

Mammals of Punjab, Pakistan: Diversity, Conservation Status, and Emerging Threats

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Abstract: Punjab, the most populous province of Pakistan, has a surprisingly wide range of habitats within a relatively narrow strip of latitude, from the dry Cholistan Desert and irrigated agro-ecosystems of the central plains to riverine forest tracts along the Indus tributaries and dry subtropical hills of the Salt Range and Potohar Plateau. The environmental mosaic supports a relatively diverse mammalian fauna, although the province's site-specific surveys and taxon-specific research are scattered among numerous publications, and have not been synthesised previously. This narrative assessment integrates data from 31 published sources to describe species diversity, habitat affinities, conservation status and anthropogenic threats to mammals in Punjab. Reported species richness at individual survey sites ranged from 12 to 23 species, with Rodentia and Carnivora consistently the most diverse orders and the family Muridae the most frequently dominant taxon. Several species of high conservation concern persist in the province, including the endemic Punjab urial (*Ovis vignei punjabiensis*, Vulnerable), the Endangered Indian pangolin (*Manis crassicaudata*), and an independently and only recently assessed Indian wolf population (*Canis lupus pallipes*, Vulnerable) numbering an estimated 10 to 20 individuals within Pakistan. Habitat destruction and fragmentation, poaching and illicit wildlife commerce, human-animal interactions, and the hydrological modification of river systems were the most often recorded dangers. The review further identifies structural gaps in the evidence base, including limited systematic surveys of bats and wetland-associated mammals, an almost complete absence of long-term monitoring, and minimal application of molecular and genetic tools beyond the Punjab urial. Closing these gaps through standardized, collaborative monitoring and translating the province's growing university-led research base into a coordinated conservation strategy will be essential to safeguarding Punjab's mammalian biodiversity against continuing agricultural expansion, water-resource development, and climate change.

Key words: *mammalian diversity*; Punjab; Pakistan; conservation status; anthropogenic threats; *Ovis vignei punjabiensis*

INTRODUCTION

Pakistan lies at the junction of three major zoogeographic realms, the Palearctic, the Oriental, and, marginally, the Ethiopian, a position that has endowed the country with an unusually diverse mammalian fauna relative to its land area (Ahmad et al., 2025; Roberts, 1997). National-level assessments recognize approximately 195 species of mammals in Pakistan across ten orders, a small number of which are nationally endemic (Khushbakhat et al., 2025; Roberts, 1997). Of these, the 2003 Conservation Assessment and Management Plan (CAMP) classified 76 species as threatened at some level, including 12 Critically Endangered, 12 Endangered, 20 Vulnerable, and 32 Near Threatened taxa (Sheikh & Molur, 2004; CAMP Workshop, 2003).

Punjab, the most populated province of Pakistan is located in the eastern part of the Indus plain and harbours a large diversity of habitat types within a relatively short latitudinal region (Ahmad et al., 2025; Kanwal & Ashraf, 2021; Taber et al., 1967). These are the arid Cholistan Desert in the south, large irrigated agro-ecosystems in the central plains, riverine forest tracts along the Jhelum, Chenab, Ravi and Sutlej, and the dry sub-tropical hills of the Salt Range and Potohar Plateau in the north (Ahmad et al., 2025; Kanwal & Ashraf, 2021). This mosaic supports a correspondingly varied mammalian assemblage: desert adapted gazelles and jirds, riverine carnivores, agricultural rodent pests and, in the Salt Range, the endemic Punjab urial (*Ovis vignei punjabiensis*) (Ahmad et al., 2025; Hussain et al., 2015; Awan et al., 2006).

The mammals of Punjab have been studied extensively in the past decade. Site-specific inventories are available for protected areas like Lal Suhanra and Chinji National Parks (Wazeer et al., 2025; Kanwal & Ashraf, 2021), riverine surveys have been conducted along Chenab, Ravi and Sutlej (Sial, 2024; Altaf et al., 2014), and taxon-focused studies have investigated Punjab urial, Indian pangolin, bats and commensal rodents to some detail (Muhammad et al., 2024; Awan et al., 2006; Mahmood-ul-Hassan & Nameer, 2006). What has been lacking is a synthesis to bring these disparate efforts into one province-wide story.

The objectives of this review are to: (i) provide a summary of the published record of species richness, composition and diversity indices of mammals in Punjab; (ii) describe the habitat associations of the mammalian fauna of the province in its major ecological zones; (iii) review the conservation status of important mammal species in relation to the current IUCN Red Listing; (iv) describe the major anthropogenic threats to mammalian populations; and (v) identify knowledge gaps and research priorities for the future.

Geographical Overview of Punjab

The province is drained by five major rivers, the Indus, Jhelum, Chenab, Ravi, and Sutlej, whose confluences and associated riparian forest tracts, locally termed 'Bela', constitute some of the most biodiverse remaining habitats in an otherwise heavily cultivated landscape (Altaf, 2016; Altaf et al., 2023). Ecologically, Punjab can be divided into several broad zones relevant to mammalian conservation. The Potohar Plateau and Salt Range in the north form a dry sub-tropical hill system that is the principal stronghold of the endemic Punjab urial and supports Chinji National Park, the

Kalabagh Game Reserve, and the Soan Valley urial range (Awan et al., 2006; Khan et al., 2015). The riverine forest belts along the Jhelum, Chenab, Ravi, and Sutlej retain relict populations of species such as hog deer, smooth-coated otter, and other riverine carnivores despite extensive conversion to agriculture (Altaf et al., 2014; Sial, 2024). The irrigated central plains and agro-ecosystems around Faisalabad, Toba Tek Singh, Sheikhpura, and Gujranwala are dominated by commensal and pest rodent and bat communities (Khan & Beg, 1986; Taber et al., 1967). The arid Cholistan Desert and adjoining Bahawalpur–Bahawalnagar tract in the south supports Lal Suhanra National Park and a desert-adapted mammalian community that includes chinkara, desert fox, and desert jird (Ahmad et al., 2025; Imran et al., 2025; Wazeer et al., 2025).

The province's protected-area network has expanded in recent years. Alongside the long-established Lal Suhanra and Chinji National Parks, the Punjab Wildlife and Parks Department notified three further national parks, Tilla Reserve, Kheri Murat, and Pabbi and Rasul, between 2021 and 2023, bringing the provincial total to at least five national parks, together with 37 wildlife sanctuaries and 24 game reserves (Government of Punjab Forest, Wildlife and Fisheries Department, 2026). This represents a meaningful revision of the two-national-park figure reported in earlier secondary sources and should itself be treated as provisional, since new notifications continue to be issued. Numerous unprotected riverine and desert tracts outside this formal network continue to support wildlife under increasing anthropogenic pressure.

Methodology

This review followed a narrative synthesis approach appropriate to a taxonomically and geographically bounded literature, rather than a formal systematic-review protocol, given the comparatively small and methodologically heterogeneous evidence base available for Punjab's mammals. Relevant sources were identified through structured searches of Google Scholar, ResearchGate, the Directory of Open Access Journals, and the archives of regionally indexed journals, including the Pakistan Journal of Zoology, the Journal of Wildlife and Ecology, the Journal of Animal and Plant Sciences, and Frontiers in Ecology and Evolution, using combinations of the terms 'mammal', 'diversity', 'Punjab', and 'Pakistan' together with the names of specific taxa (for example, 'Punjab urial', 'Indian pangolin', 'Chiroptera Pakistan') and specific sites (for example, 'Cholistan', 'Chenab', 'Lal Suhanra', 'Chinji', 'Salt Range', 'Sutlej'). The search encompassed articles from 1967, the date of the earliest Punjab-specific mammal study retrieved (Taber et al., 1967), through July 2026, with particular emphasis on the last decade, during which most site-based diversity studies have occurred. Nomenclature, distribution and historical conservation status was checked against the original survey literature (Roberts, 1997 The Mammals of Pakistan; Sheikh & Molur, 2004 CAMP status assessment) throughout.

We included sources that provided primary field data, population or distribution assessments, or conservation-status information for wild mammals occurring in Punjab. Studies of domestic livestock, laboratory animals, or

mammals from other provinces were excluded unless cited for comparative or methodological purposes. We have synthesised 31 sources that fit these requirements. Seven site-based diversity surveys comprise the quantitative core and are summarised in Table 1. As with any narrative review of a literature that includes theses, conference proceedings, and journals with limited international indexing, this approach cannot guarantee exhaustive coverage of Punjab's grey literature; this limitation, together with its consequences for cross-site comparison, is revisited in Section 8.

Mammalian Diversity in Punjab

Across the sources reviewed, species richness reported at individual survey sites in Punjab ranged from 12 species, recorded at three water-head sites along the Sutlej River (Sial, 2024), to 23 species, recorded in the Cholistan Desert (Ahmad et al., 2025). Rodentia and Carnivora were consistently the most speciose orders across sites, with the family Muridae the most frequently dominant taxon by both richness and relative abundance (Ahmad et al., 2025; Sial, 2024). Table 1 summarizes species richness and diversity indices reported for the principal surveyed sites.

Diagrammatic representation of Punjab, Pakistan, highlighting the estimated positions of conservation zones, waterways, and research places mentioned in the analysed literature. These coordinates are approximate, the map is intended to be a visual guide, not an exact mapping tool. It must be reconstructed from the GIS layers prior to submission.

In addition to the examined locations mentioned in Table 1, taxon-specific publications contribute further depth to the documented diversity. Bats (order Chiroptera) in Punjab include several genera including *Rhinopoma*, *Pipistrellus*, *Scotophilus* and *Scotoecus*. The recent first district records of a number of species suggest an under-representation of this order in the past as compared to larger mammals (Javid et al., 2014; Mahmood-ul-Hassan et al., 2012). The Indian pangolin (*Manis crassicaudata*), the only pholidotan in Pakistan, is found sporadically throughout the Potohar Plateau and neighbouring Salt Range regions of northern Punjab, where its elusive, burrowing behaviour has traditionally hindered systematic documentation despite its significant conservation status (Muhammad et al., 2024; Akrim et al., 2017).

Habitat Associations

The mammalian species of Punjab exhibit distinct habitat segregation that largely reflects the ecological regions of the state. In riverine forest tracts along the Chenab, Jhelum, and Ravi, wild boar (*Sus scrofa*), small Indian mongoose (*Herpestes javanicus*), jungle cat (*Felis chaus*), and golden jackal (*Canis aureus*) are consistently reported as locally common (Altaf et al., 2014). Historically present large mammals such as tiger, lion, cheetah, and hog deer are considered to have been extirpated from these riverine systems through direct persecution and habitat conversion over the past century (Altaf et al., 2014; Taber et al., 1967). Riparian rodents, including the Indian gerbil (*Tatera indica*) and the short-tailed bandicoot rat (*Nesokia*

indica), appear to have been favored by the conversion of thorn-scrub to irrigated cropland (Taber et al., 1967).

In the arid Cholistan Desert and the Lal Suhanra tract, desert-adapted species dominate, including chinkara (*Gazella bennettii*), the desert fox (*Vulpes vulpes*), the Indian desert jird, and Cheesman's gerbil (*Gerbillus cheesmani*) (Ahmad et al., 2025; Wazeer et al., 2025). Reintroduced populations of blackbuck (*Antelope cervicapra*) and nilgai (*Boselaphus tragocamelus*) are maintained within managed enclosures following their near-extirpation from the wild Cholistan landscape (Ahmad et al., 2025; Wazeer et al., 2025). The Salt Range and Potohar Plateau in northern Punjab support the endemic Punjab urial alongside golden jackal, Bengal fox (*Vulpes bengalensis*), Indian wolf (*Canis lupus pallipes*), and, in favorable rocky terrain, the Indian pangolin (Hussain et al., 2015; Awan et al., 2006; Khan et al., 2015). Agro-ecosystems across the central plains, by contrast, are dominated by commensal and pest rodent species such as house mouse (*Mus musculus*), house rat (*Rattus rattus*), soft-furred field rat (*Millardia meltda*), and Indian gerbil, together with insectivorous bats and shrews that exploit the abundant invertebrate prey associated with irrigated cropland (Bajwa et al., 2023; Khan & Beg, 1986).

Several studies point to markedly asymmetric outcomes across taxa within the same landscape as land use has changed. Generalist, disturbance-tolerant species such as the golden jackal, wild boar, and commensal rodents appear to have expanded in both range and abundance (Khushbakhat et al., 2025; Altaf et al., 2014). Conversely, habitat specialists like hog deer, otters, caracal (*Caracal caracal*) and the bigger carnivores have contracted significantly or disappeared from vast areas of their historical range within the province (Hussain et al., 2015; Altaf et al., 2014).

Conservation Status of Mammals in Punjab

Table 2 summarizes the reported conservation status of selected mammal species recorded in the Punjab literature, drawing on current IUCN Red List categories and, where relevant, provincial protection schedules under the Punjab Wildlife (Protection, Preservation, Conservation and Management) Act (IUCN, 2025; Michel & Ghoddousi, 2021; Muhammad et al., 2024; Awan et al., 2006; Sheikh & Molur, 2004).

The Punjab urial remains the province's single most extensively studied mammal from a conservation-genetics and demographic standpoint, reflecting decades of dedicated research at the Kalabagh Game Reserve and the Eastern Salt Range (Hussain et al., 2015; Awan et al., 2006; Awan et al., 2005). By contrast, many species of equal or higher conservation interest such as the smooth-coated otter, the caracal and riverine bat groups are virtually completely unstudied at the provincial level.

Threats to Mammalian Fauna

The body of literature aligns on a uniform array of human-induced stresses on Punjab's mammalian species, albeit the emphasis differs based on species and habitat. Table 3 categorises these concerns based on their reported frequency and the robustness of the data, while Figure 2

illustrates a conceptual framework that connects these factors to the noted reductions in mammalian variety and the conservation measures addressed subsequently in this research.

The pressure of poaching on the Punjab urial was shown to vary a lot depending on the intensity of local enforcement. Comparative studies in the Eastern Salt Range (weak enforcement) and Kalabagh Game Reserve (relatively strong enforcement) found very different rates of lamb poaching and age structure, suggesting that it is the capacity for governance, not simply biological constraints, that is often the proximate driver of decline (Awan et al., 2006). Human wildlife conflict becomes a distributed, cross-cutting threat: although formal conflict assessments have focused on adjoining provinces, similar patterns of crop damage by wild boar and livestock predation attributed to jackals and foxes are consistently reported from Punjab's riverine and agricultural districts. This fosters negative attitudes towards wildlife among rural communities and, in turn, retaliatory killing. The 2025 CITES proposal to bolster international trade controls on the striped hyena, partly due to concerns about the South Asian population, is a reminder that Punjab's carnivore populations are exposed to trade and enforcement pressures that extend well beyond the province's own regulatory reach (CITES Secretariat, 2025).

Knowledge Gaps

The analysis of the examined sources uncovers multiple structural deficiencies that hinder province-wide conservation planning, as outlined in Table 4.

Future Research Directions

Based on the gaps identified above, this review proposes several priorities for future research and monitoring in Punjab. A standardized, province-wide camera-trap and sign-survey network across representative habitat types, using harmonized protocols and diversity-index reporting, would permit cross-site and temporal comparison for the first time. Systematic, multi-season Chiroptera surveys across Punjab's agro-ecological zones are needed, given the demonstrated but still incompletely documented bat diversity of the province (Mahmood-ul-Hassan & Nameer, 2006). Expanding genetic and molecular tools, including DNA barcoding and population-genetic analysis, to threatened taxa beyond the Punjab urial, particularly the Indian pangolin and the riverine carnivores, would address a further gap (Akrim et al., 2017; Muhammad et al., 2024). Dedicated population and habitat-suitability assessment of wetland-associated mammals, including the smooth-coated otter, along the Jhelum, Chenab, Ravi, and Sutlej systems is similarly warranted. Integrating socio-ecological research methods, including household-level surveys, into human-wildlife conflict studies at a province-wide scale would build on the site-specific work already conducted along the Sutlej. Recent climate envelope modelling for the Punjab urial indicates that shrub lands and open grasslands provide the most optimal habitat, whereas urban and intensively farmed areas diminish habitat suitability, with temperature seasonality and dry month precipitation being significant distribution predictors (Neelam & Jabeen, 2025); applying this methodology to other range-restricted and habitat-

specialist species would adhere to an established precedent for Punjab.

Enhanced cooperation among university research teams, which have produced the majority of the primary literature examined herein, the Punjab Wildlife and Parks Department, and global conservation entities would facilitate the conversion of this growing research foundation into a unified provincial conservation plan (Government of Punjab Forest, Wildlife and Fisheries Department, 2026).

Conclusion

representative of a broader trend of increase among generalist and disturbance-tolerant taxa, and decline among habitat-specialist taxa (Awan et al., 2006; Muhammad et al., 2024; Altaf et al., 2014). The Indian wolf's recently independent IUCN evaluation, and the number of individuals this suggests remain in Pakistan, is a reminder that provincial conservation priorities can alter as assessment methodologies improve, not merely as populations fluctuate (IUCN, 2025). The most common hazards reported include habitat loss, poaching, human-wildlife conflict and hydrological modification of river systems (Altaf et al., 2014, 2023; Awan et al., 2006). Gaps in long-term monitoring, genetic characterisation, wetland-mammal evaluation and continued gaps in bat surveys hinder the translation of this developing knowledge foundation into province-wide conservation action (Mahmood-ul-Hassan & Nameer, 2006). Filling these gaps by standardised joint monitoring and research will be critical for the conservation of Punjab's mammalian biodiversity in the midst of ongoing agricultural expansion, water-resource development and climate change.

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TABLES AND FIGURES

Table 1. Species richness and diversity indices reported for major surveyed sites in Punjab, Pakistan, as extracted from the reviewed primary literature.

Site / study area	Orders	Species	Diversity indices / notes	Source
Chenab riverine forest (Head Marala, Khanki, Qadirabad)	6	15	Shannon–Wiener $H' = 0.86–0.975$; dominated by <i>Sus scrofa</i> and <i>Herpestes javanicus</i>	Altaf et al. (2014)
Cholistan Desert	6	23	$H' = 2.24$; richness = 5.45; evenness = 0.73; Cheesman's gerbil and northern palm squirrel dominant	Ahmad et al. (2025)
Bahawalnagar district, South Punjab	6	21	Relative abundance dominated by <i>Rattus rattus</i> , <i>Herpestes edwardsii</i> , and <i>Millardia meltada</i>	Imran et al. (2025)
Lal Suhanra National Park, Bahawalpur	6	21	Shannon index 1.38–2.02; Simpson's index 0.70–1.71; Indian wolf and striped hyena recorded	Wazeer et al. (2025); Khan et al. (2018)
Chinji National Park, Chakwal (Salt Range)	6	22	$H' = 0.91$; evenness = 0.77; Margalef = 5.31; desert hare and golden jackal dominant	Kanwal & Ashraf (2021)
Sutlej River (Sulemanki, Islam, Panjnad water-heads)	4	12	$H' = 2.14–2.45$ across sites; Panjnad water-head showed the greatest diversity and evenness	Sial (2024)
Potohar rural villages (agro-ecosystem, small mammals)	1 (Rodentia)	6+	$H' = 2.54$; Simpson = 0.20; Berger–Parker = 0.27; <i>Mus musculus</i> and <i>Rattus</i> spp. dominant	Altaf et al. (2014); Mahmood-ul-Hassan et al. (2012)

Table 2. Conservation status of selected mammal species recorded from Punjab, Pakistan, as reported in the reviewed literature

Species	IUCN status	Distribution in Punjab	Notes
Punjab urial (<i>Ovis vignei punjabiensis</i>)	Vulnerable (endemic subspecies) (Michel & Ghoddousi, 2021)	Salt Range; Kalabagh Game Reserve; Soan Valley; Chinji NP	A 2024–25 survey estimated roughly 530 animals at Kalabagh Game Reserve alone, consistent with reports of localized recovery, though lamb poaching for the pet trade continues (Hanif et al., 2025; Awan et al., 2006)
Indian pangolin (<i>Manis crassicaudata</i>)	Endangered	Potohar Plateau; Salt Range districts	Reported as the most heavily trafficked mammal in Pakistan; population density has shown a marked decline at monitored sites (Muhammad et al., 2024)
Indian wolf (<i>Canis lupus pallipes</i>)	Vulnerable (IUCN in 2025)	Lal Suhanra NP; Salt Range	Now assessed separately from the wider <i>Canis lupus</i> account; an estimated 10–20 individuals persist in Pakistan out of roughly 2,900–3,300 across its South Asian range (IUCN, 2025)
Striped hyena (<i>Hyaena hyaena</i>)	Near Threatened	Lal Suhanra NP and adjoining tracts	Recorded at low relative abundance in camera-trap and sign surveys; Pakistan proposed strengthened CITES trade controls for the species in 2025 (CITES Secretariat, 2025)
Chinkara (<i>Gazella bennettii</i>)	Least Concern (locally declining)	Cholistan; Lal Suhanra NP	Near-extirpated historically in parts of its range; maintained through managed populations
Blackbuck (<i>Antelope cervicapra</i>)	Least Concern (globally); extirpated in the wild in Punjab	Lal Suhanra NP (enclosures only)	The global Least Concern category reflects secure populations elsewhere in South Asia; Punjab's population is entirely captive-bred and reintroduced, so provincial status is far more precarious than the global listing implies
Hog deer (<i>Axis</i>	Endangered	Historically riverine	Reported as much reduced or extirpated from

Species	IUCN status	Distribution in Punjab	Notes
<i>porcinus</i>)		tracts; now largely confined to managed enclosures	wild riverine habitat
Smooth-coated otter (<i>Lutrogale perspicillata</i>)	Vulnerable	Wetlands associated with Punjab's rivers	Data-deficient at provincial scale; rarely the subject of a dedicated survey
Golden jackal (<i>Canis aureus</i>)	Least Concern	Province-wide	Abundant generalist; frequently implicated in human–wildlife conflict
Wild boar (<i>Sus scrofa</i>)	Least Concern	Province-wide	Managed as an agricultural pest species in most districts

Table 3. Ranked threats to mammalian diversity in Punjab, Pakistan, based on frequency and strength of evidence in the reviewed literature.

Rank	Threat	Evidence base	Principally affected taxa
1	Habitat loss, fragmentation, and conversion of riverine forest to agriculture	Altaf et al. (2014, 2023); Sial (2024)	Hog deer, otters, nilgai, smaller carnivores, riparian small mammals
2	Poaching and illegal wildlife trade	Awan et al. (2006); Muhammad et al. (2024); Akrim et al. (2017); CITES Secretariat (2025)	Punjab ural, Indian pangolin, striped hyena
3	Human–wildlife conflict and retaliatory killing	Awan et al. (2006); Altaf et al. (2014); comparable conflict assessments along the Sutlej	Wild boar, golden jackal, Indian porcupine, red fox
4	Hydrological alteration and pollution of river systems	Sial (2024); Altaf et al. (2023)	Riverine mammal assemblages generally; smooth-coated otter
5	Agrochemical use and rodent-control practices	Sial (2024); Khan & Beg (1986)	Commensal and field rodents; indirectly, their predators
6	Climate variability and range contraction	Bajwa et al. (2023); Hussain et al. (2015); Neelam & Jabeen (2025)	Punjab ural; other range-restricted endemics
7	Limited protected-area capacity and enforcement	CAMP Workshop (2003); Government of Punjab Forest, Wildlife and Fisheries Department (2026)	Province-wide, particularly large carnivores and ungulates

Table 4. Key knowledge deficiencies detected in the analysed literature on Punjab's mammalian wildlife.

Gap	Description
Chiroptera under-recording	Bat surveys in Punjab remain opportunistic and taxon specific, largely single new district or family records, rather than systematic; no comprehensive province-wide inventories are available although Pakistan's bat fauna is at the international level known to be under-studied (Mahmood-ul-Hassan & Nameer, 2006).
Absence of long-term monitoring	Nearly all studies assessed are single-season or short-duration surveys lasting from months to at most a few years; no source maintained in this evaluation reports a standardised, multi-decade monitoring time series for any Punjab location.
Limited molecular and genetic characterization	Genetic methods are applied almost exclusively to the Punjab ural and, more recently, to nematode barcoding in ural populations; genetic assessment of other threatened taxa, including the pangolin, otter, and small carnivores, is essentially absent from the reviewed literature.
Wetland and riverine mammals poorly quantified	Species such as the smooth-coated otter receive only incidental mention in wetland species lists rather than dedicated population assessments within Punjab.
Inconsistent diversity-index reporting	Surveys use varying combinations of linear-count, trapping, camera-trap, and questionnaire methods and report differing subsets of diversity indices, which constrains direct cross-site comparison and precludes formal meta-analysis.
Socio-economic dimensions of poaching and conflict	While the ecological consequences of poaching and conflict are documented, province-scale socio-economic drivers, including market chains and household-level cost–benefit calculations, remain thinly researched for Punjab specifically.
Climate-vulnerability assessment	Climate-driven range-shift modeling has so far been applied to only one species, the Punjab ural (Neelam & Jabeen, 2025); comparable assessments for other range-restricted or habitat-specialist mammals are lacking.

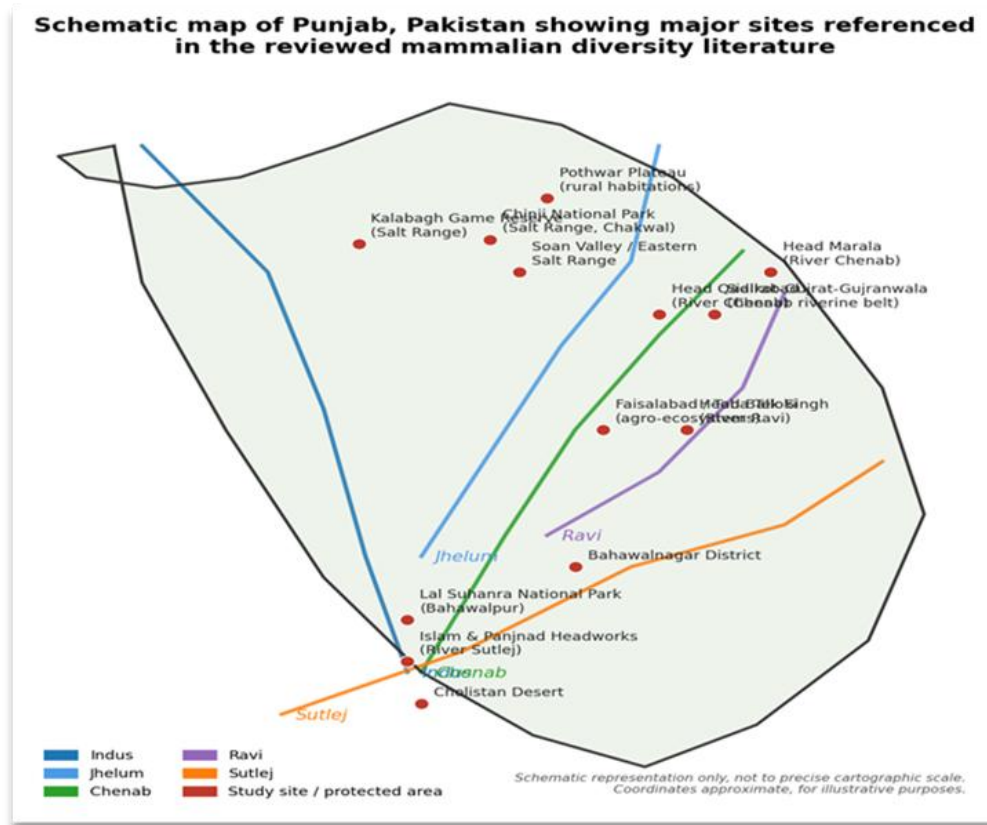


Fig. 1 Estimated positions of conservation zones, waterways, and research places mentioned in the analysed literature.

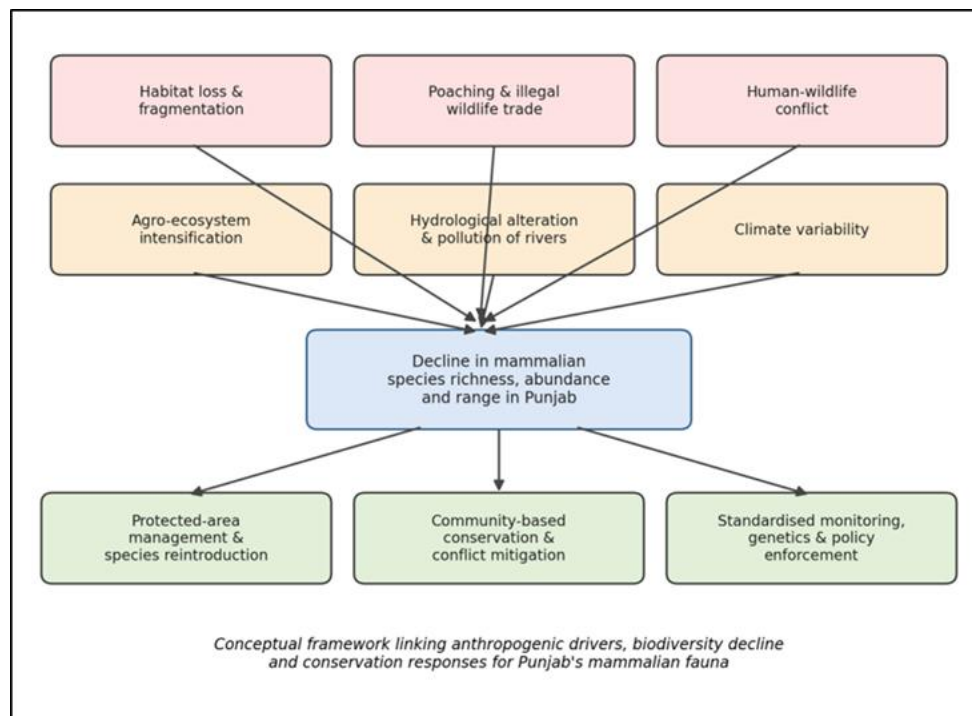


Fig. 2 A conceptual framework connecting the primary human-induced factors in Punjab's mammalian species