

# **Integrating Scientific Data and Community Insights for Biodiversity Conservation in Alaungdaw Kathapa National Park: Special focus on Indian Leopard**

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## **Abstract**

Alaungdaw Kathapa National Park (AKNP) serves as a critical refuge for numerous threatened species, including the Indian leopard (*Panthera pardus*). However, conservation efforts in the park are increasingly challenged by habitat degradation, illegal logging, poaching, agricultural expansion, and human-wildlife conflict. Despite its ecological significance, there remains a paucity of scientific studies assessing species distributions, habitat preferences, and conservation threats. This study integrates species distribution modelling, camera trap surveys, SMART patrol data, and local ecological knowledge to provide a comprehensive evaluation of biodiversity patterns and conservation challenges in AKNP, with a particular focus on leopard ecology. Findings indicate that leopards predominantly occupy mid-elevation zones (400–600 m) in the southern and central regions of the park, exhibiting a clear avoidance of human settlements and roads. Intriguingly, leopard presence is positively correlated with high illegal logging densities, potentially attributable to increased prey availability in secondary forests. Camera trap and SMART patrol data confirm the presence of 21 mammal species, including red muntjac (*Muntiacus vaginalis*), sambar (*Rusa unicolor*), wild pig (*Sus scrofa*), and Asiatic black bear (*Ursus thibetanus*), while community interviews document 32 mammal species and 15 bird species. However, discrepancies across datasets, such as the unverified presence of tigers (*Panthera tigris*) reported by local respondents, pointing the importance of integrating multiple data sources to enhance species detection reliability. Threat assessments reveal poaching, illegal wildlife trade, habitat fragmentation, and logging as primary pressures on AKNP's biodiversity. Poaching is particularly prevalent for key prey species, while illegal logging continues to degrade leopard habitats. To address these challenges, the study recommends expanding SMART patrol coverage, strengthening intelligence-driven anti-poaching enforcement, and promoting community-based conservation initiatives. Additionally, the establishment of buffer zones and ecological corridors is crucial to maintaining habitat connectivity. Long-term camera trap surveys, prey density assessments, and remote sensing analyses should be prioritized to refine conservation strategies further. By integrating scientific methodologies with local ecological knowledge, this study provides a data-driven framework for biodiversity conservation in

AKNP. Findings underscore the necessity of multi-stakeholder collaboration among conservation organizations, government agencies, and local communities to ensure the park's ecological integrity. Given its role as a key stronghold for leopards and other threatened species, AKNP's protection is essential for advancing regional conservation efforts for large carnivores and preserving Myanmar's biodiversity.

## 1. Introduction

Biodiversity is the foundation of a sustainable earth, supporting ecological stability, people's livelihoods, and global climate resilience (Bellard et al., 2012). However, the world is currently facing an unprecedented biodiversity crisis, with habitat destruction, climate change, and human exploitation driving species to extinction at alarming rates (Basnet et al., 2019). Southeast Asia, recognized as one of the most biodiverse yet highly threatened regions, is experiencing severe biodiversity loss due to deforestation, illegal wildlife trade, and habitat fragmentation (Sodhi et al., 2010). Among the region's critical ecosystems, Myanmar's forests remain one of the last refuges for many globally endangered species (Borras et al., 2020).

Myanmar is home to vast tracts of forests that harbour unique and threatened wildlife, including the Asian elephant (*Elephas maximus*), Malayan sun bear (*Helarctos malayanus*), and a variety of large carnivores (Lynam, 2003). Despite its rich biodiversity, conservation efforts in Myanmar face mounting challenges due to habitat degradation, poaching, and socio-political instability. Protected areas play a vital role in safeguarding the country's biodiversity, yet many remain understudied and under-resourced. Among these, Alaungdaw Kathapa National Park (AKNP) stands out as one of Myanmar's largest and most ecologically significant protected areas (Instituto Oikos & BANCA, 2011).

Located in the Sagaing Region, AKNP encompasses approximately 1,598 km<sup>2</sup> of diverse ecosystems, ranging from dense tropical forests to mountainous landscapes. Established in 1989, the park serves as both a critical biodiversity hotspot and a site of cultural and spiritual significance, attracting thousands of pilgrims to the revered shrine of Alaungdaw Kathapa. According to Instituto Oikos & BANCA, 2011, mixed deciduous forest (moist upper, dry upper and lower) is the typical forest type of the site. Other forest types are evergreen forest and pine forest. About 150 tree species, 42 orchid species, 10 bamboo species, 4 cane species and more than 50 medicinal plants have been recorded from the park. Regarding the wildlife, the tiger (*Panthera tigris*) is probably not present anymore. But, leopards (*Panthera pardus*), Asian elephants (*Elephas maximus*), gaurs (*Bos gaurus*), sambar (*Cervus unicolor*), muntjac,

bear, wild cat species, insects and aquatic animals have been observed by park staff (Instituto Oikos & BANCA, 2011). Thirteen reptile species, 240 butterfly species and more than 240 bird species are also recorded from the park. Despite its official protected status, AKNP faces significant conservation challenges, including illegal logging, poaching, and human-wildlife conflicts. The park's remote nature and limited scientific studies have left critical knowledge gaps in understanding species distributions, habitat preferences, and the extent of human-induced pressures.

This study aims to bridge these knowledge gaps by integrating scientific data with community insights to assess biodiversity and conservation challenges within AKNP, with a particular focus on leopards (*Panthera pardus*). By combining species distribution models (SDMs), camera trap surveys, and local knowledge, this research provides a comprehensive understanding of the park's ecological significance and threats. The findings will contribute to evidence-based conservation strategies, ensuring the long-term survival of AKNP's biodiversity while promoting sustainable coexistence between wildlife and local communities.

## **2. Methodology**

### **2.1 Study Area**

AKNP is situated between 22° 5' N and 94° 26' East in Sagaing Region. The Park is situated in the Yinmabin Township, Mingin and Kani townships, Sagaing Region – west of the lower Chindwin River and the Myittha valley (Fig.1). AKNP is in a well-forested mountainous region - comprising the Patolon reserved forests and two thirds of the adjoining Taungdwin reserved forests. The average elevation in AKNP is about 1,000 m (ranging between 200 and 1,400 m); steep slopes and narrow ridges characterise all regions. The series of the parallel ridges are major features of the areas and are characterized by fairly steep escarpments on the eastern face and moderate slopes on the west. The area has a monsoon climate but is sheltered to some extent from the full effect of the South-West monsoon by the western Chin Hill. The soil is generally a sandy loam with varying proportions of sand (Oo. N., T., 2006).

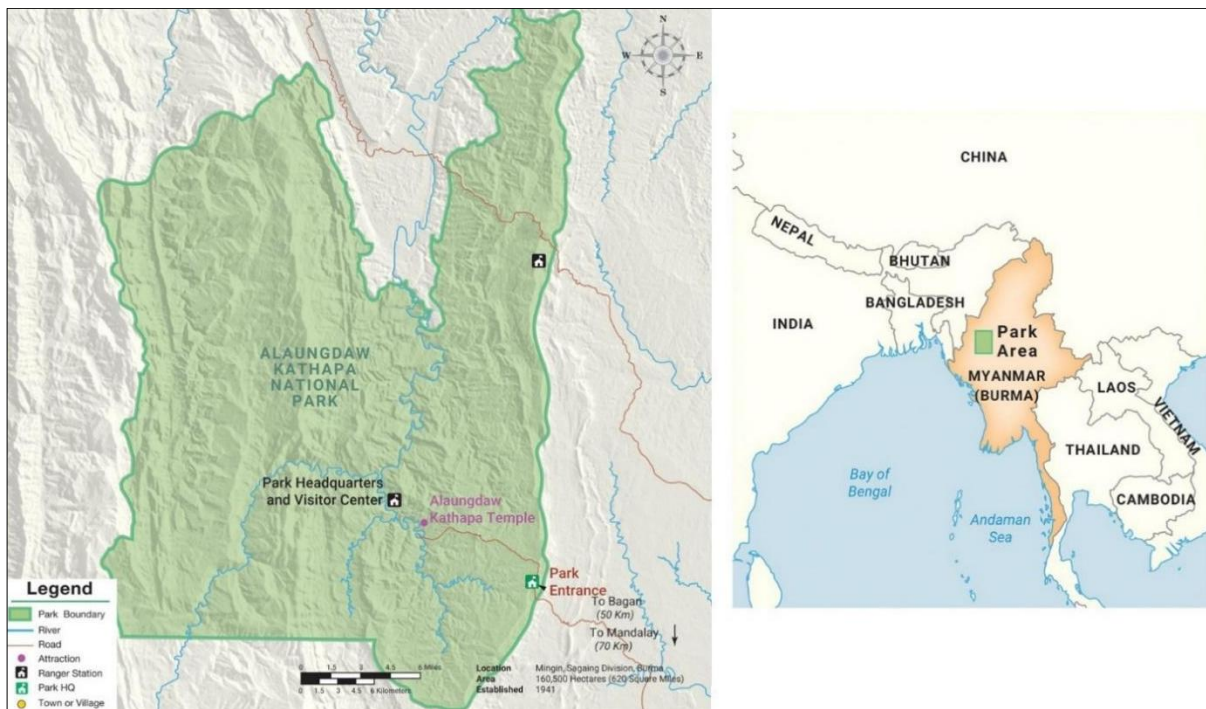


Figure 1 Location of the Alaungdaw Kathapa National Park, in Sagaing Region, Myanmar

## 2.2 Data Collection

### 2.2.1 Interview surveys

The interview surveys were conducted with community members from selected villages around AKNP. Sampling for the interview surveys targeted at least 10 out of the 31 villages surrounding AKNP, with a focus on those closest to park boundaries and with the highest levels of interaction with wildlife. This strategic sampling ensured a diversity of perspectives and a representative understanding of the human-wildlife dynamics around the park. These interviews were focused on the local population's wildlife sightings, behaviour of key species, and interactions between humans and wildlife, including instances of conflict (Appendix-I). In total, we interviewed 42 individuals, including park staff, hunters and local people around AKNP. Survey respondents also provided insight into human activities such as hunting, logging, and resource use, which could be affecting wildlife populations. This qualitative information was crucial for understanding the socio-economic drivers behind biodiversity threats in the region.

### 2.2.2 Fauna Surveys

Wildlife population data were requested from the Wildlife Conservation Society (WCS) who conducted camera trap surveys in AKNP during 2017-2018. Digital camera traps (Acorn Camera, Model LTL-5210A with wide angle Trail Camera) were used. According to the recent reconnaissance survey, the camera traps have been set up by avoiding areas with cliffs, very

thick vegetation like bamboo brakes and deep and wide streams due to logistical challenges (Karanth et al., 2004). And the camera traps were deployed on natural animal trails, old logging roads and dry stream beds where track and sign of sun bear (*Helarctos malayanus*) were observed. WCS deployed camera traps at different (20) locations each year. At each station, WCS used a pair of single camera traps, set at ~ 45 - 60 cm height from ground level and ~ 3.5 – 5.0 m distance on either side of the suspected animal trail. Camera traps were in position for 45 consecutive days.

The wildlife observation data from Spatial Monitoring and Reporting Tool (SMART) implemented in Alaungdaw Kathapa National Park (AKNP) were also derived between 2017 and 2019. The SMART data includes detailed measurements and documentation of wildlife tracks, which validate indirect observations. Intensities of illegal activities records within the parks could also be accessed from the SMART data.

### **2.2.3 Environmental Covariates**

Covariate such as distance to water source, roads, patrol stations (based camp), villages, as well as canopy height, elevation, aspect and slope were collected (Table.1). In addition to that, kernel density maps of illegal activities including logging, fishing, hunting and NTFPs collection were also gathered. The distance to road (including highway road and old logging roads) and water bodies (including rivers, and streams), and kernel density map of illegal activities were calculated by using ArcGIS Pro. And then we created each raster file (.geotiff) containing those attributes. Canopy heights were acquired from the NASA earth data (<https://search.earthdata.nasa.gov/search>). For the dataset, we carefully chose the acquiring dates which represent the survey period (November 2017 to May 2018). And then, masked with the 1km buffer of the AKNP boundary. Elevation raster was generated using Digital Elevation Models (DEM) - Digital Elevation - Global 30 Arc-Second Elevation (GTOPO30) downloaded from USGS earth explorer (<https://earthexplorer.usgs.gov/>). And then the elevation raster was masked by using a 1 km buffer of the boundary. Slope and aspect raster are calculated by using DEM in the slope tool of ArcGIS Pro.

### **2.2.4 Data Analysis**

#### **2.2.4.1 Interview Data**

The interview data was analysed using both qualitative and quantitative techniques. Descriptive statistics was applied to quantify wildlife sightings and trends in human-wildlife interactions, while content analysis extracted common themes from community responses using SPSS (Statistical Packages for Social Science Version). This has provided an

in-depth understanding of local perceptions of wildlife, the socio-economic factors driving unsustainable resource use, and the level of community engagement in conservation efforts.

### 2.2.4.2 Species Distribution Modelling

Data analysis was conducted using a range of advanced methodologies to assess habitat suitability and distribution of key species, particularly leopards, within AKNP, using species presence locations derived from camera trap surveys and SMART data (Fig. 2). Species Distribution Modeling (SDM) techniques, including Maximum Entropy (MaxEnt), Generalized Linear Models (GLM), and Random Forest, were employed to predict potential species distribution (Zurell et al., 2020). Environmental variables such as aspect, canopy height, elevation, distance to roads, distance to villages, distance to water sources, slope, and illegal activities were incorporated to refine these predictions. Descriptive statistics were used to explore the relationships between environmental variables and species presence, providing a foundational understanding of the ecological and anthropogenic factors affecting leopard habitats. The performance of the SDM models was evaluated using metrics such as the Area Under the Curve (AUC), which ensured accuracy and reliability in the generated habitat suitability maps (Burnham et al., 2002). Model produced detailed spatial maps, offering insights into species distribution and habitat characteristics.

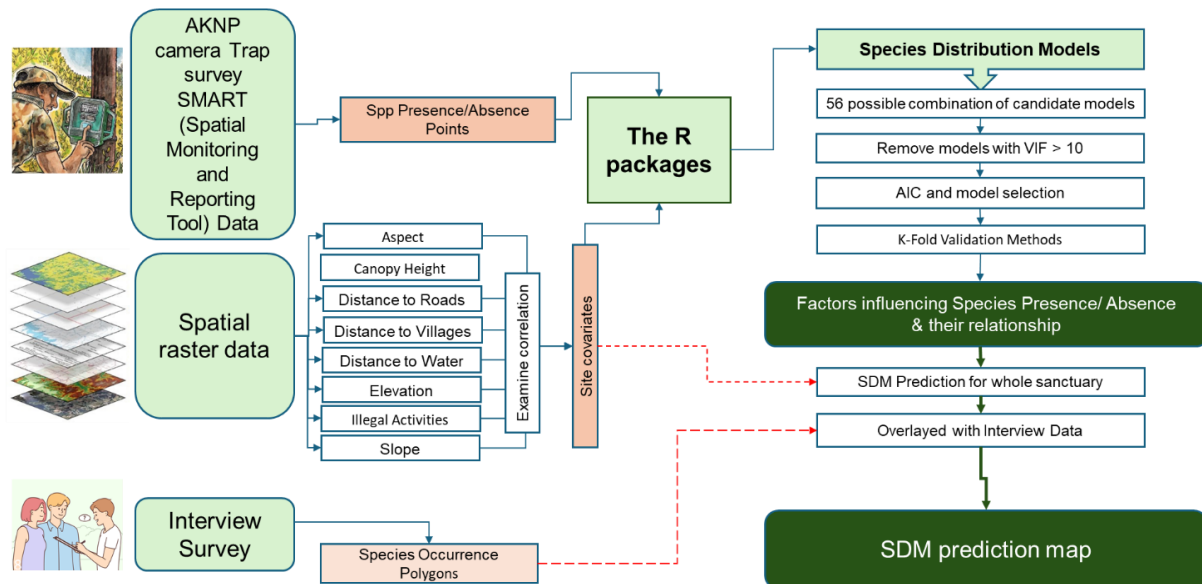


Figure 2: Flowchart of data analysis process, to produce the species distribution map of leopard using presence/ absence points from camera traps survey, SMART patrolling, and validated with Interview survey data in Alaungdaw Kathapa National Park, Sagaing Region, Myanmar

### 3. Result

#### 3.1 Species Diversity

##### 3.1.1 Interview surveys

Respondents reported the presence of 32 mammal and 15 bird species in AKNP (See Appendix-II). The top six commonly observed species are rhesus macaque (22.3%), sambar (19.8%), banteng (16.5%), black bear (14.9%), red muntjac (14.0%), and leopard (12.4%) in various locations of the AKNP (Fig. 3). Regarding the uses of the wildlife parts, red muntjac is targeted for its horns, tusks, and skin, which are commonly used in traditional medicine, decorative items, and leather goods, highlighting the economic incentives driving poaching. Similarly, the Sambar is highly sought after for its horns, used for ornamental purposes, and its skin, which is processed into commercial leather products, making it a prime target for poachers due to its large size and market value. Wild pig is exploited for its tusks, which are utilized in decorative crafts and traditional medicine, rendering it vulnerable in areas where such practices persist. Lastly, the *Rhesus macaque* is hunted for its meat, primarily for subsistence or as part of local cultural traditions.

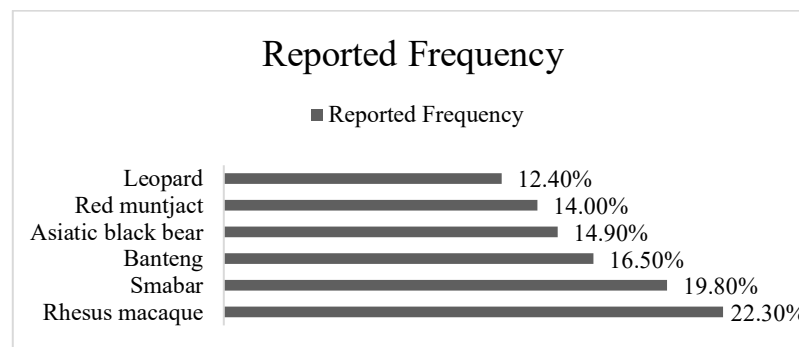


Figure 3: Reported frequency of key wildlife species by the respondents

##### 3.1.2 Camera Trap Surveys

During 1,654 trap nights, 355 wildlife photographs were recorded, and 21 wildlife species were identified (Appendix-III). The red muntjac and Eurasian wild pig were found to be the most abundant, exhibiting the highest Relative Abundance Index (RAI), indicating their prevalence in the study area (Fig. 4). Species such as the leopard, sambar, and Malayan porcupine showed moderate RAI values, suggesting that they are less commonly detected but still play a significant role within the ecosystem. On the other hand, the dhole, Asiatic golden cat, and crab-eating mongoose were rarely detected, with very low RAIs, highlighting their rarity or possible elusiveness in the park. Additionally, temporal variations in RAI between 2017 and 2018 for certain species suggest fluctuations in their detectability, which

could be attributed to ecological factors such as prey availability, habitat conditions, or human activities.

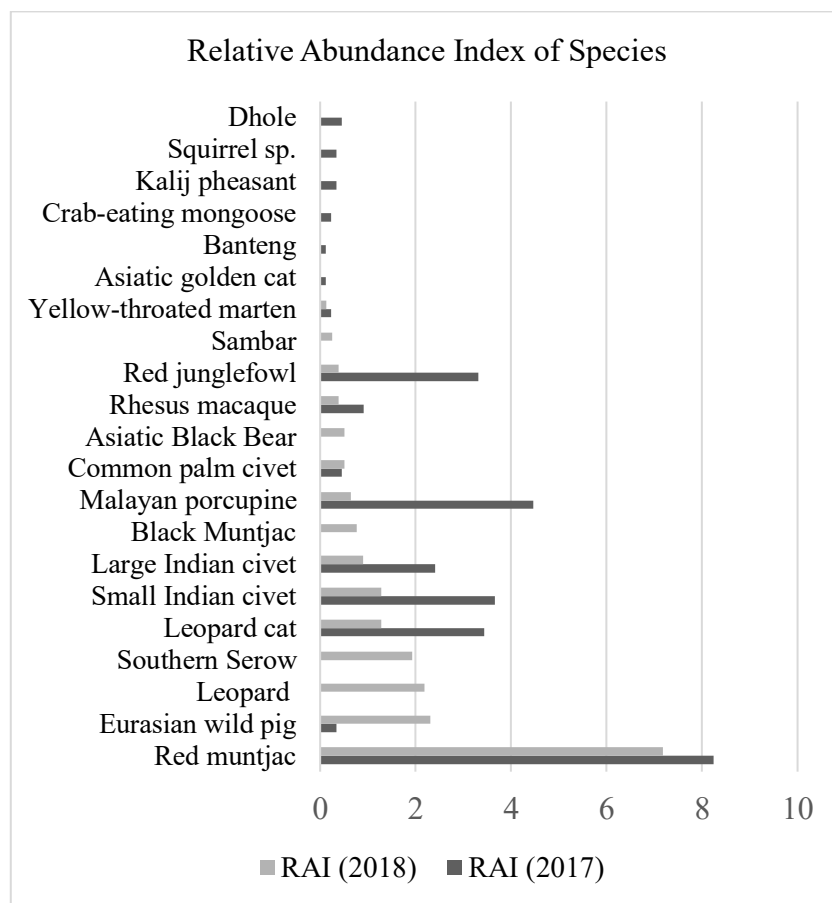


Figure 4: Relative abundance index of wildlife species calculated based on the camera trap surveys in 2017-2018

### 3.1.3 SMART

The red muntjac and *rhesus macaque* recorded the highest number of observations, reflecting their relative abundance within the study area (Fig. 5). Other frequently observed species include the leopard, Asian elephant, and Eurasian wild pig. Moderately observed species, such as the banteng, Asiatic black bear, and Chinese serow, further emphasize the park's ecological diversity. In contrast, the Malayan sun bear and gaur were observed infrequently, indicating their rarity or elusive behaviour in the region.

### 3.1.4 Threats

According to the interview survey, since 2010, the most common threats include illegal logging, poaching, illegal wildlife trading, and farmland conversion, all of which pose substantial risks to local ecosystems. Before 2010, biodiversity faced threats such as poisoning, mine explosions, electrofishing, and poaching. The shift in threats reflects evolving human activities and their impact on natural habitats.

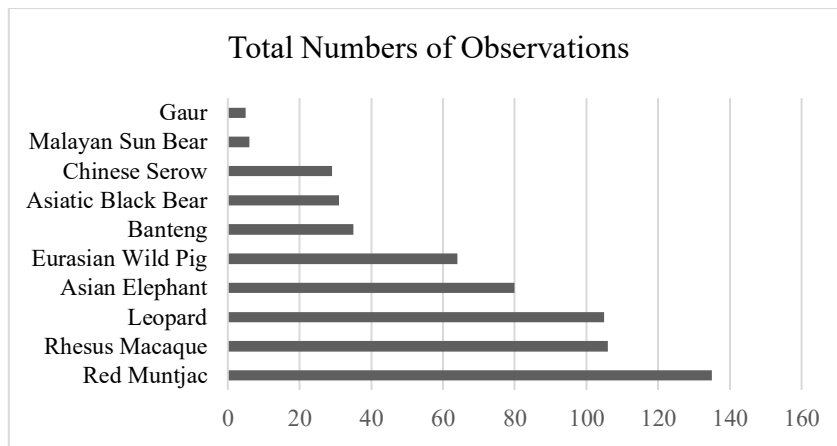
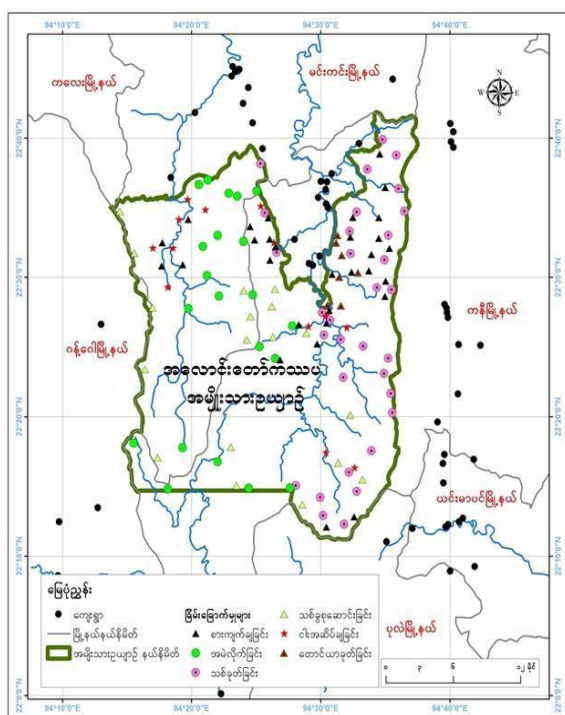


Figure 5: Total numbers of wildlife species observation by SMART patrol in 2017-2018

In addition, the following map (Fig.6) illustrates the spatial distribution of biodiversity threats



within the study area, highlighting key zones of concern. Different symbols and markers indicate specific activities such as poaching, illegal trading, farmland conversion, and other harmful practices (such as grazing, illegal logging, shifting cultivation, poisoning). Green-shaded areas likely represent protected or forested zones, while colored markers pinpoint locations where biodiversity threats are most prevalent. The clustering of threats in certain regions suggests hotspots of human-wildlife conflict, habitat degradation, or illegal activities. This spatial analysis underscores the urgent need for targeted conservation efforts in these high-risk areas to preserve biodiversity and mitigate the impact of human activities.

Figure 6: Locations of threats recorded in AKNP during the SMART patrol in 2017-2019

### 3.2 Leopard Distribution and Responses to Environmental Factors

The SDM prediction shows moderate probabilities of leopard presence distributed broadly across the park. Higher probabilities are concentrated in the southern and central parts of AKNP (Fig 7A-E). Similarly, the interview survey also revealed that leopards are most commonly found in dense forest areas, such as Mahu Mountain and locations near pagodas in the southern and central parts of AKNP (Fig 7E). The respondents reported a pattern of habitat use over time: the latest sighting in 2023 occurred in dense forests, while earlier

observations include a forest border in 2018, near agricultural field in 2009, and beside Thinganhlan Creek in 2012.

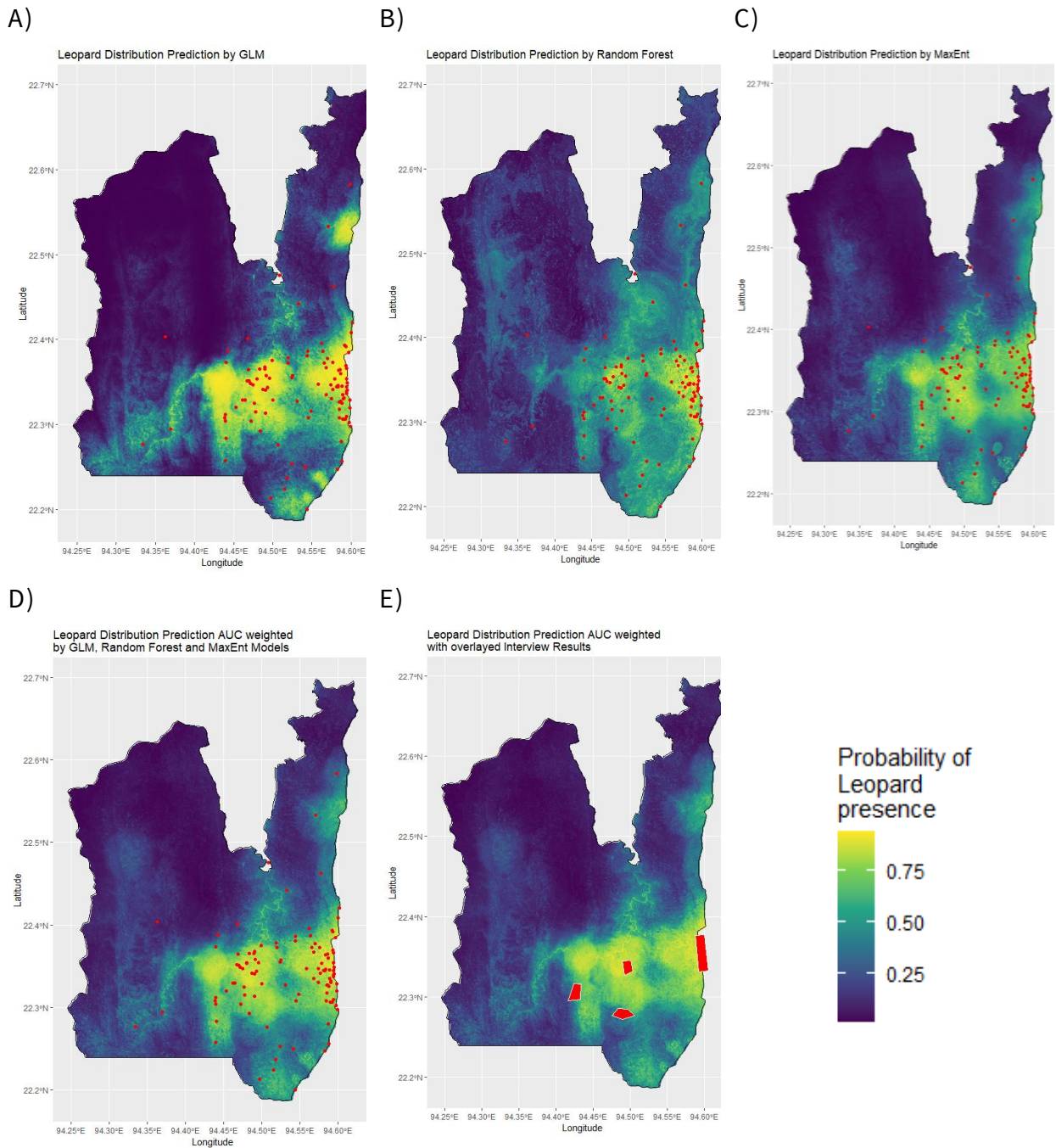
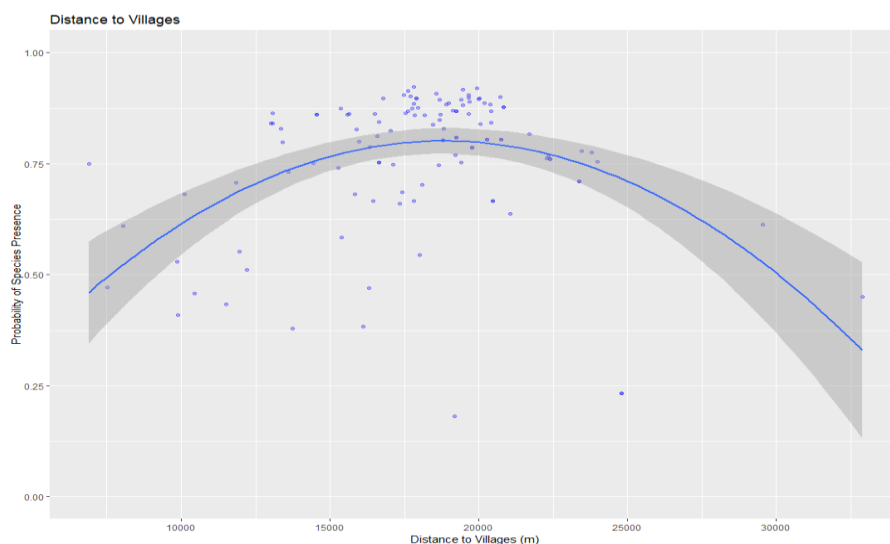


Figure 7: Probability of Leopard (*Panthera pardus*) distribution generated by A) Generalized Linear Model (GLM), B) Random Forest, C) Maximum Entropy (MaxEnt) models, and D) AUC weighted Ensembled Models, in Alaungdaw Kathapa National Park in Sagaing Region, Myanmar. E) Final Species Distribution map were overlaid by interview survey result polygon (red coloured).

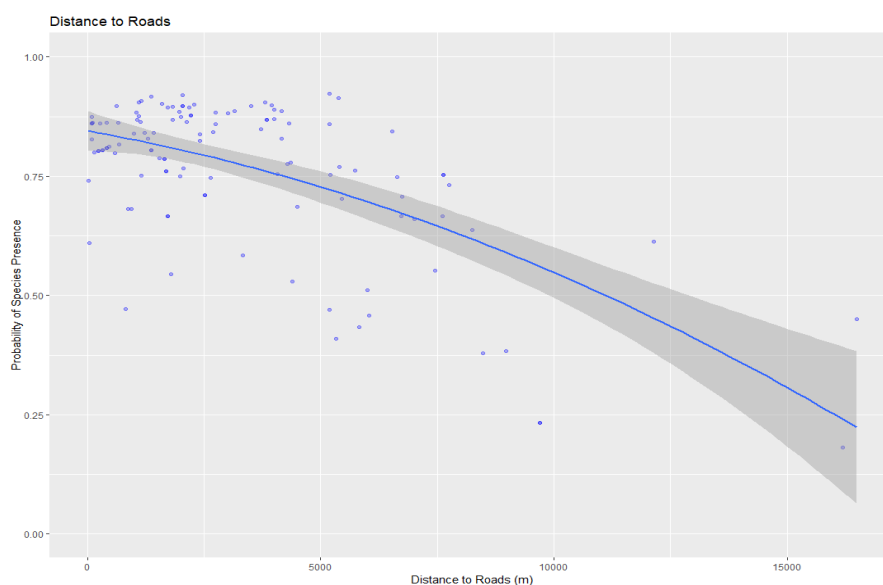
Although environmental factors such as distance to water, slope, aspect, and non-timber forest product (NTFP) collection were not significant in predicting leopard distribution,

leopard distribution include elevation, distance to roads, distance to villages, and illegal logging are most influencing in the models. Distance to villages emerged as the most significant factor, with leopards being more likely to inhabit areas farther (~ 20 kilometers) from human settlements, indicating their preference for less disturbed habitats (Fig 8A). Similarly, distance to roads was another significant factor, showing that leopards avoid areas around and near the roads, and most likely to be present at a distance of 10-25 km away from the roads (Fig 8B). Elevation also played a crucial role, with leopards favouring mid-elevation zones (400–600 m), but at low elevations (<400 m), leopards are less likely to inhabit (Fig 8C). Logging activities significantly impacted leopard distribution, underlining the adverse effects of human-induced habitat alterations. There is a positive relationship between the probability of species presence and the kernel density of illegal logging activities (measured as activities per 900 square meters) (Fig 8D).

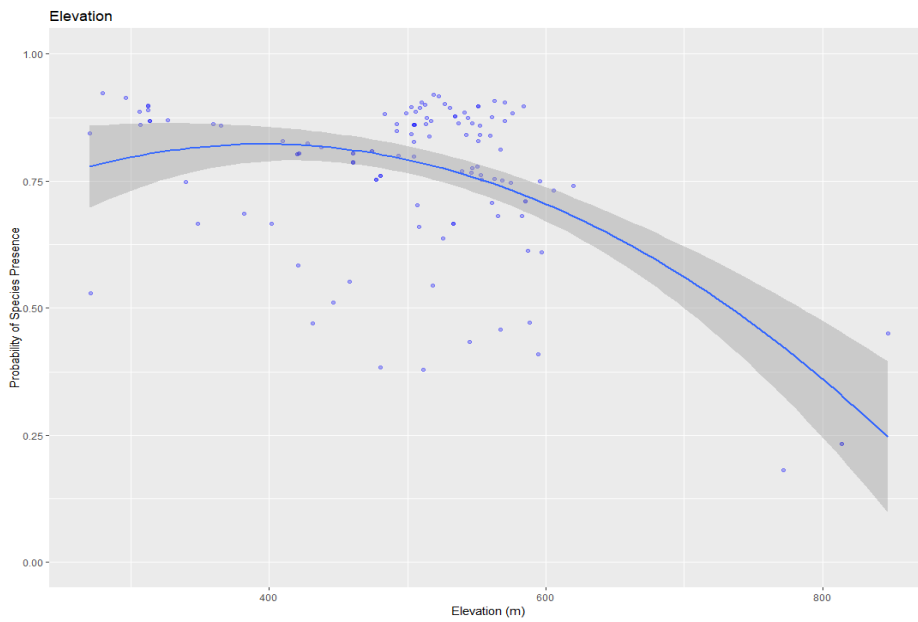
A)



B)



C)



D)

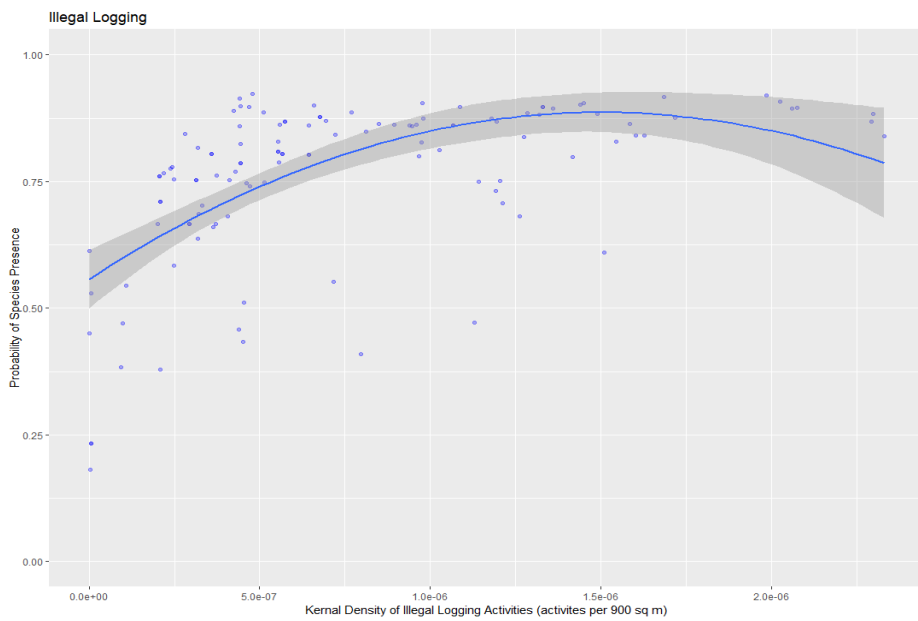


Figure 8: Leopard response to Environmental factors A) distance to villages, B) distance to roads, C) Elevation, D) Illegal logging

#### 4. Discussion

The study highlights the integration of camera trap data, SMART data, and local interviews to analyze species distribution and conservation challenges in AKNP. Key findings emphasize the park's ecological richness, showcasing abundant species such as red muntjac, Eurasian wild pig, and leopard while identifying critical threats like habitat loss, logging, and human-wildlife conflicts. The SDMs using GLM, Random Forest, and MaxEnt identified mid-elevation areas in the park's southern and southeastern regions as critical leopard habitats. These

areas feature dense forests, moderate climatic conditions, and abundant prey availability. The analysis also reveals the adverse impact of human activities, including road proximity and illegal logging, on species distribution. By overlaying model predictions with interview data, the research underscores the importance of incorporating local knowledge to validate and refine conservation strategies. The findings call for targeted measures, such as protecting mid-elevation zones, regulating logging, and reducing human disturbances, to ensure the long-term survival of biodiversity in AKNP.

#### **4.1 Wildlife Species**

Both interview surveys, camera trap projects, and SMART data generated many similar wildlife species, but there were some disparities. For example, respondents from interview surveys reported tiger (*Panthera tigris*) in the AKNP, but the camera trap and SMART data did not show any tracks and signs of the tiger. This might be because local communities might misidentify the leopards' track and signs with tigers. But, although Myanmar National Tiger Surveys in 1999-2002 included the AKNP as a potential study site, tiger photos could not be recorded during the surveys. Instead, only 10 tracks and signs of big cats (not sure they were tigers) were recorded (Lynam, 2003). However, 14 leopards' photos were recorded during the National Tiger Surveys. Interestingly, although interview surveys and SMART data revealed the presence of the elephants in AKNP, the latest camera trap surveys did not record any elephant photos. The results agreed with the finding of Verma (2008), stating that the status of wild elephants in this park is not well known and has not been scientifically studied. The available information is based only on indirect observations and the dung density was very low (Verma, 2008).

In AKNP, 26 wildlife species were recorded in 1999-2002 National Tiger Surveys. Line Transect surveys in 2009 recorded 20 species (Varma, 2009). Similarly, the camera trap surveys in 2017-2018 recorded 20 wildlife species, excluding Hog Barger, elephant, and Malayan sun bear which were recorded in 1999-2002. That might be due to different camera traps models, sampling design, space and time. On the other hand, the park staff who conducted the SMART patrolling only recorded 10 species because the patrol team recorded only the important species such as elephant, bears, and leopard, while the community reported 32 mammals species including tiger. Despite those inconsistencies across different observation methods in different time frames, these findings underscore AKNP's critical role as a biodiversity hotspot in Sagaing Region. In AKNP, only 11% individuals represented a single species, but for every 5 individuals, one new species was encountered in AKNP (Varma, 2009).

The integration of community-reported observations and scientific methods, such as GIS and camera trap data, has enhanced the understanding of species distribution patterns.

Key observations from the camera trap surveys include the identification of species with varying levels of abundance in the area. Red muntjac and Eurasian wild pig were found to be the most abundant, exhibiting the highest Relative Abundance Index (RAI), indicating their prevalence in the study area. Species such as the leopard, sambar, and Malayan porcupine showed moderate RAI values, suggesting that they are less commonly detected but still play a significant role within the ecosystem. On the other hand, the dhole, Asiatic golden cat, and crab-eating mongoose were rarely detected, with very low RAIs, highlighting their rarity or possible elusiveness in the park. Additionally, temporal variations in RAI between 2017 and 2018 for certain species suggest fluctuations in their detectability, which could be attributed to ecological factors such as prey availability, habitat conditions, or human activities. The species composition in AKNP enhances the prey availability for leopards and there is almost no competitor species for the leopard. As a result, AKNP can be the strong holds for the leopard with highly adaptive features (Athreya et al., 2016; Bharali et al., 2020; Carter et al., 2015) even though poaching and illegal activities were pressing their existence.

#### **4.2 Threats**

According to Oikos and BANCA (2011) the threats found in AKNP are roads and railroads, hunting and collecting terrestrial animals. Gathering terrestrial plants, logging and wood harvesting, annual and perennial non-timber crops, oil and gas drilling. But respondents from our interviews exposed only major threats including poaching, illegal trade, and habitat loss from agricultural expansion. These activities are concentrated in border and farmland-adjacent areas. The survey highlighted poaching as the top threat, corroborating the historical and current risks identified. Meanwhile, SMART data also showed that illegal logging, fishing, NTFP collections, and hunting had occurred along the border and roads around and inside the park. Communities around the park rely heavily on forest resources, contributing to unsustainable practices like logging and hunting, as confirmed by interviews. As a result, forest degradation along with habitat loss occurred, pointed out by the interviews results in 2021 as well (McGinn et al., 2021).

Interview surveys also revealed the use of wildlife species and their parts. Mostly wildlife are targeted for meat, horns, tusks, skin, traditional medicine, decorative items. Most hunted species are red muntjac, sambar, wild pig and rhesus macaque - agreed with finding of McEvoy et al., 2019. However, the most popular wildlife species in illegal wildlife trade in

Myanmar such as pangolin, elephants, and turtle (McEvoy et al., 2019) were not found in the interview results. The possible reason is that a significant majority (59.52%) of the respondents are farmers, reflecting the prominence of agriculture in the region. Others were teachers, government staff from Myanmar Timber Enterprise, Forest Department, casual workers, carpenters, shoppers, and former Wildlife Conservation Society (WCS) staff (See Appendix-II). As a result, their answers might not cover enough the illegal trade happening in the local area as much as targeted illegal trade market surveys.

### **4.3 Leopard Distribution and Responses to Environmental Factors**

Leopards are highly adaptive to different environmental conditions ranging from desert to snow lands, and from human dominated landscape to undisturbed habitats (Goldberg et al., 2015). However, in our study area, leopards' distribution were limited to around the central parts and southern parts of the parks, where mid-level elevation ranges (400-600 m), away from the roads (10-25 km) and villages (20 km), with higher densities of illegal logging activities. But, Leopards live in mountainous environments up to an altitude of 4,600 m on Mt. Kenya and 5,200 m in the Himalayas (IUCN, 2015). Although leopard responses to the roads and human settlement were indicating their preferences for undisturbed habitats, it might be the only case for AKNP. On the other hand, this study's finding which is the higher the illegal logging densities, the higher the probability of leopard presence further proved that leopards have survived where high human densities (Athreya et al., 2013; Singh, 2005) although associated levels of conflict can also be high (Athreya et al. 2013). Therefore, it seems to be relatively related to prey availability (Chatterjee et al., 2022; Karanth & Sunquist, 1995; Krishnakumar et al., 2022), although this study could not incorporate these variables into the SDMs for leopard. Future studies of leopards in AKNP should consider integrating prey species densities when predicting the distribution of leopards in AKNP and surrounding study areas such as Htamanthi Wildlife Sanctuary.

### **5. Conclusion**

This study integrates scientific data from camera trap surveys, SMART patrols, and species distribution modeling with local ecological knowledge to assess biodiversity conservation challenges in AKNP, with a specific focus on the Indian leopard (*Panthera pardus*). The findings underscore AKNP's ecological significance as a biodiversity stronghold while highlighting the persistent threats posed by illegal logging, poaching, and habitat fragmentation.

The SDMs results indicate that leopards predominantly occupy mid-elevation regions (400–600 m) in the southern and central portions of the park, where human disturbances are

relatively lower. Notably, leopard presence exhibits a positive association with areas of high illegal logging activity, a pattern that may reflect increased prey availability in secondary forests resulting from habitat disturbance (Akrim et al., 2018). However, such short-term ecological benefits do not mitigate the long-term consequences of habitat degradation. Furthermore, avoidance of roads and human settlements suggests that anthropogenic pressures play a significant role in shaping habitat use patterns.

The analysis of conservation threats reveals poaching, illegal wildlife trade, and forest resource exploitation as the principal drivers of biodiversity loss in AKNP. Community interviews indicate that species such as red muntjac (*Muntiacus vaginalis*), sambar (*Rusa unicolor*), and wild pig (*Sus scrofa*) are particularly vulnerable due to their economic value in local markets. The absence of pangolins, elephants, and turtles in community responses, despite their prominence in Myanmar's illegal wildlife trade, suggests the potential underreporting of targeted species or knowledge gaps within local communities. These findings highlight the necessity of complementary field-based monitoring and targeted market surveys to fully assess the scale of illegal wildlife trade in the region.

Comparisons between camera trap records, SMART data, and local knowledge surveys reveal inconsistencies in species detection, suggesting the importance of multi-source data integration for robust biodiversity assessments. For instance, while some community respondents reported tiger presence in AKNP, no confirmed photographic or track-based evidence supports their persistence in the park over the past two decades. Similarly, the lack of elephant detections in camera trap surveys despite their documentation in SMART patrol reports suggests methodological limitations in detecting certain taxa, particularly those with large home ranges. These discrepancies reinforce the need for standardized, multi-method biodiversity monitoring frameworks.

## **5.1 Conservation Implications and Recommendations**

To enhance biodiversity conservation in AKNP and mitigate existing threats, a multi-pronged, evidence-based conservation strategy is essential:

*Strengthening Protected Area Management and Law Enforcement:* expanding SMART patrol coverage to improve spatial and temporal monitoring of illegal activities, enhancing anti-poaching measures and intelligence-driven enforcement to curb wildlife trafficking, and strengthening collaboration between local communities, conservation organizations, and government agencies to ensure effective law enforcement and wildlife protection are recommended.

Habitat Protection and Sustainable Land-Use Planning: strict land-use policies to regulate agricultural expansion and prevent further encroachment into critical wildlife habitats will be required. The parks and local authorities should also develop sustainable forest management initiatives to address illegal logging while providing alternative livelihoods for local communities. Furthermore, establishing buffer zones and ecological corridors could maintain habitat connectivity and mitigate fragmentation effects.

Advancing Scientific Research and Adaptive Management: It is required to conduct comprehensive prey density assessments to better understand leopard prey availability and refine species distribution models. And then, future research should integrate remote sensing and GIS technologies to monitor habitat changes and identify high-risk conservation zones. Expanding long-term camera trap surveys and genetic analyses to assess population dynamics and genetic diversity of leopards and other key species can also be beneficial. On the other hand, it also suggests implementing community-based ecological monitoring programs to leverage local knowledge for real-time biodiversity assessments.

In conclusion, AKNP remains one of Myanmar's most ecologically significant protected areas, harbouring diverse and threatened wildlife. However, habitat degradation, human-wildlife conflicts, and resource exploitation continue to pose significant conservation challenges. The integration of scientific research with community knowledge provides a comprehensive framework for understanding species distributions, identifying conservation threats, and formulating effective mitigation strategies. Moving forward, a holistic, interdisciplinary approach—combining advanced ecological modelling, participatory conservation initiatives, and strengthened law enforcement—is imperative to ensure the long-term viability of AKNP's biodiversity. By fostering sustainable coexistence between local communities and wildlife, conservation efforts can be more effectively tailored to preserve Myanmar's rich natural heritage while addressing socio-economic realities.

## 6. References

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