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HUMAN–LEOPARD CONFLICT IN NASHIK: PATTERNS, DRIVERS, ECOLOGICAL CONTEXT, AND PATHWAYS TO COEXISTENCE

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ABSTRACT:

Human–leopard conflict is an escalating conservation and socio-ecological issue across many parts of India, and Nashik district (Maharashtra) has seen a notable rise in leopard sightings, livestock depredation, and peri-urban intrusions in recent years. This review synthesizes open-access scientific literature, government working plans, NGO guidance, and verified local reports to (1) characterise the Nashik landscape and leopard ecology; (2) summarise patterns of human–leopard interactions; (3) identify proximate and ultimate drivers of conflict; and (4) propose evidence-based interventions for sustainable coexistence. Key drivers in Nashik include habitat fragmentation, availability of anthropogenic prey (notably free-roaming dogs and unsecured small livestock), and agricultural systems (e.g., sugarcane, orchards) that provide dense refuge. Effective mitigation requires integrated landscape planning, community participation, improved livestock management, stray dog control, rapid response capacity, and transparent compensation mechanisms. The review emphasises the need for systematic incident documentation at the district level, long-term ecological monitoring (camera traps, telemetry), and participatory governance for durable coexistence.

KEYWORDS: *leopard, Panthera pardus, Nashik, human–wildlife conflict, coexistence, Maharashtra.*

INTRODUCTION:

Human–wildlife conflict (HWC) is a major conservation and rural development challenge in many biodiverse countries (Redpath et al., 2013). Among large carnivores, leopards (*Panthera pardus fusca*) are notable for their exceptional ecological plasticity: they persist across a spectrum of habitats from protected forests to agricultural mosaics and peri-urban landscapes (Athreya et al., 2013). Nashik district in northern Maharashtra exemplifies such a mosaic: forest fragments, basaltic hills, riparian corridors, extensive agriculture (sugarcane, vineyards, orchards), and growing peri-urban settlements. This spatial juxtaposition creates both opportunities for leopard persistence and heightened potential for negative interactions with people (Maharashtra Forest Department, West Nashik Working Plan).

Leopard presence near agricultural fields and settlements generates a diverse set of conflict events: livestock depredation (goats, calves), predation on domestic dogs, visual sightings in residential

colonies, and occasionally human injury or fatalities following surprise encounters or stressful rescue operations (Naha et al., 2018; Project Waghoba guidelines**).** Nashik's recent surge in reported incidents and rescue operations underscores the urgency for an evidence-based synthesis that connects ecological patterns with practical mitigation.

This review uses open-access science, government plans, NGO technical guidance, and systematically-collected grey literature to examine patterns and drivers of human–leopard conflict in Nashik, and to outline interventions grounded in ecological understanding and community realities.

METHODS (REVIEW APPROACH):

This review follows a structured narrative approach focused on open-access sources to ensure verifiability and reproducibility. The literature search prioritized peer-reviewed, open-access papers, government working plans, NGO manuals, and publicly available incident reports. Major databases and sources included PLOS ONE, Scientific Reports, government PDFs (Maharashtra Forest Department), Project Waghoba/ WT I technical documents, and trusted national/regional news outlets for recent local incidents.

Data extraction focused on: landscape description; leopard ecology (diet, movement, denning); conflict typologies; documented management responses; and recommendations from prior studies. Nashik-specific government documents (West Nashik working plan) and local ecological studies (diet/scat analyses in agricultural talukas) were prioritized where available (Maharashtra Forest Department; local scat/diet studies).

STUDY AREA: NASHIK DISTRICT- LANDSCAPE AND HUMAN USE:

Nashik district (northern Maharashtra) spans a diverse ecological and land-use gradient. The western part includes the higher rainfall, rocky hill systems and riparian vegetation associated with the northern Western Ghats (Trimbakeshwar–Anjaneri–Igatpuri ranges), while the central and eastern plains are intensively farmed (sugarcane, vineyards, pomegranate, onion) and hold most of the human population and settlements (Maharashtra Forest Department, West Nashik Working Plan).

Key landscape features relevant to leopard ecology and conflict:

- **Fragmented forest patches and rocky outcrops**: Used for resting and denning; caves and crevices in basaltic hills offer refuges near human habitations.
- **Agricultural cover**: Tall crops (sugarcane), orchards, and vineyards create dense cover analogous to understorey and enable concealment. These patches function as surrogate habitat enabling leopards to rest by day and move at night.
- **Peri-urban expansion**: Nashik city's outward growth and development of industrial estates (Sinnar, Ambad) produce edge habitats that leopards traverse while moving between fragments.
- **Water bodies**: Dams and streams (e.g., Gangapur Dam) provide water and support prey species.
- **Human livelihoods**: Mixed agriculture, small ruminant rearing, domestic dogs, and seasonal labour patterns determine exposure and vulnerability.

Because leopards require relatively little continuous forest and exploit matrix habitats, this heterogeneous landscape sustains leopard presence but also increases overlap with human activity—creating the conditions for recurring conflict (Athreya et al., 2010; Pawar et al., 2019).

Leopard ecology and behaviour relevant to conflict:

Understanding leopard ecology clarifies why and how conflict arises in human matrices.

a. Behavioural plasticity and habitat use:

Leopards exhibit marked behavioural plasticity: they shift activity to nocturnal hours where human activity is high by day, use linear and agricultural features as movement corridors, and exploit anthropogenic food subsidies where available (Athreya et al., 2013; Naha et al., 2018). Camera-trap and telemetry studies from Maharashtra and similar agro-forest landscapes show leopards frequently use orchards, sugarcane stands, riparian strips, and marginal forest fragments as resting sites and travel routes, enabling movement across otherwise hostile matrices (Pawar et al., 2019**;** Vanak et al., 2023).

b. Diet and prey selection:

Leopards are opportunistic feeders. In agro-forest mosaics with low wild ungulate densities, domestic animals (dogs, goats, calves) often comprise a large portion of consumed biomass (Naha et al., 2018; **Vanak et al., 2023).** Scat analyses in Maharashtra's agricultural talukas indicate that domestic dogs frequently dominate diet samples where dogs are abundant, which draws leopards into closer proximity with settlements (Pawar et al., 2019). The abundance of accessible domestic prey thus functions as a proximate driver of leopard persistence near human habitations.

c. Denning and cub rearing in agricultural matrices:

Females may den and raise cubs in dense crop stands (e.g., sugarcane) or rocky crevices close to settlements. Denning behaviour in tall crops increases the likelihood of accidental encounters during agricultural operations (harvesting, ploughing), and can lead to situations where cubs are temporarily separated from mothers during human activities—creating rescue scenarios and human–animal stress.

d. Movement and dispersal:

Juvenile dispersal and male movement across the agricultural matrix lead to transitory use of village fringes and roads. Road networks fragment the landscape and create collision risks. Dispersing subadults, unfamiliar with human presence, can cause unusual encounter patterns (Naha et al., 2018).

Diet, prey base, and the role of anthropogenic subsidies:

Leopard diets in human-dominated landscapes often reflect local prey availability. Two patterns are relevant to Nashik:

a. Domestic dog subsidy:

Free-roaming and semi-feral dogs are abundant around towns and villages, sustained by garbage, marketplaces, and human food waste. Several studies in western India find that when dog density is high, leopards show increased nocturnal movement into settlements to exploit this predictable food source**.** Dog predation not only provides calories but also reduces the need for longer range hunting—encouraging leopards to remain within or near human matrices.

b. Small livestock vulnerability:

Small livestock (goats, sheep) and calves are frequently targeted when husbandry practices leave animals unsecured overnight or in poorly fenced enclosures. Economic losses from such depredation are rapid and visible to households, generating strong negative attitudes if compensation is absent or delayed (WTI / Project Waghoba guidelines).

c. Wild prey scarcity and substitution:

Where wild ungulate densities are low (due to habitat loss or hunting), leopards substitute with domestic prey. This substitution is a classic mechanism linking habitat degradation to increased human–carnivore conflict (Naha et al., 2018).

Patterns of human–leopard interactions in Nashik:

Human–leopard interactions in Nashik manifest as a mixture of sightings, livestock depredation, dog predation, accidental encounters in crops, rescue operations, and sporadic human injuries. A pattern summary:

a. Sightings and peri-urban intrusions:

Frequent visual sightings—residents reporting leopards in residential colonies or captured on CCTV—are common in peri-urban Nashik. Sightings are socially salient: even non-injurious sightings generate fear and cause behavioural changes (avoidance of early/late travel, school route changes).

b. Livestock depredation:

Small livestock depredation is a primary economic impact recorded in many talukas, particularly where night shelters are inadequate or where open grazing occurs. Farmers report repeated losses during certain seasons, prompting calls for compensation.

c. Rescue operations and trapping:

Nashik Forest Department conducts rescue and trapping operations when leopards enter settlements or become trapped in fields. Rescue operations sometimes result in human injuries, especially when crowds gather in rescue attempts (Athreya et al., 2010; field reports).

d. Human injury and fatality (rare):

Leopard attacks on people are rare relative to the number of sightings, but when they occur the social and political consequences are disproportionate. Many documented human injuries result from surprise encounters in dense crop fields or from stressful capture situations where the animal reacts defensively (Athreya et al., 2013).

Drivers of conflict-proximate and ultimate causes:

Conflict emerges from the interaction of proximate ecological conditions and broader socio-economic drivers.

a. Ecological proximate drivers:

- **Habitat fragmentation and loss**: Linear infrastructure, urban sprawl, and agricultural conversion reduce natural habitat and force leopards to use marginal and human-dominated patches as movement corridors (Naha et al., 2018).
- **Anthropogenic prey availability**: High densities of free-roaming dogs and unsecured livestock provide reliable food, encouraging leopards to remain near human settlements (Pawar et al., 2019).
- **Agricultural cover (sugarcane, orchards)**: Tall crops provide daytime concealment and denning opportunities, increasing accidental human encounters during agricultural operations.

b. Socio-economic and behavioural drivers:

- **Livestock husbandry practices**: Night grazing and poorly protected shelters increase vulnerability.

- **Garbage and waste management**: Improper solid-waste practices sustain dog populations.
- **Human behaviour during sightings/rescues**: Crowding and provocation intensify stressed animal responses, occasionally causing injuries (Athreya et al., 2010).
- **Perception and fear**: Media amplification of incidents can escalate local fear and reduce tolerance for wildlife; this influences local political responses and management priorities.

c. Administrative and historical drivers:

- **Past translocation/removal practices**: Evidence from Maharashtra suggests that indiscriminate capture and release without addressing root causes often fails to reduce conflict and may exacerbate it by creating territorial vacancies and immigrant individuals (Athreya et al., 2010).
- **Resource allocation and response capacity**: Rapid response, veterinary care, and transparent compensation require sustained institutional capacity that is not uniformly available across talukas.

Why Nashik is predisposed to recurring conflict:

Bringing the above elements together explains Nashik's predisposition to recurring human–leopard conflict:

1. **Landscape suitability:** The mosaic of fragments, rocky outcrops, and dense agricultural cover offers the structural habitat leopards need without requiring large continuous forests.
2. **Food subsidies:** High densities of free-roaming dogs and abundant unsecured small livestock provide accessible prey.
3. **Human density and expansion:** Rapid peri-urban development creates more edges and increases the frequency of human–leopard overlap.
4. **Seasonal dynamics:** Crop cycles (planting/harvest), monsoon vegetation growth, and seasonal water availability modulate leopard movement and visibility, creating temporal peaks in incidents.
5. **Institutional response cycle:** Reactive rescue and translocation, coupled with limited long-term landscape planning, produce a management spiral of temporary fixes rather than preventive measures.

This synthesis suggests that mitigation in Nashik must be multi-pronged, addressing ecological drivers (connectivity, prey base), human behaviour (livestock protection, waste management), and governance (rapid response, compensation, participatory planning).

Comparative Case Studies & Lessons from Across Maharashtra and India:

While peer-reviewed ecological studies directly from Nashik are limited, research from other regions in Maharashtra and peninsular India- in landscapes ecologically similar to Nashik- offers important lessons and guidance. These comparative cases help inform what might work (or not) in Nashik.

a. Plantation and Agro-Forest Landscapes: Lessons from Anamalai Hills and Surrounding Areas:

In plantation-dominated landscapes such as the Anamalai Hills, long-term studies have documented human–leopard coexistence through a combination of habitat maintenance, livestock management, community awareness, and minimal removal of leopards (conflict individuals only removed under strict criteria). In such systems, researchers suggest that removal or translocation of leopards should be a last resort; emphasis should be on reducing attractants (e.g., unsecured livestock, free-roaming dogs), improving livestock enclosures, and strengthening community engagement

Key lessons: (Athreya et al., 2013; WTI/Project Waghoba guidelines).

- Mixed-use landscapes with forest cover fragments + plantation/agricultural cover can sustain leopards without high rates of human–leopard conflict, if anthropogenic prey subsidies and livestock vulnerability are managed carefully.
- Over-reliance on translocation or removal disrupts population structure and may increase conflict elsewhere.
- Strong community participation and long-term monitoring result in better coexistence outcomes.

For Nashik — which similarly combines rocky hills, riparian patches, agricultural fields (sugarcane, vineyards, orchards), and peri-urban settlements — these lessons are directly relevant.

b. Agriculture-dominated Regions: Example from Junnar Forest Division (Maharashtra):

Junnar, another agro-forest mosaic in Maharashtra, faced high levels of conflict, largely due to sugarcane fields being used by leopards as refuge and domestic dogs serving as prey base. Detailed studies revealed that conflict intensity correlated with crop-cycle, availability of water, and density of stray dogs (Pawar et al., 2019). Management interventions there focused on community engagement, livestock protection, night-sheltering of vulnerable animals, and reducing dog populations.

Lessons for Nashik:

- Sugarcane and tall-crop agriculture — while economically important — pose significant risk if not managed with wildlife-safe practices (e.g., checking for animals before harvesting, avoiding night-work in high-risk zones).
- Dog population control (Animal Birth Control programmes) can reduce a major attractant for leopards.
- Conflict mitigation must address root ecological and anthropogenic causes — not just symptom (e.g., rescue/translocation).

Media-Reported Human- Leopard Incidents in Nashik (2024–2025):

This standalone section presents a compilation of publicly accessible, media-documented incidents in Nashik district between 2024 and 2025. These incidents are drawn from reputable news outlets, to illustrate the real-time conflict dynamics and underscore the urgency of systematic monitoring. Because media reports constitute grey literature, they are presented here for context and illustration, not as empirical ecological data.

Date / Period	Location (approx.)	Incident summary	Relevance / Outcome
Aug 26, 2025	Pimpalgaon-Khamb (outskirts of Nashik city)	A female leopard trapped by Forest Dept. in cage; transported to transit centre at Mhasrul. Reported as second rescue in same locality within days.	Demonstrates increasing peri-urban rescues, frequency of leopard presence near city fringes, and active government response. (Times of India, 2025a)
Sep 2025	Vadner-Dumala (near Deolali Camp)	Male leopard rescued after 5-hour operation from a grass farm; rescue followed earlier fatal attack on a child in August.	Highlights intensive rescue operations in rural–agricultural zones; shows human injury potential after attacks; underlines community vulnerability. (Times of India, 2025b)

Nov 2025	Multiple residential colonies (Kamgar Nagar, Sant Kabir Nagar, Gurukul Colony, Taramangal Society)	A leopard strayed into residential zones; during a 2.5-hour rescue, five persons were reportedly injured.	Example of urban/colony intrusion; shows risk to human safety during rescue / containment when animals enter dense human habitation. (Times of India, 2025c)
Nov 15, 2025	Mahatma Nagar (Nashik city)	Five-hour chase and capture of leopard; nine people injured (residents + forest personnel); CCTV footage circulated widely.	Demonstrates how leopards navigate built environments; human injuries during rescue; social stress and media visibility. (NDTV India, 2025)
2023–2024 (approx)	Sawatanagar & Govindnagar (residential areas)	Two separate leopards entered settlement zones; captured with involvement of NGO and Forest Dept.	Shows collaboration between NGOs and government; indicates repeated pattern of settlement incursions even before 2025. (Hindustan Times, 2024)
Nov 07, 2025	Lohshingve village (rural Nashik)	Fatal leopard attack on 30-year-old man; local outrage and demand for safety measures reported.	Illustrates severe risk to vulnerable rural populations; social consequences; need for preventive measures. (Maharashtra Times, 2025)
2025 summer (aggregate)	District-wide (Nashik)	Reports indicate at least seven human fatalities and approximately 20 leopards rescued by August 2025 — a spike compared to previous years.	Suggests an upward trend in conflict; shows growing pressure on forest and rescue systems; underlines the need for systematic documentation. (Times of India, 2025a; 2025b)

Note: Because these are media reports, details (exact locations, dates, individual identities) may vary between reports; caution is advised in using them as data for statistical inference.

These grey-literature examples underline that conflict in Nashik is current, widespread, and involves both rural and peri-urban zones. They reinforce the ecological patterns discussed earlier, showing how leopards exploit the mosaic landscape and how human activities mediate risk. However, the sporadic and selective nature of media reporting — typically focusing on dramatic incidents (injuries, fatalities, rescues) — means that many routine events (livestock depredation, near-misses, nocturnal sightings) likely go unreported.

Thus, the media-reported incident archive is **incomplete and biased**, but **valuable for illustrating** the human dimension of conflict and its recent intensification in Nashik (see Limitations below).

Current Management Practices & Institutional Responses in Nashik / Maharashtra:

Effective mitigation of human–leopard conflict requires structured, science-informed institutional frameworks. Based on available records from Maharashtra Forest Department, NGO

guidance documents, and government policy pronouncements, the following summarises current practices and institutional responses.

a. Rescue & Capture Protocols:

The state follows guidelines developed under Project Waghoba / Wildlife Trust of India (WTI), which outline Standard Operating Procedures (SOPs) for rescue, capture, transportation, and release of conflict-causing leopards (Athreya et al., 2013; WTI, 2017).

Key elements:

- Use of cage-traps or tranquilisation under veterinary supervision.
- Minimum disturbance crowd control — avoid loud gatherings or direct human proximity to animals during capture.
- Short-term holding in transit centres, medical inspection, and release or rehabilitation per health evaluation.
- Data recording (location, date, approximate reason for capture) for future monitoring.

In Nashik, recent directives (Nov 2025) instruct creation of two dedicated rescue/ rehabilitation centres capable of housing large numbers of big cats, indicating institutional strengthening **(Times of India, 2025d).**

b. Community Awareness and Outreach:

Forest Department and NGOs conduct community meetings, school-level awareness programmes, and distribute informational material about safe behaviour (avoiding lone walks at night, precautions in sugarcane fields, safe livestock enclosures). These educational efforts aim to reduce fear, misinformation, and risky human behaviour that leads to panic or stress during leopard sightings.

c. Livestock & Domestic Animal Management:

Initiatives include:

- Promoting secure bomas (night shelters) for livestock.
- Encouraging small-livestock owners to avoid open grazing at night.
- Supporting Animal Birth Control (ABC) programmes for stray and semi-feral dogs to reduce anthropogenic prey subsidy — though scale remains inadequate.

d. Monitoring, Research & Data Collection:

Maharashtra Forest Department's West Nashik Working Plan recommends periodic monitoring via camera traps, pug-mark surveys, and community-based reporting; however, consistent long-term monitoring remains limited due to resource constraints. Researchers advocate establishing a formal conflict-incident database at district level to systematically archive all conflict events (scientific and media-reported), enabling quantitative analysis and hotspot mapping (Naha et al., 2018).

Evidence-Based Mitigation & Coexistence Strategies for Nashik:

Drawing on scientific literature, comparative case studies, and local media-documented incidents, the following multi-tiered strategy is proposed for Nashik to move toward sustainable human–leopard coexistence:

a. Short-Term:

1. **Strengthen Rapid Response Teams (RRTs):** Equip rescue teams with cage-traps, tranquiliser kits, veterinary support, and clear SOPs. Improve crowd-control protocols during rescues to minimize human–animal injury risk.
2. **Emergency Awareness Drives:** Launch immediate information campaigns in high-conflict zones (town fringes, agricultural belts) to educate residents about safe practices: checking fields before harvesting, not roaming alone at night, securing livestock, avoiding crowding during rescues.
3. **Livestock Protection Support:** Distribute subsidised materials (wire mesh, lockable shelters) to vulnerable livestock owners for building predator-proof night enclosures. Provide technical guidance.
4. **Stray Dog Population Control:** Expand and resource ABC programmes aggressively in towns and villages — decreasing domestic dog density reduces major anthropogenic prey subsidy.

Medium-Term:

5. **Establish and Maintain Conflict-Incident Database:** Require all rescue operations, livestock depredation, sightings, and human injuries/deaths to be logged with GPS location, date/time, incident type — maintained by district forest office and accessible to researchers.
6. **Scientific Monitoring:** Deploy systematic camera-trap grids across hotspot talukas (e.g., Niphad, Sinnar, Trimbakeshwar, Igatpuri). Where feasible, collar a small number of individuals for telemetry to understand movement corridors, seasonal dispersal, habitat use.
7. **Landscape Planning & Zoning:** Identify and demarcate wildlife corridors, restrict further urban expansion or industrial development in identified corridor zones, and promote buffer zones with lower-cover crops around settlements.
8. **Community-Based Conservation Committees:** Form local committees including farmers, village leaders, municipal representatives, and forest staff to oversee livestock protection, report sightings, coordinate with RRTs, and plan preventive measures.

Long-Term:

9. **Habitat Connectivity Restoration:** Replant native vegetation in degraded patches, restore riparian corridors, protect hill-forest fragments, and promote agroforestry practices to increase wild prey base and reduce reliance on domestic prey.
10. **Sustainable Livelihood Diversification:** Promote alternatives to high-risk livestock rearing (e.g., less vulnerable poultry, small ruminants with better enclosures), and encourage eco-tourism, agro-tourism, or forest-based livelihoods under landscape-friendly guidelines.
11. **Institutional Capacity Building:** Fully operationalise the proposed rescue/rehabilitation centres, maintain trained staff, funding for recurrent activities (veterinary, monitoring, outreach), and transparent compensation systems for losses — to build public trust and reduce retaliatory action.

These measures, taken together, address ecological, social, and institutional drivers of conflict — increasing chances for long-term coexistence.

Research Gaps:

- **Lack of long-term ecological data from Nashik:** There is no published telemetry or comprehensive camera-trap study that tracks leopard population dynamics, movement corridors, or seasonal habitat use in Nashik.
- **Inadequate incident documentation:** Media-reported incidents are fragmented and selective; systematic logging by forest authorities is not publicly available or standardised.

- **Sparse data on prey base:** Quantitative data on prey density (wild ungulates, rodents, dogs) across Nashik's varied landscape zones is missing.
- **Limited socio-economic assessments:** Few studies examine human perceptions, attitudes, economic loss due to depredation, or effectiveness of mitigation interventions in Nashik context.

Filling these gaps requires long-term field studies, collaboration between forest department, NGOs, academic institutions, and local communities, and building transparent open-access data systems.

Ethical Considerations:

- **Animal welfare:** Rescue, capture, and translocation must follow humane standards under veterinary supervision; unnecessary removals should be avoided.
- **Community rights and livelihoods:** Livestock owners, farmers, and vulnerable rural populations must be fairly compensated for losses; mitigation should not impose undue burden.
- **Transparency:** Data on incidents, rescue operations, and compensation should be publicly available (with anonymity) to maintain legitimacy and inform research.
- **Participatory governance:** Communities must be involved in decision-making, especially for land-use planning and management of shared landscapes.

CONCLUSION:

Nashik district exemplifies a human–wildlife landscape at a critical juncture: a mosaic of forest fragments, agricultural lands, water bodies, and expanding urban/peri-urban settlements- conditions under which leopards can persist, but also under which human–leopard conflict flourishes. The ecological plasticity of leopards, coupled with anthropogenic prey subsidies (free-roaming dogs, unsecured livestock) and dense agricultural cover (sugarcane, orchards), creates a setting where conflict becomes almost inevitable unless proactive management and coexistence strategies are implemented.

Scientific evidence, comparative case studies, and recent media-documented incidents point to a multi-layered solution: one that integrates robust wildlife ecology, human livelihoods, governance capacity, and community participation. Short-term rescue capacities and awareness programmes must be complemented by long-term planning- habitat connectivity, prey base management, livestock protection, data transparency, and institutional commitment.

If such a holistic, evidence-based approach is adopted, Nashik has the potential to become a model landscape for large-carnivore coexistence in agro-forest mosaics across India.

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