premolar vs <i>P. planiceps</i>

2.1.1.2. Taxonomy

Kingdom	: <i>Animalia</i> (animals)
Phylum	: <i>Chordata</i> (vertebrates)
Class	: <i>Mammalia</i> (mammals)
Order	: <i>Carnivora</i> (carnivores)
Family	: <i>Felidae</i> (cats)
Subfamily	: <i>Felinae</i> (small cats)
Genus	: <i>Prionailurus</i>
Species	: <i>Prionailurus viverrinus</i> (Bennett, 1833)

The fishing cat was initially described by Edward Turner Bennett in 1833 as *Felis viverrina*. Its taxonomic placement has since undergone several revisions, and based on morphological and molecular evidence, it is now classified under the genus *Prionailurus*, along with the leopard cat (*P. bengalensis*), flat-headed cat (*P. planiceps*), and rusty-spotted cat (*P. rubiginosus*) (Johnson *et al.*, 2006).

A comprehensive felid taxonomic review by Kitchener *et al.* (2016) recognises two subspecies of the fishing cat, differentiated by morphology and geographic range:

1. *Prionailurus viverrinus viverrinus* (Bennett, 1833)
 - Type locality: Probably the Malabar coast, India
 - Distribution: India, Sri Lanka, Pakistan, Bangladesh, Nepal, Bhutan, and Indochina
2. *Prionailurus viverrinus rhizophoreus* Sody, 1936
 - Type locality: Pamanoeakan, north coast of West Java
 - Distribution: Endemic to Java
 - *Distinguishing features*: Shorter basal skull length compared to *P. v. viverrinus* specimens from Thailand (Sody, 1936)

The IUCN Cat Specialist Group currently recognises these subspecies and follows the taxonomy adopted in the revised global felid classification (Kitchener *et al.*, 2016).

Historically, the species was variously placed in genera such as *Viverriceps* and *Zibethailurus*, and even misclassified as *Leopardus* or *Serval*, mainly due to its civet-like appearance and semi-aquatic adaptations (Brongersma, 1935). However, consensus based on classical morphology and molecular phylogenetics firmly supports its placement in *Prionailurus* (Johnson *et al.*, 2006).

No additional subspecies beyond the two recognised forms have been proposed or validated, underscoring the need for broader morphological and genetic sampling across Southeast Asia (Kitchener *et al.*, 2016). While the Javan subspecies exhibits a shorter basal skull length, consistent pelage differences across regions have not been documented (Sody, 1936; Pocock, 1939).

Table 2.2.

Taxonomic classification and subspecies of the fishing cat. The table presents the current scientific classification of the genus *Prionailurus*, including recognised species and subspecies. It reflects contemporary taxonomic revisions based on morphological characteristics and molecular evidence.

Species Name	Scientific Name	Distribution	Source(s)
Fishing Cat	<i>Prionailurus viverrinus</i>	South and Southeast Asia	Johnson <i>et al.</i> , 2006; Kitchener <i>et al.</i> , 2016
Fishing Cat (Mainland subspecies)	<i>Prionailurus viverrinus viverrinus</i>	India, Sri Lanka, Nepal, Bhutan, Bangladesh, Pakistan, Indochina	Kitchener <i>et al.</i> , 2016
Fishing Cat (Javan subspecies)	<i>Prionailurus viverrinus rhizophoreus</i>	Endemic to Java	Sody, 1936; Kitchener <i>et al.</i> , 2016

2.1.2. Historic and Current Distribution

The fishing cat occupies a broad but ecologically restricted range across South and Southeast Asia, and is consistently associated with water-rich landscapes. Its distribution largely corresponds to the presence of perennial wetlands such as rivers, marshes, swamps, mangroves, oxbow lakes and reed beds, which support the aquatic prey base that defines its ecological niche.

2.1.2.1. Global Distribution

2.1.2.1.1. South Asia

South Asia has historically formed the core of the fishing cat's range, encompassing lowland wetlands, river basins, and coastal ecosystems. The species was once widespread across the Sundarbans of India and Bangladesh, the Terai lowlands of Nepal, the floodplains and highlands of Sri Lanka, and the Indus Basin of Pakistan. Although significant local declines have occurred, particularly in western India and Pakistan, recent records confirm its continued presence across a variety of habitats, from PAs to human-modified landscapes. This variation in habitat use reflects its adaptability and highlights the need for region-specific conservation measures.

BANGLADESH



Historically, the fishing cat was widely distributed across Bangladesh's lowland wetlands, with major strongholds in the eastern, southern and western Sundarbans that are contiguous with India (Nowell & Jackson, 1996; Rahman *et al.*, 2016; A. Barlow, pers. comm., 2016). It was also reported from unprotected wetlands in the Brahmaputra basin (Rahman & McCarthy, 2014; Chowdhury *et al.*, 2015) and from the Chittagong Hill Tracts. Evidence from the latter remains weak and is based mainly on pugmarks and an unverified video that was likely of a leopard cat (Chakma, 2015; Karim & Ahsan, 2016). Current confirmed camera trap records include the Sundarbans (M. A. Aziz, pers. comm., 26 March 2023), Patharia Hill Reserve and Hakaluki Haor Wetland in the northeast (Rahman *et al.*, 2023; Sadik & Akash, 2023), and Teknaf WLS in the southeast (Feeroz *et al.*, 2012). More than 40 additional sightings have been reported from riparian zones, wetlands and human-modified landscapes in the Ganges and Brahmaputra basins (Chowdhury *et al.*, 2015; Sultana *et al.*, 2022; M. A. Aziz, pers. comm., 26 March 2023). Sightings have also been recorded from the coastal areas of southeastern Bangladesh (M. A. Aziz, pers. comm., 26 March 2023).

NEPAL



Historically, the fishing cat was recorded in Royal Bardia NP and Royal Chitwan NP, and southern Nepal was regarded as a key stronghold (Nowell & Jackson, 1996; Hunter, 2015). The species is currently found across the Terai Arc Landscape, ranging from the western to the eastern lowlands. In the far-western Terai, it has been reported in Shuklaphanta NP (Yadav *et al.*, 2020) and along the upper Babai River valley in Bardia NP (Yadav *et al.*, 2018). Earlier tiger-monitoring camera trap surveys did not detect the species in Bardia (Lamichhane & Yadav, pers. comm., 2016). Records also exist from the Jagadishpur

Reservoir Ramsar Site in Kapilvastu District (Dahal *et al.*, 2015; Dahal, 2016). In the central Terai, the species is confirmed in Chitwan and Parsa NPs (Mishra *et al.*, 2018; Poudel *et al.*, 2019; Maharjan *et al.*, 2024). Mortalities outside PAs in Bara and Nawalparasi Districts indicate movement into adjacent landscapes (Mishra *et al.*, 2021; Mishra, 2022). In the eastern Terai, the species occurs in and around Koshi Tappu WR and nearby wetlands, supported by several camera trap and field records (Pandey *et al.*, 2012; Taylor *et al.*, 2016; S. Dahal & A. Appel, pers. comm., 2016; Mishra *et al.*, 2021).

SRI LANKA



Historically, the fishing cat was reported from Flood Plains, Maduru Oya, Bundala, and Horton Plains NPs (Nowell & Jackson, 1996). It now occurs both inside and outside PAs across coastal and inland regions (A. Kittle, pers. comm., 2012). The species is well-established in urban environments, particularly in Colombo, and has also been recorded in Kandy, Matale, and Nuwara Eliya Districts (Ratnayaka, 2016; Thudugala, 2016). Since 2016, its presence has been confirmed in Ritigala Strict Natural Reserve, Gal Oya NP and adjoining non-PAs, Namal Oya Sanctuary, Nimalawa Sanctuary, the Yala NP buffer zone, forest patches around Sigiriya, tea estates in the Central Highlands, and in and around Maduru Oya NP (Kittle & Watson, 2018; Jayasekara & Mahaulpatha, 2022). It remains common in urban wetlands in Colombo (Ratnayaka *et al.*, 2022) and has been sighted in coastal lagoons (Anjali Watson & Andrew Kittle, unpublished data). Species distribution models indicate a broad distribution across various habitat types, with higher suitability near waterbodies, shrublands and mosaics of cropland and natural vegetation (Englebracht, 2024).

PAKISTAN



Historically, the fishing cat was found in the wetland habitats of the lower Indus River Basin, including Keti Bander North and South, with peripheral records from the riverine wetlands of the Ravi and Sutlej Rivers (Roberts, 1977; Nowell & Jackson, 1996). By the early 1970s, the population was considered close to extinction (Roberts, 1977). In 2015, camera trap images confirmed the presence of the species at Chotiari Reservoir in Sanghar District (Islam *et al.*, 2015). Since 2020, individuals have been rescued from wells near Guddu Barrage, Haleji Lake, Keenjhar Lake, and Karachi, with one release reported in Hub Dam WLS (J. Mahar, pers. comm., 14 November 2022). Camera trap surveys conducted from 2021 to 2022 confirmed the presence of the species around Haleji and Keenjhar Lakes (Z. Shaikh, pers. comm., 27 April 2024). Unverified reports exist from Hamal Lake, Drigh Lake, Lungh Lake WLS, areas south of Sukkur Barrage, Nara Canal, Nareri Lagoon and the Indus Delta (J. Mahar, pers. comm., 25 January 2023). There are also records of individuals being sold in Karachi wildlife markets (Bhatti, 2015; F. Ubairi, pers. comm., 2015).

In summary, South Asia holds the largest share of the global fishing cat population. Bangladesh, eastern India, the Terai region of Nepal and Sri Lanka are critical strongholds. These regions support populations across a wide range of habitats, including coastal mangroves, inland wetlands, irrigation landscapes, urban peripheries and highland estates. However, the distribution across the subcontinent is highly fragmented and faces increasing pressures from wetland loss, urban growth and inadequate protection of freshwater ecosystems. Although the species exhibits considerable ecological adaptability, its long-term survival in South Asia depends on stronger cross-boundary conservation initiatives, the safety and restoration of wetlands, improved habitat connectivity, and the integration of the species into broader landscape-level planning.

2.1.2.1.2. Southeast Asia

Southeast Asia once represented a broad but poorly documented extension of the fishing cat's range, including river deltas, coastal mangroves and inland wetlands in Myanmar, Thailand, Cambodia, Vietnam, Laos, and the islands of Java and Sumatra. The current distribution in this region is highly restricted. Confirmed populations are now limited to fragmented lowland wetlands in parts of Myanmar, southern Thailand and coastal Cambodia. Large portions of the historical range, particularly inland PAs and most of Indonesia and Vietnam, now lack verifiable evidence of continued presence. This indicates widespread local extirpations and reflects a steep regional decline.

MYANMAR



Historically, the species was believed to occur in the Irrawaddy River delta (Nowell & Jackson, 1996), with confirmed sightings in 2015 (T. Zaw, pers. comm., 2016). Captive individuals in Myanmar are thought to have originated from wild-caught specimens from the Ayeyarwady Delta during the 1990s (T. Zaw *et al.*, 2014). The only confirmed historical record outside the delta region comes from the Hukaung Valley in northern Myanmar in the early 20th century (T. Zaw, pers. comm., 2016). Recent verifiable photographic records confirm the presence of the species at two widely separated locations in the Ayeyarwady Delta: Meinmahla Kyun WLS in 2016 and a commercial fishpond near Maubin Township in 2018 (Naing Lin & Platt, 2019).

THAILAND



Historically, the fishing cat was recorded from several PAs in Thailand, including Salawin NP, Huai Kha Khaeng WLS, Phu Hin Rong Kla NP, Khao Ang Ru Nai WLS, Khao Sam Roi Yot NP, Khlong Saeng WLS and Tarutao Island (Nowell & Jackson, 1996). Recent assessments indicate that the species is now mainly restricted to coastal wetlands. Confirmed recent records include repeated observations in and around Khao Sam Roi Yot NP and Thale Noi Non-Hunting Area (Cutter & Cutter, 2009; Cutter, 2015; Phosri *et al.*, 2021). Surveys did not detect the species in several inland PAs that were previously considered part of its range (Tantipisanuh *et al.*, 2014). The northernmost recent record is from Phitsanulok Province in the Chao Phraya River basin (Chutipong *et al.*, 2019). Within the Chao Phraya delta, one individual was roadkilled, and three individuals were live-trapped along the inner Gulf of Thailand (Chutipong *et al.*, 2019). Further south, camera traps recorded the species in unprotected coastal wetlands in Phantai Norasing and Phetchaburi Province, with a roadkill documented in Surat Thani Province (N. Tantipisanuh, D. Ngoprasert, K. Phosri, unpublished data). Additional confirmed occurrences have been reported from Songkhla and Pattani Provinces. The southernmost verified record in Thailand is from a mangrove forest in Mai Kaen District, Pattani (Buatip *et al.*, 2013; Chutipong *et al.*, 2019; Tantipisanuh & Khaewphakdee, 2023).

CAMBODIA



Historically, the fishing cat was believed to occur around the Tonlé Sap Lake, although this remained unconfirmed (Nowell & Jackson, 1996). The only camera trap record from the early 2000s came from Kulen Promtep WLS in the northeast in 2003 (Rainey & Kong, 2010). Subsequent surveys in the same region did not detect the species (Edwards *et al.*, 2012; Griffin *et al.*, 2020). A kitten found in Botum-Sakor NP in 2009 was initially identified as a fishing cat (Royan, 2009); however, it may have actually been a leopard cat (Mukherjee *et al.*, 2025). Since 2015, confirmed records have come mainly from coastal mangrove habitats. These include Peam Krasop WLS and Ream NP (Thaung *et al.*, 2018), the Koh Kapik Ramsar Site in Koh Kong Province (Herranz Muñoz & Neak, 2024), and Stung Kampong Smach KBA next to Ream NP in Sihanoukville Province (V. H. Muñoz, pers. comm., 10 August

2023). A dead fishing cat was recovered at a bushmeat stall near Tonlé Sap wetlands in 2018 (Wildlife Rapid Rescue Team, pers. comm., 27 September 2018). In 2022, a live individual was photographed on a tree in the Boeung Chhmar Ramsar Site, one of the core zones of the Tonlé Sap BR (C. Phan, pers. comm., 17 October 2022; Sophanith, 2022). Although these recent records confirm persistence, many historic claims remain unverified or incorrect, and targeted surveys across much of Cambodia have yielded limited evidence of the species (Mukherjee *et al.*, 2025).

VIETNAM



Historically, the fishing cat was thought to occur in the Mekong River Delta and possibly in the Red River Delta, although both areas lack PAs and robust survey data (Nowell & Jackson, 1996). The last confirmed camera trap record was from the U Minh wetlands of the Mekong Delta in 2000 (Willcox, 2016). Subsequent surveys in the Mekong Delta have not detected the species (Willcox *et al.*, 2017; Gray *et al.*, 2024). The probability of occurrence in the Red River Delta is considered very low. The species has never been confirmed there, and no targeted surveys have been undertaken to assess presence or local extinction (Willcox *et al.*, 2014). In 2021, a single individual was filmed on Phu Quoc Island off the western coast of Vietnam; however, the footage's origin could not be verified, and the record remains inconclusive (M. Trinh, pers. comm., 25 August 2021).

LAOS



Records of the fishing cat from Lao PDR remain very uncertain (Mukherjee *et al.*, 2025). Most historic claims are considered erroneous or unverifiable (Duckworth *et al.*, 2010). The only potentially credible account is a 1996 sighting beside a mountain river in a steep-sided valley at an elevation of 580 m, although this record lacks corroboration and remains unvalidated (Duckworth *et al.*, 2010; Mukherjee *et al.*, 2025).

INDONESIA



- Sumatra: Several NPs, including Way Kambas, Berbak, Gunung Leuser, Kerinci Seblat, and Bukit Barisan Selatan, were historically considered potential habitats (Nowell & Jackson, 1996). However, no verified records of the species exist. Multiple intensive camera trap studies across Sumatra have failed to confirm its presence (Pusparini *et al.*, 2014; Sunarto *et al.*, 2015; Haidir *et al.*, 2021).
- Java: Java represented the southeasternmost confirmed limit of the fishing cat's historical range. The subspecies *P. v. rhizophoreus* was described by Sody (1936) from specimens collected along the island's northern coast. Historically, the species was reported only from the western and northern coastal regions of Java, up to 15 km inland (Sody, 1949; Melisch *et al.*, 1996). Observations during the early 1990s, including tracks and scats from coastal areas such as Banten Bay and Ujung Kulon NP, were never conclusively verified (Melisch *et al.*, 1996; Nowell & Jackson, 1996; A. Compost, pers. comm., 2012). The last confirmed photographs of fishing cats in the wild in Java were taken in 2000 in a mangrove forest at Pulau Dua Bird Sanctuary. These individuals may have been escaped captive animals, and the population was reported to have disappeared by 2006 (A. Compost, pers. comm., 2012, 2023). More recent claims from the Wonorejo mangroves near Surabaya in northeastern Java, based on Cytochrome b gene analysis, lack morphological verification and are likely misidentifications of Sunda leopard cats, *Prionailurus javanensis* (Handono *et al.*, 2023; Kuntjoro *et al.*, 2023).

MALAYSIA



Fishing cat occurrence in Peninsular Malaysia remains unconfirmed (Mukherjee *et al.*, 2025). The only historical record is from Bahau, Negeri Sembilan, where an individual was reportedly captured in 1967 and later died at Melaka Zoo in 1977 (Van Bree & Khan, 1992). Its true origin remains uncertain (Nowell & Jackson, 1996). Swinhoe (1862) also reported examining a specimen from Malacca,

although no further details were provided, and the specimen may have originated elsewhere (Melisch, 1995). A mounted specimen acquired in early nineteenth-century Singapore may have originated from either Peninsular Malaysia or Thailand, but its exact origin remains unresolved (Jusoh *et al.*, 2022). No confirmed modern records exist (Duckworth *et al.*, 2009; Jusoh *et al.*, 2022), although a nearby verified record in southern Thailand (Buatip *et al.*, 2013) lies close to the Malaysian border.

BORNEO, TAIWAN & CHINA



There are no confirmed records of the fishing cat from China (Wang & Wang, 1986). It may occur in border regions such as Guangxi and Yunnan, which border northern Vietnam. Reports from other parts of China, as well as from Borneo and Taiwan, remain unsubstantiated and lack credible supporting evidence (Nowell & Jackson, 1996; Sunquist & Sunquist, 2002; Jutzeler *et al.*, 2010).

In summary, the fishing cat's historical range in Southeast Asia extended from Myanmar to southern Vietnam and Java, with scattered wetland habitats across the region. Currently, confirmed populations persist only in a few fragmented locations, including the Ayeyarwady Delta in Myanmar, coastal wetlands in southern Thailand, and mangrove habitats in southwestern Cambodia. Scattered and unverified reports continue to emerge from Vietnam and Java. Across large parts of the former range, including Laos, Sumatra, Peninsular Malaysia, Borneo and China, the species appears to be locally extinct or was historically misidentified. This marked regional decline reflects extensive wetland loss, weak legal protection and a lack of targeted conservation action. There is an urgent need for systematic surveys, long-term monitoring and wetland conservation to prevent further extirpations in Southeast Asia.

Table 2.3.

Global distribution (historic and current) of the fishing cat. The table summarises the historical and current distribution of the fishing cat across its range in South and Southeast Asia, highlighting ecological persistence, probable local extinctions, and regional conservation concerns. Data are derived from camera-trap records, surveys, and published field observations as referenced in the main text.

Country	Historic Distribution	Current Distribution	Current Status Summary
Bangladesh	Widespread across lowland wetlands, the Sundarbans, the Brahmaputra basin, and the Chittagong Hill Tracts	Confirmed in Sundarbans, Patharia Hill, Teknaf WLS; scattered sightings across Ganges-Brahmaputra	Stronghold region; persistent across human-modified landscapes
Nepal	Southern Terai, including Royal Bardia NP and Royal Chitwan NP	Distributed across the Terai Arc; confirmed in Shuklaphanta, Bardia, Chitwan, Parsa, Koshi Tappu	Viable population across lowlands; dispersal outside PAs
Sri Lanka	Flood Plains NP, Maduru Oya NP, Bundala NP, Horton Plains NP	Confirmed in and outside PAs; urban records from Colombo, the highlands, and coastal wetlands	Confirmed across diverse habitats; notable urban presence
Pakistan	Lower Indus River Basin, Ravi and Sutlej wetlands	Confirmed around Chotiari, Haleji, Keenjhar; rescue records near Guddu and Karachi	Likely remnant population; recent confirmations via camera traps and rescues
Myanmar	Irrawaddy River delta and Hukaung Valley	Confirmed in Ayeyarwady Delta; Meinmahla Kyun WLS and Maubin Township	Very restricted range; small population persists in the delta
Thailand	Several PAs across Thailand have a broad wetland presence	Restricted to coastal wetlands; confirmed in Khao Sam Roi Yot NP, Thale Noi, and Phitsanulok	Coastal restriction; extinct in many former inland sites
Cambodia	Around Tonlé Sap Lake and the northeast forested areas	Confirmed in Peam Krasop, Ream NP, Koh Kapik Ramsar site, Stung Kampong Smach	Scattered but confirmed presence in mangroves; other claims unverified
Vietnam	Mekong and Red River deltas	Last confirmed in 2000, the U Minh wetlands, and a recent unverified Phu Quoc sighting	Possible extirpation; historic records not supported by recent data
Laos	Sparse records, one unverified sighting in 1996	No verified current records	No validated records; likely absent
Indonesia (Sumatra)	Suspected in several NPs but unverified	No confirmed records despite intensive surveys	Likely extinct; no verified presence
Indonesia (Java)	Confirmed in the northern and western coastal zones	No recent confirmations; population likely extinct by 2006	Presumed extinct; historic sightings unclear
Malaysia (Peninsular)	Single historic capture in Negeri Sembilan	No confirmed records	No recent or confirmed records
China	Unconfirmed claims in the southern border areas	No confirmed presence	No known occurrence
Taiwan	Unverified claims, not confirmed	No confirmed presence	Unverified historical reports; likely absent
Borneo	No credible records	No confirmed presence	No evidence of presence

2.1.2.2. Indian Distribution

The distribution of the fishing cat in India spans a wide range of wetland-dominated landscapes, from the floodplains and mangroves of eastern India to fragmented pockets along riverine and coastal systems in the southern and western regions. Historically, the species has been reported from major river basins, deltaic systems, and marshlands. Recent evidence indicates a patchy and fragmented distribution. Targeted surveys, photographic records, and molecular confirmations over the past two decades have refined current knowledge of its occurrence across six broad regions of India: Northern, Central, Western, Eastern, Northeastern, and Southern India.

Northern India: Fishing cats were historically reported from Dudhwa TR in Uttar Pradesh (Nowell & Jackson, 1996). In the early 2000s, confirmed records came from Dudhwa TR and Soor Sarovar Bird Sanctuary (Mukherjee *et al.*, 2012; B. Raj, pers. comm., 2016), and from Corbett TR in Uttarakhand (A. Harihar, pers. comm., 2012). Around the same period, the species was reported from Pilibhit FD outside PAs (M. Anwar, pers. comm., 2011), and sightings were noted from the Ganges floodplain near New Delhi (Express News Service, 2012). In 2012, it was photographed in Lansdowne FD (A. Harihar in litt., 25 October 2012) and later confirmed in Sonanadi WLS (Q. Qureshi, pers. comm., 9 May 2016). More recent records include Corbett TR (Azad, 2020; Safi *et al.*, 2023), Amargarh TR (Safi *et al.*, 2023), two rescues from Greater Noida and the Gomti River near Sultanpur (Rana, 2020), and a molecularly confirmed scat sample near a tributary of the Pandai River, as well as Valmiki TR in Bihar (Rana, 2020; Habib *et al.*, 2025). Expanded surveys have documented the species in Dudhwa TR, Pilibhit TR, Kishanpur WLS, Katarniaghat WLS, Suhelwa WLS, Laggabagga corridor and Rampur Range in Uttar Pradesh, and in the Bhakra River region and Nandhaur WLS in Uttarakhand (Jhala *et al.*, 2021; Guleria *et al.*, 2022; Habib *et al.*, 2025). In Punjab, recent confirmations have been made from Harike WLS and Beas Conservation Reserve (G. Kanwar, pers. comm., 2 March 2020). Sporadic records have also been reported near the Ramganga River and northwest of Lucknow (Buzz Staff, 2023; HT Correspondent, 2023). These records indicate a fragmented but persistent distribution across Northern India (Mukherjee *et al.*, 2016, 2025; Habib *et al.*, 2025).

Central India: Historically, fishing cats were not known to occur in Central India, and no confirmed historical records exist (Nowell & Jackson, 1996; Mukherjee *et al.*, 2016). This may reflect both the natural rarity of the species in the region and the limited targeted surveys conducted in suitable wetland habitats. Recent records indicate a few scattered occurrences from Panna TR (Dutta *et al.*, 2021) and Bandhavgarh TR (Talegaonkar *et al.*, 2018), suggesting possible low-density or transient populations in parts of Madhya Pradesh (Mukherjee *et al.*, 2016, 2025).

Western India: Historically, fishing cats were reported from Keoladeo Ghana NP in Rajasthan (Sharma & Sankhala, 1984; Haque, 1988; Haque & Vijayan, 1993; Nowell & Jackson, 1996). Later records confirmed their presence in Keoladeo Ghana NP (Mukherjee *et al.*, 2012; Singh *et al.*, 2017), in Ranthambhore TR in Rajasthan (Sadhu & Reddy, 2013), and in the surroundings of Sur Sarovar Bird Sanctuary in Uttar Pradesh near the Rajasthan border (Perna *et al.*, 2016). These limited confirmations indicate sparse occurrence in isolated wetland patches within an otherwise dry landscape (Mukherjee *et al.*, 2016, 2025).

Eastern India: Historically, fishing cats were reported from the Sundarbans mangroves in West Bengal and the Bhitarkanika wetlands in Odisha (Nowell & Jackson, 1996). Subsequent confirmations include Sundarbans TR (Y. V. Jhala, pers. comm., 2015) and several small wetlands outside PAs near Kolkata and surrounding areas, including the Howrah and Hooghly districts (Anonymous, 1989; Adhya, 2011), as well as the Medinipur and Nadia districts. Mortality data from 2019 to 2020 confirm the species in Howrah (5 cases), Hooghly (2), South 24 Parganas (2), North 24 Parganas (1) and Bardhaman (1) (Ganguli, 2020). In Odisha, the species was reported from the human-dominated northeastern part of Chilika Lake and Tangi district (T. Adhya, pers. comm., 2016). Recent surveys document multiple records across the lower Ganges floodplain and delta (Mukherjee *et al.*, 2012; Dey, 2018; Kolipaka *et al.*, 2019; Chakraborty *et al.*, 2020a, 2020b, 2022, 2024; Chakraborty, 2024) as well as in the Sundarbans mangroves (Habib *et al.*, 2025; Jhala *et al.*, 2020, 2021). In Odisha, confirmed records exist from Bhitarkanika mangroves, Kathajodi River, Khordha District, and around Chilika Lake (Shekhar Palei *et al.*, 2018; Charan Palei *et al.*, 2021; Adhya *et al.*, 2023). Additional reports include a wetland near an industrial complex in Paradeep (Ganguly & Adhya, 2022), Kansardia mangroves in Jagatsinghpur District (T. Adhya, pers. comm., 3 February 2023), and the edge of Tampara Lake (Das *et al.*, 2023). These records highlight Eastern India, particularly the Sundarbans and coastal Odisha, as key strongholds for the species (Mukherjee *et al.*, 2016, 2025).

Northeastern India: Historically, fishing cats have been reported from several sites in Northeastern India, including Jaldapara WLS in northern West Bengal, Balpakram NP in Meghalaya, and Namdapha TR and Pakhui (Pakke) TR in Arunachal Pradesh (Nowell & Jackson, 1996).

- In Arunachal Pradesh, the species is considered rare and patchily distributed across well-watered areas, with confirmed records from Namdapha TR, D'Ering Memorial WLS, Eagle's Nest WLS, Itanagar WLS, Kamlang TR, Mehao WLS, Pakke TR, Sessa Orchid Sanctuary and possibly Talle WLS (Choudhury, 2003, 2013; A. Datta, pers. comm., 2012). Important habitats also occur on the chapories of the Dibang and Lohit rivers (Choudhury, 2013).
- In Assam, fishing cats are found across well-watered landscapes, with sporadic records from Kaziranga TR (relatively common), Manas TR, Dibru–Saikhowa, Nameri TR, Orang NP, Burhachapori WLS, Laokhowa WLS, Pabitora WLS, and Pani-Dihing WLS (Choudhury, 2013). Specimens were previously documented from the undivided Cachar district, and individuals were recorded from Karimganj (Guwahati Zoo, late 1990s), Sonitpur (Biswanath Ghat, 1997), and near NH-37 in Kaziranga (two roadkills during the 1998 floods) (R. K. Das, pers. comm.). More recent confirmations include the Kaziranga–Karbi Anglong landscape (J. Borah, pers. comm., 2012) and the Manas TR (Borah *et al.*, 2013; Q. Qureshi, pers. comm., 9 May 2016). A systematic camera trapping survey at 473 locations over 507.7 km² in Manas NP between 2017 and 2019 did not record the species (Bhatt & Lyngdoh, 2023). Additional recent records confirm the species in Pobitora WLS, Orang NP, and areas in and around Kaziranga NP (Ahmed *et al.*, 2017; Jhala *et al.*, 2020, 2021; Das *et al.*, 2024; Habib *et al.*, 2025), along with an unverified sighting from Behali RF (Kakati & Borah, 2021).
- In Tripura, the species is considered very rare and occurs at low densities, with a historic presence noted in Gumti WLS, particularly around Dumbur Lake (Choudhury, 2013). A live-trapped individual was recorded in a rural area of Sepahijala district in March 2021 (NE Now News, 2021), and a camera-trap image from inside a PA in spring 2024 confirmed the species' presence (Jadhav, 2024). In Meghalaya, the species is considered rare but present across the state. Sporadic historical records include a sighting from Artan (Simleng River area) in the Jaintia Hills district in 1990 (L. Ao, pers. comm.), and additional accounts from riversides in the Pechaduar and Lakadong areas within Narpuh Block I RF, Jaintia Hills district, in 1996–1997 (Mr Swer, pers. comm.). Fishing cats have also been documented from Balpakram NP (Nowell & Jackson, 1996). There are also sporadic reports from Keibul Lamjao NP (Manipur), parts of Mizoram (along the Tlawng and Kolodyne Rivers and Palak Dil) and unconfirmed records from Nagaland. In northern West Bengal, records include Jaldapara WLS, with recent confirmations from Gorumara NP, Buxa TR and Jalpaiguri district. The species is considered widespread up to 1800 m in East and South Sikkim (Avasthe & Jha, 1999; Choudhury, 2013).

Collectively, these records indicate a widespread but uneven distribution of the fishing cat across Northeastern India. Ecological strongholds occur primarily in Assam and parts of Arunachal Pradesh, with confirmed reappearances in Tripura (Mukherjee *et al.*, 2025).

Southern India: Historical sources suggest that the fishing cat occurred in parts of the Western Ghats and the western coastal region, including Bandipur (Nowell & Jackson, 1996; MacKinnon & MacKinnon, 1986). However, these reports have not been validated through recent targeted surveys and may be erroneous (Janardhanan *et al.*, 2014). In Andhra Pradesh, the species has been confirmed from Coringa WLS and the surrounding Godavari mangroves (Kolipaka, 2006; Mukherjee *et al.*, 2012; Malla & Sivakumar, 2014; Sathiyaselvam *et al.*, 2016; Shankar *et al.*, 2020; Malla *et al.*, 2018a, 2018b, 2024; Malla, 2022; Shameer *et al.*, 2024), the Krishna River delta (Naidu *et al.*, 2015; Kantimahanti, 2016), and from two small streams in human-dominated areas (Kantimahanti *et al.*, 2019, 2022). On the southeastern coast of Tamil Nadu, a purported individual was captured on video in the Karangadu mangroves, which may represent the southernmost known record of the species in India (HT, 2023).

In summary, the fishing cat in India has a fragmented yet ecologically significant distribution that closely follows the country's remaining lowland wetland systems. Historically widespread across the Gangetic and Brahmaputra floodplains, the eastern coastal belt and parts of northern and central India, the species is now concentrated in the Bengal–Assam–Terai landscape, the mangrove and delta regions of Odisha and Andhra Pradesh, and a few isolated pockets in southern, central and western India. Major strongholds include the Sundarbans, Chilika Lake, Kaziranga and Coringa regions. Recent records from Tamil Nadu indicate a possible extension of the southern range. Central and western India continue to show sparse or unconfirmed records, which may be due to natural rarity, large-scale wetland loss or inadequate survey effort. Although historic mentions exist from the Western Ghats and the southwest coast, these remain unverified. India is likely home to one of the largest remaining global populations of the species, possibly numbering in the low thousands. Sustained wetland conservation, along with systematic monitoring, will be critical for ensuring the long-term survival of the fishing cat in the country.



Figure 2.2.

Fishing cat occurrence records in India across three time periods: Historic (1000-1975), intermediate (1976-2000), and most recent (2001-2025). Historic records are derived from museum specimens but are not mapped due to the absence of precise geographic coordinates. These records were obtained from: (i) Naturalis Biodiversity Centre (NL) – Mammalia ($n = 2$), (ii) ZFMK Mammalia collection ($n = 2$), (iii) Muséum national d'Histoire naturelle (MNHN – Paris) ($n = 1$), (iv) AMNH Mammal Collections ($n = 1$), and (v) INSDC Sequences ($n = 2$). No presence records were available for the intermediate period. Green dots on the map indicate recent confirmed records, sourced from (i) iNaturalist Research-grade Observations ($n = 12$) and (ii) India Biodiversity Portal publication-grade dataset ($n = 1$). All records were screened for spatial accuracy and temporal validity; however, the distribution pattern may still be influenced by sampling bias, uneven reporting effort, and observer detectability.

Figure 2.3.

Distribution of the fishing cat across its range in South and Southeast Asia. The map illustrates the species' distribution based on the IUCN Red List assessment (Mukherjee *et al.*, 2025), highlighting its fragmented presence in wetland-associated habitats. Notable distribution zones in India include the Terai-Dooars landscape, the Gangetic-Brahmaputra floodplains, the Eastern coastal plains, and wetland-rich areas of the Western coast, as well as isolated populations in the Andaman & Nicobar Islands. This distribution reflects the fishing cat's strong association with marshes, mangroves, swamps, and riverine ecosystems, as well as its vulnerability to wetland degradation and fragmentation across its range.

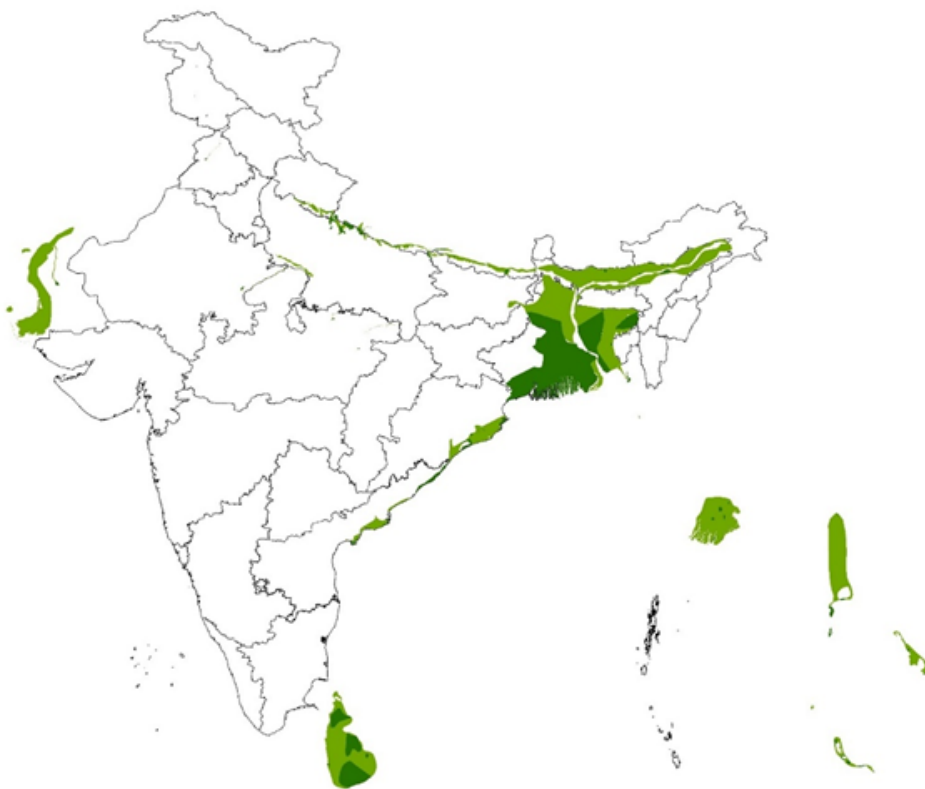


Table 2.4.

Indian distribution (historic and current) of the fishing cat. The table summarises the historic and current distribution of the fishing cat across India, region- and state-wise. It highlights areas of persistence, local extirpation, or recent confirmation, based on available ecological records and observations. All referenced literature is cited in the main text.

State	Historic Distribution	Current Distribution	Current Status Summary
Uttar Pradesh	Reported from Dudhwa, Pilibhit, Soor Sarovar; sporadic records near rivers and corridors	Confirmed in Dudhwa TR, Pilibhit TR, Suhelwa WLS, Kishanpur, Katerni-ghat, Laggabagga corridor, Gomti	Fragmented but persistent; stronghold in Terai wetlands
Uttarakhand	Historic records from Corbett and Lansdowne FD	Confirmed in Corbett TR, Sonanadi WLS, Nandhaur WLS	Fragmented presence; confirmed in multiple PAs
Punjab	Not historically confirmed	Recent confirmations in Harike WLS, Beas Conservation Reserve	Emerging population; presence confirmed
Delhi (NCT)	No confirmed historical data	Photographic evidence from the Yamuna floodplains	Marginal; urban-wetland interface records
Bihar	No historic confirmations	Scat DNA confirmation near Pandai River	Low-density; confirmation from molecular data
Madhya Pradesh	No historic records	Reports from Panna TR, Bandhavgarh TR	Rare or transient; limited data
Rajasthan	Historically reported from Keoladeo Ghana NP	Confirmed in Keoladeo Ghana NP, Ranthambhore fringe wetlands	Sparse, isolated wetland records
West Bengal	Stronghold in Sundarbans and peri-urban wetlands near Kolkata	Confirmed in Sundarbans TR, Howrah, Hooghly, Medinipur, Nadia, Bardhaman districts	High density in the Sundarbans and the lower delta
Odisha	Historic records in Bhitarkanika, Chilika, and coastal areas	Confirmed in Bhitarkanika, Chilika, Khordha, Tangi, Jagatsinghpur, Paradeep	Stronghold; persistent population
Assam	Widespread records from major PAs and river islands	Confirmed in Kaziranga, Manas, Orang, Dibru–Saikhowa, Pobitora, Laokhowa, Burhachapori, Pani-Dihing	Stronghold in the northeast; persistent in multiple sites
Arunachal Pradesh	Historic reports from Namdapha, Pakke, D'Ering, others	Confirmed in Namdapha, Pakke, Kamlang, Mehao, Itanagar, Sessa	Sparse, scattered presence across riverine and forested zones
Tripura	Historic reports from Dumbur Lake and Gumti WLS	Confirmed from Sepahijala; camera trap inside PA	Confirmed reappearance; low density
Meghalaya	Records from riversides and forests in Jaintia Hills, Balpakram NP	Confirmed in Balpakram–Baghmara and Nongkhylliem	Persistent populations in southern Meghalaya
Mizoram	Records from multiple PAs and rivers	Confirmed in Dampa TR, near Murlen	Threatened by poaching; patchy but confirmed
Manipur	Reported from Keibul Lamjao NP	No recent confirmations	Uncertain; requires targeted surveys
Nagaland	Historical sightings in village forests	Confirmed in Intanki NP, Mount Saramati	Small, restricted populations
Sikkim	Records from Khangchendzonga BR, WLSs	Confirmed in Khangchendzonga; agro-ecosystem presence	Sparse but confirmed
Andhra Pradesh	Historic range in Godavari and Krishna deltas	Confirmed in Coringa WLS, Krishna Delta, and nearby wetlands	Persistent coastal population; stronghold in Coringa
Tamil Nadu	No historic confirmation	Camera trap video in Karangadu mangroves	Southernmost recent record; status unverified
Karnataka, Kerala, Goa	Historical mention in the Western Ghats	No confirmed records	Likely erroneous or extirpated

2.1.3. Population Trends

2.1.3.1. Global

The global population of the fishing cat is in continuing decline across its fragmented range in South and Southeast Asia, primarily due to wetland loss, degradation and increasing human disturbance (Mukherjee *et al.*, 2025). There is no reliable global population estimate. Available data are limited to local or site-level assessments, which indicate small, isolated and often vulnerable subpopulations. In **Pakistan**, the only population estimate is based on the Chotiari Reservoir, where 6 to 7 individuals are inferred from extrapolated densities of 3 to 3.5 individuals per 100 km² across an area of 190 km² (Nair, 2012). In **Nepal**, estimated densities range from 4.37 to 6.06 individuals per 100 km² in Chitwan NP (Mishra, 2016) and 8.4 individuals per 100 km² in Koshi Tapu WLS (Mishra *et al.*, 2021). Extrapolated densities of 3 to 3.5 individuals per 100 km² have been suggested for Shuklaphanta NP and Jagadishpur Reservoir. In **Bangladesh**, a potentially significant population persists within the Sundarbans RF and adjoining WLSs (4,154 km²). Extrapolated densities of 18 to 70 individuals per 100 km² indicate a population of approximately 748 to 2,907 individuals (Sathiyaselvam *et al.*, 2016; Phosri *et al.*, 2021). In **Sri Lanka**, a national population of 1,392 to 2,187 individuals has been projected based on a crude density of 7 to 11 individuals per 100 km² across 19,879.8 km² of high-suitability habitat. However, this estimate relies on relative abundance indices and may be an overestimate (Jayasekara *et al.*, 2021; Englebracht, 2024). In **Thailand**, densities reach up to 18 individuals per 100 km² in Khao Sam Roi Yot NP, with reduced densities of 5 individuals per 100 km² or lower inferred for disturbed areas, including Phantai Norasing and coastal landscapes of southern Thailand (Phosri *et al.*, 2021; Tantipisanuh, Ngoprasert and Phosri, pers. comm., 2024). For **Cambodia**, population density has been estimated at 12-24 individuals per 100 km², based on habitat similarity with coastal Thailand (Phosri *et al.*, 2021), although empirical data are lacking. Many historic strongholds, including the Indus Basin, Mekong Delta, Irrawaddy Delta and much of Vietnam, have experienced severe declines or near extirpation due to conversion of wetlands for agriculture, aquaculture and urban development (Nowell & Jackson, 1996; Cutter, 2015; Appel & Duckworth, 2016; Mukherjee *et al.*, 2025). Overall, the global population is estimated to have declined by at least 30 per cent over the past 15 years, with most remaining subpopulations likely comprising fewer than 50 individuals and being affected by isolation, habitat fragmentation, and limited connectivity (Mukherjee *et al.*, 2025).



Table 2.5.

Fishing cat population density estimates across South and Southeast Asia. The table compiles available estimates of fishing cat population densities (individuals/100 km²), population size, and survey area from various regions across South and Southeast Asia. These values are derived from camera-trap surveys, extrapolated models, and empirical estimates, reflecting variability in survey effort, habitat quality, and anthropogenic pressures. NA = Not Available.

Region/Area	Density (ind./100 km ²)	Estimated Population Size	Sample Area (km ²)	Notes
Nepal				
Chitwan NP	4.37–6.06	7–10	160	Empirical estimate; capture and spacecap models
Koshi Tappu WLR	8.4	17 (14–25)	231	Camera-trap study
Shuklaphanta NP; Jagadishpur Reservoir	3–3.5	6–7; 1–2	212; 33	Extrapolated, based on a similar habitat to the Indian Terai
Bangladesh				
Sundarbans RF and WLSs	18–70	748–2,907	4,154	Extrapolated from multiple density values and suitable habitat
Sri Lanka				
National estimate (Island-wide; based on suitable habitat)	7–11	1,392–2,187	19,879.80	Estimated from relative abundance and habitat suitability models
Thailand				
Khao Sam Roi Yot NP	12–24	NA	NA	High-density core area
Phantai Norasing and the South Coast	≤5	NA	NA	Lower density in disturbed areas
Cambodia				
Coastal Cambodia (estimated)	12–24	NA	NA	Extrapolated; estimated from habitat similarity to the Thai coast
Pakistan				
Chotiari Reservoir	3–3.5	6–7	190	Extrapolated from habitat size

2.1.3.2. India

India remains a significant stronghold for the fishing cat, yet populations are fragmented and declining across much of the country (Mukherjee *et al.*, 2025). Historically widespread in the floodplains of the Ganga and Brahmaputra, as well as in coastal and inland wetlands, the species is now largely restricted to the Sundarbans, the Brahmaputra Valley in Assam, and the Terai region (Nowell & Jackson, 1996; Mukherjee *et al.*, 2025). In the Terai Arc Landscape, a study in Kishanpur and Dudhwa recorded 38 individuals (range 35 to 51) across 1,195.75 km², yielding a density of 3.14 to 3.48 individuals per 100 km² based on 549,605 camera-trap days (Nair, 2012). In the Sundarbans, densities vary considerably across sites. On Lothian Island, density was 0.44 ± 0.13 individuals per km², with an estimated 13–28 individuals recorded over 260 camera-trap days (Das *et al.*, 2017). Another study estimated 73 individuals (range: 95–100) across 134 km², equivalent to 70 individuals per 100 km², based on 11,520 camera-trap days (Sathiyaselvam *et al.*, 2016). A more exhaustive Sundarbans TR survey identified 385 individuals, including kittens, across 2,585 km², using 19,173 camera trap days; however, no density estimate was provided (Das *et al.*, 2022). In Odisha, surveys in the Chilika Lagoon recorded 156 ± 23 and 185 ± 91 individuals in two blocks, with densities of 0.67–0.69 individuals per km² (Adhya *et al.*, 2024a). Outside PAs, rapid wetland conversion and degradation have resulted in local extinctions, particularly in Kerala and Karnataka (Kumara & Singh, 2007; Mukherjee *et al.*, 2013). However, recent records from non-traditional habitats, including Ranthambhore (Rajasthan) and dry forest landscapes in central India, indicate a degree of ecological adaptability (Sadhu & Reddy, 2013; Talegaonkar *et al.*, 2018). Overall, population densities in India exhibit substantial variation, ranging from less than 1 to 70 individuals per 100 km². Most subpopulations remain small, isolated, and at risk from habitat loss, fragmentation, and human pressures (Mukherjee *et al.*, 2025).

Table 2.6.

Fishing cat population density estimates across key landscapes in India. The table summarises localised estimates of fishing cat population densities (individuals/100 km²), total population size, and survey effort across various regions in India. Estimates are derived from camera-trap studies and extrapolated models, highlighting the species' fragmented but important strongholds such as the Sundarbans, Chilika Lagoon, and Terai Arc Landscape. NA = Not Available.

Region/Area	Density (ind./100 km ²)	Estimated Population Size	Sample Area (km ²)	Notes
Kishanpur WLS and Dudhwa NP (Terai Arc)	3.14–3.48	38 (35–51)	1,195.75	Based on camera traps in Terai Arc Landscape, high camera trap effort: 5,49,605 days
Lothian Island (Sundarbans)	0.44 ± 0.13	13–28	24.6	Lothian Island block, camera-trap based; camera trap effort: 260 days
Coringa WLS	70	73 (95–100)	134	High density in protected mangrove zone; camera trap effort: 11,520 days
Sundarbans TR (4 blocks)	NA	385 (approx. with kittens)	2,584.9	Total estimated population, no density reported; camera trap effort: 19,173 days
Chilika Lagoon Block 1	0.67	156 ± 23	NA	Block-level estimate in human-use landscape; camera trap effort: 2,940 days
Chilika Lagoon Block 2	0.69	185 ± 91	NA	Block-level estimate in human-use landscape; camera trap effort: 1,440 days
Landsdowne FD	NA	2	55	-
Nandhaur WLS	NA	4	116	-
Pilibhit TR and RF	NA	14–17	474	-
Katerniaghat WLS	NA	12–14	400	-
Suhelwa WLS	NA	1–2	33	-
Rampur Range	NA	1–2	33	-
Valmiki NP floodplain	NA	6–7	187	-
Orang NP	NA	2–3	72.2	-
Kaziranga NP	NA	13–16	440	-
Kuakhai River basin	NA	1–2	40	-
Jagatsinghpur	NA	1–2	33	-
Khurda District	NA	2–3	74	-
Bhitarkarnika NP & WLS	NA	74–289	412	-
Kansardia mangroves	NA	09–34	49	-
Chilika basin	NA	145–562	803	-
Coringa WLS + Godavari mangroves	NA	79–308	440	-
Krishna River delta	NA	90–350	500	-
Total	NA	984-2,181	8096.45	-
Extrapolated: 3–3.5 individuals/100 km² in inland areas				
Extrapolated: 18–70 individuals/100 km² in coastal areas				

2.1.4. Conservation Status

2.1.4.1. Global

The fishing cat is currently listed as *Vulnerable (VU)* on the IUCN Red List (Mukherjee *et al.*, 2025). It was previously classified as *Endangered* in 2008 but was downlisted in 2016 due to improved knowledge of its distribution and a slightly slower rate of decline (Mukherjee *et al.*, 2010, 2016). Nevertheless, its global population continues to decline, and it remains at significant risk of extinction (Mukherjee *et al.*, 2025). The species is also included in *CITES Appendix II*, which regulates international trade to prevent overexploitation.



Legal protection varies across its range countries. In Bangladesh and Nepal, the fishing cat is listed as *Endangered* in national red lists and is protected under wildlife laws; however, in Nepal, protections are primarily restricted to PAs (IUCN Bangladesh, 2015; K. B. Shah, pers. comm., 2015; Amin *et al.*, 2018). In Vietnam, it receives the highest level of legal protection under *Decree 32/2006/ND-CP*, as listed in Appendix I-B (Mukherjee *et al.*, 2016). Sri Lanka, Thailand, and Cambodia also afford legal protection (Nowell & Jackson, 1996; Appel & Duckworth, 2016). Despite these measures, enforcement remains weak in many areas. Poaching for fur and meat continues in parts of Southeast Asia (Thaung & Herranz Muñoz, 2016), and retaliatory killings in response to livestock or fish pond depredation are widely reported (Cutter, 2015; Mishra *et al.*, 2021).

2.1.4.2. India

In India, the fishing cat is listed under *Schedule I* of the WPA, 1972, which grants it the highest level of legal protection. This status prohibits hunting or capture and enforces strict penalties for violations. Some states have taken notable conservation steps—for example, West Bengal has declared the fishing cat its *state animal* and initiated awareness campaigns and wetland restoration projects to support its population (Appel & Duckworth, 2016). Conservation efforts increasingly focus on habitat protection, conflict reduction, and transboundary collaboration—particularly in the India–Bangladesh Sundarbans landscape (Appel & Duckworth, 2016).

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2.1.5. Ecology and Biology

2.1.5.1. Life History & Demography

Fishing cats are medium-sized, muscular, stocky build felids, with adult males typically weighing 11–12 kg and females around 6–7 kg (Sunquist, 1991). They reach adult body size by 8–9 months and become independent at about 10 months of age (Weigel, 1975; Nowell & Jackson, 1996). Sexual maturity typically occurs between 15 and 18 months (Hunter, 2015). In captivity, they live an average of 10–12 years, with some individuals reaching up to 15 years, although such lifespans are unlikely in the wild due to predation and anthropogenic threats (K. Corbett, pers. comm., 1993; Nowell & Jackson, 1996; Hunter, 2015).

Wild demographic parameters, including survival rates and juvenile mortality, remain poorly studied due to limited long-term field monitoring (Mukherjee *et al.*, 2025). Known causes of mortality include predation, drowning in flood-prone habitats, and human-related factors such as road accidents (Mishra *et al.*, 2022; Mukherjee *et al.*, 2025).

Population viability analyses suggest that even stable subpopulations have low intrinsic growth potential, primarily due to slow reproductive rates and the species' specialised wetland dependency (Petersen *et al.*, 2022). With many populations now small, fragmented, and genetically isolated, fishing cats are increasingly vulnerable to demographic stochasticity and inbreeding depression (Mukherjee *et al.*, 2025). Without landscape connectivity and targeted conservation action, local extinctions may become irreversible (Mishra *et al.*, 2022; Mukherjee *et al.*, 2025).

Table 2.7.

Life history traits of the fishing cat. The table summarises key life history and demographic characteristics of the fishing cat based on captive observations and limited field studies. Parameters include body size, reproductive maturity, lifespan, and indicators of population viability. Estimates are based on available published literature and expert observations, with noted limitations due to data gaps from wild populations.

Trait	Value / Range	Source(s)
Adult Body Weight	Males: 11–12 kg; Females: 6–7 kg	Sunquist, 1991
Age at Adult Size	8–9 months	Weigel, 1975; Nowell & Jackson, 1996
Age at Independence	10 months	Weigel, 1975; Nowell & Jackson, 1996
Age at Sexual Maturity	15–18 months	Hunter, 2015
Longevity (Captivity)	10–12 years (up to 15 years)	K. Corbett, pers. comm., 1993; Nowell & Jackson, 1996; Hunter, 2015
Longevity (Wild)	Likely shorter due to predation and human threats	K. Corbett, pers. comm., 1993; Mukherjee <i>et al.</i> , 2025
Reproductive Rate	Low; slow reproductive rate	Petersen <i>et al.</i> , 2022; Mukherjee <i>et al.</i> , 2025
Juvenile Mortality	Unknown; inferred to be high in fragmented habitats	Mukherjee <i>et al.</i> , 2025
Survival Rates	Poorly studied; data deficient	Mukherjee <i>et al.</i> , 2025
Known Mortality Factors	Predation, drowning, roadkill, and other human-related threats	Mishra <i>et al.</i> , 2022; Mukherjee <i>et al.</i> , 2025
Population Growth Potential	Low intrinsic growth potential	Petersen <i>et al.</i> , 2022
Demographic Concerns	Susceptible to demographic stochasticity and inbreeding depression	Mishra <i>et al.</i> , 2022; Mukherjee <i>et al.</i> , 2025

2.1.5.2. Reproduction

Fishing cats show a defined breeding season across much of their range, particularly in India and Nepal, with peak mating occurring in January–February and most births recorded between March and May (Bhattacharyya, 1992). A secondary breeding period has also been observed during June and July, suggesting a potential second estrus if the initial attempt fails (Bhattacharyya, 1992). The gestation period lasts approximately 63–70 days (Ulmer, 1968; Mellen, 1989), after which females give birth to litters of 1–4 kittens, averaging 2 (Green, 1991; Mellen, 1989). Newborns are altricial, weighing approximately 170 grams, and are raised in concealed dens near water sources, such as reedbeds, hollow logs, or dense thickets (Jayewardene, 1975; Sunquist & Sunquist, 2002).

Kittens open their eyes by 16–17 days and begin eating solid food by 6–8 weeks (Sunquist & Sunquist, 2002). Weaning typically concludes between 4 and 6 months, although juveniles may accompany their mother during hunts to develop foraging skills (Sunquist & Sunquist, 2002). They reach adult body size and disperse to establish territories by 8 to 10 months of age (Ulmer, 1968; Sunquist & Sunquist, 2002).

In captivity, males have occasionally been observed providing parental care—bringing food or grooming kittens—though this behaviour is rarely seen in the wild, where the female is generally the sole caregiver (Sunquist & Sunquist, 2002). Females typically breed once per year in natural conditions; however, a second breeding attempt may occur if the initial litter is lost due to predation or environmental pressures (Sunquist & Sunquist, 2002). On average, a female may produce two kittens annually under favourable conditions; however, offspring survival is heavily influenced by threats such as predation, habitat degradation, and human disturbance (Mukherjee *et al.*, 2025).

Table 2.8.

Reproductive parameters of the fishing cat. The table summarises the key reproductive characteristics of the fishing cat, including its mating system, litter size, developmental milestones, and parental care. Information is derived primarily from field observations, captive studies, and comparative data, with limited documentation from wild populations.

Parameter	Description	Source(s)
Breeding season	Primarily January–February; births peak in March–May; secondary breeding in June–July	Bhattacharyya, 1992
Gestation period	~63–70 days	Ulmer, 1968; Mellen, 1989
Litter size	1–4 kittens; average of 2	Green, 1991; Mellen, 1989
Neonatal weight	~170 g	Sunquist & Sunquist, 2002
Denning habitat	Concealed sites near water: reedbeds, logs, dense thickets	Jayewardene, 1975; Sunquist & Sunquist, 2002
Eye opening	16–17 days after birth	Sunquist & Sunquist, 2002
Solid food initiation	6–8 weeks	Sunquist & Sunquist, 2002
Weaning	Completed by 4–6 months	Sunquist & Sunquist, 2002
Age at independence	8–10 months (dispersal and adult size)	Ulmer, 1968; Sunquist & Sunquist, 2002
Parental care	Primarily maternal; occasional paternal care in captivity	Sunquist & Sunquist, 2002
Breeding frequency	Typically annual; second attempt possible if first litter lost	Sunquist & Sunquist, 2002
Reproductive output	Avg. two kittens per year under favourable conditions	Sunquist & Sunquist, 2002
Offspring survival constraints	Predation, environmental stress, and human disturbance	Mukherjee <i>et al.</i> , 2025

2.1.5.3. Dispersal

Fishing cats typically disperse from their natal areas around 10 months of age, coinciding with the onset of independence (Weigel, 1975; Nowell & Jackson, 1996). Although quantitative data on dispersal distances are lacking, juveniles are believed to move along riverine corridors and wetland networks in search of unoccupied territories, reflecting their strong ecological dependence on aquatic habitats (Nowell & Jackson, 1996; Cutter, 2015). In fragmented landscapes, such dispersal often brings them into proximity with human settlements, increasing their exposure to threats such as road mortality, canal drownings, and conflict-related killings (Cutter, 2015; Shekhar Palei *et al.*, 2018; Adhya, 2019; Adhya *et al.*, 2024a).

Field observations indicate that juveniles may attempt to settle in areas vacated by deceased adults, but these attempts can lead to aggressive confrontations if resident individuals are present (Cutter, 2015). Dispersal thus entails significant risks, particularly in human-altered landscapes where natural cover and connectivity are limited.

Maintaining connectivity between wetland habitats is vital for facilitating dispersal, ensuring gene flow, and sustaining demographic stability among fragmented subpopulations. The degradation of dispersal corridors—such as riparian forest strips and mangrove fringes—can lead to population isolation and increased inbreeding risks (Mukherjee *et al.*, 2025). Conservation efforts increasingly emphasise protecting and restoring these linkages to support the long-term persistence of the fishing cat (Mishra *et al.*, 2022).

2.1.5.4. Home Range & Movements

2.1.5.4.1. Home Range

Fishing cats are solitary and territorial, with home ranges varying by sex, habitat type, and prey availability (Sunquist & Sunquist, 2002). Early radio-telemetry in Chitwan NP, Nepal, indicated home ranges of approximately 4–8 km² for females and about 22 km² for males (D. Smith, pers. comm., 1993). In Thailand’s coastal wetlands, males ranged over ~8.8 km² and females over ~3.9 km², likely due to high prey abundance in productive marshlands (Cutter, 2015).

More recent GPS telemetry from Koshi Tappu Wildlife Reserve in southeast Nepal showed significantly larger spatial use (Mishra *et al.*, 2025). From 2021 to 2023, 11 individuals (5 males, 6 females) were tracked: males had average ranges of 58.03 km², and females averaged 21.72 km² (Mishra *et al.*, 2025). This increase in range size in human-dominated landscapes likely reflects habitat fragmentation and the dispersal of anthropogenic food resources, such as fish farms and rice fields (Mishra *et al.*, 2025).

2.1.5.4.2. Movements

Fishing cat movements are primarily centred around aquatic habitats such as rivers, creeks, ponds, and marshes, with most activity occurring at night (Hunter, 2015). They are strong swimmers and regularly cross water channels while hunting (Sunquist & Sunquist, 2002). Individuals typically maintain core areas of intensive use—often a specific section of wetland or riverbank—with periodic exploratory forays into surrounding areas (Sunquist & Sunquist, 2002).

Males usually have territories that overlap with those of several females, consistent with a polygynous mating system, while overlap between adult males tends to be minimal (Sunquist & Sunquist, 2002). Females, particularly during the breeding season, are believed to defend exclusive core territories for raising offspring, although peripheral territories may overlap with those of other individuals (Sunquist & Sunquist, 2002).

Territorial communication, particularly through scent marking, plays a key role in regulating movement and space use among individuals of different status (Wemmer & Scow, 1977; Mellen, 1993; Sunquist & Sunquist, 2002). Fishing cats spray urine, defecate in prominent locations, and rake surfaces to mark territory boundaries and indicate reproductive status (Mukherjee, 1989). These cues help minimise direct encounters, shaping movement patterns and reducing conflict. However, during the breeding season, male–male aggression may intensify as competition for mates increases (Cutter, 2015).

2.1.5.5. Survival & Mortality

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In natural ecosystems, adult fishing cats function as top predators within wetland food webs, with few natural threats (Mukherjee *et al.*, 2025). Occasional predation by larger carnivores, such as tigers or leopards, has been recorded where their ranges overlap (Nowell & Jackson, 1996). Meanwhile, juveniles may fall prey to jackals, large snakes, or raptors (Nowell & Jackson, 1996). However, in recent decades, anthropogenic factors have emerged as the dominant causes of mortality (Mukherjee *et al.*, 2025). Road accidents are a leading threat, particularly in wetland landscapes intersected by highways and canal roads, where fishing cats often move at night (Shekhar Palei *et al.*, 2018). For instance, at least seven roadkill incidents were reported in Odisha, eastern India, within a short timeframe (Shekhar Palei *et al.*, 2018).

Retaliatory killings are also widespread, often triggered by predation on poultry, ducks, or fish from local enclosures, prompting villagers to trap or kill the offending cats (Cutter, 2015; Mishra *et al.*, 2021). In Thailand, a study of radio-collared individuals revealed that most mortalities occurred within months of capture, with annual adult survival estimated at below 80%, primarily due to road kills and conflict-related deaths (Cutter, 2015).

While large-scale commercial hunting has declined, illegal trade in skins persists in parts of Southeast Asia (Thaung *et al.*, 2018). The degradation of wetlands due to anthropogenic factors has increased exposure to threats such as dog attacks, drowning in fish ponds with netting, poisoning, and plastic ingestion or entanglement in fishing gear (Adhya *et al.*, 2022; Ratnayaka *et al.*, 2023). Disease transmission from domestic cats, such as feline distemper, remains a potential but poorly studied risk (Sunquist & Sunquist, 2002; Hunter, 2015).

In response, conservation strategies now prioritise reducing anthropogenic mortality through public awareness, conflict resolution programs, and infrastructure solutions such as wildlife underpasses, fencing, and signage in high-risk zones (Shekhar Palei *et al.*, 2018; Mishra *et al.*, 2021).

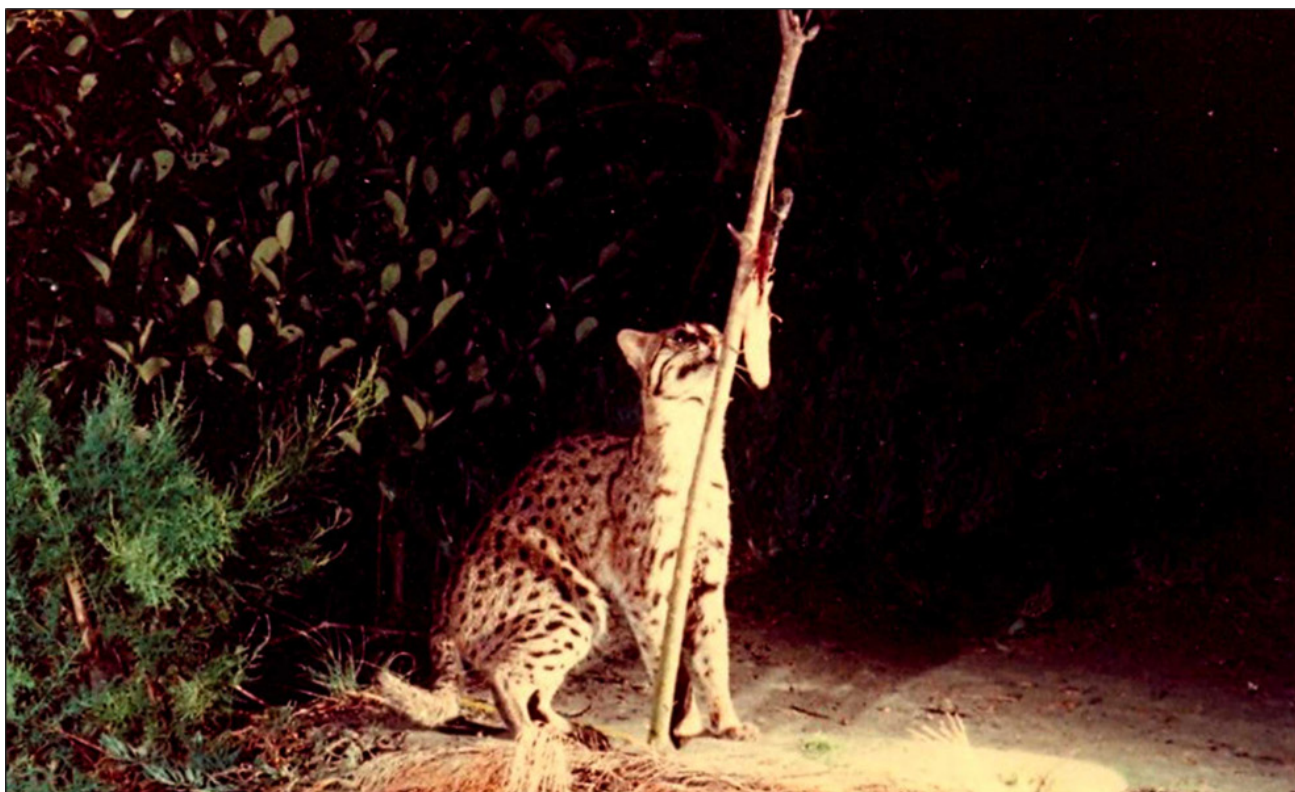


Figure 2.4.

A historic image captures the first known camera-trap photograph of a fishing cat in India and likely the world, documented during an early baiting experiment. This landmark evidence significantly contributed to validating the species' elusive behaviour and nocturnal ecology. (Photo By- Kushal Mukherjee and team Prakriti Samsad)

2.1.5.6. Intraspecific Interactions & Social Behaviour

Fishing cats are predominantly solitary, and information on their social or mating behaviour in the wild is limited (Sunquist & Sunquist, 2002; Hunter, 2015). Radio-telemetry from Chitwan NP, Nepal, suggests a typical small felid spatial pattern: males occupy larger home ranges (16–22 km²) that overlap the smaller, exclusive ranges of multiple females (4–6 km²), indicating a polygynous system (Sunquist & Sunquist, 2002; Hunter, 2015).

Like other felids, fishing cats communicate using scent, vocalisations, and body language. Scent marking—via urine spraying, cheek rubbing, and head rubbing—is used by both sexes to signal territory and social status (Wemmer & Scow, 1977; Sunquist & Sunquist, 2002). Their vocal repertoire is poorly known but includes a repetitive “eh-eh-eh” chuckle, birdlike “chirrup” from kittens, and possibly gurgles in adults (Ulmer, 1966; Peters, 1984b; Sunquist & Sunquist, 2002).

Though wild fishing cats tend to avoid conspecifics, captive observations reveal they can tolerate proximity and group housing (Sunquist & Sunquist, 2002). At the Colombo Zoo in Sri Lanka, individuals of both sexes and juveniles cohabited peacefully (Jayewardene, 1975). Some pet owners have reported tame and affectionate behaviour, contrasting with their aggressive reputation in zoos (Sunquist & Sunquist, 2002).

Their crepuscular and nocturnal habits likely reduce confrontations in the wild, as olfactory signals help maintain spatial separation (Hunter, 2015). However, further field-based studies are needed to understand the nuances of their social behaviour and intraspecific interactions.

2.1.5.7. Behaviour & Activity Patterns

Fishing cats are solitary, semi-aquatic carnivores whose activity centres around wetlands and waterbodies. They are primarily crepuscular and nocturnal, with peak activity at dusk and night (Cutter, 2015; Hunter, 2015). In areas with low human disturbance, such as parts of Sri Lanka, they have occasionally been seen active during the day, basking or patrolling the water's edge at midday (Phillips, 1935). Typically, they rest in dense vegetation during daylight, avoiding heat and human presence.

Their foraging behaviour is closely tied to water. Fishing cats employ various techniques: some wait motionless at water edges and scoop fish with swift forepaw strikes (Sunquist & Sunquist, 2002), while others wade, swim, or even dive underwater to catch prey—a behaviour observed by Breeden (1989). Although only slightly more developed than in other cats, their partially webbed forepaws aid in fishing (Kitchener, 1991).

Their diet is broad and opportunistic. While fish and crabs form staples, they also consume frogs, rodents, birds, snakes, crustaceans, and occasionally larger prey such as young deer or livestock (Mukherjee, 1989; Cutter, 2015). Instances of taking waterfowl from below the water surface (Roberts, 1977), scavenging tiger kills (D. Smith, pers. comm., 1993), and feeding on livestock carcasses—such as cows in Keoladeo NP (Haque, 1988)—reflect their dietary flexibility despite their aquatic specialisation. On land, they use stealthy movements to stalk and ambush their prey, much like domestic cats. They are powerful enough to attack larger prey, including goats or calves in rare instances (Sanyal, 1992), and also hunt insects, rodents, and crabs with swift pounces or digs (Sunquist & Sunquist, 2002).

Captive individuals exhibit unusual feeding behaviours, such as dunking meat in water, tossing frogs, and re-capturing them—actions thought to aid prey handling or mimic hunting (Iwaniuk & Blankstein, 2001; Haque & Vijayan, 1993; Sunquist & Sunquist, 2002).

Fishing cats are solitary by nature and do not display group behaviours. They maintain defined paths—along marshes, dikes, and trails—leaving clear pugmarks that researchers and locals use to monitor their presence (Adhya, 2019). Though ground-dwelling, they are capable climbers and may ascend trees to escape threats such as dogs or flooding (Sunquist & Sunquist, 2002).

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Their nightly movement distances vary by habitat quality. In prey-rich wetlands, they may travel only a few kilometres, while in fragmented landscapes, movements of 5–10 km per night have been recorded (Mishra *et al.*, 2024).

2.1.5.8. Food Habits

Fishing cats are opportunistic carnivores with a pronounced dependence on aquatic and semi-aquatic prey. Across their range, fish constitute the principal component of their diet, typically captured using a sit-and-wait approach along water edges or through active swimming and diving (Haque & Vijayan, 1993; Breeden, 1989; Mukherjee, 1989). Their diet also includes crustaceans, molluscs, amphibians, water-associated reptiles such as monitor lizards and snakes, and semi-aquatic rodents like *Bandicota bengalensis* and *Rattus rattus* (Mukherjee, 1989; Adhya, 2015; Hunter, 2015; Malla *et al.*, 2018a).

Scat analyses from Keoladeo Ghana NP revealed that fish remains were present in 76% of samples, followed by birds (27%), insects (13%), and rodents (9%) (Haque & Vijayan, 1993). In highly urbanised wetlands like Howrah, rodents dominated up to 70% of dietary records (Adhya, 2015). Water birds—including ducks, coots, and shorebirds—are occasionally caught, sometimes via underwater ambushes (Roberts, 1977; Sunquist & Sunquist, 2002; Malla *et al.*, 2018a). While insects frequently appear in scats, they are presumed to offer limited nutritional value (Hunter, 2015).

Although infrequent, larger prey items, such as hares, Indian civets, chital fawns, and occasionally domestic livestock, have been reported (Sterndale, 1884; Sanyal, 1992; P. Sanyal, pers. comm., 1991). Historical claims of attacks on human infants lack evidence and are considered implausible (Hunter, 2015).

Recent camera-trap evidence from Andhra Pradesh documented a fishing cat preying on a checkered keelback (*Xenochrophis piscator*) in a freshwater riverine habitat within a human-dominated landscape, marking the first such record for the species in inland freshwater ecosystems. Notably, this predation occurred despite an abundant fish population, indicating that non-fish prey selection may not necessarily reflect low fish availability (Kantimahanti *et al.*, 2022).

Fishing cats also scavenge opportunistically. They have been observed feeding on livestock carcasses and scavenging kills left by larger predators, such as tigers (Haque, 1988; Nowell & Jackson, 1996; D. Smith, pers. comm., 1993). One such case involved a fishing cat feeding on a cow carcass in Keoladeo NP (Haque, 1988). Despite their name, their dentition is generalised—suitable for a varied carnivorous diet but not morphologically specialised for fish capture or mollusc crushing (Pocock, 1939; Hunter, 2015).

Captive individuals display unique food-handling behaviours, such as dipping meat or prey into water, possibly to rinse or reorient it (Leyhausen, 1979). They have also been observed ambushing birds by swimming underwater and seizing them from below (Roberts, 1977).

In summary, fishing cats are flexible foragers with a strong ecological association to wetlands. Their diet shifts seasonally: aquatic prey dominate during wet periods, while rodents and birds become more prominent in drier or cooler months. Despite this adaptability, their survival remains closely tied to healthy, fish-rich wetland ecosystems.

2.1.5.9. Genetics & Genetic Characteristics

The fishing cat is currently classified into two subspecies based on geographic distribution and cranial morphology (Kitchener *et al.*, 2016):

1. *Prionailurus viverrinus viverrinus* (Bennett, 1833), found across mainland South and Southeast Asia, including India, Nepal, Bangladesh, Bhutan, Sri Lanka, and Indochina;
2. *Prionailurus viverrinus rhizophoreus* (Sody, 1936), restricted to Java.

Historical reports of fishing cats in Sumatra and the Malay Peninsula remain unverified, and these areas are not currently included in the confirmed range (Sody, 1949; Van Bree & Momin Khan, 1992; Duckworth *et al.*, 2009). Overall, geographic variation within the species remains poorly understood.

Phylogenetically, the fishing cat belongs to the *Leopard Cat* lineage within the family Felidae, which diverged around 6.2 million years ago during the Late Miocene (Johnson *et al.*, 2006). This lineage includes *P. bengalensis* (leopard cat), *P. rubiginosus* (rusty-spotted cat), and *P. planiceps* (flat-headed cat), with both mitochondrial and nuclear DNA confirming the fishing cat's distinct evolutionary position (Kitchener *et al.*, 2016).

Genetic studies to date indicate relatively low mitochondrial diversity. Kuntjoro *et al.* (2023), for instance, sequenced a 307-bp fragment of the cytochrome *b* gene from a Javan fishing cat (Surabaya) and found only 0.7–2.4% divergence from Sri Lankan and Nepalese sequences in GenBank, suggesting conserved matrilineal ancestry across a wide geographic range.

Within India, microsatellite analysis by Rana (2020) revealed moderate genetic diversity across populations in Odisha, West Bengal, and surrounding areas. However, it also identified genetic isolation in urbanised or fragmented habitats such as Howrah and Chilika. Elevated F_{ST} values and clustering patterns indicated reduced gene flow between subpopulations, underscoring the need to restore ecological connectivity. Mukherjee (2011) conducted the first phylogeographic assessment of the fishing cat in India using non-invasive sampling, reporting moderate genetic diversity, no distinct population structure, and highlighting key conservation populations in the Terai and West Bengal.

Elsewhere, Luo *et al.* (2014) reported initial phylogeographic patterns based on mitochondrial and nuclear markers from northern Indochina, but significant gaps in regional sampling persist. As Kitchener *et al.* (2016) emphasised, there is an urgent need for range-wide genetic assessments given the increasing threats to the species' habitats.

To address these challenges, Adhya *et al.* (2024b) proposed an “interactive wild–ex situ continuum” for conservation, advocating the use of genetic data to identify evolutionarily significant units (ESUs), manage captive populations, and minimise inbreeding.

Together, existing studies highlight the fishing cat's evolutionary uniqueness and its fragmented gene pool. Future conservation strategies must incorporate genetic data to inform population management, guide reintroduction efforts, and prioritise the restoration of habitat corridors to maintain gene flow across its range.

2.1.6. Bioclimatic Zone, Ecosystem, and Habitat

The fishing cat is a wetland specialist predominantly found in tropical and subtropical climates (Nowell & Jackson, 1996). It inhabits low-lying areas with high humidity, significant rainfall, and access to permanent or seasonal water bodies (Nowell & Jackson, 1996). The species thrives in tropical monsoon and subtropical humid zones, and is closely associated with riparian and wetland ecosystems, including both freshwater and estuarine environments.

Key habitat types:

- **Marshes, swamps, & floodplains:** Fishing cats are frequently recorded in marshlands, floodplain grasslands, and reed beds. In the Himalayan Terai region of India and Nepal, they inhabit tall grasslands interspersed with oxbow lakes and sluggish streams, with dense vegetation, such as *Phragmites australis*, *Typha elephantina*, and *Saccharum narenga*, providing cover and denning sites (Mishra *et al.*, 2018; Adhya, 2015; Mukherjee *et al.*, 2016). These wetlands also support abundant prey, including fish and frogs (Mishra *et al.*, 2018).
- **Mangrove forests & coastal wetlands:** Fishing cats are strongly associated with mangrove habitats, especially in the Sundarbans of India and Bangladesh, where they traverse tidal creeks, mudflats, and dense mangrove thickets to hunt fish and crabs (Mukherjee, 1989). Beyond the Sundarbans, they also occur in estuaries, lagoons such as Chilika Lake, and tidal mudflats with dense vegetation in coastal regions of India and Sri Lanka (Adhya *et al.*, 2024a). In Sri Lanka, they are documented in both urban wetlands around Colombo and wetlands situated in hilly areas (Thudugala, 2016; Ratnayaka *et al.*, 2022).
- **Riverine forests & streams:** Fishing cats are found along rivers and streams (characterised by slow-moving water) with dense riparian cover, even in hilly terrain. In the Himalayan foothills, they are found up to ~1,500 m, with a record from 2,100 m in Nepal (Prater, 1971; Amin *et al.*, 2018). In dry regions like central India, they use perennial rivers and reservoir margins, as documented in Panna TR (Dutta *et al.*, 2021). They also persist in evergreen and dry deciduous forests near water bodies, such as marshes or sluggish streams (Rabinowitz & Walker, 1991; Hunter, 2015).

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Habitat requirements:

Across landscapes, several consistent requirements define the fishing cat habitat:

- **Proximity to water:** They are rarely found far from permanent water bodies and are often seen near lakes, reservoirs, irrigation tanks, or aquaculture ponds (Nowell & Jackson, 1996).
- **Dense vegetation:** Thick cover—such as mangrove thickets, reed beds, dense scrub, or tall grass—is essential for daytime resting and ambush hunting (Sunquist & Sunquist, 2002).
- **An abundant prey base:** Wetlands supporting high densities of fish, amphibians, and rodents are crucial to their presence (Mishra *et al.*, 2018, 2022).

Habitat flexibility & human-altered landscapes:

Fishing cats demonstrate some adaptability by utilising modified habitats, such as flooded rice paddies, fish farms, shrimp aquaculture ponds, artificial fishponds, and sewage-fed wetlands, particularly when these environments mimic natural wetland structures (Sanyal, 1992; Cutter, 2015; Adhya, 2019). However, these are often secondary habitats, used in the absence of intact natural wetlands (Sanyal, 1992). They tend to avoid intensively cultivated croplands, dry uplands, fast-flowing hill streams, or urbanised areas lacking vegetative cover (Cutter, 2015; Kolipaka *et al.*, 2019). Severely polluted or heavily modified wetlands also appear unsuitable (Hunter, 2015).

Conservation implications:

The fishing cat's ecological niche—wetlands with slow-moving or stagnant water and dense cover—has become increasingly threatened. Over 50% of Asia's wetlands have been lost in the past century due to drainage, urbanisation, and degradation (Dugan, 1993). Consequently, the conservation of the fishing cat is closely linked to the preservation of wetlands. Restoration of degraded marshes, sustainable management of floodplain ecosystems, and protection of coastal habitats are vital to ensuring the survival of this wetland-dependent felid (Adhya, 2019; Mukherjee *et al.*, 2012).



Figure 2.5.

Mangrove habitat of the fishing cat. Representative view of mangrove ecosystem—one of the primary wetland habitats supporting fishing cat populations. (Photo By- Debranjana Laha)

2.1.7. Conservation Threats

2.1.7.1. Habitat Loss & Fragmentation

Habitat loss and fragmentation represent the most pervasive and severe threats to the fishing cat throughout its range in South and Southeast Asia.

In India, the species is particularly impacted by the degradation and conversion of wetlands, floodplains, and associated grasslands—ecosystems historically misclassified as “wastelands” and extensively altered for agriculture, aquaculture, and urban expansion (Adhya, 2015). Along the east coast, shrimp farming alone expanded by ~300 km² between 1988 and 2013, resulting in the widespread loss of mangroves and intertidal mudflats (Jayanthi *et al.*, 2018). Between 1977 and 2021, natural habitats within the fishing cat’s range declined by nearly 9,900 km², while built-up and commercially used land increased by over 9,600 km² (Mukherjee *et al.*, 2015; Harika *et al.*, 2023; Hasan, 2023). River systems vital to the ecology of the fishing cat are increasingly compromised by dam construction, water diversion, and pollution from agricultural runoff and untreated sewage (Bassi *et al.*, 2014). The Sundarbans and Coringa mangrove ecosystems, key strongholds for the species, are deteriorating due to sea-level rise, cyclone impacts, aquaculture expansion, and illegal land-use changes (Salunke *et al.*, 2020; Sievers *et al.*, 2020; Chengappa & Saha, 2022; Giri *et al.*, 2022). Similar pressures are observed in the Terai, Dooars, and Brahmaputra floodplains, where infrastructure projects, invasive vegetation, and rapid urbanisation have contributed to the degradation of riparian habitats (Debnath *et al.*, 2022; Baruah *et al.*, 2023; Nath *et al.*, 2023).

Comparable threats exist across the species’ broader range. In Pakistan’s Sindh Province, the construction of barrages and reservoirs has disrupted seasonal flooding regimes and degraded riverine forests, exacerbating the effects of pollution and saline water intrusion (Qasim *et al.*, 2016; Inam *et al.*, 2022; Shahab *et al.*, 2019).

In Bangladesh, nearly 45% of wetlands have been lost, particularly in the Haor basin and coastal regions, due to conversion for aquaculture, agriculture, and human settlement (Chowdhury *et al.*, 2015; Hoque *et al.*, 2022; Siddik *et al.*, 2022). In Nepal's Terai lowlands, the shrinkage of wetlands driven by land-use change and invasive vegetation has contributed to the local extirpation of fishing cats (Mishra *et al.*, 2022). In Sri Lanka, ~13.5% of the land area has undergone land-use change since 1993, including extensive forest loss in the dry zone and degradation of coastal lagoons and mangroves due to urban development and irrigation expansion (Rathnayake *et al.*, 2020; Selvam *et al.*, 2024). Myanmar's Ayeyarwady Delta lost over 15,000 km² of mangroves between 2000 and 2018, and much of its floodplain grasslands have been converted into rice fields (Chen *et al.*, 2020; Murray & Keith, 2020). In Thailand and Cambodia, large tracts of mangroves have been cleared for shrimp farms, salt pans, and real estate ventures (Veettil & Quang, 2019; Bukoski *et al.*, 2022). The remaining habitats in these countries are often fragmented and located outside PAs (Chutipong *et al.*, 2019).

These cumulative changes have increasingly confined fishing cats to small, isolated habitat patches, reducing ecological resilience and connectivity (Mukherjee *et al.*, 2016) and threatening their long-term survival.

2.1.7.2. Human–Wildlife Conflict

Fishing cats frequently come into conflict with humans, especially in landscapes where habitat fragmentation brings them into close contact with people.

In India, conflict is most pronounced outside PAs, where aquaculture ponds, poultry farms, and village water bodies overlap with the habitat of the fishing cat. Retaliatory killings are a significant cause of mortality—particularly in the Sundarbans and along the eastern coast—where villagers often kill cats accused of preying on poultry or damaging fishing nets (Mukherjee *et al.*, 2012; Chakraborty *et al.*, 2022). Between 2010 and 2021, southern West Bengal reported 115 fishing cat deaths and 91 rescues across 15 districts, with most deaths attributed to conflict or road accidents (Ganguly, 2020; Chakraborty *et al.*, 2022). On the eastern coast, fishers in Andhra Pradesh and Odisha have admitted to killing fishing cats to prevent damage to their nets or losses to livestock (Sathiyaselvam *et al.*, 2016). Roadkill is an emerging concern—data from the Odisha Forest Department indicate that vehicle collisions are a significant cause of death (Shekhar Palei *et al.*, 2018; Charan Palei *et al.*, 2021). In the Terai, fishing cat kittens are often abandoned during sugarcane harvesting, and adults are occasionally misidentified and killed as leopards (D. Rana, pers. comm. 2023).

Similar conflict dynamics are observed outside India. In Bangladesh, between 2010 and 2017, at least 46 of 120 captured individuals were killed, with 96 additional incidents—including conflict-related deaths and road-kills—recorded between 2017 and 2023 (Chowdhury *et al.*, 2015; M. A. Aziz, pers. comm., 2023). Killings are often motivated by fear, livestock predation, or community expectations to display “bravery” (Sultana *et al.*, 2022). In Sri Lanka, 54 roadkill incidents were reported in the hill country from 2013 to 2021 (Thudugala, 2016; Jayasekara & Mahaulpatha, 2022). Additionally, plastic ingestion has been detected in scat samples from urban wetlands, indicating growing pollution threats (Ratnayaka *et al.*, 2023). In Thailand, conflict and road mortality are the leading threats to biodiversity outside PAs. A three-year radio-telemetry study found that only 2 of 16 fishing cats survived, with additional roadkill reports between 2020 and 2023 (Cutter, 2015; Tantipisanuh, pers. comm., 2023). Retaliatory killings due to shrimp, fish, and livestock losses are also common in coastal communities (Chutipong *et al.*, 2019).

Across its range, the fishing cat remains highly vulnerable to persecution in human-dominated landscapes, with human–wildlife conflict emerging as a key driver of local declines.

2.1.7.3. Climate Change Impacts

Climate change poses an increasingly severe threat to the habitats of the fishing cat, particularly in low-lying coastal and riverine areas.

Along the eastern coast of India, the frequency and intensity of extreme weather events—especially cyclones in the Bay of Bengal—have increased markedly since 2008 (Tiwari *et al.*, 2022). In the Indian Sundarbans, where mangrove cover has declined by 20–21% since the 1960s, sea-level rise and cyclone-induced flooding are submerging critical habitats, further endangering this ecosystem (Sievers *et al.*, 2020; Chengappa & Saha, 2022). Mangrove health is also compromised by air pollution from fishing boats and biomass burning (Ghosh *et al.*, 2024), while estuarine sediments contain elevated levels of polyethylene microplastics, primarily derived from aquaculture gear (Chatterjee *et al.*, 2024).

Comparable climate-driven pressures are evident in other range countries. In Myanmar, the Ayeyarwady Delta lost 64.2% of its mangroves between 1978 and 2011 due to conversion to aquaculture and rice fields, intensifying flood vulnerability (Chen *et al.*, 2020). The delta's mangrove and floodplain systems are now classified as Endangered, while central floodplain grasslands are Critically Endangered due to climate-sensitive land-use shifts (Murray *et al.*, 2020a, 2020b; Murray & Keith, 2020). In Sri Lanka, mangrove and lagoon ecosystems are affected by declining salinity and oxygen levels, siltation, and increasing acidity, which are exacerbated by the presence of irrigation infrastructure and development (Selvam *et al.*, 2024). In Bangladesh, rapid urban expansion and aquaculture growth in climate-vulnerable areas, such as the Haor Basin and the Ganges Delta, have intensified seasonal wetland drying, leading to increased conflict between humans and fishing cats (Eva *et al.*, 2022; M. Akash, per. comm., 28 February 2024). Similarly, in Nepal's Terai region, wetland shrinkage linked to rising temperatures and erratic rainfall has reduced the availability of perennial swamps and oxbow lakes. These drying wetlands, including those in Chitwan NP, are being replaced by grassland or degraded into human-dominated fragments, reducing the suitability of foraging areas (Chaudhary *et al.*, 2016; Mishra *et al.*, 2022).

Without accessible higher-elevation refuges, fishing cats in coastal zones are at high risk of local extinction due to sea-level rise and extreme weather events (Mukherjee *et al.*, 2016). Invasive aquatic plants such as water hyacinth may also expand under warmer, disturbed conditions, while pollutant concentrations may rise during low-flow periods, further degrading habitat quality (Chaudhary *et al.*, 2016). Although species-specific climate models remain limited, the fishing cat's strong dependence on stable wetland ecosystems renders it highly vulnerable to climatic and hydrological changes (Mukherjee *et al.*, 2025). Projections suggest that, without intervention, climate-related habitat loss could significantly accelerate population declines in the coming decades (Mishra *et al.*, 2022).

2.1.7.4. Socioeconomic & Institutional Constraints

Persistent policy gaps, weak governance, and underfunding impede the conservation of the fishing cat across South and Southeast Asia.

In India, wetlands historically labelled as “wastelands” remain excluded from PA networks and conservation planning, enabling widespread conversion for agriculture, aquaculture, and urban expansion (Bassi *et al.*, 2014; Adhya, 2015). Key habitats in states like West Bengal, Assam, and Tamil Nadu lie outside PAs and are poorly monitored (Duckworth *et al.*, 2014; Kolipaka *et al.*, 2019).

Rapid urban growth and aquaculture expansion continue to degrade wetlands and exacerbate conflicts, while roadkills, poaching, and ineffective rescue efforts often remain undocumented or unaddressed (Qasim *et al.*, 2016; Mukherjee *et al.*, 2025).

In Bangladesh and Nepal, governance issues are compounded by unregulated land-use change and limited resources. In northeastern Bangladesh, the expansion of aquaculture and the influx of refugees in Teknaf and Ukhia have intensified human–cat conflict and strained conservation capacity (Hossain & Moniruzzaman, 2021; Eva *et al.*, 2022; Sultana *et al.*, 2022). In Nepal, wetland degradation continues due to encroachment, infrastructure, and grazing, particularly outside PAs (Amin *et al.*, 2018; Sharma *et al.*, 2019).

Fishing cat habitats often overlap with those of marginalised communities that depend on wetlands for subsistence. Without compensation, even minor losses of poultry or fish can trigger retaliatory killings (Chowdhury *et al.*, 2015). Awareness remains low; communities often misidentify fishing cats and are unaware of their legal status or ecological role (Chowdhury *et al.*, 2015). In parts of eastern India, they are still hunted for food or folk

medicine (Adhya *et al.*, 2011).

Outreach efforts remain localised and insufficient. In West Bengal and Sri Lanka, cats are misidentified as leopards or pests, leading to fear-based killings (Adhya, 2015; Ratnayaka *et al.*, 2023). Initiatives such as the Fishing Cat Project and wetland ambassador models offer promise but have not yet been widely replicated (Ganguly & Adhya, 2022).

Funding constraints are acute—small wild cats receive <2% of global felid conservation funds, forcing reliance on under-resourced NGOs and leading to data gaps (Mugerwa *et al.*, 2020). Poor interagency coordination further impedes integration of wetland protection into regional planning (Mishra *et al.*, 2022).

In Southeast Asia, weak governance and land grabs for aquaculture and tourism drive wetland loss in Myanmar and Cambodia (Flynn & Ball, 2022; Sarum & Keeton-Olsen, 2023). Cambodia also faces indiscriminate snaring in PAs (Gray *et al.*, 2018; Herranz Muñoz & Neak, 2024). In Sri Lanka, post-war infrastructure development has altered wetlands, while efforts to mitigate roadkill and control pollution remain inadequate (Ranagalage *et al.*, 2020; Jayasekara & Mahaulpatha, 2022; Ratnayaka *et al.*, 2023). In Thailand, decentralised governance and rising land taxes incentivise habitat conversion outside PAs (Sridith, 2022).

To complement ecological conservation, more vigorous legal enforcement, better integration of wetlands into national policies, community co-management, and equitable funding for small felids are urgently needed (Adhya & Dey, 2020; Mishra *et al.*, 2022).

2.2

Conservation Action Plan

The fishing cat is the only wild felid in South and Southeast Asia strongly tied to wetlands, floodplains, and mangrove ecosystems. As a semi-aquatic predator, it occupies a unique ecological niche, with its persistence closely linked to the health of water-rich habitats. Despite its ecological distinctiveness, the species is highly vulnerable to wetland degradation, fragmentation, overfishing, and human–wildlife conflict. Its occurrence across diverse ecosystems, from the Terai floodplains and central Indian river valleys to coastal mangroves of eastern and southern India, highlights both ecological adaptability and exposure to varied threats.

Safeguarding the fishing cat requires a strategic shift from scattered documentation and incidental protection to coordinated, wetland-focused conservation actions. Because wetlands are among the most threatened ecosystems in India, maintaining their ecological integrity and ensuring connectivity across floodplains, lagoons, and mangrove corridors are crucial to the survival of these species. Priority landscapes include the Terai Arc wetlands of Uttar Pradesh and Bihar, the central Indian riverine habitats of Madhya Pradesh, the semi-arid wetlands of Rajasthan, the coastal mangroves and brackish lagoons of West Bengal and Odisha, the Coringa mangroves of Andhra Pradesh, and the floodplains of Assam and Arunachal Pradesh. By embedding fishing cat conservation within national wetland management frameworks and aligning with community values and climate resilience agendas, the species can serve as both a flagship for wetland protection and an indicator of freshwater ecosystem health.

2.2.1. Goal

Conserving the fishing cat in India requires a clear, integrated direction that recognises both its wetland dependence and its precarious conservation status. As a habitat specialist distributed patchily across multiple biogeographic zones, the species faces localised extinctions where wetlands are drained or converted. At the same time, its persistence in human-dominated landscapes highlights its role as a flagship for wetland stewardship and a rallying point for participatory conservation.

The goal is to secure and sustain viable, interconnected populations of fishing cats across their current distribution in India, while safeguarding wetland ecosystems, ecological processes, and community stewardship systems that are essential to their persistence.



2.2.2. Themes / Objectives

Conserving the fishing cat requires an integrated framework that addresses both ecological and socio-political challenges. As a wetland-dependent species, its persistence hinges not only on protecting critical habitats but also on restoring degraded wetlands, maintaining hydrological connectivity, and embedding conservation into broader governance and community systems. Given its close association with human-modified landscapes such as fishponds, aquaculture zones, and floodplains, conflict mitigation and participatory management are central to ensuring coexistence.

At the same time, fishing cat conservation must go beyond site-level protection to embrace forward-looking strategies. Climate change adaptation, inclusive community engagement, and awareness-building provide resilience in rapidly changing landscapes. Strengthening institutional capacities, research, and monitoring frameworks will be crucial in filling knowledge gaps and guiding adaptive management. Collectively, these nine themes create a scaffold for a coordinated national strategy that aligns wetland protection, climate resilience, and sustainable livelihoods, ensuring the long-term survival of the fishing cat across India's diverse landscapes.

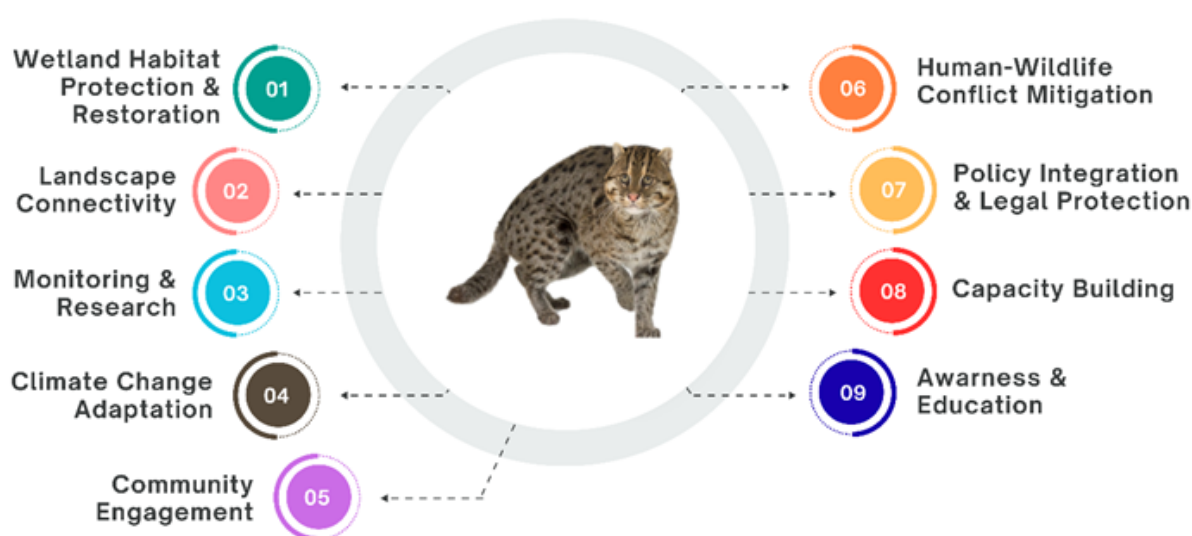


Figure 2.6.

Strategic framework for the conservation of the fishing cat in India. The diagram illustrates the nine thematic pillars of the fishing cat Conservation Action Plan: (1) Wetland Habitat Protection & Restoration, (2) Landscape Connectivity, (3) Monitoring & Research, (4) Climate Change Adaptation, (5) Community Engagement, (6) Human-Wildlife Conflict Mitigation, (7) Policy Integration & Legal Protection, (8) Capacity Building, and (9) Awareness & Education. Collectively, these interconnected themes provide a holistic framework for conserving fishing cats by securing wetlands, ensuring ecological connectivity, reducing conflict, and fostering participatory governance. They emphasise integrating species conservation into broader wetland management and climate resilience agendas, ensuring the long-term survival of fishing cats across India's diverse landscapes.

2.2.3. Shortlisting of Priority Landscapes

Identifying priority landscapes for fishing cat conservation planning is a critical step in designing an effective and targeted survey strategy. Given the species' patchy distribution, strong association with wetlands, and high vulnerability to anthropogenic pressures, a systematic, criteria-driven approach is essential to ensure that selected sites capture both current strongholds and potential habitats requiring urgent attention. The shortlisting process integrates ecological, distributional, and management considerations with on-ground feasibility to maximise the conservation value of field assessments.

2.2.3.1. Criteria for Landscape Prioritisation

The shortlisting of landscapes for rapid field assessment of fishing cats will be guided by clearly defined ecological, distributional, and management criteria to ensure that the selected areas provide the most relevant and actionable conservation insights. Priority will be given to:

- **Confirmed and potential presence:** Landscapes where recent camera-trap detections, sign surveys, media-verified records, or occupancy model outputs (Habib *et al.*, 2025) indicate a confirmed or likely occurrence of fishing cats, particularly in areas lacking systematic surveys despite historical records.
- **Habitat quality and extent:** Large and ecologically intact wetland complexes—including floodplains, marshes, swamps, mangroves, and oxbow lakes—that retain natural hydrological regimes, dense emergent vegetation, and minimal anthropogenic disturbance.
- **Ecological representativeness:** A range of wetland types will be considered, encompassing the species' distribution from coastal mangrove belts and estuarine lagoons to inland riverine wetlands and high-floodplain grasslands, thereby ensuring representation of diverse ecological conditions.
- **Biogeographic zone coverage:** Priority sites will be shortlisted to ensure representation across India's major biogeographic zones where fishing cats occur. This will allow assessments to capture regional ecological variation and strengthen zone-specific conservation strategies.
- **Connectivity potential:** Riparian and wetland corridors that link known or potential fishing cat populations across district, state, or national boundaries, with emphasis on corridors identified through connectivity assessments but yet to be field-validated, especially those linking to Nepal and Bangladesh.
- **Threat intensity:** Sites experiencing severe pressures such as habitat conversion to agriculture or aquaculture, wetland reclamation, hydrological alteration, overfishing, pollution, and high roadkill incidence, where rapid assessments can generate urgent, management-relevant information.
- **Governance diversity:** Inclusion of wetlands under various governance regimes, including PAs, RFs, community-managed wetlands, and multiple-use landscapes, to assess species status and threats across different management contexts.
- **Feasibility of surveys:** Consider practical aspects, such as seasonal accessibility, flood dynamics, field safety, and the availability of local institutional or community support, to enable effective, rapid assessments.

The application of these criteria will ensure that priority landscapes represent both confirmed strongholds and data-deficient but high-potential areas, while capturing ecological diversity and addressing urgent conservation needs across the species' range in India.

2.2.3.2. Proposed Priority Landscapes

Applying the prioritisation criteria and site-selection framework, six broad landscapes emerge as priority sites for the conservation of the fishing cat in India. To ensure ecological representativeness, one site was selected from each of the major biogeographic zones where the species occurs, ranging from Himalayan foothill wetlands to coastal mangroves. This approach captures the diversity of wetland ecosystems and ensures that conservation actions reflect the full ecological spectrum of species.

- ✓ **L1. Gangetic Plains (North India):** The Terai Arc Landscape, comprising the wetland complexes of Dudhwa TR, Pilibhit TR, Katarniaghat WLS, Hastinapur WLS, and Patna WLS (Uttar Pradesh), serves as the northern stronghold of the fishing cat. These habitats provide opportunities to examine the species' adaptation to floodplain wetlands and grassland mosaics along the Himalayan foothills. Recent confirmations from Corbett TR (Uttarakhand) and parts of Bihar further highlight the importance of securing connectivity across this mosaic.

- ✓ **L2. Deccan Peninsula (Central India):** Unanticipated records from Panna and Bandhavgarh TRs (Madhya Pradesh) point to the species' ecological plasticity in non-traditional, drier habitats. These sites urgently require systematic surveys to determine whether the records reflect transient dispersal events or small, resident populations at the edge of the fishing cat's ecological tolerance.
- ✓ **L3. Semi-Arid Zone (Western India):** Ranthambhore TR and Keoladeo Ghana NP (Rajasthan) represent the westernmost confirmed range of the fishing cat in India. Conservation assessments in these areas are crucial for testing the persistence of the species in dry deciduous forests, semi-arid wetlands, and riverine corridors embedded within an arid landscape matrix.
- ✓ **L4. Coasts (Eastern India):** The Sundarbans mangroves (West Bengal) and the Bhitarkanika–Chilika–Tampara wetland complex (Odisha) remain global conservation strongholds. These coastal ecosystems, ranging from tidal mangroves to brackish lagoons and freshwater marshes, offer critical insights into the survival strategies of species in heavily human-dominated, climate-vulnerable coastal belts.
- ✓ **L5. Coasts (Southern India):** The Godavari–Coringa WLS and Krishna WLS (Andhra Pradesh) mark the southernmost secure distribution limit of the fishing cat in India. These mangrove–estuarine habitats are vital for understanding the species' ecological dependence on fish resources and the pressures from aquaculture expansion, which necessitate long-term monitoring.
- ✓ **L6. Northeast & Eastern Himalaya (Northeast India):** Floodplain wetlands such as Kaziranga–Orang–Pobitora complex, Barail WLS, Bordoibam–Bil Mukh Bird Sanctuary, and Deepor Beel WLS (Assam), along with riparian habitats in Namdapha TR and D'Ering WLS (Arunachal Pradesh), Keibul Lamjao NP and Jiri-Makru WLS (Manipur), and Nongkhylllem WLS (Meghalaya) are key but under-surveyed strongholds. These sites span alluvial floodplains, hill wetlands, and transboundary river systems, making them indispensable for filling distributional knowledge gaps and securing connectivity to Myanmar.

Overall, the proposed priority sites cover all major biogeographic zones of India where the fishing cat persists—Gangetic Plains, Deccan Plateau, Semi-Arid Zone, Eastern Coast, Southern Coast, and Northeast Himalaya. Collectively, they represent tidal mangroves, brackish lagoons, freshwater marshes, grassland–wetland mosaics, and inland riverine corridors. This zonal representation ensures that conservation strategies address both ecological diversity and regional threats, while highlighting confirmed strongholds and frontier areas where targeted conservation can generate critical knowledge for long-term species recovery.



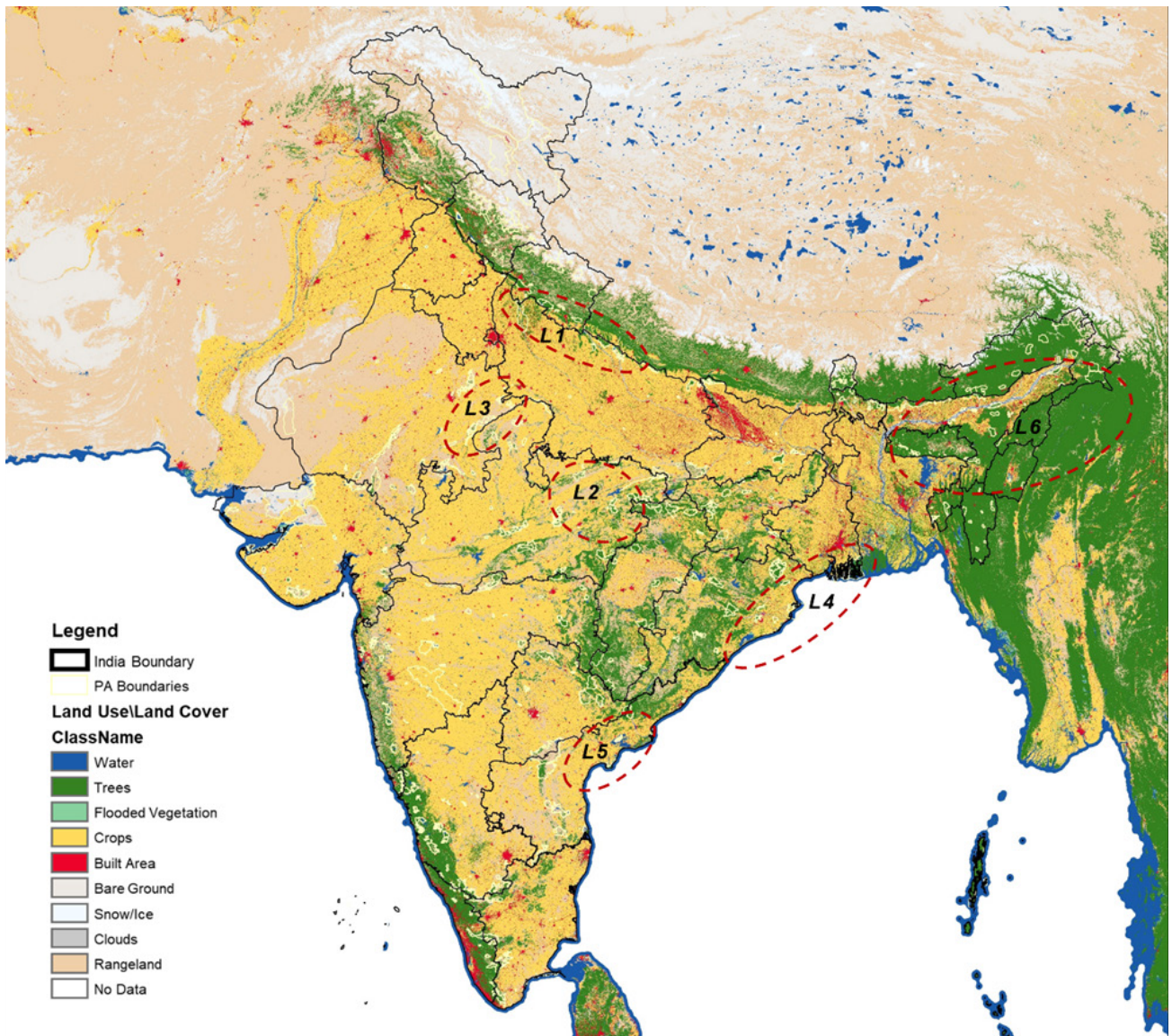


Figure 2.7.

Proposed priority landscapes (L1–L6) for fishing cat conservation in India. The landscapes were identified based on species distribution records, ecological representativeness, and biogeographic zonation. Land-use and land-cover classes (trees, flooded vegetation, crops, built-up areas, water bodies, and bare ground) highlight the habitat mosaic within which these priority sites occur.

2.2.4. Assessment of Current Knowledge

Knowledge of fishing cats in India is derived from MEE reports of TRs, NPs, and WLSs (Yadav *et al.*, 2023; Awasthi *et al.*, 2025), as well as peer-reviewed studies, published reports, and grey literature documenting species records, habitat conditions, and threats. MEE evaluations highlight recurring gaps, such as staff shortages, inadequate patrolling, limited funding, and weak corridor management, that drive wetland degradation, poaching pressures, and insufficient monitoring of wetland-dependent species like the fishing cat.

At the same time, camera-trap detections, sign surveys, and ecological observations confirm the species' continued presence across diverse landscapes, from mangroves and floodplains to oxbow lakes and urban wetlands. These records reaffirm its ecological significance and demonstrate persistence in strongholds as well as adaptability to human-modified ecosystems.

The following site-wise accounts present strengths, weaknesses, and ecological insights for fishing cats, integrating evidence from MEE evaluations with findings from scientific and community-based studies in both protected and multiple-use wetlands. Covering habitats from Terai floodplains and semi-arid riparian zones to the Sundarbans, Godavari delta, and East Kolkata wetlands, they illustrate the species' patchy distribution, dependence on fragile ecosystems, and ecological plasticity.

Together, these assessments underscore the urgent need for systematic monitoring, wetland restoration, and community-led coexistence strategies to ensure the species' long-term survival across India's diverse biogeographic zones.

Table 2.9.

Major site-level strengths, weaknesses, and ecological insights for the fishing cat across priority landscapes in India. The table synthesises findings based upon the most recent MEE reports (Yadav *et al.*, 2023; Awasthi *et al.*, 2025), peer-reviewed ecological studies, and other published literature. For landscapes not covered by MEE (e.g., community-managed forests), information is derived from ecological field studies and published reports. "Site Strengths" reflect favourable habitat, connectivity, and management attributes; "Site Weaknesses" highlight systemic and site-specific threats; and "Ecological Insights" summarise species-specific observations critical for conservation planning.

Sites	Site Strengths	Site Weaknesses	Key Ecological Insights
L1	Extensive floodplain–wetland mosaic of Ghaghara–Sharda–Girwa river systems; large marshes, oxbows, and tall-grass alluvials forming rich aquatic and prey base; strong landscape connectivity with Nepal (Shuklaphanta–Bardia complex) and western Bihar floodplains; functional network of protected and community-managed wetlands; high potential for integrated riverine and floodplain conservation.	High human population density and agricultural expansion (sugarcane, paddy, aquaculture); wetland drainage, siltation, and canal-induced hydrological alterations; encroachment and resource pressure from fishery and grazing; fisher conflict and retaliatory killing; weak inter-departmental coordination; insufficient monitoring in fringe wetlands; poaching and habitat fragmentation along transboundary river corridors.	Northernmost inland freshwater stronghold of the Fishing Cat; species adapts to floodplain wetlands and grassland mosaics along the Himalayan foothills; persistence depends on maintaining river-corridor connectivity (Dudhwa–Pilibhit–Katarniaghat–Corbett–Bihar); viability linked to wetland restoration, fisher coexistence, and pollution control; key landscape for long-term monitoring and transboundary coordination with Nepal.
L2	Ecological mosaic of dry deciduous forests, plateaus, and river systems (Ken, Son, Johila); well-protected core habitats with natural grasslands and riparian belts; functional connectivity with nearby reserves (Sanjay–Dubri, Guru Ghasidas, Kanha); community awareness and relocation initiatives improving habitat quality; confirmed opportunistic <i>Fishing Cat</i> records indicating hydrological refugia.	Species presence uncertain and possibly transient; limited perennial wetland availability and high seasonal water fluctuation; anthropogenic pressures from agriculture, mining, and sand extraction; fragmentation and infrastructure expansion (Ken–Betwa link, highways); weak community engagement and restricted monitoring capacity; conflict and retaliatory killing risk in fringe villages.	It represents the ecological plasticity of the Fishing Cat in drier, non-traditional habitats; records suggest edge-range adaptation to semi-arid and plateau wetlands; viability is dependent on remnant riparian and reservoir systems; there is an urgent need for systematic surveys and hydrological assessments to confirm population persistence; and there is a potential stepping-stone landscape linking the Gangetic and central Indian ranges.

L3	Ecotone of Aravalli–Vindhyan junction supporting a mosaic of dry deciduous forests, ravines, riparian tracts, and semi-arid wetlands; presence of perennial and seasonal water bodies (Banar, Chambal, Soorwal, and Keoladeo wetlands) offering potential Fishing Cat refugia; high prey diversity including fish, amphibians, and water birds; legal protection under TR and World Heritage designations; strong tourism-based conservation network and motivated management staff.	Seasonal wetland limitation and dependence on erratic rainfall; drying of small wetlands and grazing pressure from livestock; urbanisation and pilgrimage-related disturbance; increasing tourism footprint in core areas; weak EDC engagement and limited local awareness on wetland fauna; fragmented riverine corridors between Ranthambhore–Keoladeo–Chambal; unregulated fishing and waste pollution.	Represents the westernmost distributional limit of the Fishing Cat; occurrence in semi-arid riverine and wetland mosaics demonstrates ecological flexibility; persistence is likely restricted to perennial riparian and artificial wetlands; it serves as a critical test zone for species' adaptation to arid landscapes; long-term survival is dependent on water availability, wetland restoration, and mitigation of human–wildlife pressures.
L4	World's largest mangrove delta (Sundarbans) and India's largest brackish lagoon (Chilika) forming globally significant coastal–estuarine ecosystems; tidal creeks, mudflats, and mangrove forests offering abundant fish and crustacean prey; high wetland productivity supporting multiple threatened species; Ramsar and UNESCO protection across key zones; ongoing wetland-restoration and community co-management programs enhancing local stewardship.	High anthropogenic pressure from aquaculture, settlement expansion, and pollution; wetland shrinkage and siltation reducing prey habitat; frequent cyclones and saline ingress altering vegetation and hydrology; conflicts with fishers and retaliatory trapping; infrastructure and port-linked development fragmenting coastal corridors; weak enforcement in community-managed areas; climate-change impacts causing erosion and mangrove loss.	Coastal arc represents a global stronghold of the Fishing Cat; the species demonstrates ecological plasticity across saline, brackish, and freshwater systems; viable populations persist in mangrove–wetland mosaics despite intense human interface; long-term survival depends on mangrove restoration, sustainable aquaculture, and cyclone-resilience planning; landscape serves as a key model for climate-adaptive conservation of small cats in coastal India.
L5	Extensive mangrove–estuarine ecosystems along the Godavari and Krishna deltas; Coringa represents India's second-largest contiguous mangrove forest after Sundarbans; high primary productivity and rich fish–crustacean base supporting semi-aquatic carnivores; natural tidal creeks and mudflats interlinked with backwater channels; legal protection under WLS status and recognition as Important Coastal and Marine Biodiversity Area; ongoing restoration and mangrove plantation by Andhra Pradesh Forest Department and community groups.	Intense aquaculture expansion (shrimp and prawn farms) leading to large-scale mangrove loss and salinisation; pollution from industrial effluents and fishing harbours; unregulated fishing and hunting pressure in estuarine zones; encroachment and conversion of wetlands for agriculture and aquaculture ponds; limited scientific monitoring and weak enforcement capacity; vulnerability to cyclones, sea-level rise, and erosion impacting mangrove regeneration.	Represents the southernmost ecological limit of Fishing Cat occurrence in India; species' persistence is tightly linked to mangrove–estuarine fish availability and freshwater inflow; demonstrates dependence on coastal food webs and tolerance to moderate salinity; crucial landscape for studying human–wildlife interface in aquaculture-dominated deltas; long-term survival contingent on integrated coastal management, restoration of tidal flow, and participatory monitoring frameworks.
L6	Extensive floodplain–hill wetland mosaic spanning Assam, Arunachal Pradesh, Manipur, and Meghalaya; includes Kaziranga–Orang–Pobitora complex, Barail WLS, Bordoibam–Bil Mukh, and Deepor Beel—important lowland wetlands supporting rich aquatic prey and piscivorous fauna; upper Brahmaputra tributaries and foothill valleys linked to Namdapha TR and D'Erang WLS; hydrologically active wetlands along Brahmaputra, Dibang, and Lohit systems; unique phumdis of Keibul Lamjao NP and Loktak Lake; hill forests of Jiri–Makru and Nongkhyllam WLS forming refugia within Indo-Myanmar transition zone; key role in maintaining riverine and montane wetland connectivity across transboundary basins.	Severe wetland degradation and siltation due to encroachment, pollution, and agricultural runoff; hydrological alteration from dams and sand mining; fragmentation of riparian and floodplain habitats; urban pressure around Deepor Beel, Loktak Lake, and Guwahati; unregulated fishing and aquaculture expansion; invasive aquatic weeds (water hyacinth) and eutrophication; limited coordination among multiple wetland authorities; hunting and retaliatory killing in hill landscapes (Barail, Namdapha fringes); inadequate ecological monitoring and prey base studies.	Represents the easternmost distribution stronghold of the Fishing Cat in India; critical for assessing adaptation to high-rainfall riverine and montane wetlands; ensures ecological linkages between the Gangetic plains and the Indo-Myanmar region; floodplain complexes (Kaziranga–Orang–Pobitora–Deepor Beel) are ideal for camera-trap and eDNA surveys; there is an urgent need for coordinated wetland governance and community-led fishery regulation; restoration of degraded floodplain corridors (Dibang–D'Erang–Namdapha) is essential for long-term connectivity; promote invasive-species control, participatory hydrological monitoring, and integrated basin-level conservation planning.

2.2.5. Identification of Knowledge Gaps

The synthesis of available literature, field studies, and credible reports reveals a highly uneven distribution of research and knowledge on the fishing cat across India's PA network and adjoining wetlands. While the species' presence has been confirmed in several key landscapes, notably the Terai floodplains (Uttar Pradesh, Bihar, Uttarakhand), Central Indian wetlands (Madhya Pradesh), and the eastern and southern coastal belts (West Bengal, Odisha, Andhra Pradesh), systematic studies on ecological and behavioural parameters remain scarce. Most sites are represented by isolated photographic records or short-term surveys rather than long-term monitoring programs. Only a few regions, such as the Sundarbans, the Chilika–Bhitarkanika complex, and the Godavari–Coringa delta, have yielded detailed ecological insights through density estimation, dietary analysis, and habitat-use studies.

Despite its broad distribution across diverse wetland systems, significant gaps persist in understanding the species' spatial ecology, movement patterns, and population dynamics. Reliable estimates of density, home range, and dispersal remain limited to a handful of coastal sites, whereas inland populations are represented solely by opportunistic camera-trap detections. Information on dietary composition and prey availability, though locally documented in the Godavari delta and Sundarbans, is lacking for most freshwater and floodplain systems. Likewise, genetic, health, and disease data are virtually absent, constraining any assessment of population connectivity or viability across fragmented wetland mosaics. Knowledge of interspecific interactions, particularly competition with sympatric carnivores such as the jungle cat or leopard cat, is also minimal.

The absence of climate-linked, hydrological, and landscape connectivity assessments further limits conservation planning for this semi-aquatic felid. With many key habitats lying outside the PA network, research on the impacts of aquaculture expansion, pollution, poaching, and retaliatory killing is urgently needed. The current evidence underscores the necessity for a coordinated national research framework that integrates ecological, genetic, and socio-environmental dimensions. Addressing these critical knowledge gaps through systematic monitoring, participatory wetland governance, and long-term ecological studies is essential to secure the persistence of the fishing cat across India's dynamic wetland and coastal landscapes.

Table 2.10.

Comprehensive knowledge gaps (gap analysis) in fishing cat research, ecology, and conservation across landscapes and PAs in India, based on published studies, unpublished reports, and credible media sources. ✓ indicates that at least one source (peer-reviewed paper, technical report, government document, thesis, or credible media account) provides evidence for the parameter in the respective PA. X indicates the absence of any PA-specific evidence in the reviewed sources. L1–L6 correspond to the proposed priority landscapes listed in Section 2.2.3.2.

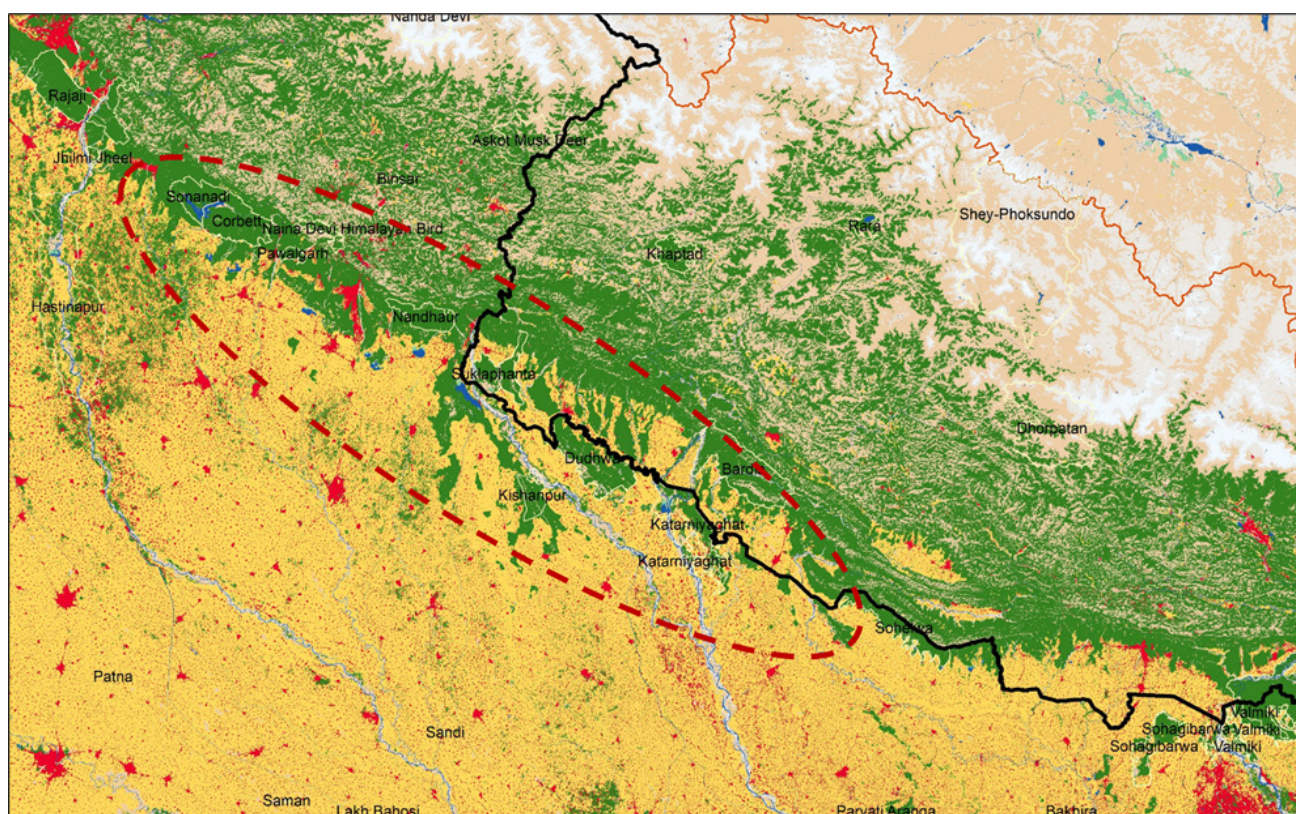
Land-scapes (PA-wise)	Species presence	Density / abundance	Behaviour / activity	Habitat use	Food habits	Dispersal	Home range & movement	Intra / inter-specific interactions	Genetics	Climate change impacts	Connectivity / corridor modelling	Poaching & hunting	Human wildlife conflict	Health / disease
L1														
Dudhwa TR	✓	✓	✓	✓	X	X	X	✓	✓	X	X	✓	✓	X
Pilibhit TR	✓	✓	X	X	X	X	X	X	X	X	X	X	X	X
Katarni- aghat WLS	✓	✓	X	X	X	X	X	X	✓	X	X	✓	✓	X
Hastinapur WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Patna WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Corbett TR	✓	X	✓	✓	X	X	X	X	✓	X	X	X	X	X
L2														
Panna TR	✓	X	✓	✓	X	X	X	X	X	X	X	X	X	X
Bandhav- garh TR	✓	X	✓	✓	X	X	X	X	X	X	X	X	X	X
L3														
Ranthamb- hore TR	✓	X	✓	✓	X	X	X	X	X	X	X	X	X	X
Keoladeo Ghana NP	✓	X	✓	✓	✓	X	X	X	✓	X	X	X	X	X

L4														
Sundarban TR	✓	✓	✓	✓	✓	X	X	X	✓	✓	X	✓	✓	X
Bhitarkani-ka NP	✓	✓	X	✓	X	X	X	X	✓	✓	X	✓	✓	X
Chilika Wetland	✓	✓	✓	✓	✓	X	X	X	✓	✓	X	✓	✓	X
Tampara Wetland	✓	X	X	✓	✓	X	X	X	✓	X	X	X	X	X
L5														
Godavari WLS	✓	✓	✓	✓	✓	X	X	✓	X	X	X	✓	✓	✓
Coringa WLS	✓	✓	✓	✓	✓	X	X	X	✓	X	X	✓	✓	✓
Krishna WLS	✓	✓	✓	✓	✓	X	X	X	X	X	X	✓	✓	X
L6														
Kaziranga TR	✓	✓	X	X	X	X	X	X	X	X	X	X	X	X
Orang TR	✓	✓	X	X	X	X	X	X	X	X	X	X	X	X
Pobitora WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Barail WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Bordoi-bam-Bil Mukh Bird Sanctuary	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Deepor Beel WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Namdapha TR	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
D'Ering WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Keibul Lam-jao NP	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Jiri-Makru WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X

2.2.6. Priority actions

Effective conservation of the fishing cat requires translating the identified knowledge gaps, threats, and management challenges into site-specific, theme-based actions that directly support wetland protection and species recovery. The priority landscapes outlined in this Action Plan represent the most critical strongholds for the species across India, encompassing freshwater floodplains, coastal mangroves, estuarine deltas, and highland marsh ecosystems. Within these landscapes, coordinated strategies are necessary to maintain hydrological integrity, secure habitat connectivity, and mitigate human-induced pressures on wetland mosaics that support viable fishing-cat populations. The proposed priority actions are structured around nine thematic pillars of conservation—ranging from wetland restoration and connectivity planning to research, community participation, and policy integration. Each landscape section provides practical, site-based interventions derived from MEE evaluations, published/unpublished studies, on-the-ground realities, and media reports, ensuring that the recommendations are both evidence-based and actionable.

L1. Gangetic Plains (North India): Dudhwa TR, Pilibhit TR, Katarniaghat WLS, Hastinapur WLS, Patna WLS, Corbett TR



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Figure 2.8.

Priority landscape (L1) for fishing cat conservation in the Gangetic Plains (North India). The map illustrates the spatial extent of the Gangetic Plains landscape, highlighting the Terai-Gangetic wetland mosaic extending across Uttarakhand, Uttar Pradesh, and Bihar. The delineated area connects major PAs, such as Dudhwa, Pilibhit, and Katarniaghat, through a network of riverine floodplains and agricultural interfaces that serve as crucial habitats for the fishing cat.

Table 2.11.

Thematic priority actions for fishing cat conservation in the Gangetic Plains (North India) (L1).

Themes	Priority Actions
Wetland Habitat Protection & Restoration	- Desilt and revive ox-bow lakes, chauras, jheels and village ponds inside/beside PAs; maintain seasonal water regimes using existing sluices/embankments where feasible. - Remove invasive aquatic/macrophyte choke (e.g., water hyacinth, <i>Ipomoea</i>) and restore native emergent reeds/sedges to improve fish/refuge cover. - Complete boundary surveys, pillar/stone demarcation, and fencing, as officially approved, to curb encroachment in floodplain pockets (especially near town fringes). - Re-establish riparian buffers (≥30 m where possible) with mixed native species along Ganga-Ghaghara-Sharda-Ramganga banks and canal margins. - Repair/upgrade wetland watchtowers, anti-poaching/beat camps and foot-patrol paths to improve presence and reduce illegal extraction.
Landscape Connectivity	- Secure the Dudhwa-Pilibhit-Katarniaghat linkage along the Sharda-Suheli-Girwa-Ghaghara floodplains through corridor notification/agreements with the Revenue/Irrigation departments. - Maintain Corbett-Terai wetland links via Ramganga-Kosi-Sonanadi and Nandhaor-Kishanpur belts; keep riverine RFs free of new permanent structures. - Retrofit culverts/bridges and canal crossings with ledges/ramps to permit animal egress; map “drowning blackspots” and fix first. - Identify and mitigate linear infrastructure pinch points (NH/SH, rail) at causeways by implementing speed calming measures, signage, rumble strips, and camera monitoring. - Formalise ‘no-net-expansion’ (zero new fish-pond conversions) zones inside PA buffers; incentivise pond restoration where abandoned.

Monitoring & Research	- Establish a unified wetland-focused camera-trap grid at perennial/seasonal waterbodies across all PAs to estimate occupancy and temporal activity. - Build a regional scat-DNA library for ID/sex/genetics; standardise sampling along riparian transects and canal embankments. - Track prey base (fish and amphibians) with simple catch-per-unit-effort indices in community ponds/ox-bows paired with habitat covariates. - Pilot telemetry in floodplain mosaics (1–2 individuals/site) to quantify crossing of roads/canals and refine mitigation placement. - Create a mortality/incident database (including roadkill, snares, and fish-pond conflicts) linked to rapid response and signage.
Climate Change Adaptation	- Map hydroperiod and flood depth classes; designate/raise earthen “refuge mounds” flood for wildlife and patrol camps. - Stabilise eroding banks with bio-engineering and riparian plantings; prioritise Ramganga and Ghaghara bends near settlements. - Install/upgrade rain- and river-gauge early warning systems, utilising village WhatsApp/SMS groups, for preemptive livestock relocation and enhanced patrol safety. - Maintain/restore side channels and backwaters to spread peak flows and retain water during the dry season.
Community Engagement	- Revive/strengthen EDCs and co-management groups in fishing/ghat villages; adopt participatory wetland work plans and monitoring days. - Develop community pond restoration (de-silt, native re-veg) with benefit-sharing; employ local youth as “wetland guardians.” - Promote low-impact nature-based livelihoods (guiding, birding) at select sites; support women’s self-help groups for reed crafts. - Set up village-level grievance hotlines for encroachment, grazing, sand mining and illegal netting offences.
Human-Wildlife Conflict Mitigation	- Publish and implement a Fish-pond Protection SOP: perimeter netting (mesh ≤ 5 cm), overhead criss-cross lines, night lighting, guard rotation, and rapid-response release protocols. - Provide conflict-risk kits (nets, gloves, crates) and train staff/community teams for safe capture/release; ensure a veterinarian is on call. - Place warning signage and speed calming measures at recurrent roadkill sites near bridges/causeways; schedule joint night patrols during the monsoon dispersal period. - Establish time-bound ex gratia/relief for verified fish-pond losses with simple, evidence-based forms.
Policy Integration & Legal Protection	- Notify/strengthen ESZs to include key floodplain wetlands, village tanks and canals that function as corridors. - Use Wetlands (Conservation & Management) Rules, 2017, to list/notify high-value jheels/ox-bows; integrate with Ganga floodplain zoning. - Sign MoUs with tea estates, agriculture, irrigation, and fisheries where relevant for zero herbicide drift into PAs, sluice scheduling, fish-passage-friendly works, and waste management. - Prioritise Conservation/Community Reserve proposals for ecologically critical RFs abutting PAs (<i>e.g.</i>, along Ramganga/Sonanadi and Ghaghara).
Capacity Building	- Train frontline staff on wetland ecology, fishing cat identification, rescue & handling, and evidence-based conflict mitigation, including Fisheries/Irrigation/Disaster staff. - Provision essential gear: boats, life vests, GPS/camera traps, rescue nets, thermal scopes, flood-season kits, and first aid. - Introduce joint refresher courses on M-STrIPES/SMART for floodplains, including geo-tagged encroachment/illegal-netting reporting.
Awareness & Education	- Run annual “Wetland Week” campaigns in schools and fisher settlements; co-create boards on safe netting and protected-species bycatch. - Install interpretive signage at visitor nodes (Dudhwa, Katarniaghat, Corbett) on fishing cat ecology and safe responses during encounters. - Launch a citizen-science reporting channel (WhatsApp + IBP/iNaturalist triage) with validation by PA staff/NGOs; publish quarterly “wetland watch” bulletins. - Create bilingual SOP posters (Hindi/English and local language) for fish-pond protection and safe release.

L2. Deccan Peninsula (Central India): Panna TR, Bandhavgarh TRs

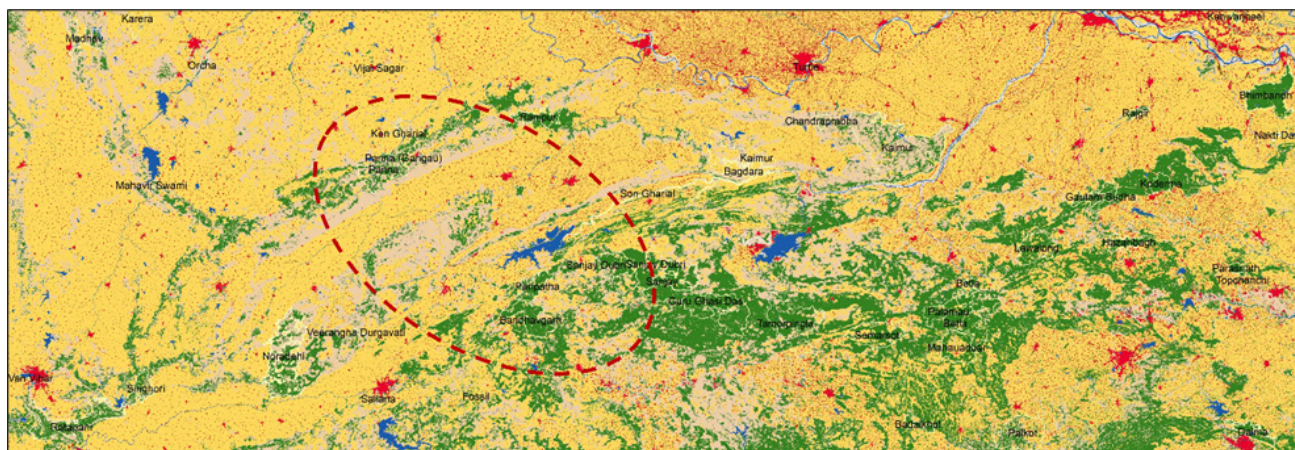


Figure 2.9.

Priority landscape (L2) for fishing cat conservation in the Deccan Peninsula (Central India). The map illustrates the spatial extent of the central Indian landscape, highlighting recent records of the inland fishing cat from the Panna and Bandhavgarh TRs. The landscape represents an ecologically atypical occurrence for the species, highlighting its adaptability to non-coastal and freshwater habitats such as riverine grasslands, seasonal wetlands, and reservoirs embedded within a matrix of dry deciduous forests and human-modified areas.

Table 2.12.

Thematic priority actions for fishing cat conservation in the Deccan Peninsula (Central India) (L2).

Themes	Priority Actions
Wetland Habitat Protection & Restoration	- Identify and restore degraded wetlands, reservoirs, and riverine grasslands within the Ken–Son–Baghelkhand basin (e.g., Madla, Hinouta, Mandla ranges). - Desilt small tanks, nullahs and talabs (especially in Panna and Bandhavgarh buffers) to sustain dry-season water availability and prey fish. - Control invasive <i>Prosopis</i>, <i>Lantana</i>, and <i>Cassia</i> infestations in riparian zones to reestablish native wetland flora. - Secure catchment vegetation of Ken and Son tributaries through contour trenching and natural regeneration. - Promote native grass–reed mosaics (<i>Typha</i>, <i>Saccharum</i>, <i>Phragmites</i>) in valley wetlands to enhance prey refuge and nesting habitats.
Landscape Connectivity	- Maintain ecological corridors linking Panna–Ken–Son and Bandhavgarh–Sanjay–Guru Ghasidas–Kaimur complexes through riparian forest protection and ESZ-based zoning. - Map and restore linear gaps along the Ken River and inter-TR buffer forests (Rookhad–Shahnagar–Umaria axis). - Integrate wetland and grassland connectivity in the Ken–Son basin with NGT/river basin management plans. - Retrofit canal/bridge crossings for faunal movement; create vegetated underpasses or culvert shelves. - Develop micro-corridor restoration with local panchayats for ponds and tanks outside PA boundaries.
Monitoring & Research	- Initiate occupancy and camera-trap surveys in Panna and Bandhavgarh floodplain wetlands (Ken, Son, Johila tributaries). - Collect and genetically validate scat samples to confirm species presence and understand population source–sink linkages. - Map distribution of prey fish, amphibians, and waterbirds as proxy indicators for fishing cat habitat suitability. - Assess seasonal water dynamics and prey base through eco-hydrological surveys in reservoirs and oxbows. - Maintain a shared central database with Madhya Pradesh FD, WII, and NGOs for fishing cat sightings and camera-trap detections.
Climate Change Adaptation	- Identify climate-resilient refugia (perennial ponds, shaded wetlands) for protection during drought years. - Develop a hydro-meteorological early-warning system for prolonged dry spells and water shortages in the Ken–Son basins. - Promote watershed restoration and recharge pits to maintain wetland water levels. - Establish micro-catchments for local ponds and tanks to buffer seasonal variability in water retention.

Community Engagement	- Strengthen EDCs and JFMCs to incorporate wetland restoration and fish stock management into eco-development activities. - Train local fishing and farming communities in sustainable practices, including the use of native fish species, zero plastic, and no chemical inputs. - Develop participatory wetland health scorecards with local schools and eco-guides. - Encourage alternative livelihoods—such as eco-guiding, nature crafts, and organic produce—to reduce dependence on wetland extraction.
Human-Wildlife Conflict Mitigation	- Develop a protocol for responding to incidental captures of fishing cats near fish ponds, tanks, or villages. - Establish compensation norms for verified fish losses or livestock damage near PA boundaries. - Install solar fencing or low-light deterrents in buffer zones around vulnerable fish ponds. - Conduct awareness training for staff and local communities on safe capture, release and reporting. - Document and monitor all incidents of retaliatory killings or conflict through district wildlife cells.
Policy Integration & Legal Protection	- Integrate the fishing cat as a “flagship wetland species” within the MP State Biodiversity Board and river rejuvenation schemes (Ken–Son–Johila). - Notify critical riparian wetlands under Wetlands (Conservation and Management) Rules, 2017. - Include key fishing cat habitats in revised ESZ proposals for Panna and Bandhavgarh. - Encourage convergence with Jal Shakti Abhiyan, MGNREGA, and River Rejuvenation Missions for joint wetland actions.
Capacity Building	- Conduct training workshops for PA staff, fisheries, and irrigation officers on wetland ecology and species identification. - Equip frontline teams with GPS devices, rangefinders, and water-quality testing kits for effective wetland monitoring. - Develop inter-departmental task forces (forest–fisheries–irrigation) for collaborative habitat management. - Include wetland and riparian management modules in the training curricula for Forest Guards and Foresters.
Awareness & Education	- Prepare an illustrated field guide on “Wetlands and Fauna of the Vindhyan Plateau,” highlighting the presence of the fishing cat. - Create interpretation boards at Raneh Falls, Madla, and Umaria Gate, emphasising the fishing cat’s ecology and safe human interactions. - Run awareness drives on World Wetlands Day and World Wildlife Day through schools and eco-clubs. - Involve local NGOs and students in biodiversity documentation and citizen reporting (e.g., iNaturalist, Bhuvan).

L3. Semi-Arid Zone (Western India): Ranthambhore TR, Keoladeo Ghana NP

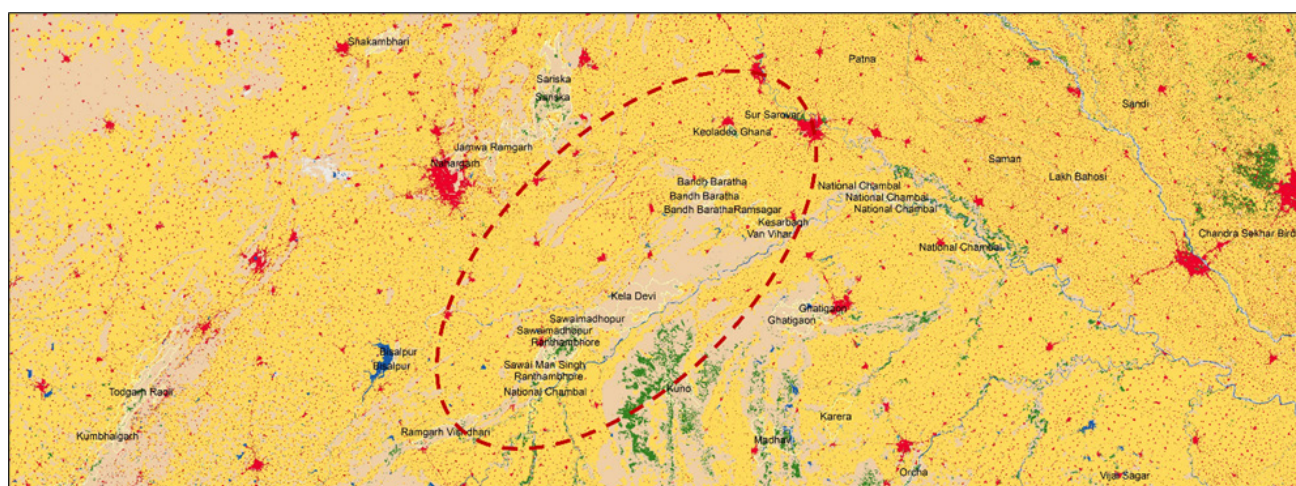


Figure 2.10.

Priority landscape (L3) for fishing cat conservation in the Semi-Arid Zone (Western India). The map delineates the western semi-arid landscape, where sporadic records of fishing cats from Ranthambhore and Keoladeo Ghana highlight their unexpected presence in arid and freshwater wetland mosaics. These records mark the species’ ecological tolerance beyond coastal and riverine systems, emphasising the conservation importance of small, isolated wetlands and artificial reservoirs that sustain fragmented populations amidst predominantly dry landscapes.

Table 2.13.

Thematic priority actions for fishing cat conservation in the Semi-Arid Zone (Western India) (L3).

Themes	Priority Actions
Wetland Habitat Protection & Restoration	• Prepare and implement an annual water budget for the core wetlands (Padam/Rajbagh/Malik Talabs; Ghana marshes), ensuring pre-monsoon assurance by releasing water from designated canals and dams. • De-silt, de-weed, and re-profile silted marsh edges and village tanks that feed the parks; maintain seasonal mudflats and reed belts to support fish and amphibians. • Control invasives (<i>Prosopis juliflora</i>, <i>Lantana</i>, <i>Ipomoea</i>, <i>Eichhornia</i>) with phased mechanical removal and native shrub–reed restoration. • Fence or pillar-demarcate fragile riparian pockets near high-use visitor/pilgrimage zones to prevent trampling and illegal access. • Upgrade/repair sluices, anicuts and feeder channels; install simple staff gauges to track wetland levels.
Landscape Connectivity	• Secure the Ranthambhore–Kaila Devi–Sawai Mansingh landscape links by protecting the Banas, Chambal, and seasonal nallahs; avoid new permanent construction in identified riparian RFs. • Map and treat pinch points (State/NH roads, rail, and canal crossings) with speed calming, signage, and camera monitoring; explore culvert ledges where feasible. • Notify/keylist satellite wetlands (outside Keoladeo TR boundary) that function as dry-season refuges; manage them under Wetlands Rules, 2017. • Collaborate with local bodies to restore village tanks/stepwells within a 5–10 km radius of park edges as micro-corridors and drought refugia.
Monitoring & Research	• Establish a wetland-focused camera-trap grid around major talabs/marshes, canal mouths and village tanks to estimate occupancy/activity. • Build a scat-DNA library (ID/sex/genetics) using riparian transects; pair with eDNA/water sampling to verify presence and prey fish. • Quarterly hydro-ecology monitoring: water depth, area, macrophyte cover, dissolved oxygen/temperature, and basic fish CPUE. • Maintain a mortality/incident database (including roadkill, dog interactions, and fish-pond events) with geo-tags to effectively place mitigation measures.
Climate Change Adaptation	• Identify and protect drought-resilient refugia (perennial tanks, shaded pools); ring-fence from livestock and vehicular disturbance. • Create percolation trenches and recharge pits in catchments, and prioritise desilting feeder tanks before the peak summer season. • Prepare a heat wave and drought SOP for patrols, rescue, and water provisioning to key marsh cells. • Diversify water sources (e.g., staggered releases, rainwater harvesting on park buildings) to reduce the risk of single-source failure.
Community Engagement	• Strengthen EDCs/JFMCs to co-lead tank restoration, de-silting drives and anti-netting patrols on canals/ponds. • Pilot benefit-sharing from wetland restoration (e.g., reed crafts, guided birding) with local SHGs, especially around Bharatpur villages. • Co-create village wetland watch groups for night-time vigilance at sensitive ponds during dry months. • Establish a simple grievance line for encroachment, illegal netting and tourist/pilgrimage spill-over into marsh edges.
Human-Wildlife Conflict Mitigation	• Issue and train on a Fish-pond Protection SOP (perimeter netting, overhead criss-cross lines, night watch, safe release protocol). • Implement free-roaming dog management (sterilisation, vaccination, waste management) at pilgrim/urban fringes to reduce depredation and disease risk. • Install speed-calming and warning signage at recurrent wildlife crossings near bridges and canal causeways. • Ensure time-bound ex gratia for verified fish-pond losses with simple evidence forms and rapid verification.
Policy Integration & Legal Protection	• Use Wetlands (Conservation & Management) Rules, 2017, to notify/declare priority satellite wetlands that feed Keoladeo and Ranthambhore marsh complexes. • Align ESZ provisions to include riparian corridors, tanks, and marsh clusters that are critical for connectivity. • Formalise MoUs with Irrigation/Water Resources for assured releases, sluice operations, and sediment management before the wintering season. • Converge with Jal Jeevan/AMRUT/Smart City for sewage interception and stormwater quality improvements around Bharatpur/Sawai Madhopur.
Capacity Building	• Train frontline staff, irrigation and municipal teams in wetland diagnostics, fishing-cat ID, safe capture/release, and evidence-led conflict response. • Provide boats, life jackets, thermal scopes, water-quality kits, GPS/camera traps, and flood/heat-wave safety kits. • Conduct joint rapid-assessment drills (water assurance failure, mass fish kill, stray dog packs) before peak season.
Awareness & Education	• Develop bilingual interpretation at high-use visitor/pilgrimage nodes on wetland etiquette and the ecology of fishing cats. • Run Wetland Week and school eco-club programmes with citizen science reporting (validated WhatsApp/IBP/iNaturalist). • Display SOP posters on fish-pond protection and safe responses during sightings at village notice boards and park gates. • Quarterly “Marsh Watch” bulletin summarising water levels, restoration progress and wildlife incidents for public transparency.

L4. Coasts (Eastern India): Sundarban TR, Bhitarkanika NP, Chilika Wetland, Tampara Wetland



Figure 2.11.

Priority landscape (L4) for fishing cat conservation in the Coasts (Eastern India). The map delineates the coastal landscape of eastern India, encompassing the deltaic, estuarine, and lagoonal ecosystems that sustain one of the most important strongholds for the fishing cat. It highlights the spatial extent of mangrove forests, brackish wetlands, and associated human-use zones that together form a critical habitat continuum from the Sundarbans to coastal Odisha. The area is of high conservation significance due to its ecological productivity, species–community interactions, and vulnerability to coastal development and climate change.

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Table 2.14.

Thematic priority actions for fishing cat conservation in the Coasts (Eastern India) (L4).

Themes	Priority Actions
Wetland Habitat Protection & Restoration	- Strengthen mangrove regeneration and natural sediment accretion programs in Sundarbans TR and Bhitarkanika NP, prioritising degraded creeks and embankments. - Undertake mechanical and biological control of invasive Nipa palm, <i>Prosopis juliflora</i> and <i>Eichhornia</i> in estuarine fringes and lagoon marshes. - Re-establish buffer mangroves and salt marsh belts around vulnerable villages to reduce erosion and storm-surge impacts. - Implement water-quality monitoring and sewage interception in feeder canals that drain into the Chilika and Tampara wetlands. - Promote sustainable traditional aquaculture (no-feed, low-stock) in community ponds adjoining PAs.
Landscape Connectivity	- Identify and maintain hydrological linkages connecting the Sundarbans, Bhitarkanika, Chilika, and Tampara through the coastal rivers (Matla–Bidyadhari–Baitarani–Mahanadi). - Prevent embankment hardening and new permanent construction in inter-delta corridors; encourage soft-engineering and green belts. - Map and restore coastal oxbows, mudflats, and creek systems acting as dispersal routes for fishing cat and other semi-aquatic fauna. - Integrate PA connectivity zones with ICZM and State Wetland Authority plans to sustain tidal-freshwater exchange.
Monitoring & Research	- Initiate standardised camera-trap and eDNA-water surveys across Sundarbans, Bhitarkanika, Chilika & Tampara to confirm occurrence and activity hotspots. - Develop a long-term monitoring framework for the prey base, including fish, amphibians, and crustaceans, and correlate it with seasonal salinity levels. - Digitise historic records, sightings, and strandings into a shared database coordinated by WII – State FDs – NGOs. - Research ecological thresholds for salinity tolerance and habitat use by the fishing cat in brackish wetlands.

Climate Change Adaptation	- Stabilise eroding embankments using mangrove belts and vegetated bunds; integrate with MGNREGS and Jal Shakti schemes. - Develop cyclone-resilience protocols for key wetlands, including temporary fish refuge ponds, early warning systems, and evacuation plans. - Enhance freshwater inflows to estuarine wetlands by maintaining upstream flow releases (Mahanadi & Matla basins). - Promote community mangrove nurseries and mixed plantations to aid rapid post-cyclone recovery.
Community Engagement	- Activate and empower EDCs around all coastal PAs for wetland restoration, crab-fattening regulation, and mangrove nurseries. - Provide eco-livelihood training in mangrove apiculture, reed crafts, shell jewellery, and regulated homestays. - Facilitate participatory wetland health monitoring (including water level, fish diversity, and pollution index) among schools and fisher cooperatives. - Involve women's SHGs in plastic-free wetland campaigns and seedling production.
Human-Wildlife Conflict Mitigation	- Formulate conflict-response guidelines for fishing cat interactions with fish ponds, crab pens, or poultry sheds; include safe release SOPs. - Provide insurance/compensation for verified fish-pond losses and livestock predation near mangrove villages. - Implement dog population control and vaccination to reduce depredation and disease spillover. - Pilot solar lighting and low-cost fencing around high-risk aquaculture units in Bhitarkanika and Chilika peripheries.
Policy Integration & Legal Protection	- Ensure that all major wetlands (Chilika, Tampara, Bhitarkanika, and Sunderban buffer) are notified under the Wetlands (Conservation and Management) Rules, 2017. - Align CRZ and ICZM plans with fishing-cat habitat needs to restrict reclamation and sand mining. - Mainstream fishing cat into State Biodiversity Action Plans and CAMPA funding priorities for wetland restoration. - Develop joint inter-state MoUs (West Bengal–Odisha) for cross-delta monitoring and enforcement against illegal trade and encroachment.
Capacity Building	- Train frontline staff and local fishery inspectors in species identification, track recognition, camera-trap operation, and eDNA sampling. - Supply boats, binoculars, GPS units, safety gear, water-quality meters, and tidal-monitoring tools for patrol teams. - Conduct joint simulation drills for cyclone preparedness, oil-spill response, and wildlife rescue. - Integrate wetland modules into forest guard and coastal police training curricula.
Awareness & Education	- Develop bilingual interpretation panels at visitor centres (Sajnekhali, Dangamal, Satapada) that highlight the ecology of the fishing cat and provide coexistence tips. - Organise World Wetlands Day and Mangrove Day campaigns focusing on youth and fishers. - Prepare a visual field guide on “Wetland Fauna of Coastal India” featuring the fishing cat. - Encourage citizen science (photo validation via iNaturalist/India Biodiversity Portal) to supplement distribution data.

L5. Coasts (Southern India): Godavari WLS, Coringa WLS, Krishna WLS

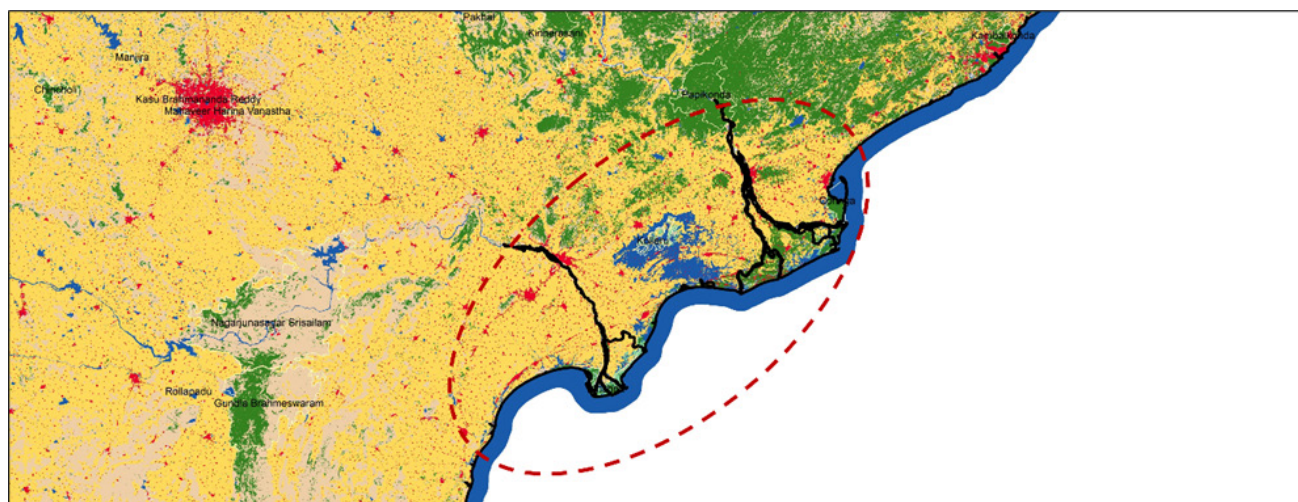


Figure 2.12.

Priority landscape (L5) for fishing cat conservation in the Coasts (Southern India). The map depicts the southern coastal landscape of Andhra Pradesh, encompassing the Godavari–Krishna delta complex, which highlights a mosaic of mangroves, estuaries, and agricultural wetlands critical for the persistence of the fishing cat. This region represents the southernmost confirmed distribution of the species in India and supports viable populations within human-dominated environments. The map delineates PAs, wetland clusters, and adjoining land uses that form a crucial continuum to ensure habitat connectivity and mitigate anthropogenic pressures along the Coringa–Krishna coastal zone.

Table 2.15.

Thematic priority actions for fishing cat conservation in the Coasts (Southern India) (L5).

Themes	Priority Actions
Wetland Habitat Protection & Restoration	• Restore degraded mangrove patches and intertidal mudflats in the Godavari–Coringa–Krishna delta, especially around Gollaprolu–Yanam–Machilipatnam. • Remove unauthorised shrimp ponds within notified wetland areas and rehabilitate abandoned ones to facilitate natural mangrove regeneration. • Undertake reforestation using native mangrove species (<i>Avicennia marina</i>, <i>Rhizophora mucronata</i>, <i>Sonneratia apetala</i>) in degraded creek zones. • Establish buffer belts and silt traps along river distributaries to reduce sediment inflow and eutrophication. • Coordinate with the Andhra Pradesh Forest Department and Coastal Zone Management Authority for periodic wetland boundary demarcation and CRZ compliance.
Landscape Connectivity	• Map and maintain hydrological corridors between Coringa, Krishna and Kolleru wetlands to secure tidal and freshwater exchange. • Restore disrupted distributaries of the Godavari (Gautami, Vashishta) and Krishna deltas by dredging blocked inlets and removing bunds. • Integrate village tanks and irrigation canals as freshwater refuges supporting wetland connectivity during dry periods. • Prevent fragmentation caused by linear infrastructure and aquaculture bund roads, especially near Yanam and Bhairavapalem.
Monitoring & Research	• Implement long-term camera-trap and eDNA surveys across the Coringa, Krishna, and Godavari mangrove belts to confirm population persistence. • Develop a wetland prey-monitoring protocol for fish and crustacean abundance, integrating local fisher participation. • Establish a biodiversity observatory node at Coringa, linked with WII and ZSI, for periodic updates on species. • Compile and digitise all historical records and sightings of fishing cats and sympatric species (smooth-coated otters, jackals, jungle cats) for distribution mapping.
Climate Change Adaptation	• Promote bio-shield plantations of mixed mangroves and salt-tolerant grasses to mitigate cyclone impacts. • Construct eco-engineered embankments using coir logs and native vegetation to reduce tidal erosion. • Install salinity loggers and hydrological monitoring stations at estuarine mouths to track salt intrusion. • Encourage climate-resilient aquaculture models such as low-salinity brackish ponds integrated with mangroves.
Community Engagement	• Re-activate EDCs in Coringa–Yanam–Machilipatnam sectors for mangrove nursery management and anti-poaching patrols. • Train local fisher cooperatives in sustainable crab collection and eco-tourism management. • Encourage community-led wetland clean-up drives and plastic-free estuary initiatives across Krishna and Godavari districts. • Facilitate SHG-based mangrove seedling nurseries through convergence with MGNREGS and state livelihood missions.
Human-Wildlife Conflict Mitigation	• Develop rapid-response protocols for rescuing fishing cats from aquaculture ponds and creeks. • Introduce damage-assessment and compensation mechanisms for verified losses in aquaculture pens. • Conduct vaccination and sterilisation of feral dogs in fringe villages to reduce disease and depredation risks. • Promote non-lethal deterrents such as illumination and bamboo fencing to minimise nocturnal incursions into shrimp farms.
Policy Integration & Legal Protection	• Strengthen enforcement of the Wetlands (Conservation and Management) Rules 2017 in Coringa–Krishna–Godavari complexes. • Integrate fishing cat conservation into the Andhra Pradesh State Wetland Action Plan and Biodiversity Strategy (2025–2030). • Notify ESZs around Coringa and Krishna WLS to restrict high-impact aquaculture and industrial expansion. • Establish a joint monitoring committee comprising the MoEFCC, Government of Andhra Pradesh, and the district coastal regulators to track CRZ violations.
Capacity Building	• Organise training for frontline forest staff and coastal police on mangrove ecology, wildlife rescue and species identification. • Provide field infrastructure, including boats, GPS units, safety gear, and water-testing kits, for wetland patrolling. • Conduct workshops for district wetland officers and irrigation engineers on ecological flow and fish-migration needs. • Facilitate exposure visits of local EDCs to successful mangrove eco-restoration sites such as Bhitarkanika and Sundarbans.
Awareness & Education	• Establish interpretation centres at Coringa and Krishna, highlighting fishing cat and mangrove biodiversity. • Develop bilingual outreach materials on sustainable wetland use for schools and fisher communities. • Celebrate World Wetlands Day and World Mangrove Day with local NGOs and schools. • Promote citizen-science documentation of fishing cat sightings through national wildlife observation platforms.

L6. Northeast & Eastern Himalaya (Northeast India): Kaziranga TR, Orang TR, Pobitora WLS, Barail WLS, Bordoibam–Bil Mukh Bird Sanctuary, Deepor Beel WLS, Namdapha TR, D’Ering WLS, Keibul Lamjao NP, Jiri-Makru WLS, Nongkhyllem WLS

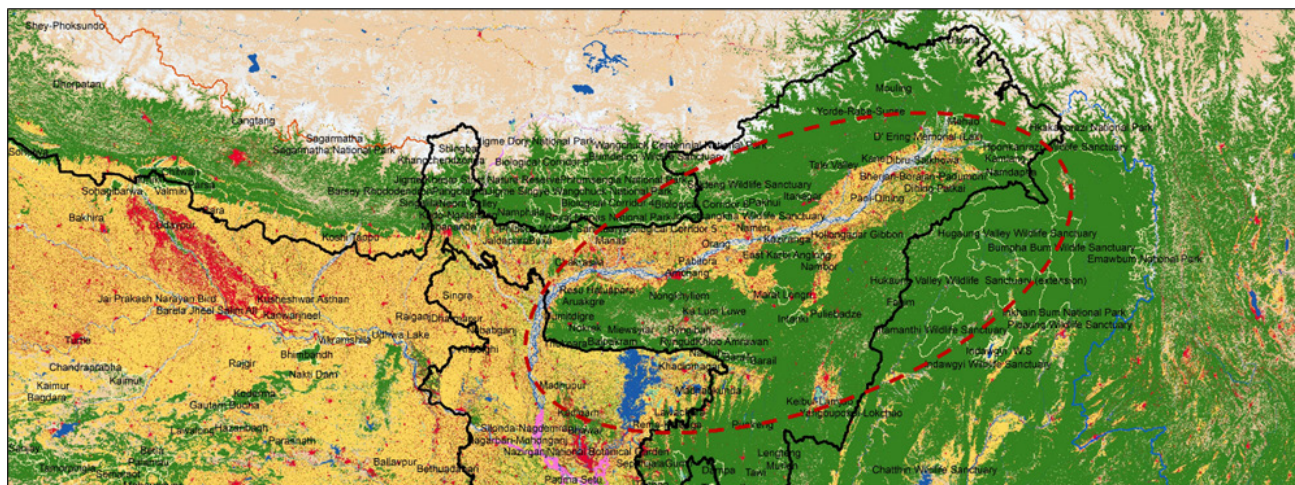


Figure 2.13.

Priority landscape (L6) for fishing cat conservation in the Northeast and Eastern Himalaya (Northeast India). The map highlights the extensive wetland–forest mosaic of Northeast India, encompassing the Brahmaputra and Barak floodplains, as well as the adjoining hill ranges of Arunachal Pradesh, Assam, and Manipur. These areas form one of the most ecologically complex and least-explored regions for the fishing cat, linking multiple Ramsar sites and PAs across transboundary landscapes contiguous with Bhutan, Bangladesh, and Myanmar. The delineated landscape underscores the importance of lowland wetlands, riverine systems, and floodplain connectivity for the long-term persistence of the species in the northeastern biogeographic zone.

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Table 2.16.

Thematic priority actions for fishing cat conservation in the Northeast and Eastern Himalaya (Northeast India) (L6).

Themes	Priority Actions
Wetland Habitat Protection & Restoration	• Deepor Beel WLS: stop solid-waste dumping and sewage inflow by diverting drains and building silt traps/constructed wetlands at main inlets; remove legacy trash from the railway stretch with fortnightly joint drives. • Loktak–Keibul Lamjao: operate a seasonal hyacinth and phumdi (floating biomass) thinning program that keeps fishing-cat foraging edges open while safeguarding sangai core areas; install floating booms to contain hyacinth before manual removal. • Bordoibam–Bil Mukh BS & Pobitora fringe beels: create community fish refuges with annual desilting of feeder channels. • D’Ering WLS: restore tall/short grass mosaics through rotational early-dry-season burns and fire lines; uproot invasive Mimosa/Chromolaena from riverine islands using paid village squads. • Kaziranga–Orang floodplain beels: reopen silted cut-offs to reconnect oxbow wetlands to Brahmaputra; use low-cost brushwood spurs to reduce bank erosion near key beels. • Nongkhyllem & Barail: protect perennial swamp patches by notifying micro-wetlands as “waterbird/otter conservation plots” with no-grazing and no-timber rules.
Landscape Connectivity	• Secure the Kaziranga–Orang–Laokhowa–Burachapori corridor by removing encroachments on sand-bars and notifying seasonal “wildlife passage windows” during low water. • Mark and legally record Deepor Beel’s southern elephant corridor as a dedicated ESZ sub-zone; install speed-calming and underpasses where the railway intersects animal paths. • Keep Loktak–Keibul Lamjao connected by dredging two clogged channels between core phumdis and peripheral beels and by regulating sluice gates to maintain seasonal exchange. • For Barail–Jiri-Makru–D’Ering: retain forested riparian buffers (≥50 m each bank) on new road projects; route powerlines along existing rights-of-way and fit bird diverters at river crossings. • Establish village-level “no new fish ponds” strips (20–30 m) along Orang TR’s northern boundary to keep a continuous reed–grass edge for wildlife movement.

Monitoring & Research	- Conduct a landscape-wide survey of fishing-cat occupancy using camera traps at wetland edges across Kaziranga, Orang, Pobitora, Deepor, Loktak, and Bordoibam–Bil Mukh, repeating it every 2–3 years with consistent protocols. - Pilot eDNA sampling for fishing-cat and prey (fish/amphibians) at 30 sentinel beels (10 Assam flood-plain, 10 Manipur, 10 Meghalaya) and store samples in a state repository. - In Deepor Beel and Loktak, install water-level and turbidity loggers at key inlets/outlets and share weekly dashboards with the divisions. - Document bycatch in fishing nets and poultry depredation incidents around Pobitora/Orang through a mobile form; use results to target gear/coop improvements. - Namdapha & Barail: deploy passive acoustic recorders near streams to track human presence and hunting pressure proxies.
Climate Change Adaptation	- Prepare flood contingency plans for Kaziranga–Orang–Pobitora, including raised fodder depots, elevated anti-poaching camps, and boat caches at each range, and pre-identify high-ground refugia beels. - Loktak–Keibul Lamjao: adopt seasonal water-level bands that keep phumdis afloat in late winter yet expose foraging margins by pre-monsoon; link to barrage operations through a standing committee. - D’Ering and Kaziranga sandbars: plant flood-tolerant native grasses (<i>Saccharum</i>, <i>Phragmites</i>, <i>Vetiver</i>) to stabilise banks around breeding wetlands. - Deepor Beel: restore upstream urban stormwater detention (ponds/retention parks) to buffer against extreme inflows. - Nongkhyllem/Barail: integrate spring-shed protection and rainwater harvesting for fringe villages to reduce dry-season extraction.
Community Engagement	- Activate or reconstitute EDCs around Deepor, Loktak, Pobitora, Orang, and Bordoibam–Bil Mukh, with revenue sharing from community-run wetland safaris, bird hides, and guided night frog walks. - Introduce “net exchange” days: swap fine-mesh and monofilament gillnets for legal-mesh multi-filament nets plus a buy-back to reduce bycatch. - Promote community fish sanctuaries (no-take beel cores) with annual fish-seed support in Pobitora/Orang fringes and along Barail foothill streams. - Women’s SHGs: train and contract for hyacinth removal, reed-thatch harvesting, and eco-souvenir production (Loktak/Deepor). - Incorporate traditional institutions (village councils/clans) in Nongkhyllem and Barail for joint patrolling of sacred groves and riparian wetlands.
Human-Wildlife Conflict Mitigation	- Roll out predator-proof poultry coops (featuring wire mesh, raised floors, and lockable doors) in fishing-cat conflict villages around Pobitora, Orang, and Deepor; provide a 50% subsidy, tied to coop-use verification. - Promote low-bycatch fishing gear, including turtle-excluder-style escape openings for trap nets, heavier float lines, and illuminated gillnets, to reduce nocturnal bycatch. - Install reflective wildlife crossing signage and solar flashers along railway stretches near Deepor and road segments skirting the Kaziranga–Orang beels; enforce night speed limits during the flood season. - Create RRTs with cages, nets, and trained handlers for fishing-cat rescues in Guwahati fringe, Morigaon, and Loktak basin.
Policy Integration & Legal Protection	- Notify Deepor Beel’s entire hydrological catchment as ESZ with sub-zones for waste and effluent control; align city waste-management tenders to ESZ norms. - Fast-track consolidation of boundary and mutation records for Orang TR and Pobitora WLS; clear encroachment cases with time-bound district plans. - The State Water Resources, PWD, Fisheries, and Power departments should jointly establish a multi-agency water governance committee to align barrage operations with ecological water levels in the Loktak–Keibul Lamjao system. - Notify community-conserved micro-wetlands in Barail/Jiri-Makru under state rules and integrate with District Mineral Foundation funds for restoration. - Include fishing-cat and small-cat friendly gear standards in state fisheries advisories for the Brahmaputra and Loktak basins.
Capacity Building	- Annual wetland-management training for frontline staff (Kaziranga–Orang–Pobitora–Deopur–Loktak) covering safe boat use, aquatic weed control, water-quality monitoring, and wildlife rescue. - Cross-posting and exposure visits between Kaziranga/Orang and Loktak/Deepor teams on flood operations and community co-management. - Train village youth as “wetland wardens” for patrolling, bird monitoring, and visitor management at Bordoibam–Bil Mukh and Deepor. - Build veterinary capacity and equip mobile units to release aquatic fauna and rehabilitate fishing cats in the Guwahati–Morigaon–Imphal corridors.
Awareness & Education	- Launch a “Beel Mitra” program with schools around Deepor, Pobitora, and Loktak, featuring monthly wetland walks, waste cleanups, and nest box building. - Develop multilingual IEC materials (Assamese, Manipuri, Khasi, Garo, Mizo) on safe fishing practices, legal mesh sizes, and poultry coop designs, and distribute them through EDCs and fisheries cooperatives. - Install interpretation centres/hides at the following locations: Deepor (railway side), Bordoibam–Bil Mukh (island edge), Loktak (phumdi boardwalk), and Nongkhyllem (river-view point). - Run seasonal media campaigns on wildlife road safety before the monsoon, and on responsible boating in flooded parks after the monsoon.

Following the detailed landscape-specific action plans (L1–L6), it is essential to consolidate these recommendations into an integrated framework that can guide implementation, monitoring, and adaptive management across the entire range of the fishing cat in India. While landscape tables identify critical interventions at the site level, an overarching framework ensures that conservation actions remain:

1. Comparable across wetland systems – by using harmonised indicators of ecological health, connectivity, and community participation for long-term assessment and evaluation;
2. Scalable to national and regional priorities – by aligning with *MoEFCC* wetland and biodiversity conservation programmes, state action plans, and transboundary cooperation initiatives with Nepal, Bhutan, and Bangladesh; and
3. Adaptive and accountable – by embedding continuous monitoring, evaluation, and threat-tracking into the planning cycle to ensure responsive and evidence-based conservation outcomes.

Accordingly, the following sections outline three interlinked frameworks:

- a) Implementation Framework – defining indicators of success, priority ranking, timelines, monitoring mechanisms, and responsible agencies for each thematic pillar;
- b) Threat Tracking Framework – categorising major threats, indicators for tracking, mitigation actions, and frequency of monitoring; and
- c) Monitoring & Evaluation Framework – detailing specific indicators, tools, and institutional responsibilities to assess progress and effectiveness of conservation measures.

Together, these frameworks provide managers and policymakers with a comprehensive and adaptive mechanism to safeguard fishing cat populations across India’s wetlands and floodplains, while ensuring accountability, cross-sectoral coordination, and the long-term sustainability of conservation outcomes.

Table 2.17.

Integrated Implementation, Threats Tracking, and Monitoring & Evaluation Frameworks for Fishing Cat Conservation in India (2025–2035). For each theme, the frameworks outline indicators of success, priority ranking, timelines, monitoring mechanisms/methods, responsible agencies, and evaluation frequency. In parallel, the Threats Tracking Framework links threat categories, indicators, monitoring methods/sources, mitigation responses, priority ranking, and monitoring frequency. The Priority Ranking (High, Medium, Low) reflects the urgency and feasibility of each task. The Priority Timeline is categorised as Short-term (2025–2028), Medium-term (2029–2032), and Long-term (2033–2035). The Implementation Framework (a) focuses on actions and institutional responsibilities for wetland restoration, connectivity enhancement, and community-based conservation. The Threats Tracking Framework (b) focuses on key drivers of decline—such as habitat degradation, hydrological alteration, pollution, and bycatch—and their mitigation through measurable indicators. The Monitoring & Evaluation Framework (c) focuses on conservation outcomes and impacts, including stable or increasing occupancy, restored wetland functionality, improved community stewardship, and strengthened legal compliance. Monitoring mechanisms integrate ecological and hydrological indices (NDWI/NDVI, sedimentation rate, prey/fish biomass, camera traps, eDNA sampling) with management tools (M-STrIPES, SMART, NPCA wetland audits, and MEE reviews). The evaluation framework ensures adaptive management and accountability through multi-scale reporting, from site to national levels. Responsible agencies include MoEFCC, State Forest & Wetland Departments, WII, CPCB/SPCBs, River Basin Authorities, NGOs (WWF-India, WTI, Aaranyak, Wetlands International), universities, and community institutions (EDCs, JFMCs, and fisher cooperatives).

Aspect	Wetland Habitat Protection & Restoration	Landscape Connectivity	Monitoring & Research	Climate Change Adaptation	Community Engagement	Human-Wildlife Conflict Mitigation	Policy Integration & Legal Protection	Capacity Building	Awareness & Education
(a) Implementation Framework									
Indicators of Success	% increase in wetland area; reduced siltation; invasive species controlled; functional hydrological inflows restored	Key wetland linkages (rivers, floodplains, mangrove corridors) mapped & maintained; fish-prey connectivity restored	Occupancy & detection rates improved across landscapes; prey & fish abundance monitored annually	Refugia mapped; flood regulation structures eco-optimised; restored mangroves & riparian buffers	Active EDCs/JFMCs (>50% participation); local wetland committees functional	Reduction in fishing net entanglements; retaliatory killings; prey-base conflict cases	State wetland rules implemented; notified Conservation Reserves/ESZs for key floodplain complexes	Trained wetland guards; researchers & community monitors in place	Awareness drives in schools, fisher communities, & urban wetland clusters are conducted annually
Priority Ranking	High	High	High	Medium	High	High	Medium	Medium	Medium
Priority Timeline	Short	Short	Continuous	Medium	Short	Short	Medium	Short	Short
Monitoring Mechanisms	NDWI/NDVI (Sentinel/Landsat 10–30 m); sedimentation & water-quality monitoring; vegetation plots (0.1 ha quadrats)	GIS-based wetland linkage modelling (e.g., hydrological networks & e-flow mapping); camera traps at corridors	Standardised 1 km ² camera-trap grids; prey/fish surveys; eDNA sampling; telemetry & photo-ID	Hydrological & rainfall monitoring; salinity & water table logging; phenology plots	Participatory wetland mapping; livelihood tracking; fisher group feedback	Conflict database (fish depredation, poultry predation); snare & net removal audits; compensation records	State wetland inventory & NPCA audit; ESZ/Conservation Reserve notification tracking; WPA & Wetland Rules compliance	Training records; quarterly skill audits; refresher workshops at WII/State Wetland Centres	Citizen science records; outreach event tracking; annual eco-club reporting
Responsible Agencies	MoEFCC; State Wetland Authorities; CPCB/SPCBs; Forest/Fisheries Department; WII, NGOs (WWF, WTI), FCCA	MoEFCC; WII; Forest Departments; FCCA	WII; MoEFCC; State Forest/Wetland Departments; NBA; FCCA	MoEFCC; IMD; State Disaster Management Authority; CPCB; ICAR	MoEFCC; State Forest Departments; NGOs; Local Councils; Fisher Co-ops; FCCA	Forest Departments; Police; NGOs; EDCs/JFMCs; FCCA	MoEFCC; State Government Legal Cells; National Green Tribunal; WII	WII; MoEFCC; State Forest Departments; Universities; FCCA	WII; MoEFCC; Schools; NGOs; FCCA; Local Media
Notes / Other Considerations	Restoration must align with NPCA guidelines; encroachment near wetlands is critical	Cross-sectoral coordination with the Water & Fisheries Departments is required	Integrate citizen science (eBird, iNaturalist) with formal monitoring	Climate projections needed for the Brahmaputra–Mahanaadi basins	Wetland livelihoods are central to success; women's SHGs are key	Conflict linked to declining fish stocks; promote alternative livelihoods	Strengthen legal enforcement under the 2017 Wetland Rules	Shortage of skilled wetland ecologists & frontline staff	Awareness must include both rural & peri-urban audiences

(b) Threats Tracking Framework									
Threat Category	Wetland loss; siltation; invasive spread; encroachment	Fragmentation of riparian & floodplain linkages; hydrological barriers (embankments, roads, sluices)	Data deficiency on distribution, fish/prey dynamics, & wetland health	Floods; droughts; cyclones; salinisation	Socio-economic dependence on unsustainable fishing & wetland resource extraction	Bycatch; retaliatory killing; prey competition	Weak implementation of Wetland Rules 2017; ESZ/ Conservation Reserve notification delays	Lack of trained wetland ecologists & enforcement staff	Low public visibility and misconceptions about the fishing cat's behaviour
Indicators to Track	% wetland area change (NDWI); shoreline encroachment; invasive macrophyte cover; illegal reclamation	Corridor integrity index; E-flow status; road/rail kill records; culvert passability	Survey coverage; detection rate trends; prey/fish biomass indices; eDNA sample coverage	No. of refugia secured; flood frequency & duration; salinity intrusion extent	No. of functional EDCs/JFMCs; participation in livelihood alternatives; women's SHG engagement	No. of entanglement & conflict incidents; compensation disbursed; rapid response rate	No. of notified wetlands under NPCA; ESZ/ Conservation Reserve proposals processed; legal enforcement cases	Vacancy rate; % staff trained in wetland monitoring; refresher training frequency	No. of outreach programmes; awareness scores (pre/post); citizen science submissions
Priority Ranking	High	High	High	Medium	High	High	Medium	Medium	Medium
Monitoring Method / Source	Sentinel/Landsat NDWI; bathymetry; sediment cores; ground GPS mapping; invasive monitoring plots	GIS-hydrology modelling; telemetry; camera traps at culverts & wetland corridors; roadkill transects	1 km ² camera-trap grids; fish and waterbird transects; eDNA; telemetry; citizen science records	IMD flood/cyclone data; rainfall loggers; salinity loggers; refugia mapping	Household & livelihood surveys; participatory mapping; fisher diary tracking	SMART/M-STrIPES data; hotline logs; necropsy & case reports; compensation database	NPCA audits; gazette notifications; WPA enforcement reviews; legal case tracking	Training records; performance audits; WII certification lists	Eco-club reports; media analytics; school/community surveys
Response / Mitigation Action	Demarcate wetland boundaries; remove invasives; restore hydrology; buffer planting; prevent reclamation	Maintain riparian buffers; retrofit wildlife-friendly culverts; secure ecological flows	Fund long-term monitoring; unify protocols; maintain an open database	Restore mangroves and freshwater refugia; climate-proof embankments	Co-develop alternative livelihoods (ecotourism, cage-culture, crafts); participatory restoration	Rapid response to conflict; promote net-safe zones; compensate promptly	Strengthen state wetland authorities; align NPCA-WPA enforcement; legal follow-up	Train staff in hydrology, fish ecology, & eDNA; equip wetland units	Design sustained campaigns linking the fishing cat to wetland health
Frequency	Annual remote + bi-seasonal field review	Continuous; biennial synthesis	Continuous; 5-year national synthesis	5-year risk reviews + post-disaster audits	Annual	Continuous response; quarterly reviews	Annual compliance audit	Annual	Annual; 5-year perception studies
Notes / Other Considerations	Encroachment is severe around urban beels and floodplain villages	Cross-sector coordination is critical with Water/Fisheries/PWD	Data sharing is often fragmented across states	Climate vulnerability is highest in coastal and deltaic sites	Sustained local benefits drive participation	Conflict concentrated near aquaculture and poultry zones	Delays in CR/ESZ notification limit landscape protection	Staff rotation hampers monitoring continuity	Awareness must include peri-urban & fisher communities

(c) Monitoring & Evaluation Framework									
Outcome Indicators	1% intact wetland area; NDWI/stable water extent; invasive cover ↓; boundary encroachment cases ↓; priority wetlands with active restoration ↑	No. of riparian/wetland corridors maintained; verified dispersal/use at culverts/bridges; roadkill incidence ↓; e-flow compliance sites ↑	Occupancy stable/increasing across priority landscapes; detection rates & prey/fish indices stable; unified datasets published & accessible	No. of refugia secured; % erosion/salinisation-prone edges stabilised; post-disaster recovery completed within planned timelines	% households in EDCs/JFMCs with diversified income; participation rates ↑; community-led restoration sites ↑	Net entanglements/retaliatory cases ↓; mean response time to incidents ↓; proportion of approved compensation paid within 60 days ↑; snare/confiscation trends ↓	% priority wetlands notified/managed under NPCA; ESZ/Conserve proposals issued & legally notified; WPA compliance maintained	% vacancies filled; staff retained ≥3 years; no. of personnel trained in wetland hydrology/eDNA/SMART ↑; equipment uptime ↑	Awareness scores ↑ (schools & fisher groups); no. of annual outreach events; citizen-science records (camera-trap/eBird/wetland logs) ↑
Evaluation Frequency	Annual remote sensing + ground validation (pre-/post-monsoon); 5-year synthesis	Biennial connectivity audits (GIS + field), with quarterly roadkill reviews	Continuous data collection; annual technical audit; 5-year national synthesis	5-year climate-risk reviews; post-flood/cyclone audits within 90 days	Annual household surveys; biennial participatory mapping	Monthly patrol & incident analytics; quarterly conflict review; annual third-party audit	5-year policy/legal compliance review; mid-term (2–3 yr) follow-ups	Annual training audits; 3-year independent evaluation	Annual school/community surveys; 5-year perception studies
Accountability / Reporting	State Forest Department & State Wetland Authority publish Annual Wetland Habitat Audit; MoEFCC compiles national status note	WII leads Corridor-Use Synthesis; State Forest Departments share roadkill & e-flow reports with MoEFCC/CWC	WII & universities publish peer-reviewed outputs; open data repository maintained; MoEFCC issues National Monitoring Brief	MoEFCC Climate Cell with IMD/CWC publishes 5-year Climate Risk Report	FD/EDCs/NGOs publish Social Audit Reports; community feedback integrated into AOPs	SMART/M-STrIPES/Crime data published; enforcement agencies release annual wildlife-crime stats	MoEFCC legal cell publishes Compliance Audit; state gazette updates tracked	MoEFCC/ WII maintains the national Wetlands Training Registry; states report staffing / equipment status	NGOs, schools, & the Forest Department share Outreach Impact Reports; citizen-science platforms provide annual summaries

Integration of Thematic Actions with Enabling Mechanisms

The site- and theme-specific actions provide the operational backbone for the conservation of fishing cats across India's freshwater and coastal wetland landscapes. These actions directly address wetland protection and restoration, landscape connectivity, monitoring and research, climate resilience, community engagement, human–wildlife conflict mitigation, policy integration, capacity building, and awareness at both PA and landscape scales.

However, to ensure that these thematic interventions are ecologically sustainable, financially viable, and institutionally coordinated, they must be supported by a complementary set of enabling mechanisms. The enabler framework identifies eight strategic categories: funding mobilisation, cross-sectoral partnerships, hydrological and technological integration, species–ecosystem research, climate mainstreaming, livelihood incentives, policy integration, and independent evaluation. Together, these enablers provide:

- Financial security (*e.g.*, NPCA, CAMPA, CSR, and international donors) to sustain wetland restoration, pollution control, catchment management, and community stewardship programmes.
- Cross-sector partnerships among Forest, Wetland, Fisheries, Irrigation, and Local Governance Departments to integrate ecological flow maintenance, wetland buffer management, and participatory monitoring.
- Technological and ecological innovations, such as NDWI/NDVI monitoring, automated water-level sensors, eDNA sampling, and AI-assisted wetland mapping, can improve monitoring accuracy and enhance adaptive decision-making.
- Policy mainstreaming and periodic independent evaluation to embed fishing cat conservation within broader national frameworks for wetland management, biodiversity targets, and climate adaptation.

By linking landscape-level priority actions with these systemic enablers, the Fishing Cat Action Plan ensures that conservation interventions are scientifically grounded, socially inclusive, and economically resilient, thereby bridging ecological priorities with governance reforms and long-term sustainability.

Table 2.18.

Implementation Mechanisms for Fishing Cat Conservation in India. The table outlines enabling mechanisms required to operationalise the Fishing Cat Conservation Action Plan. Eight enabler categories are presented, each with key actions, indicators of success, monitoring mechanisms, responsible agencies/partners, and indicative timelines. These enablers ensure that site-specific and thematic interventions are supported by sustainable financing, hydrological governance, technological innovation, and adaptive review, thereby strengthening long-term conservation outcomes for the species.

Enabler Category	Key Actions	Indicators of Success	Monitoring Mechanisms	Responsible Agencies / Partners	Timeline
Funding & Resource Mobilisation	• Leverage NPCA, CAMPA, and Wetlands Division funds for wetland restoration, hydrological management, and anti-poaching. • Access international wetland conservation grants (GEF, UNDP, CEFP, Ramsar Small Grants). • Explore CSR, eco-tourism, and blue-carbon finance mechanisms.	% of wetland restoration budget secured; number of diversified funding sources.	Annual financial audits; fund utilisation; wetland project progress reports.	MoEFCC (Wetlands Division), State Forest & Wetland Departments, NGOs, CSR boards.	Short & Medium term
Partnerships & Trans-boundary Cooperation	• Formalise MoUs among Forest, Wetland, Fisheries, and Irrigation Departments. • Establish inter-state and trans-boundary coordination (<i>e.g.</i>, Ganga–Brahmaputra–Meghna basin states). • Create regional multi-stakeholder Wetland Management Committees.	Number of formal MoUs; frequency of coordination meetings; basin-level wetland management plans developed.	MoU progress reviews; inter-agency coordination reports; stakeholder meeting minutes.	MoEFCC, State Wetland Authorities, CPCB/SPCBs, River Basin Organisations, WII, NGOs.	Short & Medium term

Technology Integration	- Deploy AI-enabled wetland image analysis for NDWI, NDVI, and sediment mapping. - Integrate eDNA and acoustic monitoring for fish, amphibians, and Fishing Cat prey species. - Expand the use of camera traps and drones for floodplain and mangrove monitoring.	% of wetlands under remote-sensing surveillance; datasets generated; archived annually.	Tech deployment records; eDNA sampling logs; satellite & drone-based wetland assessments.	WII, State Forest Departments, CPCB, Research Institutes, ISRO, NGOs.	Short & Long term
Genetic & Connectivity Research	- Develop a national Fishing Cat genetic and isotope database. - Monitor genetic flow between fragmented wetland populations. - Integrate connectivity modelling with hydrological corridor planning.	Number of samples analysed; population connectivity indices; peer-reviewed outputs.	Genetic lab reports; connectivity and isotope data synthesis; periodic re-search audits.	WII, Universities, National & International Research Partners, NGOs.	Medium & Long term
Climate Change Mainstreaming	- Integrate Fishing Cat and wetland resilience goals into SAPCC. - Link wetland restoration with carbon sequestration (REDD+/Blue Carbon) initiatives. - Promote adaptive water management during drought and flood cycles.	Inclusion in SAPCC; carbon or blue-carbon credits generated; adaptive water policy adopted.	SAPCC progress reviews; hydrological monitoring; climate risk audits.	MoEFCC (Climate Division & Wetlands Division), State Forest Departments, DST, CPCB, UNFCCC focal agencies.	Medium & Long term
Livelihood & Incentives	- Promote PES for community-led wetland protection. - Strengthen fisher cooperatives and provide insurance schemes for climate and conflict resilience. - Encourage sustainable aquaculture and eco-tourism linked to wetland health.	% of households receiving PES or insurance; no. of functional fisher cooperatives; increase in eco-tourism income.	Household surveys; cooperative audits; periodic socio-economic assessments.	State Forest Departments, Panchayats, Fisheries Department, NGOs, Insurance Boards.	Short & Medium term
Policy Integration	Align PA. integrate with other agencies, and wetland buffer regulations under a unified management approach.	No. of state/national policies revised to include Fishing Cat; policy adoption at the basin level.	Policy review reports; gazette notifications; MEE & NPCA evaluation summaries.	MoEFCC, State Governments, NMCG, Planning Commissions.	Medium term
Independent Review & Evaluation	- Commission third-party audits of fishing cat and wetland projects (5-year cycle). - Conduct a national synthesis review every 10 years to assess outcomes and funding utilisation. - Establish annual technical evaluation committees under the MoEFCC.	No. of audits conducted; % of targets met; evaluation reports submitted.	Audit reports; independent review notes; MoEFCC evaluation summaries.	MoEFCC, Independent Experts, NGOs, Academic Institutions.	Short, Medium & Long term

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03

CLOUDED LEOPARD

(Neofelis nebulosa)



Summary

The clouded leopard (*Neofelis nebulosa*) is one of Asia's most enigmatic and evolutionarily distinct wild cats, representing the most basal lineage within the Pantherinae. Characterised by its striking cloud-shaped markings, elongated canines, exceptional climbing abilities, and specialised arboreal adaptations, the species occupies a unique ecological niche in tropical and subtropical forests. Historically distributed across South and Southeast Asia, including Nepal, Bhutan, India, Bangladesh, southern China, Myanmar, Thailand, Laos, Cambodia, Vietnam, and Peninsular Malaysia, the clouded leopard has experienced substantial population declines due to habitat loss, fragmentation, hunting, and illegal wildlife trade. Consequently, the species is currently listed as Vulnerable on the IUCN Red List, with global populations estimated to have declined by more than 30% over the past two decades.

The clouded leopard inhabits a wide range of forest ecosystems, from tropical evergreen and subtropical broadleaf forests to montane habitats. Although capable of both arboreal and terrestrial movement, it remains strongly associated with dense forest cover and occurs naturally at low densities. As a solitary carnivore, it preys on a variety of mammals, birds, and reptiles and plays an important ecological role in maintaining the structure and function of forest ecosystems. Despite its wide distribution, it remains one of the least-studied felids in Asia due to its elusive behaviour and the logistical challenges of studying forest-dwelling carnivores.

Across its global range, important populations persist in Bhutan, Myanmar, Thailand, Peninsular Malaysia, and parts of Northeast India. In contrast, populations in Bangladesh, Vietnam, Taiwan, and large parts of China have undergone severe declines, with several regions now supporting only small and isolated populations or facing local extinction. Widespread snaring, illegal hunting, and rapid forest conversion throughout Southeast Asia continue to threaten the long-term survival of the species.

India supports one of the most important remaining populations of the mainland clouded leopard and therefore plays a critical role in its global conservation. The species is primarily restricted to the northeastern states and the eastern Himalayan region, with confirmed records from Arunachal Pradesh, Assam, Meghalaya, Mizoram, Nagaland, Sikkim, northern West Bengal, Tripura, and Bihar. Important strongholds include Namdapha TR, Pakke TR, Kamlang TR, Eaglenest WLS, Manas TR, Dehing Patkai NP, Dampa TR, Balpakram NP, Intanki NP, Buxa TR, and Neora Valley NP. Although recent camera-trap surveys have improved understanding of its distribution, many forested landscapes remain inadequately surveyed, and population status is poorly understood across much of its range.

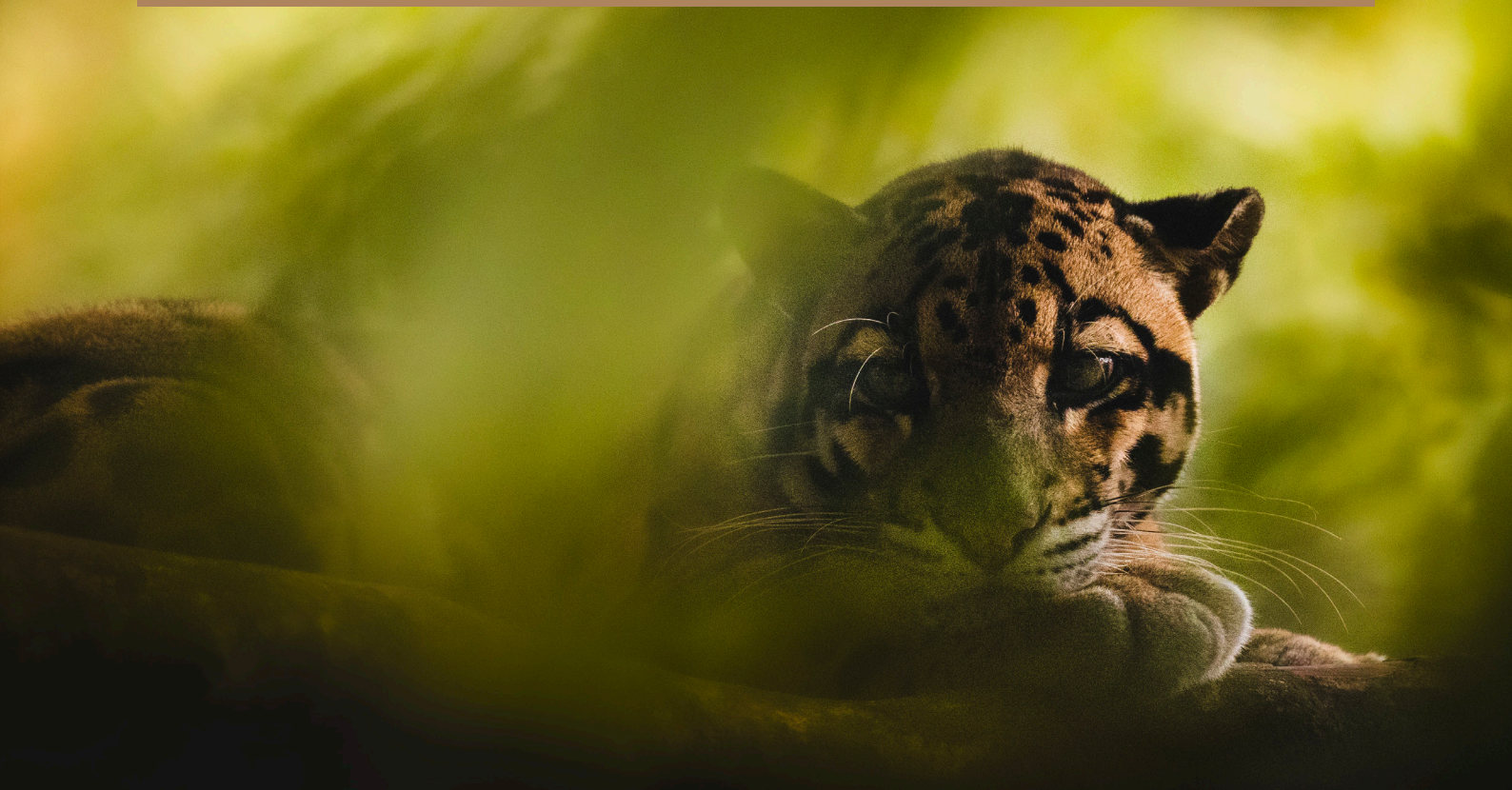
The principal threats to clouded leopards include habitat loss, degradation, and fragmentation resulting from infrastructure development, agricultural expansion, mining, plantations, and human settlements. Illegal hunting and trade in skins and body parts continue to threaten populations across several range countries, while prey depletion, human disturbance, road development, and climate change further exacerbate conservation challenges. These threats are particularly significant because clouded leopards depend upon extensive, connected forest habitats and occur at naturally low population densities.

The overall goal of the Conservation Action Plan (CAP) is to secure viable, connected, and genetically healthy clouded leopard populations while conserving the forest ecosystems upon which they depend. The plan adopts a landscape-level approach focused on habitat protection, restoration of ecological connectivity, reduction of hunting pressures, scientific monitoring, ecological research, and stakeholder participation. Particular emphasis is placed on maintaining connectivity among forest landscapes in Northeast India and adjoining transboundary regions to facilitate long-term population persistence and genetic exchange.

Priority conservation landscapes identified under the Action Plan include the Arunachal Pradesh landscape, the Assam–Arunachal Forest complex, the Manas transboundary landscape, the Meghalaya plateau, the Mizoram hill forests, the Nagaland highlands, and the northern West Bengal–Sikkim landscape. The plan highlights the need to strengthen habitat protection, secure wildlife corridors, improve management effectiveness, and enhance transboundary cooperation with neighbouring countries. It also emphasises long-term research, standardised monitoring protocols, non-invasive genetic studies, capacity building, wildlife crime prevention, and improved data-sharing mechanisms to support evidence-based conservation.

Recognising that many clouded leopard habitats occur outside protected areas and overlap with community-managed forests, the Action Plan places strong emphasis on community participation, conservation awareness, and stakeholder engagement. Successful implementation will require collaboration among forest departments, local communities, researchers, conservation organisations, and policy-makers.

The clouded leopard serves as a flagship species for the conservation of tropical and subtropical forests across South and Southeast Asia. Protecting the species and its habitats will contribute not only to the survival of one of the world's most distinctive felids but also to the conservation of extensive forest ecosystems that support exceptional biodiversity, ecological processes, climate resilience, and ecosystem services. Through coordinated implementation of the proposed conservation actions, strengthened regional collaboration, and sustained scientific monitoring, the long-term persistence of clouded leopard populations across their range can be significantly improved.



3.1

Species Profile

The mainland clouded leopard is one of the most enigmatic and evolutionarily distinct wild cats in Asia, occupying a unique position among the Pantherinae due to its primitive skull morphology and exceptional arboreal adaptations (Nowell & Jackson, 1996; Sunquist & Sunquist, 2002). Found across a broad but fragmented range in South and Southeast Asia, the species is most closely associated with dense tropical and subtropical forests, including lowland rainforests, hill forests, and montane habitats (Hunter, 2015; Ching & Allen, 2017). Despite its wide distribution, the clouded leopard remains elusive and sparsely studied, with most ecological knowledge derived from field surveys in select protected areas and captive observations (Giordano, 2022).

Clouded leopards are currently listed as Vulnerable on the IUCN Red List due to a suspected population decline of over 30% in the past two decades, primarily driven by habitat loss, hunting, and fragmentation (Gray *et al.*, 2021). As a medium-sized felid with highly specialised morphological traits, including a long tail, large canines, and flexible ankle joints, the species exhibits remarkable climbing and predatory capabilities, allowing it to occupy both terrestrial and arboreal niches (Sunquist & Sunquist, 2002; Giordano, 2022). However, threats from snaring, illegal trade, and forest conversion continue to erode its populations across much of its range, emphasising the need for intensive landscape-level conservation strategies (Hunter, 2015; Gray *et al.*, 2021).

3.1.1. Description and Taxonomy

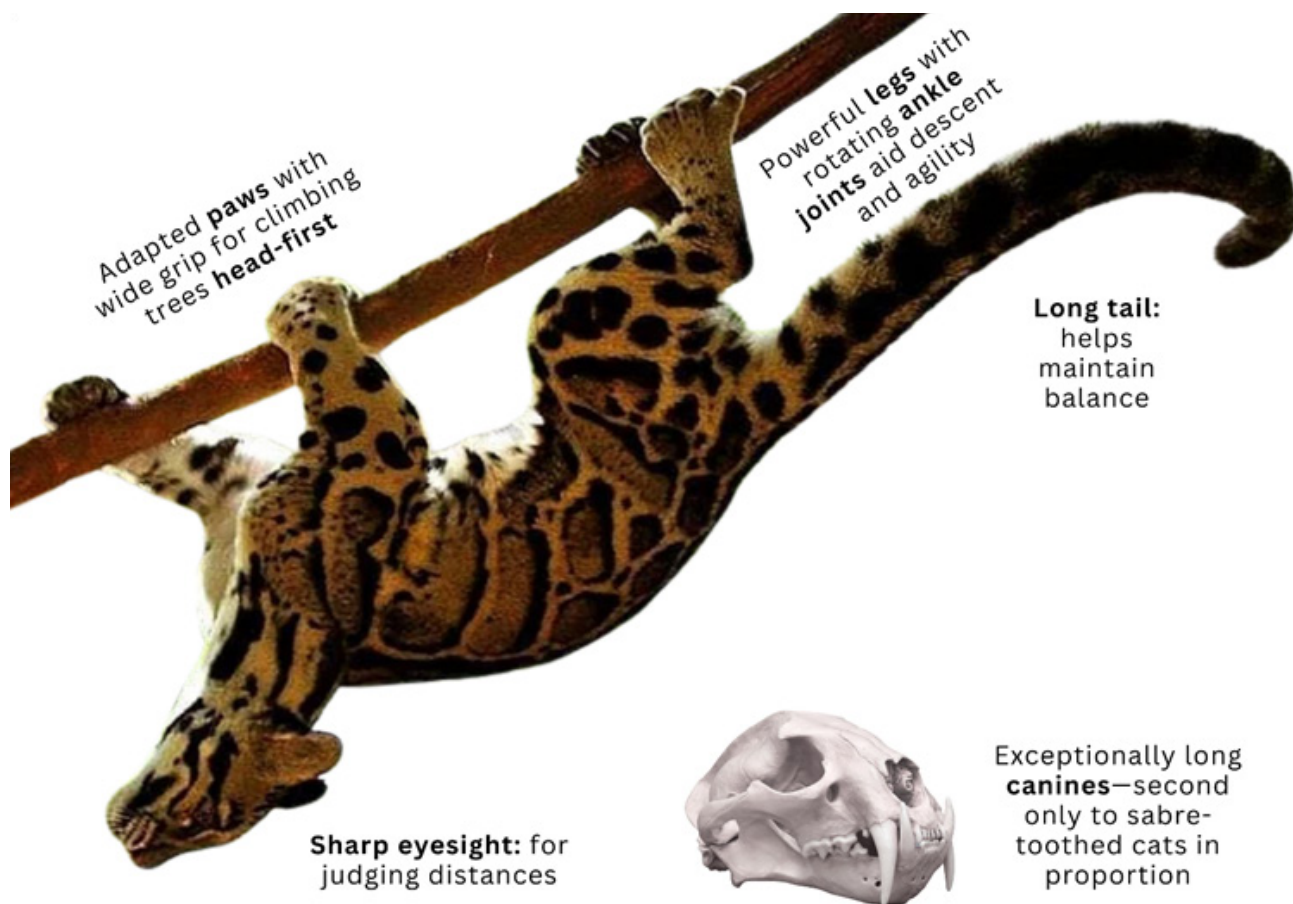
3.1.1.1. Description

The clouded leopard (*Neofelis sp.*) is a medium-sized felid found across Southeast Asia, with two currently recognised species: the mainland clouded leopard (*Neofelis nebulosa*) and the Sunda clouded leopard (*Neofelis diardi*) (Pocock, 1939; Nowell & Jackson, 1996). These cats are distinguished by their dramatic coat patterns, arboreal agility, and sabertooth-like dentition (Christiansen, 2006; Sunquist & Sunquist, 2002). They represent the most basal lineage within the Pantherinae, retaining several primitive skull features compared to larger pantherine cats (Christiansen, 2006; Giordano, 2022).

Their pelage features large, irregular cloud-shaped markings edged in black, set against a base colour ranging from pale ochre to smoky grey (Pocock, 1939; Kitchener *et al.*, 2006). This cryptic colouration enables them to blend seamlessly into the dappled light of forest environments, thereby enhancing their ambush predation strategies (Nowell & Jackson, 1996; Sunquist & Sunquist, 2002). The cloud patterns vary individually and may serve as camouflage in the structurally complex habitats they occupy (Ching & Allen, 2017).

Adults typically weigh between 11 and 23 kg, with males being significantly larger than females (Nowell & Jackson, 1996; Sunquist & Sunquist, 2002). Head–body length ranges from 70 to 110 cm, and the tail, exceptionally long for a felid, can reach up to 90 cm (Guggisberg, 1975; Nowell & Jackson, 1996; Hunter, 2015). This makes the clouded leopard's tail among the longest relative to body size in the cat family (Sunquist & Sunquist, 2002), accounting for approximately 47% of total body length. Tail lengths range from 74–91 cm in males and 61–82 cm in females (Pocock, 1939; Nowell & Jackson, 1996; Sunquist & Sunquist, 2002). This elongated, flexible tail enhances balance, manoeuvrability, and aerial agility, especially when running, turning sharply, or leaping among tree branches (Wozencraft, 2005).

Clouded leopards possess the longest upper canines of any living cat proportionally, reaching lengths of up to 4 cm (Christiansen, 2006; Pocock, 1939). Their skull structure is highly specialised: a short rostrum, a deep mandibular symphysis, and an enlarged sagittal crest allow both the accommodation of elongated canines and the generation of powerful bite forces (Christiansen, 2006). These adaptations enable a nape-bite killing technique common to larger felids (Sunquist & Sunquist, 2002). Despite their moderate body size, these dental and cranial features mirror those of extinct sabre-toothed cats, underscoring their evolutionary uniqueness (Christiansen, 2006).



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Figure 3.1.

Unique arboreal adaptations of the clouded leopard. Key arboreal adaptations of the clouded leopard include rotating ankles, long canines, gripping paws, and a balance-assisting tail.

Their limbs are relatively short but robust, with large feet, short but muscular limbs, and strongly curved, fully retractile claws that allow climbing, branch-hanging, and even grasping with the hindfeet (Nowell & Jackson, 1996; Guggisberg, 1975; Hunter, 2015). Uniquely, clouded leopards can descend vertical tree trunks head-first, thanks to highly flexible ankle joints capable of rotating backwards (Guggisberg, 1975; Sunquist & Sunquist, 2002). Their skeletal and muscular adaptations make them among the most arboreal of the Pantherinae, although they also travel and hunt on the ground (Nowell & Jackson, 1996). Field and captive observations confirm their ability to climb upside down on horizontal branches and hang by their hindlimbs while manipulating prey or other objects with the forelimbs (Giordano, 2022).

Sexual dimorphism is present, with males exhibiting larger body size, more robust skulls, and slightly longer canines (Sunquist & Sunquist, 2002). This difference may be related to mating competition or niche partitioning between the sexes (Christiansen, 2006).

Differences between the two species, *N. nebulosa* and *N. diardi*, include variations in coat pattern, body size, and genetic divergence. *N. diardi* is generally darker with more distinct markings, and exhibits molecular distinctions in both mitochondrial and nuclear DNA, supporting its recognition as a separate species (Buckley-Beason *et al.*, 2006; Wilting *et al.*, 2007, 2011). Furthermore, Wilting *et al.* (2011) proposed two subspecies within *N. diardi*: *N. d. borneensis* in Borneo and *N. d. diardi* in Sumatra, based on cranial morphology and molecular data, reflecting the species' biogeographic isolation and evolutionary divergence. By contrast, *N. nebulosa* appears to have a more continuous distribution across mainland Southeast Asia, although some regional morphological differences have been noted (Ching & Allen, 2017; Gray *et al.*, 2021).

Table 3.1.

Morphological characteristics of the clouded leopard. The table summarises key morphological characteristics of the clouded leopard, including body size, tail length, skull and dental adaptations, and arboreal features. Data are drawn from multiple sources (provided in text) and reflect sexual dimorphism, as well as unique anatomical adaptations for arboreal locomotion and predation.

Characteristic	Description
Body weight (adult)	11–23 kg; males are significantly heavier than females
Head–body length	70–110 cm
Tail length	61–91 cm; up to 90 cm; among longest tail-to-body ratios in felids (~47% of total length)
Shoulder height	~50–55 cm (estimated)
Pelage	Pale ochre to smoky grey with large, black-edged cloud-shaped blotches
Sexual dimorphism	Males are larger in body size, skull robustness, and canine length
Canines	Upper canines up to 4 cm; proportionally longest among living cats
Skull and jaw	Short rostrum, deep mandibular symphysis, enlarged sagittal crest
Limbs and feet	Short, robust limbs with large feet and curved, fully retractable claws
Arboreal adaptations	Long tail, flexible ankle joints enabling head-first descent; branch-grasping with hindfeet
Climbing ability	Exceptional; can descend trees head-first and hang from branches with hindlimbs

3.1.1.2 Taxonomy

The clouded leopard belongs to the subfamily Pantherinae, which includes the largest and most evolutionarily derived members of the Felidae family. Historically considered a single species (*Neofelis nebulosa*), taxonomic revisions based on molecular and morphological evidence have recognised two distinct species within the genus *Neofelis* (Buckley-Beason *et al.*, 2006; Kitchener *et al.*, 2006; Wilting *et al.*, 2007).

Current Scientific Classification

Kingdom : Animalia (animals)
 Phylum : Chordata (vertebrates)
 Class : Mammalia (mammals)
 Order : Carnivora (carnivores)
 Family : Felidae (cats)
 Subfamily : Pantherinae Pocock, 1917 (big cats)
 Genus : *Neofelis* Gray 1867
 Species:

1. *Neofelis nebulosa* (Griffith, 1821) – Mainland clouded leopard,
2. *Neofelis diardi* (Cuvier, 1823) – Sunda clouded leopard

The genus *Neofelis* was once considered a basal member of Pantherinae, but recent phylogenetic studies have confirmed it as a sister group to the *Panthera* lineage, with the two lineages diverging approximately 6–8 million years ago (Johnson *et al.*, 2006). Distinct morphological traits, such as dentition, cranial structure, and pelage patterns, alongside mitochondrial and nuclear DNA evidence, support the split into two species: *N. nebulosa*, found on the Asian mainland, and *N. diardi*, found on Borneo and Sumatra (Kitchener *et al.*, 2006; Buckley-Beason *et al.*, 2006).

Further genetic analyses have identified two subspecies within *N. diardi* (Wilting *et al.*, 2007, 2011):

- *Neofelis diardi borneensis* (Wilting *et al.*, 2011) – Borneo
- *Neofelis diardi diardi* (Cuvier, 1923) – Sumatra

This subspeciation is likely due to historical biogeographic barriers, such as the Pleistocene separation of the Sunda Shelf, which isolated populations on Borneo and Sumatra (Wilting *et al.*, 2011).

The divergence between *N. nebulosa* and *N. diardi* is supported not only by genetic data but also by apparent differences in pelage: *N. diardi* typically exhibits smaller, more densely packed cloud-like markings, darker fur colouration, and a relatively shorter tail (Nowell & Jackson, 1996; Sunquist & Sunquist, 2002; Giordano, 2022). These differences were corroborated by analyses of cranial morphology and coat patterns (Kitchener *et al.*, 2006; Wilting *et al.*, 2007).

More recent work has underscored that taxonomic separation is robust and is now widely accepted by the IUCN Red List, the IUCN Cat Specialist Group, and most conservation planning frameworks (Hunter, 2015; Gray *et al.*, 2021). The recognition of two species has significant implications for conservation, as *N. nebulosa* and *N. diardi* occupy distinct ecological niches and face differing degrees of threat, necessitating species-specific conservation strategies (Ching & Allen, 2017; Giordano, 2022).

Table 3.2.

Taxonomic classification and subspecies of the clouded leopard. The table outlines the current scientific classification of the genus *Neofelis*, including recognised species and subspecies. It reflects contemporary taxonomic revisions based on morphological and genetic evidence.

Species Name	Scientific Name	Distribution	Source(s)
Mainland Clouded Leopard	<i>Neofelis nebulosa</i>	South and Southeast Asia	Kitchener <i>et al.</i> , 2006
Sunda Clouded Leopard	<i>Neofelis diardi</i>	Borneo, Sumatra	Buckley-Beason <i>et al.</i> , 2006
Bornean subspecies	<i>Neofelis diardi borneensis</i>	Borneo	Wilting <i>et al.</i> , 2011
Sumatran subspecies	<i>Neofelis diardi diardi</i>	Sumatra	Wilting <i>et al.</i> , 2011

3.1.2. Historic and Current Distribution

3.1.2.1. Global Distribution

The mainland clouded leopard historically ranged across a vast arc of forested landscapes in South and South-east Asia. Its distribution spanned the mid-hill forests of Nepal and Bhutan, northeastern and eastern India, and parts of eastern Bangladesh. It extended eastward across southern China, including Hainan Island, and into Indochina, encompassing Myanmar, Thailand, Laos, Cambodia, Vietnam, and the Malaysian Peninsula. The species was also historically present on Taiwan, where the endemic Formosan subspecies is now considered extinct. Although it once occupied large, contiguous forest blocks spanning from the Himalayan foothills to tropical lowlands and montane forests, the clouded leopard has always occurred at low densities and remained poorly documented due to its secretive behaviour and preference for dense habitats. Recent advances in camera-trap surveys, ecological modelling, and local reporting have begun to clarify its current distribution, revealing a fragmented but ecologically significant presence in some regions and likely extirpation from others, such as Taiwan and much of Vietnam.

NEPAL



Historically, the mainland clouded leopard was recorded in the forests of Nepal's lower Himalayas, including the Langtang Valley (Hodgson, 1853; Nowell & Jackson, 1996). The species was believed extinct in Nepal by the mid-20th century, but it was rediscovered in the 1980s (Dinerstein & Mehta, 1989). Since then, clouded leopards have been documented along the mid-hills eastwards of the Annapurna Conservation Area, Chitwan NP, Parsa NP, Kanchenjunga Conservation Area, Langtang NP, Makalu Barun NP, Rara NP, and Shivapuri Nagarjun NP (Hodgson, 1853; Borradaile *et al.*, 1977; Jnawali *et al.*, 2011; Pandey, 2012; Ghimirey *et al.*, 2013; Lamichhane *et al.*, 2014; Ghimirey and Acharya, 2018; Poudel *et al.*, 2019; Can *et al.*, 2020). Outside PAs, it has been recorded in several habitats in the eastern part, namely the Sunsari and Ilam districts, through Janakpur (the middle part of lowland Nepal) to Kaski, Kailali, and Mugu in the western part (Dinerstein & Mehta, 1989; Jnawali *et al.*, 2011; Ghimirey & Acharya, 2018). However, the reliability of reports of their distribution west of the Annapurna Conservation Area, such as in Rara NP, Kaptad NP, and the Kailali and Mugu districts, has been questioned (Ghimirey & Acharya, 2018). The species occupy densely forested mid-hill and mountainous terrain, with recent habitat suitability models predicting a substantial area suitable for them in the Middle Hills outside existing reserves (Shrestha *et al.*, 2021). Occurrences now span from the eastern Himalayan foothills to central Nepal, indicating a potential westward expansion or reoccupation of the historical range (Ghimirey *et al.*, 2013).

BHUTAN



Historically, mainland clouded leopards likely occurred throughout Bhutan's contiguous forests, such as the Royal Manas Complex (combined with India's Manas Landscape), and they remain locally common relative to surrounding countries due to extensive forest cover and strong protection measures (Nowell & Jackson, 1996; Gray *et al.*, 2021). The species is widely distributed across Bhutan's forests, ranging from southern tropical forests to temperate zones, and even in human-occupied landscapes (Penjor *et al.*, 2018). Camera-trap surveys and local reports confirm the presence of clouded leopards in many PAs and biological corridors across Bhutan, including most NPs and connecting wildlife corridors such as Wangchuck Centennial NP, Sakteng WLS, Jigme Dorji NP, and Bundling WLS (Tempa *et al.*, 2013). The species shows the highest probability in the southern PAs, including Royal Manas NP, Phipsoo WLS, Phrumsengla NP, Jomotsangkha WLS, Jigme Khesar Strict Nature Reserve, and Jigme Singye Wangchuck NP (Lungten *et al.*, unpub. data). Additionally, clouded leopards occasionally utilise forested landscapes near human settlements (Penjor *et al.*, 2018; Letro & Duba, 2019). The species ranges across a broad elevational gradient in Bhutan, including foothill jungles up to montane forests above 3,000 m (Wangchuk *et al.*, 2004). These records suggest Bhutan may serve as a refugium, with clouded leopards persisting even in rugged areas alongside large human populations (Penjor *et al.*, 2018).

BANGLADESH



Bangladesh lies at the western fringe of the historical range of the mainland clouded leopard. The species was historically recorded in the forested Chittagong Hill Tracts (Rajkandi RF and Pabla Khali WLS) and possibly in the northeastern border regions (Pocock, 1939; Nowell & Jackson, 1996). Even during the early 20th century, it was considered uncommon in the country's lowland tropical forests (Nowell & Jackson, 1996). In recent decades, there have been no verified sightings or confirmed specimens, and the species is now considered likely extirpated from most of Bangladesh (Grassman *et al.*, 2016). However, a single camera-trap photograph taken between 2011 and 2015 from the Sangu-Matamuhuri RF suggests that a small, highly isolated, and possibly remnant population may persist in the remote mountainous regions of the southeastern Chittagong Hill Tracts (Creative Conservation Alliance, 2016; Grassman *et al.*, 2016).

CHINA



Mainland clouded leopards were historically widespread across much of southern China, ranging from the eastern Himalayan foothills through Guangdong and Fujian provinces, extending south of the Yangtze River to Hainan Island and westward into Yunnan (Swinhoe, 1870; Nowell & Jackson, 1996). In the 19th century, the species was also documented in Taiwan (then Formosa) and Hainan (Swinhoe, 1870; Guggisberg, 1975). Specific historical records in China include the Nangun River in Yunnan, Mount Fanjing in Guizhou, and the Wuyi Mountains in Fujian (Nowell & Jackson, 1996). By the early to mid-20th century, the species was already in decline, with Hainan's population reportedly vanishing by

mid-century and other regions experiencing similar losses (Nowell & Jackson, 1996). Over the past century, the species' range in China has contracted dramatically. Although it was historically found in 17 provincial-level administrative divisions, the species can now be confirmed at only 10 study sites in two regions: Yunnan Province and the Tibet Autonomous Region (Ma *et al.*, 2022). Recent camera-trap records from Medog County in southeastern Tibet, as well as Yiwu and Tongbiguan in Yunnan, suggest that small, isolated populations may persist in transboundary forests adjoining Myanmar, India (Arunachal Pradesh), and Laos (Liu *et al.*, 2020; Ma *et al.*, 2022). No verifiable evidence of the species has been recorded in 12 of its formerly occupied divisions for over two decades (Ma *et al.*, 2022). Overall, the clouded leopard is now nearly extinct across most of China, with its remaining populations extremely fragmented and on the brink of extirpation (Nowell & Jackson, 1996; Grassman *et al.*, 2016).

TAIWAN



Taiwan (formerly Formosa) was historically home to the Formosan clouded leopard, a subspecies of *the clouded leopard* (*Neofelis nebulosa*). Early naturalists documented the species on the island during the 19th and early 20th centuries (Swinhoe, 1862; Kano, 1930). Skins and specimens were collected from Taiwan's mountainous forests up to the mid-1900s, after which the species' status became increasingly uncertain due to hunting and habitat loss. Historical records specifically note occurrences in Yushan and the Tawu Mountains, which represent two of Taiwan's most prominent forested highlands (Nowell & Jackson, 1996). In recent decades, extensive surveys have been conducted to determine if any survive. From 1997 to 2012, a nationwide camera-trap survey across 1,249 sites (1,13,636 trap-days) failed to photograph any clouded leopards, confirming the species' extinction in Taiwan's wild (Chiang *et al.*, 2015). The last confirmed evidence dates back to the early

1980s, and despite local anecdotal claims, no scientific confirmation has been found thereafter (Rabinowitz 1988). Today, the Formosan clouded leopard is considered extinct, likely due to deforestation and intensive hunting pressure in the mid-20th century. Conservation attention has shifted to the possibility of reintroduction, given that Taiwan still retains thousands of square kilometres of suitable habitat and prey, provided that hunting can be controlled (Chiang *et al.*, 2015; Wang *et al.*, 2024).

MYANMAR (BURMA)



Historically, Myanmar has been a core region for the mainland clouded leopard, with early naturalists documenting specimens across the Arakan Hills in the west, through the teak forests of central Myanmar, to the Tenasserim region in the south (Pocock, 1939). Htamanthi WLS (Sagaing Region) was also included in the species' historical range (Nowell & Jackson, 1996). In recent decades, camera-trap studies have confirmed the continued presence of clouded leopards across multiple forested regions, though with a patchy distribution. In northern Myanmar, individuals have been recorded in Kachin State (*e.g.*, Hukaung Valley WLS, Hkakaborazi NP, Imaw Bum, Bumphar Bum, Hponkanrazi WLS, Myit Sone Area), as well as parts of Sagaing State (*e.g.*, Htamanthi WLS, Alaungdaw Kathapa NP, proposed Mahamyng WLS, Mt. Saramati Area) (Zaw *et al.*, 2014; Naing *et al.*, 2019). Further south, the species has been recorded in the Tanintharyi and Kayin States, with photographic evidence from PAs like Tanintharyi Nature Reserve, Kaser Doh Conservation Landscape, Ler Mu Lah, Lenya RfS, and proposed reserves such as Kweekoh, Kadoh Mae Nyaw, Yoe Mu Kyo, Megatha, and Maw Kee (Moo *et al.*, 2018; KFD unpub. data). However, detection rates have

been low in some apparently suitable habitats, such as Tu Ter Lor WLS and Klermu Thoepli WLS, indicating a fragmented and declining population (Moo *et al.*, 2018; KFD unpub. data). Although the species appears widespread across Tanintharyi and northern forest blocks, its distribution has become increasingly fragmented, with reduced or unconfirmed presence in parts of Rakhine (Rakhine Yoma), Bago (Bago Yoma), and Shan States (Paunglaung area) (Zaw *et al.*, 2014; Greenspan *et al.*, 2020). Despite this, Myanmar remains one of the most important strongholds for mainland clouded leopard due to the extent of remaining forest cover and recent conservation efforts (Zaw *et al.*, 2014).

LAOS (LAO PDR)



Historically, the mainland clouded leopard was widely distributed across Lao PDR's forested regions, including both the north and south of the country, with historical records from Xe Bang Nouane and Muang Son (Nowell & Jackson, 1996). In recent decades, however, intensive hunting, particularly widespread snaring, has led to severe population declines and local extirpations (Rasphone *et al.*, 2019; Gray *et al.*, 2021). One of the last known strongholds is Nam Et-Phou Louey National Protected Area (NPA), where clouded leopards were previously the most widely distributed large carnivore (Rasphone *et al.*, 2022). Nevertheless, population monitoring revealed a decline in density between 2013 and 2017, suggesting their persistence even in core habitats is under threat without significant reductions in poaching pressure (Rasphone, 2018; Rasphone *et al.*, 2021). Elsewhere in Laos, the species is extremely rare and is likely to be extirpated from suitable forested habitats (Gray *et al.*, 2021). Camera-trap surveys conducted between

2007 and 2011 in Nakai-Nam Theun NPA detected the species in low numbers; however, more recent surveys since 2018 have failed to record its presence (Coudrat *et al.*, 2014; Coudrat, per. comm., 2020). In contrast, clouded leopards remain present in Karst limestone regions, such as Phou Hin Poun NPA, where reduced human disturbance may aid their persistence (Brakels & Soudachit, 2020). West of the Mekong River, recent camera-trap photographs from Nam Poui NPA suggest that a tiny, isolated population may persist (F. Guegan, pers. comm., 2020). There are no recent confirmed records from southern Laos (e.g., Xe Sap or Xe Pian NPAs), and if clouded leopards survive in these regions, their numbers are likely extremely low (Gray *et al.*, 2021).

THAILAND



Historically, the mainland clouded leopard was reported across much of Thailand's forested landscapes, including relatively open, dry tropical forests (C. Wemmer in Dinerstein & Mehta, 1989; Rabinowitz & Walker, 1991). Protected areas historically identified within its range include several major forest complexes, such as Nam Nao-Phu Luang, Huai Kha Khaeng, Khao Yai, Kaeng Krachan, and Khlong Saeng (Nowell & Jackson, 1996). In recent decades, camera-trap data, primarily obtained as bycatch during tiger monitoring programs, have confirmed the species' continued presence in multiple forest complexes, including the Western Forest Complex, Kaeng Krachan, Khlong Saeng–Khao Sok, Hala-Bala, Eastern Forest Complex, Dong Phrayayen–Khao Yai, and Phu Khieo–Nam Nao (Petersen *et al.*, 2020b; Gray *et al.*, 2021). However, the current status of the species remains uncertain in several under-surveyed regions, especially in northern forest complexes such as Lum Nam Pai–Salawin, Sri Lanna–Khun Tan, Doi Phu Kha–Mae Yom, Mae Ping–Om Koi, and Phu Meang–Phu Thong, as well as northeastern and southern complexes including Phu Parn, Phanom Dongkrak–Pha Tam, Khao Luang, and Khao Bantad (Petersen *et al.*, 2020b; Gray *et al.*, 2021).

VIETNAM



Historically, the mainland clouded leopard was widely distributed across Vietnam's evergreen forests, with confirmed records from various regions including Cat Ba Island (Hai Phong Province), Ba Be NP (Bac Kan Province), Cúc Phương NP (Ninh Binh Province), Kon Ka Kinh (Gia Lai Province), Yok Don NP (Đắk Lắk Province), and the Nam Bai–Cat Tien Complex (Nowell & Jackson, 1996). Confirmed early 2000s records include a direct sighting in February 2001 in Hang Toong Chung Forest, Yen Bai Province, within the Mu Cang Chai SHCA, where an individual was observed resting on a tree branch at 05:00 h (Le Trong Dat *et al.*, 2001; Long *et al.*, 2001; Swan & O'Reilly, 2004; L. T. Dat, per. comm., 2013). Another confirmed record from the same area was a freshly skinned adult trapped from Che Thao Forest, observed in Che Thao village on 5 March 2001 (Le Trong Dat *et al.*, 2001; Long *et al.*, 2001; L. T. Dat, per. comm., 2013). The last verified record in Vietnam is from 19 December 2003, when a clouded leopard was camera-trapped in Pu Luong Nature Reserve, a karst limestone-dominated landscape (Do Ngoc Cuong, 2004). A nationwide review documented only two other verified records between 1995 and 2013 (Wilcox *et al.*, 2014). Despite the potential for occasional dispersal from neighbouring Lao PDR (A. Giordano, pers. comm., 2020), extensive camera-trap surveys conducted since 2013 in at least 19 protected areas, including Pu Luong, have failed to record the species (Gray *et al.*, 2021).

CAMBODIA



Historically, the mainland clouded leopard was believed to occur throughout Cambodia's evergreen and semi-evergreen forests, likely absent only from the lowland floodplains surrounding the Tonle Sap (Gray *et al.*, 2021). Lomphat Reserve was historically identified as a part of its range (Nowell & Jackson, 1996). In the past two decades, however, the species has experienced significant declines in both distribution and abundance (Gray *et al.*, 2021). Since 2014, confirmed records exist only from the northeastern region, including Siem Pang WLS—where a camera trap photographed a single individual in April 2016, and a pregnant female was captured in a snare in February 2020 (J. C. Eames, per. comm., 2020)—and from Virachey NP, where multiple camera-trap detections have been made post-2018 (Mc-

Cann *et al.*, 2020). In the southwest, the species has been recorded in at least four PAs within the Cardamom Rainforest Landscape: Botum Sakor NP, Central Cardamom NP, Southern Cardamom NP, and Tatai WLS, with camera-trap confirmations from multiple locations post-2018 (Gray *et al.*, 2017a). Virachey and the Cardamoms comprise Cambodia's largest and most remote evergreen forest blocks, and now represent the last strongholds for the species; however, the number of camera-trap records remains too limited to reliably estimate population density (Gray *et al.*, 2021). Elsewhere, clouded leopards are extremely scarce and are likely to be extirpated from many areas (Gray *et al.*, 2021). In Siem Pang WLS complex (Stung Treng Province), a camera trap photographed a single individual in April 2016, and a pregnant female was snared in a snare in February 2020 (J. C. Eames, per. comm., 2020). In the Eastern Plains of Mondulkiri Province, the species was last camera-trapped in December 2012 within Phnom Prich WLS (WWF-Cambodia, pers. comm., 2020). No confirmed records exist from the more extensive Seima WLS since 2006, when an individual was released from a snare; the last camera-trap image dates back to March 2003 (WWF-Cambodia, per. comm., 2020). In the Northern Plains of Preah Vihear, the previous detection was from Chepp WLS in 2014; however, a clouded leopard was camera-trapped in Phnom Dongrak, near the Thai border, in November 2020 (L. Grassman, pers. comm., 2020). No recent records exist from Prey Lang WLS (WCS-Cambodia, per. comm., 2020), and although tracks were noted in Phnom Tnaout WLS in 2014, no further signs have been found (S. Davis, per. comm., 2020).

MALAYSIA (PENINSULAR MALAYSIA)



Mainland clouded leopards remain relatively widespread across Peninsular Malaysia, occurring from the northern border with Thailand to the southernmost state of Johor (Perhiltan, 2017). Historically, their presence was recorded in the Krau Wildlife Reserve (Nowell & Jackson, 1996). Today, the species predominantly occurs within the Central Forest Spine, a ~51,000 km² landscape encompassing

most of the peninsula's remaining forest cover (DTCP, 2009). This area includes large PA complexes (such as Belum–Temengor, Taman Negara, and Endau-Rompin), several key RFs (such as Pasoh FR, Ulu Muda FR, Pasir Raja Selatan FR, Tanum FR, and Sungai Yu FR), and designated linkage zones (such as Primary Linkage 7 and Primary Linkage 8) (Mohamad *et al.*, 2015; Tan *et al.*, 2017; Rostro-García *et al.*, unpub. data). Much of this forested landscape remains contiguous; however, outside the CFS, habitat patches are smaller and more fragmented (Gray *et al.*, 2021). While clouded leopards may still occur in some of these isolated areas, their long-term persistence is uncertain due to increasing fragmentation and habitat degradation (Gray *et al.*, 2021).

In summary, the mainland clouded leopard remains patchily distributed across its historical range, with notable strongholds in Bhutan, northern and southern Myanmar, Peninsular Malaysia, and parts of northeast India and Thailand. Viable populations persist in contiguous forest blocks, such as Bhutan's NPs, the Cardamom Mountains in Cambodia, and Malaysia's Central Forest Spine. However, across much of Laos, Vietnam, southern China, and Bangladesh, populations have declined severely or become locally extinct, often due to intensive hunting, habitat fragmentation, and inadequate protection. While recent records confirm the species' adaptability to varied elevations and forest types, including some human-modified landscapes, its continued survival depends on the preservation of large, connected forest tracts and targeted conservation interventions. The species' rarity across large parts of its former range underscores the urgency of implementing transboundary conservation strategies and enhancing field research in under-surveyed areas.

Table 3.3.

Global distribution (historic and current) of the mainland clouded leopard. The table summarises the historical and current distribution of the mainland clouded leopard across its range in South and Southeast Asia. It highlights areas of persistence, probable extirpation, and conservation concern based on ecological surveys, camera-trap data, and habitat assessments. All referenced literature is cited in the main text.

Country	Historic Distribution	Current Distribution	Current Status Summary
Nepal	Mid-hill forests across the central and eastern regions	Documented from Annapurna to Kanchenjunga; mostly mid-hill PAs	Recolonising or persisting in mid-hill forests
Bhutan	Widespread across tropical to temperate forests	Widespread; locally common in most protected areas	Refugium with intact connectivity and strong legal protection
Bangladesh	Chittagong Hill Tracts, north-eastern regions	Likely extirpated except for a single record from SE Chittagong	Possibly extinct, except for one recent record
China	South of the Yangtze River to Hainan and Taiwan	Fragmented; limited to the Yunnan and Tibet borders	Severely contracted; small, isolated populations remain
Taiwan	Mountainous forests, including Yushan and Tawu Mountains	Extinct; no records since the 1980s despite large-scale surveys	Declared extinct
Myanmar	Arakan Hills, central teak forests, Tenasserim, Htamanthi WLS	Patchy but widespread from Kachin to Tanintharyi and Kayin	Key stronghold with a viable population in the N and S regions
Laos	Nationwide, including Xe Bang Nouane and Muang Son	Very rare; persists in Nam Et-Phou Louey and Phou Hin Poun	Severe decline due to hunting and snaring
Thailand	Across forested landscapes and dry tropical forests	Present in major forest complexes like the Western Forest Complex	Patchy but present in multiple forest complexes
Vietnam	Evergreen forests, including Cat Ba, Cuc Phuong, Nam Bai-Cat Tien	Likely extirpated; last confirmed record in 2003	Presumed extinct; few historical records confirmed
Cambodia	Evergreen and semi-evergreen forests, including Lomphat	Survives in Cardamom and Virachey; rare in Eastern/Northern Plains	Confirmed in NE and SW; declining in Eastern and Northern Plains
Malaysia (Peninsular)	Krau Wildlife Reserve, Central Forest Spine	Widespread in Central Forest Spine and large RFs	Stronghold with a relatively stable presence in large landscapes

3.1.2.2. Indian Distribution

Mainland clouded leopards were historically widespread across Northeast and East India, with confirmed records from Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, northern West Bengal, and northern Bihar. Their presence was documented through specimens, skins, and sightings across a variety of habitats, including lowland tropical forests, montane forests, and remote, community-managed landscapes, both within and outside protected areas. Key strongholds included Namdapha, Pakke, and Kamlang in Arunachal Pradesh; Manas, Dehing Patkai, and Nameri in Assam; Balpakram and Nongkhyllam in Meghalaya; and Dampa in Mizoram. While recent camera-trap surveys have confirmed the species' persistence at several sites, including Neora Valley in West Bengal and Dampa in Mizoram, a lack of recent records from parts of Manipur and Tripura suggests possible local extirpation or undetected persistence in poorly surveyed areas. The clouded leopard's fragmented distribution today reflects a legacy of historical occupancy alongside growing conservation concerns in increasingly degraded or marginal habitats.

ARUNACHAL PRADESH



Historically, Arunachal Pradesh supported a widespread distribution of mainland clouded leopards, with records from major PAs such as Namdapha and Mouling (Das *et al.*, 1995; Nowell & Jackson, 1996; Choudhury, 1996; De *et al.*, 2006; Mishra *et al.*, 2006; Srinivasulu & Srinivasulu, 2012; Choudhury, 2013; Kumar, 2018). Additional historic records span other PAs, including Kamlang, Pakke, Dibang, Eaglenest, Itanagar, Kane, Talle, and Sessa Orchid Sanctuary, as well as non-PAs such as Panir RF and Seijosa (Choudhury, 1993; Choudhury, 1996; Borah *et al.*, 2010). Further evidence includes sightings in Mehao WLS and skin records from Etalin and Anini in Dibang Valley (1992, 2004), Chayangtajo and Bameng in East Kameng (2001), Sangram in Kurung Kumey, Sagalee in Papum Pare (2011), and

Mechuka in West Siang (1997) (A. K. Sen, per. comm.; F. Ahmed, per. comm.; Choudhury, 2008, 2013). Currently, camera-trap surveys have confirmed the species' continued presence in several PAs, including Kamlang TR, Namdapha TR, Pakke TR, Eaglenest WLS, Talle WLS, Dibang WLS, and the Singchung Bugun Village CR (Adhikarimayum & Gopi, 2018; Mukherjee *et al.*, 2019; Jhala *et al.*, 2020, 2021; Gray *et al.*, 2021; Qureshi *et al.*, 2023; Habib *et al.*, 2025).

ASSAM



Historically, the mainland clouded leopard was widely distributed across Assam, with notable strongholds in the Karbi Plateau and the India–Bhutan Manas landscape (Das *et al.*, 1995; Nowell & Jackson, 1996; De *et al.*, 2006; Srinivasulu & Srinivasulu, 2012; Choudhury, 2013). Field surveys conducted between 1986 and 1991 documented seven additional records outside PAs: a skin from Boro Mulkoi in the Barail Range (North Cachar Hills, 1986); a skull and repeated sightings from Khulichara and Gharmura in the Inner Line RF (Cachar, 1987); a skin from Naloi Khasia Punji in Patharia Hills RF (Karimganj, 1989); a live capture at Dirpai and a skin from Pale Basti near the Assam–Arunachal border in Subansiri RF (Dhemaji, 1990); and a skin from Maroachara in Barail RF (Cachar, 1991) (Choudhury, 1993). Notably, clouded leopards were not recorded from Manas or Nameri during these particular surveys (Choudhury, 1993).

Other early records include an individual shot near Ranga RF in Lakhimpur (1962), a sighting in Kakoij RF, and a record from Dibru-Saikhowa NP in 1992 (N. Sharma, per. comm.; Hazarika, 1996; Choudhury, 2000). Outside PAs, occurrences were reported from Katakhal (Kutinala, Hailakandi, the late 1970s), Chirang (Ultapani, Kokrajhar, 1982), Patharia Hills (Karimganj, 1985–86), Inner Line (Cachar, 1986–87), Naduar (Sonitpur, 1994), Subansiri (1990), Manas RF (2005), and Upper Dihing (W and E blocks, 1993 and 2009) (A. M. Choudhury, per. comm.; B. Talukdar, per. comm.; K. Kakati, per. comm.; P. Singh, per. comm.). Museum specimens include one from undivided Sibsagar (Sivasagar) housed in the Indian Museum, and another in the Field Museum of Natural History (Sclater, 1891; Choudhury, 2013). Additional accounts include a record from Boro Mulkoi (NC Hills, 1985) and one from Silonijan, Karbi Anglong (2010) (A. Goswami, per. comm.).

In Manas NP, the species was reported near the Bhutan border (1990), Doimari (2006), Koklabari (2003–04), and through camera-trap evidence (B. S. Bonal, per. comm.; R. Bhattacharjee, per. comm.; Choudhury, 2013). Additional historical records come from Nameri NP, Dihing-Patkai WLS, Barail (Maroachara, late 1980s), East Karbi Anglong, Garampani, Hollongapar Gibbon, Marat Longri, Nambor, Nambor–Doigurung, and North Karbi Anglong (M. K. Sinha, per. comm.; Choudhury, 2013).

Currently, camera-trap evidence confirms the species' persistence in multiple PAs, including Kaziranga TR, Manas TR, Nameri TR, and Dehing Patkai NP (Borah *et al.*, 2014; Jhala *et al.*, 2020, 2021; Gray *et al.*, 2021; Bhatt & Lyngdoh, 2023; Ghade *et al.*, 2025; Habib *et al.*, 2025).

MANIPUR



Historically, the mainland clouded leopard was reported from several locations across Manipur, including Keilam Hill (Churachandpur), Yangoupokpi–Lokchao (Chandel), Nungbi–Shirol NP–Anko (Ukhrul), and Makru RF (Tamenglong), based on observations by locals and forest officials (Choudhury, 1997; Mandal *et al.*, 2005; Srinivasulu & Srinivasulu, 2012; Choudhury, 2013). However, no recent camera-trap confirmations exist, and the species' current status remains uncertain, suggesting either local extirpation or undetected persistence in remote, under-surveyed forest patches (Gray *et al.*, 2021).

MEGHALAYA



Historically, the mainland clouded leopard was reported across all districts of Meghalaya, with records from the Jaintia Hills (*e.g.*, Lumshnong, Lamabasti - south of Rymbai, Umtryah, Narpuh Block I RF - near Pechaduar, Lakadong Forest, the Pechaduar–Muktapur corridor from the mid-1990s, and east of Pechaduar in 1996), the Khasi Hills (both East and West, including Upper Laban near Shillong in the early 1960s and multiple sites reported in 1998), and the Garo Hills (Western part and notably near Tura

in 1997) (Mr Swer, per. comm.; Das *et al.*, 1995; Srinivasulu & Srinivasulu, 2002; Choudhury, 2013; Kakati & Kabra, 2015; Lyngdoh *et al.*, 2019). Confirmed presence was also noted in key PAs such as Nongkhylllem WLS (Ri-Bhoi in 1997) and Balpakram NP (Choudhury, 2013). More recently, camera-trap records from 2013 to 2015 confirm the species' continued presence in the Balpakram–Baghmara landscape (Balpakram NP and Baghmara RF) and Nongkhylllem NP (Mukherjee *et al.*, 2019).

MIZORAM



Historically, mainland clouded leopards have been widely reported across Mizoram, with records from several PAs including Dampa TR (camera-trapped), Lengtong, Murlen, Ngengpui, Blue Mountain NP (sightings in the late 1990s at Phawngpui Peak, 2157 m asl, and Farpak Forest Rest House, 1875 m asl), Tokalo, Thorangtlang, Tawi, and Khawnglung WLS (D. Ghose, per. comm.; Das *et al.*, 1995; Ghosh, 2002; Datta-Roy *et al.*, 2007; Mandal *et al.*, 2007; Srinivasulu & Srinivasulu, 2012; Choudhury, 2013). Additional reports came from private forests near Sihpir, ~15 km north of Aizawl (K. Lianthanga, pers. comm., 2010). Recent evidence includes camera-trap records from Dampa TR in 2014, 2019, and 2022 (Singh & Macdonald, 2017; Jhala *et al.*, 2020, 2021; Habib *et al.*, 2025). Furthermore, in 2019, clouded leopard carcasses and body parts (including skins, bones, and claws) were seized from villages near Murlen NP, confirming the ongoing presence and underscoring the threats from illegal trade (Bal *et al.*, 2023).

NAGALAND



Historically, mainland clouded leopards were documented from multiple locations across Nagaland, including specimen records from Itanki WLS (Kohima district, 1992), and from Suruhuto, Sukhai, and Satoi in Zunheboto district (1996), with broader reports from the Saramati and Noklak regions (Choudhury, 1997; Srinivasulu & Srinivasulu, 2002; Choudhury, 2013). More recently, camera-trap evidence confirmed the species' presence in Intanki NP (Peren district) in 2018 and Dimaapur district in 2022 (Jhala *et al.*, 2020, 2021; Qureshi *et al.*, 2023). Additionally, two distinct individuals were photo-captured during 2020–2021 near the summit of Mount Saramati, one at an elevation of 3,700 m asl and another at 3,436 m asl, highlighting the species' continued presence in high-elevation CFs (Nair *et al.*, 2021).

SIKKIM



Historically, mainland clouded leopards have been recorded across Sikkim, with specimens from two unidentified locations housed at the ZSI and another from Labong, possibly in Darjeeling (Avasthe & Jha, 1999; Chattopadhyay *et al.*, 2006; De *et al.*, 2006; Srinivasulu & Srinivasulu, 2012; Choudhury, 2013). Confirmed records were reported from Khangchendzonga BR at elevations up to 3,800 m asl during 2008–2010, and from Barsey Rhododendron WLS and Fambhonglho WLS during 2016–2017 (Sathyakumar *et al.*, 2011; Lepcha *et al.*, 2017). More recently, a camera-trap photograph taken on 26 February 2020 confirmed the species' presence at 1,263 m above sea level (asl) in the Darjeeling–Sikkim Himalaya across three farming systems: tea cultivation, agro-pastoral, and agro-ecosystems (Naulak & Pradhan, 2021).

TRIPURA



Historically, mainland clouded leopards were reported across Tripura, with notable records from Bholamurah in the Sonamura subdivision (1997)—a captured specimen likely originating from Trishna WLS—and Gumti WLS in the 1980s, where a cub was kept as a pet by a paramilitary jawan (Srinivasulu & Srinivasulu, 2002; Choudhury, 2013). More recently, indirect evidence from 2011 confirmed the species' presence in Sepahijala WLS, suggesting its continued, though likely fragmented, persistence in the state (Kumar *et al.*, 2013).

NORTHERN WEST BENGAL



Historically, mainland clouded leopards were reported from several sites across northern West Bengal, notably Buxa TR, where one individual was killed at Hantapara, and another died following a fight with a common leopard at Samsing (Gruning, 1911; Inglis *et al.*, 1919; Nowell & Jackson, 1996; Srinivasulu & Srinivasulu, 2012). Additional records are available from Singalila NP, Neora Valley NP, Mahananda WLS, Jaldapara WLS, and the vicinity of Alipur Duar Town (Roychowdhury, per. comm.; Gruning, 1911; Srinivasulu & Srinivasulu, 2012; Choudhury, 2013). In Neora Valley NP, sightings since the early 1980s have occurred in the East Nar (17, 19, 22) and West Nar (3, 4, 5) compartments, as well as in degraded forest zones near Khasmahal and Bhujelgaon (Mallick, 2012). Specific sites such as Jaributi, Tukre Jhora, and cardamom plantations around Mouchowki yielded reports of pugmarks, dens, and direct sightings (Mallick, 2012). A cub named *Badal* was rescued in 1991 from the forest edge near Neora Valley NP, although it died in captivity in 1993 (Mallick, 2012). More recently, camera-trap surveys confirmed the species' continued presence in Buxa TR in 2018 and 2022 (Jhala *et al.*, 2020, 2021; Habib *et al.*, 2025), as well as in Neora Valley NP, Mahananda WLS, and Jaldapara WLS in 2022 (Qureshi *et al.*, 2023; Habib *et al.*, 2025).

BIHAR



There are no historical records of mainland clouded leopards from Bihar. However, a single confirmed record exists from Valmiki TR, where an individual was photo-captured on 15 December 2016 in the Raghia Range (northern part) at an elevation of 230 m asl (Shafi *et al.*, 2019).

The current distribution of mainland clouded leopards in Northeast and East India reveals a fragmented but regionally vital presence, anchored in several protected areas and adjoining forest corridors. Confirmed recent detections—through camera traps, carcass seizures, and field surveys—highlight surviving populations in Arunachal Pradesh, Assam, Meghalaya, Mizoram, Nagaland, and northern West Bengal. At the same time, the presence in states like Manipur and Tripura remains uncertain or marginal. Sikkim and parts of the Darjeeling Himalayas also support populations, including in human-modified landscapes. Notably, the first and only confirmed record from Bihar (Valmiki TR) suggests rare, peripheral occurrences. This geographic patchwork of persistence amid historical decline underscores the importance of landscape-scale conservation, intensified field monitoring, and cross-border collaboration to secure the future of clouded leopards in India's eastern frontier.



Figure 3.2.

Clouded leopard occurrence records in India across three time periods: Historic (1000-1975), intermediate (1976-2000), and most recent (2001-2025). Red dots represent historic occurrences based exclusively on museum specimens curated by the Field Museum of Natural History (Zoology) Mammal Collection ($n = 4$). Green dots indicate recent confirmed records, sourced from (i) sharing vertebrate occurrence data from camera traps in Asia ($n = 7$), (ii) iNaturalist Research-grade Observations ($n = 2$), (iii) India Biodiversity Portal (IBP) publication-grade dataset ($n = 1$), and (iv) INSDC Sequences ($n = 1$). No symbols are shown for the intermediate period as no records were available for this timeframe. Data compilation was based on the Global Biodiversity Information Facility (GBIF) and iNaturalist. All records were screened for spatial accuracy and temporal validity; however, the observed pattern may still be influenced by uneven survey effort, variable observer coverage, and reporting bias.

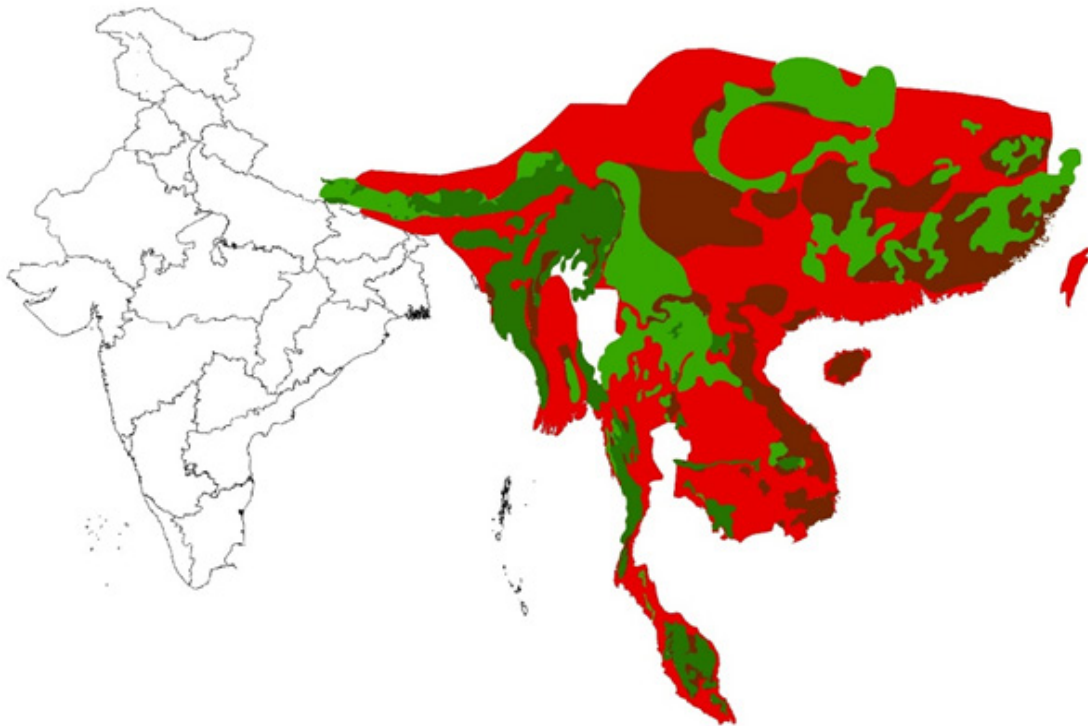


Figure 3.3.

Distribution of the clouded leopard across its range in South and Southeast Asia. The map illustrates the distribution of clouded leopards, based on the IUCN Red List assessment (Gray *et al.*, 2021). It demonstrates the species' historical and current extent, with green representing extant (resident) populations, light green indicating possibly extant (resident) populations, red denoting areas where the species is extinct, and maroon marking perhaps extinct zones. The distribution spans from the Himalayan foothills of northeastern India through Myanmar, Thailand, Laos, Cambodia, and Vietnam, extending south into Peninsular Malaysia and east into parts of southern China and Taiwan. The fragmented nature of the range reflects extensive habitat loss, degradation, and hunting pressures. This visualisation provides a baseline for identifying priority conservation areas and assessing population connectivity across the species' transboundary range.

Table 3.4.

Indian distribution (historic and current) of the mainland clouded leopard. The table summarises the historical and current distribution of the mainland clouded leopard across its range in India. It highlights areas of persistence, probable extirpation, and conservation concern based on ecological surveys, camera-trap data, and habitat assessments. All referenced literature is cited in the main text.

State	Historic Distribution	Current Distribution	Current Status Summary
Arunachal Pradesh	Widespread across major and minor PAs and non-PAs; multiple sighting and specimen records	Confirmed presence in multiple PAs, including Namdapha, Kamlang, Pakke, Eaglenest, Dibang	Robust presence across multiple reserves; core stronghold in the northeast
Assam	Widespread; strongholds in Karbi Plateau and Manas landscape; multiple records outside PAs	Confirmed from Kaziranga, Manas, Nameri, Dehing Patkai	Moderate to strong presence in key PAs; fragmented elsewhere
Manipur	Reported from several locations, including RFs and proposed NPs	No recent camera-trap records; status uncertain	Uncertain; possibly extirpated or under-surveyed
Meghalaya	Reported across all districts, strongholds in Balpakram and Nongkhylliem	Camera-trap confirmed in Balpakram-Baghmara and Nongkhylliem landscapes	Persistent in PAs; evidence of viable populations
Mizoram	Widespread in multiple PAs; records from high-elevation sites and CFs	Confirmed in Dampa, poaching evidence near Murlen	Confirmed presence with ongoing threats from poaching
Nagaland	Records from multiple locations, specimens and sightings from PAs and village forests	Confirmed in the Intanki NP and Mount Saramati region	Small, persistent population; significant altitudinal range
Sikkim	Confirmed from Khangchendzonga BR and other WLSs; museum records	Confirmed in Khangchendzonga BR and agro-ecosystems in Sikkim-Darjeeling	Sparse but confirmed presence; includes human-modified habitats
Tripura	Historical reports from WLSs and captured specimens	Indirect evidence from Sepahijala; status uncertain	Uncertain; marginal occurrence likely
Northern West Bengal	Reported from multiple NPs and WLSs; old specimens and sightings in Neora and Buxa	Confirmed from Neora Valley and Buxa TR via camera traps	Confirmed low-density presence; significant for corridor conservation
Bihar	No historic records	Single confirmed record from Valmiki TR in 2016	Peripheral population; single confirmed record

3.1.3. Population Trends

3.1.3.1. Global

Mainland clouded leopards occur at low population densities across their South and Southeast Asian range, including within PAs and intact forest habitats (Gray *et al.*, 2021). These densities vary considerably across sites, shaped by ecological conditions, interspecific interactions, and anthropogenic pressures (Gray *et al.*, 2021). In Bhutan, density estimates are among the lowest globally, ranging from 0.30 ($\pm$ SE 0.12) to 0.40 ($\pm$ SD 0.10) individuals/100 km², despite strong associations with forest and riverine habitats (Penjor *et al.*, 2018). In Myanmar's Htamanthi WLS, densities varied from 0.60 $\pm$ SD 0.24 individuals/100 km² in forests with more tigers to 3.05 $\pm$ SD 1.03 individuals/100 km² in areas with fewer tigers—likely due to reduced competition and lower levels of disturbance such as snaring and gold mining (Naing *et al.*, 2019). In Peninsular Malaysia, densities ranged from 3.63 $\pm$ SE 1.00 individuals/100 km² in logged forests to 1.83 $\pm$ SE 0.61 individuals/100 km² in unlogged primary forests, possibly reflecting differences in prey availability and competition from larger carnivores (Mohamad *et al.*, 2015). Other unlogged forests have yielded lower estimates, such as 1.15 $\pm$ SE 0.35 individuals/100 km² (Ab Razak *et al.*, 2019). The relatively high density (likely the highest in Southeast Asia) was recorded in the core zone of Thailand's Khlong Saeng–Khao Sok Forest Complex, at 5.06 $\pm$ SE 1.61 individuals/100 km², while the disturbed edge zone had a lower estimate of 3.13 $\pm$ SE 1.05 individuals/100 km² (Petersen *et al.*, 2020b). Despite these site-specific estimates, the global population trend is declining (Grassman *et al.*, 2016). The species is currently listed as *Vulnerable* on the IUCN Red List, with fewer than 10,000 mature individuals remaining in the wild (Gray *et al.*, 2021). Over the past two decades (1999–2019), populations are estimated to have declined by approximately 30%, primarily due to widespread deforestation, habitat fragmentation, and extensive snaring (Gray *et al.*, 2021). Particularly severe declines—estimated at 40–45% since the late 1990s—have been reported from the Indochinese range (comprising Myanmar, Vietnam, Laos, and Cambodia) and southern China, driven by forest loss and commercial wildlife trade (Rostro-García *et al.*, 2016).

In contrast, declines have been comparatively slower in parts of South Asia, including India, Nepal, Bhutan, Thailand, and Malaysia, likely due to stronger protected area coverage and ongoing conservation interventions (Grassman *et al.*, 2016; Abedin *et al.*, 2024). Nonetheless, the species has been extirpated from Taiwan (the Formosan subspecies) and is likely near extinction in Bangladesh, Vietnam, and China, highlighting a sharp contraction in its historical range (Gray *et al.*, 2021). Recent detections in central Nepal and parts of eastern India suggest possible recolonisation or undetected persistence in previously extirpated areas (Dinerstein & Mehta, 1989; Ghimirey & Acharya, 2018; Shafi *et al.*, 2019). However, these scattered records do not offset the broader trend of ongoing decline, and urgent conservation measures are required to halt further losses (D’Cruze & Macdonald, 2015; Gray *et al.*, 2021).

3.1.3.2. India

In India, clouded leopards are rare and patchily distributed, primarily confined to the northeastern region and parts of the eastern Himalayas (Gray *et al.*, 2021). Historically, they were reported across forested hills of the Northeast and described as relatively common during the 19th century (Jerdon, 1874). However, widespread deforestation and hunting through the 20th century caused sharp declines, and by the late 1900s, the species was feared to be extirpated from many parts of its Indian range (Choudhury, 1993; Ghose, 2002).

Today, clouded leopards persist in small, isolated populations across Assam, Arunachal Pradesh, Meghalaya, Nagaland, Mizoram, Manipur, Tripura, and northern parts of West Bengal and Bihar (Gray *et al.*, 2021). However, there is still no reliable estimate of the species’ total population in India, mainly due to limited detections and the elusive nature of the animal (Bhatt & Lyngdoh, 2023).

Most data on abundance come from localised camera-trap studies in PAs. In Manas NP, Assam—a critical TR—population densities were estimated at $4.73 \pm \text{SE } 1.43$ individuals/100 km², slightly exceeding those of leopards ($3.4 \pm \text{SE } 0.82$ individuals/100 km²) and far greater than that of tigers in the same area (Jhala *et al.*, 2011; Borah *et al.*, 2014). However, a later study in the same landscape (2017–2019) reported a reduced density of $1.73 \pm \text{SE } 1.27$ individuals/100 km², likely due to low photographic capture rates (Bhatt & Lyngdoh, 2023). This reduced detection was attributed to the species’ naturally low abundance, cryptic behaviour, and potential spatial and temporal avoidance of dominant sympatric carnivores, such as leopards and tigers (Bhatt & Lyngdoh, 2023).

In Mizoram’s Dampa TR, where tigers may have been extirpated, clouded leopard density was estimated at $5.14 \pm \text{SD } 1.80$ individuals/100 km²—among the highest recorded in Southeast Asia—suggesting reduced interspecific competition in this site (Singh & Macdonald, 2017). These high-density pockets likely represent exceptions, as in most Indian forests, clouded leopards occur at much lower densities or remain undetected.

Table 3.5.

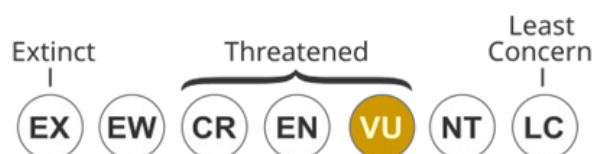
Clouded leopard population density estimates across South and Southeast Asia. The table summarises estimated population densities (individuals/100 km²) of mainland clouded leopards across different countries and landscapes, based on localised camera-trap and ecological studies. Variation in density reflects regional differences in habitat quality, anthropogenic pressure, and interspecific competition. Sources for these estimates are cited in the corresponding descriptive text.

Country/Region	Density Estimate (ind./100 km ²)	Notes
Bhutan	0.30 ± 0.12 to 0.40 ± 0.10	Low densities despite strong habitat associations
Myanmar (Htamanthi WLS)	0.60 ± 0.24 (high tiger density) 3.05 ± 1.03 (low tiger density)	Higher density in areas with fewer tigers and less disturbance
Peninsular Malaysia (logged forest)	3.63 ± 1.00	Higher density in logged than in unlogged forests
Peninsular Malaysia (unlogged forest)	1.83 ± 0.61 ; 1.15 ± 0.35	Varies based on prey and competition
Thailand (Khlung Saeng–Khao Sok)	5.06 ± 1.61 (core); 3.13 ± 1.05 (edge)	Likely highest in SE Asia; varies with disturbance
India (Manas NP, Assam)	4.73 ± 1.43 (2017–2019); 1.73 ± 1.27 (2009–2010)	Declining over time, likely due to competition (with tiger and leopard) and detection challenges
India (Dampa TR, Mizoram)	5.14 ± 1.80	Highest in S and SE Asia; high due to the absence of tigers and leopards

3.1.4. Conservation Status

3.1.4.1. Global

The mainland clouded leopard is classified as Vulnerable on the IUCN Red List, reflecting an estimated population reduction exceeding 30% over the past three generations and a total number of mature individuals likely below 10,000 (Grassman *et al.*, 2016; Gray *et al.*, 2021). This classification, first assigned in 2008, was reaffirmed in 2016 and 2021, in light of ongoing threats such as habitat loss, fragmentation, and exploitation (Gray *et al.*, 2021; Abedin *et al.*, 2024). No known subpopulation contains more than 1,000 mature individuals, and most are small, fragmented, and isolated (Gray *et al.*, 2021). The species is also listed under CITES Appendix I, which bans international commercial trade of clouded leopards and their parts. Despite widespread legal protection across range countries, enforcement remains weak and inconsistent (Nowell, 2007).



The Sunda clouded leopard (*Neofelis diardi*), restricted to Borneo and Sumatra, is similarly listed as Vulnerable, but its two subspecies—*N. d. borneensis* and *N. d. diardi*—are assessed as Endangered due to higher threats from habitat loss and isolation (Hearn *et al.*, 2008, 2015).

Overall, the global conservation outlook for clouded leopards remains precarious, with all species and subspecies experiencing significant declines in both population and habitat quality. Coordinated international conservation efforts are urgently required to address these challenges and protect remaining populations

3.1.4.2. India

In India, the clouded leopard is listed under Schedule I of the Wildlife (Protection) Act (WPA), 1972, which prohibits hunting, trade, and possession, with stringent penalties for violations. The species occurs across multiple PAs in the northeastern states, benefiting from habitat protection and forest management interventions (Borah *et al.*, 2014; Velho *et al.*, 2016). However, conservation attention outside PAs remains limited. Recognising its conservation priority, the species has been included in the MoEFCC's Species Recovery Programme under the IDWH scheme, aiming to safeguard the species beyond PA boundaries.

Despite these measures, on-ground conservation remains insufficient due to gaps in enforcement, ecological monitoring, and threat-specific interventions (Bhatt & Lyngdoh, 2023). Although no state-level recovery plan is currently in place, notable state recognitions include Meghalaya, which has designated the clouded leopard as its State Animal, and Tripura, which established the Clouded Leopard NP within Sepahijala WLS—the only Indian sanctuary named after the species.

In conclusion, while the species is legally well protected under national legislation, effective conservation requires urgent, targeted action—such as ecological studies, population monitoring, threat mitigation, and expanded protection outside PAs—to ensure its survival in India's northeastern landscapes (Gray *et al.*, 2021; Bhatt & Lyngdoh, 2023).

3.1.5. Ecology and Biology

3.1.5.1. Life History & Demography

Clouded leopards are medium-sized felids exhibiting marked sexual dimorphism: adult males typically weigh 20–22 kg, while females range from 11–14 kg, approximately 55–65% of male body mass (Pocock, 1939; Nowell & Jackson, 1996; Sunquist & Sunquist, 2002; Giordano, 2022). Although their lifespan in the wild is unknown, individuals in captivity live an average of 13 years, with maximum reported longevity reaching 17 years (Prator *et al.*, 1988; Nowell & Jackson, 1996; Che-Castaldo *et al.*, 2019). The generation length is estimated at 7 years, a value used in conservation assessments to evaluate population viability (Pacifici *et al.*, 2013; Gray *et al.*, 2021). Clouded leopards follow a K-selected life history strategy, characterised by slow reproductive turnover, small litters, long juvenile dependency, and high maternal investment (Sunquist & Sunquist, 2002). Both sexes attain sexual maturity at around two years of age, and females in captivity have reproduced as early as 26 months, suggesting that wild females may also begin breeding shortly after reaching maturity (Yamada & Durrant, 1989; Nowell & Jackson, 1996; Mackinnon, 2008). Under favourable conditions, females may give birth annually or biennially, contingent on cub survival (Fletcher, 2002).

Demographic data from wild populations remain sparse, with no published estimates of age-specific survival, sex ratios, lifetime reproductive success, or juvenile mortality under natural conditions (Chiang & Allen, 2017; Gray *et al.*, 2021). However, insights from ex-situ records reveal high cub mortality in captivity—approximately 40% of juveniles die within their first year, mainly due to maternal neglect or trauma linked to stress and mating aggression (Fletcher, 2002). Hand-rearing improves survival significantly (84% vs. ~59% in mother-raised cubs) (Mackinnon, 2008). Comparable or higher levels of juvenile mortality may be expected in the wild due to predation and environmental threats, although empirical data are lacking. Adult survival in undisturbed habitats is presumed to be 70–80%, comparable to other medium-sized felids (Hearn *et al.*, 2013).

Field surveys occasionally report a male-biased detection rate, potentially reflecting real demographic patterns—such as males having wider ranges due to polygynous mating systems—or sampling biases (Borah *et al.*, 2014; Singh & Macdonald, 2017). For example, a camera-trap study in Manas identified four males and five females (with seven unsexed) (Borah *et al.*, 2014). At the same time, ten and twelve individuals were photo-captured in Dampa and Manas (recent study), respectively, though their sex was not reported (Singh & Macdonald, 2017; Bhatt & Lyngdoh, 2023). Such inconsistencies highlight the challenges of determining accurate sex ratios and age structures in wild populations.

The absence of long-term demographic datasets makes clouded leopards among the least understood pantherines in terms of life history and population dynamics (Sunquist & Sunquist, 2002; Giordano, 2022). The species' slow reproductive rate and extended generation time render it particularly vulnerable to anthropogenic pressures such as poaching and habitat fragmentation. Even modest increases in adult mortality may lead to prolonged population declines (Gray *et al.*, 2021). Therefore, establishing robust baseline demographic parameters through long-term field studies, radio-telemetry, and individual-based monitoring is a critical research and conservation priority (Chiang & Allen, 2017; Giordano, 2022).

Table 3.6.

Life history traits of the clouded leopard. The table provides a synthesis of life history parameters for clouded leopards, including generation length, age at maturity, lifespan, litter size, and juvenile survival. These traits influence the species' population growth and vulnerability.

Trait	Value / Range	Source(s)
Average adult body mass	Males: 20–22 kg; Females: 11–14 kg	Nowell & Jackson, 1996; Sunquist & Sunquist, 2002; Giordano, 2022
Sexual dimorphism	Males are ~55–65% heavier than females	Pocock, 1939; Sunquist & Sunquist, 2002
Age at sexual maturity	Both sexes ~2 years; captive females as early as 26 months	Nowell & Jackson, 1996; Mackinnon, 2008; Yamada & Durrant, 1989
Gestation length	85–109 days (avg. ~93 ± 6 days)	Yamada & Durrant, 1989; Nowell & Jackson, 1996; Sunquist & Sunquist, 2002

Litter size	1–5 cubs (most commonly 2–3)	Sunquist & Sunquist, 2002; Mackinnon, 2008
Cubs' birth weight	140–280 g	P. Andrews, per. comm., 1993; Fellner, 1965, 1968; Fontaine, 1965
Eye-opening (postnatal)	2–11 days	Fellner, 1965; Yamada & Durrant, 1989
Weaning age	80–100 days	Sunquist & Sunquist, 2002
Onset of independent feeding	7–10 weeks	Sunquist & Sunquist, 2002; Mackinnon, 2008
Cub dependency period	Up to 10–12 months	Mackinnon, 2008
Lifespan	Avg. 13 years (wild); up to 17 years (captive)	Nowell & Jackson, 1996; Che-Castaldo <i>et al.</i> , 2019; Giordano, 2022
Generation length	7 years	Pacifici <i>et al.</i> , 2013; Gray <i>et al.</i> , 2021
Estimated adult survival	An estimated 70–80% (in the wild)	Hearn <i>et al.</i> , 2013 (Sunda CL, inferred)
Juvenile mortality	~40% die within the first year (in captivity)	Fletchall, 2002; Mackinnon, 2008
Reproductive frequency	Annual or biennial, depending on cub survival	Fletchall, 2002; Mackinnon, 2008

3.1.5.2. Reproduction

The reproductive biology of wild clouded leopards is poorly understood, with most knowledge derived from captive populations and comparative studies of other felids. The species exhibits a solitary, polygynous/promiscuous mating system, in which males maintain overlapping territories with multiple females and mate opportunistically with any receptive female (Sandell, 1989; Mackinnon, 2008). There is no evidence of pair bonding in the wild. In captivity, breeding introductions are challenging due to frequent male aggression, including documented fatal attacks on females if introductions are not carefully managed (Seager & Demorest, 1978; Collins, 1987; Sunquist & Sunquist, 2002; Wielebnowski *et al.*, 2002; Mackinnon, 2008). To reduce such aggression, successful breeding programs—such as those at Howletts Zoo and the Rare Feline Breeding Centre—often raise potential mates together from an early age to promote familiarity and bonding (Bandy, 1971; Griessel & Gensch, 1976). In captivity, copulation involves repeated matings over several days, each lasting approximately 25 seconds and typically accompanied by the male biting the female's nape, a behaviour common among felids (Yamada & Durrant, 1988).

Captive females reach sexual maturity between 17 and 28 months, with an average age of first reproduction at ~26 months (Yamada & Durrant, 1989; Nowell & Jackson, 1996). They exhibit an oestrous cycle averaging 30 days, with estrus lasting about 6–8 days (Yamada & Durrant, 1989; Mackinnon, 2008). Clouded leopards exhibit both spontaneous and mating-induced ovulation, indicating flexibility in reproductive physiology (Howard *et al.*, 1996; Brown, 2011).

Courtship involves vocalisations (such as prusten calls), scent marking, and the male grasping the female's nape (Peters, 1984a, 1984b; Sunquist & Sunquist, 2002). Copulations are brief (~25 seconds) but repeated over several days and typically followed by a characteristic growl from the female (Yamada & Durrant, 1988; Sunquist & Sunquist, 2002). As with other felids, the penis is spined, aiding in stimulation and ovulation (Sunquist & Sunquist, 2002). However, captive females often exhibit subtle behavioural signs of estrus, such as rolling and lordosis, which can complicate breeding introductions (Mackinnon, 2008).

Gestation ranges from 85 to 109 days, with an average of 93 ± 6 days (Yamada & Durrant, 1989; Nowell & Jackson, 1996; Sunquist & Sunquist, 2002). Females give birth in secluded dens such as hollow trees, dense thickets, or caves (Prater, 1971; Grassman *et al.*, 2005). Litter sizes range from 1 to 5 (Nowell & Jackson, 1996; Sunquist & Sunquist, 2002; Mackinnon, 2008), with three cubs being most common (7 of 9 litters reported by P. Andrews, per. comm., 1993). Cubs are born blind and helpless, weighing 140–280 g, open their eyes within 2–11 days, begin to walk by ~19–20 days, climb at ~6 weeks, and start consuming solid food between 7–10 weeks, though suckling continues until 80–100 days (P. Andrews, per. comm.; Fellner, 1965, 1968; Fontaine, 1965; Griessel & Gensch, 1976; Murphy, 1976; Eaton, 1984). By around 6 months, cubs develop an adult-like coat (Yamada & Durrant, 1988).

Cubs stay with their mothers for approximately 10 to 12 months, during which they learn essential survival skills (Mackinnon, 2008). Males provide no parental care. Dispersal is presumed to occur around 1 year of age, coinciding with the mother's next reproductive cycle or the juvenile's ability to establish a territory (Sandell, 1989; Mackinnon, 2008). While siblings may initially disperse together, they eventually become solitary, and there is no evidence of long-term coalitions (Mackinnon, 2008).

In terms of longevity, captive individuals live an average of ~11 years, with some reaching 17 years (Prator *et al.*, 1988; Nowell & Jackson, 1996). A more recent estimate places mean life expectancy in captivity at ~13 years (Che-Castaldo *et al.*, 2019; Giordano, 2022). The generation length is estimated at 7 years, which is relevant for assessing population viability (Pacifici *et al.*, 2013; Gray *et al.*, 2021).

No confirmed observations of wild mating, parturition, or cub-rearing exist (Sunquist & Sunquist, 2002; Hunter, 2015). However, scent-marking behaviours such as urine spraying, scraping, and cheek rubbing, observed in both Sunda and mainland clouded leopards, likely play a role in reproductive communication (Allen *et al.*, 2016; Giordano, 2022).

These gaps highlight the significance of field-based reproductive and demographic research in informing both in-situ and ex-situ conservation efforts (Sunquist & Sunquist, 2002; Chiang & Allen, 2017; Giordano, 2022). The IUCN Red List highlights the lack of demographic data on litter survival, recruitment, and reproductive success in wild populations, which hinders population modelling (Gray *et al.*, 2021).

In conclusion, clouded leopards exhibit slow reproductive rates, extended maternal care, and a secretive mating system, which is complicated by intersexual aggression, all of which contribute to their low recruitment potential. These reproductive traits, combined with increasing threats, underscore the species' vulnerability and emphasise the urgency of integrating reproductive biology into conservation strategies (Wielebnowski *et al.*, 2002; Mackinnon, 2008; Gray *et al.*, 2021).

Table 3.7.

Reproductive parameters of the clouded leopard. The table summarises the key reproductive characteristics of clouded leopards, including their mating system, age at first reproduction, oestrous cycle, gestation length, litter size, and interbirth intervals. Information is based primarily on captive observations and comparative data, with limited documentation from the wild.

Parameter	Description	Source(s)
Sexual maturity	~2 years in both sexes; earliest recorded reproduction at 26 months	Nowell & Jackson, 1996; Mackinnon, 2008
Oestrous cycle length	~30 days	Yamada & Durrant, 1989; Mackinnon, 2008
Estrus duration	6–8 days	Yamada & Durrant, 1989; Mackinnon, 2008
Ovulation type	Spontaneous and induced	Howard <i>et al.</i> , 1996; Brown, 2011
Copulation	Multiple matings per day for several days; ~25 seconds per event	Yamada & Durrant, 1988; Sunquist & Sunquist, 2002
Gestation period	85–109 days (average ~93 ± 6 days)	Yamada & Durrant, 1989; Sunquist & Sunquist, 2002
Litter size	1–5 cubs; 3 most common	Nowell & Jackson, 1996; Sunquist & Sunquist, 2002; Mackinnon, 2008
Neonatal weight	140–280 g	P. Andrews, per. comm.; Sunquist & Sunquist, 2002
Eye opening	Within 2–11 days	Griessel & Gensch, 1976; Murphy, 1976
Walking & climbing	Walks ~19–20 days; climbs by ~6 weeks	Sunquist & Sunquist, 2002
Solid food intake	Begins at 7–10 weeks; suckling continues till 80–100 days	Griessel & Gensch, 1976; Mackinnon, 2008
Independence	~10–12 months	Mackinnon, 2008
Reproductive frequency	Annually or biennially, depending on cub survival	Fletcher, 2002, in Mackinnon, 2008
Generation length	~7 years	Gray <i>et al.</i> , 2021; Giordano, 2022

3.1.5.3. Dispersal

Information on dispersal in clouded leopards remains limited due to the species' elusive behaviour and the lack of long-term ecological tracking of subadults (Gray *et al.*, 2021). However, available data from radio-telemetry, camera traps, anecdotal observations, and genetic studies provide valuable insights into their dispersal potential, particularly in the context of habitat fragmentation and recolonisation (Chiang & Allen, 2017; Gray *et al.*, 2021).

Dispersal likely occurs around one year of age, when juveniles become independent from their mothers (Sunquist & Sunquist, 2002; Mackinnon, 2008). Like other solitary felids, subadult males are presumed to disperse farther to avoid competition with resident males, while females may settle in territories adjacent to or overlapping those of their mothers if prey is abundant (Sandell, 1989; Sunquist & Sunquist, 2002). These subadults often remain as transient “floaters” until they secure a territory, an energetically demanding and risky life stage associated with increased mortality, including from human-wildlife conflict (D'Cruze & Macdonald, 2015).

Although specific dispersal distances remain undocumented, juveniles are assumed to disperse over tens of kilometres, consistent with adult home-range sizes (Sunquist & Sunquist, 2002). One documented case involves a subadult male captured in dry woodland in Nepal, radio-collared, and released approximately 100 km east in Chitwan NP; it travelled at least 8 km over 10 days, demonstrating its movement capacity through human-modified landscapes (Dinerstein & Mehta, 1989). Similarly, in Peninsular Malaysia and Borneo, radio-collared individuals have crossed oil palm plantations up to 2.5 km wide to access forest patches; however, they moved rapidly through these non-forested matrices, indicating limited suitability (Hunter, 2015).

Camera-trap detections further support the species' movement. In India, individual clouded leopards were recorded at camera stations placed 2.0 to 13.6 km apart, implying wide-ranging movement across rugged terrain (Chiang & Allen, 2017). The species' strong association with dense forest cover suggests that dispersal likely follows contiguous forest corridors (Bhatt & Lyngdoh, 2023). In Northeast India and Southeast Asia, river valleys and lowland forests may function as dispersal conduits, while large rivers, agricultural expanses, and infrastructure pose significant barriers (Wilting *et al.*, 2007; Borah *et al.*, 2014; Singh & Macdonald, 2017; Bhatt & Lyngdoh, 2023).

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Historical and recent recolonisation events further suggest a notable dispersal capacity. The species was rediscovered in central Nepal in the 1980s after presumed extinction, indicating likely dispersal from eastern Nepal or Northeast India to as far west as Annapurna (Dinerstein & Mehta, 1989; Ghimirey *et al.*, 2013; Chiang & Allen, 2017). Similarly, its appearance in Valmiki TR, Bihar, in 2016 points to movement from the Chitwan–Parsa complex of Nepal into previously undocumented Indian Terai habitats (Shafi *et al.*, 2019). Clouded leopards have also recolonised parts of Mizoram, such as Blue Mountain NP (Ghose, 2002), and have been recorded in small, mosaic forest patches, reflecting adaptability to fragmented landscapes (Velho *et al.*, 2016).

Genetic studies provide indirect evidence of dispersal. While there is clear genetic differentiation between mainland and Sundaic clouded leopards—confirming the absence of dispersal across oceanic barriers—genetic continuity across mainland populations suggests historic gene flow and regular movement among forested regions, except in severely fragmented habitats (Buckley-Beason *et al.*, 2006).

Nonetheless, contemporary dispersal is increasingly constrained by anthropogenic pressures. Habitat fragmentation resulting from agriculture, infrastructure development, and deforestation, combined with direct persecution and incidental snaring, impedes movement and gene flow, thereby increasing the risk of local population isolation (Gray *et al.*, 2021; Giordano, 2022). While recolonisation demonstrates ecological resilience, the long-term viability of such populations is uncertain in the absence of habitat connectivity.

In conclusion, dispersal in clouded leopards is presumed to begin at ~1 year of age and involves moderate to long-distance movement through forest corridors. It plays a critical role in enabling gene flow, recolonisation, and long-term population persistence. Protecting habitat linkages, especially transboundary forest corridors in the Himalayan and Indo-Burma regions, is crucial for sustaining viable metapopulations and facilitating natural dispersal processes (Gray *et al.*, 2021; Abedin *et al.*, 2024).

3.1.5.4. Home Range & Movement

3.1.5.4.1. Home Range

Clouded leopards maintain relatively large home ranges for their body size—an ecological adaptation linked to their solitary nature, low population densities, and wide-ranging foraging habits. Telemetry studies from Thailand offer the most detailed estimates: in Khao Yai NP, 95% fixed kernel home ranges were ~39.5 km² for a female and ~42.2 km² for a male, while in Phu Khieo WLS, ranges averaged 34–40 km² for females and 36–44 km² for males (Austin, 2003; Grassman *et al.*, 2005). Unlike many solitary felids, where male ranges are considerably larger, male and female clouded leopards appear to occupy comparably sized ranges (Bailey, 1974; Schaller & Crawshaw, 1980; Bailey, 1993; Brian *et al.*, 1996; Mizutani & Jewell, 1998).

Within these broader home ranges, smaller core areas of intensive use are evident. For instance, a denning female in Phu Khieo restricted her movements to a ~2 km² core (50% kernel), while typical core areas across individuals ranged between 3–5 km² (Grassman *et al.*, 2005). These zones likely represent denning or prey-rich sites. Variation in home range size is influenced by prey density and interspecific competition, contracting in prey-rich, predator-free landscapes and expanding in prey-scarce or tiger-dense habitats (Grassman *et al.*, 2005; Hearn *et al.*, 2013). Rabinowitz (1991) documented particularly low clouded leopard densities in Thailand's Huai Kha Khaeng in areas of high tiger density, suggesting either range expansion or displacement.

Territoriality in clouded leopards appears flexible. Grassman *et al.* (2005) reported a 39% overlap between the home ranges of two adult males—an unusually high degree of male–male spatial tolerance for solitary felids. High male–female overlap is consistent with polygynous solitary cats (Grassman *et al.*, 2005), whereas overlap between females is likely minimised during cub rearing (Sandell, 1989).

In India, home range estimates are derived from camera-trap-based SECR models. In Manas NP, earlier analyses indicated movement radii corresponding to home ranges of ~20–30 km² (Borah *et al.*, 2014). However, a more recent study estimated the movement parameter (σ) at 1.93 km, translating to a 95% activity area of ~70.2 km²—substantially larger than prior estimates (Bhatt & Lyngdoh, 2023). In Dampa TR, a high estimated density (5.14 individuals/100 km²) implies smaller home ranges (~20 km²), likely due to the abundance of prey (Singh & Macdonald, 2017). Conversely, low-density areas such as Nandapha (India) and Borneo are associated with larger estimated home ranges, likely exceeding 50 km² (Datta *et al.*, 2008; Brodie & Giordano, 2012). Clouded leopards have been recorded at camera stations spaced 2.0–13.6 km apart, reinforcing evidence of extensive movement even within high-density habitats (Chiang & Allen, 2017).

Notably, the home range of clouded leopards in Thailand (~30–45 km²) is nearly double that of male leopards (*Panthera pardus*) in the same region (~18 km²) (Grassman, 1999), contradicting the expected positive correlation between body size and range size (Harestad & Bunnell, 1979; Mace *et al.*, 1983). Such variability—sometimes up to ten-fold—has also been documented in other solitary felids like bobcats (*Lynx rufus*), jaguars (*Panthera onca*), leopards (*Panthera pardus*), and pumas (*Puma concolor*) (Bailey, 1974; Schaller & Crawshaw, 1980; Bertram, 1982; Rabinowitz & Nottingham, 1986; Crawshaw & Quigley, 1991; Brian *et al.*, 1996; Mizutani & Jewell, 1998; Elbroch *et al.*, 2015).

This variability in home range size likely reflects underlying regional differences in prey density, habitat quality, and landscape configuration. As with other felids, home range size appears closely linked to prey availability and distribution (Bailey, 1974; Seidensticker, 1976; Emmons, 1988; Crawshaw & Quigley, 1991; Mizutani & Jewell, 1998). Although home ranges of ~30–50 km² are typical in optimal habitat, conservation strategies must consider this ecological plasticity (Sunquist & Sunquist, 2002; Grassman *et al.*, 2005). A single breeding pair may require at least 50–60 km² of contiguous forest, highlighting the importance of maintaining large, connected landscapes.

3.1.5.4.2. Movement

Clouded leopards exhibit a blend of arboreal agility and terrestrial mobility, consistent with their semi-arboreal lifestyle and ambush predation strategy (Gray *et al.*, 2021). Their flexible ankle joints and large paws enable them to exhibit exceptional climbing abilities, including head-first descents and inverted suspension (Sunquist & Sunquist, 2002; Christiansen, 2006). While they navigate tree canopies adeptly, especially for resting or avoiding larger predators (Ross *et al.*, 2013), most long-distance travel occurs on the ground or through the understory (Grassman *et al.*, 2005). Camera-trap records from northeast India consistently show ground-level movement along trails, ridgelines, and streambeds, suggesting routine terrestrial travel within their home ranges (Borah *et al.*, 2014; Singh & Macdonald, 2017; Bhatt & Lyngdoh, 2023).

Telemetry studies indicate that clouded leopards typically travel 1–3 km per day (Austin, 2003; Grassman *et al.*, 2005). In Phu Khieo WLS, Thailand, radio-collared individuals moved an average of approximately 2.0 km per day (mean = 1,932 m across four individuals), nearly twice the distance observed in Khao Yai NP, where daily movements averaged 977 m for a female and 1,168 m for a male (Austin, 2003; Grassman *et al.*, 2005). These are straight-line distances, and actual paths may be longer due to meandering (Grassman *et al.*, 2005). Notably, 84% of all recorded movement occurred in closed-canopy forest (Grassman *et al.*, 2005).

Clouded leopards display cathemeral (arrhythmic) activity patterns, with movement typically increasing from late afternoon to early morning and declining around midday (Grassman *et al.*, 2005; Chiang & Allen, 2017). Their movement includes walking, stalking, and short sprints—behaviours supported by limb adaptations for climbing and stealth rather than endurance running (Christiansen, 2006). Males are known to follow regular patrol circuits within their ranges and may increase their movement during the female estrus period (Grassman *et al.*, 2005). These felids frequently rest on horizontal tree limbs 6–15 meters above ground and typically descend in the late afternoon to forage (Sunquist & Sunquist, 2002). Although not well documented, anecdotal reports suggest they may ambush prey by leaping from trees. Clouded leopards also exhibit considerable altitudinal mobility, having been recorded from near sea level up to 3,000–3,700 m in Bhutan and Northeast India (Sathyakumar *et al.*, 2011; Penjor *et al.*, 2018; Can *et al.*, 2020; Nair *et al.*, 2021; Nijhawan, per. comm., 2021). At some sites, they may occupy higher elevations (>1,253 m), potentially to avoid interference competition (Tantipisanuh *et al.*, 2014).

Given their reliance on forest cover for stealthy movement, habitat fragmentation poses a significant threat. Crossing open or human-modified landscapes increases the risk and may disrupt natural ranging behaviour (Grassman *et al.*, 2005; Gray *et al.*, 2021). However, clouded leopards can traverse between forest blocks using narrow riparian corridors or hilly terrain, provided canopy connectivity is maintained (Abedin *et al.*, 2024). Ensuring such connectivity is essential to support their natural movement ecology across landscapes.

3.1.5.5. Survival & Mortality

144 Empirical data on the survival and mortality of clouded leopards in the wild remain limited due to their elusive nature (Nowell & Jackson, 1996; Sunquist & Sunquist, 2002). However, extrapolations from field and captive records suggest that individuals may live up to 13 years in undisturbed wild environments (Che-Castaldo *et al.*, 2019; Giordano, 2022), while some have survived up to 17 years in captivity (Prator *et al.*, 1988; Nowell & Jackson, 1996).

The natural causes of mortality in the wild are largely speculative due to limited field data. Still, they may be at risk of injury while hunting large prey, falls from trees (mainly cubs), or infrequent predation (Sunquist & Sunquist, 2002). Interspecific competition is a recognised risk; clouded leopards may be killed by larger predators, such as tigers or leopards, during territorial conflicts or while scavenging (Seidensticker, 1976). Their tendency to avoid areas of high tiger density may be an adaptive strategy to mitigate such risks (Bhatt & Lyngdoh, 2023). Juveniles and cubs face higher vulnerability to predation by eagles, dholes, and large reptiles like king cobras or reticulated pythons (Davies & Payne, 1982; Sunquist & Sunquist, 2002).

Juvenile clouded leopards exhibit high mortality, particularly during the first year. Captive data report a first-year mortality rate of 41%, primarily due to factors such as maternal neglect, infanticide, and health complications (Mackinnon, 2008). Historically, poor maternal care has been a significant cause of cub loss, often necessitating hand-rearing interventions (Sunquist & Sunquist, 2002; Wielebnowski *et al.*, 2002). Male-inflicted infanticide has also been observed in captivity, further contributing to cub mortality (Sunquist & Sunquist, 2002; Wielebnowski *et al.*, 2002). However, improved husbandry practices—including stress-reduction measures and enclosures that promote natural behaviours—have led to higher cub survival rates in recent years (Hearn *et al.*, 2015; Giordano, 2022).

Anthropogenic pressures represent the most significant source of mortality. Clouded leopards are frequently hunted for their pelts, teeth, and bones, driven by demand in illegal wildlife trade and traditional medicine markets (Salter, 1983; Nowell, 1990; Low, 1991; Nowell & Jackson, 1996; D'Cruze & Macdonald, 2015). In some markets, parts of clouded leopards are more commonly encountered than those of tigers (D'Cruze & Macdonald, 2015). Snares set for bushmeat have also been implicated in incidental deaths of clouded leopards, particularly in Laos, Myanmar, and parts of Indochina (Sunquist & Sunquist, 2002; D'Cruze & Macdonald, 2015; Hunter, 2015; Rostro-García *et al.*, 2016; Gray *et al.*, 2017a; Belecky & Gray, 2020). In India, direct hunting by local communities is less common but persists in parts of Northeast India, particularly to obtain meat or pelts

(Datta *et al.*, 2008). Although roadkill is rarely documented for clouded leopards in India, the expansion of road infrastructure in forested regions poses an emerging threat (Datta *et al.*, 2008; Giordano, 2022). Human-wildlife conflict is relatively rare; the species rarely preys on livestock larger than poultry or young goats (Giordano, 2022). Nevertheless, retaliatory killings—such as a case reported from Meghalaya—have occurred (WTI archives).

Despite prevailing threats, clouded leopards demonstrate resilience in captivity when provided with optimal care. Successful breeding and cub survival have been reported in zoos where enclosures support natural behaviours and minimise stress (Sunquist & Sunquist, 2002; Giordano, 2022). However, the high mortality risk during early life, both in captivity and presumably in the wild, emphasises the critical role of maternal care and early-life conditions. In the wild, human-induced mortality remains the primary threat to survival. While adult natural mortality is believed to be low, unsustainable losses from poaching and snaring continue to impact populations severely (D'Cruze & Macdonald, 2015). Given the species' inherently low reproductive rate, even moderate increases in mortality can significantly hinder population recovery. Conservation strategies such as anti-poaching patrols and snare removal are essential to reduce preventable deaths, with a particular emphasis on safeguarding adult females due to their reproductive importance. Where such protections are in place, clouded leopards have persisted over time, as seen in well-protected reserves. Conversely, unprotected populations may face rapid local extinction (Datta *et al.*, 2008; Rostro-García *et al.*, 2016).

3.1.5.6. Intraspecific Interactions & Social Behaviour

Clouded leopards are predominantly solitary felids, with adults interacting only briefly for mating (Sunquist & Sunquist, 2002). The only prolonged social bond is between a mother and her offspring, which typically lasts until cubs disperse at 10–12 months of age (Prater, 1971; Sunquist & Sunquist, 2002; Grassman *et al.*, 2005). They do not engage in cooperative hunting or social grouping, consistent with the behaviour of most mid-sized felids (Sandell, 1989).

Their social structure is maintained through reliance on chemical and acoustic communication. Scent marking—including urine spraying, scraping, head rubbing, and clawing logs—is used by both sexes to signal territorial boundaries and reproductive status (Hemmer, 1968; Wemmer & Scow, 1977; Yamada & Durrant, 1988; Sunquist & Sunquist, 2002). Territoriality is evident, although home-range overlap—especially among males—suggests temporal rather than strict spatial exclusion (Grassman *et al.*, 2005).

Vocal communication includes mews, growls, hisses, spits, growls, a prusten-like chuff (also found in tigers, snow leopards, and jaguars), and a distinctive moaning call reported from hilltops in Thailand, although the function (whether territorial, reproductive, or both) of this long-distance vocalisation remains unclear (Hemmer, 1968; Lekagul & McNeely, 1977; Peters, 1978, 1984a, 1984b; Smith *et al.* 1989; Peters & Hast, 1994; Sunquist & Sunquist, 2002; Chiang & Allen, 2017). Their vocal repertoire is acoustically similar to that of tigers, prompting some taxonomic suggestions to group them closely (Leyhausen *et al.*, 1990). Visual cues such as posture and facial expressions also convey mood and social intent (Mackinnon, 2008).

While direct interactions between adults are rare in the wild, camera-trap studies and anecdotal observations suggest that occasional tolerance or temporal co-occupancy of space may occur (Singh & Macdonald, 2017; Bhatt & Lyngdoh, 2023). A few reports describe two individuals together—possibly a mother with an older offspring or siblings dispersing together—while one unverified account from Borneo described a pair cooperatively hunting a proboscis monkey (Gibson-Hill, 1950; Nowell & Jackson, 1996).

Captive studies confirm that clouded leopards have low social tolerance. Pairs raised together from a young age may cohabit peacefully, but mismatched adults—especially males—often exhibit severe aggression toward conspecifics (Mellen, 1993; Wielebnowski *et al.*, 2002). Stress-related behaviours in captivity, including pacing and overgrooming, are associated with restricted space and social frustration (Wielebnowski *et al.*, 2002).

In summary, clouded leopards are solitary, territorial carnivores that use scent, sound, and visual cues to avoid direct conflicts. While some flexibility in spacing exists, their social system relies heavily on spatial separation and low population density. Understanding these behavioural dynamics is critical for managing captive populations and conserving viable wild populations through habitat connectivity and dispersal space (Sandell, 1989).

3.1.5.7. Behaviour & Activity Patterns

Clouded leopards are predominantly nocturnal (Grassman *et al.*, 2005; Mukherjee *et al.*, 2019; Bhatt & Lyngdoh, 2023), though they can exhibit cathemeral activity (Lynam *et al.*, 2013). In Thailand, 73% of camera-trap detections ($n=79$) across 24 study sites in 14 PAs occurred between sunset and sunrise, though some detections extended into late morning hours, suggesting occasional diurnal activity (Lynam *et al.*, 2013). This was further supported by a daytime sighting (Davies, 1990). Radio telemetry of four individuals (2 males, 2 females) in Phu Khieo WLS, Thailand, revealed arrhythmic activity with notable peaks around mid-morning and sunset (Grassman *et al.*, 2005). Daytime activity has also been reported in captive and wild individuals, with some suggesting crepuscular tendencies influenced by prey activity and human disturbance (Sunquist & Sunquist, 2002). Although long considered highly arboreal, recent field observations suggest that clouded leopards may be more terrestrial than previously thought (Sunquist & Sunquist, 2002). Their morphological traits, such as a long tail, short limbs, and large paws, facilitate arboreal movement (Hemmer, 1968). They are capable of remarkable climbing feats, including descending head-first and hanging by their hind feet (Weigel, 1961; Hemmer, 1968). However, hunting accounts and field sightings show many individuals were flushed or hunted on the ground (Selous & Banks, 1935; Guggisberg, 1975). A 1986 survey in Sabah and Sarawak found that 82% of clouded leopard sightings occurred on the ground, especially on roads and trails (Rabinowitz *et al.*, 1987). Almost all arboreal sightings occurred in primary forests during the daytime, suggesting that trees are primarily used as resting or refuge sites (Rabinowitz *et al.*, 1987). Their Malaysian name, *harimau-dahan* (branch-tiger), also reflects this arboreal association (Weigel, 1961).

Interactions with larger carnivores, such as leopards and tigers, may subtly influence the activity of clouded leopards (Giordano, 2022). In Thailand, clouded leopards showed greater temporal overlap with smaller leopard cats than with leopards (Lynam *et al.*, 2013). Although their presence was similar in areas with or without leopards, fine-scale patterns indicated weak spatial avoidance (Ngoprasert *et al.*, 2012). In Nepal, activity overlapped with both leopards and musk deer, suggesting shared nocturnal habits and possible overlap in foraging times (Can *et al.*, 2020).

In Dampa TR (Mizoram, India), clouded leopards showed bimodal activity with peaks from dusk (1800 h) to early morning (0300 h), and again from dawn (0600 h) to midday (1200 h), in the absence of leopards or tigers (Singh & Macdonald, 2017). Their activity closely overlapped with that of golden cats ($\Delta = 0.60\text{--}0.86$), implying similar temporal niches when dominant carnivores are absent (Singh & Macdonald, 2017). A comparable pattern was reported in northern Laos, where clouded leopards and golden cats exhibited high overlap ($\Delta = 0.80$), with peak activity occurring near dawn (Rashphone *et al.*, 2020). In Manas NP (Assam, India), clouded leopards exhibited bimodal activity, with peaks at 19:00–23:00 and 02:00–04:00, and high temporal overlap ($\Delta > 0.70$) with other carnivores, although with distinct peak times (Bhatt & Lyngdoh, 2023). No clear spatial co-occurrence was found, suggesting behavioural or spatial separation may facilitate coexistence (Bhatt & Lyngdoh, 2023).

Historical and telemetry data further confirm that clouded leopards can be highly terrestrial (Sunquist & Sunquist, 2002). In southern Nepal, a radio-collared subadult male, captured in dry woodland, moved across floodplains and sal forests, consistently utilising terrestrial habitats (Dinerstein & Mehta, 1989). This supports broader observations that although clouded leopards are capable climbers, their ground-based activity is extensive and ecologically important. As with margays, whose arboreal capabilities are well known but whose collared individuals travelled primarily on the ground (Konecny, 1989), clouded leopards, too, appear to favour terrestrial locomotion, possibly for efficiency.

Elevational shifts may further facilitate the avoidance of competition. In Thailand, clouded leopards have been recorded at altitudes above 1,253 m (Tantipisanuh *et al.*, 2014). In Sumatra, where similar elevational patterns are observed, this has been interpreted as a strategy to avoid dominant predators, such as tigers (McCarthy *et al.*, 2015; Sunarto *et al.*, 2015). Overlaps with sympatric felids such as golden and marbled cats may also be mediated by temporal or elevational partitioning (Hearn *et al.*, 2018).

In summary, clouded leopards are behaviourally flexible, adjusting their activity patterns based on prey availability, habitat features, and interactions with other carnivores. Their ability to operate both nocturnally and diurnally enhances their adaptability and may reduce direct competition with sympatric predators. Despite their physical adaptations for climbing, extensive evidence indicates they frequently use the ground for movement, hunting, and travel, highlighting a more versatile ecological role than previously assumed.



Figure 3.4.

Camera-trap image of a clouded leopard in Manas NP. A nocturnal camera-trap photograph capturing a clouded leopard walking along a forest trail in Manas NP, Assam, India. Such images provide valuable insights into the species' behaviour, habitat use, and presence in the tropical evergreen forest.

3.1.5.8. Food Habits

In contrast to larger felids, such as leopards and tigers, the feeding ecology of both clouded leopard species remains poorly understood due to the absence of systematic studies and reliance on anecdotal, opportunistic, and small-sample observations (Nowell & Jackson, 1996; Hunter, 2015; Giordano, 2022). Nevertheless, morphological features such as long upper canines, robust skulls, muscular forelimbs, and strong arboreal adaptations support their capacity to take a wide variety of prey, including large-bodied species (Pocock, 1939; Nowell & Jackson, 1996; Meachen-Samuels & Van Valkenburgh, 2009a, 2009b).

Primates appear to be key prey, with multiple confirmed and suspected predation events (Giordano, 2022). Sunda clouded leopards have been documented preying on adult and juvenile proboscis monkeys (*Nasalis larvatus*), red leaf monkeys (*Presbytis rubicunda rubicunda*), and juvenile siamangs (*Symphalangus syndactylus*) (Matsuda *et al.*, 2008; Morino, 2010; Otani *et al.*, 2012; Giordano & Rustam, 2016). A wild juvenile orangutan (*Pongo pygmaeus*) death in Danum Valley was attributed to a clouded leopard (Kanamori *et al.*, 2012), and two rehabilitated orangutans in Central Kalimantan sustained severe injuries likely from a predation attempt (Sunderland-Groves *et al.*, 2020). Additional reports include predation on pig-tailed macaques and gibbons in Khao Yai NP (Davies, 1990; W. Brockelman, per. comm., 1993; Hunter, 2015), and two confirmed cases of proboscis monkey predation from trees (Davis, 1962; J. Payne, per. comm., 1992).

Mobbing behaviour and anti-predator responses by primates suggest clouded leopards exert significant predation pressure (Giordano, 2022). For instance, stalking behaviour by a clouded leopard elicited alarm calls and evasive actions among Phayre's leaf monkeys (*Trachypithecus phayrei*) in northeastern Thailand (Lloyd *et al.*, 2006). Simulations of clouded leopard presence triggered stronger responses in white-handed gibbons (*Hylobates lar*) than simulations of tigers, pythons, or eagles (Clarke *et al.*, 2012). Joint mobbing by agile gibbons (*H. albibarbis*) and maroon langurs, and changes in primate sleeping site selection—favouring isolated trees or river-edge forests—may function as anti-predator strategies (Davies, 1990; Phoonjampa *et al.*, 2010; Albert *et al.*, 2011; Matsuda *et al.*, 2011; Cheyne *et al.*, 2012; Wilcox *et al.*, 2016).

Beyond primates, clouded leopards also prey on other arboreal and terrestrial animals, including ungulates (Giordano, 2022). In Thailand's Phu Khieo WLS, scats from trapped individuals contained remains of slow loris (*Nycticebus bengalensis*), Asiatic brush-tailed porcupine (*Atherurus macrourus*), and ground squirrels (*Menetes berdmorei*), with telemetry and carcass data suggesting additional predation on Malayan pangolin (*Manis javanica*), hog deer (*Hyelaphus porcinus*), and possibly Indian muntjac (*Muntiacus muntjak*) (Grassman *et al.*, 2005). In Peninsular Malaysia, a clouded leopard was photographed carrying a binturong (*Arctictis binturong*), a highly arboreal civet, indicating possible arboreal hunting (Lam *et al.*, 2014; Willcox *et al.*, 2016).

In India, clouded leopards have been reported to feed on small deer and similarly sized animals, including livestock such as goats and pigs (Pocock, 1939). Birds and poultry are also taken occasionally; for instance, a subadult male captured in Nepal was found inside a chicken coop (Dinerstein & Mehta, 1989). A recent camera trap study in Dehing Patkai NP documented the first confirmed predation on a Bengal slow loris (*Nycticebus bengalensis*), highlighting their ability to hunt nocturnal arboreal primates (Ghade *et al.*, 2025). In Assam, past reports also mention attacks on domestic goats, though such incidents are rare (Hazarika, 1996).

On Borneo, clouded leopards prey on pigs, deer, monkeys, orangutans, and other small mammals (Payne *et al.*, 1985). Field studies from Malaysian Borneo have documented kills of sambar deer, barking deer, and bearded pigs, with carcasses exhibiting cranial bite marks consistent with predation by the clouded leopard (Rabinowitz *et al.*, 1977). The activity patterns of Sunda clouded leopards in Sabah were strongly associated with those of ungulates, such as sambar (*Rusa unicolor*) and mouse deer (*Tragulus sp.*), indicating dietary importance (Hearn *et al.*, 2018). In Dermakot FR, researchers found the fresh carcass of a juvenile sambar (~30–35 kg) near a camera-trap site where a known male clouded leopard had been photographed, with evidence of a bite to the front leg (Mohamed *et al.*, 2009). In Tabin Wildlife Reserve, a bearded pig (*Sus barbatus*) carcass was similarly suspected to be a clouded leopard kill, with signs of caching behaviour (Mohamed *et al.*, 2009).

Dietary flexibility appears high, with regional and ecological variation likely depending on prey availability and interspecific competition (Hunter, 2015). On Borneo, where clouded leopards are the apex predator, their diet may include a broader range of prey than in mainland areas where tigers, leopards, and dholes co-occur (Hunter, 2015). Captive feeding observations offer further insight: a juvenile male in Sarawak refused dead meat but consumed two chickens daily, plucking feathers and even licking fur off monkeys before eating (Selous & Banks, 1935). Clouded leopards often use their incisors and canines to tear meat while jerking their heads upward—a behaviour otherwise typical of big cats (Weigel, 1972). Fish and poultry are occasionally reported in local accounts, and one subadult male in Nepal was trapped in a chicken coop (Hunter, 2015).

Feeding behaviour and kill techniques are also distinctive. Clouded leopards reportedly kill large prey with bites to the back of the head and spine—unlike other felids that use throat bites—likely linked to their unique dentition (Hunter, 2015). One adult male hog deer was killed by a bite that penetrated 3 cm through the spine above the shoulders (Hunter, 2015). This cranial bite method is supported by reports from Sabah and Sarawak (Hunter, 2015). While clouded leopards are morphologically adapted for arboreal locomotion, radio-collared individuals predominantly hunted on the ground, often pursuing arboreal prey into trees (Hunter, 2015).

In summary, the clouded leopard is a versatile predator feeding on a diverse array of forest animals. Its diet ranges from tiny rodents to medium-sized ungulates, underscoring its unique mesopredator role between larger cats and smaller carnivores. The presence of long canines and arboreal skill suggests an evolutionary adaptation to subdue prey in the canopy and take on relatively large kills by delivering lethal bites (Christiansen, 2006). Maintaining healthy populations of its prey (small deer, primates, *etc.*) is critical – studies have found that in “empty forests” where ungulates are overhunted by people, clouded leopard occurrence declines as well (Datta *et al.*, 2008). Thus, prey conservation (anti-poaching for prey species) goes hand in hand with clouded leopard conservation.

3.1.5.9. Genetics & Genetic Characteristics

Mainland clouded leopards (*Neofelis nebulosa*) represent one of the most ancient and genetically distinct lineages within the subfamily Pantherinae, having diverged from the *Panthera* genus approximately 6.19 million years ago (Johnson *et al.*, 2006; Wilting *et al.*, 2007; Yuan *et al.*, 2023). Their evolutionary distinctiveness is reflected in specialised morphological traits—particularly elongated upper canines and arboreal adaptations—driven by directional selection on genes associated with craniofacial development, pigmentation, and tail morphology (Christiansen, 2006; Harano & Kutsukake, 2018; Yuan *et al.*, 2023).

Genetic analyses have played a pivotal role in clarifying the taxonomy within the genus *Neofelis*. Buckley-Beason *et al.* (2006) and Kitchener *et al.* (2006) demonstrated that clouded leopards from Borneo and Sumatra were genetically and morphologically distinct from mainland forms, leading to the formal recognition of *Neofelis diardi* as a separate species. MtDNA analyses (*e.g.*, ATPase-8, cytochrome b, and control region) revealed 39 fixed nucleotide differences between *N. diardi* and *N. nebulosa*, with divergence estimates of 1–2 million years, likely triggered by mid-Pleistocene isolation (Buckley-Beason *et al.*, 2006; Wilting *et al.*, 2007). Microsatellite data further confirmed this split, showing non-overlapping allele sizes and limited historical gene flow (Buckley-Beason *et al.*, 2006; Wilting *et al.*, 2007).

Within *N. nebulosa*, historical taxonomy recognised four subspecies based on geographic distribution and morphology: *N. n. macrosceloides* (India–Nepal–Bhutan), *N. n. nebulosa* (mainland Southeast Asia and China), *N. n. brachyura* (Taiwan, now extinct), and *N. n. diardi* (now classified as *N. diardi*) (Kitchener *et al.*, 2006). While recent genetic evidence suggests predominantly clinal variation and limited population structure across the mainland, specific peripheral populations, such as those in the Indian subcontinent and Taiwan, may retain unique mitochondrial haplotypes (Chiang, 2007; Yuan *et al.*, 2023).

Genome-wide analyses have revealed signals of positive selection in genes related to tooth and skull morphology, pigmentation, and tail function—traits contributing to the species' arboreal lifestyle and enlarged canines (Christiansen, 2006; Harano & Kutsukake, 2018; Yuan *et al.*, 2023). These adaptations may represent evolutionary trade-offs shaped by ecological constraints (Yuan *et al.*, 2023).

From a conservation standpoint, recognising *N. nebulosa* and *N. diardi* as distinct species necessitates separate management strategies (Buckley-Beason *et al.*, 2006; Wilting *et al.*, 2007). Within *N. nebulosa*, peripheral populations—particularly in India, Nepal, and southern China—should be treated as distinct conservation units due to potential regional differentiation. Maintaining habitat connectivity is essential to facilitate gene flow and prevent genetic erosion. As indicators of genetic health, recent genomic assessments underscore declining diversity and an accumulation of deleterious mutations, highlighting the urgency for genomically informed conservation planning (Yuan *et al.*, 2023).

Captive data further reflect low genetic diversity in *N. nebulosa*. Historically, management treated clouded leopards as a single taxon, potentially contributing to genetic homogenisation (Hunter, 2015; Giordano, 2022). However, growing genetic evidence supports recognition of population-level variation within the species, including tentative support for historical subspecies divisions such as *N. n. macrosceloides* and *N. n. nebulosa* (Sunquist & Sunquist, 2002; Yuan *et al.*, 2023).

In summary, *Neofelis nebulosa* represents an evolutionarily distinct felid lineage with deep divergence, specialised adaptations, and declining genetic health. Effective conservation must incorporate genomic insights to preserve remaining genetic diversity, ensure habitat connectivity, and guide both in situ and ex situ management (Buckley-Beason *et al.*, 2006; Wilting *et al.*, 2007; Yuan *et al.*, 2023).

3.1.6. Bioclimatic Zone, Ecosystem, and Habitat

The mainland clouded leopard occupies a broad biogeographic range spanning southern and eastern Nepal, northeastern India, Bhutan, Bangladesh, and southern China, extending eastward through Myanmar, Lao PDR, Thailand, Cambodia, Vietnam, and south into Peninsular Malaysia (Nowell & Jackson, 1996; Sunquist & Sunquist, 2002; Giordano, 2022). A former subspecies, the Formosan clouded leopard (*N. n. brachyurus*), endemic to Taiwan (Swinhoe, 1862), is now considered extinct (Chiang *et al.*, 2015; Greenspan *et al.*, 2020).

Clouded leopards are generally considered to be most closely associated with lowland primary evergreen tropical rainforests (Raffles, 1821; Swinhoe, 1862; Sterndale, 1884; Selous & Banks, 1935; Pocock, 1939; Banks,

1949; Wood, 1949; Prater, 1971), where they benefit from dense canopy cover, structural complexity, and abundant arboreal and terrestrial prey. However, the species shows notable ecological flexibility, inhabiting a variety of other forest types and ecosystems across its range.

These include:

- Secondary and logged forests, where the species has been reported using regrowth and selectively logged habitats, provided sufficient canopy and understory remains (Davies & Payne, 1982; Rabinowitz *et al.*, 1987; Santiapillai & Ashby, 1988; Johns, 1989; M. Khan, per. comm., 1991; Menon, 2023).
- Grassland and scrub habitats, particularly those interspersed with forest or acting as transitional areas. Sightings in such landscapes suggest that clouded leopards may traverse or even exploit these ecotones under certain conditions (Santiapillai & Ashby, 1988; Dinerstein & Mehta, 1989; Nowell & Jackson, 1996).
- Dry tropical and open degraded forests, including relatively open deciduous formations such as those found in parts of Burma and Thailand (C. Wemmer in Dinerstein & Mehta, 1989; Rabinowitz & Walker, 1991; Grassman *et al.*, 2005; Austin *et al.*, 2007; Menon, 2023).
- Mangrove swamps, as recorded in Borneo, indicate tolerance of coastal and swampy lowland habitats under forested conditions (Davis, 1962; Davies & Payne, 1982).
- Peat swamp forests and mixed forest–grassland mosaics, especially in Southeast Asia, where they have been documented in transitional or heterogeneous landscapes (Nowell & Jackson, 1996).

In the Himalayan region, clouded leopards inhabit a broad elevational gradient. They have been recorded in subtropical dry forests of the Himalayan foothills (Dinerstein & Mehta, 1989; Ghimirey *et al.*, 2018), as well as in temperate and montane forests at elevations ranging from 1,450 m to over 3,000–3,500 m, well above the seasonal snow line in parts of Nepal, India, and Bhutan (Jerdon, 1874; Biswas *et al.*, 1985; Sathyakumar *et al.*, 2011; Can *et al.*, 2020).

In China, where the species occurs widely south of the Yangtze River, it reportedly uses a range of forest types (Tan, 1984; China Cat Specialist Group meeting, 1992). However, detailed ecological or habitat preference data remain scarce for this large portion of its distribution (Nowell & Jackson, 1996).

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Collectively, the clouded leopard's occurrence across diverse ecosystems, from evergreen rainforests to deciduous woodlands, montane forests, peat swamps, and logged secondary growth, highlights its adaptability. However, the species remains reliant on substantial vegetative cover and complex vertical forest structure to support its arboreal lifestyle and cryptic hunting strategy.



Figure 3.5.

Clouded leopard habitat in moist tropical forests. Typical semi-evergreen and evergreen forest habitat that supports the arboreal and cryptic lifestyle of clouded leopards. (Photo By- Saurav Chaudhary)

3.1.7. Conservation Threats

Mainland clouded leopards face multiple human-induced threats that have driven population declines across their range and continue to imperil their survival. Key challenges include habitat loss and fragmentation, illegal trade and snaring, climate change impacts, and deep-rooted socioeconomic and institutional constraints.

3.1.7.1. Habitat Loss & Fragmentation

Habitat loss and fragmentation are among the most critical threats to clouded leopards (Gray *et al.*, 2021). Rapid deforestation across South and Southeast Asia, particularly in the Indo-Burma region, has significantly reduced the extent and quality of forests essential to their persistence (Gray *et al.*, 2021). Between 1990 and 2010, the area experienced one of the world's highest deforestation rates, at 0.6% per year, primarily driven by agricultural expansion, logging, and infrastructure development (Stibig *et al.*, 2014). A range-wide analysis found a 34% reduction in high-quality habitat strongholds between 2000 and 2018 (Petersen *et al.*, 2020a).

The remaining forest landscapes are increasingly fragmented, with degraded or isolated patches surrounded by agricultural lands or infrastructure (Gray *et al.*, 2021). This loss of functional connectivity restricts movement, limits access to prey, and increases the species' vulnerability to stochastic events and human threats (Gray *et al.*, 2021). Infrastructure projects such as roads, hydropower dams, and economic development corridors are intensifying this fragmentation (Giordano, 2022). In Myanmar, for instance, planned infrastructure expansion is likely to disrupt existing habitat connectivity further, thereby compounding the species' risk (Kaszta *et al.*, 2020). Similarly, a surge in hydropower and rural road projects in Nepal has emerged as a potential threat to the remaining clouded leopard habitat in the country (Ghimirey & Acharya, 2018).

Remaining forest landscapes are increasingly fragmented into smaller patches, surrounded by farmland and roads, which disrupt connectivity and prey access and elevate vulnerability to human pressures (Gray *et al.*, 2021). Infrastructure projects, such as roads, dams, and economic development corridors, are further fragmenting habitat (Giordano, 2022). For instance, infrastructure expansion in Myanmar and a rise in hydropower and rural road development in Nepal are key threats (Kaszta *et al.*, 2020; Ghimirey & Acharya, 2018). Although oil palm expansion is more severe in the Sundaic region, it also affects the northern Thai-Malay Peninsula, which is home to the mainland subspecies (Shevade & Loboda, 2019).

Even in forested areas, selective logging and edge effects degrade habitat quality, and clouded leopards show a preference for intact canopies (Giordano, 2022). Fragmentation also increases human access to remote areas, raising risks of hunting and conflict (Nowell & Jackson, 1996; Giordano, 2022). While the species exhibits some adaptability to secondary forests, its firm reliance on closed-canopy habitats makes it particularly vulnerable to the cumulative impacts of fragmentation (Brodie *et al.*, 2015). As Nowell and Jackson (1996) noted decades ago, deforestation was already recognised as the primary threat to clouded leopards; however, the extent of their tolerance to habitat clearance remained poorly understood.

3.1.7.2. Illegal Trade & Snaring

Illegal Trade and Targeted Hunting:

Illegal hunting and trade are significant drivers of population decline in mainland clouded leopards, both through direct targeting and incidental capture (Gray *et al.*, 2021). Despite legal protection across most of their range, weak enforcement enables persistent exploitation, particularly for skins, bones, teeth, claws, and meat—used in traditional medicine, ornaments, ceremonial attire, or exotic cuisine (Nowell & Jackson, 1996; Nowell, 2007; Hunter, 2015; Giordano, 2022). Extensive surveys highlight the scale of trade: Oswell (2010) reported body parts from 149 individuals at just two markets between 2001 and 2010, while Nijman and Shepherd (2015) recorded remains from 482 individuals over 23 years, making clouded leopards the most commonly traded wild felid in Southeast Asia. The demand is primarily driven in China, Myanmar, and along the Thai-Lao border, with items such as skins, canines, and claws often used solely for ornamental purposes (Min, 2020).

Snaring and Indiscriminate Hunting:

The most severe and widespread threat to clouded leopards across Indochina is the indiscriminate use of wire snares (Gray *et al.*, 2017b; Giordano, 2022). Cheap and easily deployed, snares are used extensively across PAs and non-PAs, contributing to the collapse of medium- to large-sized mammal communities (Gray *et al.*, 2018). They indiscriminately kill both target and non-target species and are difficult to control even with

active removal campaigns (Gray *et al.*, 2018). Clouded leopards have already disappeared from large parts of Vietnam, where hunting practices are deeply entrenched (MacMillan & Nguyen, 2014; Willcox *et al.*, 2014). In Laos, snares have contributed to the extirpation of tigers and other large carnivores (Johnson *et al.*, 2016; Rostro-Garcia *et al.*, 2016). In Cambodia, recent sightings in Keo Seima and Western Seam Pang WLS have involved individuals caught in snares set for ungulates (Gray *et al.*, 2021). The cascading impact of this snaring epidemic extends to prey depletion, further reducing habitat suitability and ecological carrying capacity for clouded leopards (Sandom *et al.*, 2017, 2018).

Compounding this crisis, infrastructure development—particularly Chinese-funded projects under the Belt and Road Initiative—has increased access to remote forests, facilitating hunting and trafficking (Kaszta *et al.*, 2020). Roads and transport networks open new corridors for poachers, intensifying exploitation. The combined effects of illegal trade, opportunistic hunting, and landscape modification pose a profound and escalating threat to the species across its mainland range (D'Cruze & Macdonald, 2015; Giordano, 2022).

3.1.7.3. Climate Change Impacts

Climate change exacerbates existing threats by reducing habitat suitability, altering prey dynamics, increasing fire risk, and limiting elevational and geographic range shifts, thereby posing a significant long-term threat to mainland clouded leopards (Can *et al.*, 2020; Gray *et al.*, 2021; Abedin *et al.*, 2024).

While habitat loss and poaching are immediate threats, climate change poses a long-term risk to clouded leopard survival by altering forest ecosystems across South and Southeast Asia (Abedin *et al.*, 2024). Rising temperatures and shifting precipitation patterns are projected to reduce suitable habitat, potentially leaving up to 41% of the species' current range unsuitable under future climate scenarios (Abedin *et al.*, 2024).

Shifts in forest composition—from evergreen to deciduous or savanna-like ecosystems—will reduce the dense canopy cover critical for the species (Abedin *et al.*, 2024). These changes may also disrupt prey dynamics, such as fruiting cycles important to primates (Abedin *et al.*, 2024). Prolonged dry seasons are already intensifying wildfire risk in moist forest habitats, such as the Indo-Burma region, with fires documented in Myanmar and Thailand (Abedin *et al.*, 2024).

In montane regions, climate-induced upslope shifts of forest belts may shrink available habitat, especially in Nepal, Bhutan, and Northeast India, where elevation limits further expansion (Abedin *et al.*, 2024). Can *et al.* (2020) specifically highlighted the vulnerability of populations in higher-elevation areas of central Nepal. While warming in southern China might theoretically allow northward range expansion, human-dominated landscapes make such shifts unlikely (Abedin *et al.*, 2024).

3.1.7.4. Socioeconomic & Institutional Constraints

Clouded leopards face significant conservation challenges stemming not only from direct threats such as poaching and habitat loss but also from deeper socioeconomic and institutional barriers that impede adequate long-term protection. A significant challenge is the limited ecological and distributional data, particularly in Myanmar and India, where clouded leopards are being overlooked in conservation planning and most PAs still lack targeted surveys or monitoring (Gray *et al.*, 2021; Lyngdoh *et al.*, 2023).

Funding and institutional priorities tend to favour charismatic megafauna, such as tigers, elephants, and rhinoceroses, while smaller carnivores, like clouded leopards, remain marginalised in national strategies (Nowell & Jackson, 1996; Giordano, 2022). Unlike flagship programs such as Project Tiger, there is no national initiative for small cat conservation, though recent efforts are beginning to address this gap (Bhatt & Lyngdoh, 2023).

Many PAs are too small, poorly connected, or lack effective enforcement, and key populations also persist outside formal reserves—in CFs in Northeast India or in unprotected landscapes in Myanmar (Gray *et al.*, 2021; Lyngdoh *et al.*, 2023). Political instability, such as insurgencies in Nagaland and the Bodo unrest in Assam, has previously led to governance breakdowns and spikes in wildlife loss (Goswami & Ganesh, 2014; Bhatt & Lyngdoh, 2023).

Local communities in regions like Laos and Northeast India depend heavily on forests for subsistence (such as protein, fuelwood, and income). Practices such as shifting cultivation, bushmeat hunting, and opportunistic killing of predators persist due to limited livelihood alternatives (MacMillan & Nguyen, 2014; Gray *et al.*, 2017b; Giordano, 2022; Bhatt & Lyngdoh, 2023).

Enforcement agencies are often understaffed and under-equipped—sometimes with just one forest guard covering over 50 km² of rugged terrain—making anti-poaching efforts ineffective (Giordano, 2022; Lyngdoh *et al.*, 2023). Corruption, weak coordination, and inadequate cross-border collaboration further exacerbate illegal trade, particularly in hotspots such as the Golden Triangle (Oswell, 2010; Environmental Investigation Agency, 2019).

Public awareness and political will to protect and conserve clouded leopards remain low. Misidentification with other small felids, limited media visibility, and minimal donor interest have led to weak institutional momentum (Giordano, 2022; Lyngdoh *et al.*, 2023). While NGOs and conservation groups have started promoting small cat conservation (Nowell, 2007; WWF Malaysia, 2019), clouded leopards remain underrepresented in mainstream policy and funding frameworks.

3.2

Conservation Action Plan

The clouded leopard is among the most evolutionarily distinct and among the least studied felids in Asia, occupying a unique ecological niche as an arboreal predator in the forests of Northeast India and the Eastern Himalaya. Although widely distributed, the species persists at low densities and remains highly sensitive to canopy disruption, prey decline, and hunting. Its presence across multiple PAs, RFs, and community-managed landscapes underlines its role as an umbrella species, with conservation benefits extending to a range of forest-dependent fauna. However, systematic conservation efforts have remained marginal compared to other large cats, with management and monitoring largely centred on tigers.

Safeguarding the clouded leopard requires a shift from incidental protection to targeted, species-focused actions that address its unique ecological needs. Because it is an arboreal felid vulnerable to fragmentation, maintaining canopy continuity and ensuring transboundary landscape planning are central to its persistence. Community-managed forests in Nagaland and Meghalaya, the transboundary corridors of Arunachal, Assam, and Mizoram, and the elevational gradients of Sikkim and West Bengal (northern part) together form critical landscapes for long-term survival. By embedding the species within national and state-level conservation frameworks and aligning with local cultural values (such as its status as the state animal of Meghalaya), the clouded leopard can serve as both a flagship and an indicator of the health of India's eastern forests.

3.2.1. Goal

Conserving the clouded leopard in India requires a clear, integrated direction that recognises both its ecological significance and vulnerable conservation status. As a forest-dependent felid that occurs at low densities (partly due to its elusive behaviour and low detection probability) and across fragmented ranges, the clouded leopard serves as both a flagship and umbrella species for the conservation of Northeast India's evergreen and semi-evergreen forests.

The goal is to secure and sustain viable, interconnected populations of clouded leopards across their current distribution in India, while safeguarding ecological processes, habitat integrity, and community stewardship systems that are essential to their persistence.

3.2.2. Themes / Objectives

Conserving the clouded leopard requires an integrated framework that addresses both ecological and socio-political challenges. While habitat protection remains foundational, the species' persistence depends equally on maintaining functional connectivity across fragmented forests, mitigating threats from human activities, and embedding conservation into broader policy and governance structures. These priorities reflect the clouded leopard's wide distribution across multiple land-use types, including PAs, RFs, and CFs, where management approaches must be harmonised.

At the same time, conservation action must extend beyond conventional protection measures to embrace forward-looking strategies. Climate change adaptation, community participation, and education form critical pillars for ensuring resilience in rapidly changing landscapes. Building institutional and local capacities, strengthening research and monitoring frameworks (including for prey), and promoting awareness will be central to sustaining long-term efforts. Collectively, these objectives provide the scaffolding for a coordinated national strategy that aligns with state-level priorities and transboundary initiatives, ensuring that clouded leopard conservation contributes to broader ecological integrity and human well-being.

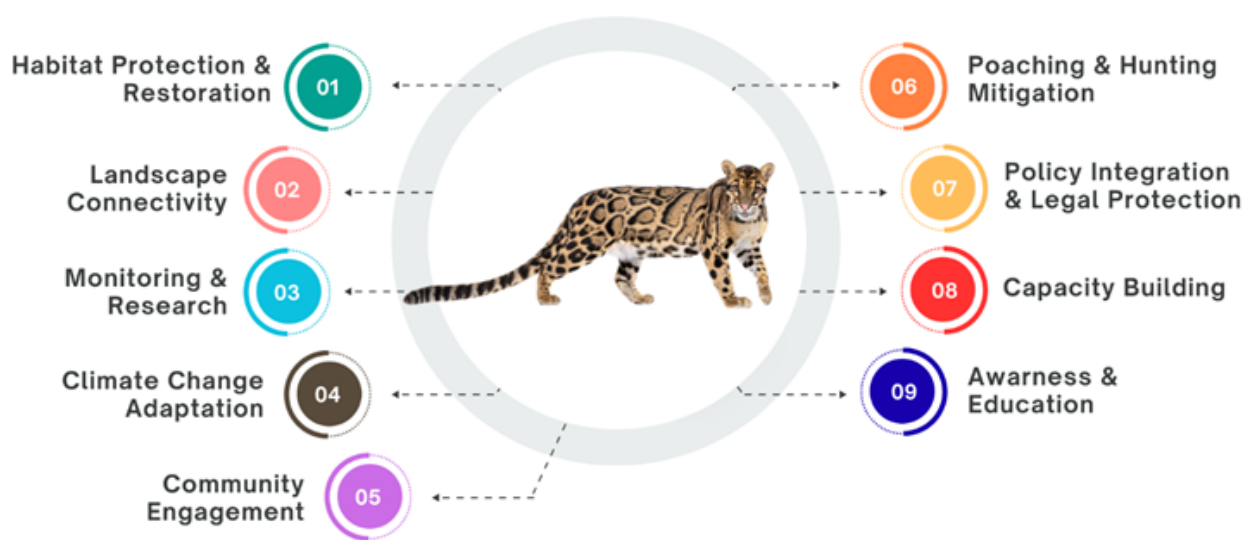


Figure 3.6.

Strategic framework for clouded leopard conservation in India. The diagram illustrates the nine thematic pillars of the clouded leopard Conservation Action Plan: (1) Habitat Protection & Restoration, (2) Landscape Connectivity, (3) Monitoring & Research, (4) Climate Change Adaptation, (5) Community Engagement, (6) Poaching & Hunting Mitigation, (7) Policy Integration & Legal Protection, (8) Capacity Building, and (9) Awareness & Education. Together, these interconnected themes underscore the need for integrated management approaches that span PAs, RFs, and community lands. They also emphasise transboundary collaboration, canopy continuity, and cultural values as central to ensuring the long-term survival of the clouded leopard in India's Northeast and Eastern Himalayan landscapes.

3.2.3. Shortlisting of Priority Landscapes

3.2.3.1. Criteria for Landscape Prioritisation

A combination of recent scientific evidence, spatial analyses, and expert knowledge will guide the process of shortlisting priority landscapes for clouded leopard conservation planning. Building on occupancy modelling outputs from Habib *et al.* (2025), historical records, and camera-trap detections, the approach will identify landscapes that not only support existing populations but also have high potential for undocumented occurrences. Emphasis will be placed on ecologically representative sites that capture the species' range of habitats and elevational gradients, while also addressing gaps in monitoring coverage. This strategic selection will ensure that the ensuing rapid assessments generate actionable data for conservation planning, habitat management, and connectivity maintenance at both regional and transboundary scales.

The shortlisting of landscapes for rapid field assessment of clouded leopards will follow a set of defined ecological, distributional, and management criteria to ensure selected areas yield the most relevant conservation insights. Priority will be given to:

- **Confirmed and potential presence:** Landscapes where recent camera-trap detections, occupancy modelling outputs (Habib *et al.*, 2025), or historical records indicate confirmed or likely occurrence of clouded leopards, especially in areas that have not undergone systematic surveys in recent decades.
- **Habitat quality and extent:** Large, contiguous forest tracts with high canopy cover, vertical stratification, and low levels of anthropogenic disturbance, spanning both primary and high-quality secondary forests.
- **Ecological representativeness:** The inclusion of diverse habitat types that cover the species' full elevational and ecological range—from lowland tropical forests and alluvial floodplains to montane and cloud forests—to capture variation in ecological conditions.
- **Connectivity potential:** Corridors and stepping-stone habitats linking core populations within and between states, and across international boundaries with Bhutan, Nepal, Myanmar, and Bangladesh, especially those identified through connectivity modelling.
- **Threat intensity:** Sites facing high anthropogenic pressures, including poaching, habitat loss from logging or shifting cultivation, and linear infrastructure development, where rapid assessment will provide time-critical data for intervention planning.
- **Governance diversity:** Inclusion of landscapes under different management regimes (PAs, RFs, and CFs), including transboundary PAs, to assess species occurrence and threats across governance types.
- **Feasibility of surveys:** Practical considerations such as terrain accessibility, seasonal constraints, field safety, and the availability of local partners and stakeholder support, ensuring that rapid assessments will be logistically viable.

Following the application of these prioritisation criteria, landscapes were shortlisted to ensure ecological and geographical diversity, representation across management regimes, and inclusion of sites with varying degrees of survey coverage. This approach combines confirmed detection sites with data-deficient but high-potential areas, as well as critical connectivity zones requiring urgent conservation attention. The resulting list of proposed priority landscapes serves as the basis for targeted monitoring, conservation interventions, and landscape-level management strategies.

3.2.3.2. Proposed Priority Landscapes

Based on the prioritisation criteria and the site-selection framework, 14 landscapes have been identified as priority landscapes for clouded leopard conservation in India. Together, these represent a balanced mix of confirmed occurrence areas, critical connectivity corridors, under-surveyed but ecologically significant habitats, and frontier landscapes essential for climate resilience. Importantly, the proposed sites can also be viewed in relation to the Brahmaputra River system, which acts as both a biogeographic barrier and a connectivity axis. The landscapes north of the Brahmaputra (*e.g.*, Sikkim–West Bengal, West Bengal–Assam, and Assam–Arunachal Pradesh) provide altitudinal linkages and critical transboundary corridors that connect to Nepal and Bhutan. In contrast, the south bank landscapes (*e.g.*, Kaziranga–Karbi Anglong–Intanki, Assam–Meghalaya hill corridors, and the Mizoram–Tripura) secure the last large contiguous forest tracts, while also supporting frontier linkages into Bangladesh and Myanmar. This north–south division is ecologically significant, as it highlights differences in habitat continuity, human pressures, and the role of transboundary cooperation in maintaining long-term connectivity.

North Bank Landscapes

(Brahmaputra north / Himalayan foothill–Assam–Arunachal complex)

- ✓ **L1. Sikkim – West Bengal; linked with Bhutan & Nepal (*Khangchendzonga NP – Kanchenjunga Conservation Area, Nepal – Singba WLS – Barsey WLS – Maenam WLS – Fambhonglho WLS – Kyongnosla Alpine WLS – Pangolakha WLS – Jigme Khesar Strict Nature Reserve, Bhutan – Neora Valley NP – Chapramari – Gorumara NP – Mahananda WLS – Senchal WLS – Singalila NP – Adjacent RFs*):** The Sikkim – West Bengal landscape, linked with Bhutan and Nepal, connects Khangchendzonga NP with a chain of PAs in Sikkim and West Bengal, extending into Kanchenjunga Conservation Area (Nepal) and Jigme Khesar Strict NR (Bhutan). It provides a complete altitudinal gradient and strong transboundary connectivity, though pinch-points in the Dooars (Neora–Gorumara axis) remain vulnerable.
- ✓ **L2. West Bengal – Assam; linked with Bhutan (*Jaldapara NP – Buxa TR – Manas TR – Adjacent RFs – Phibsoo WLS, Bhutan – Royal Manas NP, Bhutan – Jomotsangkha WLS, Bhutan*):** The West Bengal – Assam landscape, linked with Bhutan, connects Jaldapara NP, Buxa TR, and Manas TR with Bhutan's Royal Manas NP, Phibsoo WLS, and Jomotsangkha WLS. It forms one of the most important transboundary strongholds for clouded leopards, with Manas–Royal Manas–Phibsoo offering seamless connectivity, while the Buxa–Jaldapara corridor remains fragmented and requires restoration.
- ✓ **L3. Assam – Arunachal Pradesh (*Eaglenest WLS – Pakke TR – Itanagar WLS – Nameri TR – Sonai Rupai WLS – Adjacent RFs*):** The Assam – Arunachal Pradesh landscape links Eaglenest WLS, Pakke TR, Nameri TR, and Sonai Rupai WLS into a strong north bank complex, with Itanagar WLS connected through intervening RFs. The Eaglenest–Pakke–Nameri–Sonai Rupai axis is highly contiguous and ecologically significant, while the Pakke–Itanagar linkage is weaker due to urbanisation and habitat fragmentation.
- ✓ **L4. Arunachal Pradesh (*Talle Valley WLS – Yorde Rabe Supse WLS – Mouling NP – Dibang WLS – Mehao WLS – Adjacent RFs*):** The Arunachal Pradesh central cluster includes Talle Valley, Yorde Rabe Supse, Mouling, Dibang, and Mehao WLSs, together representing extensive high-elevation forests. Connectivity among these sites is weak and fragmented, with large rivers and human use creating natural barriers, so they function more as complementary refugia rather than a continuous corridor.



Clouded Leopard Pugmark
in Manas National Park

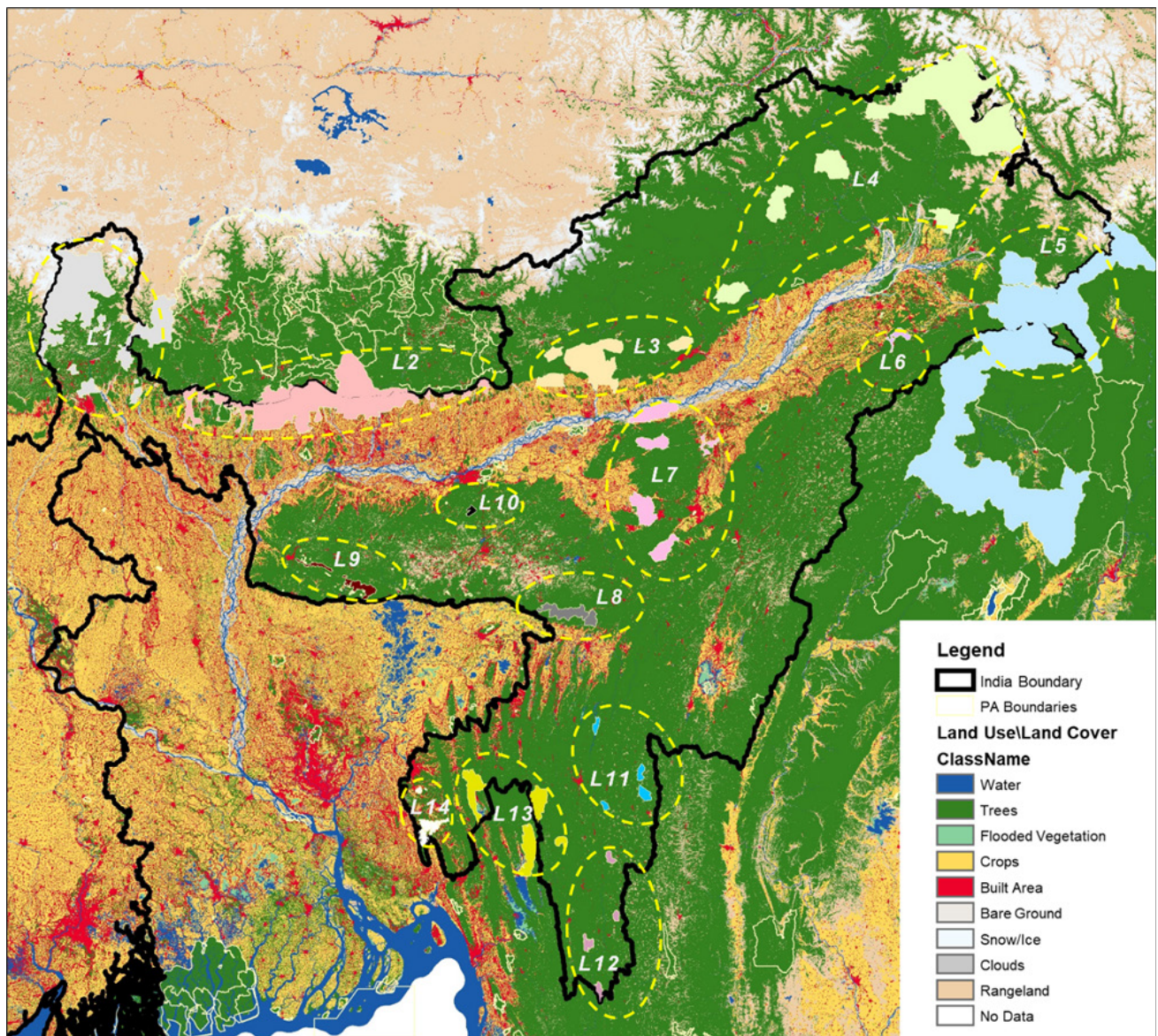


Figure 3.7.

Proposed priority landscapes (L1–L14) for clouded leopard conservation across Northeast India. The landscapes represent a mix of confirmed occurrence areas, potential connectivity corridors, and frontier habitats essential for long-term species persistence, divided across the north (L1–L4) and south banks (L5–L14) of the Brahmaputra River.

South Bank Landscapes

(Brahmaputra south/floodplain–hill complexes of Assam, Meghalaya, Mizoram, Tripura, Nagaland, Manipur)

- ✓ **L5. Arunachal Pradesh; linked with Myanmar (Namdapha TR – Hponkanrazi WLS, Myanmar – Hukaung Valley WLS, Myanmar – Kamlang TR – Adjacent RFs):** The Namdapha – Kamlang – Myanmar landscape forms one of the largest intact transboundary forest blocks in Asia, linking Namdapha TR and Kamlang TR with Myanmar's Hponkanrazi and Hukaung Valley WLSs. Connectivity is very strong between Namdapha, Kamlang, and Hponkanrazi, while the Namdapha–Hukaung linkage is weaker due to logging and mining pressures in Myanmar.
- ✓ **L6. Assam (Dihing Patkai NP – Adjacent RF):** The Dihing Patkai landscape represents the last remaining lowland rainforest complex of Assam, comprising Dihing Patkai NP and adjoining RFs such as Digboi, Dirok, and Jeyapore. While ecologically rich and critical for clouded leopards and other small cats, the area is severely fragmented by mining, oil exploration, and encroachment, making corridor restoration essential.
- ✓ **L7. Assam – Nagaland (Kaziranga TR – Karbi Anglong Hills – Intanki NP – Adjacent PAs/RFs/CFs):** The Assam–Nagaland landscape links Kaziranga TR, Karbi Anglong Hills (East Karbi Anglong, Nambor, Nambor-Doigrung, Garampani, Marat Longri WLSs), and Intanki NP into a critical south bank complex. Kaziranga–Karbi Anglong provides strong floodplain–hill connectivity, supporting dispersal of wide-ranging species. The Karbi Anglong–Intanki corridor is weak and fragmented, with pressures from encroachment, mining, and settlements reducing functional connectivity. Despite these challenges, the landscape remains ecologically significant for maintaining carnivore assemblages, including clouded leopard, tiger, leopard, and dhole, and for sustaining linkages between Assam's floodplains and the hill forests of Nagaland and Manipur.
- ✓ **L8. Assam – Meghalaya (Karbi Anglong Hills – Barail WLS – Narpuh WLS – Adjacent PAs/RFs/CFs):** The Assam – Meghalaya landscape links the Karbi Anglong Hills (RFs) with Barail WLS in Assam and Narpuh WLS in Meghalaya, forming a transitional hill corridor. While ecologically important, connectivity is weak and fragmented by mining, shifting cultivation, and linear intrusions in the Barail–Jaintia ranges, highlighting the need for corridor restoration and community-managed forest linkages.
- ✓ **L9. Meghalaya; linked with Bangladesh (Balphakram NP – Nokrek NP – Siju WLS – Baghmara Pitcher Plant WLS – Adjacent PAs/CFs):** The Meghalaya (Garo Hills) landscape includes Balphakram NP, Nokrek NP, Siju WLS, Baghmara Pitcher Plant WLS, and adjoining CFs. The Balphakram–Siju–Baghmara cluster retains moderate connectivity, whereas Nokrek remains largely isolated due to fragmentation caused by coal mining and jhum cultivation. Despite this, the complex is a biodiversity-rich stronghold with cross-border links to Bangladesh forests.
- ✓ **L10. Meghalaya (Nongkhylllem WLS – Adjacent PAs/CFs):** The Nongkhylllem landscape centres on Nongkhylllem WLS and adjoining PAs/CFs in northern Meghalaya. Though relatively small and semi-isolated, it supports rich biodiversity and functions as an important hill forest refuge, with potential to strengthen connectivity through surrounding community-managed forests.
- ✓ **L11. Mizoram; linked with Myanmar (Tawi WLS – Murlen NP – Lengteng WLS – Pualreng WLS – Adjacent PAs/RFs/CFs – Myanmar Forests):** The Mizoram – Myanmar (northern cluster) links Tawi WLS, Murlen NP, Lengteng WLS, and Pualreng WLS with adjoining RFs/CFs and Myanmar's Chin Hills forests. This complex retains high landscape connectivity, forming a critical Indo–Myanmar transboundary block, though pressures from shifting cultivation and logging in adjoining areas require close management.
- ✓ **L12. Mizoram; linked with Myanmar (Khawnglung WLS – Blue Mountain NP – Ngengpui WLS – Tokalo WLS – Adjacent RFs/CFs – Myanmar Forests):** The Mizoram – Myanmar (southern cluster) includes Khawnglung WLS, Blue Mountain (Phawngpui) NP, Ngengpui WLS, and Tokalo WLS, with adjoining RFs/CFs and linkages to Myanmar's forests. It forms the southern Indo–Myanmar frontier, maintaining moderate to strong connectivity, though fragmentation from shifting cultivation and settlements in the Lushai Hills poses growing challenges.
- ✓ **L13. Mizoram – Tripura; linked with Bangladesh (Dampa TR – Thorangtlang WLS – Adjacent RFs/CFs – Pabla khali WLS, Bangladesh – Gumti WLS):** The Mizoram – Tripura – Bangladesh landscape spans Dampa TR, Thorangtlang WLS, Gumti WLS, and adjacent RFs/CFs, extending into Bangladesh's Pabla khali WLS. It secures the last contiguous forests of the Lushai Hills and provides vital transboundary connectivity, though habitat loss and high human pressures along the frontier weaken functional corridors.
- ✓ **L14. Tripura; linked with Bangladesh (Sepahijala WLS – Clouded Leopard NP – Trishna WLS – Bison NP):** The Tripura–Bangladesh landscape includes Sepahijala WLS, Clouded Leopard NP, Trishna WLS, and Bison (Rajbari) NP, linked with the forests of Sylhet in Bangladesh. Though highly fragmented and relatively small, these sites act as stepping-stone habitats, retaining ecological value for clouded leopards amidst intense human pressures.

The inclusion of these fourteen landscapes in the action plan will generate critical insights into population status, habitat use, connectivity, and threats, while strengthening strategies for management effectiveness, community stewardship, and transboundary cooperation.

3.2.4. Assessment of Current Knowledge

The current understanding of clouded leopards in India is informed by recent MEE reports on TRs, NPs, and WLSs (Yadav *et al.*, 2023; Awasthi *et al.*, 2025), along with peer-reviewed studies, published reports, and grey literature documenting species records, habitat conditions, and conservation challenges. MEE evaluations reveal recurring management gaps, such as staff shortages, weak patrolling, limited funding, and ineffective corridor management, that contribute to habitat degradation, poaching pressures, and inadequate monitoring of lesser-known carnivores such as the clouded leopard. Despite these challenges, camera-trap detections, ecological observations, and site-specific studies confirm the species' continued presence across multiple landscapes, reaffirming its conservation importance.

The following landscape-wise accounts synthesise strengths, weaknesses, and ecological insights, combining MEE evidence with findings from ecological studies and community-managed forests not covered under formal evaluations. Given the species' wide but patchy distribution, such assessments are crucial for identifying strongholds, connectivity corridors, and management challenges.

Overall, the assessment highlights that while clouded leopards persist across multiple landscapes from the Himalayan foothills to the Indo–Myanmar, Indo–Bhutan, and Indo–Bangladesh frontiers, their conservation is compromised by limited systematic ecological research, the absence of long-term monitoring frameworks, and the increasing fragmentation of corridors. Large, contiguous forest habitats highlight the species' resilience. However, urgent attention is required in weaker landscapes, where ecological isolation and anthropogenic pressures threaten long-term persistence.



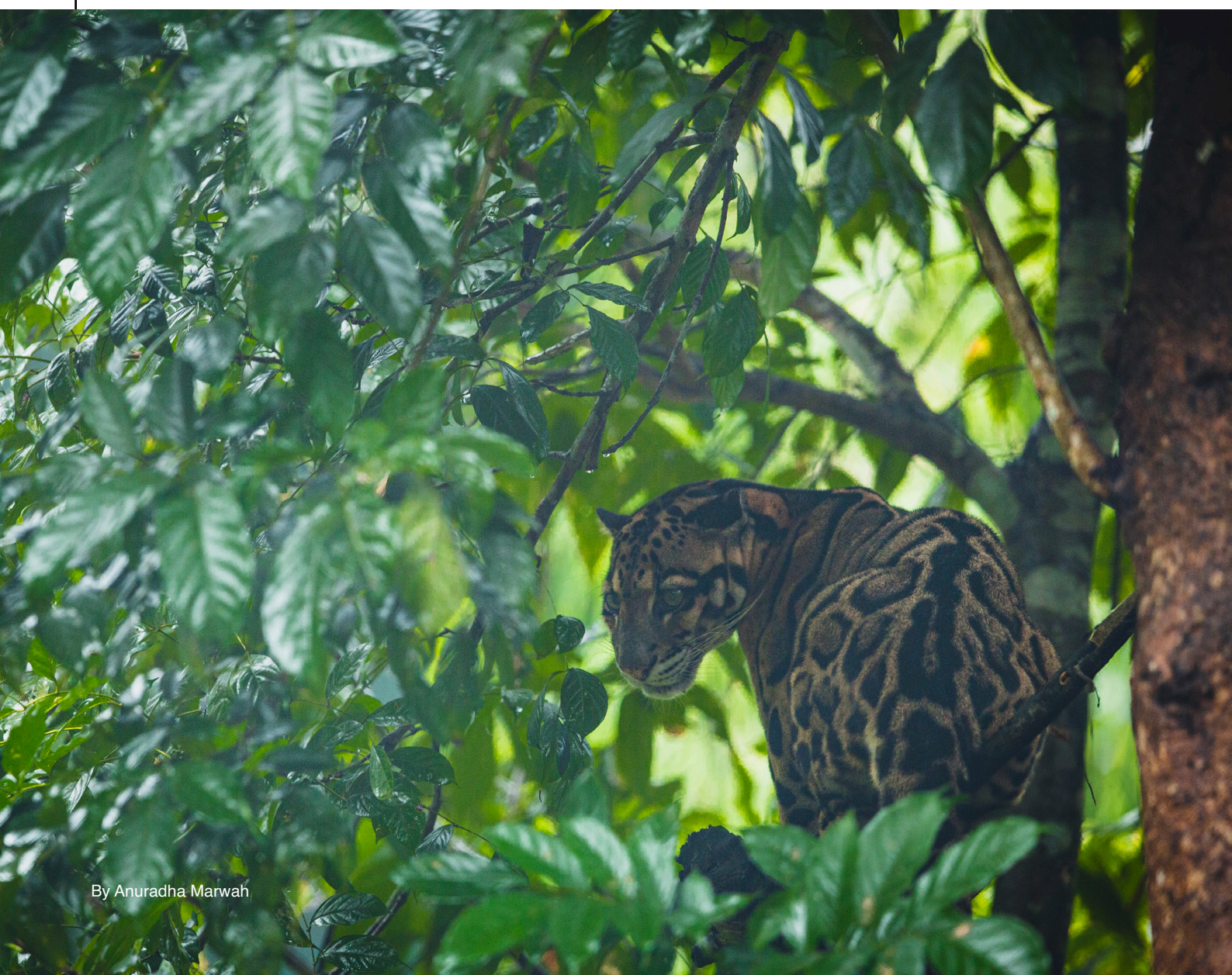
Table 3.8.

Major site-level strengths, weaknesses, and ecological insights for the clouded leopard across priority landscapes in India. The table synthesises findings based on the most recent MEE reports (Yadav *et al.*, 2023; Awasthi *et al.*, 2025), peer-reviewed ecological studies, and other published literature. For landscapes not covered by MEE (e.g., community-managed forests), information is derived from ecological field studies and published reports. “Site Strengths” reflect favourable habitat, connectivity, and management attributes; “Site Weaknesses” highlight systemic and site-specific threats; and “Ecological Insights” summarise species-specific observations critical for conservation planning. L1–L14 correspond to the proposed priority landscapes listed in Section 4.2.3.2.

Sites	Site Strengths	Site Weaknesses	Key Ecological Insight
L1	Intact altitudinal gradient from subtropical foothills to alpine forests; large PA cluster (Khangchendzonga, Neora Valley, Singalila, Senchal, Gorumara, Chapramari, Mahananda) provides connectivity; smaller WLSs (Barsey, Maenam, Fambhonglho, Kyongnosla, Pangolakha, Singba) act as stepping-stones; Khangchendzonga is a UNESCO World Heritage site; strong eco-tourism and community initiatives; transboundary links with Kanchenjunga CA (Nepal) and Jigme Khesar Strict NR (Bhutan).	Corridor pinch points in Dooars (Neora–Chapramari–Gorumara); high anthropogenic pressures from tea estates, highways, and settlements in the Siliguri corridor; heavy tourism load in the Sikkim and Darjeeling Himalaya; smaller WLSs face staff shortages and weak monitoring; habitat degradation in RF linkages.	Clouded leopard presence confirmed in Khangchendzonga, Neora, Singalila, Senchal, and Mahananda; records extend up to ~3,800 m in Sikkim; corridor forests between Neora–Singalila critical for movement; functions as a transboundary bridge linking Nepal, Bhutan, West Bengal, and Sikkim populations.
L2	Large contiguous forest block across the Indo–Bhutan border; Buxa, Jaldapara, and Manas harbour high biodiversity; Royal Manas and Phibsoo (Bhutan) strengthen cross-border connectivity; Manas is a UNESCO World Heritage site; community conservation and eco-tourism are improving stewardship.	Buxa–Jaldapara corridor fragmented by encroachment, grazing, and tea gardens; Jaldapara under pressure from railways and roads; Buxa faces staff shortages and weak monitoring; Manas continues to suffer from encroachment, grazing, insurgency pressures; weak interstate and international coordination.	Clouded leopard confirmed from Manas, Buxa, Jaldapara and RFs; part of a multi-carnivore guild with tiger, leopard, and dhole; transboundary dispersal documented between Manas–Royal Manas and Buxa–Phibsoo; landscape is a major stronghold for long-term connectivity between India and Bhutan.
L3	Eaglenest, Pakke, Nameri, Sonai Rupai, and Itanagar form a contiguous belt; Pakke has strong community engagement and eco-development; Nameri provides riverine–semi-evergreen forests linking with the Arunachal hills; Sonai Rupai acts as a buffer; RFs add ecological extension; landscape links Assam floodplains to the Himalayan foothills.	Pressures from jhum, grazing, encroachment, and road expansion; Itanagar faces urbanisation, hunting, and poor enforcement; Sonai Rupai is degraded by grazing and encroachment; Nameri is constrained by conflict and staff shortages; Pakke faces terrain challenges and settlement pressures; weak inter-state coordination.	Clouded leopard confirmed from Eaglenest, Pakke, Nameri; detections from Sonai Rupai and RFs support corridor value; species part of carnivore assemblage with tiger, leopard, dhole; elevational spread up to montane forests in Eaglenest; landscape critical for east–west connectivity across Arunachal–Assam foothills.
L4	Large intact forests across Dibang Valley, Mishmi Hills, and Dihang–Dibang BR; Talle Valley and Yordi Rabe Supse protect temperate–subtropical forests with orchids, pheasants, and carnivores; Mouling and Dibang secure vast elevational gradients with red panda, Mishmi takin, and snow leopard; Mehao has wetlands and mid-elevation forests; extensive RFs provide buffers and connectivity.	Acute staff shortages, poor infrastructure, limited research and management plans in smaller WLSs; Dibang faces poaching, grazing, road expansion, and shifting cultivation; Mehao suffers from encroachment, hunting, and weak eco-development; Mouling is limited by resource dependence and funding gaps; across sites, absence of systematic monitoring and weak institutional capacity.	Clouded leopard recorded in Mehao, Dibang, Mouling; presence across subtropical to montane forests; landscape is a stronghold for arboreal carnivores and east–west dispersal across central Arunachal; RFs enhance connectivity but threatened by extraction.
L5	Namdapha is among India’s largest and most biodiverse PAs, with intact lowland–montane forests; Kamlang adds complementary habitats; forms one of the largest intact transboundary forest blocks in Asia; connectivity with Hponkanrazi and Hukaung in Myanmar; globally important for tiger, clouded leopard, red panda, hornbills; extensive RFs maintain buffers.	Namdapha is under severe encroachment, hunting, staff shortages, weak protection, and difficult terrain; Kamlang is still consolidating and faces grazing, bamboo extraction, and weak eco-development; the Myanmar side is threatened by logging, mining, hunting, and encroachment; and there is an overall absence of systematic monitoring and weak transboundary governance.	Clouded leopard confirmed in Namdapha, Kamlang, RFs; species co-occurs with tiger, leopard, dhole; elevational range from lowland evergreen to montane forests; transboundary connectivity strong with Hponkanrazi, weaker toward Hukaung; overall, one of the last strongholds on the Indo–Myanmar frontier.

L6	Last significant lowland rainforest in Assam; high diversity including elephants, primates, hornbills, clouded leopard, marbled cat, leopard cat; adjacency of Digboi–Dirok–Jeyapore RFs expands habitat; recognised as conservation hotspot; potential for community-based eco-tourism and restoration.	Severe fragmentation from coal mining, oil exploration, tea estates, encroachment; high pressure from hunting, fuelwood, and grazing; absence of systematic research, monitoring, and a comprehensive management plan; staff shortages and poor protection infrastructure; broken connectivity between NP and RFs.	Clouded leopard confirmed in Dihing Patkai and Jeyapore RF; also holds marbled cats, leopard cats, Asiatic golden cats; supports critical lowland rainforest populations distinct from NE hill forests; RFs act as corridors but are rapidly degrading; restoration and corridor strengthening essential.
L7	Kaziranga is a UNESCO World Heritage site with strong protection, high prey biomass, and robust anti-poaching network; Karbi Anglong WLSs (East Karbi Anglong, Nambor, Nambor–Doigrung, Garampani, Marat Longri) provide critical hill cover and ecological contiguity; Intanki adds connectivity into Nagaland; landscape provides a vital floodplain–hill–upland complex.	Kaziranga faces flooding, invasive species, poaching, and infrastructure gaps; Karbi Anglong faces encroachment, mining, unregulated extraction, and staff shortages; Intanki faces weak monitoring and enforcement under hunting pressure; overall, corridor linkages are fragmented by settlements, mining, and roads.	Clouded leopard confirmed from Kaziranga, Karbi Anglong, and Intanki; species part of the carnivore guild with tiger, leopard, and dhole; Kaziranga–Karbi Anglong connectivity crucial for long-term persistence; Intanki provides ecological continuity into the Nagaland–Manipur hill forests.
L8	Karbi Anglong provides extensive hill forests contiguous with Kaziranga; Barail protects montane evergreen forests; Narpuh protects subtropical forests in the Jaintia Hills; CFs add buffers; the landscape acts as a transitional corridor between the Brahmaputra floodplains and the Meghalaya plateau.	Karbi Anglong forests are under severe pressure from encroachment, logging, shifting cultivation, and mining; Barail fragmented by mining, disturbance, poor staffing, and monitoring; Narpuh suffers from staff shortages, weak protection, and a lack of eco-development; across sites, connectivity is fragmented by roads and settlements; weak carnivore monitoring.	Clouded leopard confirmed from Karbi Anglong, Barail; potential in Narpuh but under-surveyed; corridor function between Assam hill forests and Meghalaya plateau important but degraded; urgent need for restoration of RF linkages and regulation of mining.
L9	Balphakram: large plateau forests with elephants, primates, and carnivores; Nokrek is a UNESCO BR with rich citrus diversity and elephant habitat; Siju protects caves and limestone ecosystems; Baghmara conserves rare <i>Nepenthes khasiana</i> ; CFs provide buffers; cross-border linkages with Bangladesh forests.	Balphakram is constrained by staff shortages, weak protection, insurgency, and limited eco-development; Nokrek suffers fragmentation from coal mining, jhum, staff and monitoring gaps; Siju is very small, with poor infrastructure, weak research and protection; Baghmara is limited by tiny size, staff shortage, grazing, plastic waste; overall severe fragmentation and weak integration of CFs.	Clouded leopard confirmed from Balphakram, Nokrek, Baghmara; multiple small cats also present; Balphakram–Siju–Baghmara retain moderate connectivity, while Nokrek is ecologically isolated; cross-border forests in Bangladesh provide dispersal opportunities, but corridors are shrinking.
L10	Nongkhylliem integrated with RFs and CFs; an important hill forest habitat for elephants, primates, and carnivores; ESZ proposed; local community support and cultural traditions provide buffers; functions as a small but important biodiversity refuge.	Small size and semi-isolation; absence of a management plan; staff shortages; weak monitoring; limited ecotourism and interpretation; pressures from jhum, fuelwood collection, and encroachment.	Clouded leopard recorded; presence of other small cats (marbled cat, leopard cat); acts as a stepping-stone between Kaziranga–Karbi Anglong to the north and Garo Hills to the south; requires systematic surveys and habitat linkage restoration.
L11	Large, contiguous hill forests with multiple PAs (Murlen, Lengteng, Tawi, Pualreng) creating a mosaic of protection; rugged terrain and bamboo-dominated forests support persistence of clouded leopard, small cats, primates, hornbills; community involvement in eco-tourism noted; overall landscape connectivity remains high.	Major pressures from jhum, illicit logging, and bamboo extraction; staff and funding shortages; weak enforcement; poor research and eco-tourism facilities; hunting and HWC persist; climate vulnerability from bamboo die-offs and erratic rainfall.	Clouded leopard confirmed across Murlen and Lengteng; species co-occurs with leopard, golden cat, marbled cat; transboundary linkages to Myanmar's Chin Hills critical for gene flow; requires bilateral and community-based corridor management.
L12	Blue Mountain protects montane forests of cultural and ecological value; Ngengpui and Tokalo secure foothill habitats; Khawnglung adds hill refugia; rugged terrain provides secure habitats; supports rich biodiversity, including clouded leopard, golden cat, marbled cat, leopard cat, elephants, and hornbills; and has potential for eco-tourism.	Jhum, logging, forest degradation around PA boundaries; staff shortage, weak enforcement, limited eco-development and research; hunting of ungulates, weak eco-tourism facilities; climate extremes (erratic monsoon, landslides) exacerbate threats.	Clouded leopard confirmed in Blue Mountain, Ngengpui; co-occurs with other small cats; connectivity to Myanmar (Chin Hills) moderately strong but threatened by jhum and settlements; requires corridor restoration and transboundary cooperation.

L13	Dampa is the largest PA in Mizoram, part of the Global Tiger Conservation Landscape; Thorangtlang expanded to 198 km ² , securing elephant and carnivore habitats; Gumti adds a wetland–forest interface; Pablakhali (Bangladesh) provides transboundary continuity; together they protect the last contiguous forests of the Lushai Hills; high diversity of clouded leopard, dhole, small cats, primates, hornbills.	Severe pressures from jhum, encroachment, poaching, and grazing; Dampa faces staff shortages, weak monitoring, and inadequate infrastructure; Thorangtlang is affected by ~20 fringe villages with heavy forest dependence; Gumti is under habitat loss, weak enforcement, and poor research; Pablakhali is heavily degraded by settlements and resource extraction; overall weak Indo–Bangladesh coordination.	Clouded leopard confirmed from Dampa and adjoining forests; species co-occurs with tiger, dhole, leopard cat; transboundary connectivity with Pablakhali and Gumti critical but weakened by habitat loss; landscape is one of the last large strongholds for carnivores in the Indo–Bangladesh frontier.
L14	Cluster of small PAs (Sepahijala, Clouded Leopard NP, Trishna, Bison) forms Tripura's core network; Sepahijala hosts India's only ex-situ clouded leopard breeding program with interpretation and awareness facilities; Trishna and Bison secure semi-evergreen forests contiguous with Sylhet forests (Bangladesh); community participation through EDCs and eco-tourism (nature trails, butterfly parks, botanical gardens).	Highly fragmented and small PAs with weak connectivity; heavy encroachment, grazing, fuelwood collection, and poaching; staff shortages, weak patrolling, poor monitoring and management plans; road networks and settlements fragment habitats; conflict with elephants and livestock grazing in Trishna and Bison NP.	Clouded leopard is historically recorded in Trishna and Sepahijala, though recent records are sparse due to limited surveys; Sepahijala's ex-situ program adds conservation value; Trishna and Bison act as stepping-stones linking with Sylhet forests; the landscape is primate-rich (Phayre's leaf monkey, capped langur, slow loris) with gaur, elephants, small cats, but long-term persistence depends on corridor restoration and Indo–Bangladesh cooperation.



3.2.5. Identification of Knowledge Gaps

The current synthesis of literature, reports, and credible media sources highlights the highly uneven state of knowledge on the clouded leopard across India's PA network. While species presence has been confirmed in most priority landscapes, systematic research on key ecological and conservation parameters remains extremely limited. Only a handful of sites, such as Manas TR (Assam) and Dampa TR (Mizoram), have generated robust data on density, activity patterns, habitat use, and interspecific interactions. In contrast, the majority of sites are represented solely by occurrence records, often from a single photographic capture, checklist, or anecdotal report.

Critical aspects of the species' ecology, including dispersal, home range, movement behaviour, prey use, and responses to human pressures, remain almost entirely unstudied in the Indian context. Similarly, information on genetics, health and disease, and impacts of climate change is absent or restricted to isolated captive or molecular studies, with little linkage to wild populations. Although hunting and poaching pressures have been documented in Mizoram, other threat-related studies are sparse and geographically restricted. This table underscores the need for a coordinated research agenda that systematically addresses these gaps, integrating ecological and management perspectives across landscapes to guide conservation planning.

Table 3.9.

Comprehensive knowledge gaps (gap analysis) in clouded leopard research, ecology, and conservation across landscapes and PAs in India, based on published studies, unpublished reports, and credible media sources. ✓ indicates that at least one source (peer-reviewed paper, technical report, government document, thesis, or credible media account) provides evidence for the parameter in the respective PA. X indicates the absence of any PA-specific evidence in the reviewed sources. L1–L14 correspond to the proposed priority landscapes listed in Section 3.2.3.2.

Landscapes (PA-wise)	Species presence	Density / abundance	Behaviour / activity	Habitat use	Food habits	Dispersal	Home range & movement	Intra / inter-specific interactions	Genetics	Climate change impacts	Connectivity / corridor modelling	Poaching & hunting	Human-wildlife conflict	Health / disease
L1														
Khangchend-zonga NP/ BR	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Barsey WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Fambhonglho WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Kyongnosla Alpine WLS	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pangolakha WLS	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Maenam WLS	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Singba WLS	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Neora Valley NP	✓	X	X	X	X	X	X	X	X	X	X	X	✓	X
Mahananda WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Gorumara NP	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chapramari WLS	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Senchal WLS	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Singalila NP	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
L2														
Jaldapara NP	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Buxa TR	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Manas TR	✓	✓	✓	✓	X	X	✓	✓	X	X	✓	X	X	X

L3														
Eaglenest WLS	✓	X	✓	X	X	X	X	✓	X	X	X	X	X	X
Pakke TR	✓	X	✓	X	X	X	X	✓	X	X	X	X	X	X
Itanagar WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Nameri TR	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Sonai Rupai WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
L4														
Talle Valley WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Yorde Rabe Supse WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Mouling NP	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Dibang WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Mehao WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
L5														
Namdapha TR	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Kamlang TR	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
L6														
Dihing Patkai NP	✓	X	X	X	✓	X	X	X	X	X	X	X	X	X
L7														
Kaziranga TR	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
East Karbi Anglong WLS (Karbi-Anglong)	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Nambor WLS (Karbi-Anglong)	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Nambor-Doi-grung WLS (Karbi-Anglong)	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Garampani WLS (Karbi-Anglong)	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Marat Longri WLS (Karbi-Anglong)	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Intanki NP	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
L8														
Karbi-Anglong	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Barail WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Narpuh WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
L9														
Balpakram NP	✓	✓	X	X	X	X	X	✓	X	X	X	X	X	X
Nokrek NP	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Siju WLS	✓	✓	X	X	X	X	X	✓	X	X	X	X	X	X
Baghmara Pitcher Plant WLS	✓	✓	X	X	X	X	X	✓	X	X	X	X	X	X
L10														
Nongkhylllem WLS	✓	✓	X	X	X	X	X	✓	X	X	X	X	X	X

L11														
Tawi WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Murlen NP	✓	X	X	X	X	X	X	X	X	X	X	✓	X	X
Lengteng WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Pualreng WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
L12														
Khawnglung WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Blue Mountain NP	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Ngengpui WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Tokalo WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
L13														
Dampa TR	✓	✓	✓	✓	X	X	X	✓	X	X	X	X	X	X
Thorangtlang WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Gumti WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
L14														
Sepahijala WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Clouded Leopard NP	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Trishna WLS	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Bison NP	X	X	X	X	X	X	X	X	X	X	X	X	X	X

3.2.6. Priority actions

Effective conservation of the clouded leopard requires translating the knowledge gaps and management challenges identified in the preceding sections into concrete, site- and theme-specific actions. The priority landscapes identified in this Action Plan represent the most critical strongholds for the species across India, securing a complete altitudinal range, critical corridors, and transboundary linkages with Bhutan, Nepal, and Myanmar. Within these landscapes, actionable strategies are needed to address both the ecological requirements of the species and broader management issues affecting PAs and adjoining RFs. The priority actions outlined here are structured around the nine thematic pillars of the conservation strategy. Each landscape section provides practical, site-specific actions drawn from MEE evaluations, published/unpublished studies, on-the-ground realities, and media reports, ensuring that the recommendations are both evidence-based and implementable.

L1. Sikkim – West Bengal; linked with Nepal and Bhutan (Khangchendzonga NP – Kanchenjunga Conservation Area, Nepal – Singba WLS – Barsey WLS – Maenam WLS – Fambonglho WLS – Kyongnosla Alpine WLS – Pangolakha WLS – Jigme Khesar Strict Nature Reserve, Bhutan – Neora Valley NP – Chapramari – Gorumara NP – Mahananda WLS – Senchal WLS – Singalila NP – Adjacent RFs)

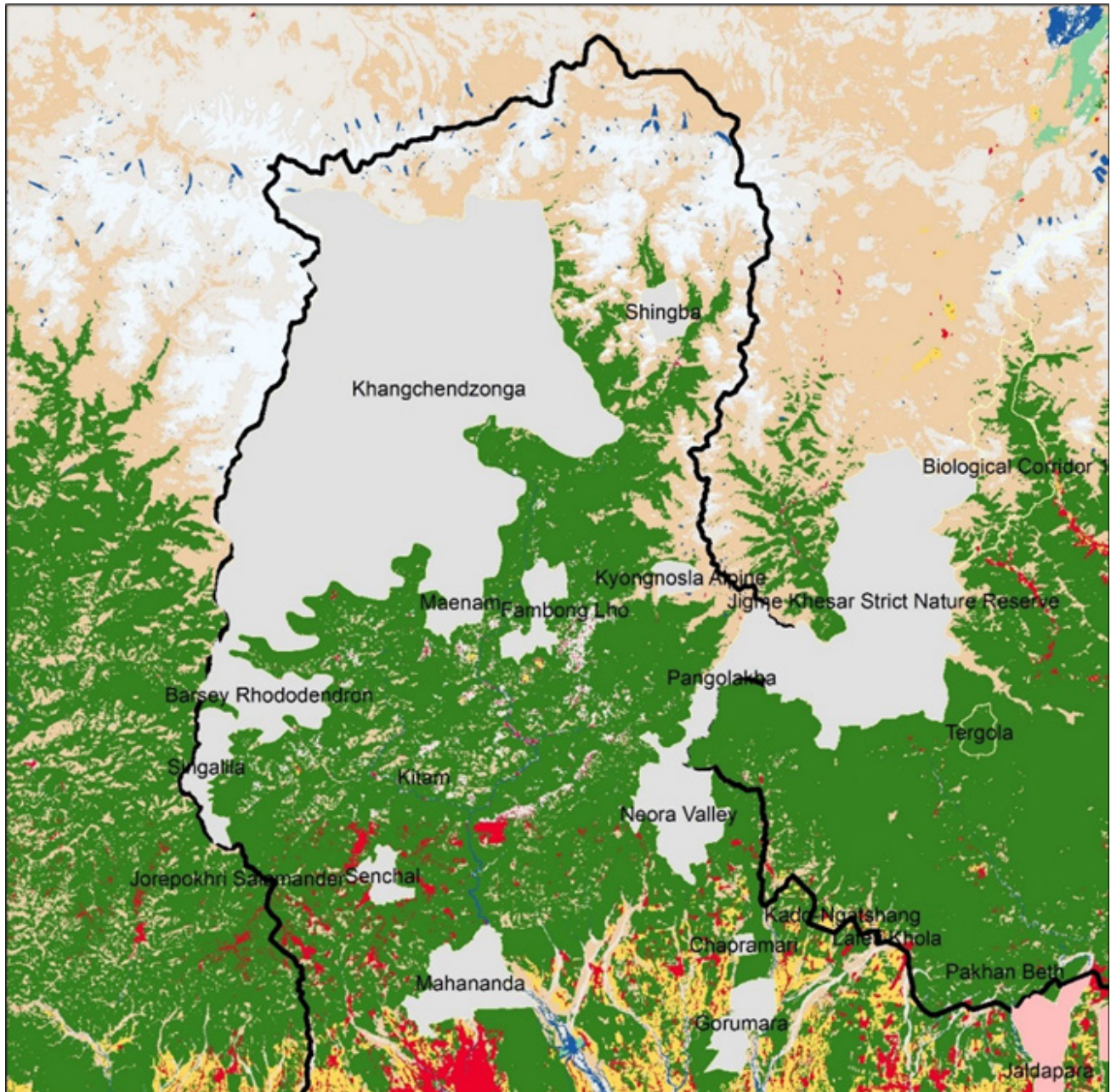


Figure 3.8.

Priority landscape (L1) for clouded leopard conservation in Sikkim–West Bengal and adjoining transboundary areas. The map shows the spatial extent of the Sikkim–West Bengal landscape (L1), connecting Khangchendzonga BR with a chain of PAs in Sikkim and West Bengal.

Table 3.10.

Thematic priority actions for clouded leopard conservation in the Sikkim–West Bengal (linked with Nepal & Bhutan) landscape (L1).

Themes	Priority Actions
Habitat Protection & Restoration	• Restore degraded patches through invasive control and assisted regeneration along tea-garden boundaries and riverine belts (Neora foothills, Gorumara–Chapramari). • De-silt and revitalise water bodies inside Gorumara/Chapramari to stabilise prey base and reduce dry-season stress. • Strengthen boundary demarcation (pillars, signage, fencing) in Neora, Mahananda and Senchal to prevent encroachments. • Regulate night traffic and enforce speed calming (NH31 near W. Bengal PAs, NH10/NH310 in Sikkim) with speed guns, rumble strips, and thermal cameras. • Explore MoUs with tea estates for effective conservation.
Landscape Connectivity	• Secure the Neora–Gorumara–Chapramari corridor (Dooars pinch-point) with ESZ notifications, eco-restoration, signage, and mitigation planning for linear projects. • Maintain Sikkim altitudinal linkages (Kyongnosla–Pangolakha–Maenam–Barsey–Singba) by stabilising landslip scars, preventing unmitigated road widening, and keeping trekking routes clean. • Strengthen transboundary micro-corridors by establishing joint patrolling and monitoring nodes at Pangolakha–Jigme Khesar (India–Bhutan) and Singalila–KCA (India–Nepal). • Upgrade ecologically critical RFs abutting Singalila/Mahananda (Darjeeling & Kalimpong divisions) into Conservation/Community Reserves.
Monitoring & Research	• Establish a unified camera-trap grid across Neora, Singalila, Mahananda, Gorumara–Chapramari and Sikkim WLSs to generate occupancy and activity updates. • Initiate non-invasive scat genetic studies for diet in Khangchendzonga NP and Sikkim WLSs, coupled with prey monitoring in Neora and Singalila. • Monitor corridor-use in Neora–Gorumara axis with camera traps and track plots; publish six-monthly status reports. • Develop a joint monitoring protocol with Bhutan and Nepal to enable data sharing and annual analysis workshops.
Climate Change Adaptation	• Conduct altitudinal shift modelling for clouded leopard habitat in Khangchendzonga, Kyongnosla and Pangolakha to identify refugia. • Treat chronic landslip zones along forest roads and bridle paths in Sikkim PAs; stabilise riparian buffers in Neora/Teesta tributaries with native planting. • Integrate mainstream climate risk strategies into PA management plans, including early-warning protocols for fire, storms, and heat.
Community Engagement	• Strengthen weak EDCs/JFMCs in Sikkim PAs with transparent micro-plans for anti-snaring, riverbank restoration and invasive control. • Conduct participatory threat-mapping in tea-estate margins and villages (Kalimpong, Darjeeling, Jalpaiguri) to locate snares, cattle-kill zones, and bushmeat routes. • Provide stall-feeding, predator-proof sheds, and quick compensation for livestock (poultry) losses around Dooars. • Promote organic/low-chemical buffer farming around Gorumara and Chapramari to curb pesticide drift; link with horticulture schemes.
Poaching & Hunting Mitigation	• Organise pre- and post-monsoon snare-removal drives in Chapramari, Mahananda, fringe RFs, and tea-estate belts. • Build intelligence networks and conduct periodic checks at weekly markets and roadside eateries to monitor the bushmeat trade. • Undertake joint patrols with Bhutan along the Pangolakha–Jigme Khesar route, using interoperable radios and shared patrol schedules. • Create prosecution-support cells to fast-track wildlife crime cases; ensure forensic sampling within 48 hrs.
Policy Integration & Legal Protection	• Notify or strengthen ESZs in Neora–Gorumara–Chapramari and Singalila fringes to regulate quarries, resorts, and linear intrusions. • Integrate clouded leopard corridors into district/state DPRs for roads and other infrastructure; mandate wildlife passages in new/widened alignments. • Sign MoUs between Forest, PWD, Tourism, and the Tea Board for signage, speed regulation, and responsible tourism. • Propose Community/Conservation Reserves for critical RF links identified through modelling.
Capacity Building	• Fill sanctioned vacancies of frontline staff in Neora Valley NP, Chapramari WLS, Mahananda WLS, Senchal WLS and Singalila NP; rationalise beat boundaries. • Train staff in SMART/e-patrolling, GIS, wildlife crime handling, non-invasive genetics, and camera-trap management. • Provide essential equipment: night-vision scopes, speed guns, GPS, body-cams, and repair/upgrade patrolling tracks. • Upskill eco-guides in Gorumara–Chapramari and Singalila to include small cats and canopy carnivores in visitor interpretation.

Awareness & Education	• Modernise interpretation centres in Neora and Chapramari with bilingual exhibits, clouded leopard displays, and QR-coded trails. • Develop clouded-leopard school kits for Darjeeling, Kalimpong and East Sikkim schools; host an annual “Lesser Cats Week.” • Partner with local newspapers and FM radio to discourage bushmeat and snaring, while highlighting conservation success stories. • Launch citizen-science photo-reporting modules (with geo-blurring) in state wildlife apps to record incidental sightings.
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L2. West Bengal – Assam; linked with Bhutan (Jaldapara NP – Buxa TR – Manas TR – Adjacent RFs – Phibsoo WLS, Bhutan – Royal Manas NP, Bhutan – Jomotsangkha WLS, Bhutan)

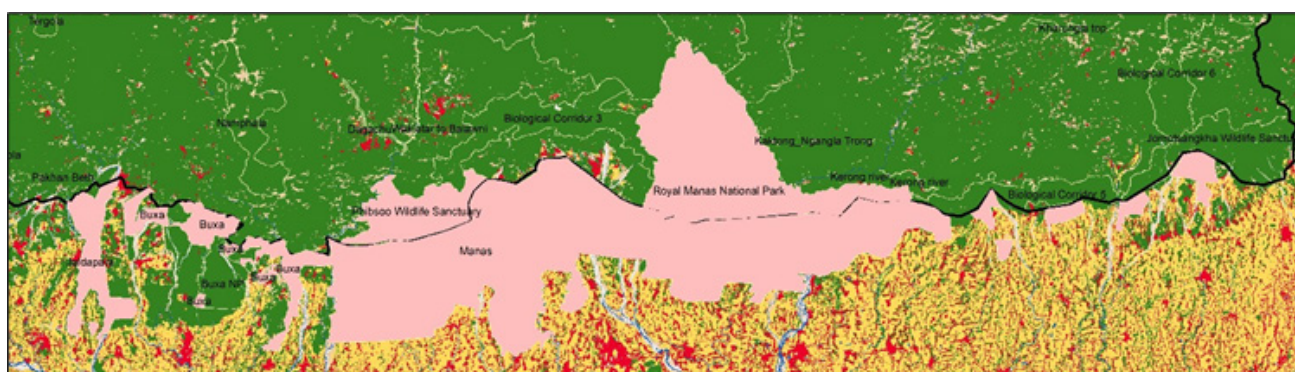


Figure 3.9.

Priority landscape (L2) for clouded leopard conservation in West Bengal – Assam (linked with Bhutan) and adjoining transboundary areas. The map highlights key PAs and RFs forming the West Bengal–Assam–Bhutan landscape.

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Table 3.11.

Thematic priority actions for clouded leopard conservation in the West Bengal–Assam (linked with Bhutan) landscape (L2).

Themes	Priority Actions
Habitat Protection & Restoration	• Expedite the relocation of notified forest villages from the Buxa TR core (e.g., Bhutia Basti, Gangutia) following due process and providing adequate compensation packages. • In Jaldapara NP, proactively manage grasslands and fire, control invasive weeds, repair/maintain water sources (Torsa and channels), and close illegal entry points. • In Buxa TR, step up weed removal and grass-slip planting in degraded blocks and old plantation areas. • Minimise night disturbance.
Landscape Connectivity	• Prepare and implement a Buxa–Jaldapara corridor restoration plan across the tea-garden/settlement matrix (secure wayleaves, small acquisitions/easements, assisted natural regeneration, riparian buffers). • Use tea-estate MoUs for guard lines and weed control. • Coordinate with railways/NH for speed limits, signage and wildlife crossings at Jaldapara’s road/rail pinch-points to cut mortality. • Keep the Manas–Royal Manas–Phibsoo link seamless through synchronised patrolling and joint seasonal closures on both sides of the border. • Use Conservation Reserve/ESZ zoning over key choke points between Buxa–Jaldapara and in adjoining RFs to legally secure corridor lands.
Monitoring & Research	• Implement the dedicated proposal (noted in MEE) for special protection and research on clouded leopard in Buxa TR, including habitat enrichment plantations, wetland creation, and systematic long-term monitoring. • Equip protection camps with adequate Android/M-STrIPES devices; train and refresh staff regularly for data collection and adaptive use. • Issue and enforce SOPs for record-keeping, complaint handling, protection monitoring and animal sightings across TR ranges. • Compile all published studies from Buxa/Manas/Jaldapara, identify research gaps, and roll out a long-term research plan focused on small cats (occupancy, behaviour, prey base, snaring risk). • Maintain clouded-leopard camera-trap/occupancy sampling in Buxa–Jaldapara and along transboundary beats, building on recent confirmations from Buxa, Jaldapara and nearby PAs.

Climate Change Adaptation	- In Manas TR, maintain/expand tall-grass blocks and riparian buffers to withstand extreme floods and channel shifts; prioritise early desilting of tourism roads, culverts post-monsoon. - Control invasive weeds (e.g., <i>Chromolaena</i>, <i>Mikania</i>) across Buxa and Jaldapara and reseed with native grasses.
Community Engagement	- Activate JFMC/EDC micro-planning and roll out Eco-Development Programmes in all Buxa fringe villages; tie participation to patrolling support and no-poaching pledges. - In Jaldapara, resolve enclave villages and reduce resource pressure via negotiated relocation/voluntary resettlement and livelihood support (rhino-tourism revenue sharing, skill programs). - Develop cross-border community dialogues with Royal Manas/Phibsoo fringe villages to reduce snaring and bush-meat trade on both sides.
Poaching & Hunting Mitigation	- Fill vacancies, constitute mixed foot/vehicle patrols along porous tea-garden edges, and intensify border patrols with SSB/Forest Protection Force. - Target snaring/bush-meat hunting and illicit felling in Buxa's 46 fringe villages, 34 tea gardens and 37 forest villages through focused operations and market surveillance. - Standardise case documentation and evidence management to aid prosecution; link seized-skin/photo databases with NTCA/WCCB.
Policy Integration & Legal Protection	- Constitute/operationalise LAC for Buxa to regulate eco-tourism and support corridor-friendly land-use. - Ensure timely APO and fund releases by State/NTCA to avoid missing seasonal works (fire lines, grass planting, road maintenance). - Notify/prioritise Conservation Reserve status for critical Buxa–Jaldapara links in adjoining RFs; align with ESZ conditions and district land records. - Enforce speed limits for roads and rail through Jaldapara and ensure signage at accident-prone curves/bridges.
Capacity Building	- Fill sanctioned frontline vacancies and stabilise protection presence—especially in Buxa TR, where ~56% posts were vacant. - Develop specialised in-house training modules for Buxa staff; maintain training records; prepare a staff development plan; extend social security benefits to casual workers (e-Shram, Ayushman). - Regular M-STrIPES refreshers for field staff; pair with practical GIS/SMART/camera-trap data management sessions. - Strengthen interpretation and visitor management capacity (briefing system, materials) beginning with Manas (Bagori) and outreach points in Jaldapara/Buxa.
Awareness & Education	- Upgrade interpretation centres (start with Manas Bagori) and institute mandatory pre-entry briefings for visitors and drivers. - Use bilingual signage and rail-station/roadside messaging in the Jaldapara–Hasimara–Falakata belt to promote speed, snare reporting, and small-cat conservation. - Publicise recent clouded-leopard confirmations from Buxa/Jaldapara to build local pride; run school/college talks and citizen-science photo modules with geo-blur for sensitive locations.

L3. Assam – Arunachal Pradesh (Eaglenest WLS – Pakke TR – Itanagar WLS – Nameri TR – Sonai Rupai WLS – Adjacent RFs)

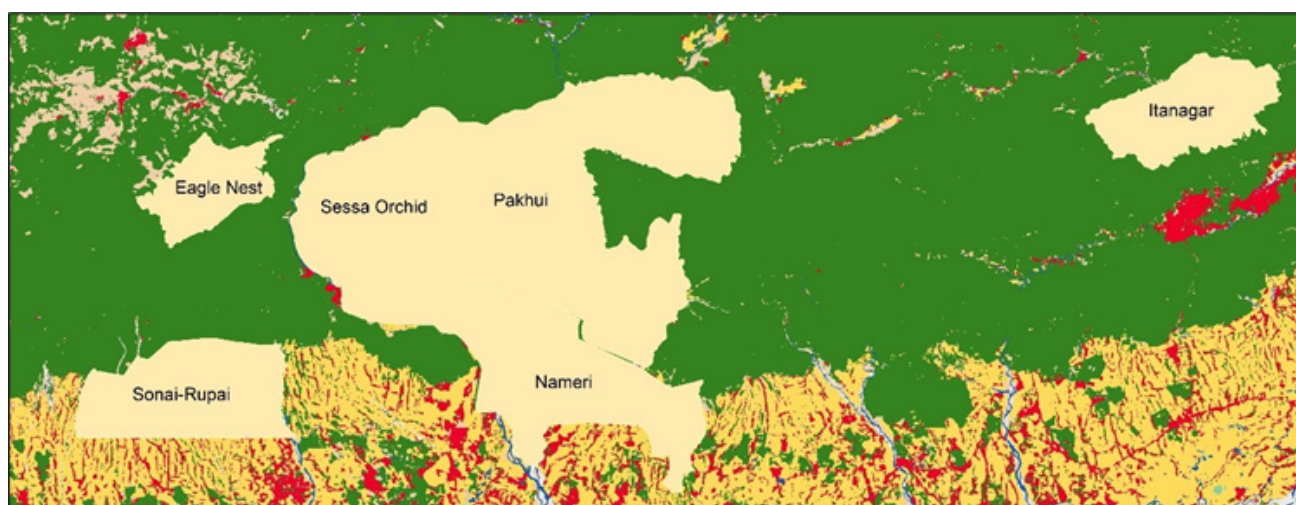


Figure 3.10.

Priority landscape (L3) for clouded leopard conservation in Assam–Arunachal Pradesh. The map shows the Assam–Arunachal Pradesh landscape (L3), including various PAs and adjacent RFs, which together form a critical habitat complex for clouded leopards. The landscape provides important connectivity across the Himalayan foothills and requires targeted conservation interventions to address threats such as fragmentation, hunting, and human disturbance.

Table 3.12.

Thematic priority actions for clouded leopard conservation in the Assam–Arunachal Pradesh landscape (L3).

Themes	Priority Actions
Habitat Protection & Restoration	• Fill sanctioned frontline vacancies and equip Anti-poaching Camps (APCs) across Pakke and Nameri TRs; restore staff housing and basic amenities (solar power, water, wireless). • Complete boundary survey, pillar repair and signage for Itanagar and Sonai Rupai WLSs; remove fresh encroachments and halt new road cuts/laying of utilities inside notified PA limits. • CAMPA-fund assisted natural regeneration in degraded edges of Sonai Rupai and adjacent RFs (Sonitpur) and in community land fringing Eaglenest; prioritise native bamboo, canes and fruiting trees to stabilise gullies and improve arboreal connectivity for clouded leopard. • Reclaiming and desilting of perennial waterholes and nala plugs in dry foothill beats of Pakke/Nameri; fencing (bio-fencing) elephant depredation hotspots bordering farmland rather than inside the core.
Landscape Connectivity	• Notify and manage a Pakke–Eaglenest–Singchung–Tenga corridor package by stitching PA, Singchung Bugun CR and adjacent RFs; regulate quarrying and hill cutting on the Tenga–Shergaon road. • Restore the Nameri–Sonai Rupai–adjacent RFs link (Sonitpur) by invasive removal (<i>Mikania</i>, <i>Lantana</i>), riparian planting along Jia-Bhoroli/Doigrung, and negotiated gap-planting across narrow tea-estate bottlenecks. • Maintain seasonal “canopy bridges” (retained climbers/bamboo culms) along powerline/road verges used by arboreal fauna; avoid hard pruning during breeding season. • With the Assam & Arunachal PWD/NH authorities, install wildlife underpasses and speed-calming measures, and signage on NH-15 (Nameri frontage) and key approach roads to Itanagar WLS to reduce roadkill.
Monitoring & Research	• Specifically monitor clouded leopard and other co-predators in Pakke TR (as strongly emphasised by MEE), using long-term camera-trap and occupancy frameworks integrated with tiger monitoring. • Establish a landscape camera-trap grid spanning Eaglenest–Itanagar–Nameri–Sonai Rupai and adjacent RFs using standard protocols; include a few arboreal camera placements for clouded leopards. • Begin occupancy & connectivity modelling (SCR/SECR + least-cost paths) to prioritise corridor tracts and tea-estate pinch points (Sonitpur); repeat every 2–3 years. • Standardise snare/illegal-activity recording (SMART/HAWK/Suraksha) with monthly analytics shared across Assam–Arunachal divisions. • Initiate diet/prey assessments (ungulate/rodents/primates/galliformes) with scat metabarcoding and CTDS; link findings to habitat restoration sites.
Climate Change Adaptation	• Map climate-refugia (north-facing slopes, perennial streams) in Eaglenest and Pakke; prioritise these for fire-line maintenance and exclusion of intensive tourism. • Expand water security: gravity-fed tanks/solar pumps to remote guards’ camps; revive check-dams in dry beats of Nameri/Sonai Rupai. • Integrate forest-fire early warning and prescribed cool-season burns in leaf-litter-rich Sal/banj-oak interfaces to protect canopy and coarse woody debris used by clouded leopards.
Community Engagement	• Reactivate/strengthen EDCs/JFMCs around Pakke & Nameri with micro-plans that fund tea-bush shade-tree planting, bamboo craft value chains and LPG/clean-cooking coverage to reduce fuel-wood dependence. • Co-develop community patrolling beats (Bugun, Nyishi, Mising villages) along RF edges and key trails; provide honoraria and identity gear; set up women’s SHGs for eco-services/handicrafts. • Resolve legacy tenure/boundary disputes around Itanagar WLS and select Sonitpur RFs through participatory demarcation, grievance redressal and livelihood packages tied to conservation compliance. • Promote community-run visitor services (homestays, porter/guide system) at Eaglenest/Singchung, with caps on numbers and strict codes (no spotlighting, drone ban).
Poaching & Hunting Mitigation	• Intensify snare sweeps pre- and post-monsoon across all PAs/RFs; destroy recovered wire stockpiles; conduct quarterly joint operations with STF/Police along inter-state routes and in bazaars. • Operationalise fully-equipped Rapid Response Teams in Pakke and Nameri with wildlife crime kits, tranquiliser capacity and 24x7 hotline; maintain cross-border information exchange with Royal Manas/Phibsoo units for trade intel. • Regulate night traffic and impose speed limits on NH-15, which skirts Nameri; implement a seasonal night closure on select forest roads (Beat permission system). • Targeted outreach to reduce opportunistic trapping of small cats (jaw-traps, bird-lime) near settlements; incentivise snare-free village declarations.
Policy Integration & Legal Protection	• Notify/strengthen ESZs for Itanagar and Sonai Rupai WLSs with explicit restrictions on new stone quarries, sand mining in critical rivers (Jia-Bhoroli/Doigrung) and linear intrusions through identified corridors. • Fast-track settlement of rights and relocation by consent from fresh encroachments inside Sonai Rupai and sensitive beats of Nameri; ensure fair R&R and post-relocation livelihood support. • Issue divisional Standing Orders on road works: no widening or hill-cutting during bird breeding months; mandatory wildlife clearances and EMPs in corridor polygons shared by both states. • Formal inter-state coordination cell (Assam–Arunachal) meeting quarterly at the FD/DFO level for patrol intelligence, tourism regulation on shared rivers, and joint actions in RF connections.

Capacity Building	• Annual joint field trainings (Assam & Arunachal staff) on arboreal carnivore sign recognition, canopy-cam deployment, SECR analytics, and legal procedures; include Judiciary/Police sensitisation. • Provide essential equipment: night-vision scopes, GPS, range finders, bodycams, power banks, field uniforms; create divisional repair-and-spares cells. • Establish a landscape GIS cell (Tezpur/Seijosa) for patrol planning, corridor monitoring and encroachment watch, with interns from local universities. • Prepare a vet/forensics roster (Khanapara/ICAR) for carcass necropsies, DNA of seized parts, and chain-of-custody adherence.
Awareness & Education	• Upgrade interpretation centres at Nameri and Pakke with bilingual panels on lesser cats; add “canopy life” exhibits and QR-coded trails. • Develop clouded-leopard school kits for Tezpur/Seijosa/Bhalukpong clusters; run a yearly “Lesser Cats Week” with nature clubs and NSS units. • Partner with local media/FM radio to discourage bushmeat and snaring; showcase success stories of EDC-led conservation and snare-free villages. • Launch a citizen-science photo-reporting module (with geo-blurring) in state wildlife apps to log incidental sightings, tracks and snares.

L4. Arunachal Pradesh (Talle Valley WLS – Yorde Rabe Supse WLS – Mouling NP – Dibang WLS – Mehao WLS – Adjacent RFs)

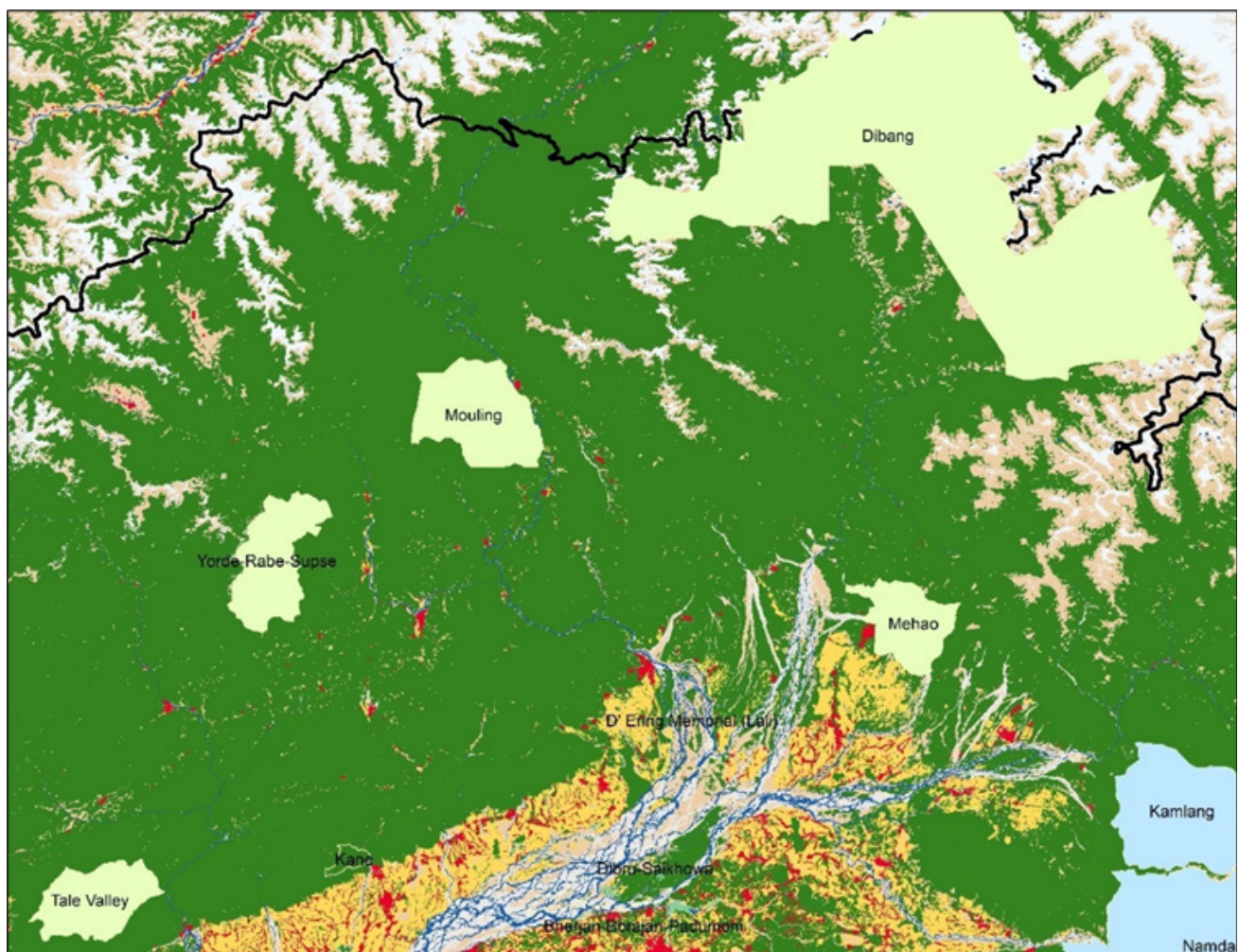


Figure 3.11.

Priority landscape (L4) for clouded leopard conservation in Arunachal Pradesh. The map depicts the central Arunachal Pradesh priority landscape, comprising various PAs, intervening forested tracts, and river systems. This complex of contiguous montane forests and riverine valleys provides critical habitat for clouded leopards and supports high biodiversity, including red pandas, takins, and Asiatic black bears.

Table 3.13.

Thematic priority actions for clouded leopard conservation in the Arunachal Pradesh landscape (L4).

Themes	Priority actions
Habitat Protection & Restoration	- Complete boundary survey and physical demarcation (pillars, signage) in Talle Valley, Mehao and Dibang WLSSs, followed by a time-bound encroachment removal plan. - Restore degraded fringes through assisted natural regeneration around Mehao wetlands and settlement edges; prioritise native cane/bamboo and fruiting trees that support small-prey recovery. - Prepare micro-plans for water-source protection and small check-dams in the dry slopes of Mouling and Talle to reduce erosion in jhum-affected catchments. - Institute strict work protocols for road works (no night work, spoil containment, wildlife passes where needed) in Dibang and Mehao to curb habitat damage from road expansion.
Landscape Connectivity	- Notify/strengthen conservation in adjacent RFs that currently provide buffers and movement space; halt new extraction permits in identified link patches between Yorde Rabe Supse – Talle – Mouling – Dibang. - Secure river-valley crossing points (Siang/Dibang tributaries) by maintaining riparian forest strips and keeping new embankments vegetation-lined. - Map and notify village conservation areas that stitch Mehao–Dibang mid-elevation forests to surrounding RFs.
Monitoring & Research	- Establish a unified, annually repeated camera-trap/occupancy grid across Mehao, Dibang and Mouling to track clouded leopards and key prey; integrate spoor and interview surveys in Talle and Yorde Rabe Supse, where access is difficult. - Extend monitoring into non-state/CF areas adjoining the PAs through participatory camera trapping and data sharing with village councils. - Create a shared dataset (metadata standards, GPS/photo protocols) for all divisions to close the “absence of systematic monitoring” gap.
Climate Change Adaptation	- Identify and manage high-elevation refugia and seasonal use zones in Dibang Valley/Mishmi Hills; schedule pre- and post-monsoon patrols/monitoring when upslope movements are likely. - Maintain/restore native broadleaf cover along ridge lines to keep microclimate and prey resources for arboreal carnivores. - Incorporate climate-risk screens (landslides, flood pulses on the Siang system) into annual work plans and beat priorities.
Community Engagement	- Reactivate/strengthen EDCs/JFMCs around Mehao, Dibang, and Mouling; co-design village rules for hunting, dog control, and fuelwood extraction; link to small grants for clean energy and orchards. - Support community-led patrolling in sensitive corridors (e.g., RF links between Talle–Yorde Rabe Supse and Mouling–Dibang). - Develop community-based bird/forest tourism at safe sites (interpretation huts, homestay standards) to reduce reliance on resources.
Poaching & Hunting Mitigation	- Quarterly anti-snare/anti-trap sweeps with geo-tagged evidence; prioritise Dibang areas where hunting pressure is noted; ensure destruction and chain of custody of seized gear. - Enforce no-hunting zones and community accords; targeted outreach on penalties and species protection, addressing demand for pelts/canines. - Equip Rapid Response teams for night patrolling along motorable tracks and new roads in the Mehao/Dibang area.
Policy Integration & Legal Protection	- Expedite ESZs implementation around Mehao, Mouling and Talle; regulate quarrying, new roads and power lines through mandatory wildlife clearances. - Issue divisional orders to pause the issuance of new extraction permits in RF corridors until connectivity plans are finalised. - Institutionalise inter-division coordination (Pasighat–Roing–Anini) for joint operations where pressures span PA/RF boundaries.
Capacity Building	- Urgently fill frontline vacancies, post beat staff to sensitive beats, and provide long-range radios, GPS, and field camping kits—addressing the widespread staffing and infrastructure gaps. - Train staff and community patrollers in arboreal-carnivore sign ID, evidence handling, and smart patrolling (spatial effort mapping). - Set up a small regional Wildlife Crime Cell node at Roing with links to Anini/Yingkiong for quick intelligence flow.
Awareness & Education	- Roll out bilingual education modules (Adi, Idu Mishmi, and Hindi/English) for schools around Roing, Anini, and Yingkiong on small cat conservation and legal provisions. - Install low-impact interpretation at approved viewpoints/roadheads to reduce off-trail entry and disturbance in Mehao and Mouling. - Promote citizen reporting of illegal hunting/snares by uploading geo-blurred photos through division WhatsApp helplines.

L5. Arunachal Pradesh; linked with Myanmar (Namdapha TR – Hponkanrazi WLS, Myanmar – Hukaung Valley WLS, Myanmar – Kamlang TR – Adjacent RFs)

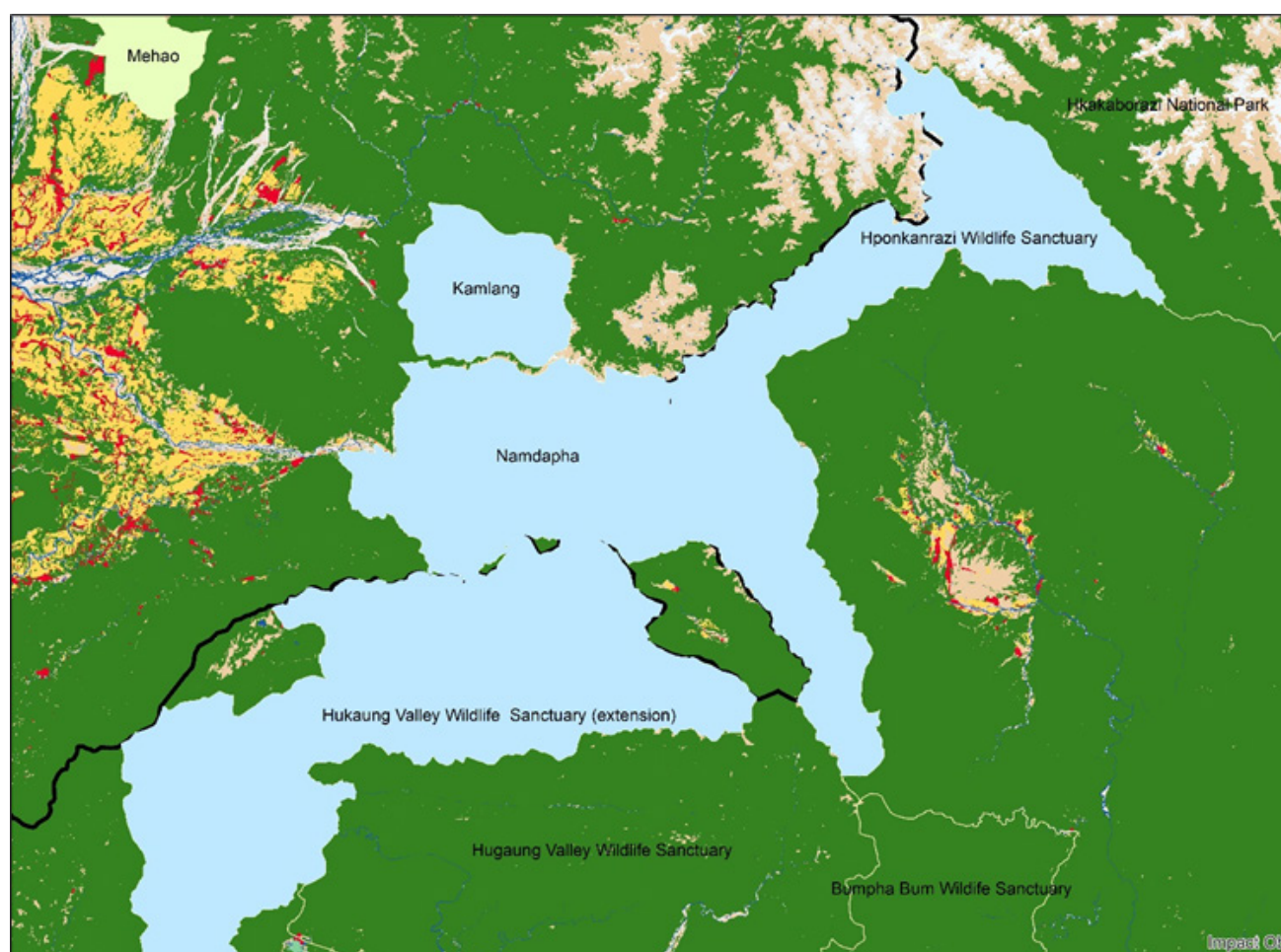


Figure 3.12.

Priority landscape (L5) for clouded leopard conservation in Arunachal Pradesh, linked with Myanmar. Map showing the extent of forest cover, PAs and their connectivity with transboundary sites in northern Myanmar. The figure highlights intact habitats and corridors that are critical to ensuring landscape-scale persistence of clouded leopards and other sympatric carnivores.

Table 3.14.

Thematic priority actions for clouded leopard conservation in the Arunachal Pradesh (linked with Myanmar) landscape (L5).

Themes	Priority Actions
Habitat Protection & Restoration	- Complete ground demarcation and pillar repair of core/buffer in Namdapha and Kamlang TRs; clear encroachments along river islands and valley bottoms. - Prepare/notify micro-plans for fringe villages, prioritising fuelwood alternatives and controlled grazing zones. - Restore degraded patches (old jhum/abandoned clearings) with native cane, bamboo and mixed ever-green species; avoid monoculture. - Maintain/repair anti-erosion measures on key rivers (e.g., Noa-Dihing) to reduce flood-driven habitat loss inside TRs.
Landscape Connectivity	- Notify & manage Kamlang–Namdapha–Hukanjuri–Deban RF link roads as “wildlife corridors” in Working Plans; restrict night traffic, enforce speed calming and zero new quarrying on corridor sections. - Initiate a joint Namdapha–Kamlang–Hponkanrazi–Hukaung (IN–MM) corridor working group for data-sharing on elephant/carnivore movements and snare hotspots; synchronise seasonal patrolling on border ridges and passes. - Secure riparian belts along the Noa-Dihing & Kamlang rivers as continuous movement strips; prioritise eviction of fresh sandbar farming inside the core.
Monitoring & Research	- Establish a unified, TR-wide camera-trap grid (clouded leopard, dholes, leopard cats) coordinated between Namdapha & Kamlang; repeat every 2–3 years. - Start snare-index and encounter-rate monitoring on all patrol routes (SMART/Android) and publish quarterly dashboards. - Commission rapid occupancy modelling for clouded leopard across RFs south of the TRs to refine corridor priorities. - Launch targeted arboreal-camera pilots (over trails/salt licks) and train staff in tree-mounted traps and rope-access. - Partner with local universities for prey assessments and road-kill logging along Miao–Vijoyanagar & Deban–Hornbill stretches.
Climate Change Adaptation	- Map & protect high-elevation refugia and cool riparian groves used in drought months; keep fire lines minimal in wet evergreen belts and ban summer grass burning. - Integrate landslide/flood risk in beat-level patrolling plans; pre-position supplies/boats at flood-prone camps (Deban, Hornbill, Embyong). - Climate-proof camps (raise plinths, solar lighting, water harvesting) and include heat/rain gear in SOP kits.
Community Engagement	- Activate/strengthen EDCs around Miao, Diyun, Vijoyanagar and Kamlang fringe; deliver LPG/clean energy, stall-feeding & NTFP value-addition linked to conservation agreements. - Roll out participatory anti-snare drives and a “no-wire, no-snare” pledge with village councils; establish community hotlines offering rewards for information. - Develop community-guided trekking/birding routes outside the core (season-bound) to provide regulated livelihoods while reducing illegal entry.
Poaching & Hunting Mitigation	- Intensify foot patrols along known hunting ingress routes (Vijoyanagar–Dapha bum trails; border ridge paths to Hponkanrazi) with seasonal joint ops and a permanent informant network. - Conduct monthly snare-sweeps in riverine/scrub edges and along logging tracks; destroy seized wire stores; maintain geo-tags of hotspots. - Establish a Rapid Response Team for each Miao & Jairampur range; equip with boats, night optics, first-aid, and satellite communication for deep-field ops. - Regular market checks (Miao, Jairampur, Nampong) for wild meat/skins with the district police & STF; ensure chain of custody and fast-track prosecution.
Policy Integration & Legal Protection	- Finalise Tiger Conservation Plans (TCP) updates for both TRs, including a dedicated clouded-leopard module (monitoring, connectivity, snare control, human–wildlife interface). - Bring critical RF links into ESZ notifications where pending; align Forest Working Plans with corridor prescriptions. - Issue district orders to regulate road-widening, bridges and stone quarries within 10 km of TR boundaries; mandatory wildlife clearance & mitigation designs. - Formalise SOP for joint India–Myanmar coordination (customs, IB/Assam Rifles/Forest) on cross-border wildlife crime.
Capacity Building	- Fill all sanctioned frontline vacancies; recruit/retain local youth as STPF/Forest Guards; institute annual refresher on SMART, evidence handling, and human rights-compliant enforcement. - Hands-on training for arboreal camera-trapping, rope work, river patrolling & flood rescue; certify staff as instructors for scaling up. - Establish a Field Skills Hub at Deban (Namdapha) with a gear bank (including GPS, night optics, camera traps, and climbing kits) and a repair workshop.
Awareness & Education	- Co-create multilingual (Hindi/Assamese/Arunachali/Thai-Kachin) outreach on clouded leopard and snaring impacts; use local FM stations, schools, and monasteries. - Install interpretation panels at Deban, Hornbill, and Kamlang gates, highlighting corridor links to Myanmar and legal penalties for hunting/trade. - Promote citizen-science photo-reporting with geo-blur for fringe villages; channel tips to RRTs.

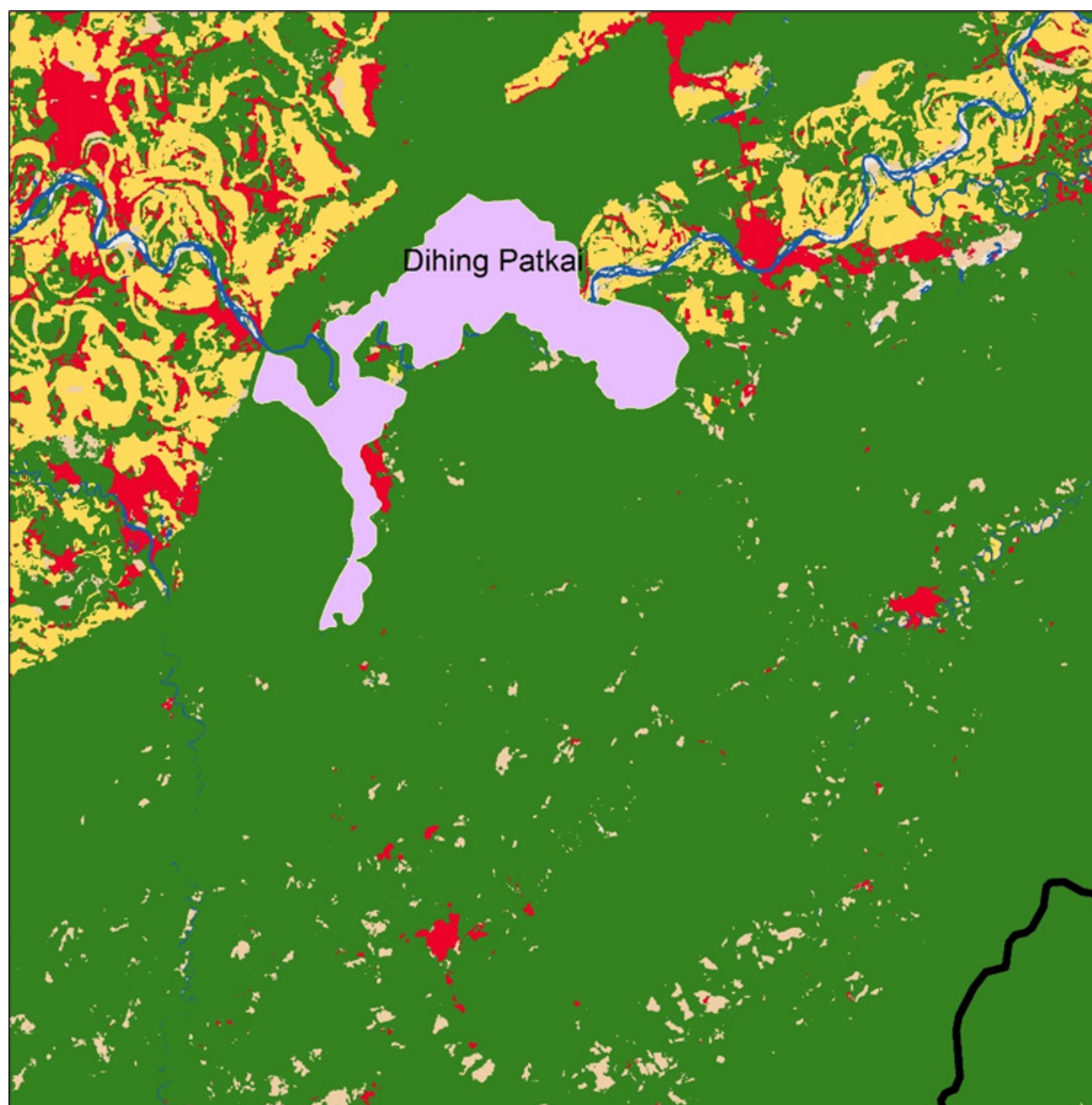


Figure 3.13.

Priority landscape (L6) for clouded leopard conservation in Assam. Map illustrating forest cover, Protected Area boundaries, and surrounding land use in the Dihing Patkai landscape of upper Assam. The figure highlights intact forests and fragmented edges that are critical for maintaining habitat connectivity and reducing pressures from encroachment, mining, and the expansion of linear infrastructure.

Table 3.15.

Thematic priority actions for clouded leopard conservation in the Assam landscape (L6).

Themes	Priority Actions
Habitat Protection & Restoration	• Notify, demarcate, and physically mark the NP–RF boundaries; clear encroachments through due process. • Prepare and implement a site-specific habitat restoration plan for degraded RF compartments (abandoned coal/stone extraction patches, fire-affected areas) using native evergreen species. • Institute seasonal closure and rapid-response protocols for forest fires; equip frontline staff with blowers and fire lines in vulnerable RF beats. • Regulate and rehabilitate old extraction tracks inside RFs; convert critical ones to patrol paths and close the rest.
Landscape Connectivity	• Secure legal, on-ground corridor links between Dihing Patkai NP and adjoining RFs (Jeypore–Upper Dihing blocks) by notifying eco-sensitive/corridor zones and integrating them into district land-use plans. • Prioritise underpasses/guarded crossings at rail and road pinch points used by wildlife; fence approach stretches where necessary, in consultation with the Railways/NHAI. • Undertake negotiated relocation/compensation for new linear infrastructure proposals that sever NP–RF connectivity; require wildlife passage designs at DPR stage. • Promote community forestry in tea-estate fringes to create shaded native buffers along estate–forest edges.
Monitoring & Research	• Establish a landscape camera-trap grid (NP + RFs) for clouded leopard and prey; repeat every 2–3 years to gauge trends. • Start systematic snare and hunting-sign surveys and map hotspots to guide patrols. • Deploy a rail/road wildlife mortality monitoring log (with GPS) to feed into mitigation design. • Partner with local universities/NGOs for diet, activity-pattern, and occupancy studies; archive data on WII/NIC portals.
Climate Change Adaptation	• Maintain/restore riparian belts along the Burhi Dihing and tributaries to reduce erosion and retain moist refugia. • Identify high-risk fire and drought areas; pre-position water tanks and salt licks for prey where appropriate. • Include climate risk screening in working plans of adjacent RFs and estate-level CSR planting drives.
Community Engagement	• Strengthen and fund EDCs/JFMCs around NP–RF fringes with performance-linked micro-plans (NTFP value-addition, fuel-efficient cookstoves, homestead horticulture). • Create estate-level MoUs with tea companies for joint patrolling of estate–forest edges, waste control, and quick reporting of wildlife emergencies. • Operationalise youth “Green Brigades” for fire prevention, snare-free drives, and stream clean-ups; provide safety gear and small incentives.
Poaching & Hunting Mitigation	• Intensify foot-patrol coverage in RF beats historically affected by hunting; adopt SMART/PAWS for patrol planning and evidence capture. • Institute targeted night patrols on market days/festivals when hunting risk spikes; coordinate with police on highway checks. • Run a metal-snare buyback and scrap-collection scheme via EDCs; quarterly snare sweeps in hotspot coupes. • Train staff to investigate online wildlife trade signals (messaging apps/social) and work with the State WL Crime Control Unit for prosecutions.
Policy Integration & Legal Protection	• Finalise a unified Dihing Patkai NP–RF Landscape Action Plan aligned to the Assam Working Plan Code and NP Management Plan, with corridor maps notified in revenue records. • Ensure strict enforcement of the 2021 NP notification—no fresh mining/boring inside NP; expedite closure and ecological restoration of legacy pits in RFs per court/government orders. • Notify and manage ESZ with graded regulation of high-impact activities (quarries, brick kilns, sawmills) around NP gates and RF chokepoints.
Capacity Building	• Fill frontline vacancies; equip each beat with GPS, camera, first-aid, and SMART-compatible mobiles; maintain a repair fund for field gear. • Conduct annual trainings on evidence documentation, cybercrime basics for wildlife cases, and humane conflict response. • Cross-post short staff exchanges with nearby PAs (Kaziranga/Manas/Nameri) to learn best-practice patrolling and casework.
Awareness & Education	• Run estate-and-village outreach on the legal status of clouded leopard and trade penalties; develop Assamese/Adivasi-language IEC on snare risks and rail safety near forests. • Create school nature clubs with forest walks and camera-trap “citizen science” days; display corridor maps at GP/tea-estate offices. • Partner with media for effective conservation.

L7. Assam – Nagaland (Kaziranga TR – Karbi Anglong Hills – Intanki NP – Adjacent PAs/RFs/CFs)

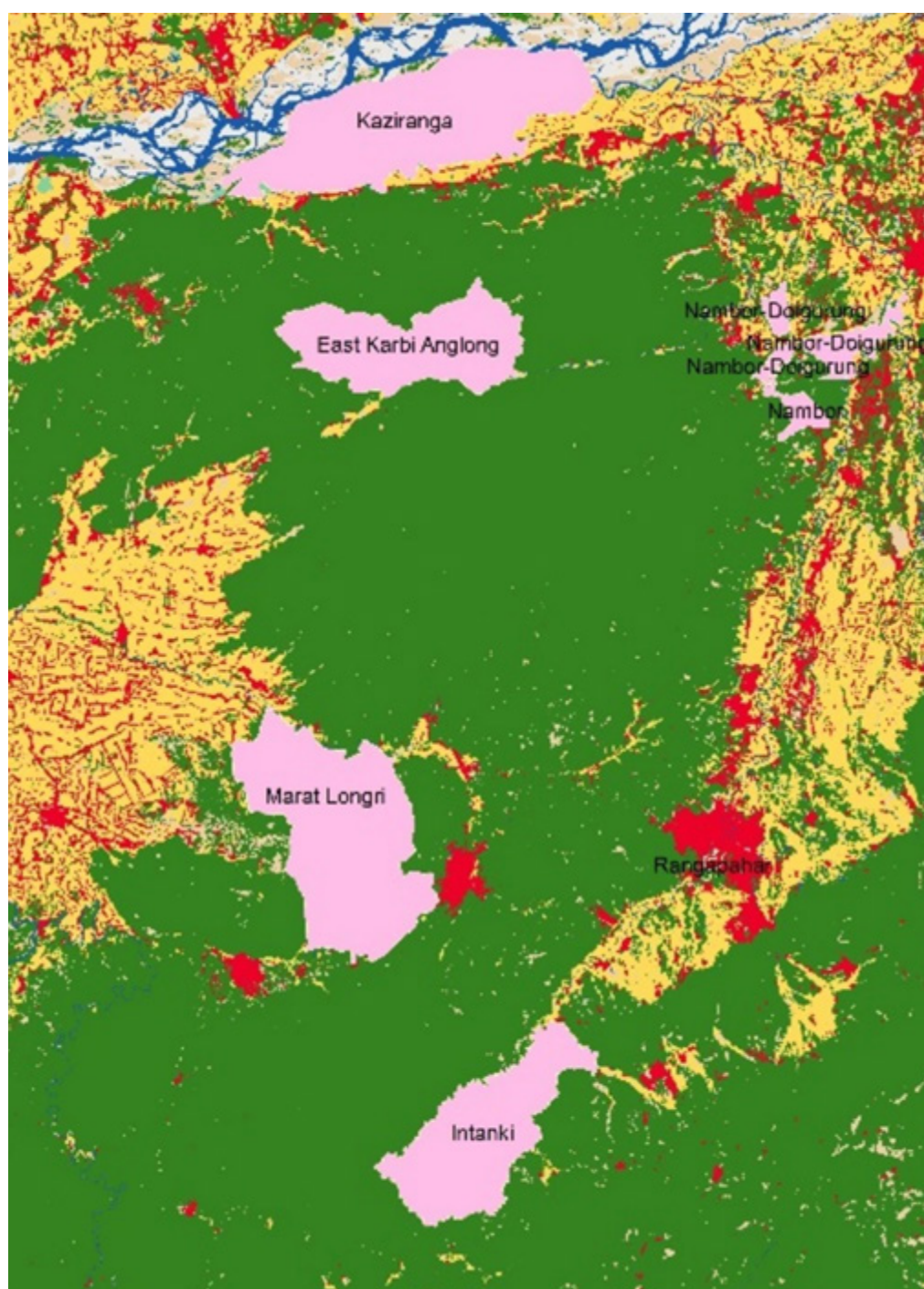


Figure 3.14.

Priority landscape (L7) for clouded leopard conservation in the Assam–Nagaland region (Kaziranga TR – Karbi Anglong Hills – Intanki NP – Adjacent PAs/RFs/CFs). The map illustrates the extent of forest cover, PAs, RFs, and CFs across the Kaziranga–Karbi Anglong–Intanki landscape in Assam and Nagaland. It highlights intact habitats, fragmented edges, and potential connectivity corridors critical for maintaining landscape-scale conservation of clouded leopards.

Table 3.16.

Thematic priority actions for clouded leopard conservation in the Assam–Nagaland landscape (L7).

Themes	Priority Actions
Habitat Protection & Restoration	- Kaziranga: Maintain/raise highlands and natural mounds as flood refugia; restore eroded grasslands and control invasive <i>Mimosa/Lantana</i> along floodplains. - Karbi Anglong WLS: Demarcate PA boundaries on the ground; fence/mark critical edges only where human safety demands; accelerate removal of invasive shrubs and replant with native evergreen species. - Intanki NP: Complete boundary rationalisation and pillar repair; initiate assisted natural regeneration in degraded jhum fallows that abut the NP. - Landscape-wide: Notify/strengthen ESZs to regulate quarrying, sand mining and linear works near PA edges; rehabilitate abandoned tea/stone extraction sites with native trees.
Landscape Connectivity	- Kaziranga → Karbi Anglong: Legally secure and actively manage the NH-37/515 underpasses/animal crossing stretches; prevent new resorts, brick kilns or petrol pumps in known corridor cells (Hollongapar–Kaziranga side and Kaziranga–Karbi Anglong foothills). - Karbi Anglong WLSs (East Karbi Anglong, Marat Longri, Nambor/Doigrung, Garampani): Prepare a single “Karbi Anglong Connectivity Plan” that maps village forests and RFs linking south to Intanki; prioritise community conservation areas in gap patches. - Intanki NP: Identify and secure the Intanki–Marat Longri–Diphu sector through joint patrolling MoUs between Assam & Nagaland divisions; keep new farm roads gated. - Landscape-wide: Utilise land swaps or compensatory afforestation to widen pinch points and riparian connectors used by clouded leopards and other mesocarnivores.
Monitoring & Research	- Landscape-wide: Establish a coordinated camera-trap grid (shared design, 2–3-year cycle) across Kaziranga, the five Karbi Anglong WLSs and Intanki to track clouded leopard occupancy and prey; integrate with NTCA/MEE indicators. - Conduct sign surveys and eDNA sampling at corridor bottlenecks to validate clouded leopard use. - Kaziranga: Add flood-season telemetry on small and medium cats to understand refuge use. - Karbi Anglong & Intanki: Initiate community ungulate counts in village forests that serve as feeding corridors. - Create a single shared data repository (state forest servers) with standardised metadata.
Climate Change Adaptation	- Kaziranga: Pre-position boats, fuel, rations and mobile APCs for peak floods; maintain elevated patrol tracks and animal rescue SOPs. - Karbi Anglong WLSs: Stabilise landslide-prone slopes with bio-engineering; climate-proof bridges/culverts on key patrol routes. - Intanki: Develop a fire management plan that incorporates early-season controlled burns and community fire lines to mitigate late-season wildfires. - Landscape-wide: Maintain riparian buffers (≥50 m) along all streams that drain from hills into floodplains.
Community Engagement	- Activate/strengthen EDCs/JFMCs around each PA with micro-plans focused on fuelwood alternatives, stall-feeding, and NTFP value-addition; link to state livelihoods missions. - Set up community conservation areas in gap patches between Marat Longri–Nambor and Intanki sides; provide boundary signage and small conservation grants. - Create participatory grazing regulation around Garampani/Nambor-Doigrung to reduce edge degradation. - Establish grievance redress and benefit-sharing protocols for tourism jobs near Kaziranga and Karbi Anglong.
Poaching & Hunting Mitigation	- Landscape-wide: Intensify joint night patrols across the Assam–Nagaland boundary (Diphu–Peren axis) using a common radio channel and sharing weekly intelligence. - Build village-level informer networks targeting wire snaring and the bush meat trade; fast-track the prosecution of organised hunting cases. - Intanki & Karbi Anglong: Seasonal patrolling surge during festivals/market days; conduct snare-sweeps along ridge trails and jhum peripheries; incentivise snare-free villages. - Kaziranga: Maintain riverine patrols during floods; equip teams with thermal binoculars for night checks.
Policy Integration & Legal Protection	- Notify missing ESZs and update those under revision around all five Karbi Anglong WLSs and Intanki to include critical RFs/CFs. - Issue district orders to prevent new stone quarries, brick kilns, and sawmills from operating within mapped corridors. - Include corridor cells in District and State GIS-based land-use plans; require wildlife passage audits for any highway or transmission upgrades between Kaziranga, Karbi Anglong, and Intanki. - Explore upgradation/clubbed management units for the five Karbi Anglong WLSs to enable a single budget and annual plan.
Capacity Building	- Fill sanctioned frontline vacancies; provide hill-terrain driving, GIS, e-patrolling, and wildlife crime training annually (familiar Assam–Nagaland modules). - Kaziranga: Swift-water rescue and flood-line animal handling refreshers each pre-monsoon. - Karbi Anglong & Intanki: Train local youth as paid “corridor guardians” (beat-linked honoraria, smart-phone reporting). - Equip remote APCs with solar power, VHF repeaters, rain-gear and first-aid kits.
Awareness & Education	- Launch an Assam–Nagaland “Clouded Leopard Landscape” campaign: school talks, markets, and transport hubs highlighting penalties on hunting and the value of corridors. - Produce simple multilingual (Assamese, Karbi, Nagamese) brochures and WhatsApp creatives for snare-free villages. - Develop nature-guide training for community homestays near Garampani/Marat Longri and village walks near Intanki to build pride and income around intact forests.

L8. Assam – Meghalaya (Karbi Anglong Hills – Barail WLS – Narpuh WLS – Adjacent PAs/RFs/CFs)

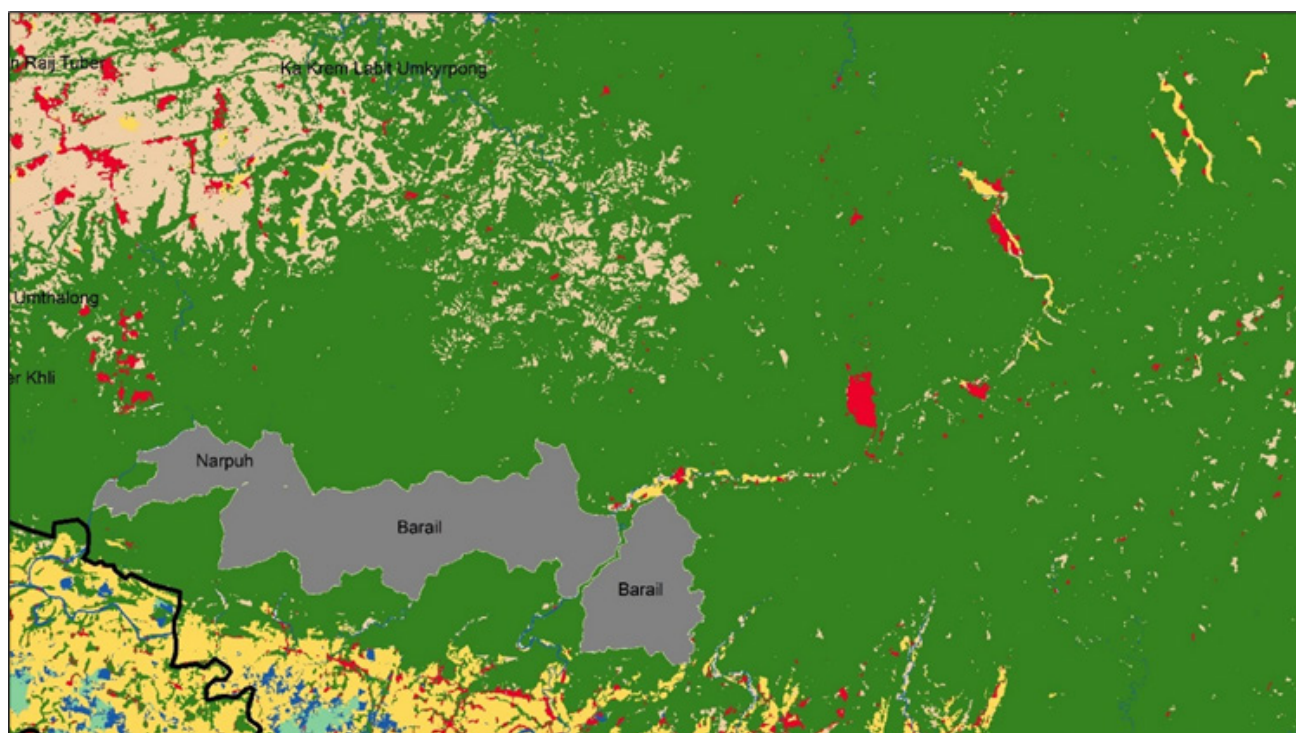


Figure 3.15.

Priority landscape (L8) for clouded leopard conservation in the Assam–Meghalaya region. The map illustrates forest cover, PAs, RFs, and CFs across the Assam–Meghalaya landscape. The figure highlights intact forests, fragmented patches, and potential connectivity corridors that are essential for maintaining clouded leopard habitats and mitigating pressures from land-use change and linear infrastructure.

Table 3.17.

Thematic priority actions for clouded leopard conservation in the Assam–Meghalaya landscape (L8).

Themes	Priority Actions
Habitat Protection & Restoration	• Demarcate and GPS-pillar the legal boundaries of Barail WLS and sensitive Karbi Anglong RF blocks that still retain semi-evergreen cover. • Identify and close illegal entries to RF/WLS beats; institute zero-tolerance on fresh encroachment with weekly joint drives (DCF + District Administration). • Use CAMPA for 3–5 year block-planting of native evergreen species on eroded edges and abandoned mine/quarry patches (Cachar, Dima Hasao, Jaintia Hills). • Rapidly rehabilitate degraded RF coupes with assisted natural regeneration (ANR) and invasive removal along roads and settlements.
Landscape Connectivity	• Notify Conservation Reserves/eco-sensitive corridors to keep functional links between Karbi Anglong hill forests ↔ Barail WLS ↔ Narpuh WLS, prioritising road-crossings and settlement bottlenecks. • Undertake micro-plans with Village Councils/Autonomous Councils to secure CF strips that connect RF beats to PA boundaries. • Work with PWD/NHAI to retrofit culverts and canopy rope-bridges where gorges/riparian breaks sever arboreal movement (pilot at steep Barail/Narpuh streams).
Monitoring & Research	• Establish a joint Assam–Meghalaya carnivore monitoring grid (utilising camera traps/occurrence surveys) that covers Barail, Narpuh, and adjoining RFs, repeating the effort every 2–3 years. • Start snare/kill-sign surveys and prey monitoring on SMART; create a unified data repository at Circle HQ. • Commission rapid landscape models to identify corridor pinch-points and restoration polygons (RF compartments; abandoned mines).
Climate Change Adaptation	• Stabilise landslide-prone Barail/Narpuh road cuts with bio-engineering and evergreen plantings; maintain fire lines in dry fringe forests. • Protect/restore riparian buffers along the Barak and its tributaries to reduce flood/erosion impacts on corridors. • Introduce climate-smart patrolling calendars (pre-monsoon landslides, winter fire windows).

Community Engagement	- Constitute or strengthen EDCs/JFMCs around Borail and Narpuh for jhum-reduction alternatives (NTFP value-addition, homestays, LPG/solar). - Launch CF stewardship agreements for corridor strips (performance-linked micro-grants, social fencing). - Support women/youth patrols for snare removal with incentives and recognition at the beat level.
Poaching & Hunting Mitigation	- Form an Assam–Meghalaya joint WCCB/Police–Forest task cell for intelligence on cat-skin/teeth trade; run periodic market checks (Silchar–Haflong–Jowai axis). - Intensify foot/mobile patrols on access roads to mining belts and RF edges; integrate snare-sweeps into monthly beat targets. - Issue standing orders to seize wire/steel-trap materials found in forests; prosecute under WPA/Arms/IPC as applicable.
Policy Integration & Legal Protection	- Move priority linkage patches for notification as Conservation Reserve (Karbi Anglong–Barail foothills; Narpuh–Rymbai RF arc). - Integrate clouded leopard and small-cat measures into the Working Plans of RF divisions and into Narpuh/Borail PA plans. - Enforce mining/stone-quarry regulation within 10 km of PA boundaries via strict compliance checks and ESZ conditions.
Capacity Building	- Fill all frontline vacancies in Barail and Narpuh; deploy at least one trained researcher-cum-monitoring assistant per Range. - Train staff on SMART, crime-scene handling, CDR-based intelligence, GIS mapping, and corridor restoration planning; equip them with GPS, trap cutters, first-aid kits, and camera traps. - Create a shared Operations Calendar (joint patrols, snare-sweeps, market checks) across bordering divisions.
Awareness & Education	- Run year-round pride campaigns on small cats and the clouded leopard across Karbi Anglong, Cachar and Jaintia Hills schools/colleges; develop bilingual RF/PA signage and visitor briefings. - Establish a compact interpretation node at Barail (Jatinga/Harangajao road) and a mobile outreach van for Narpuh fringe villages, tying messaging to corridor stewardship and snare-free forests.

L9. Meghalaya; linked with Bangladesh (Balphakram NP – Nokrek NP – Siju WLS – Bagmara Pitcher Plant WLS – Adjacent PAs/CFs)

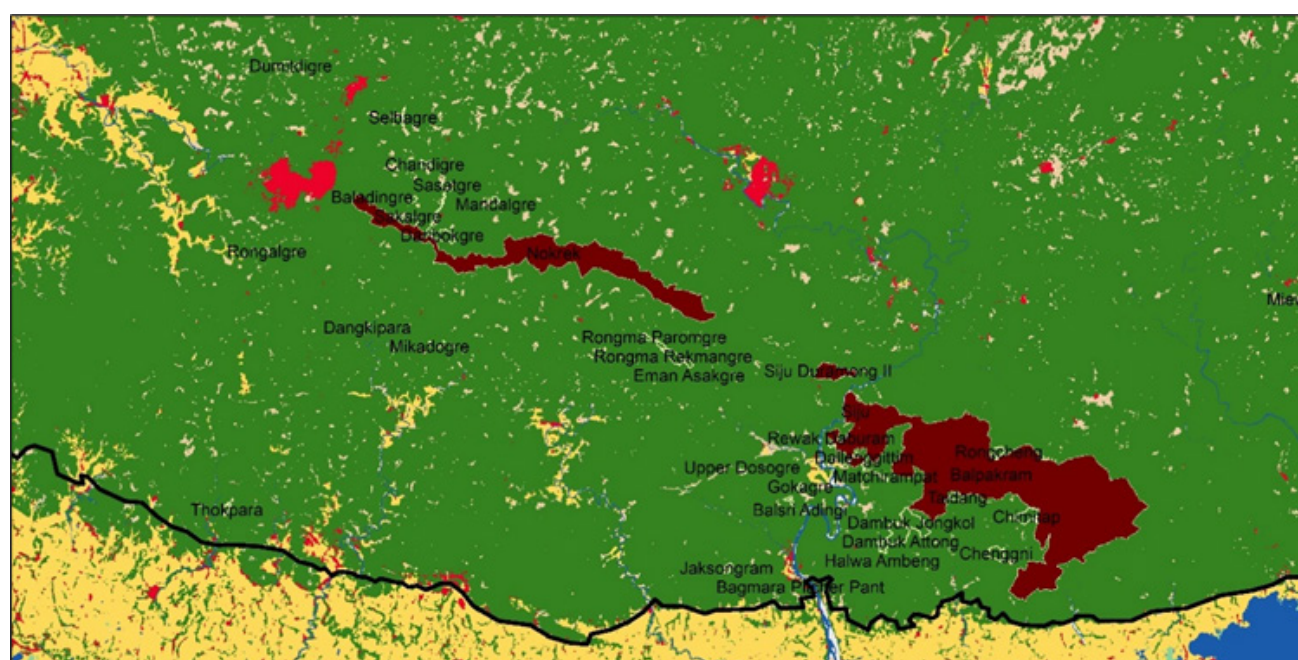


Figure 3.16.

Priority landscape (L9) for clouded leopard conservation in Meghalaya, linked with Bangladesh. The map illustrates forest cover, PAs, and connectivity corridors across the Garo Hills landscape of Meghalaya, highlighting ecological linkages with adjacent sites in northern Bangladesh. The figure highlights intact forests, fragmented patches, and potential corridors that are critical for maintaining habitat connectivity and ensuring the long-term conservation of clouded leopards.

Table 3.18.

Thematic priority actions for clouded leopard conservation in the Meghalaya (linked with Bangladesh) landscape (L9).

Themes	Priority Actions
Habitat Protection & Restoration	• Fill sanctioned frontline vacancies in Balphakram and Nokrek and re-post guards to high-pressure beats (coal edges, grazing fronts, tourist zones). • Rapidly notify/strengthen ESZs and finalise Balphakram and Nokrek boundary pillars where pending. • Launch assisted natural regeneration in degraded jhum/coal-mined patches around Nokrek–Siju–Baghmara, using native evergreen species and bamboo removal where it impedes regeneration. • Create invasive and weed control squads for pitcher-plant habitat at Baghmara Pitcher Plant WLS and streambanks near Siju caves. • Establish seasonal grazing-free enclosures and stall-feeding support for villages abutting Balphakram.
Landscape Connectivity	• Secure and manage CF corridors between Nokrek–Siju–Baghmara and Balphakram–South Garo Hills blocks through MoUs with GHADC/Autonomous District Councils. • Prioritise acquisition/voluntary relocation of tiny in-holdings that sever Balphakram’s southern link to Bangladesh forests; where relocation is not feasible, negotiate regulated-use conservation agreements. • Mark and keep motorable tracks outside the identified corridor strips; gate/close redundant forest roads used by illegal extractors. • Coordinate with the Forest Department & BSF for patrolling along the international boundary to deter cross-border timber/charcoal inflow, while maintaining lawful traditional non-timber foot access.
Monitoring & Research	• Establish a landscape camera-trap and sign survey grid (standard protocols) across Balphakram–Nokrek–Siju–Baghmara and CFs to track clouded leopard and prey. • Start monthly SMART patrolling with GPS-enabled data in all four PAs; generate quarterly threat maps (mines, encroachment, fire). • Begin seasonal monitoring of pitcher-plant populations and hydrology at Baghmara with a fixed set of photo-plots and groundwater dip-wells. • Commission mine-edge ecological impact studies around Nokrek and produce mitigation guidance for district authorities. • Partner with local colleges/NEHU for cave-wildlife and bat-disease risk assessments in Siju.
Climate Change Adaptation	• Prepare PA-specific climate risk checklists (erratic rainfall, heat stress, landslides, fire) and integrate them into annual plans. • Restore riparian buffers (30–50 m) on perennial streams in Balphakram and Nokrek to reduce flash-flood/erosion impacts. • Establish early-warning and pre-positioned fire lines/water tanks at dry-season fire hotspots bordering CFs and revenue lands. • Promote climate-resilient alternative energy (LPG/clean cookstoves) in fringe villages to cut fuelwood pressure during drought months.
Community Engagement	• Reactivate/constitute EDCs around Balphakram and Nokrek with small grants tied to conservation compliance (no new jhum in corridor, no charcoal kilns). • Support village micro-enterprises (honey, broom-grass processing, homestays, cave guiding) with skill training and market links via the District & Tourism Department. • Sign site-level agreements with traditional institutions (e.g., A’king/Nokma) to protect identified CF corridors and sacred groves, with annual incentives for compliance. • Establish joint problem-solving forums (FD–GHADC–BSF–community) to rapidly address boundary conflicts and crop-raiding.
Poaching & Hunting Mitigation	• Increase night patrols on coal-truck routes and river ghats used for wildlife product movement; coordinate with local police for seizure protocols. • Introduce village-level “no snare/no trap” campaigns, accompanied by the buyback of wire snares and rewards for reporting them. • Standardise wildlife crime recording and case follow-up using CIS/WWCC formats at Baghmara, Nokrek, and Baghmara Range. • Pilot community grain banks and crop-guarding toolkits where bushmeat hunting spikes during lean months.
Policy Integration & Legal Protection	• Propose the addition of adjoining high-value CF/RF patches to Balphakram and Nokrek ESZs; evaluate up-gradation of key CF corridors as Conservation Reserves with community co-management. • Enforce Meghalaya Minor Mineral Rules near PA boundaries; make mine-closure and ecological restoration plans mandatory for existing leases around Nokrek. • Issue and implement SOPs for cave tourism at Siju (group size, lighting, waste, bat-season closures). • Institutionalise quarterly coordination meetings between the FD, District Administration, GHADC, Tourism, Police and BSF for cross-border issues and linear-infrastructure proposals.
Capacity Building	• Conduct annual refresher courses for frontline staff on SMART, cyber-crime, evidence handling, human–wildlife conflict response, and first aid. • Train community scouts/eco-guides for Siju caves and Baghmara interpretation; certify them through the Tourism Department. • Develop in-house rapid-assessment teams (wildlife health, fire, landslide) with essential equipment kits at each PA HQ.
Awareness & Education	• Roll out a multilingual (English/Khasi/Garo/Bangla, where appropriate) awareness campaign on clouded leopard and cave fauna using schools, churches, and market days. • Establish interpretation centres/kiosks at Siju and Baghmara with exhibits on cave ecology and pitcher-plant conservation; update the Nokrek visitor centre with exhibits on mining impacts. • Launch “Garbage-Free Trails & Caves” drives with local youth clubs; install/maintain waste-segregation points at key viewpoints and cave mouths.

L10. Meghalaya (Nongkhylllem WLS – Adjacent PAs/CFs)

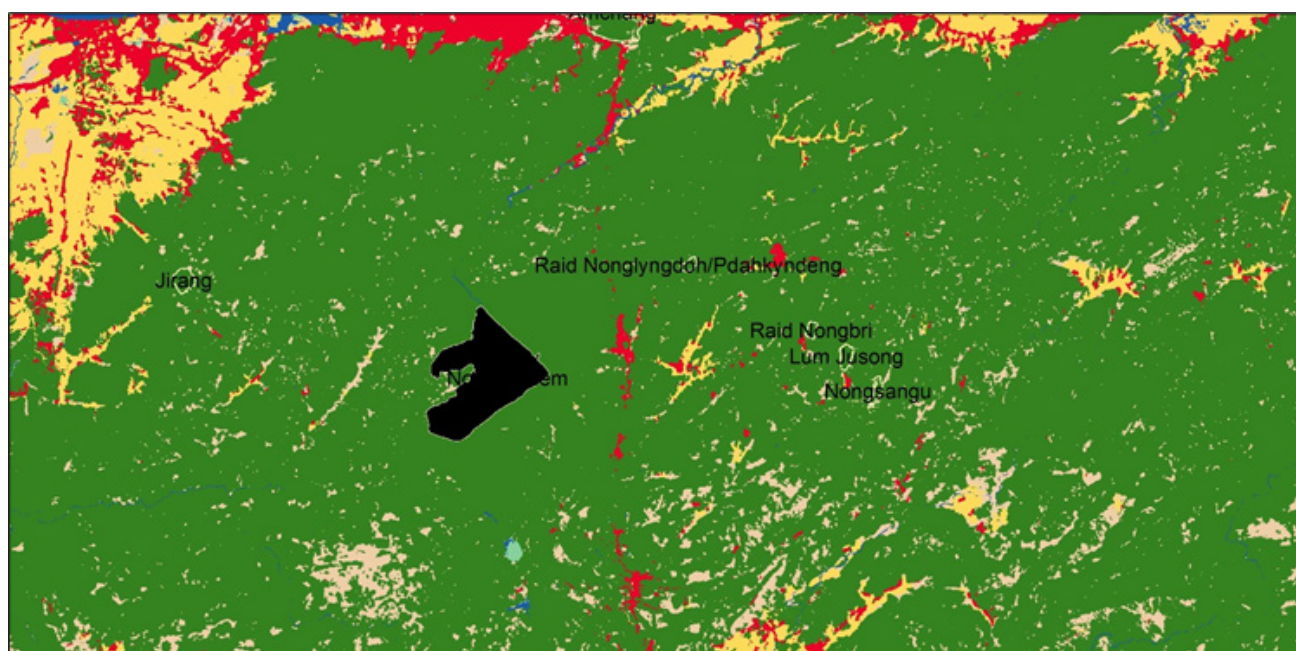


Figure 3.17.

Priority landscape (L10) for clouded leopard conservation in Meghalaya. The map illustrates forest cover, Nongkhylllem WLS, and adjacent CFs and RFs in Meghalaya. It highlights intact forest patches, surrounding land-use pressures, and potential connectivity corridors vital for maintaining habitat integrity and long-term conservation of clouded leopards.

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Table 3.19.

Thematic priority actions for clouded leopard conservation in the Meghalaya landscape (L10).

Themes	Priority Actions
Habitat Protection & Restoration	- Finalise and operationalise the Nongkhylllem WLS Management Plan (with a clear habitat management & patrolling calendar). - Demarcate and maintain the ESZ and beat boundaries; erect low-impact boundary pillars where missing. - Identify and restore degraded edges (fire scars, invasives, old jhum fallows) with native evergreen species; monitor survival. - Regulate and phase out fuelwood extraction and unsanctioned grazing through designated community woodlots and stall-feeding support. - Strengthen fire prevention: early-season fire lines, watch-and-ward, and community fire squads with incentives.
Landscape Connectivity	- Map and secure corridors from Nongkhylllem WLS to adjacent CFs/RFs (Raid Nongkyndong, Padu Kyrempe, etc.) using village by-laws and micro-plans. - Negotiate no-new linear intrusions (roads, transmission) across linkages; where unavoidable, include overpasses/underpasses/canopy rope bridges and speed-calming. - Prioritise community conservation reserves at bottlenecks; finance via CAMPA/IDWH and state eco-restoration grants. - Coordinate seasonal corridor patrolling across FDs and CF guards to deter snaring.
Monitoring & Research	- Establish a camera-trap grid for clouded leopard and prey; repeat every 2–3 years to track trends. - Begin snare encounter-rate and illegal activity monitoring linked to SMART patrolling. - Baseline vegetation & prey assessments (ungulates, primates, pheasants); integrate with adaptive management in the Plan. - Document human–wildlife interactions (livestock depredation, crop loss) and evaluate mitigation effectiveness. - Partner with Meghalaya universities for long-term ecological studies and training for frontline staff.
Climate Change Adaptation	- Include rainfall/heat risk and landslide/fire risk maps in the Management Plan; plan waterholes and shade refugia along patrolling routes. - Promote mixed-native species in restoration to enhance drought resilience and protect riparian buffers. - Climate-proof infrastructure (culverts, bridges, staff housing) using flood-resilient siting and materials.

Community Engagement	• Reactivate/expand EDCs/JFMCs around sensitive beats; sign MoUs on access rules, fire control, and anti-snare commitments. • Support alternative energy (LPG/clean cookstoves) and livelihoods (NTFP value chains, eco-guiding, homestays) to reduce forest pressure. • Implement benefit-sharing for corridor villages (priority job cards for watchers, nursery contracts, wages for restoration). • Develop a participatory grazing plan with stall-feeding and fodder plot support.
Poaching & Hunting Mitigation	• Roll out joint anti-snare drives before and after local hunting seasons/festivals; publicly destroy recovered snares. • Operationalise SMART patrolling with GPS tracks, weekly analysis, and targeted patrols in high-risk beats. • Strengthen informant networks and inter-agency coordination (police/Customs) for trade interception. • Set up a wildlife crime hot-spot board at Range HQ and monthly review meetings.
Policy Integration & Legal Protection	• Notify/confirm ESZ; update working plans of adjoining RFs to recognise clouded-leopard corridors and ban new quarrying/clear-felling in linkages. • Where communities agree, notify CR at key choke points. • Ensure compensation & relief (for depredation and accidental fires) are rapid and transparent to maintain local support.
Capacity Building	• Fill vacancies (guards, foresters) and create a dedicated anti-poaching squad for Nongkhylliem. • Conduct annual refresher training on wildlife law, evidence collection, SMART, first aid, and conflict response. • Provide basic gear, including GPS, field phones, rain/flood gear, camera traps, night-vision equipment, and trauma kits; maintain a repair budget line.
Awareness & Education	• Establish/upgrade a modest interpretation centre (Nongpoh/Range HQ) featuring clouded leopard ecology and safe forest practices. • Run school- and youth-naturalist clubs in corridor villages; promote “no snare, no poison” pledges. • Produce bilingual outreach (Khasi/English) on legal penalties, ESZ dos & don’ts, and reporting channels.

L11. Mizoram; linked with Myanmar (Tawi WLS – Murlen NP – Lengteng WLS – Pualreng WLS – Adjacent PAs/RFs/CFs – Myanmar Forests)

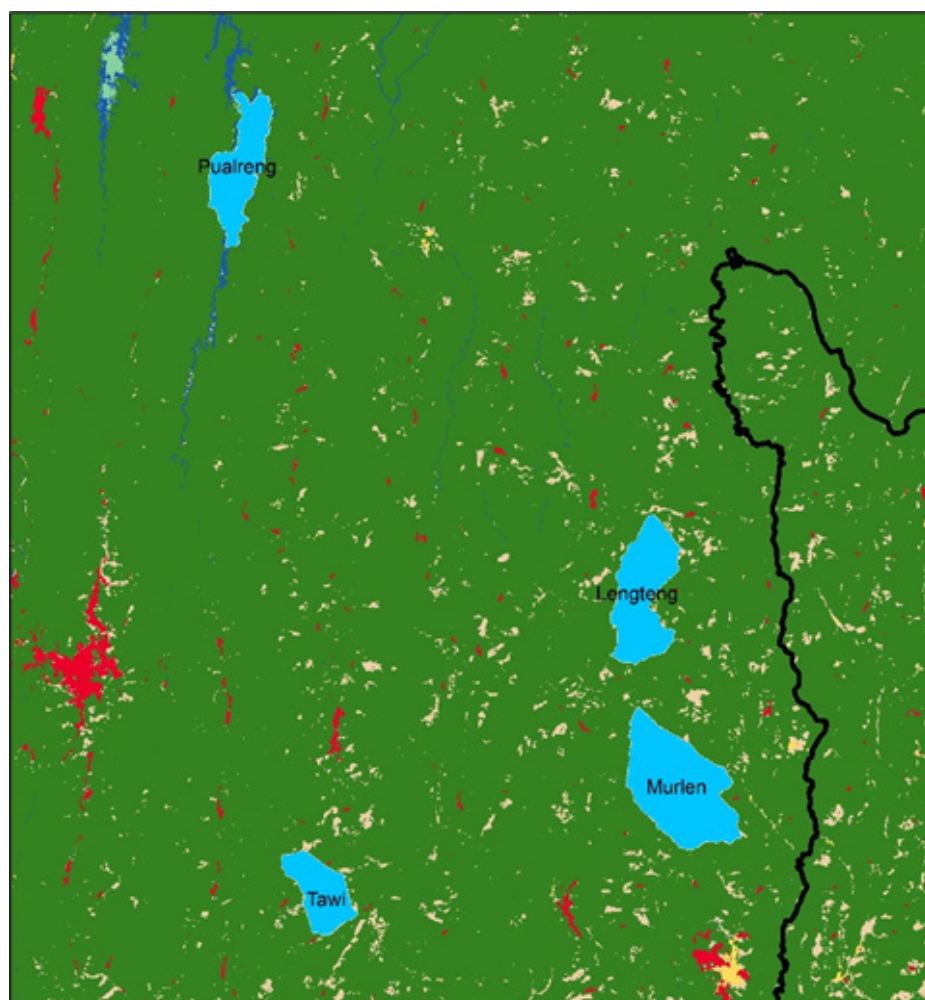


Figure 3.18.

Priority landscape (L11) for clouded leopard conservation in Mizoram, linked with Myanmar. The map shows forest cover, PAs, adjacent RFs and CFs, and contiguous forest tracts in Myanmar. It highlights intact transboundary habitats, fragmented patches, and connectivity corridors essential for maintaining clouded leopard movement and long-term population viability.

Table 3.20.

Thematic priority actions for clouded leopard conservation in the Mizoram (linked with Myanmar) landscape (L11).

Themes	Priority Actions
Habitat Protection & Restoration	• Consolidate PA boundaries by resolving overlaps with village lands and encroachments. • Undertake targeted habitat restoration in degraded patches (jhum fallows, bamboo brakes) through assisted natural regeneration. • Control forest fires and grazing pressure in fringe areas. • Secure hydrological sources and riparian habitats that support prey base and carnivores.
Landscape Connectivity	• Establish and legally recognise corridors linking Murlen, Lengteng, and the Myanmar Chin Hills. • Strengthen forest cover in Pualreng–Tawi–adjacent RFs to maintain dispersal pathways. • Mainstream connectivity conservation in district land-use planning to reduce fragmentation from roads and shifting cultivation. • Promote cross-border coordination with Myanmar to protect forest corridors.
Monitoring & Research	• Conduct systematic camera-trap and occupancy surveys across all PAs and adjacent RFs. • Initiate long-term monitoring of clouded leopard populations, prey density, and threats (poaching, forest loss). • Document human–wildlife conflict and bushmeat hunting patterns through socio-ecological studies. • Assess genetic connectivity with Myanmar populations.
Climate Change Adaptation	• Identify and secure climate-resilient forest refugia in montane zones (Lengteng and Murlen). • Integrate climate vulnerability mapping into PA management plans. • Enhance the resilience of community-managed forests by promoting mixed native-species plantations.
Community Engagement	• Strengthen community-based conservation (EDCs, JFMCs). • Support sustainable livelihoods (eco-tourism, handicrafts, NTFP value chains) to reduce dependence on forest hunting. • Promote participatory boundary demarcation and PA-friendly agriculture practices. • Incentivise village councils for conservation-linked development schemes.
Poaching & Hunting Mitigation	• Strengthen patrolling in poaching-prone areas (notably Murlen and Pualreng fringes where carcasses were seized). • Enhance intelligence networks to curb illegal trade in skins and bones. • Engage community youth in anti-snaring patrols. • Scale up awareness of WPA penalties for hunting.
Policy Integration & Legal Protection	• Notify and strengthen ESZs around PAs. • Integrate PA-level recommendations of MEE into the State Wildlife Action Plan. • Ensure convergence with the Act East Policy and Indo–Myanmar border development projects to safeguard the corridors. • Facilitate the signing of MoUs with Myanmar for transboundary carnivore conservation.
Capacity Building	• Enhance frontline staff training in species monitoring, M-STrIPES, and SMART patrolling. • Improve staff numbers and provide field gear, vehicles, and wireless sets. • Build the capacity of local NGOs and youth for ecological monitoring and eco-tourism.
Awareness & Education	• Develop interpretation centres in Murlen and Lengteng to highlight the ecology of the clouded leopard. • Introduce conservation education in village schools near PAs. • Organise state-level campaigns on the impacts of bushmeat and the value of biodiversity. • Promote citizen science (camera-trap sharing, reporting of sightings) to engage local residents.

L12. Mizoram; linked with Myanmar (Khawnglung WLS – Blue Mountain NP – Ngengpui WLS – Tokalo WLS – Adjacent RFs/CFs – Myanmar Forests)

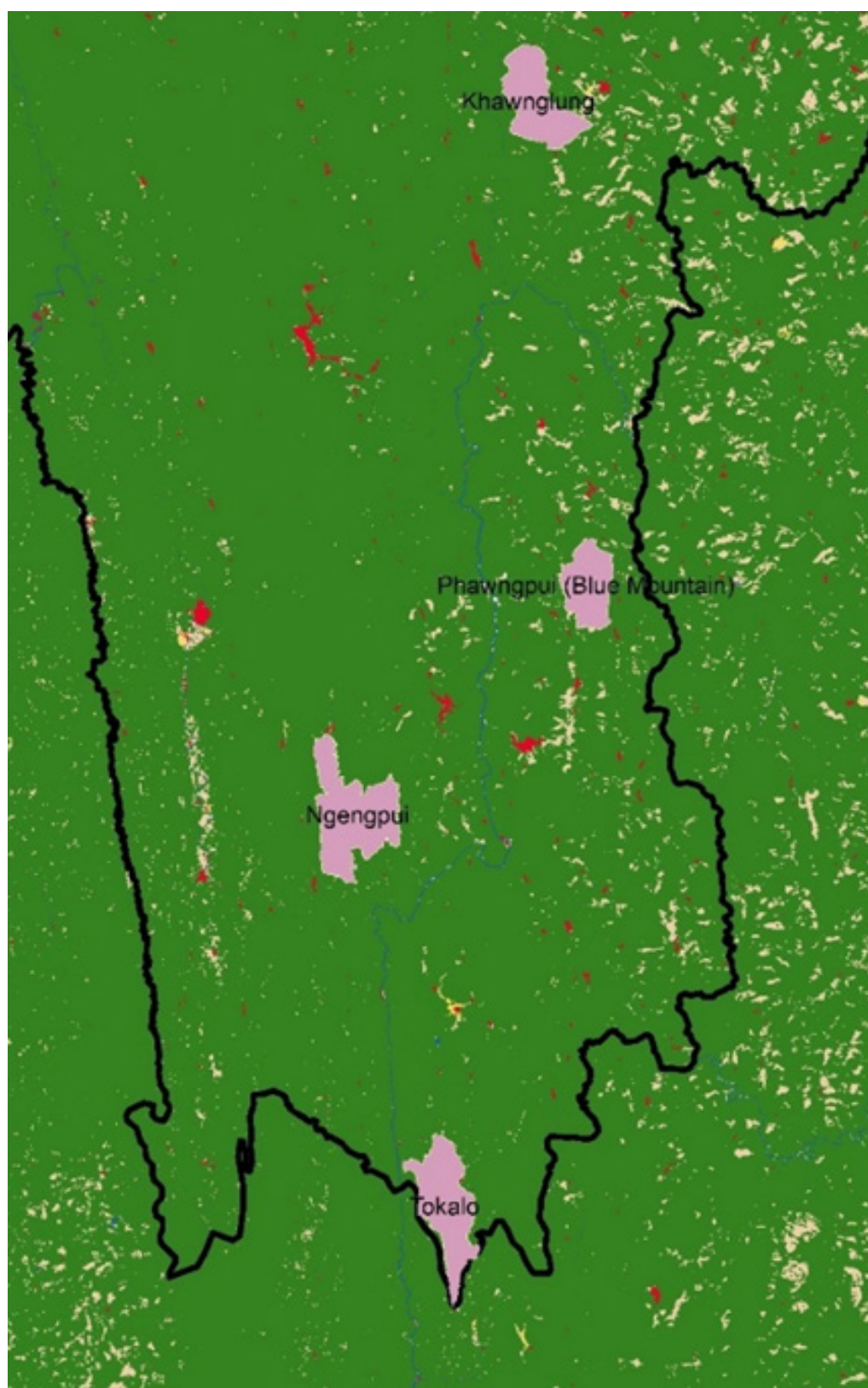


Figure 3.19.

Priority landscape (L12) for clouded leopard conservation in Mizoram, linked with Myanmar. The map illustrates forest cover, PAs, adjacent RFs and CFs, and contiguous forest tracts in Myanmar. It highlights intact habitats, fragmented areas, and potential connectivity corridors crucial for sustaining clouded leopard populations across the Indo–Myanmar landscape.

Table 3.21.

Thematic priority actions for clouded leopard conservation in the Mizoram (linked with Myanmar) landscape (L12).

Themes	Priority Actions
Habitat Protection & Restoration	• Conduct DGPS boundary surveys for Khawnglung WLS and Tokalo WLS. • Prevent further encroachment and shifting cultivation along Ngengpui and Blue Mountain fringes. • Undertake restoration of degraded bamboo brakes in Ngengpui and Tokalo. • Promote assisted natural regeneration of evergreen patches to secure prey habitats. • Implement soil and water conservation to safeguard riparian habitats used by prey species.
Landscape Connectivity	• Identify and map corridors between Ngengpui–Blue Mountain NP–Myanmar forests. • Secure the Tokalo–Chhimtuipui river corridor for dispersal to Myanmar’s Chin Hills. • Legally recognise adjacent RFs/CFs as buffer zones and incentivise JFMCs. • Integrate connectivity corridors into district land-use and road planning. • Promote transboundary landscape planning with Myanmar forest agencies.
Monitoring & Research	• Launch systematic camera-trap surveys in all four PAs. • Develop long-term prey base monitoring programs (ungulates, primates, galliformes). • Study patterns of bushmeat hunting and snaring intensity at village fringes. • Assess the genetics and connectivity of clouded leopards with Myanmar populations. • Establish permanent biodiversity monitoring plots to track forest health and prey vegetation.
Climate Change Adaptation	• Map elevation-linked climate refugia in Blue Mountain NP and Khawnglung WLS. • Promote climate-resilient mixed native plantations in degraded CFs and RFs. • Integrate climate vulnerability assessments into PA management plans. • Safeguard altitudinal corridors to allow species’ range shifts under warming scenarios.
Community Engagement	• Strengthen EDCs in Ngengpui and Tokalo villages. • Provide eco-tourism livelihood opportunities (guiding, homestays, handicrafts). • Incentivise wildlife-friendly farming (cash crops, agroforestry) to reduce reliance on jhum. • Develop conflict mitigation mechanisms (livestock insurance, predator-proof corrals). • Engage women’s SHGs in NTFP value addition to reduce reliance on hunting.
Poaching & Hunting Mitigation	• Intensify anti-poaching patrols and intelligence networks in Khawnglung and Tokalo. • Scale up anti-snaring drives in Ngengpui and adjacent RFs. • Establish village-level informant networks to check wildlife trade. • Train forest staff and police in the handling of wildlife crime. • Coordinate with border security agencies to check cross-border trade into Myanmar.
Policy Integration & Legal Protection	• Upgrade vulnerable RF corridors to Conservation Reserves. • Strengthen ESZs around Khawnglung, Tokalo, and Ngengpui. • Ensure clouded leopard is integrated into the State Biodiversity Strategy & Action Plan (SBSAP). • Mainstream PA recommendations into State Climate Action Plans. • Pursue bilateral MoUs with Myanmar for Indo–Myanmar transboundary carnivore monitoring.
Capacity Building	• Recruit and train additional frontline staff for Ngengpui and Tokalo. • Build capacity in SMART/M-STrIPES patrolling. • Provide equipment support (wireless sets, GPS, vehicles). • Train local youth in biodiversity documentation and guiding. • Develop exchange training modules with Myanmar forest staff.
Awareness & Education	• Run awareness drives on the impacts of bushmeat in villages near all four PAs. • Establish an interpretation centre at Blue Mountain NP to highlight the transboundary values of carnivores. • Engage schools and colleges in Lawngtlai, Lunglei, and Saiha districts with conservation curricula. • Prepare local-language brochures, posters, and short films on clouded leopard conservation. • Promote citizen-science initiatives for reporting sightings and threats.

L13. Mizoram – Tripura; linked with Bangladesh (Dampa TR – Thorangtlang WLS – Adjacent RFs/CFs – Pablakhali WLS, Bangladesh – Gumti WLS)

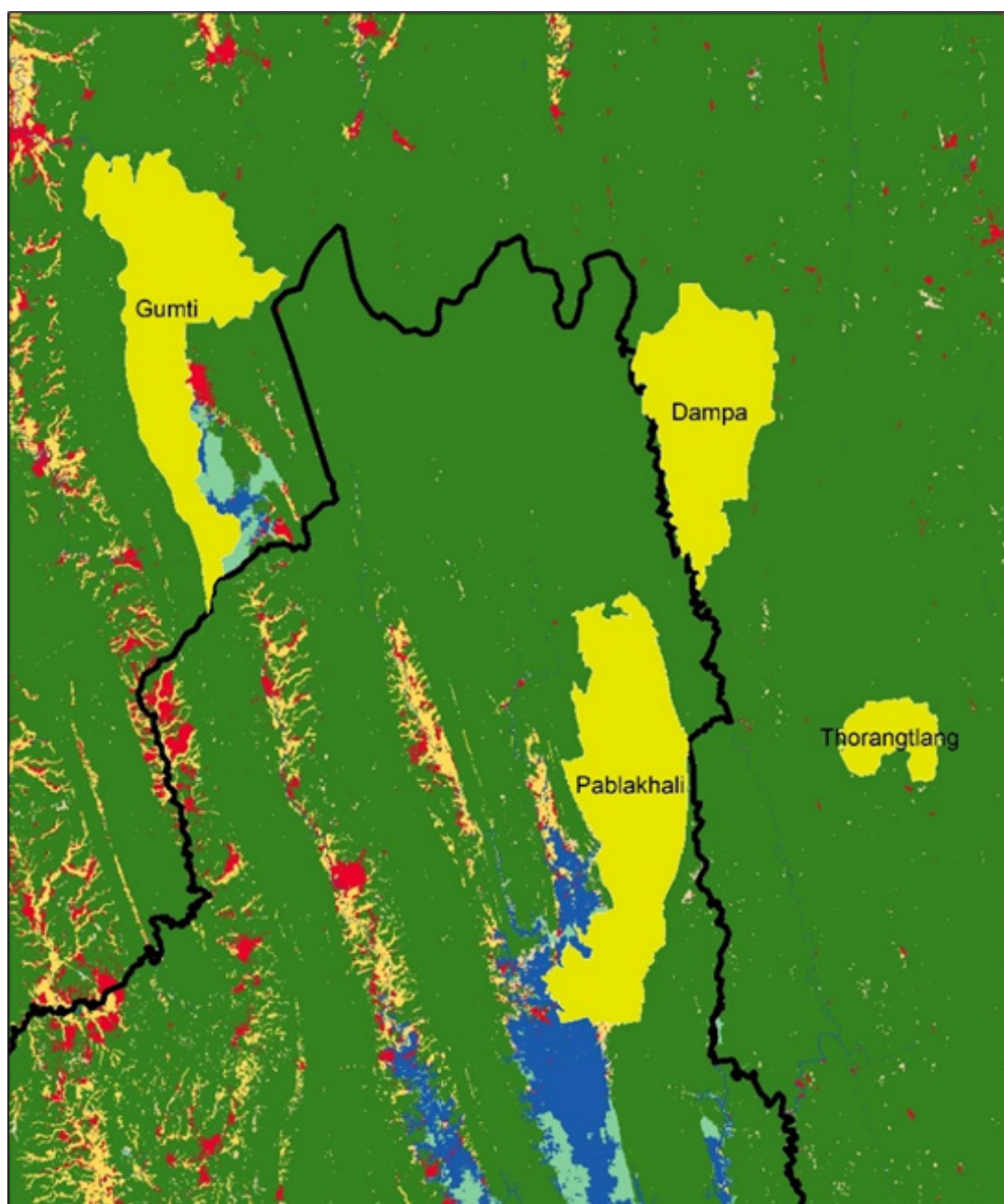


Figure 3.20.

Priority landscape (L13) for clouded leopard conservation in Mizoram–Tripura, linked with Bangladesh. The map shows forest cover, PAs, and adjacent RFs and CFs. It highlights intact habitats, forest–agriculture interfaces, and critical transboundary corridors that sustain connectivity between India and Bangladesh for clouded leopard populations.

Table 3.22.

Thematic priority actions for clouded leopard conservation in the Mizoram–Tripura (linked with Bangladesh) landscape (L13).

Themes	Priority Actions
Habitat Protection & Restoration	• Strictly protect core forest blocks in Dampa TR and Thorangtlang WLS through enhanced boundary demarcation. • Restore degraded bamboo brakes and shifting cultivation fallows in adjacent RFs/CFs. • Implement eco-restoration in encroached areas of Dampa TR with native species. • Develop land-use zoning to minimise conflicts between agriculture and forests along the Gumti–Dampa belt. • Secure habitat patches within the Gumti WLS that are threatened by grazing and encroachment.
Landscape Connectivity	• Secure the Dampa–Pablakhali (Bangladesh) corridor by bilateral dialogue and habitat restoration. • Maintain forested linkages between Thorangtlang and Dampa for dispersal. • Prioritise Gumti–Trishna–Rowa linkages within Tripura for stepping-stone connectivity. • Integrate RF/CF corridors into Mizoram’s state biodiversity strategy to ensure long-term habitat continuity.
Monitoring & Research	• Establish long-term camera-trap grids across Dampa, Thorangtlang, and Gumti to track clouded leopard population trends. • Initiate systematic prey-base monitoring (ungulates, primates). • Research the potential for transboundary movement in Bangladesh forests (<i>e.g.</i>, Pablakhali WLS). • Document hunting/poaching hotspots with participatory monitoring. • Develop an ecological baseline for CFs bordering PAs (currently data-poor).
Climate Change Adaptation	• Identify climate-resilient refugia in the higher elevation forests of Thorangtlang. • Promote mixed-species reforestation (evergreen + bamboo) to buffer climate variability. • Integrate carbon sequestration programmes in CFs for climate financing. • Monitor phenological shifts in prey and forest composition linked to climate change.
Community Engagement	• Expand participatory eco-tourism initiatives around Dampa and Thorangtlang to generate local income. • Strengthen EDCs in Gumti WLS and buffer villages. • Incentivise CF protection through benefit-sharing (<i>e.g.</i>, NTFPs, PES). • Conduct participatory land-use planning in shifting cultivation areas to balance livelihood and conservation.
Poaching & Hunting Mitigation	• Intensify anti-poaching patrols in Dampa and Thorangtlang; deploy SMART/M-STrIPES. • Establish joint enforcement teams with the BSF in Indo–Bangladesh sensitive zones. • Launch targeted awareness and enforcement to control trade in skins and bones (documented in Mizoram). • Incentivise the reduction of bushmeat hunting through alternative protein schemes in forest villages.
Policy Integration & Legal Protection	• Integrate Gumti WLS corridors into Tripura’s forest working plans. • Strengthen the Indo–Bangladesh bilateral dialogue on Pablakhali connectivity for a wide range of species. • Ensure enforcement of WPA Schedule I for clouded leopard protection in RFs/CFs. • Incorporate clouded leopard habitats into Mizoram State CAMPA and Green India Mission programs.
Capacity Building	• Recruit and train additional frontline staff at Dampa TR. • Provide advanced patrolling gear (GPS, wireless, vehicles). • Conduct training workshops on SMART patrolling, community engagement, and species monitoring. • Build veterinary and forensic capacity to respond to wildlife crime and carcass seizures.
Awareness & Education	• Develop locally relevant awareness materials on clouded leopard conservation in the Mizo and Kokborok languages. • Partner with schools and colleges near Gumti and Dampa to include conservation modules. • Celebrate the annual “Clouded Leopard Day” across Mizoram and Tripura. • Create community theatre and folk media campaigns on the impacts of poaching and forest protection.

L14. Tripura; linked with Bangladesh (Sepahijala WLS – Clouded Leopard NP – Trishna WLS – Bison NP)

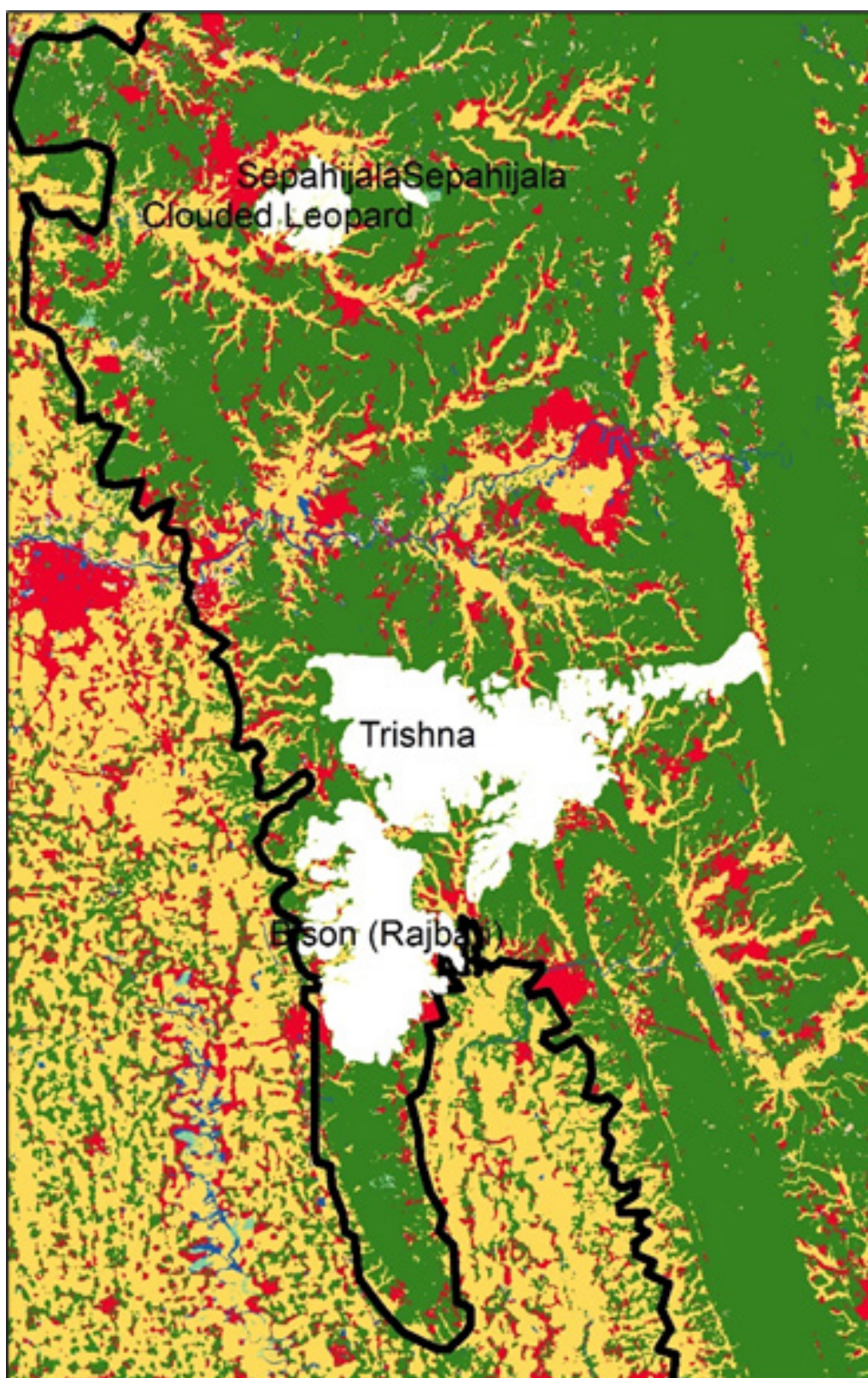


Figure 3.21.

Priority landscape (L14) for clouded leopard conservation in Tripura, linked with Bangladesh. The map shows forest cover, PAs, and adjacent forested regions along the Indo–Bangladesh border. It highlights fragmented habitats, land-use pressures, and critical transboundary corridors that sustain connectivity between Tripura and Bangladesh for the conservation of the clouded leopard.

Table 3.23.

Thematic priority actions for clouded leopard conservation in the Tripura (linked with Bangladesh) landscape (L14).

Themes	Priority Actions
Habitat Protection & Restoration	• Demarcate and secure PA boundaries (Sepahijala, Trishna, Bison NP) using updated GPS/DGPS surveys to address encroachment. • Undertake restoration of degraded bamboo brakes and sal patches inside Trishna and Rajbari NP. • Re-vegetate open edges and village–forest interfaces with native evergreen + bamboo species. • Remove invasive weeds along wetlands in Sepahijala and enrich with native species. • Improve waterhole and riparian habitat management in all four PAs to support prey base.
Landscape Connectivity	• Secure Trishna–Bison NP interface and adjacent plantations as stepping-stone corridors. • Safeguard the Sepahijala–Clouded Leopard NP continuity by regulating roadside/tree belt degradation. • Integrate PA–RF corridors into district land-use and working plans to prevent fragmentation. • Explore bilateral dialogue for cross-border connectivity with Sylhet (Bangladesh) forests.
Monitoring & Research	• Establish systematic camera-trap grids across all four PAs to monitor clouded leopards and sympatric carnivores over the long term. • Initiate prey base assessments (ungulates, primates, galliforms) with repeated surveys. • Develop a participatory threat-mapping approach to identify snaring and bushmeat hotspots. • Study potential cross-border movements with Bangladesh using camera traps and genetic analysis. • Institutionalise the publication of short monitoring reports every 2–3 years.
Climate Change Adaptation	• Identify climate-resilient refugia in Trishna and Bison NP; buffer micro-wetlands in Sepahijala. • Promote mixed-species climate-resilient plantations in degraded RF/CFs adjoining PAs. • Restore riparian buffers along streams and wetlands to safeguard water security. • Integrate climate vulnerability assessments into all PA management plans.
Community Engagement	• Strengthen EDCs in villages around Trishna, Bison, and Sepahijala. • Provide eco-tourism and guiding opportunities (nature trails, homestays, interpretation) for youth and women's SHGs. • Incentivise wildlife-friendly farming (agroforestry, shade trees) to reduce pressure on WLSs. • Launch citizen science initiatives (reporting sightings, snare locations) in buffer villages.
Poaching & Hunting Mitigation	• Intensify anti-snaring patrols and integrate SMART/M-StrIPES across all four PAs. • Coordinate with Tripura Police and BSF to address cross-border hunting and trade. • Establish village informant networks and link them to Range Offices. • Run market-day surveillance for bushmeat and bird trade. • Conduct quarterly snare-sweep drives before and after monsoon seasons.
Policy Integration & Legal Protection	• Notify and enforce ESZs around all PAs. • Integrate these actions into the State Wildlife Action Plan (SWAP) and the State Biodiversity Strategy & Action Plan (SBSAP). • Mainstream habitat protection into CAMPA and Green India Mission funding. • Initiate an Indo–Bangladesh dialogue on the Pablakhali–Sylhet linkage relevant to Tripura PAs.
Capacity Building	• Recruit and train additional frontline staff. • Provide wireless sets, GPS units, patrolling vehicles, and field kits to all four PAs. • Train staff in SMART patrolling, wildlife crime handling, and cybercrime awareness. • Conduct exchange training workshops with NGOs and universities on carnivore monitoring.
Awareness & Education	• Develop interpretation centres/upgrades in Sepahijala and Bison NP, focused on clouded leopard ecology. • Introduce local language (Kokborok, Bengali) education materials for schools and villages. • Celebrate an annual “Clouded Leopard Day” across Tripura to raise awareness. • Utilise folk media, theatre, and radio to disseminate messages about the impacts of poaching and forest protection.

Following the detailed landscape-specific action plans (L1–L14), it is essential to synthesise these recommendations into a set of integrated frameworks that can guide implementation, monitoring, and adaptive management across the entire range of the clouded leopard in India. While the landscape tables highlight priority interventions at the site level, an overarching framework ensures that conservation actions are:

1. Comparable across landscapes – using common indicators of success and standardised monitoring methods;
2. Scalable to national and transboundary priorities – by aligning with MoEFCC programmes, state biodiversity plans, and regional cooperation with Bhutan, Nepal, Bangladesh, and Myanmar; and
3. Adaptive and accountable – by embedding monitoring, evaluation, and threat-tracking into the planning cycle.

Accordingly, the subsequent sections present three interlinked components:

- a) Implementation Framework – outlining indicators of success, priority ranking, timelines, monitoring mechanisms, and responsible agencies for each thematic pillar;
- b) (b) Threats Tracking Framework – identifying categories of threats, indicators to track, mitigation actions, and monitoring frequency; and
- c) (c) Monitoring & Evaluation Framework – providing specific indicators and institutional responsibilities to assess conservation outcomes over time.

Together, these frameworks provide managers and policymakers with a comprehensive tool for safeguarding clouded leopard populations across priority landscapes, while ensuring accountability and measurable progress.

Table 3.24.

Integrated Implementation, Threats Tracking, and Monitoring & Evaluation Frameworks for Clouded Leopard Conservation in India (2025–2035). For each theme, the frameworks outline indicators of success, priority ranking, timelines, monitoring mechanisms/methods, responsible agencies, and evaluation frequency. In parallel, the Threats Tracking Framework links threat categories, indicators, monitoring methods/sources, mitigation responses, priority ranking, and monitoring frequency. The Priority Ranking (High, Medium, Low) reflects the urgency and feasibility of each task. The Priority Timeline is categorised into Short-term (2025–2028), Medium-term (2029–2032), and Long-term (2033–2035). Implementation Framework (a) focuses on actions and responsibilities. Threats Tracking Framework (b) focuses on drivers of decline and their mitigation. The Monitoring & Evaluation Framework (c) focuses on outcomes and impacts (*e.g.*, stable/increasing occupancy, reduced poaching, community participation, and compliance with legal frameworks). Monitoring mechanisms combine ecological indices (camera traps, remote sensing, occupancy surveys, prey transects, and eDNA) with management tools (M-STrIPES, SMART, and MEE reviews). The evaluation framework ensures accountability and adaptive management. Responsible agencies include MoEFCC, State Forest Departments, WII, conservation partners, universities, and community councils.



Aspect	Habitat Protection & Restoration	Landscape Connectivity	Monitoring & Research	Climate Change Adaptation	Community Engagement	Poaching & Hunting Mitigation	Policy Integration & Legal Protection	Capacity Building	Awareness & Education
(a) Implementation Framework									
Indicators of Success	% increase in intact forest; restored prey habitats; secured PA boundaries	Functional corridors maintained; dispersal confirmed (camera-trap, telemetry)	Occupancy & activity trends published; prey density monitored; joint datasets with Nepal/Bhutan	Climate refugia mapped; slope stabilisation; riparian buffers restored	Functional EDCs/JFMCs; threat-mapping exercises completed	Decline in snaring & bushmeat hunting incidents	ESZs/CRs notified; WPA compliance achieved	Staff positions filled; trained workforce in place	Awareness campaigns conducted; tea-estate MoUs functional
Priority Ranking	High	High	High	Medium	Medium	High	Medium	Medium	Medium
Priority Timeline	Short	Short	Continuous	Medium	Short	Short	Medium	Short	Short
Monitoring Mechanisms	Remote sensing (NDVI, NDWI; Landsat 30 m / Sentinel 10 m resolution); vegetation plots (0.1 ha permanent quadrats); canopy continuity indices	GIS corridor modelling; telemetry of dispersers; occupancy surveys using 1 km ² camera-trap grids in corridors; annual roadkill mitigation audits	Unified 1 km ² camera-trap grids across PAs/corridors; prey transects at 2 km intervals; systematic scat DNA analysis; occupancy/density estimation with CTDS	Climate refugia mapping (bioclimatic layers at 1 km ²); hydrological monitoring of perennial streams; quarterly phenology plots of indicator species	Household livelihood surveys (≥10% of fringe households sampled); participatory land-use mapping (annual)	Patrol-based SMART/M-STripes data (monthly, effort-corrected); consolidated annual snare/confiscation records	WPA compliance audits (annual); gazette notifications; ESZ/Conservation Reserve status reviews (every 3–5 years)	Training records (quarterly updates); audits of patrol resources (vehicles, GPS, equipment)	School-level surveys (≥2 per village cluster annually)
Responsible Agencies	MoEFCC, Sikkim/WB FD, WII, NGOs	MoEFCC, State FD, Bhutan/Nepal FD	WII, State FD, Bhutan/Nepal partners	MoEFCC Climate Division, State FD	FD, EDCs, NGOs, local councils	FD, Police, NGOs	MoEFCC, State Government, Legal Department	MoEFCC, WII, NGOs	FD, NGOs, schools, tea estates
Notes / Other Considerations	Tea estate boundaries sensitive; needs funding & tenure clarity	Cross-border coordination is essential with Bhutan & Nepal	Must integrate datasets from Bhutan/Nepal; risk of duplication	Road-widening & landslide-prone slopes need special focus	Long-term benefit-sharing key for sustaining EDCs/JFMCs	Bushmeat is deeply cultural; it requires alternative protein sources	Enforcement is weak in RFs; it requires a local government push	High vacancy rate; training resource gaps	Awareness must link to tea-estate CSR & schools
(b) Threats Tracking Framework									
Threat Category	Habitat degradation & encroachment	Fragmentation & linear intrusions	Data deficiency	Climate risks (landslides, storms)	Socio-cultural pressures	Poaching & bushmeat	Weak enforcement	Staff shortages	Low awareness
Indicators to Track	Forest cover change; % invasive spread; boundary encroachment cases	Corridor integrity index; roadkill records; telemetry dispersal	Occupancy trends; prey density indices; monitoring frequency	No. of refugia identified; landslip zones stabilised	No. of active EDCs/JFMCs; participation rates	Snare counts; bushmeat cases reported	ESZ/Conservation Reserve notifications issued; compliance audits	No. of staff recruited/trained	No. of awareness events; materials disseminated
Priority Ranking	High	High	High	Medium	Medium	High	High	Medium	Medium

Monitoring Method / Source	Satellite imagery (Sentinel 10 m, annual); GIS maps of invasive spread; boundary encroachment case records; vegetation plots (0.1 ha)	GIS corridor integrity index; fortnightly roadkill surveys on highways; telemetry dispersal monitoring; camera-traps (1 km ² spacing) at pinch-points	Long-term 1 km ² camera-trap datasets; scat DNA libraries (replicate samples); prey density indices updated every 3 years	Climate models (CMIP6 at 1 km ² resolution); hydrological surveys pre/post-monsoon; quarterly phenology of keystone plants	Household/community surveys (≥10% of fringe households); participatory mapping (biennial); conflict records & compensation claims	SMART/M-STRIPES patrol data (monthly); targeted bushmeat market monitoring (quarterly); seizure records (annual)	Government gazettes; ESZ/Conservation Reserve compliance audits (biennial); policy/legal reviews of WPA enforcement.	Staff vacancy audits (annual); training completion reports; resource gap assessments	Satellite imagery (Sentinel 10 m, annual); GIS maps of invasive spread; boundary encroachment case records; vegetation plots (0.1 ha)
Response / Mitigation Action	Boundary demarcation; invasive removal; habitat enrichment; waterhole management	Corridor restoration; ESZ notification; canopy rope-bridges where needed	Joint monitoring protocols with Nepal/Bhutan; prey-base restoration	Stabilise slopes; restore riparian buffers; integrate climate plans	Strengthen EDCs; participatory threat-mapping; eco-tourism	Anti-snarling patrols; informant networks; awareness drives	Update state biodiversity plans; enforce WPA; integrate CAMPA/GIM	Training workshops; fill vacancies; provide patrol gear	Awareness campaigns in schools & tea estates; citizen science
Frequency	Annual	Continuous	Continuous	5-yearly assessments + interim updates	Annual	Continuous	Policy cycle (5-year)	Annual	Annual
Notes / Other Considerations	Encroachment concentrated in the tea garden fringes	Road expansion & hydropower projects pose major risks	Lack of long-term funding for monitoring	Climate refugia are poorly understood; they need modelling	EDCs require micro-plan funding & transparency	Snaring is mostly seasonal (monsoon-winter)	Legal delays are common; they require periodic follow-up	Staff transfers affect continuity	Awareness is episodic; needs structured programs
(c) Monitoring & Evaluation Framework									
Outcome Indicators	% increase in intact forest cover; canopy continuity index stable; reduced encroachment cases	No. of corridors functionally maintained; verified dispersal across corridors; reduced roadkill incidence	Occupancy stable/increasing; prey density estimates available every 3 years; published datasets accessible	No. of refugia secured; % of erosion/landslide sites stabilised; riparian buffers restored	% of households with diversified livelihoods; active EDCs/JFMCs; conflict cases declining	Decline in snares/bushmeat incidents; patrol coverage rate (km patrolled / km ²); seizure convictions upheld	% of ESZ/Conservation Reserve proposals legally notified; WPA compliance maintained; inclusion in state biodiversity plans	% vacancies filled; trained staff retained ≥3 years; refresher trainings conducted	% increase in school/community participation; citizen science records submitted annually
Evaluation Frequency	Annual (remote sensing + field validation)	Biennial connectivity surveys; telemetry updates	Continuous data collection; 5-year synthesis reports	5-year assessments with interim reviews	Annual household surveys; biennial participatory mapping	Monthly patrol data audits; quarterly wildlife crime reviews	5-year policy/legal reviews; mid-term compliance checks	Annual training audits; 3-year independent evaluations	Annual school/community surveys; independent perception studies every 5 years
Accountability / Reporting	State Forestry Department annual habitat audit; MoEFCC publishes national synthesis	Wild corridor-use synthesis; Forest Department reports shared with MoEFCC	Wild & universities lead peer-reviewed outputs; MoEFCC compiles national status report	MoEFCC Climate Division publishes 5-year climate risk reviews	FD/NGOs publish social audit reports; community feedback is integrated	SMART/M-STRIPES audits published; enforcement agencies share annual crime stats	MoEFCC legal cell publishes compliance audits	MoEFCC/WII maintains a national training database	NGOs, schools, and the Forest Department share outreach impact reports

Integration of Thematic Actions with Enabling Mechanisms

The site- and theme-specific actions provide the operational backbone for clouded leopard conservation across India's priority landscapes. These actions directly address habitat protection, connectivity, monitoring, climate resilience, community engagement, poaching mitigation, policy integration, capacity building, and awareness at the Protected Area and landscape scales.

However, to ensure that these thematic interventions are sustainable, adequately resourced, and effectively coordinated, they must be supported by a complementary set of enabling mechanisms. The enabler framework identifies eight strategic categories—funding mobilisation, partnerships, technology integration, genetic/connectivity research, climate mainstreaming, livelihood incentives, policy integration, and independent review. Together, these enablers provide:

- Financial security (*e.g.*, CAMPA, CSR, international donors) to sustain habitat restoration, anti-poaching, and community initiatives.
- Cross-border and multi-stakeholder partnerships to secure transboundary corridors and strengthen enforcement.
- Technological and genetic innovations to improve monitoring accuracy, understand connectivity, and integrate adaptive management.
- Policy mainstreaming and periodic independent evaluation to embed clouded leopard conservation in wider biodiversity, climate, and development agendas.

By linking landscape-level priority actions with systemic enablers, the Action Plan ensures that conservation interventions are not only ecologically sound but also institutionally feasible, socially acceptable, and resilient in the long term.

Table 3.25.

Implementation Mechanisms for Clouded Leopard Conservation in India. The table outlines enabling mechanisms required to operationalise the Clouded Leopard Conservation Action Plan. Eight enabler categories are presented, each with key actions, indicators of success, monitoring mechanisms, responsible agencies/partners, and indicative timelines. These enablers ensure that site-specific and thematic interventions are supported by sustainable financing, governance, technological innovation, and adaptive review, thereby strengthening long-term conservation outcomes for the species.

Enabler Category	Key Actions	Indicators of Success	Monitoring Mechanisms	Responsible Agencies / Partners	Timeline
Funding & Resource Mobilisation	• Leverage CAMPA funds for habitat restoration & anti-poaching infrastructure. • Access international donors (GEF, UNDP, CEPF). • Explore CSR and eco-tourism revenue-sharing.	% of budget secured vs required; number of diversified funding sources.	Annual financial audits; fund utilisation reports.	MoEFCC, State Forest Departments, NGOs, Corporate CSR boards.	Short & Medium term
Partnerships & Trans-boundary Cooperation	• Formalise MoUs with Bhutan, Bangladesh, Myanmar, and Nepal. • Strengthen WCCB and TRAFFIC partnerships. • Create multi-stakeholder regional working groups.	Organize Cross border meeting and joint patrolling.	MoU progress reviews; joint enforcement records.	MoEFCC, MEA, State Forest Departments, Bhutan/BD/MM/NP Forest Departments, WCCB.	Short & Medium term
Technology Integration	• Deploy AI-enabled camera trap image analysis. • Expand eDNA & genetic connectivity monitoring. • Explore drones, acoustic sensors, and citizen science apps.	% of sites using advanced tools; datasets generated annually.	Tech deployment records; peer-reviewed publications.	WII, State Forest Departments, Research Institutions, NGOs.	Short & Long term
Genetic & Connectivity Research	• Establish a national CL genetic database. • Monitor gene flow across fragmented populations. • Integrate genetics with corridor planning.	Number of samples analysed; genetic diversity indices.	DNA lab reports; cross-site connectivity assessments.	WII, Universities, International Research Partners.	Medium & Long term

Climate Change Mainstreaming	- Integrate CL needs into SAP-CC. - Link habitat restoration with REDD+/carbon projects.	Inclusion in SAPCC; carbon credits generated.	Climate policy reviews; forest carbon monitoring.	MoEFCC (Climate Division), State Forest Departments, DST, UNFCCC focal agencies.	Medium & Long term
Livelihood & Incentives	- PES (Payments for Ecosystem Services) schemes. - Crop/livestock insurance linked to HWC mitigation. - Green job creation (ecotourism guides, handicrafts).	% households covered by PES/insurance; number of green jobs created.	Household surveys; insurance records; eco-tourism audits.	State Forest Departments, Panchayats, NGOs, Insurance Boards.	Short & Medium term
Policy Integration	- Embed CL strategies into State Wildlife Action Plans (SWAPs). - Mainstream conservation of CL into forest & land-use policies.	Number of SWAPs & policies updated with CL measures.	Policy review reports; gazette notifications.	MoEFCC, State Governments, NTCA, Planning Commissions.	Medium term
Independent Review & Evaluation	- Annual third-party audits of progress on the action plan. - Mid-term (5-year) and final (10-year) reviews.	Audit reports completed; % of targets met on schedule.	Independent audit reports; MoEFCC review notes.	MoEFCC, Independent Experts, NGOs, Academic Institutions.	Short, Medium, & Long-term

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04

STAKEHOLDER CONSULTATIONS & *Technical Meetings*

By Neil Bowman

The development of Conservation Action Plans (CAPs) for Caracal, Fishing Cat, and Clouded Leopard under the GEF-7 Project *“Strengthening conservation and resilience of globally significant wild cat landscapes through a focus on small cat and leopard conservation”* followed a participatory and consultative approach. These species, despite their ecological significance and conservation importance, remain relatively understudied and underrepresented in conservation planning compared to larger felids. Recognising the need for science-based and implementable conservation strategies, the project sought to integrate available scientific knowledge with the practical experience and perspectives of conservation managers, researchers, local stakeholders, and policy-makers.

To facilitate stakeholder engagement and obtain expert feedback, the Global Tiger Forum (GTF) organised a series of consultations and technical meetings at national, landscape, and transboundary levels. These meetings brought together representatives from government agencies, conservation practitioners, researchers, local stakeholders, and partner organisations to discuss species-specific conservation challenges, knowledge gaps, monitoring needs, habitat management priorities, and opportunities for collaborative conservation action. The consultations also served as a platform to present and deliberate on the proposed CAP framework, review species assessments, identify priority conservation landscapes, and develop consensus on strategic actions required for the long-term conservation of the focal species.

The discussions further provided opportunities to examine landscape-level conservation issues, transboundary challenges, monitoring protocols, research priorities, community engagement approaches, and institutional mechanisms for implementation. Recommendations generated through these interactions helped validate the proposed conservation strategies, refine priority actions, and strengthen the scientific and management foundations of the Conservation Action Plans. The insights and feedback received during these consultations were subsequently incorporated into the final CAPs for Caracal, Fishing Cat, and Clouded Leopard.

Conservation Action Plan for Asiatic Caracal, Fishing Cat, and Clouded Leopard were discussed during following meetings which were attended by the representatives from the Ministry of Environment, Forest and Climate Change (MoEFCC), National Tiger Conservation Authority (NTCA), Global Tiger Forum (GTF), Wildlife Institute of India (WII), United Nations Development Programme-India (UNDP-India), WWF-India (World Wide Fund for Nature-India), State Forest Departments, International Big Cat Alliance (IBCA), Wildlife Crime Control Bureau (WCCB), South Asia Wildlife Enforcement Network (SAWEN), officers from Nepal and Bhutan, technical experts working on small wild cat conservation and monitoring, and other partner organisations.

A **“Planning and Orientation Workshop”** under the **“GEF-7 Small Wild Cat Project”** was organised on 8–9 July 2025 at Eros Hotel, Nehru Place, New Delhi.

A technical consultation meeting on **“Monitoring Protocol for Small Wild Cats”** under the **“GEF-7 Small Wild Cat Project”** was organised on December 15 2025, at Lutyens Hall, Eros Hotel, New Delhi.

A transboundary consultation meeting under the **“GEF-7 Small Wild Cat Project”** was organised on 12–13 March 2026 in the Dudhwa Landscape, Uttar Pradesh.



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