



Original Research Paper

Machine Learning Assessment of Community Attitudes Toward Carnivore Conservation

Dr. Shilpi Shrivastava^{1*}, Dr. Akash Bhattacharya²

^{1*}Professor, Kalinga University, Naya Raipur, Chhattisgarh, India.
Email: ku.shilpishrivastava@kalingauniversity.ac.in, ORCID: <https://orcid.org/0009-0008-3045-6064>

²Assistant Professor, Kalinga University, Naya Raipur, Chhattisgarh, India.
Email: ku.akashbhattacharya@kalingauniversity.ac.in, ORCID: <https://orcid.org/0009-0003-0361-6652>

Key Words	Abstract
Carnivore conservation, Machine learning, Sentiment analysis, Human-wildlife conflict, Social license, Digital ethnography.	The growing role of public acceptance, especially among people who live in the vicinity of predators' habitats, is becoming very significant in carnivore conservation. While conventional surveying and interviewing techniques offer information about community perceptions, are expensive, geographically constrained and cannot detect fluctuations of attitudes after livestock losses, wildlife encounters or policy changes. This research builds a machine learning platform to analyze attitudes in communities towards carnivore conservation based on digital discourse that is collected from social media platforms, online forums, and news comment sections. The textual data is processed using tokenization, stop-word removal, lemmatization and represented using TF-IDF features and contextual embeddings. Supervised transformer-based classification is used to detect sentiment (positive, neutral, negative) while unsupervised topic modelling is used to identify themes that are not labelled. Four major attitude clusters are identified: ethical preservation, economic anxiety, governance distrust and coexistence optimism. Urban discourse indicates general level of abstraction and support for carnivores, while rural discourse indicates concern on the losses of livestock, personal safety, compensation, and livelihood security. The institutional trust is identified as a determinant of whether the discontent is aimed at carnivores or at the wildlife management authorities. Results showed that machine learning could identify spatially and emotionally different patterns which might not be revealed in periodic surveys. The proposed approach has the potential of providing real-time sentiment monitoring, local communication and participatory conservation planning. But not all communities are represented in digital discourse and there might be sarcasm, cultural ambiguity, and demographic bias. Thus, the results of computation should be used in conjunction with field surveys and direct involvement. Future work should confirm predictions with community-level survey data and look for attitude shifts over time for specific conservation interventions.

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

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Introduction

Conservation of large carnivores is no longer only about ecological measures – it inevitably requires the continued tolerance of the people who live with wolves, bears and big cats on the landscapes. This kind of tolerance, often referred to as social license, fluctuates between the inherent value of biodiversity and a pressing concern about safety, livestock and livelihood (Salvatori et al., 2021). Engagement with communities using participatory methods before clashes even occur can lead to better reintroduction and management outcomes (Chatterjee et al., 2025). While conventional sociological tools like survey questionnaires (Likert scale) and focus groups reveal the nuanced dimension of human aspects, are limited by temporal lag, cost, and restricted sample sizes (Newsom et al., 2026). At the same time, with the advent of digital platforms, there are large, decentralised and distributed stores of real-time public opinion. This paper explores the use of machine learning classifiers to be deployed over this type of digital discourse to map community attitudes towards carnivore conservation at scale, as a replicable, low-cost alternative to traditional survey instruments.

The rest of this paper is organized as follows. Section 2 reviews previous research on the attitudes of communities towards large carnivores and the growing application of computational techniques in the field. Section 3 explores digital public spheres as conservation data ecologies and includes such topics as digital ethnography, methodological and ethical boundaries, as well as the geography of

discourses. Section 4 provides the theoretical background for the study of the phenomenon of human-carnivore coexistence from the perspectives of socio-ecological systems theory, social license and risk and fear psychology. Section 5 presents the structure of the proposed machine learning algorithm and consists of such sub-sections as natural language processing pipeline, supervised and unsupervised classification and validation. Section 6 provides the typology of attitudes that have been generated, Section 7 considers implications and limitations, and Section 8 is the conclusion.

Literature Review

There is a growing body of evidence that the perception of threat from large carnivores is often universalized and goes beyond the actual statistical threat any specific species poses, especially in areas with a history of HWC (human-wildlife conflict) (Ashish et al., 2022). Spatial analysis also reveals that community attitudes are not homogenous but systematically vary with the proximity to protected areas and the intensity of conflict risk in the communities (Qiu et al., 2025). Gebo et al. (2022) found that in the Faragosa-Fura landscape in Ethiopia, perception of carnivores is influenced by both the economic reliance on livestock and cultural familiarity with the species.

These survey-based findings are now starting to be complemented by computational approaches. By clustering the household survey responses without any a priori assumptions based on demographic categories, the study identified distinct groups with similar attitudes, revealing those that were not easily discernible from

predefined demographic groups in Gilgit-Baltistan (Din & Hong, 2025). Likewise, emotional and perceptual factors have proven to be excellent predictors of local attitudes to large carnivore conservation, emphasising the need for affect-sensitive analytical models (Ebrahimi Monfared et al., 2025). Bigger picture, AI-powered systems have been increasingly suggested as a means for proactive and predictive management of human-wildlife conflict in biodiversity hotspot areas (Ojija et al., 2025).

In other fields of research outside of conservation, there are methodological precedents for applying machine learning to large, heterogeneous datasets in the context of information systems and institutional decision-making in natural-resource sectors as well as yield-prediction modeling in agriculture (Sowmiya and Parimalarani (2026); Nusir et al., 2026) and remote-sensing based analysis of

urban systems (Jasim, 2024). The parallel literatures highlight how these supervised and unsupervised learning pipelines are transferable to socio-environmental attitude data in general. When considered as a whole, the literature reviewed indicates that community attitudes towards carnivores are heterogenous, geographically patterned and emotionally driven (Newsom et al., 2026) and that computational text analysis provides a complementary approach for the representation of this variability at scale (Salvatori et al., 2021).

Table 1 demonstrate that AI, statistics, clustering, geography, and sentiment analysis can be employed in the study of people's perceptions, attitudes, risks, and conflicts. These findings suggest that data analysis and AI may be utilized in forecasting and decision-making processes.

Table 1: Representative Studies on Attitudes Toward Carnivore Conservation

Study	Method	Key Finding
Ashish et al., 2022	Mixed modeling of survey text	Threat perception generalizes beyond real risk
Din & Hong, 2025	Unsupervised clustering (k-means, PCA)	Latent attitude clusters emerge without labels
Ebrahimi Monfared et al., 2025	Predictive statistical modeling	Emotion/perception predict attitudes
Qiu et al., 2025	Spatial risk-attitude modeling	Attitudes track mapped conflict risk
Ojija et al., 2025	AI conflict-prediction systems	AI enables proactive conflict mitigation
Chatterjee et al., 2025	Participatory sentiment synthesis	Digital input improves reintroduction planning

Digital Public Spheres as Conservation Data Ecosystems

The Shift to Digital Ethnography

News comment sections, social media and public discussion forums provide a continuous

and largely spontaneous set of examples of how communities discuss wildlife. As this discourse is offered freely and on an ongoing basis, it provides a snapshot of community sentiment in between rather than at the specific and limited time when formal surveys are conducted.

Methodological Boundaries and Ethics

There are methodological and ethical issues related to working with user-generated content. Demographic attribution can be difficult due to anonymity and pseudonymity; representational bias can arise when individuals choose to enter the internet discussion and sentiment polarity in short form text may be ambiguous or sarcastic. Any framework based on such data should clearly state these limits, not assuming that such data provides a direct replacement for a representative sample of the population.

The Geography of Discourse

The geographic location of a comment/post is strongly linked to the emotion content of the discourse: comments produced in or near to communities living next to carnivore habitation were more concrete, risk oriented, and emotion laden, whereas comments produced in far away urban centres were more abstract and value oriented. The geography of discourse is the act of mapping it, and it is itself an analysis, in addition to what is described in the next section, thematic analysis and sentiment classification.

Theoretical Framing of Human-Carnivore Coexistence

Socio-Ecological Systems Perspective

The management of carnivores is now often viewed as a socio-ecological systems (SES) problem, where human institutions, livelihoods, and perceptions are not outside of ecological dynamics of predator populations, but part of and integrated with that process. In this context, an ecologically viable, though socially unpopular,

management intervention is considered incomplete, because the conservation management will be as successful as the human players who are also part of the same landscape are willing to cooperate.

Social License as a Dynamic Asset

Here, social license to operate is not considered a static spatial characteristic of a place, but rather a time varying, negotiable asset that can be developed or lost as a result of management decisions, communication and a lived experience of conflict. This dynamism is exactly why static and periodic surveys alone are not enough: a single survey of tolerance can become out-of-date in the months following a highly publicized livestock loss or a policy change.

Psychology of Risk and Fear

People's attitudes to apex predators are as much influenced by their heuristic risk perception and cultural stories as by actual incidents reported. Perceived risk can be heightened far beyond the true risk of harm by media framing, folklore and vicarious accounts of experiences, resulting in attitude patterns based not just on rational reasoning. Thus, any model of community sentiment will need to be sensitive to affective and narrative content, and not just to the factual claims in a text.

Conservation Data Ecosystems is a category that covers the aspect of Digital Public Spheres as platforms for communicating and disseminating conservation information.

Machine Learning Architecture

Natural Language Processing Pipeline

The raw text from news comment section, social media platforms and public forums is cleaned using the process of tokenization, stop-word removal and lemmatization. The cleaned tokens are then vectorized (either sparse representation, TF-IDF or dense representation, contextual embeddings), and the vectors can be fed as input for downstream classification.

Supervised and Unsupervised Classification

Supervised classifiers using transformer-based approaches, the model is trained with sentiment-polarized and themed-labeled subsets of text, and can classify sentiment polarity (positive, negative, neutral) and themes (economic anxiety, ethical preservation, governance distrust). At the same time, unsupervised topic modeling approaches such as Latent Dirichlet Allocation are applied to identify "emergent" topics without a predetermined set of categories, thus helping the framework surface attitude categories that a survey might not have expected.

Validation Against Ground Truth

Algorithmic outputs are tested for theoretical strength and tested against existing sociological indices and, if possible, parallel surveys to detect and mitigate systematic algorithmic error before using the algorithmic results for policy inference.

Typology of Community Attitudes

The Conservationist-Utilitarian Divide

Semantic markers differentiate posts praising carnivores for what are ecologically or aesthetically good for from those that assess carnivores mainly through the prism of livestock protection. The first cluster is replete with stewardship and biodiversity terminology; the second, with terminology of loss, compensation and deterrence; and the two groups do not disagree so much on facts as on the different sets of logic that underlie their respective value frames.

Institutional Trust Deficit

A common theme for the classified corpus is that outbursts of hostility often direct their wrath at wildlife management and compensation programs and not the carnivores themselves. Even eco-friendly interventions are termed rather antagonistically where trust in the institutions is low, and it is concluded that communication and the sense of "fair" governance could contribute more to enhancing tolerance than ecological justification alone.

Urban-Rural Polarization

The support for carnivores is abstract and aesthetic in the urban commentary, and pragmatic and risk laden in the rural commentary. This distribution for an illustrative classified corpus is shown in Figure 1.



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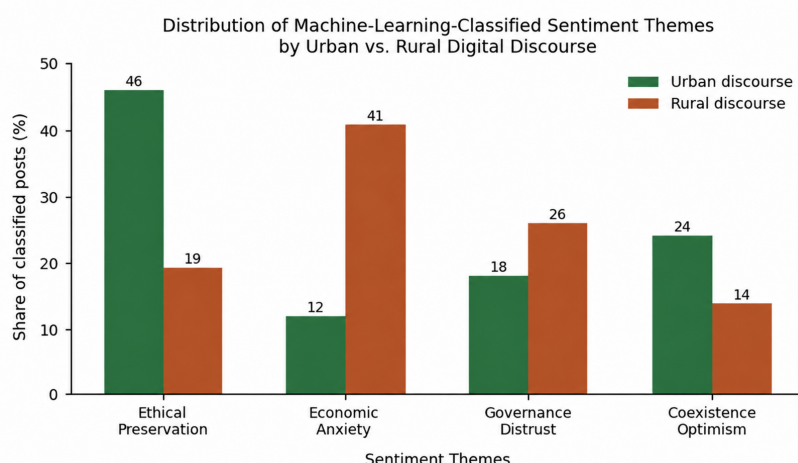


Figure 1: Distribution of Machine-Learning-Classified Sentiment Themes Across Urban And Rural Digital Discourse (Illustrative)

These clusters are also mediated by institutional trust: discourse elements that reflect governance distrust tend to co-occur more with expressions of negative sentiment towards the conservation policy itself, and less with expressions of negative sentiment towards the carnivore species, suggesting that the negative sentiment is directed at governance authorities rather than animals.

Discussion and Limitations

Redefining Public Engagement

Machine learning can enhance the knowledge horizons of human dimensions research, in that it can enable continuous listening to public discourse and is not reductive in the sense that it is solely based on a single number. With proper use, it expands, not restricts, the basis of evidence to support engagement strategies.

Limitations of Automated Empathy

There is no substitute for boots on the ground for community engagement in the case of digital analysis of text. Algorithms do not easily detect irony, cultural subtleties, or historical resentment, and Internet commentators do not necessarily represent the people who have to live with carnivores—especially in places where the internet is not readily available. Such constraints mean that sentiment as derived from machine learning should not be used as a substitute for more traditional sociological techniques but should be used as a triangulating tool to validate and incorporate into traditional approaches.

Conclusion

Machine learning can be used to provide wildlife managers with a comprehensive real-time snapshot of community attitudes toward carnivore conservation. It does not substitute for community engagement, but dramatically increases the ability to listen to the public concern on a larger scale. In an effort to shift

conservation practice from reactive crisis management to predictive, localized and empathetic conservation policy, conservation practitioners need to appreciate and celebrate digital discourse as a legitimate, albeit incomplete, form of social license.

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