

Research Article

Exploration of Mitigation Strategy in the Resolution of Human-wildlife Conflict in Bakossi National Park, Southwest Region, Cameroon

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Abstract

Bakossi national park is a biodiversity hotspot that is home to a rich array of wildlife species. However, the park has also been the site of ongoing human-wildlife conflicts (HWC), as the expansion of agricultural activities and human settlements has encroached into wildlife habitats and corridors. These conflicts have led to crop damage, livestock depredation, and even human injuries and fatalities, posing significant challenges for both local communities and conservation efforts. This study aimed to explore the mitigation strategies employed to address HWC within and around the national park, and to assess their effectiveness in resolving these conflicts. Research data collection was done by questionnaire administration in all the 36 villages within and around the national park. HWC mitigation strategies revealed a significant association on the local knowledge of conflict mitigation $r=0.267$ $P=0.005$, local community involvement in the mitigation program $X^2=3.463$ $df=3$ $P<0.05$, and the role played by local community in mitigating the conflict $X^2=3.323$ $df=6$ $P<0.05$ respectively. HWC is a significant global issue, with local communities often bearing the brunt of interactions between humans and wildlife. Also, there was a significant relation between conflict mitigation strategy and the role of stakeholders in resolving the conflict $X^2=14.880$ $df=9$ $P<0.05$. Furthermore, human-wildlife conflict mitigation strategy associated significantly with the occupation of local community inhabitants in the conflict resolution $X^2=5.309$ $df=3$ $P<0.05$. Additionally, conflict mitigation strategy significantly related with the role played by gender in the resolution program $X^2=10.871$ $df=3$ $P=0.012$. Gender plays a significant role in shaping the experiences, perspectives, and roles of individuals within local communities when it comes to mitigating HWC. While some of these strategies have shown promising results in reducing HWC incidents, their overall effectiveness was found to be hindered by various contextual factors, such as resource constraints, limited community engagement, and weak institutional coordination. The research concludes with recommendations for a more holistic, integrated approach to HWC management, emphasizing the importance of community participation, cross-sectorial collaboration, and adaptive management strategies. By leveraging this evidence-based understanding of effective mitigation approaches, policymakers and practitioners can work towards more equitable and ecologically viable solutions to HWC in Cameroon and beyond.

Keywords

Mitigation Strategy, Biodiversity Hotspot, Local Knowledge, Local Community

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1. Introduction

Human-wildlife conflict (HWC) is a complex and pervasive issue that poses significant challenges to biodiversity conservation and human well-being, [8, 18]. In Cameroon, a Central African country renowned for its rich biodiversity, HWC has become a growing concern as expanding human settlements, agricultural activities, and infrastructure development encroach on the natural habitats of various wildlife species [24, 27]. The consequences of HWC in Cameroon are multifaceted, affecting both human and animal populations. On the human side, HWC can result in crop damage, livestock depredation, injury, and even loss of human life, often leading to retaliatory actions against wildlife [3, 10, 11]. For wildlife, HWC can contribute to increased mortality, habitat fragmentation, and the disruption of ecological processes, ultimately threatening the long-term conservation of vulnerable species [13, 31]. To address this complex issue, the exploration and implementation of effective mitigation strategies are crucial. Mitigation strategies are interventions designed to prevent, reduce, or manage the negative impacts of HWC, aiming to find a balance between the needs of human communities and the conservation of wildlife [10, 22, 28].

In Cameroon, various mitigation strategies have been proposed and implemented, ranging from physical barriers and deterrents to community-based approaches and policy interventions [23, 27]. However, the effectiveness and sustainability of these strategies remain understudied, and a comprehensive understanding of the factors influencing their success or failure is still lacking [2, 4]. This research study aims to explore the mitigation strategies employed in Cameroon to address HWC, analyze their effectiveness, and identify the key factors that contribute to their success or failure. By gaining a deeper understanding of the complex dynamics of HWC and the efficacy of mitigation approaches, this study seeks to provide valuable insights that can inform policy decisions, guide the development of more effective conservation strategies, and ultimately contribute to the sustainable coexistence of humans and wildlife in Cameroon.

HWC is a global issue that has been extensively studied in various contexts, including Cameroon. A significant body of research has examined the drivers, impacts, and mitigation strategies employed to address HWC in Cameroon and other parts of Africa. The primary drivers of HWC in Cameroon are well-documented in the literature. Several studies have identified the expansion of human settlements, agricultural activities, and infrastructure development as key factors contributing to the encroachment of human activities into wildlife habitats [2, 24, 27]. This has led to increased competition for resources and the disruption of traditional wildlife migration routes, ultimately resulting in more frequent interactions and conflicts between humans and wildlife. In addition, the presence of high-value crops and livestock in close proximity to wildlife habitats has been shown to increase the risk of crop raiding and livestock depredation, exacerbating HWC [23, 27].

Cultural and socioeconomic factors, such as traditional land-use practices and the dependence of local communities on natural resources, have also been identified as contributing to the complex dynamics of HWC in Cameroon [4, 11].

Community-based approaches, on the other hand, have focused on promoting coexistence and collaborative management of natural resources. These strategies include the implementation of community-based wildlife management programs, the development of alternative livelihoods, and the integration of local knowledge and participation in conservation efforts [4, 22, 23]. In addition, policy and institutional interventions, such as the establishment of protected areas, the development of compensation or insurance schemes, and the strengthening of wildlife management regulations, have also been explored as potential mitigation strategies [8, 18, 28]. However, the effectiveness and sustainability of these mitigation strategies in Cameroon have been mixed, and a comprehensive understanding of the factors influencing their success or failure remains limited [2, 4]. Further research is needed to evaluate the long-term impacts of these strategies and to identify the most promising approaches for resolving HWC in the Cameroonian context.

2. Materials and Methods

2.1. Description of the Study Area

Bakossi national park is located in the Southwest Region of Cameroon, situated between latitudes 4°54'N and 5°12'N, and longitudes 9°36'E and 9°48'E [15]. The park covers an area of approximately 29,320 hectares and surrounded by 36 communities which are further divided into four management clusters (Figure 1). The climate in the national park is tropical, with a high annual rainfall. The area experiences a rainy season from March to October and a dry season from November to February [1]. The average annual rainfall ranges from 2,000 to 3,500 mm, and the mean annual temperature is around 22°C [1]. The vegetation in the park is primarily composed of montane and submontane forest, with a diverse range of plant species. According to a study by [20], the park is home to over 1,000 species of plants, including several endemic and threatened species. The dominant tree species include *Oubanguia alata*, *Carapa procera*, and *Albizia gummifera* [20]. More so, the park is known for its rich wildlife diversity. It provides habitat for a variety of mammals, including the endangered Cross River gorilla (*Gorilla gorilla diehli*), the vulnerable drill (*Mandrillus leucophaeus*), chimpanzee (*Pan troglodytes*), giant goliath frog (*Conraua goliath*), pangolin (*Phataginus tricuspis*) and the vulnerable forest elephant (*Loxodonta cyclotis*). The park also supports a diverse avifauna, with over 300 species of birds recorded, including several endemic and threatened species [14]. The mount Kupe bush shrike (*Chlorophoneus kupeensis*) is an important bird species in the

Bakossi National Park. Furthermore, the park's drainage system consists of a network of rivers and streams, including the mungo river, which flows through the park [15]. These water

bodies play a crucial role in supporting the park's ecosystems and provide important resources for the local communities.

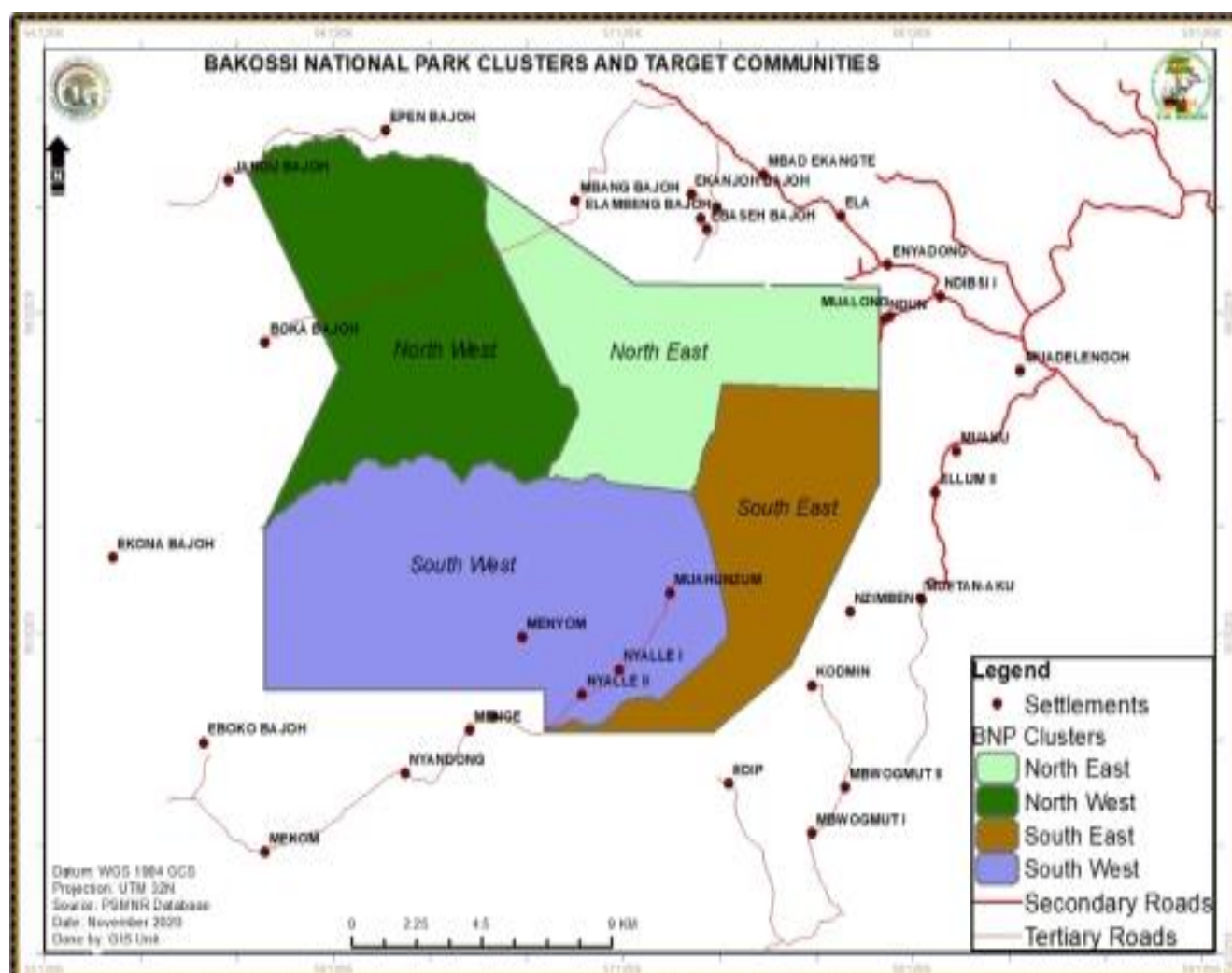


Figure 1. Map of Bakossi National Park showing target communities and clusters.

2.2. Method of Research Data Collection

Prior to research questionnaire administration program, the research team obtained the necessary clearance permission from protected area authorities. Confidentiality and anonymity was maintained, and respondents were made aware of the purpose and use of the data collected [5, 30]. The questionnaire was designed to collect both quantitative and qualitative data relevant to the research objective. Questionnaire were pilot-tested to ensure clarity and appropriateness of the questions [5]. Questionnaires administered through face-to-face interviews, focus group discussions, or self-administration, depending on the literacy levels and accessibility of the respondents [19, 30].

2.3. Data Analysis

Quantitative data from the questionnaires was analyzed using descriptive statistics and inferential techniques, such as correlation (r) analysis and chi-square (X^2) tests. Qualitative data was also analyzed using inferential statistical models [19, 30].

3. Results and Discussions

Human-wildlife conflict (HWC) mitigation strategies revealed a significant association on the knowledge of conflict mitigation $r=0.267$ $P=0.005$ (Figure 2), local community involvement in the mitigation program $X^2=3.463$ $df=3$ $P<0.05$

(Figure 3), and the role played by local community in mitigating the conflict $X^2=3.323$ $df=6$ $P<0.05$ (Figure 4) respectively. Human-wildlife conflict (HWC) is a significant global issue, with local communities often bearing the brunt of interactions between humans and wildlife [24]. The mitigation of these conflicts requires an understanding of the knowledge and perspectives of the affected communities [3]. Research has shown that local communities often possess extensive knowledge of wildlife behavior and effective strategies for mitigating conflicts [16]. Pastoralist communities in Kenya developed techniques such as using fire, noise, and physical barriers to deter wildlife from encroaching on their land and livestock [21]. Thus, effective mitigation of HWC requires the active involvement and participation of local communities [3]. Research has shown that community-based approaches can

lead to more sustainable and successful outcomes compared to top-down, centralized management strategies [24]. One key aspect of community involvement is the incorporation of traditional ecological knowledge (TEK) into conflict mitigation strategies. TEK refers to the cumulative knowledge, practices, and beliefs that indigenous and local communities have developed through generations of living in a particular environment [16]. Studies have found that TEK can provide valuable insights into wildlife behavior, habitat use, and effective deterrence methods [12]. A project in Nepal involved local communities in the development of early warning systems and rapid response teams to mitigate HWCs [25]. Thus, local communities can play a crucial role in mitigating HWC through their knowledge, practices, and collaborative efforts with conservation authorities [3, 24].

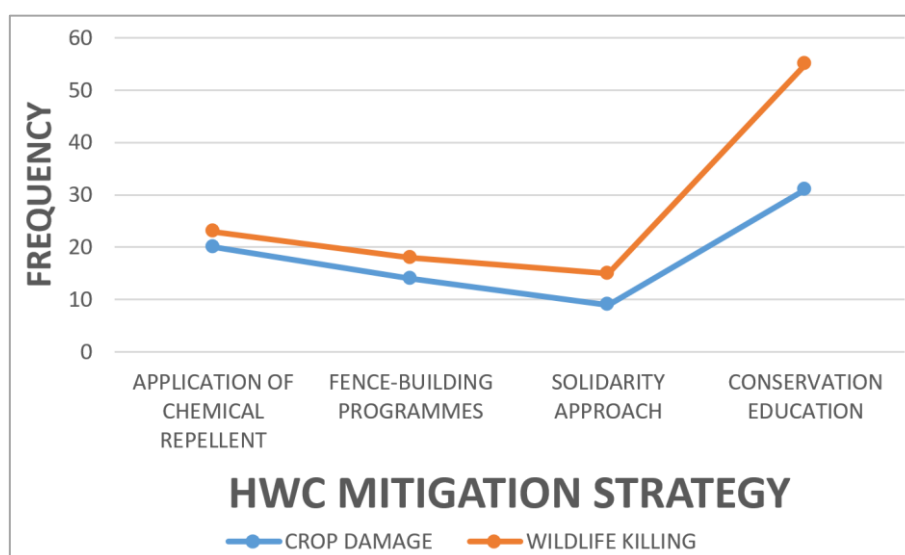


Figure 2. Mitigation strategy and knowledge on human-wildlife conflict mitigation.

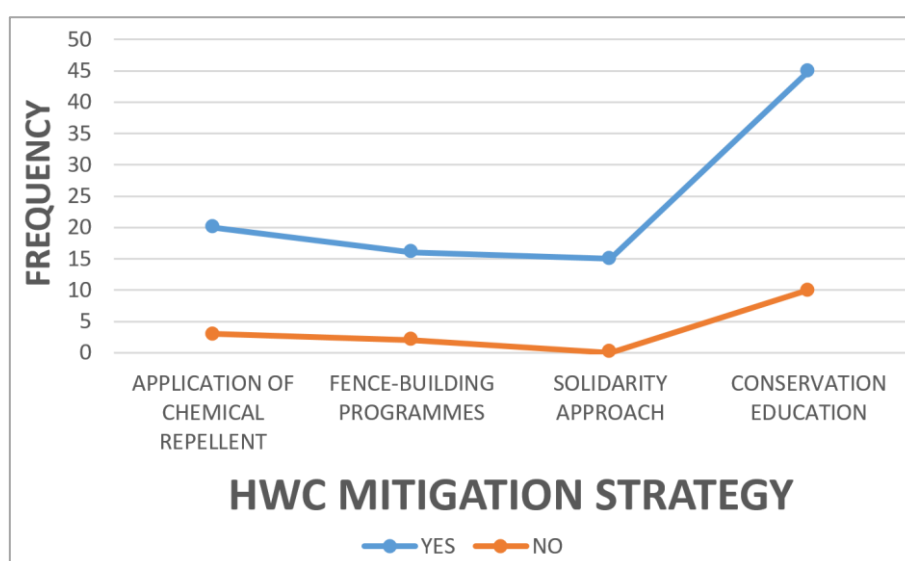


Figure 3. Mitigation strategy and community involvement in human-wildlife conflict mitigation

Farmers in India relied on traditional methods like chasing, fencing, and using scarecrows to protect their crops from wildlife damage [12]. However, this traditional knowledge is often overlooked or undervalued by conservation authorities and policymakers [9]. Integrating local community knowledge into the design and implementation of mitigation strategies can lead to more effective and sustainable conflict mitigation [3]. Several studies have highlighted the importance of collaborative approaches that combine scientific and local knowledge. A project in Nepal involved local communities in the development of early warning systems and rapid response teams to mitigate HWC [25]. The project demonstrated the value of incorporating local expertise and leveraging community-based monitoring and response mechanisms. Incorporating this knowledge into conservation and management efforts can lead to more effective and sustainable solutions [9]. Continued research and collaborative approaches are needed to further understand and leverage local community knowledge in addressing this pressing global challenge.

The project demonstrated the value of incorporating local expertise and leveraging community-based monitoring and response mechanisms. Integrating these traditional methods into

conservation and management strategies can lead to more effective and sustainable conflict mitigation. Community involvement also includes active participation in decision-making processes, resource management, and the implementation of mitigation measures. When local communities are empowered to participate in these processes, they are more likely to have a sense of ownership and investment in the success of the interventions [9]. Furthermore, community-based approaches can foster social cohesion and collective action, which are crucial for addressing the complex and multifaceted nature of HWCs [3]. By working collaboratively with local communities, conservation practitioners and policymakers can develop more tailored and context-specific solutions that address the unique needs and challenges of each community. The study highlights the importance of community involvement in the development and implementation of mitigation strategies to minimize HWC. Integrating traditional ecological knowledge, empowering local communities in decision-making, and fostering collective action can lead to more effective and sustainable conflict mitigation.

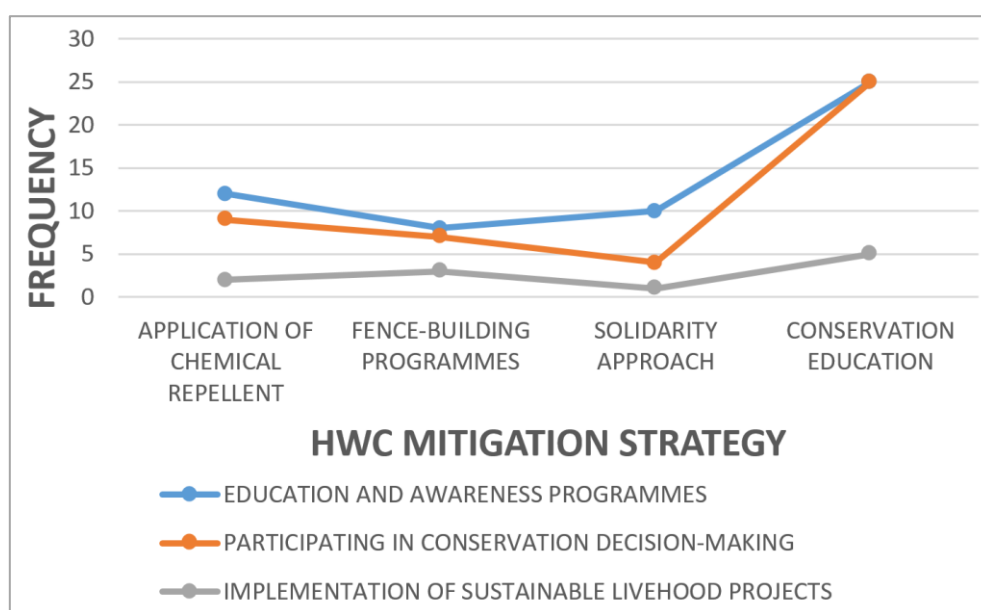


Figure 4. Mitigation strategy and community role in human-wildlife conflict management.

Studies have shown that traditional ecological knowledge (TEK) can provide valuable insights into wildlife behavior, habitat use, and effective deterrence methods [12]. Community-based approaches have demonstrated the value of incorporating local expertise and leveraging community-based monitoring and response mechanisms. Local communities can also play a critical role in the implementation and maintenance of mitigation measures. When local communities are empow-

ered to participate in decision-making processes and the implementation of interventions, they are more likely to have a sense of ownership and investment in the success of the measures [9]. This can lead to more sustainable and effective conflict mitigation strategies. This study highlights the vital role that local communities play in mitigating HWC through the application of traditional ecological knowledge, active participation in decision-making and implementation, and fostering social cohesion and collective action.

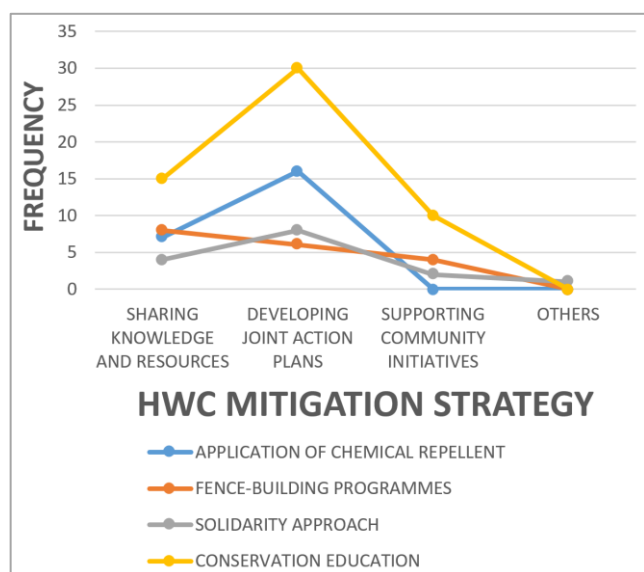


Figure 5. Mitigation strategy and essence of stakeholders in human-wildlife conflict management.

The study has shown that mitigation strategy of the local community significantly associated with the essence of stakeholders in human-wildlife conflict resolution, $X^2 = 14.889$ $df=9$ $P<0.05$ (Figure 5). Effective mitigation of human-wildlife conflicts requires the active engagement and collaboration of multiple stakeholders, including local communities, conservation authorities, policymakers, and researchers [3, 24]. Local communities are particularly crucial stakeholders in this

process, as they are directly affected by and have first-hand experience with HWCs [9]. Local communities possess valuable traditional ecological knowledge (TEK) about wildlife behavior, habitat use, and effective deterrence methods, which can provide valuable insights for developing context-specific mitigation strategies [12, 16]. By working collaboratively with local communities, conservation practitioners and policymakers can develop more holistic and inclusive solutions that address the social, economic, and ecological dimensions of the conflict [21]. In addition to local communities, other key stakeholders in mitigating HWCs include conservation authorities, policymakers, and researchers. Conservation authorities play a critical role in implementing and enforcing mitigation measures, as well as coordinating with local communities [25]. Policymakers are responsible for developing and implementing policies and regulations that address the underlying drivers of HWCs, such as habitat loss and fragmentation [24]. Researchers can contribute by providing scientific data and evidence-based recommendations to inform the development and evaluation of conflict resolution strategies [12]. The study highlights the essence of engaging multiple stakeholders, particularly local communities, in resolving human-wildlife conflicts. By leveraging local knowledge, fostering collaborative decision-making, and addressing the complex social-ecological dimensions of the conflicts, stakeholders can develop more effective and sustainable conflict mitigation strategies.

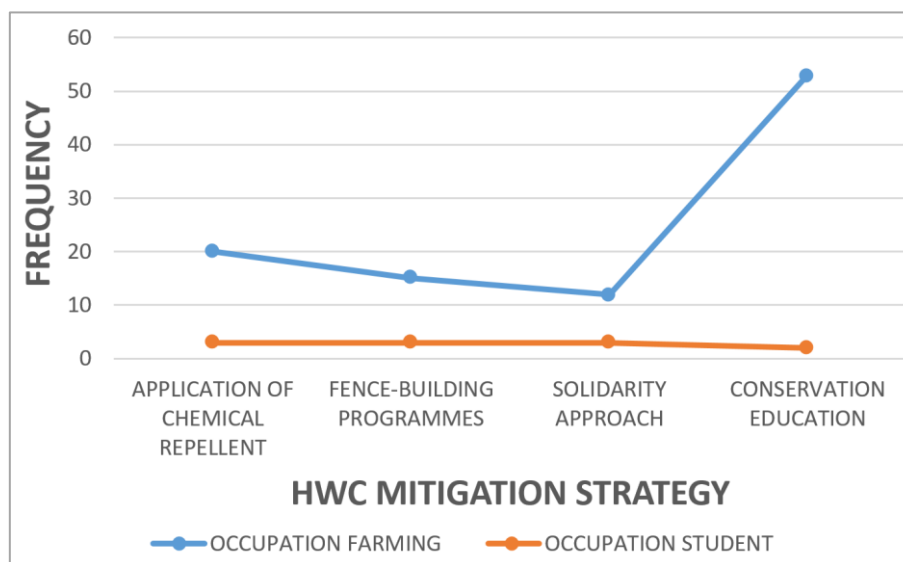


Figure 6. Mitigation strategy and occupation of local community.

Furthermore, HWC mitigation strategy associated significantly with the occupation of local community inhabitants in the conflict mitigation $X^2=5.309$ $df=3$ $P<0.05$ (Figure 6). Studies have shown that the occupations and livelihoods of

local communities can significantly influence their attitudes and responses to HWCs. Communities that are heavily dependent on agriculture or livestock tend to have more negative

perceptions of wildlife and are more likely to engage in retaliatory actions against problem animals [7, 17]. In communities with subsistence-based economies, where people rely directly on natural resources for their livelihoods, there is often a greater tolerance for wildlife due to the perceived benefits they provide, even if they also pose threats. In contrast, communities with more cash-based economies may be less tolerant of wildlife that threaten their commercial activities [3, 26].

When local communities are actively involved in conservation efforts and benefit from ecotourism or other wildlife-based enterprises, they are more likely to support and participate in HWC mitigation strategies [24, 29]. Providing training, resources, and alternative livelihood options to local communities can help reduce their dependence on activities that bring them into conflict with wildlife, thereby improving their willingness to engage in conflict mitigation strategies [7, 18].

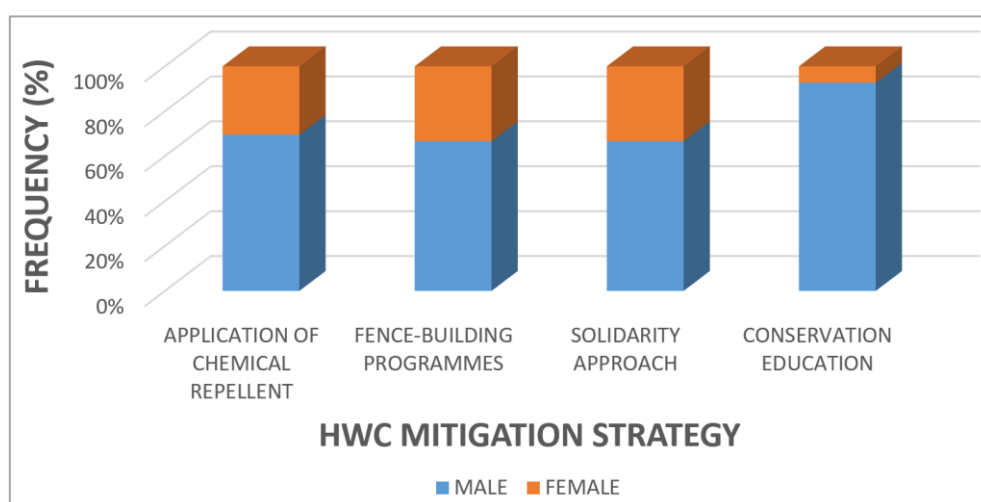


Figure 7. Mitigation strategy and the role of gender in conflict resolution.

Additionally, conflict mitigation strategy significantly related with the role played by gender in the resolution program $X^2=10.871$ $df=3$ $P=0.012$ (Figure 7). Gender plays a significant role in shaping the experiences, perspectives, and roles of individuals within local communities when it comes to mitigating HWCs [6, 21]. Studies have shown that women often bear a disproportionate burden of the impacts of HWCs, as they are more likely to be responsible for tasks such as collecting firewood, fetching water, and tending to livestock, which often bring them into close proximity with wildlife [6, 24]. As a result, women may have a deeper understanding of the daily challenges and risks associated with these conflicts [3]. At the same time, women's traditional ecological knowledge and coping strategies can be invaluable in developing effective mitigation measures. A study in Nepal found that women were often the primary managers of crop-raiding deterrents, such as using fire, noise, and physical barriers to protect their crops and livestock [25]. Similarly, research in Kenya has highlighted the role of women in monitoring wildlife movements and implementing early warning systems within their communities [21]. Moreover, the involvement of women in decision-making processes and the implementation of conflict resolution strategies can lead to more inclusive and sustainable outcomes [9]. When women are empowered to participate in these processes, they can bring unique perspectives and insights that may be overlooked in male-dominated

decision-making structures [16]. However, gender-based inequalities and social norms can often hinder women's participation and influence in the context of human-wildlife conflict mitigation [12]. Overcoming these barriers requires addressing underlying power dynamics and social inequities within local communities, as well as actively promoting women's leadership and decision-making roles [6]. The study highlights the significant influence of gender on the experiences, knowledge, and roles of individuals within local communities when it comes to mitigating HWCs. Recognizing and leveraging the unique perspectives and contributions of women, while addressing gender-based barriers, can lead to more inclusive, effective, and sustainable conflict resolution strategies.

The implementation of community-based wildlife management programs, such as the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) in Zimbabwe [11] contributed greatly to mitigate HWC. These programs aim to involve local communities in the decision-making and management of wildlife resources, thereby fostering a sense of ownership and responsibility [18]. Another strategy is the use of deterrents and barrier methods to prevent wildlife from accessing croplands and settlements. Examples include the installation of electric fences, the use of beehive fences, and the deployment of early warning systems [13]. These physical barriers have been shown to effectively reduce instances of crop-raiding and livestock depredation, while also

promoting coexistence between humans and wildlife [4].

The impacts of HWC in Cameroon are multifaceted, affecting both human communities and wildlife populations. On the human side, studies have documented the significant economic losses experienced by farmers and livestock owners due to crop damage and livestock depredation, as well as the risk of injury and loss of human life from encounters with wildlife [2, 3]. These impacts can have severe consequences for the livelihoods and food security of local communities. For wildlife, HWC can lead to increased mortality, habitat fragmentation, and the disruption of ecological processes, ultimately threatening the long-term conservation of vulnerable species [13, 31]. In Cameroon, the impacts of HWC have been particularly acute for species such as elephants, primates, and large carnivores, which are often the targets of retaliatory actions by local communities [23, 27]. Researchers have explored a range of mitigation strategies to address HWC in Cameroon, including both physical and community-based approaches. Physical barriers and deterrents, such as electric fences, beehive fences, and chili pepper-based repellents, have been implemented with varying degrees of success [2, 13, 27]. These strategies aim to physically separate humans and wildlife or deter wildlife from entering agricultural areas or human settlements.

Many local communities in Cameroon rely heavily on agriculture, livestock, and other natural resource-based livelihoods, making them highly vulnerable to the impacts of HWC [4, 11]. The limited availability of alternative economic opportunities can make it difficult for communities to adopt mitigation strategies that require them to forgo traditional practices or land-use patterns [2, 23]. Some traditional beliefs and practices, such as the cultural significance of certain wildlife species, can pose barriers to the acceptance and implementation of mitigation strategies [22, 27, 28]. Inadequate enforcement of wildlife management regulations and the lack of effective mechanisms for implementing mitigation strategies can undermine their effectiveness [8, 18]. Fragmented institutional frameworks and the absence of effective coordination between various stakeholders, such as government agencies, conservation organizations, and local communities, can hinder the successful implementation of mitigation strategies [4, 28]. The limited availability of financial and human resources can constrain the implementation and maintenance of mitigation strategies, particularly in resource-poor regions [13, 31].

The dynamic and interconnected nature of ecosystems, coupled with the varying habitat preferences and behavior of different wildlife species, can make it challenging to develop and implement effective mitigation strategies that account for these complexities [24, 27]. The lack of access to advanced technologies, such as effective wildlife deterrents or early warning systems, as well as the limited infrastructure in remote rural areas, can hamper the implementation and maintenance of mitigation strategies [2, 13]. The failure to meaningfully involve local communities in the design, implementation, and monitoring of mitigation strategies can lead to a lack of

buy-in and ownership, ultimately undermining the long-term sustainability of these efforts [4, 22]. The development of mitigation strategies without a thorough understanding of the local context and community priorities can result in strategies that do not adequately address the specific needs and challenges faced by the affected communities [18, 23]. Addressing these multifaceted challenges will require a comprehensive and coordinated approach that combines policy, institutional, technological, and community-based interventions. Fostering collaborative partnerships, building local capacity, and integrating traditional ecological knowledge into the design and implementation of mitigation strategies are crucial steps towards developing more effective and sustainable solutions to HWC in Cameroon.

In addition to physical barriers, researchers have also explored the potential of compensation and incentive-based schemes to mitigate human-wildlife conflict. These approaches aim to provide financial or in-kind reimbursement to affected communities, as well as to incentivize the protection of wildlife through revenue-sharing programs [22, 31]. Complementary to these strategies, educational and awareness-raising initiatives have also played a crucial role in addressing human-wildlife conflict [7]. By increasing the understanding and appreciation of the ecological and economic importance of wildlife among local communities, these programs can foster a more positive attitude towards conservation and promote coexistence [28]. Furthermore, the exploration of mitigation strategies in the Bakossi national park has involved a multifaceted approach, combining community-based management, physical barriers, compensation schemes, and educational initiatives [24]. The success of these strategies has been variable, and ongoing research is necessary to refine and adapt them to the specific socio-ecological context of the region [2]. Continued collaboration between researchers, conservation practitioners, and local communities will be essential in finding sustainable solutions to the human-wildlife conflict in the Bakossi National Park.

4. Conclusion

Human-wildlife conflict is a significant challenge in Cameroon, particularly in areas adjacent to protected natural areas and national parks. These conflicts often arise due to competition for limited resources, such as land, water, and food, between humans and wildlife. This study has explored various mitigation strategies to address the conflict. One common approach is the implementation of community-based wildlife management initiatives, which aim to involve local communities in the decision-making and implementation of conservation efforts. Additionally, the study has highlighted the potential for alternative livelihood strategies, such as ecotourism and sustainable agriculture, to reduce the reliance of local communities on activities that bring them into conflict with wildlife. By providing communities with alternative sources

of income and food security, these approaches can help alleviate the underlying drivers of human-wildlife conflict. Furthermore, this study has emphasized on the importance of incorporating traditional ecological knowledge and coping strategies into conflict resolution efforts. The study on human-wildlife conflict mitigation in Bakossi national park emphasizes the need for holistic, community-based approaches that address the social, economic, and ecological factors contributing to these conflicts. Addressing human-wildlife conflicts requires accounting for the social, economic, and ecological factors at play. Successful mitigation strategies involve collaborations between government, conservation organizations, and local communities. However, the research also highlights the importance of tailoring conflict resolution approaches to the specific contexts and needs of national park communities. By leveraging community participation, innovative mitigation techniques, and interdisciplinary collaboration, practitioners and policymakers can work towards more sustainable and equitable resolutions to the pressing issue of human-wildlife conflicts in Cameroon. Finally, by leveraging local knowledge, incorporating community participation, and implementing a diverse range of mitigation strategies, this study has demonstrated the potential to achieve more sustainable and equitable resolutions to human-wildlife conflicts in Cameroon.

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Author Contributions

Ettagbor Hans Erukwa: Conceptualization, Methodology, Project administration

Kome Elvis Ngame: Data curation, Resources, Software, Validation, Writing – review & editing

Melle Ekane Maurice: Formal Analysis, Supervision, Visualization, Writing – original draft

Conflicts of Interest

The authors declare that there is no conflict of interest.

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