Original Research Article

Global Surveillance Evidence of Rabies as a Threat to Wildlife Conservation

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ABSTRACT

Rabies is a fatal zoonotic disease that is widely recognized as a public health priority, yet its implications for wildlife conservation remain insufficiently examined. This study assessed whether rabies constitutes a conservation threat by analyzing international surveillance data alongside a narrative synthesis of published evidence on urban–sylvatic transmission. Reported wildlife rabies deaths were extracted from the World Organisation for Animal Health's World Animal Health Information System (WAHIS) to describe long-term global trends from 2005 to 2024 and recent regional patterns from 2020 to 2024, with species-level records mapped to International Union for Conservation of Nature Red List categories. Surveillance data showed that wildlife rabies deaths have been consistently reported across all major global regions over the past two decades, with a general decline in reported deaths since 2012. Between 2020 and 2024, 4,850 wildlife rabies deaths were reported, including 53 deaths (1.09%) in species classified as endangered, critically endangered, or vulnerable, encompassing multiple taxonomic groups and geographic regions. Although the proportion of reported deaths in conservation-priority species was small, their distribution across vulnerable taxa indicates that rabies exposure extends into populations where even limited mortality may have disproportionate conservation consequences. Interpretation of these findings is constrained by substantial underreporting and uneven surveillance capacity, particularly in resource-limited settings. Overall, the results indicate that rabies represents an underrecognized but meaningful risk to wildlife conservation, especially at domestic animal–wildlife interfaces, and that integrating rabies control measures, particularly mass dog vaccination, with conservation planning and surveillance within a One Health framework may support biodiversity protection while advancing global rabies elimination efforts.

Keywords: Wildlife; Rabies; Conservation; Surveillance; Endangered; One Health

INTRODUCTION

Rabies is a fatal zoonotic disease that has traditionally been framed as a public health problem, with global control efforts focused primarily on preventing human deaths through post-exposure prophylaxis and mass dog vaccination (1–3). Transmitted mainly through the saliva of infected mammals, rabies causes acute encephalitis and is almost invariably fatal once clinical signs appear (3–5). Despite progress in reducing human rabies mortality in

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some regions, the virus continues to circulate widely in animal populations, particularly within domestic dogs and a range of wildlife species (6, 7).

Globally, rabies transmission occurs through two interconnected epidemiological cycles: the dog-mediated, or urban, cycle and the sylvatic cycle involving wildlife (4, 7). Domestic dogs remain the principal reservoir for rabies in much of the developing world and are responsible for the majority of human cases (3–5). However, numerous wildlife species, including carnivores and bats, can maintain independent rabies variants or become infected through spillover at the interface between human settlements and natural habitats. These interfaces are expanding due to land-use change, human encroachment, and environmental pressures, increasing opportunities for cross-species transmission (2, 8–12).

Although wildlife rabies has been extensively studied from virological and epidemiological perspectives, its implications for wildlife conservation have received comparatively limited attention (13, 14). Conservation risk is not determined solely by the absolute number of rabies cases, but by the vulnerability of affected populations, their social structure, and their conservation status (15). For small or endangered populations, even limited rabies mortality can contribute to population decline, disrupt social structures, or undermine conservation and recovery efforts (7, 16). As a result, rabies may represent a disproportionate threat to biodiversity relative to its reported incidence in wildlife.

Assessing the conservation relevance of rabies is challenged by substantial underreporting, particularly in wildlife. Rabies is difficult to detect in free-ranging animals, laboratory confirmation requires specialized capacity, and carcasses often go undiscovered (13, 14). Nevertheless, systematically compiled surveillance data, when interpreted cautiously, provide valuable insight into reported patterns of wildlife rabies mortality across regions and species (3, 9, 12, 17–20). When combined with information on species conservation status, these data can help identify where rabies poses the greatest potential conservation concern (7, 8, 16, 18, 19).

Global rabies elimination initiatives such as the Zero by 30 strategy aim to eliminate human deaths from dog-mediated rabies through coordinated, multisectoral action (21). Although primarily designed as a public health effort, these initiatives may also influence rabies transmission beyond domestic animal populations by reducing spillover at wildlife interfaces. In this context, the present study focuses on reported wildlife rabies mortality while situating these patterns within a broader ecological framework. This perspective aligns with One Health principles, which emphasize the interconnectedness of human, domestic animal, wildlife, and environmental health (19, 21).

The objectives of this paper are to describe reported global patterns of reported wildlife rabies mortality using international surveillance data and to identify threatened and endangered wildlife species affected by rabies. In addition, we synthesize published evidence on urban–sylvatic transmission pathways and discuss the implications of rabies control for wildlife conservation strategies. The findings from this paper establish the importance of wildlife rabies to successful and broader wildlife conservation globally.

METHODS AND MATERIALS

Study Design

The study employed a descriptive analytical design based on secondary data analysis of international wildlife surveillance data to assess whether rabies poses a threat to wildlife conservation. The analysis focused on reported rabies-associated wildlife mortality using official country reports submitted to an international surveillance system.

Data Source

Quantitative data on wildlife rabies deaths were obtained from the World Organisation for Animal Health's World Animal Health Information System (WAHIS), accessed in September 2025) [source: https://www.woah.org/en/what-we-do/animal-health-and-welfare/disease-data-collection/world-animal-health-information-system/]. WAHIS compiles official disease reports submitted by national veterinary authorities and includes information on disease events, affected species, geographical location, year of occurrence, and reported outcomes.

Inclusion and Exclusion Criteria

The analysis included records reporting rabies-associated deaths in wild animal species. Records classified as "cases," "susceptible," or "killed and disposed of" were excluded, as these categories do not necessarily represent confirmed rabies-induced mortality. Data reported beyond the defined study period and records relating to domestic animals were also excluded. Reports aggregated above the species level

were retained for descriptive trend analysis but excluded from conservation status mapping due to taxonomic ambiguity.

Study Period

Two analytical timeframes were used. Long-term trends in reported wildlife rabies deaths were examined for the period 2005 to 2024 to describe temporal patterns. A focused analysis covering 2020 to 2024 was conducted to assess recent regional distributions and to map affected species to conservation status categories. Data reported for 2025 was excluded from quantitative analysis due to incomplete annual reporting.

Endangered species classification

Species-level records were matched to conservation status using the International Union for Conservation of Nature (IUCN) Red List. The IUCN website was used to access the list which was accessed between November and December 2025, and conservation status classification used in this analysis reflects the listings available at the time of data extraction. Endangerment categories considered included near threatened (NT), vulnerable (VU), endangered (EN), and critically endangered (CR). WAHIS database deaths reported as taxonomic groups greater than species level were excluded because endangerment status could not be confirmed.

Data analysis

Reported wildlife rabies deaths were summarized descriptively by year, geographic region, taxonomic group, and conservation status. Trends over time and regional distributions were examined using counts and proportions. The analysis was intended to describe reported patterns of wildlife rabies mortality rather than estimate true incidence or transmission dynamics.

Supplementary literature context

In addition to the quantitative analysis of WAHIS surveillance data, a narrative review of the literature was conducted to identify documented rabies events of conservation relevance that may not be fully represented in global surveillance reports. This review was used solely to contextualize surveillance findings and to highlight species and outbreaks reported in peer-reviewed publications and official reports. Literature-derived information was not used for quantitative analyses or trend estimation and was incorporated descriptively to support interpretation of results.

The WAHIS data were analyzed for 2020 to 2024 to provide a recent and comparable snapshot of reported wildlife rabies mortality, whereas the literature review included studies from 2000 onward to capture historically documented outbreaks and conservation-relevant events that may not appear in recent surveillance data.

Ethical Considerations

All data used in this study were derived from publicly available surveillance databases and published literature. No primary data collection involving animals or human subjects was conducted, and no ethical approval was required.

RESULTS

Analysis of the WAHIS database showed that wildlife rabies deaths have been consistently reported worldwide over the past two decades. Between 2005 and 2024, reported annual wildlife rabies deaths ranged from a high of 5,339 deaths in 2006 to a low of 777 deaths in 2023. Following relatively higher reported counts between 2005 and 2011, a general decline in reported wildlife rabies deaths was observed from 2012 onwards (Figure 1).

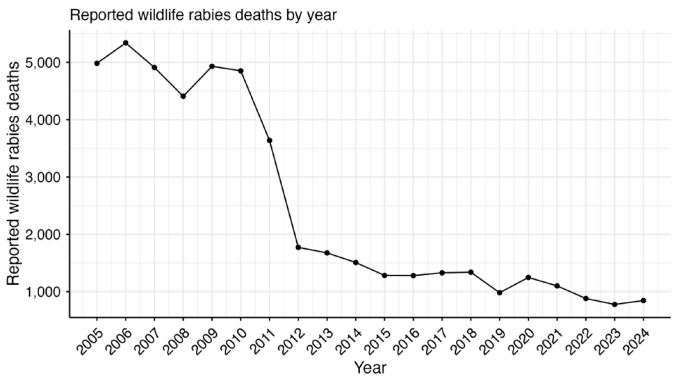

***Figure 1.* Reported wildlife rabies deaths by year (2005 to 2024).** *The annual number of reported wildlife rabies deaths (y-axis) is presented for each year (x-axis), aggregated across all regions. Points represent yearly totals and are connected by a line to display values over time. (Data Source: WAHIS)*

Reported wildlife rabies deaths were recorded across all major global regions. For the period 2020 to 2024, Europe accounted for the highest number of reported wildlife rabies deaths, followed by the Americas. Africa and Asia reported lower numbers overall, with Africa

contributing the fewest reported deaths during most years of this period, except in 2024 when Asia recorded the lowest number. Regional patterns remained broadly stable over time, with Europe showing a gradual decrease in reported deaths and the Americas displaying relatively consistent annual reporting (Figure 2).

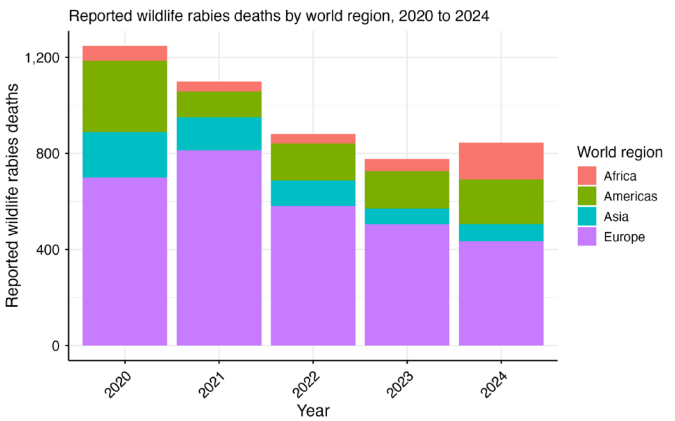

Figure 2. Reported wildlife rabies deaths by world region (2020 to 2024). *Stacked bars show the annual number of reported wildlife rabies deaths by world region. Colors represent different world regions, and total bar height represents the overall number of deaths reported in each year. (Data Source: WAHIS)*

Reported wildlife rabies deaths included a wide range of mammalian taxa, predominantly carnivores and bats. Records varied in taxonomic resolution, with some reports identifying animals at the species level and others reported at higher taxonomic levels. Species-level identification enabled further assessment of conservation status, while records lacking sufficient taxonomic detail were retained only for descriptive trend analyses.

Among reported wildlife rabies deaths recorded between 2020 and 2024, 53 deaths, representing approximately 1.09 percent, occurred in species classified as endangered, critically endangered or vulnerable according to the IUCN Red List. These included species such as African lions, African wild dogs, Persian fallow deer, and several bat species with elevated conservation concern. Reported deaths in threatened species were geographically distributed across Africa, Asia, and the Americas. Species-level details, conservation status, and regions of these records are summarized in Table 1.

Extending the analysis to the period 2005 to 2024 identified additional wildlife species of conservation concern affected by rabies. These included lion (Panthera leo) [VU], little brown bat (Myotis lucifugus) [EN], lar gibbon (Hylobates lar) [EN], southern pig-tailed macaque (Macaca nemestrina) [EN], northern pig-tailed macaque (Macaca leonina) [VU], patas monkey (Erythrocebus patas) [CR], and Asiatic wild dog (Cuon alpinus) [EN]. In addition, several records were reported at higher taxonomic levels without species-level identification, including Pteropodidae, Cercopithecidae, Cebidae, and Canidae species, which were therefore not classified to species level.

Literature-Documented Conservation-Relevant Rabies Events

The literature review identified multiple documented rabies events with direct conservation relevance that were not fully captured within global surveillance data from 2005-2024. These included outbreaks affecting Ethiopian wolves, African wild dogs, African leopard, and Cape fur seals, as well as recurrent rabies-associated mortality in bat species already experiencing population declines from other causes (Table 2) (7, 8, 12, 16, 19, 22, 23).

Table 1. Wildlife species of conservation concern with reported rabies-associated deaths based on WOAH WAHIS data (2020 to 2024). *The table presents species-level records including scientific name, common name, IUCN Red List status, region or country, year(s) reported, and number of deaths. Only species-level entries were included to enable conservation status classification. Endangerment status key: NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered.*
**Lycaon pictus global populations are endangered; certain Lycaon pictus subpopulations are critically endangered.*

Species	Common Name	IUCN status	Region/ Country	Year(s) Reported	No. of deaths reported
Panthera Leo	Lion	VU	Africa	2021, 2022	5
Myotis lucifugus	Little Brown Bat	EN	Canada	2020-2024	24
Lycaon pictus	African Wild Dog (Lycaon)	EN*	Africa	2020, 2022	20
Dama mesopotamica	Persian Fallow Deer	EN	Iran	2021	4
Total Death					53

Table 2. Wildlife species of conservation concern affected by rabies based on literature review, 2000 to 2025. *The table lists species identified in published studies along with their IUCN Red List status. This table includes species reported in the literature that may not be captured in WAHIS surveillance data.*

Ethiopian Wolves (*Canis simensis*) [EN],	*Myotis leibii* [EN],
African Leopard (*Panthera pardus*) [VU],	Mandelli's Mouse-eared Myotis (*Myotis sicarius*) [VU],
African Wild Dog (*Lycaon pictus*) [EN],	Indiana Bat (*Myotis sodalis*) [NT],
Eastern Pipistrelle Bat (*Perimyotis subflavus*) [VU],	Grey Bat (*Myotis grisescens*) [VU],
Cryptic Myotis (*Myotis crypticus*) [NT],	Long-fingered Bat (*Myotis capaccinii*) [VU],
Findley's Myotis (*Myotis findleyi*) [EN],	Bechstein's Bat (*Myotis bechsteinii*) [NT],
Dominican Myotis (*Myotis dominicensis*) [VU],	Pond Bat (*Myotis dasycneme*) [NT],
Northern Myotis (*Myotis septentrionalis*) [NT],	Escalera's Bat (*Myotis escalerai*) [NT],
Frosted Myotis (*Myotis pruinosus*) [EN],	Rickett's Big-footed Myotis (*Myotis pilosus*) [VU],
Schwartz's Myotis (*Myotis martiniquensis*) [NT],	Fish-eating Bat (*Myotis vivesi*) [VU],
Peninsular Myotis (*Myotis peninsularis*) [EN],	Scott's Mouse-eared Bat (*Myotis scotti*) [VU],
Corsican Myotis (*Myotis nustrale*) [CR],	Yanbaru Whiskered Bat (*Myotis yanbarensis*) [CR],
Flat-headed Myotis (*Myotis planiceps*) [ER],	*Myotis nyctor* [VU],
Far Eastern Myotis (*Myotis bombinus*) [NT],	*Myotis nimbaensis* [CR]
Hodgson's Bat (*Myotis formosus*) [NT],	

DISCUSSION

Principal Findings

This study indicates that rabies extends beyond commonly studied or resilient species and affects wildlife of conservation concern. The key implication is not the overall distribution of cases, but the involvement of threatened and endangered species, where even limited mortality may have disproportionate impacts. Although the number of reported deaths in conservation-priority species is small, their presence across diverse taxa highlights the potential for rabies to affect vulnerable populations. This suggests that rabies should be considered within conservation planning, particularly for species with small population sizes or restricted geographic ranges where additional mortality may influence long-term population viability.

Urban-Sylvatic transmission pathways

Transmission between urban and sylvatic cycles is facilitated by interactions involving free-roaming dogs, livestock, and wild mammals, particularly in landscapes where human settlement overlaps with wildlife habitat. Spillover from dogs to wildlife has been documented in multiple ecological settings, while wildlife-to-domestic transmission can occur when wild carnivores or bats interact with livestock or dogs (3, 6, 7, 8, 9, 12, 17–19, 23, 24). These bidirectional pathways emphasize that rabies circulation cannot be fully understood by treating urban and sylvatic cycles as separate systems, as ongoing exchange at the interface plays a key role in disease persistence.

Implications for wildlife conservation

From a conservation perspective, the impact of rabies cannot be assessed solely on the basis of case counts. In threatened or endangered species, even a small number of rabies deaths may have disproportionate consequences by reducing already limited population sizes, disrupting social structures, or compromising reintroduction and recovery programs. Social species such as wild canids may be particularly vulnerable if rabies spreads within family groups or packs (7, 12, 25–29). In these contexts, rabies functions as an additional pressure acting alongside habitat loss, human conflict, and other anthropogenic threats, reinforcing the need to consider infectious disease as part of comprehensive conservation planning.

Rabies Control as a Conservation Strategy

The findings of this study support the view that rabies control can function as an indirect conservation intervention. Measures aimed at reducing rabies circulation in domestic dogs, particularly mass dog vaccination in areas of high dog–wildlife interaction, may substantially reduce spillover risk to wildlife (30–32). Wildlife-targeted interventions, such as oral rabies

vaccination, have proven effective in some regions but remain resource intensive and geographically constrained (9–11, 19, 20, 33, 34). Integrating rabies control into conservation strategies, rather than treating it solely as a public health concern, could improve outcomes for both biodiversity protection and disease prevention. This integrated approach aligns with One Health principles, emphasizing the interconnectedness of human, animal, and environmental health (35).

Underreporting and surveillance constraints

Interpretation of reported wildlife rabies data should account for significant underreporting (6, 13, 14). Rabies is difficult to detect in free-ranging wildlife due to rapid disease progression, limited observation of clinical signs, low carcass recovery rates, and uneven access to diagnostic capacity (25). As a result, official surveillance data likely capture only a fraction of true wildlife rabies mortality and may be biased toward regions with stronger monitoring infrastructure (6, 13, 14). The involvement of threatened species identified in this study should therefore be viewed as a minimum indication of conservation risk rather than a complete representation of rabies impact on wildlife populations.

Policy relevance and global elimination efforts

Global rabies elimination initiatives have primarily focused on preventing human deaths through dog-mediated rabies control (19, 23, 36). The Zero by 30 goal, which aims to eliminate human deaths from dog-mediated rabies by 2030, is grounded in mass dog vaccination and multisectoral collaboration and therefore aligns closely with conservation objectives (21). Framing dog vaccination within a One Health framework emphasizes its dual role as both a public health intervention and a conservation strategy, linking human, domestic animal, wildlife, and environmental health (35). Aligning rabies elimination targets with conservation mandates can strengthen cross-sectoral collaboration, justify broader investment in rabies control, and support coordinated action to address zoonotic disease risk and biodiversity loss simultaneously.

Limitations

This study has several limitations. The reliance on officially reported surveillance data means that findings reflect reported rather than true incidence of wildlife rabies, with likely underestimation in regions with limited surveillance capacity. Taxonomic ambiguity in some records restricted conservation status assessment to species-level reports, potentially excluding additional threatened species. Diagnostic methods and reporting standards vary across countries, limiting comparability of data. The literature synthesis was narrative rather than systematic and may be subject to publication bias. Finally, this analysis does not quantify population-level impacts or transmission dynamics within wildlife species, which limits inference regarding long-term conservation outcomes.

Recommendations

To reduce the impact of rabies on wildlife, control strategies should be integrated with conservation planning and adapted to local ecological and resource contexts. Mass dog vaccination remains the most cost-effective approach for limiting rabies spillover into wildlife by targeting the primary source population, while oral rabies vaccination in wildlife can provide additional protection in specific high-risk settings despite its higher cost and logistical demands (9, 20, 25, 30–33, 37). Prioritizing interventions in areas with frequent dog–wildlife interactions, such as protected-area buffer zones and community forests, can improve efficiency, particularly in resource-limited regions. Complementary measures, including physical barriers and conflict-mitigation tools, can further reduce contact between wildlife, domestic animals, and livestock (38). Education and awareness programs targeting communities, animal owners, conservation practitioners, and authorities are essential to support vaccination, surveillance, and policy engagement (39–41). Finally, strengthening research and wildlife rabies surveillance is critical for reducing underreporting, identifying high-risk species and locations, and guiding more effective and targeted rabies control efforts that benefit both wildlife conservation and public health (6, 13, 14, 25).

CONCLUSION

This study shows that rabies is not only a public health concern but also an underrecognized threat to wildlife conservation. Analysis of global surveillance data indicates that rabies affects a wide range of wildlife species, including those classified as threatened or endangered, with transmission occurring primarily at the interface between domestic animals and wildlife. Integrating rabies control measures, particularly mass dog vaccination, with conservation planning, surveillance, and education is therefore essential to protect biodiversity while supporting global rabies elimination efforts.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to this work.

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