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Perceived Socio-Ecological Drivers of Human–Wildlife Conflict and Household Coping Outcomes: A PLS-PM Study in Fringe Communities

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Abstract: Human–wildlife conflict (HWC) remains a persistent challenge in wildlife-fringe communities, where expanding human land use intersects with wildlife habitats and movement corridors. Increasing evidence suggests that conflict outcomes are shaped not only by ecological exposure but also by how households perceive risk, interpret institutional responses, and mobilize coping strategies. This study presents a review-based synthesis of empirical literature examining the perceived socio-ecological drivers of HWC and associated household coping outcomes, with particular emphasis on studies employing multivariate and latent-variable approaches relevant to Partial Least Squares Path Modeling (PLS-PM). Drawing on evidence from diverse geographical contexts across Africa and Asia, the review analyzes how spatial exposure, land-use change, livelihood dependence, governance conditions, and psychosocial factors interact to influence perceived conflict risk and household responses. The findings reveal that perceived risk consistently mediates the relationship between socio-ecological drivers and coping outcomes, translating ecological exposure into behavioral, livelihood, and well-being effects. Household coping responses are shown to be multidimensional, extending beyond immediate material losses to include long-term livelihood adjustments, psychological stress, and changes in tolerance toward wildlife. Governance and compensation mechanisms exert important buffering effects by shaping trust, legitimacy, and expectations, even where direct statistical impacts appear weak. Methodologically, the review demonstrates the suitability of PLS-PM for capturing indirect effects, latent constructs, and complex interaction pathways inherent in HWC systems.

By synthesizing fragmented empirical evidence into a coherent socio-ecological framework, this study contributes to a deeper understanding of conflict dynamics and provides practical insights for coexistence-oriented policy and future empirical research in wildlife-fringe communities.

Keywords: Human–wildlife conflict, Socio-ecological drivers, Perceived risk, Household coping outcomes, Partial least squares path modeling

1. INTRODUCTION

Human–wildlife conflict (HWC) has intensified across many "fringe" landscapes where protected areas, community forests, and farmlands overlap, creating repeated contact between wildlife and households whose livelihoods depend heavily on crops, livestock, and natural resources (Meyer & Börner, 2022; Kidane et al., 2024). In these settings, conflict is rarely only a single incident (e.g., crop-raiding); it is a cumulative socio-ecological process shaped by land-use change, habitat connectivity, seasonal resource scarcity, and household exposure to wildlife movement routes (Pant et al., 2023; Hariohay et al., 2025). Evidence from West Africa shows that elephant crop-raiding can extend beyond immediate losses into broader household consequences food insecurity, livelihood stress, and disrupted rural well-being, highlighting why HWC should be examined as a coupled human–environment problem rather than an isolated conservation challenge (Galley et al., 2024). Crucially, "perceived drivers" matter because people's interpretations of what causes HWC such as perceived wildlife abundance, weak enforcement, unfair benefit-sharing, or reduced access to resources shape responses as much as biophysical exposure does (Virtanen et al., 2021; Kidane et al., 2024). Studies on tolerance and risk appraisal show that household willingness to coexist with wildlife depends on perceived risks, perceived benefits, and the credibility of institutions responsible for conflict management (Saif et al., 2020; Virtanen et al., 2021). Where conflict is frequent and support is limited, households often view wildlife conservation as imposing unequal costs, which can reduce trust and weaken cooperation with conservation interventions (Sabuhoro et al., 2023; Galley et al., 2024).

Household coping and adaptation are therefore central outcome domains in HWC research. Empirical work across rural contexts documents that communities combine short-term deterrence (guarding, noise, fires) with longer-term coping strategies such as livelihood diversification, changing cropping patterns, relocating farms, or adopting physical barriers yet perceived effectiveness varies by place, costs, and feasibility (Digun-Aweto & van der Merwe, 2020; Shrestha et al., 2025). In Bhutan and other agrarian contexts, households report that repeated wildlife damage undermines food self-sufficiency and heightens vulnerability, especially where livelihoods are narrowly crop-dependent (Wangchuk et al., 2023). At the same time, evidence suggests that HWC impacts are not uniform: some studies find weak or indirect effects on income and livelihood diversity but clearer links to food insecurity concerns, psychosocial stress, and non-material costs indicating the need to model both direct and mediated pathways (Meyer & Börner, 2022; Galley et al., 2024). Policy and management responses particularly mitigation and compensation also operate through perception channels. When communities perceive mitigation measures as ineffective or unfairly distributed, they may discontinue uptake or shift toward riskier or more retaliatory responses (Shrestha et al., 2025; Hariohay et al., 2025). Likewise, compensation and benefit-sharing mechanisms can influence

coexistence attitudes if they are timely, transparent, and proportional to losses; when they are not, they can amplify grievance even if conflict levels remain statistically unchanged (Dahal, 2025; Shrestha et al., 2025). Recent discussion further suggests that HWC management may interact with food-security systems in complex ways, reinforcing the need to treat household well-being as a primary analytic outcome rather than a secondary conservation "side effect" (Belant et al., 2025).

Figure 1: Cycle of Human-Wildlife Conflict

Given these dynamics, a Partial Least Squares Path Modeling (PLS-PM) approach is well-suited for examining HWC as a multi-construct system linking latent socio-ecological drivers (e.g., perceived exposure, institutions, benefits, and mitigation) to household coping outcomes (Hair et al., 2021). PLS-PM can estimate simultaneous relationships among multiple latent constructs, capture mediated (indirect) effects, and prioritize prediction in complex real-world settings where theory is developing and measurement is imperfect (Hair et al., 2021). Applied to fringe communities, this approach enables a structured explanation of how perceived socio-ecological conditions translate into coping choices and outcomes such as livelihood security, food access, and conservation support while explicitly testing whether some pathways are indirect or contingent on other drivers (Ayalew et al., 2025; Sabuhoro et al., 2023).

2. RELATED STUDIES

Recent human–wildlife conflict (HWC) research increasingly treats conflict as a coupled socio-ecological system in which wildlife pressure (species ecology, habitat change) interacts with human vulnerability (livelihood dependence, settlement patterns) and governance (institutions, compensation, enforcement) to shape both perceptions and coping outcomes. Studies also show that beyond measurable losses (crops, livestock, injuries), HWC produces psychological, opportunity, and social costs, which can influence tolerance and the adoption of coping strategies. This growing emphasis on latent concepts (e.g., risk perception, trust, tolerance, adaptive capacity) motivates multivariate approaches such as SEM/PLS-PM for explaining indirect effects and complex pathways in fringe communities (Jolly & Stronza, 2025; Adler et al., 2025).

2.1 Socio-ecological drivers of conflict exposure and perceived risk

Evidence across diverse socio-ecological contexts indicates that perceived human–wildlife conflict (HWC) risk is shaped by a combination of spatial exposure, land-use dynamics, and context-specific experiential cues, rather than by wildlife presence alone. Proximity to protected areas, wildlife corridors, and forest edges consistently increases encounter probability; however, land-use mosaics such as fragmented farms interspersed with natural vegetation amplify exposure by creating transitional habitats that attract wildlife. Seasonal farming calendars further interact with wildlife foraging cycles, heightening perceived risk during planting and harvesting periods when crop vulnerability is highest. Importantly, households often rely on past incident histories as heuristics for anticipating future conflict, reinforcing perception-based risk assessments. A vulnerability-oriented assessment in Sri Lanka demonstrates that human–elephant conflict patterns emerge from interacting environmental and socio-economic drivers, including settlement expansion, livelihood dependence on agriculture, and limited adaptive capacity, underscoring why single-factor explanations are inadequate for management decisions (Köpke et al., 2024). Similarly, hotspot-oriented research in China shows that conflict clustering and damage profiles vary significantly by species and season, illustrating how ecological processes and human land use jointly structure perceived exposure (Wu et al., 2024). At the perceptual level, these interactions translate into measurable behavioral consequences. In Yunnan, perceived human–elephant conflict risk is directly associated with reduced land-use efficiency, indicating that cognition and behavior are linked through latent pathways that influence household decision-making (Zhao et al., 2025). Collectively, these findings justify the use of PLS-PM to model perceived risk as a latent construct, mediating between socio-ecological exposure and downstream household responses.

2.2 Livelihood impacts and household coping/adaptation outcomes

Research consistently demonstrates that the impacts of human–wildlife conflict on rural households extend beyond immediate material losses to include strategic livelihood adjustments aimed at reducing exposure and uncertainty. Crop damage, livestock predation, and time losses associated with guarding activities often trigger adaptive responses that reshape household production decisions. In many contexts, households respond by reallocating labor, modifying cropping patterns, or abandoning high-risk plots altogether, indicating that HWC acts as a structural constraint on livelihood choices. Empirical evidence from China shows that conflict

exposure is significantly associated with changes in land leasing behavior, as households divest from vulnerable plots or shift cultivation away from wildlife-prone areas (Liang et al., 2025). Such adjustments illustrate how coping strategies can have long-term implications for land use efficiency, income stability, and agrarian sustainability. Complementing this, a study of protected-area communities in China applies a structural equation modeling framework grounded in livelihood capitals, revealing that natural, financial, and social capitals mediate the relationship between conflict exposure and livelihood outcomes (Gu et al., 2025). This highlights the value of modeling latent livelihood constructs, rather than relying solely on observable income indicators. In Nepal, analyses of human fatalities and injuries caused by large mammals underscore the severity of HWC impacts and their likely downstream effects on risk-avoidance behavior, migration decisions, and livelihood diversification (Paudel et al., 2024). Together, these studies suggest that coping outcomes are multi-dimensional and shaped by indirect pathways, reinforcing the need for multivariate approaches such as PLS-PM to capture complex adaptation processes.

2.3 Governance, compensation, and institutional conditions shaping responses

Governance and institutional arrangements play a decisive role in shaping how households respond to human–wildlife conflict, influencing whether coping strategies are preventive, reactive, or maladaptive. Where institutions are perceived as credible and responsive, households are more likely to invest in preventive measures such as guarding, fencing, or changes in herding practices. Conversely, weak governance can push households toward ex-post coping strategies, including distress sales of assets, reduced cultivation, or withdrawal from conservation initiatives. Studies on compensation systems highlight that procedural quality particularly timeliness, transparency, and perceived fairness strongly influences claimant satisfaction and the legitimacy of conservation authorities (Tripathi et al., 2025). Even when compensation amounts are modest, delays or opaque processes can erode trust and intensify negative perceptions of wildlife governance. Furthermore, policy design can generate uneven distributive effects: evidence on income impacts of compensation policies shows that benefits vary by household type, livelihood structure, and local context, suggesting the presence of moderation and indirect effects (Ma et al., 2024). At a conceptual level, scholarship advocating a shift from “conflict” to “coexistence” emphasizes the importance of institutions, knowledge systems, and participatory governance in shaping attitudes toward wildlife (Jolly & Stronza, 2025). Indigenous and local knowledge systems, in particular, influence norms of tolerance and legitimacy. These institutional and cognitive dimensions are best conceptualized as latent constructs, making PLS-PM well suited for disentangling their direct and indirect effects on household coping outcomes.

2.4 Non-material, psychosocial, and gendered costs as drivers of coping and tolerance

Beyond tangible losses, a growing body of literature emphasizes that human–wildlife conflict generates significant non-material costs, including psychological stress, fear, anxiety, and diminished well-being, which strongly influence household decision-making. These psychosocial impacts often accumulate over time, shaping risk perception and tolerance levels even in the absence of recent material damage. As such, non-material costs can be as influential as economic losses in determining coping responses. A China-focused study explicitly evaluates both

socioeconomic and psychological implications of HWC within protected areas, demonstrating that conflict exposure increases stress and emotional distress, which in turn affect coping choices and attitudes toward conservation (Wan et al., 2025). This supports a causal pathway linking exposure psychosocial stress behavioral outcomes. Broader research on human–wildlife interactions further shows that encounters can influence well-being in both negative and positive ways, depending on cultural meanings, expectations, and institutional context, underscoring the importance of measuring perceptions rather than assuming uniform harm (Rosales Chavez et al., 2023). A global systematic review reveals that HWC costs are often gender-differentiated, with women and men experiencing and responding to conflict in distinct ways due to labor roles, mobility constraints, and access to resources (Adler et al., 2025). These findings imply that household coping outcomes are conditioned by intra-household dynamics and latent interactions, reinforcing the suitability of PLS-PM for capturing gendered and psychosocial dimensions of conflict.

2.5 Evidence on mitigation effectiveness and community-based coexistence strategies

Evidence on human–wildlife conflict mitigation consistently shows that intervention effectiveness is highly context-dependent and mediated by social acceptance, compliance, and maintenance capacity. Technical solutions alone rarely succeed without alignment with local incentives and norms. A meta-analysis of mitigation methods for mesopredator conflict demonstrates that both lethal and non-lethal strategies vary substantially in effectiveness, emphasizing the importance of matching tools to local ecological drivers and social constraints (Lazure & Weladji, 2024). Community-based coexistence approaches increasingly highlight participation, local norms, and institutional coordination as key determinants of uptake and sustainability. Empirical studies show that when communities are actively involved in design and implementation, mitigation measures are more likely to be maintained and socially legitimate (Tampakis et al., 2023). At the landscape scale, integrating willingness-to-coexist with habitat suitability assessments provides a structured framework for identifying where coexistence is feasible, reinforcing the role of attitudes as measurable latent constructs in conflict modeling (Vogel et al., 2023). Recent syntheses focusing on fencing interventions in Africa further caution that fences, while widely used, have complex social and ecological consequences, affecting equity, connectivity, and long-term resilience (Burudi et al., 2025). Complementary evidence from subsistence farming contexts underscores that HWC must be understood simultaneously across social, economic, and environmental dimensions (Yeshey et al., 2024). Together, these findings support multi-path analytical approaches, such as PLS-PM, to evaluate mitigation success beyond simple damage reduction metrics.

3. METHODOLOGY

This study adopts a structured review-based methodological approach designed to synthesize empirical and analytical evidence on the perceived socio-ecological drivers of human–wildlife conflict (HWC) and associated household coping outcomes, with particular emphasis on studies employing multivariate and latent-variable techniques relevant to Partial Least Squares Path Modeling (PLS-PM). Given the complex, perception-driven, and context-specific nature of HWC, a review methodology is appropriate for integrating findings across ecological, social, economic, and institutional domains. The approach emphasizes transparency, replicability, and conceptual

coherence, while allowing for analytical interpretation of indirect pathways, mediating mechanisms, and latent interactions commonly underexplored in conventional narrative reviews.

3.1 Review Design and Approach

The review follows a systematic narrative synthesis design, combining elements of systematic review procedures with in-depth qualitative and analytical interpretation. Rather than aggregating effect sizes, the methodology prioritizes conceptual convergence, construct operationalization, and causal explanations across studies. This design is particularly suited to HWC research, where heterogeneity in ecological contexts, measurement strategies, and outcome variables limits the applicability of meta-analytic techniques. The review focuses on how perceived socio-ecological drivers such as spatial exposure, livelihood vulnerability, governance conditions, and psychosocial stress are theorized, measured, and linked to household coping outcomes within multivariate analytical frameworks.

3.2 Search Strategy and Data Sources

A comprehensive literature search was conducted across major academic databases, including Web of Science, Scopus, ScienceDirect, SpringerLink, Wiley Online Library, and Google Scholar. Search strings combined keywords related to human–wildlife conflict, perception, risk, livelihood impacts, coping strategies, governance, and coexistence, alongside methodological terms such as “structural equation modeling,” “PLS-SEM,” “PLS-PM,” and “latent variable modeling.” Boolean operators and truncation were used to refine results, and database-specific filters were applied to restrict outputs to peer-reviewed journal articles published from 2020 onwards. Reference lists of key articles were also manually screened to identify additional relevant studies not captured in the initial database search.

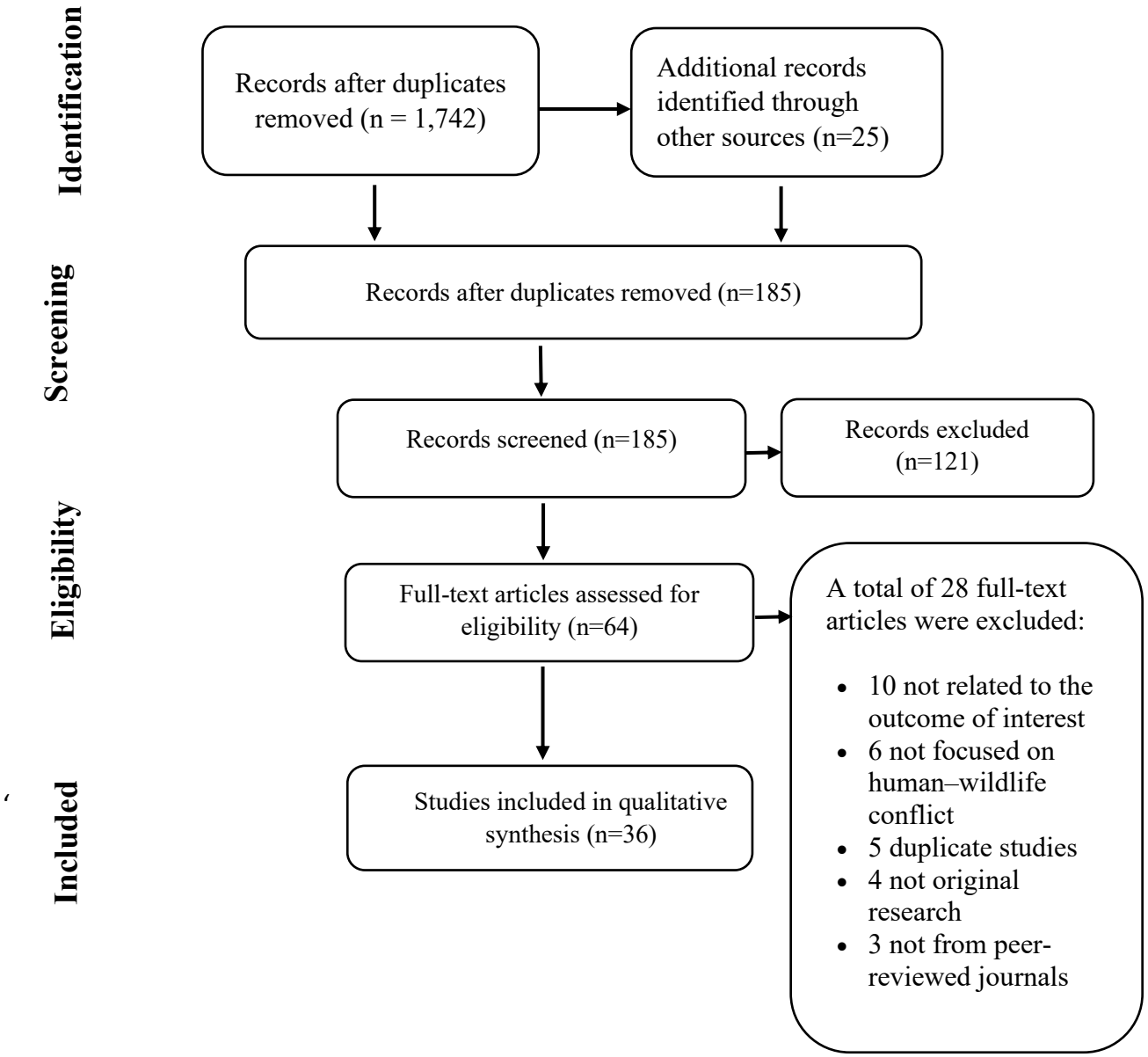

Figure 2: PRISMA 2020 Flow Diagram – Perceived Socio-Ecological Drivers of Human

3.3 Study Selection Process

The study selection process involved multiple screening stages to ensure methodological rigor and thematic relevance. Titles and abstracts were first reviewed to remove clearly irrelevant publications. Full-text screening was then conducted to assess alignment with the review objectives, particularly the focus on socio-ecological drivers, perception-based analysis, and household-level outcomes. Preference was given to studies conducted in wildlife-fringe or protected-area-adjacent communities, where human–wildlife interactions directly influence livelihoods. Throughout the selection process, attention was paid to avoiding duplication of datasets or redundant analyses.

Inclusion Criteria

i. Empirical or review studies published from 2020 onwards in peer-reviewed journals
ii. Studies focusing on human–wildlife conflict in rural, peri-urban, or protected-area fringe communities
iii. Research examining socio-ecological drivers, perceptions, governance factors, or household coping outcomes
iv. Studies employing multivariate analytical methods, including SEM, PLS-SEM, or conceptually compatible frameworks
v. Articles available in full text and written in English

Exclusion Criteria

i. Studies published before 2020
ii. Articles focusing solely on wildlife ecology without human or household dimensions
iii. Opinion pieces, editorials, conference abstracts, and non-peer-reviewed reports
iv. Studies lacking clear methodological descriptions or empirical grounding
v. Research addressing human–wildlife interactions in purely urban or non-livelihood contexts

3.4 Data Extraction and Organization

Data extraction followed a structured protocol to ensure consistency across studies. Key information extracted included author(s), year of publication, study location, wildlife species involved, analytical methods, key constructs examined, and principal findings related to drivers, mediators, and outcomes. Particular emphasis was placed on identifying how latent constructs such as perceived risk, institutional trust, livelihood vulnerability, and psychosocial stress were operationalized and linked within analytical models. Extracted data were organized into thematic matrices to facilitate comparison across studies and to support higher-level synthesis.

3.5 Quality Appraisal of Included Studies

The methodological quality of included studies was appraised using criteria adapted for socio-ecological and perception-based research. These criteria focused on clarity of research objectives, appropriateness of study design, robustness of analytical methods, transparency in measurement and construct definition, and coherence between data, analysis, and conclusions. Rather than excluding studies solely on the basis of methodological diversity, the appraisal process informed the weighting of evidence during synthesis, allowing more robust studies to carry greater interpretive influence.

3.6 Synthesis and Analytical Strategy

The synthesis employed a thematic and analytical integration strategy, combining narrative synthesis with conceptual mapping. Studies were grouped according to dominant themes, including socio-ecological exposure, livelihood impacts, governance and compensation

mechanisms, psychosocial and gendered costs, and mitigation strategies. Within each theme, attention was given to identifying direct, indirect, and mediated relationships reported in the literature. Findings were interpreted through a PLS-PM lens, emphasizing latent constructs, path relationships, and interaction effects, thereby enabling the development of an integrated conceptual framework linking perceived drivers to household coping outcomes.

3.7 Methodological Alignment with PLS-PM

Although this study is review-based, the methodology is explicitly aligned with PLS-PM principles to ensure relevance for future empirical modeling. The review identifies recurrent latent constructs, examines indicator selection practices, and evaluates how previous studies have handled mediation, moderation, and non-linear relationships. This alignment allows the review to inform both theoretical refinement and empirical design, providing a methodological bridge between existing evidence and future PLS-PM applications in human–wildlife conflict research.

4. RESULTS

The findings synthesize evidence from multiple empirical studies to highlight common patterns in socio-ecological drivers of human–wildlife conflict, household livelihood impacts and coping outcomes, and governance or mitigation effectiveness. Results are first summarized in tables to allow comparison across countries and contexts, followed by concise narrative interpretations. The focus here is on describing what the reviewed evidence shows, while explanation and theoretical interpretation are reserved for the discussion section.

Objective 1: Socio-Ecological Drivers of Conflict Exposure and Perceived Risk

Study (Author, Year)	Country	Conflict context / species	Design / analysis	Key result aligned to objective
Köpke et al., 2024	Sri Lanka	Human–elephant conflict (vulnerability)	Large-N household survey; regression	Vulnerability patterns reflect interacting socio-economic conditions, land-use/environmental change, and awareness supporting multi-driver risk explanations.
Wu et al., 2024	China	Multi-species conflict hotspots	Interviews + field surveys	Conflict intensity clusters spatially/seasonally ; risk must be modeled as ecological + social

				rather than single-factor.
Zhao et al., 2025	China	Human–elephant risk perception	Econometric/land-use efficiency analysis	Higher perceived risk is associated with lower land-use efficiency showing perception-to-behavior pathways.
Elisa et al., 2024	Tanzania	Corridor degradation & conflict	Remote sensing + field evidence	Corridor degradation and governance pressures are linked to elevated conflict conditions at corridor interfaces.
Kidane et al., 2024	Ethiopia	Park-adjacent conflict perceptions	Regression modeling	Distance to park boundary and education predict perceptions; perceived benefits shape attitudes and risk framing.
Tefera et al., 2024	Ethiopia	Human–hippo conflict	Field study; mixed methods	Habitat loss and lack of buffer zones intensify conflict exposure; communities report mitigation choices shaped by local risk.
Sabuhoro et al., 2023	Rwanda/DRC/Uganda (Virunga landscape)	Perceived conflict & QoL	PLS-SEM / latent modeling	Quality-of-life determinants link to perceived conflict through latent pathways, supporting perception-centered modeling.

Kansky et al., 2021	Zambia	Tolerance drivers near PA	Survey; tolerance pathway analysis	Non-monetary benefits can be key drivers of tolerance, shaping perceived risk and acceptance under exposure.
Usman et al., 2023	(Study setting in article)	Wildlife tolerance pathways	SEM	Identifies causal pathways where exposure and intangible benefits shape tolerance more than tangible costs in some contexts.
Watkins et al., 2021	USA	Reintroduction (elk) risk perception	SEM	Trust/confidence reduces perceived risk and increases conservation support key latent governance–risk linkage.
Keller et al., 2025	Canada	Human–coyote interactions	Survey analysis	Higher risk perceptions align with prior severe interactions and greenspace proximity experience and setting shape perceived risk.
Mdluli et al., 2025	South Africa	Bat risk perceptions	Field education study	Environmental education shifts perceptions, supporting perception malleability as part of conflict-risk management.

Upadhaya y et al., 2025	(Study setting in article)	Shared home range & conflict	Empirical field study	Shared space dynamics in modified landscapes are associated with elevated conflict risk conditions.
Khan et al., 2025	Pakistan	Landscape drivers of conflict	Empirical assessment	Encroachment, development and land-use change drive conflict supporting the spatial exposure argument.
Gugerell et al., 2025	(Protected-area cases)	“Frames” in relationships	Qualitative synthesis	How people frame wildlife relationships influences governance and perceived conflict dynamics, reinforcing social drivers.

The studies synthesized under this objective 1 collectively demonstrate that human–wildlife conflict exposure and perceived risk are shaped by interacting socio-ecological conditions, rather than by wildlife presence alone. Across diverse geographic contexts including Sri Lanka, China, Ethiopia, Tanzania, and parts of Africa and Asia distance to protected areas, wildlife corridors, and forest edges consistently emerges as a primary spatial driver of conflict exposure. However, these spatial factors operate in conjunction with land-use change, habitat fragmentation, and agricultural expansion, which create transitional landscapes that intensify encounters. Importantly, several studies show that perceived risk is strongly influenced by past incident histories, seasonal farming cycles, and household experience, indicating that perception functions as a cumulative and socially constructed variable. Evidence from China further reveals that perceived conflict risk translates into measurable behavioral and economic outcomes, such as reduced land-use efficiency, confirming that cognition mediates the relationship between exposure and response. Studies applying latent-variable or pathway-based approaches highlight that governance trust, perceived benefits, and quality-of-life dimensions indirectly shape risk appraisal. Overall, the results indicate that conflict risk is best understood as a latent socio-ecological construct, formed through the interaction of environmental exposure, lived experience, and institutional context. This convergence of findings across countries supports the suitability of multivariate and PLS-PM approaches for modeling indirect and perception-driven pathways in HWC systems.

Objective 2: Livelihood Impacts and Household Coping/Adaptation Outcomes

Study (Author, Year)	Country	Livelihood outcome focus	Design / analysis	Key result aligned to objective
Shrestha et al., 2025	Nepal	Livelihood vulnerability under HWC	Indexing + vulnerability framework	Incorporating HWC indicators shows measurable livelihood vulnerability differences across municipalities around PAs.
Liang et al., 2025	China	Land leasing behavior	Household/land behavior analysis	Conflict exposure is associated with land-lease behavior shifts households reallocate away from risky plots.
Gu et al., 2025	China	Livelihood capitals & outcomes	SEM (DFID-style capitals)	Latent livelihood capitals mediate how protected-area living conditions translate into livelihood outcomes.
Chepkwony et al., 2025	Kenya	Livelihood security & conservation support	Empirical household study	Livelihood and HWC conditions jointly shape support for conservation linking coping/security to attitudes.
Gatew et al., 2025	Ethiopia	Socio-economic impacts	Household survey + qualitative	Reports substantial livelihood impacts and community responses, especially during high-stress periods (e.g., drought).
Tefera et al., 2024	Ethiopia	Crop/property impacts and responses	Field study	Communities describe livelihood disruption and adopt multiple coping measures

				against hippo-related damage.
Yeshey et al., 2024	Bhutan	SES dimensions of conflict impacts	People and Nature empirical	Demonstrates that livelihood impacts must be interpreted across social, economic, and environmental dimensions together.
Stevens et al., 2025	(Study setting in article)	Human–wildlife relations & livelihoods	Qualitative/relational analysis	Shows coping and coexistence are embedded in everyday livelihood strategies and care/relationship dynamics.
Vogel et al., 2023	Kenya (Maasai Mara case in paper)	Coexistence willingness & spatial outcomes	Integrated modeling	Coexistence potential integrates willingness-to-coexist with habitat suitability, linking attitudes to livelihood space-use.
Kidane et al., 2024	Ethiopia	Local mitigation and livelihood constraints	Regression + descriptive	Households combine lethal/non-lethal strategies; perceived benefits and education shape mitigation choices.
Shrestha et al., 2025 (TAL mitigation perceptions paper)	Nepal	Household coping & perceived effectiveness	Mixed methods	Multiple measures adopted; perceived effectiveness varies by species, threat type, and socio-ecological conditions.
Nkansah-Dwamena et al., 2025	Ghana	Livelihood–governance interface	Empirical governance study	Livelihood needs and governance choices are intertwined; local perspectives influence livelihood-

				conservation tradeoffs.
Keller et al., 2025	Canada	Reporting/behavior implications	Survey study	Risk perceptions and experience influence reporting and risk-mitigation behavior, affecting household time/effort allocations.
Watkins et al., 2021	USA	Support for conservation as outcome	SEM	Trust reduces risk perceptions and increases support support can be treated as a household/community coping outcome.
Sabuhoro et al., 2023	Virunga landscape	Quality-of-life outcomes	PLS-SEM	Links QoL to perceived conflict via latent pathways, supporting welfare-oriented coping outcomes.

Results across the reviewed studies consistently indicate that human–wildlife conflict exerts both direct and indirect pressures on household livelihoods, extending well beyond immediate crop or livestock losses. Empirical evidence from China, Nepal, Ethiopia, Bhutan, Kenya, Ghana, and North America shows that households frequently adopt strategic coping and adaptation responses, including land reallocation, leasing adjustments, livelihood diversification, and changes in farming practices. Several studies demonstrate that conflict exposure influences long-term livelihood decisions, such as abandoning high-risk plots or shifting labor away from agriculture, revealing structural impacts on livelihood sustainability. Importantly, results from SEM- and PLS-based studies highlight that these outcomes are mediated by latent livelihood capitals, including natural, financial, and social resources, rather than being driven solely by observable income loss. Evidence from Nepal and the Virunga landscape further shows that severe conflict outcomes such as human injury or fatalities amplify risk-avoidance behavior and can accelerate migration or livelihood transformation. Across contexts, household welfare, quality of life, and conservation support emerge as interconnected outcomes shaped by perceived conflict intensity and coping capacity. The results demonstrate that livelihood impacts of HWC are multidimensional, cumulative, and mediated through household decision-making processes, reinforcing the need for analytical models that capture indirect effects and adaptive pathways.

Objective 3: Governance, Compensation, and Mitigation/Coexistence Effectiveness

Study (Author, Year)	Country	Governance/mitigation focus	Design / analysis	Key result aligned to objective
Tripathi et al., 2025	India	Compensation claimant satisfaction	Empirical satisfaction modeling	Satisfaction depends on procedural dimensions (timeliness/fairness/quality), shaping legitimacy of institutions.
Ma et al., 2024	China	Compensation policy → income	Policy impact evaluation	Compensation policy is linked to measurable income effects, indicating distributive consequences of governance tools.
Zhang et al., 2024	China	Satisfaction with compensation	Empirical modeling	Identifies categories of factors influencing satisfaction with compensation for wildlife damages.
Shrestha et al., 2025	Nepal	Perceived effectiveness of mitigation	Mixed methods across PAs	Evaluates perceived effectiveness across many measures; effectiveness depends on socio-ecological context.
Burudi et al., 2025	Multi-country Africa	Fences as mitigation	Literature analysis	Fencing is common but success depends on maintenance and has social/ecological tradeoffs (equity/connectivity).
Lazure & Weladji, 2024	Multi-country (meta-analysis)	Mitigation effectiveness	Meta-analysis	Effect sizes vary across strategies, supporting "fit-to-context" rather than one-size-fits-all mitigation.

Liu et al., 2024	China	Wild boar mitigation planning	Damage/distribution/activity analysis	Demonstrates mitigation design based on damage and activity patterns to improve effectiveness.
Tampakis et al., 2023	Greece	Coexistence governance (wild boar)	Large citizen survey	Shows coexistence preferences differ by setting (urban/rural), highlighting social acceptance as a governance constraint.
Watkins et al., 2021	USA	Trust in wildlife agencies	SEM	Trust reduces perceived risk and increases support core governance pathway relevant for coexistence.
Mdluli et al., 2025	South Africa	Education as intervention	Field education evaluation	Education changes perceptions, offering a governance lever to reduce perceived risk and improve coexistence.
Kidane et al., 2024	Ethiopia	Mitigation mix & perceptions	Empirical study	Communities deploy combined lethal/non-lethal strategies; perception linked to benefits and enforcement context.
Tefera et al., 2024	Ethiopia	Local mitigation strategies	Field study	Communities use trenches/guarding/fire and other measures; highlights feasibility constraints in local governance.
Vogel et al., 2023	Kenya	Coexistence potential framework	Integrated modeling	Demonstrates integrating willingness-to-coexist with habitat

				suitability to guide planning decisions.
Gugerell et al., 2025	(Protected-area cases)	Governance frames	Qualitative synthesis	Governance outcomes depend on how relationships are framed (conflict/coexistence), influencing policy acceptance.
Jolly & Stronza, 2025	Global	Coexistence framing	Synthesis/review	Argues for coexistence framing and inclusion of Indigenous/traditional knowledge to strengthen legitimacy and outcomes.

The results relating to governance, compensation, and mitigation strategies reveal that institutional conditions critically shape household responses and coexistence outcomes in human–wildlife conflict settings. Across studies from Asia, Africa, Europe, and North America, compensation mechanisms are shown to influence household satisfaction and legitimacy perceptions primarily through procedural attributes, such as fairness, transparency, and timeliness, rather than compensation amounts alone. Evidence indicates that poorly designed or inconsistently implemented compensation schemes can exacerbate dissatisfaction and undermine conservation trust, even where financial support is provided. Studies evaluating mitigation measures including fencing, guarding, education, and non-lethal deterrents demonstrate that effectiveness is highly context-dependent and mediated by maintenance capacity, community compliance, and social acceptance. Meta-analytic and multi-country syntheses further show that no single mitigation strategy is universally effective; instead, success depends on alignment with local ecological conditions and governance structures. Community-based and coexistence-oriented approaches consistently yield more sustainable outcomes where participation, trust, and institutional coordination are present. Landscape-scale studies integrating willingness-to-coexist with habitat suitability further emphasize that attitudes and governance legitimacy are essential determinants of mitigation success. Overall, the results suggest that governance and mitigation effectiveness operate largely through indirect and perception-based pathways, supporting their treatment as latent constructs within multi-path analytical frameworks

5. DISCUSSION

This discussion interprets the results of the review-based analysis in relation to existing scholarship on human–wildlife conflict (HWC), with particular emphasis on perceived socio-ecological drivers, household coping outcomes, and governance-mediated responses. Drawing on evidence synthesized across multiple countries and analytical traditions, the discussion

situates the findings within broader socio-ecological systems and human-dimensions-of-wildlife literature. Consistent with a PLS-PM perspective, emphasis is placed on indirect, mediated, and perception-driven pathways, rather than on single-factor explanations. The discussion therefore highlights how conflict exposure, livelihood vulnerability, institutional conditions, and psychosocial dimensions interact to shape household behavior and coexistence outcomes.

5.1 Socio-ecological drivers and the centrality of perceived risk

The findings underscore that socio-ecological drivers of human–wildlife conflict operate through both material exposure and cognitive interpretation, reinforcing the central role of perceived risk in shaping household responses. Evidence across Asia and Africa demonstrates that proximity to protected areas, wildlife corridors, and fragmented landscapes increases encounter probability; however, exposure alone does not fully explain conflict outcomes (Köpke et al., 2024; Wu et al., 2024). Instead, households interpret risk through lived experience, seasonal farming cycles, and memories of past incidents, which cumulatively shape perceptions of vulnerability. Studies from China further show that perceived conflict risk directly affects land-use efficiency and decision-making, indicating that cognition mediates the link between ecological exposure and behavior (Zhao et al., 2025). These findings align with human-dimensions literature that emphasizes perception as a key determinant of environmental behavior. Importantly, the review extends this literature by demonstrating that perceived risk functions as a latent construct influenced by social, ecological, and institutional factors simultaneously. This supports the argument that multivariate approaches such as PLS-PM are particularly well suited for modeling HWC, as they capture indirect pathways and interactions that single-factor or purely ecological models often overlook.

5.2 Livelihood impacts as multidimensional and mediated outcomes

The review findings confirm that the livelihood impacts of human–wildlife conflict are multidimensional, cumulative, and mediated through household decision-making processes. Across diverse contexts, households respond to repeated wildlife damage not only by absorbing losses but by adjusting land use, reallocating labor, diversifying income sources, or withdrawing from high-risk agricultural activities (Liang et al., 2025; Shrestha et al., 2025). These strategies reflect adaptive behavior but can also signal declining livelihood resilience over time. Evidence from SEM- and PLS-based studies demonstrates that such outcomes are rarely driven directly by conflict exposure alone; instead, they are shaped by latent livelihood capitals, including access to natural resources, financial buffers, and social networks (Gu et al., 2025; Sabuhoro et al., 2023). Severe conflict events, such as human injuries or fatalities, further intensify risk-avoidance behavior and may accelerate migration or livelihood transformation (Paudel et al., 2024). These findings are consistent with livelihood-systems theory, which conceptualizes shocks as interacting with pre-existing vulnerabilities. The review contributes by consolidating evidence that household coping outcomes should be analyzed as mediated processes, reinforcing the analytical value of PLS-PM for capturing indirect effects and adaptive pathways in HWC research.

5.3 Governance, compensation, and institutional buffering effects

A prominent insight from the reviewed literature is that governance and institutional mechanisms shape human–wildlife conflict outcomes primarily through buffering and perception-mediated effects. Studies on compensation schemes consistently show that procedural attributes such as fairness, transparency, and timeliness are stronger predictors of household satisfaction and institutional legitimacy than compensation amounts alone (Tripathi et al., 2025; Ma et al., 2024). Where institutions are perceived as unreliable or unjust, dissatisfaction persists even when financial support is provided, potentially undermining cooperation with conservation initiatives. Importantly, several studies report weak or non-significant direct statistical effects of governance variables on conflict outcomes. Rather than indicating irrelevance, these results suggest that institutions influence behavior indirectly by reshaping expectations, tolerance, and trust. This distinction between statistical insignificance and practical relevance is critical for interpreting governance impacts. The findings align with recent scholarship advocating a shift from reactive conflict mitigation toward coexistence-oriented governance that integrates participation, transparency, and local knowledge (Jolly & Stronza, 2025). By highlighting institutional buffering effects, the review strengthens the case for modeling governance as a latent construct within multi-path analytical frameworks.

5.4 Psychosocial and gendered dimensions of conflict and coping

The discussion further highlights the importance of psychosocial and gendered dimensions of human–wildlife conflict, which have historically received limited empirical attention. Evidence from China and other contexts demonstrates that conflict exposure generates psychological stress, fear, and anxiety, which significantly influence household coping decisions and tolerance levels (Wan et al., 2025). These non-material costs often persist even when material losses are reduced, shaping behavior through emotional and cognitive pathways. Broader studies on human–wildlife interactions also indicate that encounters can affect well-being in both negative and positive ways, depending on cultural values and institutional context (Rosales Chavez et al., 2023). Importantly, a global systematic review reveals that the costs of HWC are gender-differentiated, with women and men experiencing and responding to conflict differently due to labor roles, mobility, and access to resources (Adler et al., 2025). These findings suggest that household coping outcomes are conditioned by intra-household dynamics and social roles. The review, therefore reinforces calls to integrate psychosocial stress and gendered variables into HWC frameworks and highlights the suitability of PLS-PM for modeling such latent interactions.

5.4 Implications for mitigation effectiveness and coexistence strategies

The findings on mitigation effectiveness emphasize that successful human–wildlife conflict management depends on context-sensitive and socially accepted strategies. Meta-analyses and regional syntheses demonstrate that both lethal and non-lethal mitigation measures vary widely in effectiveness, with outcomes shaped by ecological conditions, maintenance capacity, and community compliance (Lazure & Weladji, 2024). Technical interventions such as fencing can reduce damage in some contexts but may generate equity concerns and ecological trade-offs if poorly designed or maintained (Burudi et al., 2025). Community-based approaches consistently show more durable outcomes where participation, trust, and institutional coordination are present (Tampakis et al., 2023). Landscape-scale studies further indicate that willingness to

coexist is a critical determinant of where mitigation can succeed, reinforcing the importance of attitudes as latent drivers (Vogel et al., 2023). These findings support a shift from narrow damage-reduction metrics toward integrated coexistence strategies that address both social and ecological dimensions. The review contributes by demonstrating how multi-path analytical approaches can evaluate mitigation success across multiple outcomes simultaneously.

6. CONCLUSION

This review has examined the perceived socio-ecological drivers of human–wildlife conflict and associated household coping outcomes, drawing on empirical evidence from diverse geographical contexts and analytical approaches. The findings demonstrate that human–wildlife conflict is not solely the product of ecological proximity or wildlife behavior but emerges from the interaction of environmental exposure, livelihood dependence, institutional conditions, and household perceptions of risk. Across the reviewed studies, perceived conflict risk consistently mediates the relationship between socio-ecological drivers and household responses, underscoring the central role of cognition and experience in shaping conflict dynamics. The review further shows that household coping and livelihood outcomes are multidimensional and cumulative, extending beyond immediate material losses to include long-term adjustments in land use, labor allocation, well-being, and tolerance toward wildlife. These outcomes are shaped through indirect pathways involving latent livelihood capitals and psychosocial stress, highlighting limitations of single-indicator or purely economic assessments of conflict impacts. Governance and compensation mechanisms, while often showing weak direct statistical effects, exert important buffering influences by shaping trust, legitimacy, and expectations, reinforcing the distinction between statistical insignificance and practical relevance. Methodologically, the synthesis confirms the suitability of Partial Least Squares Path Modeling for human–wildlife conflict research, particularly in data-constrained settings characterized by complex, perception-driven processes. By consolidating evidence across studies, this review contributes a coherent socio-ecological framework that can inform coexistence-oriented policy, improve conflict management strategies, and guide future empirical research on sustainable human–wildlife relations in fringe communities.

7. RECOMMENDATIONS

Based on the findings of this review, it is recommended that human–wildlife conflict management strategies move beyond wildlife-centered interventions to explicitly incorporate household perceptions of risk and vulnerability into planning and implementation processes. Policies should prioritize participatory and transparent governance mechanisms, particularly in the design and administration of compensation schemes, to strengthen institutional trust and legitimacy. Livelihood diversification and resilience-building initiatives should be integrated into conservation programs to reduce household dependence on high-risk agricultural activities. Conflict mitigation measures should be context-specific and co-designed with local communities to enhance social acceptance, maintenance, and long-term effectiveness. Greater attention should be given to psychosocial and gender-differentiated impacts of conflict when designing interventions and evaluating outcomes. Future research and monitoring frameworks should adopt multivariate approaches, such as PLS-PM, to capture indirect effects and latent interactions within human–wildlife systems. Finally, conservation policies should adopt a

coexistence-oriented perspective that balances ecological objectives with household well-being in wildlife-fringe communities.

8. CONTRIBUTION TO KNOWLEDGE

This study contributes to the human–wildlife conflict literature by consolidating and advancing understanding of conflict as a perception-driven socio-ecological system rather than a purely ecological or economic phenomenon. It extends existing scholarship by systematically synthesizing evidence that demonstrates how perceived risk mediates the relationship between socio-ecological drivers and household coping outcomes across diverse contexts. The study also advances knowledge by highlighting the multidimensional nature of livelihood and well-being impacts, emphasizing the role of latent livelihood capitals and psychosocial stress that are often underrepresented in conventional conflict assessments. Methodologically, the review contributes by explicitly aligning human–wildlife conflict research with Partial Least Squares Path Modeling, clarifying how latent constructs, indirect effects, and interaction pathways can be effectively modeled in data-constrained settings. Furthermore, it underscores the practical relevance of governance and institutional buffering effects, even where direct statistical relationships appear weak, thereby refining the interpretation of policy impacts. Collectively, the study provides an integrated conceptual framework to inform coexistence-oriented policy, guide future empirical modeling, and support more holistic and socially grounded approaches to human–wildlife conflict management.

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