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Conflict Aware Conservation Framework for Predicting Human-Wildlife Conflict Risk Zones

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Key Words

Human-wildlife conflict, Risk zonation, Animal behaviour, Conservation management, Species ecology, Protected area interface.

Abstract

Despite ongoing threats posed by human-wildlife conflict (HWC), not only to biodiversity conservation but also to the livelihoods of rural communities, HWC remains a major problem, especially in regions adjacent to conservation areas. The methods used to address HWC problems often involve reactive conflict management, which focuses on addressing the conflict after crops or domestic animals have been damaged or even people harmed. In this paper, the Conflict Aware Conservation Framework is introduced, a species-behaviour-focused HWC identification and prediction method prior to conflict occurrences. Four biologically-based HWC management techniques are discussed. The theory shifts the emphasis from generic spatial relationships between species and humans to species ethology, foraging ecology, and migratory behaviour as the main factors that predict the probability of conflict occurrence. The applicability of the theory is shown by demonstrating how it can be used to strategically allocate resources for mitigation, monitoring, and adaptive management within human-wildlife interaction zones. Conservation biologists and wildlife managers get a scientifically sound tool for predicting future problem spots and efficiently allocating scarce conservation resources.

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Introduction

Human-wildlife conflict (HWC) occurs as a result of negative impacts of the requirements and behaviour of the wildlife on the lives of people and vice versa (Zvidzai et al., 2023). The increasing number of conflicts involving people, domestic animals, and wildlife is caused by the extension of agricultural lands adjacent to the protected zones resulting in such consequences as the destruction of crops, livestock predation, damages to properties, and sometimes even the death of both human beings and wild animals (Khosravi et al., 2023; Sharma et al., 2020). In addition to threatening rural livelihoods, these results may affect the tolerance levels of the communities towards conservation efforts, making it difficult for people to live alongside wildlife in the long term (Osipova et al., 2018).

The current response to human-wildlife conflict by conservation practitioners is largely reactive in nature. Compensation programs, fencing programs, and translocation of the animals are used in response to conflict situations, which are already in existence (McNutt et al., 2017). The reactive strategy is expensive in both financial terms and loss of tolerance by the communities involved. There is increasing evidence from animal sciences and conservation biology that HWC is not random in nature; rather, it occurs when certain ecological and behavioural triggers are met, such as proximity to protected area boundaries, water scarcity, availability of forage and ranging habits of particular species.

This paper outlines the Conflict Aware Conservation Framework, a biologically based framework for predicting risk zones for human-wildlife conflict. This framework stands apart from hotspot mapping by placing the biological motivations of conflict at the forefront of conflict prediction, in the form of behavioural ecology, physiology, and seasonality of the species in question. The aim is to offer a biologically oriented framework for wildlife managers to better understand where and when conflict will arise.

Key Contributions

- Presents a biological-based approach to predicting risk of human-wildlife conflict prior to its occurrence.
- Based on the behaviours of animals, their interaction with habitats and resources, and ecological rhythms over time for risk zoning purposes.
- Facilitates conservation planning efforts that help with monitoring and mitigation of potential conflict.

The rest of this paper is structured as follows. Section 2 provides the theoretical foundation for the Conflict Aware Conservation Framework. Section 3 explains the behavioural and ecological measures, Section 4 introduces the framework components, Section 5 provides examples of conservation uses, Section 6 highlights the constraints and future considerations, and Section 7 concludes the paper.

Conceptual Basis of the Conflict Aware Framework

The Conflict Aware framework is founded on the basic assumption that HWC is primarily a behavioural and ecological problem before it becomes a social or economic problem. Animals which tend to be conflict prone such as large herbivores like elephants and wild boar, and predators like lions, hyenas, and leopards have behaviours that depend on the availability of resources, their reproductive periods, and predation and prey (Broekhuis et al., 2017; Osipova et al., 2018). If such behavioural traits bring them into proximity with human habitats, cultivated lands, and livestock, chances of conflict increase tremendously (Sharma et al., 2020).

There are three ecological concepts that are behind this approach. First, the concept of resource-based movement: animals have a tendency to move in the direction of the availability of water, food plants, and aggregation of prey, and human presence near these resources increases chances of conflict (Osipova et al., 2018). Second, permeable boundaries: the borders of protected areas are not impermeable to animals' movements, and animals with large home ranges regularly move from their reserve territories into nearby human territories in order to find what is not there in the reserve (Sharma et al., 2020). Third, seasonality and diurnally of behaviours: chances of conflict depend on breeding seasons, calving, ripening of crops, and diurnal vs. nocturnal habits of the particular species (Teixeira et al., 2021). All of this suggests that conflict hot spots can be predicted based on species' ethology.

Behavioural and Ecological Indicators for Risk Zone Identification

The model outlines four groups of bio-indicators used for risk zone prediction. Proximity bio-indicators measure the distance between human activities and the borders of protected zones, water bodies, and wildlife corridors, as conflicts are likely to happen close to these elements (Sharma et al., 2020). The resource competition bio-indicators evaluate the degree of overlap of human and wildlife activities such as cattle pasture or arable lands with wildlife habitat and prey base, since the competition for common resources is one of the main causes of conflict (Osipova et al., 2018). The behavioural bio-indicators take into account the species ranging habits, social system and prey or foraging strategy of the species – cooperative or ambushing hunters are more likely to be predators to cattle than solitary hunters (Broekhuis et al., 2017). The temporal activity bio-indicators consider the timing of breeding, migration and cropping seasons and thus determine the time periods of potential conflicts. In doing so, through the combination of these different types of indicators, the model goes beyond the traditional risk assessment based on distance and towards a more dynamic approach to understanding potential for conflict in relation to the biology of the species itself.

Framework Components

Species-Specific Behavioural Risk Profiling

The first element in this context requires compiling a behavioural risk profile for each of the potentially conflict-causing animals within the specific landscape. Such a behavioural risk profile is based on ethological characteristics of the animal, which include its average home range, dietary generalist, social organization, and human avoidance. In this regard, animals with high dietary generalist and low human avoidance, such as wild boars and certain primate species, often show repeated crop damage, while large carnivores exhibit sporadic but severe depredation risks associated with food shortage in protected areas (Osipova et al., 2018). Through the use of behavioural profiling, one can predict which animals are likely to cause conflicts within a particular area.

Habitat and Resource Overlap Assessment

The second factor assesses the amount of overlap between the habitat needs of wildlife and land use by humans. This involves examining the level of coverage by vegetation, availability of water, and the seasonal pattern of natural forage compared to farm land and grazing land. Locations with low natural forage levels, especially in dry seasons, tend to force herbivores to move into farmland, while depleted natural prey populations force carnivores to move to domestic animals (Osipova et al., 2018). Habitat overlap therefore explains the ecology of why specific zones have continuous conflicts and no other zones next to them.

Temporal Conflict Pattern Recognition

Thirdly, it involves the timing of biological events pertinent to the conflict. Herbivore attacks on crops are likely to be higher during the crop ripening period, while attacks on livestock by carnivores will occur more frequently during the dry period when natural prey is stressed due to scarcity of water (Zvidzai et al., 2023; Broekhuis et al., 2017). Other biological events that may lead to aggression by animals include breeding and calving seasons for some species. These events may increase territoriality among some species. Thus, understanding the timing of such events makes it possible to predict when conflicts are more likely to occur.

Integrated Risk Zonation

This last element combines various elements such as behaviour, habitats, and time into a composite risk classification for landscape zones adjacent to protected areas. These zones are divided depending on their conflict probability based on the presence of different types of risks rather than only considering any one of them alone. Zones that are near to the borders of protected areas, have high resource overlap, and coincide with peak animal activity times during particular seasons are considered to have the highest conflict risk levels because conflict tends to occur when many ecological factors coincide together, and not alone (Sharma et al., 2020; Osipova et al., 2018).

Application to Conservation Management

There are several ways that the Conflict Aware Framework will be used practically to conserve species and reduce HWC. To start with, the framework will be useful in guiding the proactive allocation of community game guards, deterrence patrols, and warning systems to areas and times of the day when conflicts may occur, as opposed to a uniform distribution of resources (McNutt et al., 2017). The framework will be useful in informing the type of interventions for livestock and crop protection designed according to the behaviour of the conflict-prone species. For example, areas that have carnivores will require good kraal designs and herbivores will require a particular type of cropping (Broekhuis et al., 2017). The framework will be very useful in designing monitoring programs where the indicators that need to be observed for conflict prediction can be determined by the community. Most importantly, since the framework will use species biology for predicting risks and not conflict incidents alone, it will be helpful in areas with insufficient data on conflicts (Sharma et al., 2020).

Limitations and Future Directions

As this approach depends on the prior knowledge of behaviour and ecology, its success in prediction will depend on the availability of ethological information about each individual species, which is uneven across taxa and geographical regions. There is a need for long-term field validation in different landscapes and species communities for fine-tuning of indicators and testing the utility of the approach beyond those landscapes and species communities from which the behavioural theory behind it was derived. Climate-related changes in forage and water availability can shift seasonal conflict patterns and make periodic recalibrations of temporal risk indicators necessary (Sharma et al., 2020). Another possibility for improving the applicability of this framework is integration with community knowledge, which frequently includes ethological details not covered by the scientific literature (Zvidzai et al., 2023).

Conclusion

Conflicts between humans and animals continue to be a persistent menace to biodiversity conservation and human well-being in regions adjacent to protected areas. The Conflict Aware Conservation Framework presents a scientifically grounded alternative approach to conflict management through its focus on animal behaviour, resource ecology, and periodic activity as means to predict conflict risk zones. Through the combination of behavioural profiling, habitat overlap evaluation, periodicity analysis, and risk zonation, the framework allows wildlife managers a scientific foundation from which to plan proactively. Validation of the framework on the field will be crucial to its success in the varied contexts of human-wildlife conflicts.

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