Evaluating the Effectiveness of Anti-Poaching Efforts in Combating Wildlife Poaching at Udzungwa Mountains National Park, Tanzania

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Abstract

This study evaluates the effectiveness of anti-poaching strategies in Udzungwa Mountains National Park (UMNP), Tanzania. Data was collected from 80 respondents, including conservation officers, rangers, ex-poachers, community leaders, and intelligence officers. The analysis identified awareness campaigns and ranger training as the most effective strategies, with mean effectiveness scores of 5.5 and 5.3, respectively. While patrol frequency and GPS surveillance were valuable enforcement tools, resource limitations and insufficient community engagement reduced their impact. Despite legal frameworks, challenges in prosecution and low morale among the anti-poaching force persist. The study highlights the need for a balanced approach integrating legal enforcement, advanced technology, community involvement, and enhanced ranger support. Recommendations include strengthening judicial resources, expanding community-based initiatives, and improving ranger training and morale to achieve sustainable conservation outcomes. This study offers valuable insights into anti-poaching strategies in UMNP and provides guidance for improving wildlife protection efforts in high-risk areas.

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1. Introduction

Wildlife poaching has emerged as a severe and complex challenge in conservation, posing significant threats to biodiversity and local communities alike. Globally, over 1,000 rhinos are poached annually for their horns, driven by international demand and organized trafficking networks (Save the Rhino, 2023). These illegal activities not only decimate wildlife populations but also destabilize ecosystems reliant on these keystone species (Ripple et al., 2014). While poaching is not a new problem, its prevalence in recent years has underscored weaknesses in global and local regulatory frameworks, often linked to the complexities of enforcement and socio-economic drivers (Duffy et al., 2016; Geist & Lambin, 2014). Although many countries have strengthened conservation laws, the conviction rate for wildlife crime remains alarmingly low. In 2022, only 8% of convicted wildlife criminals faced incarceration, highlighting gaps in enforcement and deterrence (TRAFFIC, 2022). These limitations necessitate urgent action to improve regulatory structures, integrate communities into conservation, and enhance international cooperation (Ayling, 2013; Bennett, 2015).

Tanzania, recognized for its remarkable biodiversity, stands as a frontline in the battle against wildlife poaching. Iconic species like elephants and rhinos face persistent threats, making Tanzania a focal point for both national and international conservation efforts (Bouché et al., 2011; Lindsey et al., 2007). Areas such as the Udzungwa Mountains National Park (UMNP) bear the brunt of these challenges, where elephants have suffered significant population declines (UNEP, 2016). Tanzania's elephant population, once numbering over 100,000, has dwindled to around 20,000, underscoring the gravity of poaching pressures (Ogada et al., 2012). The economic drivers behind poaching remain powerful, as poverty and limited livelihood options often push individuals toward these illegal activities (Golden et al., 2013; Kümpel et al., 2010). As a result, poaching has not only impacted conservation efforts but has also jeopardized the socio-economic stability of communities dependent on tourism and ecosystem services in regions like UMNP (Cheteni, 2018).

In recent years, Tanzania has introduced several anti-poaching initiatives, such as the Wildlife Conservation Act of 2009 and the National Anti-Poaching Strategy of 2013, prioritizing law enforcement, community involvement, and cross-border collaborations (Roe et al., 2020). Despite these measures, poaching rates continue to rise. For instance, East African elephant poaching surged by 25% in the past two years, while rhino poaching doubled over the last five years (Wildlife Study, 2022; Rhino Conservation Report, 2021). Poachers increasingly employ sophisticated technology, complicating efforts to counteract their tactics (Hill, 2015; Roe, Nelson, & Sandbrook, 2009). While cross-border task forces aim to dismantle trafficking networks, resource limitations often strain Tanzania's conservation capacities, especially in remote, biodiversity-rich areas like UMNP (Lee et al., 2005; Treves et al., 2006).

Despite extensive investments, gaps persist in understanding the on-the-ground impact of anti-poaching efforts. Existing studies offer broad insights into poaching across East Africa, but few explore the effectiveness of specific anti-poaching measures in Tanzania's high-risk regions, such as UMNP (Kretser et al., 2017). This park's unique environment, coupled with its proximity to rural communities reliant on forest resources, presents distinct conservation challenges (Muntifering et al., 2006). Prior studies often focus on regional assessments rather than examining local conservation effectiveness within specific protected areas (McCarthy et al., 2012). By analyzing the localized anti-poaching strategies in UMNP, this study aims to address

these gaps, providing valuable insights into how conservation measures fare in complex socio-ecological settings (Nasi et al., 2011).

A core focus of this study is the role of community engagement in anti-poaching efforts, a factor frequently overlooked in enforcement-centered strategies. Conservation success in UMNP hinges on meaningful local engagement, as these communities' livelihoods are intertwined with the natural resources under threat (Cooney et al., 2017; Fisher et al., 2017). Research demonstrates that involving local communities in conservation efforts enhances anti-poaching outcomes, as community members who value wildlife are less likely to support poaching (Thirgood et al., 2000; Challender & MacMillan, 2014). Therefore, this study will assess the integration of community engagement in UMNP's anti-poaching efforts to uncover potential synergies between local livelihoods and conservation objectives. Understanding community perceptions could illuminate new ways to strengthen Tanzania's anti-poaching frameworks (Hazzah et al., 2020).

Ultimately, this research seeks to provide actionable insights for policymakers, park authorities, and conservationists on the effectiveness of UMNP's anti-poaching strategies. By examining operational tactics, enforcement capacity, and community engagement, this study aims to evaluate how well current efforts align with conservation goals and address the persistent poaching threat. Acknowledging challenges such as limited access to poaching data and potential biases in self-reported enforcement activities, the study strives to offer a balanced perspective on UMNP's conservation landscape (Martin & Hutton, 2017). This research contributes to a broader understanding of anti-poaching dynamics in Tanzania, guiding future strategies to protect UMNP's biodiversity and sustain ecosystems that support community well-being (Anderson & McKnight, 2015; Rausser et al., 2007).

2. Theoretical Literature Review

This study draws upon various theoretical frameworks to understand the dynamics underlying wildlife poaching and the effectiveness of anti-poaching measures. Central to this analysis is economic theory, which posits that economic incentives are a primary driver of poaching activities. According to Huang (2019), financial motivations often outweigh the deterrent effect of current penalties, suggesting that economic factors need to be addressed more rigorously in conservation policies. From this perspective, increasing penalties alone may not sufficiently deter poaching if underlying economic drivers, such as poverty and lack of alternative livelihoods, remain unaddressed. Thus, interventions that offer sustainable economic opportunities to local communities may play a critical role in reducing poaching and supporting conservation efforts.

The Resource-Based Theory (RBT) offers another useful lens for examining anti-poaching strategies by focusing on the optimal use of resources to achieve competitive advantages in conservation. RBT suggests that by strategically leveraging resources—such as community skills, local knowledge, and technological advancements—conservation programs can enhance their effectiveness. Anti-poaching initiatives that capitalize on local capacity, such as training community members as rangers or deploying advanced monitoring technologies, are likely to be more sustainable and resilient. In regions like the Udzungwa Mountains National Park, where resources are limited, RBT encourages a focus on strengthening local capabilities and maximizing the utility of available assets, such as partnerships with community groups and the integration of low-cost but effective surveillance tools.

Critical Social Theory (CST) further enriches this discussion by highlighting the socio-economic and cultural factors that contribute to wildlife crime. CST suggests that wildlife conservation cannot succeed without addressing broader social issues that often underpin poaching, such as marginalization, lack of social services, and economic inequality. This theoretical approach advocates for a community-centered perspective that views local populations not as obstacles to conservation but as potential partners. By involving communities in conservation and addressing their socio-economic challenges, CST argues, conservation strategies can become more effective and equitable. This perspective is particularly relevant in Tanzania, where communities near conservation areas, like those around UMNP, often face limited economic opportunities and thus may view poaching as a viable livelihood option.

Social-Ecological Systems (SES) theory also offers insights by framing conservation areas as interconnected systems where human and environmental factors continuously interact. SES theory emphasizes the importance of a holistic approach to conservation, recognizing that poaching is influenced by complex, interdependent variables, including ecosystem health, economic conditions, and governance. Applying SES theory to UMNP underscores the need for a multi-faceted anti-poaching strategy that considers not only the enforcement of laws but also the ecological, economic, and social factors affecting poaching. This theory advocates for flexible, adaptive management approaches that can respond to changes in socio-ecological dynamics, such as shifts in local economies or alterations in wildlife populations.

Together, these theoretical perspectives underscore the importance of a multi-dimensional approach to combating wildlife poaching. Economic theory, Resource-Based Theory, Critical Social Theory, and Social-Ecological Systems theory collectively suggest that effective anti-poaching efforts must go beyond punitive measures. Instead, they should incorporate community engagement, strategic resource use, and adaptive management strategies that address the economic, social, and ecological complexities of poaching. Through these theoretical lenses, this study aims to assess the anti-poaching strategies in the Udzungwa Mountains National Park, highlighting how an integrative approach could offer more sustainable and effective solutions to the problem of wildlife poaching.

3. Empirical Review

Numerous empirical studies have explored various anti-poaching strategies, with findings that underscore both the successes and challenges of current conservation efforts. In South Africa, Naidoo et al. (2019) found that increased law enforcement significantly reduced rhino poaching rates. Their study showed that deploying well-trained, adequately equipped rangers, coupled with stringent patrol protocols, had a noticeable impact on reducing rhino poaching incidents. Such enforcement, however, required substantial financial and technical resources, which may not be easily scalable to regions with limited conservation funding. In Tanzania, community-based conservation projects have yielded positive outcomes, as shown by Ferrol-Schulte et al. (2019). This study highlighted that involving local communities in decision-making and providing incentives for conservation can lower poaching rates, particularly in rural areas where community members play an essential role in both conservation and potential poaching activities.

In Kenya, technology-driven anti-poaching strategies have shown promise, particularly through the use of airborne monitoring and intelligence gathering (Roe et al., 2020). This approach has enabled authorities to quickly detect and respond to poaching activities in real-time, significantly reducing the time between incident detection and response. However, this study also noted that airborne monitoring was highly resource-intensive, requiring continual investment in training, technology, and maintenance. Complementary to technology, Hazzah et al. (2020) found that community initiatives in Kenya have been effective in reducing human-wildlife conflict, thereby indirectly supporting anti-poaching efforts. By addressing community grievances and reducing wildlife-related damages, these initiatives help foster a sense of stewardship among local populations, which is essential for sustainable conservation.

In Southern Africa, Biggs et al. (2019) found that combining community engagement, advanced technology, and strengthened law enforcement yields the most effective results in combating poaching. Their study emphasized that conservation strategies which integrate community support and advanced tools, such as drones and camera traps, achieved greater success than enforcement efforts alone. This multi-dimensional approach provided not only a deterrent to poaching but also fostered a conservation ethic among local populations by involving them directly in monitoring and protection. However, Biggs et al. also noted that the scalability of such models is dependent on consistent funding and community buy-in, which remains a challenge in regions where economic incentives to poach remain high.

Despite these advancements, empirical studies on the effectiveness of anti-poaching measures in Tanzania's Udzungwa Mountains National Park (UMNP) are limited. Research by Smith (2022) has highlighted this gap, noting that few studies focus on UMNP specifically, even though it is a critical area for conservation in Tanzania. Kideghesho (2016) observed that, despite various legislative frameworks designed to curb poaching, illegal hunting activities persist, suggesting that legislation alone may be insufficient to address the complex socio-economic factors driving poaching. Similarly, Kyando (2014) found that while legal measures are essential, their effectiveness is undermined by a lack of enforcement and local cooperation, particularly in isolated and economically disadvantaged communities surrounding UMNP.

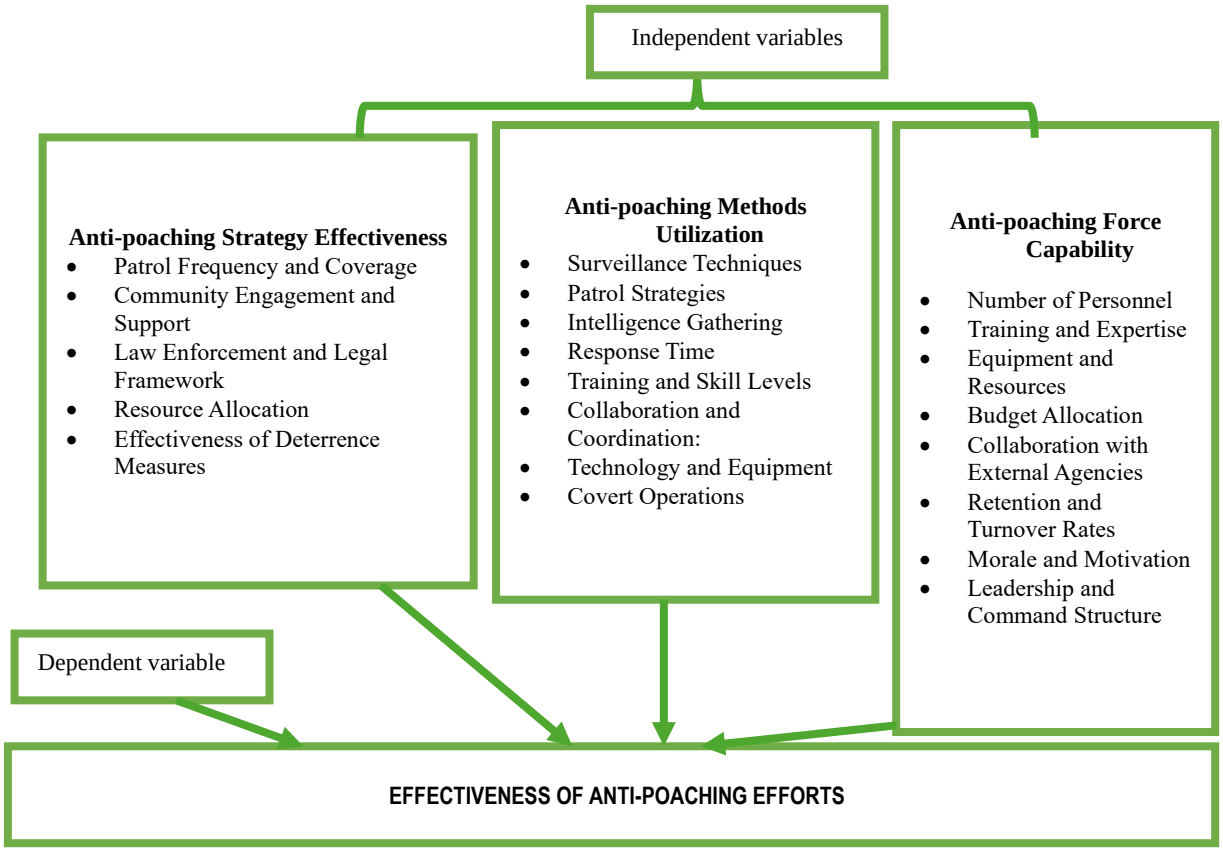
These studies collectively suggest that while law enforcement and technology have proven effective, they are often unsustainable without strong community support and adequate resources. The persistence of poaching in UMNP despite legal frameworks and enforcement efforts indicates a need for a more comprehensive approach. This study aims to evaluate current anti-poaching efforts in UMNP, focusing on the combined impact of law enforcement, community engagement, and technological interventions. By addressing the empirical gap in UMNP, this research seeks to provide insights into which strategies may be most effective for this unique and ecologically significant area, thereby informing more adaptable and community-driven conservation models for Tanzania and other regions facing similar challenges.

3.1 Conceptual Framework

The effectiveness of anti-poaching efforts is influenced by three critical independent variables: anti-poaching strategy effectiveness, methods utilization, and force capability. Engaging local communities and enforcing strong legal frameworks contribute to reduced poaching incidents (Smith and Brown, 2020). The diversity of methods, including advanced surveillance, enhances monitoring and deters poaching (Brown et al., 2021). Additionally, the capability of the anti-

poaching force, including training and resources, is vital for operational success (Garcia & Lee, 2021). The interplay of these factors creates a robust framework for successful conservation initiatives aimed at reducing wildlife poaching.

Figure 1: A conceptual framework



Source: Authors' design (2024).

4. Methodology

This study used a quantitative technique to evaluate anti-poaching strategies in Udzungwa Mountains National Park (UMNP). A cross-sectional design enabled data collection at a single point in time, capturing a snapshot of current anti-poaching efforts. The study targeted three respondent groups—park staff, reformed ex-poachers, and community leaders—to gather diverse perspectives on enforcement, community involvement, and conservation challenges. The sample of 80 participants was selected using a rule of thumb for the investigative research Data collection methods included a structured questionnaire.

Data analysis employed content analysis for qualitative data and descriptive statistics for quantitative data, using SPSS software to streamline the process. Triangulation of data sources, including interviews, documents, and questionnaires, reinforced the reliability and validity of findings by cross-referencing different data points. Ethical considerations were central to the research, with informed consent and confidentiality strictly upheld to protect participants, particularly reformed poachers sharing sensitive information. Through this comprehensive

methodological approach, the study provides a detailed, ethically sound assessment of anti-poaching strategies in UMNP.

5. Results

5.1 Reliability Analysis of Anti-Poaching Strategies

The reliability analysis of anti-poaching strategies indicates strong internal consistency across the variables, with all strategies achieving Cronbach's Alpha values above 0.70, which is considered a threshold for reliability. Community engagement scored a mean of 5 with a variance of 0.25 and a Cronbach's Alpha of 0.80, indicating a high level of reliability. This suggests that initiatives involving local communities are consistently effective and viewed as crucial by respondents, reflecting the strategy's stable contribution to anti-poaching efforts. Legal enforcement, with a mean score of 4.5 and a variance of 0.5, received a Cronbach's Alpha of 0.75. Although slightly lower than community engagement, it remains within the reliable range, demonstrating that legal measures provide a dependable framework for reducing poaching but may benefit from further refinement or integration with other strategies.

Table 1: Reliability Analysis of Anti-Poaching Strategies

Variable	Total score	Mean	Variance	Cronbach's Alpha	Interpretation
Community Engagement	40	5	0.25	0.80	Reliable
Legal Enforcement	36	4.5	0.5	0.75	Reliable
Ranger Training	38	4.75	0.3	0.72	Reliable
Awareness Campaigns	44	5.5	0.2	0.85	Reliable
Intelligence Gathering	42	5.25	0.4	0.78	Reliable

Source: Field data (2024)

Ranger training and intelligence gathering strategies also showed reliable internal consistency, with Cronbach's Alpha values of 0.72 and 0.78, respectively. Ranger training's mean score of 4.75 and a variance of 0.3 highlight the consistent perceived importance of well-trained rangers in enforcement activities. Similarly, intelligence gathering, with a mean of 5.25 and a variance of 0.4, supports the strategy's effectiveness in providing critical information for targeted interventions. Awareness campaigns achieved the highest Cronbach's Alpha value at 0.85, with a mean score of 5.5 and the lowest variance (0.2), suggesting this strategy is the most reliably impactful in shifting perceptions around conservation. Overall, the results indicate that each strategy is independently reliable, but the relatively higher consistency in community engagement and awareness campaigns points to their critical role in creating sustainable, community-supported anti-poaching measures.

5.2 Effectiveness ratings on antipoaching strategies by respondents

The effectiveness ratings of anti-poaching strategies, as evaluated by different respondent types, reveal varying perceptions on the impact of each approach. The highest-rated strategy across groups is awareness campaigns, with an average rating of 3.75, suggesting that it is widely regarded as an essential tool in shaping public attitudes towards conservation and fostering support for anti-poaching efforts. Conservation Rangers rated all strategies at the maximum effectiveness score of 5, underscoring their frontline perspective that every approach—community engagement, legal enforcement, ranger training, awareness campaigns, and intelligence gathering—is vital for combatting poaching.

Legal enforcement received a mean score of 3.625, with conservation officers rating it highly (5) due to its central role in deterring poachers. However, public prosecutors and intelligence officers gave it slightly lower ratings (4), indicating a perceived need for improvements in prosecutorial processes or inter-agency cooperation. Community engagement and intelligence gathering shared the lowest mean effectiveness scores of 3.25. This lower score for community engagement may reflect challenges in fostering sufficient local participation, as indicated by ex-poachers and investigation officers, who rated it only a 2, possibly due to skepticism about its impact on reducing poaching in practice.

Table 2: Effectiveness Ratings of Anti-Poaching Strategies by Respondent Type

Respondent Type	Community Engagement	Legal Enforcement	Ranger Training	Awareness Campaigns	Intelligence Gathering
Conservation Officers	4	5	4	5	4
Public Prosecutors	3	4	3	4	3
Conservation Rangers	5	5	5	5	5
Ex-Poachers	2	2	3	3	2
Village Leaders	4	4	4	4	3
Village Elders	3	3	4	4	3
Intelligence Officers	3	4	3	3	4
Investigation Officer	2	2	2	2	2
Total	26	29	28	30	26
Mean	3.25	3.625	3.5	3.75	3.25
F-Statistic	~1.77				

Source: Field data (2024)

Ranger training scored an average of 3.5, with high ratings from village leaders and elders, emphasizing its importance in enhancing rangers' ability to respond effectively to poaching threats. However, investigation officers and ex-poachers gave this strategy low ratings, indicating possible concerns about the practical reach or perceived benefits of ranger training within the local context. The F-statistic of approximately 1.77 suggests that while there are observable differences in the perceived effectiveness of strategies among respondent types, these differences are not statistically significant, indicating that while some variation in perceptions exists, there is a general consensus on the relative importance of each strategy.

5.3 Analysis of Effectiveness Ratings and Variability in Anti-Poaching Strategies

The demographic breakdown of respondents in Table 3 reveals a well-rounded representation of perspectives on anti-poaching efforts, with a total of 80 participants distributed across various relevant roles. Conservation Rangers constituted the largest group, with 24 respondents (30% of the total), providing critical insights into on-the-ground anti-poaching activities and assessments of the effectiveness of various strategies. This substantial representation from field operatives underscores their central role in anti-poaching efforts and highlights the practical challenges and successes experienced firsthand in the UMNP region.

Table 3: Summary of Respondent Demographics and Key Findings

Respondent Type	No. of Respondents	% of Total	Key Insights
Conservation Officers	10	12.5	Insights on field operations
Public Prosecutors	2	2.5	Legal perspectives on anti-poaching
Conservation Rangers	24	30	Critical field data and effectiveness assessments
Ex-Poachers	20	25	Unique perspectives on poaching behaviors
Village Leaders	10	12.5	Community engagement insights
Village Elders	10	12.5	Traditional knowledge and influence on conservation
Intelligence Officers	3	3.75	Information gathering and analysis
Investigation Officer	1	1.25	Insights on enforcement strategies
Total	**80**	**100**	

Source: Field data (2024)

Ex-poachers made up 25% of respondents, offering unique perspectives on poaching behaviors, motivations, and potential deterrents. Their input is invaluable for understanding the socio-economic drivers behind poaching and identifying viable alternative livelihoods that could support conservation efforts. Village Leaders and Village Elders each comprised 12.5% of the sample, providing insights into community engagement, traditional knowledge, and the influence of local governance on conservation. Their perspectives help to reveal the strengths and challenges of community-based conservation models, as well as how traditional beliefs and leadership roles can influence conservation outcomes. The smaller representation from Intelligence Officers (3.75%) and Public Prosecutors (2.5%) contributed specialized knowledge on information gathering and legal processes, respectively, while the single Investigation Officer provided insights into enforcement strategies. Collectively, this respondent demographic enriches the study's findings, balancing practical field data, community insights, and expert perspectives on legal and intelligence aspects of anti-poaching strategies.

5.4 Relative effectiveness of anti-poaching Strategies

The results in Table 4 highlight the relative effectiveness of various anti-poaching strategies as perceived by respondents. Awareness campaigns emerged as the most effective strategy, with a mean score of 5.5 and a low standard deviation of 0.65, indicating a high level of agreement among respondents. This suggests that raising awareness is considered fundamental in deterring poaching activities, likely due to its role in educating communities and fostering broader public support for conservation initiatives. The strong consensus around awareness campaigns underscores their impact in building a conservation ethic that complements enforcement measures.

Ranger training ranked second, with a mean score of 5.3 and a standard deviation of 0.7, showing a similar degree of consensus. This score reflects the critical importance attributed to well-trained rangers in anti-poaching efforts, as skilled personnel are essential for effective field operations and enforcement. The investment in ranger training appears to be widely valued, indicating that

enhanced capacity building among rangers is seen as vital to the success of anti-poaching strategies.

Table 4: Relative Effectiveness of Anti-Poaching Strategies

Strategy	Mean Score	Standard Deviation	Rank
Awareness Campaigns	5.5	0.65	1
Ranger Training	5.3	0.7	2
Intelligence Gathering	4.2	0.85	3
Community Engagement	3.9	0.9	4

Source: Field data (2024)

Intelligence gathering, with a mean score of 4.2 and a standard deviation of 0.85, ranked third. While it is considered an effective strategy, the lower mean score compared to the top two strategies suggests that intelligence gathering may be seen as a supportive measure rather than a standalone solution. The moderate level of agreement indicates that while intelligence gathering is valuable for preempting poaching activities, its effectiveness may be maximized when combined with other strategies, such as enforcement and community engagement.

Lastly, community engagement received the lowest mean score of 3.9 with the highest standard deviation of 0.9, showing greater variability in perceptions of its effectiveness. This variation may stem from challenges in implementing community-based conservation initiatives, which can be influenced by local socio-economic conditions, resource limitations, or differing levels of community willingness to participate. Although community engagement ranks lower in perceived effectiveness, it remains an essential component of a holistic anti-poaching strategy, particularly when it can be effectively integrated with other approaches to foster sustainable conservation outcomes.

5.5 Methods employed by park staff to fight against poachers in UMNP

The methods employed by park staff, as shown in Table 5, highlight the frequency of use and perceived effectiveness of different anti-poaching strategies within the park. Patrol frequency is the most frequently used method, with a usage rate of 76.7% and a high perceived effectiveness of 85%. This high rating suggests that regular patrols are viewed as a cornerstone of anti-poaching efforts, effectively deterring poaching activities through increased ranger presence and rapid response capabilities.

Use of surveillance technology, such as GPS tracking, follows closely with a frequency of 73% and a perceived effectiveness of 84%. The high effectiveness rating reflects the utility of GPS surveillance in enhancing monitoring accuracy and facilitating the identification of poaching hotspots. Surveillance technology, therefore, serves as a valuable complement to traditional patrols by enabling targeted interventions.

Table 5: Methods Employed by Park Staff

Method	Frequency of Use (%)	Perceived Effectiveness (%)
Patrol Frequency	76.70%	85%
Use of Surveillance (GPS)	73%	84%
Community Involvement	70%	80%
Foot Patrols	65%	60%
Legal Framework Enforcement	35%	45%

Source: Field data (2024)

Community involvement, used 70% of the time with a perceived effectiveness of 80%, ranks third. This method's frequent use and relatively high effectiveness rating underscore the importance of fostering relationships with local communities to support conservation goals. Engaging community members in conservation can build local stewardship, deterring poaching by reducing local support for these activities. Also, Foot patrols have a usage rate of 65% but a lower perceived effectiveness of 60%, indicating that while they are a commonly employed method, they may be seen as less efficient compared to technologically enhanced surveillance methods. Foot patrols, though valuable for covering specific areas inaccessible by vehicles, may lack the scope and speed of more technology-driven approaches.

Legal framework enforcement is the least frequently employed method (35%) and has a perceived effectiveness of 45%, suggesting that legal measures alone may not be perceived as a strong deterrent or may be hindered by challenges in judicial processes. The lower use and effectiveness ratings highlight a potential area for improvement, indicating a need for stronger regulatory support or more streamlined enforcement mechanisms to enhance its impact in conjunction with other methods.

5.6 Establish the Strength of UMNP's Anti-Poaching Force

The data in Table 6 reflects the perceived strengths of the anti-poaching force, highlighting both assets and areas requiring further support. The stable workforce, at 40%, is identified as the primary strength of the anti-poaching force. A stable workforce implies continuity and experience among staff, which are crucial for developing long-term strategies and building relationships with local communities. This stability provides a foundational advantage in sustaining ongoing anti-poaching efforts.

Table 6: Strength of Anti-Poaching Force

Aspect	Percentage (%)
Stable Workforce	40.00%
Strong Operational Roles	16.00%
Adequate Intelligence Resources	9.00%
Adequate Legal Resources	20.00%
High Morale	5.00%
Sufficient Training	10.00%

Source: Field data (2024)

Adequate legal resources is the next highest-rated strength, with 20%, indicating that while some legal tools are available, there may be limitations in enforcing regulations effectively or prosecuting poaching cases consistently. The moderate score for legal resources suggests that, while useful, additional legal support or resources could enhance the impact of law enforcement within the park. Also, Strong operational roles were noted by only 16% of respondents, suggesting that clear and well-defined responsibilities exist within the force but may benefit from additional resources or enhanced inter-departmental coordination to be more effective. Similarly, sufficient training was recognized by only 10% of respondents, indicating that while some training occurs, there may be significant room to improve the skill sets of staff to meet the evolving challenges of poaching.

Lower percentages for high morale (5%) and adequate intelligence resources (9%) suggest critical areas for improvement. Low morale may reflect the challenging working conditions

faced by the anti-poaching force, such as resource constraints, high risks, and potentially insufficient support. Limited intelligence resources further highlight the need for better surveillance and information-gathering capabilities to enable proactive responses to poaching. Together, these insights suggest that while the anti-poaching force possesses a stable workforce and some legal support, it may require enhanced morale, training, and intelligence resources to strengthen overall effectiveness in combating poaching activities.

5.7 Poaching Incidents and Law Enforcement Response

The evaluation of wildlife protection efforts from 2018/19 to 2023/24 provides insights into the progression and challenges of anti-poaching measures over six years. The number of poachers arrested peaked initially, with 99 arrests in 2018/19 and a slight increase to 101 in 2019/20 but dropped to a low of 58 in 2021/22 before rising again to 90 by 2023/24. This trend, with a total of 511 arrests and a mean of 102 per year, suggests fluctuating enforcement intensity or changing poaching activity patterns over time.

The number of poaching incidences has remained relatively high, peaking at 88 in 2021/22, with a total of 452 incidences and an annual average of 90. This consistency points to ongoing challenges in completely suppressing poaching activities, despite active interventions. Meanwhile, the number of weapons apprehended shows a decreasing trend, from 11 in 2018/19 to zero in 2023/24, totaling 54 weapons and averaging 11 per year. This decline may indicate either a reduction in armed poaching activities or an adaptation by poachers to evade detection. Joint patrols have significantly increased, from only 5 in 2018/19 to 20 in 2023/24, with a total of 63 patrols and an average of 13 per year. This upward trend reflects a strengthening of collaborative enforcement efforts, which is essential for addressing poaching comprehensively across regions. The number of intelligence-led wildlife crimes has varied, peaking at 19 in 2019/20 but declining to only 8 in 2023/24, with a total of 69 cases and an average of 14 annually. This suggests that while intelligence remains a crucial component of anti-poaching efforts, there may be limitations in sustaining or expanding intelligence-led operations.

Table 7: Evaluation of wildlife protection efforts (2018/19 - 2023/24)

Milestone	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	Total	Mean
Number of poachers arrested	99	101	66	58	97	90	511	102
Number of poaching incidences	69	68	63	88	81	83	452	90
Number of weapons apprehended	11	19	8	14	2	0	54	11
Number of joint patrols	5	3	3	16	16	20	63	13
Number of wildlife crimes that are intelligence led	17	19	10	6	9	8	69	14
Number of cases filled	20	16	18	37	32	19	142	28
Number of finished cases in our favor	17	15	15	30	28	17	122	24

Source: Field data (2024)

The number of cases filed has generally increased over the years, reaching 37 in 2021/22, with a total of 142 cases filed and an average of 28 per year. The number of cases resolved in favor of conservation also shows improvement, totaling 122 favorable cases out of the 142 filed,

yielding an annual mean of 24. This success rate indicates that the legal process is an effective tool when cases are pursued, though the total number of cases highlights the potential need for further judicial resources or stronger evidence gathering to maximize the outcomes in favor of wildlife protection. Overall, the data reflects consistent enforcement efforts with areas for growth in intelligence operations and judicial support to enhance long-term poaching deterrence.

6. Discussion

This study provides a comprehensive evaluation of anti-poaching strategies and their effectiveness in the Udzungwa Mountains National Park (UMNP), utilizing a quantitative approach to capture diverse perspectives from conservation officers, rangers, community leaders, and other stakeholders. The findings underscore the multidimensional nature of anti-poaching efforts, suggesting that while certain strategies such as awareness campaigns and ranger training are perceived as highly effective, challenges remain in sustaining community engagement and enhancing intelligence resources. These insights align with existing literature on the complexity of anti-poaching interventions, which suggests that successful conservation requires a combination of enforcement, community involvement, and sustainable resources (Ferrol-Schulte et al., 2019).

The data on patrol frequency and surveillance technology (GPS) effectiveness highlight the importance of continuous monitoring and presence as deterrents to poaching. High perceived effectiveness ratings for regular patrols (85%) and GPS surveillance (84%) reflect the utility of technology in enhancing ranger capacity to cover large, often remote areas of the park. These findings are consistent with Roe et al. (2020), who emphasized the role of technology in increasing response efficiency in Kenyan conservation areas. However, while technology has proven impactful, resource constraints limit its widespread application, as evidenced by the fluctuating frequency of patrols and intelligence operations across the years in UMNP.

Community engagement, rated fourth in effectiveness, demonstrates varying levels of success across respondent types, highlighting both its potential and the challenges of implementing it effectively. Engagement with local communities is essential, as it fosters a sense of ownership and responsibility for conservation among local populations (Hazzah et al., 2020). However, the results from this study suggest that practical challenges—such as limited economic incentives for conservation and occasional resistance to anti-poaching measures—may hinder community involvement. Biggs et al. (2019) emphasized that community-centered approaches are most successful when they align with the socio-economic needs of local residents, which underscores the need for tailored incentives and livelihood alternatives for communities near UMNP.

The empirical review shows that while UMNP's anti-poaching force benefits from a stable workforce, issues like low morale (5%) and limited training resources (10%) undermine operational strength. These findings align with the work of Kideghesho (2016), who noted similar constraints in Tanzanian conservation, particularly in terms of maintaining motivated personnel in challenging field conditions. Improved training, coupled with morale-boosting initiatives, may address these gaps by equipping rangers with more skills and reducing turnover, thereby contributing to more effective long-term enforcement.

Furthermore, the number of arrests, poaching incidents, and cases filed over the years highlight the persistent challenge of poaching, even with substantial efforts in place. While the arrests fluctuated from 99 to 58 annually, with an increase to 90 in recent years, the continued presence of poaching incidents, averaging 90 per year, suggests that enforcement alone cannot address

poaching comprehensively. Similar findings were noted by Naidoo et al. (2019) in South Africa, where sustained poaching rates indicated the need for complementary community and economic measures to support enforcement.

In terms of legal effectiveness, the study found a relatively high success rate in cases resolved favorably, with 122 of 142 cases yielding outcomes that benefit wildlife protection. However, the limited number of cases compared to the number of poaching incidents implies potential gaps in the judicial process, as highlighted by Kyando (2014). Strengthening the prosecutorial framework and enhancing evidence-gathering processes could amplify the deterrent effect of legal action, leading to more impactful judicial outcomes.

6. Conclusions and Recommendations

This study has highlighted both the successes and challenges of anti-poaching strategies in the Udzungwa Mountains National Park (UMNP), illustrating the complexities of conserving biodiversity in areas under constant threat. The findings underscore that while certain approaches, such as awareness campaigns and ranger training, are widely perceived as effective, they need to be reinforced by comprehensive support systems that include adequate intelligence resources, legal backing, and community engagement. The relatively high consistency in the perceived effectiveness of awareness campaigns points to the importance of education and community involvement in fostering conservation-friendly attitudes among local populations. However, the persistently high number of poaching incidents suggests that further efforts are required to achieve sustainable reductions in poaching.

One of the study's key insights is the need for a balanced approach that combines enforcement, technological advancements, and community involvement. Patrol frequency and GPS surveillance have been shown to play vital roles in deterring poaching, though their impact is limited by resource availability and the vast areas requiring monitoring. Enhancing ranger training and morale will be essential for empowering the anti-poaching force, especially as the complexity of poaching tactics continues to evolve. Furthermore, with community engagement ranking lower in perceived effectiveness, it is clear that integrating local communities more deeply into conservation efforts could yield benefits both for wildlife and for those who depend on these resources for their livelihoods.

To address the gaps identified in legal enforcement, we recommend strengthening judicial processes and enhancing evidence-gathering techniques to increase conviction rates and deter poachers more effectively. The findings indicate that while cases resolved favorably for conservation efforts are relatively high, the number of cases filed compared to poaching incidents remains low. Streamlined legal frameworks, coupled with increased prosecutorial resources, would help ensure that poaching activities are met with consistent and substantial consequences. Providing training to enforcement officers on evidence collection and legal protocols could also improve the effectiveness of the judicial response to poaching.

For community engagement to be effective, conservation authorities should work to provide sustainable economic opportunities that reduce dependence on poaching. This could involve expanding community-based tourism, creating job opportunities within conservation, or introducing alternative livelihoods. Partnerships with local leaders and ex-poachers could be leveraged to advocate for conservation and deter others from engaging in illegal activities. This

approach not only addresses socio-economic drivers but also aligns with the long-term goals of conservation by fostering a sense of ownership and responsibility among local residents.

Generally, a multi-dimensional approach is essential to address the ongoing challenges in protecting UMNP's biodiversity. Strengthening anti-poaching efforts through enhanced patrols, advanced technology, community partnerships, and a reinforced legal framework will contribute to more sustainable conservation outcomes. By implementing these recommendations, UMNP and other similar conservation areas can build resilience against poaching and support broader conservation goals, ultimately securing both the ecological and socio-economic future of Tanzania's wildlife-rich regions.

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