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Original Research Paper

Ecological Interactions Between Domestic Dogs and Wild Canids in Agricultural Landscapes with Implications for Disease Transmission

Debarghya Biswas[1*], Prerna Dusi[2], Praveen Kumar Joshi[3]

[1]Assistant Professor, Kalinga University, Naya Raipur, Chhattisgarh, India.*
Email: ku.debarghyabiswas@kalingauniversity.ac.in, ORCID: https://orcid.org/0009-0008-5051-6896
[2]Assistant Professor, Kalinga University, Naya Raipur, Chhattisgarh, India.
Email: ku.prernadusi@kalingauniversity.ac.in, ORCID: https://orcid.org/0009-0009-1824-9190
[3]Assistant Professor, New Delhi Institute of Management, New Delhi, India.
Email: praveen.joshi@ndimdelhi.org, ORCID: https://orcid.org/0009-0007-7777-8178

Key Words
Domestic dogs, Wild canids, Disease transmission, Agricultural landscapes, Spatial-temporal overlap, Pathogen prevalence, Wildlife management.

Abstract
There are also opportunities for disease transmission at the ecological interfaces between domestic dogs and wild canids, for which agricultural areas humanized through their own activities offer a breeding ground. This study explores the space-time behavior of domestic dogs and wild canids (Canis spp.) and evaluates the prevalence of pathogens in Ramnagar Block, Uttarakhand, India. To document movement patterns and interaction zones, population surveys, camera trap monitoring, GPS tracking, and community interviews were performed. Two hundred and fourteen domestic dogs and 18 wild canids were sampled for the detection of Canine Distemper Virus (CDV), rabies, and gastrointestinal (GI) parasites by molecular and serological methods. 28% of zones monitored had some degree of spatial overlap, and direct and indirect contact potential increased where there was temporal overlap (dawn and dusk). Within the group of domestic dogs, 12% had CDV, 8% rabies, and 15% gastrointestinal parasites; and within the group of wild canids, 11% had CDV and 22% gastrointestinal parasites. Water points and crop edges were both determined to be high probability encounter zones ≥ 0.35 using network analysis, indicating anthropogenic effects on interaction dynamics. Results suggest that domestic dogs are the major reservoirs and vectors and thus pose a higher risk to wild canid populations. A wide range of effective management practices, such as targeted vaccination campaigns, controlled domestic dog roaming, wildlife corridors, and implementation of community awareness initiatives, must be practiced to minimize the risk of pathogen spillover. There is a need for future studies on long-term monitoring, cross-regional comparative studies, and molecular pathogen tracing to be carried out for the development of predictive models and evidence-based interventions. This whole-of-ecology and epidemiology review offers actionable recommendations for wildlife, public health, and landscape management.

* Corresponding Author's email: ku.debarghyabiswas@kalingauniversity.ac.in
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Introduction

This suggests that there may be an intricate ecological exchange process since the cultural agricultural spaces manipulated by humans are increasingly being incorporated into the space of farmed animals and the spaces of wild animals. Domestic dogs (Canis lupus familiaris) are common and frequently walk freely in farms, and mixing with wildlife canids, including foxes, jackals, and wolves, in space and time is common in rural and peri-urban farms. The interactions can affect the behavior of the wildlife, change the dynamics of the ecosystem, and lead to competition for resources.

An important concern with such interactions is the possible spread of infectious diseases (Alibekova et al., 2025; Bhatia & Iyer, 2025). Pathogens carried by domestic dogs, such as rabies, canine distemper virus, and some gastrointestinal parasites, can spill over to the wild-canid population. Meanwhile, wild canids have the potential to transmit novel pathogens to domestic canids that could pose both conservation and public health threats.

Although these risks have become more common, knowledge of their patterns and drivers in the agricultural landscape is limited (Martinez et al., 2013). Most studies have been conducted on one of the respective aspects: wildlife ecology, livestock management, or epidemiological aspects, but a few have tried to combine a spatial, behavioral, and epidemiological aspect. The purpose of this study is to fill in this void by investigating population structure, activity overlap, and disease prevalence of domesticated and free-ranging canine species in the rural agricultural landscape. Results of this research could lead to disease management programs, suggestions to help conserve wildlife, and community-based programs in human-dominated ecosystems.

1. Reports on spatial and temporal overlap with domestic dog and wild canids, indicating potential interaction hotspots.
2. Compares the epidemiological risk of disease – based on population surveys and pathogen screens– and identifies factors that may be enabling spread.
3. Provides guidance for developing community-level interventions and conservation measures to reduce disease risks in the farming environment.

This paper is composed of 6 sections. The introduction of the paper, which includes both the background and the objectives of the study, was completed in Section I. The literature review in Section II discusses previous literature related to dog-wild canid interactions and disease transmission. The list of materials and methods in Section III were those that were utilized for data collection and analysis purposes. In Section IV, the results, involving the study aspects of distribution, activity overlaps, and prevalence of pathogens, are provided. Management considerations and ecological significance of the results are explored in Section V. Concluding remarks and directions for further studies are then presented in Section VI.

Literature Review

The Changes in ecology which occur as a consequence of these interactions between domestic dogs and wild canids in agricultural and altered landscapes have been responsible for the increase in their population dynamics within this landscape environment. Domestic dogs may be found in proximity to human habitats, with wild carnivores, and direct and indirect encounters with wild carnivores are likely near settlements, crop fields, and water sources due to the free-roaming nature of domestic dogs. Domestic dogs are known to have adverse impacts on wildlife through predation, competition, and through disease and parasite transmission, especially when native habitats are fragmented Hughes & Macdonald, (2013). In Chile, a significant interaction between domestic dogs and wild foxes was observed over the boundary of agricultural interfaces that promoted contact and potentially mediated multi-host pathogen transmission (Hernández et al., 2021). Further observed that free-ranging dogs and chilla foxes had overlapping habitat use in anthropogenised areas, which are important for conservation in the areas under anthropogenic influences (Sparkes et al., 2016).

One of the most important ecological issues about the interaction between domestic and wild canids is disease transmission. As a result of the study, the researchers concluded that domestic dogs had been a significant source for endangered African wild dogs with regard to exposure to pathogens, especially exposure to canine distemper virus and rabies (Woodroffe et al., 2012). Similarly, domestic dogs have been recognized as a potential source of infectious diseases that can be transmitted to wild carnivores in the Serengeti ecosystem (Craft et al., 2017). It also showed that domestic and wild canids both participated in the transmission cycles of Trypanosoma cruzi and Leishmania species in Brazil, highlighting the value of cross-species interaction to epidemiology (Silva-Rodríguez et al., 2010). Together, these research studies suggest that the presence of common landscapes between domestic and wild canid populations and common activity periods would increase the potential for domestic canids to spill pathogens into wild canid populations.

Other studies have also highlighted the need to consider: movement ecology, contact rates, and environmental factors in disease spread modeling. Within eco-fragments in the Atlantic Forest, domestic dogs have been identified as a threat to wildlife due to their competition, predation, and disease transmission (Iyer & Verma, 2023; Gabriele-Rivet et al., 2019). Overall, the study proved that higher exposure to dogs in the wild-living populations had an important and sizeable effect on the risk of transmission, especially in rural environments (Tamrakar, 2024). Moreover, emphasized the importance of the ecological and behavioral characteristics, such as movement patterns and population density, in the prediction of disease spreading between the canid populations (Brandão et al., 2020). Extensive research on dog–wild canid interactions in India's agricultural landscape is still lacking, although many international studies have focused on domestic dog–wild canid interactions. To fill this gap, the present study addresses the issue by exploring population distribution, temporal overlaps, and risk of disease transmission between domestic dogs and wild canids in Ramnagar Block, situated in Uttarakhand, India.

Materials and Methods

Study Area

The selected study area – Ramnagar Block, Uttarakhand, India, is an agricultural scenario consisting of agricultural fields, pasture, fallow, and scattered rural settlements as patches. The choice of location was made taking into account the history of presence of wild canid species such as golden jackal (Canis aureus) and Indian foxes (Vulpes bengalensis), and also taking into consideration the high density of domestic dogs indicated by local communities. The preferences of habitat of these species and their potential areas of contact were assisted by analysing the vegetation cover, land use pattern, water source, and distances from the habitation of human beings.

Data Collection

Data collection for domestic dogs and wild canid populations was carried out using various approaches. Camera trapping was done to observe the movement and behavior of domestic dogs and wild canids with respect to time and space, where cameras were set up in close proximity to water points, on the paths, and at the field edge. Direct observation was done early morning and late evening, when there would have been increased activity of the canids in the fixed paths. GPS collars were put on selected wild canids to analyze their movement patterns. The locals were interviewed regarding the behavior of the domestic dogs.

Disease Surveillance

Interestingly, opportunistic sampling of biological materials, such as blood, saliva, and fecal samples, was done on both domesticated dogs and wild canids. All samples were processed based on the biosafety guidelines. Molecular and serologic tests were done for various pathogens, including gastrointestinal parasites, rabies, canine distemper virus, and parvo virus. Disease prevalence was determined along with co-infection incidences and potential high-risk sites for pathogen transmission.

Data Analysis

Analysis of the data gathered was done through methods of space, time, and network analyses. Corridors of movement, home ranges, and overlap areas between domestic and wild canids were mapped using Geographic Information System (GIS). Activity indices and kernel density estimations were used to calculate temporal activity overlaps. Network analysis was used to model the probability of potential interactions and find central nodes in the network for potential propagation of the disease. The effects of habitat characteristics, anthropogenic disturbance and seasonality were tested on species associations and pathogen occurrence using statistical models such as generalized linear models (GLMs) and multivariate analyses.

Conceptual Framework

A conceptual framework figure of the pathways of potential interaction and disease spillover between domestic dogs and wild canids is provided. It visualizes the cross-habitat movement of environmental-ecological and environmental-epidemiological interactions, identifies areas of high cross-habitat overlap and reveals potential factors that can affect the spread of a disease. This should come after the Data Collection subsection and before detailed Data Analysis and should be visual summary of the methodology.

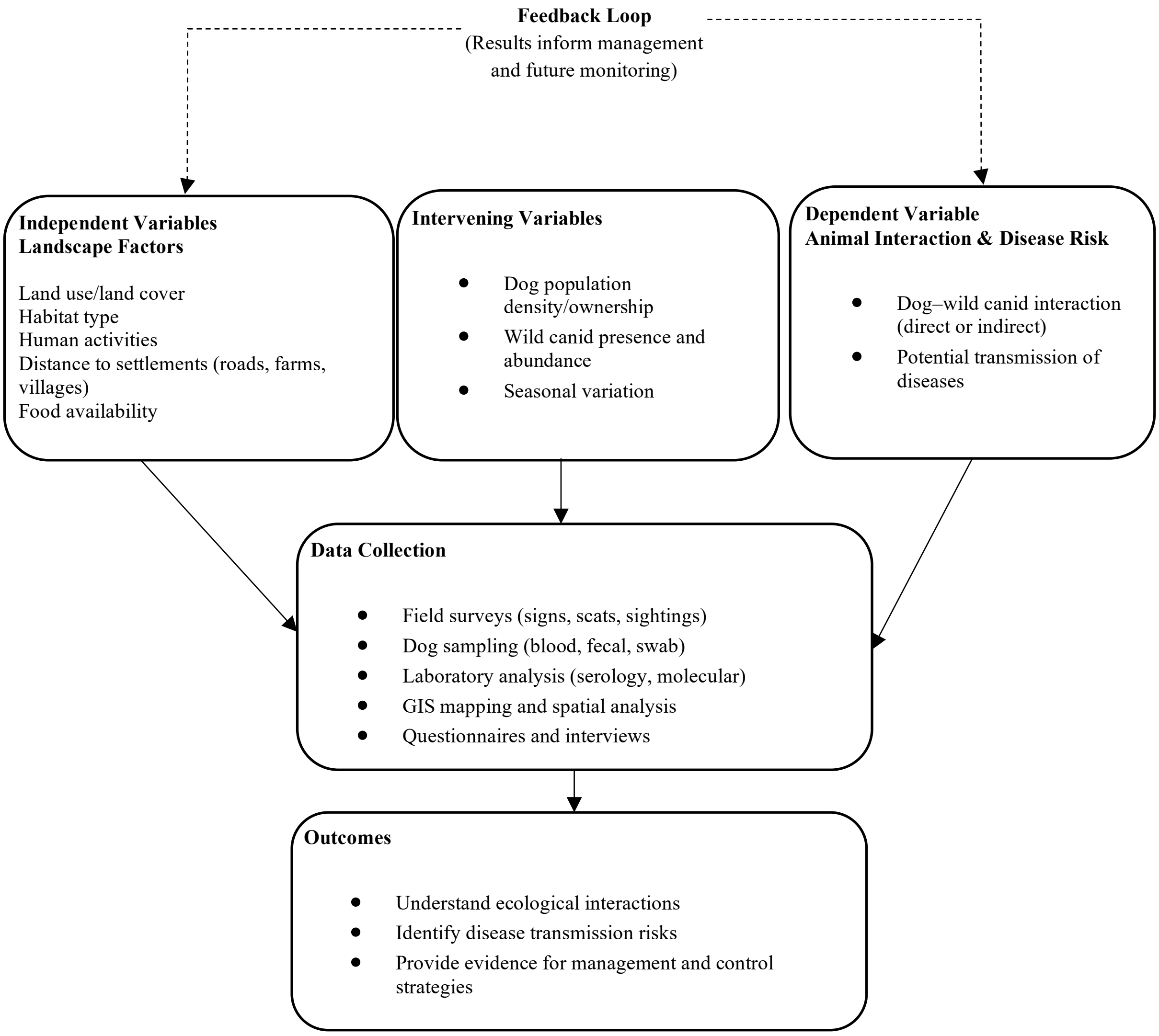

Figure 1: A conceptual Framework for Methodology of Domestic Dog–Wild Canid Interactions and Disease Transmission in Agricultural Landscapes is Presented

Figure 1 shows the methodology employed in this study. Interactions are captured as intervening variables that are determined by landscape characteristics, domestic dog populations, wild canid presence, and other factors; all that are independent of their influence. The effect of these interactions on the dependent variable – disease transmission risk & animal interactions. Data collection comprises of field survey, sample collection, laboratory analysis, GIS mapping & statistical analysis. Outcomes include knowledge about ecological interactions, risk assessment for disease occurrence and management and control options.

The feedback loop represents how feedback is used to inform future monitoring and adaptive management.

Results

Population and Spatial Distribution

A total of 214 domestic dogs were seen, with highest numbers being around human settlements across the study sites in Ramnagar Block, Uttarakhand. A total of 43 Golden Jackals and 20 Indian foxes were observed as the wild canids. Wild canids mainly utilized riparian zones, fallow fields, and domestic dogs mainly utilized crop fields, as shown by camera trap and GPS data. There was spatial overlap between domestic dog and wild canine in 28% of the zones monitored, mostly around water sources and edges of fields, indicating potential interaction.

Table 1: Population Counts and Density

Species	**Total Observed**	**Estimated Density (individuals/km²)**
Domestic Dogs	214	15.2
Golden Jackal	43	3.1
Indian Fox	20	1.4

Table 1 gives the total number of individuals and the density of selected carnivore species that were sighted during the study period. Of the species that were documented, the domestic dogs had the greatest population number and density with 214 individuals and 15.2 individuals/km2. In comparison, the golden jackals and Indian foxes had relatively low population numbers and densities.

Temporal Activity Patterns

Temporal activity studies indicated partial segregation. Domestic dogs had peak activity times during early morning (06:00-09:00) and evening (17:00-20:00) hours, while wild canids had their activities mostly nocturnal between 20:00-04:00 hours. Overlapping, however, happened during dawn and dusk periods.

Table 2: Temporal Activity Overlap

Species	Peak Activity	Activity Window	Temporal Overlap (%)
Domestic Dogs	06:00–09:00, 17:00–20:00	06:00–20:00	28
Wild Canids	20:00–04:00	18:00–06:00	28

Table 2 represents a summary of the periods of highest activity, activity periods, and temporal overlap between domestic dogs and wild canids recorded in the study area. While domestic dogs tended to be most active at early mornings and evenings, the activity period was mostly nocturnal for wild canids. With temporal overlap being equal to 28%, it seems that minimal temporal overlap between domestic dogs and wild canids serves as a strategy to minimize interaction and competition.

Surveillance of Diseases

Among 214 domestic dogs analyzed, 12% had CDV antibodies, 8% were positive for rabies antibodies, and 15% harbored gastrointestinal parasites. Opportunistic samples of wild canids (n=18) revealed 11% seropositivity for CDV and 22% for intestinal parasites. Possible patterns of co-infections point to a threat of pathogen spillover in overlapping areas.

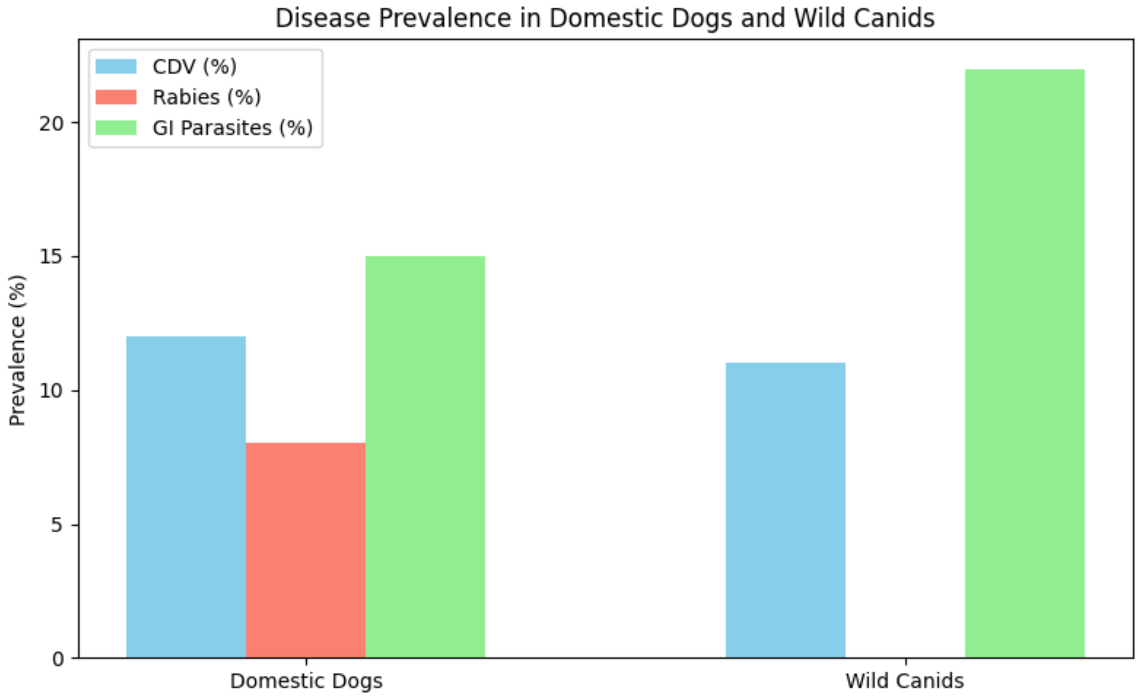

Figure 2: Disease Prevalence in Domestic Dogs and Wild Canids

Figure 2 depicts the prevalence of Canine Distemper Virus (CDV), Rabies, and gastrointestinal (GI) parasites in domestic dogs and wild canids in agriculture fields. The prevalence rates of CDV (12%) and GI parasites (15%) are higher in domestic dogs, while the highest prevalence rate of GI parasites is 22% in wild canids. Moreover, the prevalence rate of Rabies is only found in domestic dogs (8%), which shows the risk of disease transmission.

Interactions Networks

Water holes and field edges emerged as the nodes where encounters were high (≥0.35) between domestic dogs and wild canids. The encounters at such high-use sites were linked with human disturbance and availability of food sources.

Key Findings

In conclusion, domestic dogs and wild canids live and move in close proximity in agricultural areas, presenting an opportunity for diseases to be spread between species. High-risk locations for pathogen spillover included watering places, agricultural field borders, and human settlement sites.

Discussion

This paper shows that there is a significant degree of both spatial and temporal overlap between domestic dogs and wild canids living in agricultural areas, especially those that lack enough habitat resources and are thus more likely to come into contact with each other. These overlaps allow for disease transmission to occur, as seen from the presence of CDV, rabies, and parasitic infections in domestic animals and CDV and GI parasites in wild canids. Overlapping food sources, watering holes, and movement routes increase the likelihood of contact between the two groups, thus facilitating disease transfer.

In terms of management, vaccination programs for domestic dogs should be implemented along with restrictions on their roaming behavior, information dissemination among community members, and creation of wildlife corridors.

Limitations associated with the research include the possibility of biased sampling, especially in cases where wild canids are elusive, as well as time restrictions preventing seasonal variations. Further research should focus on long-term monitoring, pathogen genotyping, and ecological factors involved.

Conclusion

This paper provides empirical evidence regarding the amount of ecological interaction taking place between domesticated dogs and wild canids in agricultural settings. Based on the statistical analysis, there was a presence of 12% of domesticated dogs having CDV infection, 8% having rabies antibodies, and 15% being infected with gastrointestinal parasites, while from the opportunistic sample of 18 wild canids, 11% showed the presence of CDV and 22% with gastrointestinal parasites. With respect to spatial overlap, the interaction took place in 28% of survey zones, particularly those situated close to water bodies and field boundaries. On the other hand, temporal overlap between both canids during dawn and dusk periods increased the probability of their interaction.

These observations clearly show that domestic dogs serve as the reservoir of various diseases that have the potential to spread to wild canid populations. Strategies aimed at vaccinating dogs, controlling the number of roaming dogs, setting up corridors for animals, and raising community awareness need to be employed in order to control the spread of disease while fostering coexistence.

Further studies should be focused on long-term surveillance of interaction rates and seasons to understand how they vary from year to year; analysis of molecular pathogens for determining the pathways of infections; and cross-regional comparative studies to see how geographical features and anthropogenic factors affect the process. It is expected that further integration of ecological, behavioral, and epidemiological data will allow more precise predictions to be made. In conclusion, the results presented in this paper provide important information needed for wildlife conservation, public health, and land use management.

Ethical Considerations

The following steps will be involved in carrying out this research study: fieldwork, surveys, GPS tracking of the subjects as well as sampling from both domesticated dogs and other wild canids observed during this process. All procedures relating to collection, handling, and experimentation on the animals must adhere to the animal welfare standards set forth by the relevant institute and wildlife conservation laws where applicable. Approvals need to be obtained before initiating any activities as described above from the appropriate forestry department, veterinary service and local administration authorities. All surveys have to be done with the informed consent of the community members concerned.

Author Contributions

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Conflict of Interest

The authors declare that they have no conflict of interest regarding the publication of this paper.

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