Doctoral (Ph.D.) Dissertation

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Hungarian University of Agriculture and Life Sciences

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ASSESSING THE POTENTIAL APPLICATION OF HUNGARIAN WILDLIFE MANAGEMENT STRATEGIES TO IMPROVE WILDLIFE CONSERVATION TOOLS IN MALAYSIA

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DECLARATION

Signed below, Siti Mastura Binti Hasan, a student of the Szent István Campus of the Hungarian University of Agriculture and Life Sciences, studying for a doctoral degree (Ph.D.) in the Doctoral School of Animal Biotechnology and Animal Sciences declare that the presented Dissertation is my own work and I have used the cited and quoted literature in accordance with the relevant legal and ethical rules. I understand that the three-page-summary of my dissertation will be uploaded on the website of the Campus/Institute/Course and my Dissertation will be available at the Host Department/Institute and in the repository of the University in following with the relevant legal and ethical rules.

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Date: September / 2024

Siti Mastura Binti Hasan

Signature

DEDICATION

This dissertation is dedicated to my beloved parents,
Hasan bin Mat Zin and Noriah binti Tumin,
whose unconditional love, support, and sacrifices have been the pillars of my success. Your guidance and faith in me have made this achievement possible, and for that, I am eternally grateful.

In loving memory of my dear brother,
Khairul Akmar Bin Hasan.
Though you are no longer with us, your memory lives on in my heart and continues to inspire me in all that I do.

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List of Acronyms and Codes:

GWS	– Geo Wild System
IUCN	– International Union of Conservation Nature
CITES	– Convention on International Trade in Endangered Species
DWNP	– Department of Wildlife and National Park, Peninsular Malaysia
PERHILITAN	– Jabatan Perlindungan Hidupan Liar & Taman Negara Semenanjung Malaysia
NGMD	– National Game Management Database
SMART	– Spatial Monitoring and Reporting Tool
APC	– Asian Palm Civet
WAI	– Wildlife Attitude Index
WMMAI	– Wildlife Management Method Attitude Index
CRUD	– Create, Read, Update, and Delete
GIS	– Geographical Information System
PWA	– Progressive Web Application
APP	– Application
KDE	– Kernel Density Estimation
GDP	– Gross Domestic Product
EU	– European Union

1. INTRODUCTION AND RESEARCH PROBLEM

1.1. Introduction

The background of this study is rooted in the critical and ongoing wildlife conservation challenges in Malaysia. Malaysia is one of the world's megadiverse countries and home to plentiful species of flora and fauna, many of which are endemic and endangered (Tong, 2020). Despite its diverse ecosystem, Malaysia faces significant conservation challenges, including human-wildlife conflict, poaching, illegal wildlife trade, and habitat loss (Xin et al., 2024). Wildlife have become notable for their increasing encounters with humans, especially in areas where urban areas encroach upon natural habitats (Mohamad Muslim et al., 2018; Ciach et al., 2023; Xin et al., 2024). These issues are exacerbated by rapid urbanization, infrastructural development, and agricultural expansion, placing further pressure on the current fragile ecosystem (Cheng et al., 2023; Mohamad Muslim et al., 2024).

The Malaysian government and many NGOs have implemented various policies and strategies to tackle these conservation concerns (Tong, 2020). In this context, 'strategy' refers to overarching plans aimed at achieving long-term conservation goals (Johnson & Scholes, 2005). However, issues continue, indicating that existing strategy may need to be sufficiently effective or sustainable. This is further complicated by the socio-economic and cultural complexities that shape wildlife conservation in Malaysia, necessitating strategies that are not only ecologically sound but also culturally and socially sensitive (Pimid et al., 2022).

Internationally, countries like Hungary have been recognized for their practical approaches to game management (Nagy & Bencze, 1973), where 'game' refers to species traditionally managed for hunting, whether for sport or food. Hungary's achievements stem not only from its strategic planning but also from its well-structured management system, which encompasses the processes, regulations, and practices necessary for implementing these strategies effectively (Sillitto et al., 2017). This system goes beyond the management of game species, extending to broader wildlife conservation efforts. It is characterized by rigorous scientific research, a commitment to

sustainable use, and active community engagement. As such, Hungary provides a valuable model for countries seeking to enhance their wildlife and game management systems (e.g., Nagy & Bencze, 1973; Csányi, 1993; Báldi et al., 2001; Csányi et al., 2010; Anthony & Tarr, 2019).

However, applying these systems to countries like Malaysia, which does not have game species, presents distinct challenges. In Malaysia, wildlife management must focus on non-game species, requiring the adaptation of strategies that were originally designed for game species. This necessitates exploring how Hungary's system can be effectively modified to fit Malaysia's unique ecological, socio-economic, and cultural context.

This study background, therefore, includes the urgent need for enhanced wildlife conservation in Malaysia, the potential lessons to be learned from Hungarian wildlife management strategies, and the broader aspect of global conservation. This study aims to contribute an in-depth understanding and more effective tools for wildlife conservation, not only benefiting Malaysia but also offering insights and strategies that can be adopted by other countries facing similar challenges. It sets the platform for a comprehensive exploration of innovative methods, cross-cultural learning, and the development of tailored approaches to conserving wildlife.

1.2. Research problem

1.2.1. Increase in human-wildlife conflict in Malaysia

The increase in human-wildlife conflict in Malaysia is a multi-dimensional issue. It is not just a consequence of urbanization and habitat encroachment but also indicative of broader systemic issues. Wildlife such as the Asian palm civets (*Paradoxurus hermaphroditus*) are increasingly viewed as threats and nuisances, rather than integral components of Malaysia's natural heritage (Nakashima et al., 2010). This is particularly evident as the civet's natural habitats are shrinking due to deforestation and agricultural expansion. This leads them to forage in human-populated areas, where they are often blamed for damaging crops and disturbing residential areas. This perception and attitude are frequently due to the conflict's direct impact on human safety and livelihoods (Young et al., 2021; Mekuriaw & Getahun,

2022).

These conflicts can decrease community support for conservation, making it more challenging to implement effective and sustainable strategies (Young et al., 2021). Understanding the socio-ecological dynamics of these human-wildlife conflicts, including the socio-economic factors influencing local attitudes and the behavioral patterns of wildlife such as the Asian palm civet, is essential for developing more effective management strategies (Pimid et al., 2022).

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1.2.2. Inefficiency of existing wildlife management strategies in Malaysia

The inefficiency of existing wildlife management strategies in Malaysia can be attributed to many factors. One main issue is the need for localized context-specific approaches. While national policies may set a legal framework for wildlife conservation, their implementation often does not account for the diverse socio-economic and cultural background of its local communities or varied ecological conditions across Malaysia (DWNP, 2023). This lack of localization can result in less effective strategies or even be counterproductive in certain aspects (Melick et al., 2012). In addition, there is often a gap in monitoring and enforcement with insufficient resources allocated to ensure that wildlife conservation policies are effectively implemented on the ground (DWNP, 2023).

Another critical issue is better stakeholder engagement in the developing and implementing wildlife management strategies in Malaysia. Local communities near wildlife are often the most affected by conflicts but may not mention how these issues are managed. Their needs and knowledge are frequently overlooked in the decision-making process, leading to a disconnect between wildlife conservation policies and the realities faced by these local communities (Ernest, 2023). Engaging local communities, understanding their needs, perceptions, and attitudes, and involving them in conservation efforts are essential for developing sustainable and effective wildlife management strategies (Mogomotsi et al., 2020).

Furthermore, the research problem is intensified by the need for more holistic strategies for wildlife conservation. Current strategies often focus on

specific species or issues without considering the broader socio-economic and ecological system (DWNP, 2023; Kurz et al., 2023). A broader and integrated strategy is needed, which considers economic development, local community well-being and land use planning alongside wildlife conservation goals. These strategies should also incorporate technology and cutting-edge science, including geographic information system and data analytics, to understand better and manage wildlife populations and their habitats (Zhang, 2019; Casazza et al., 2023).

In conclusion, the research problem is multifaceted and complex, requiring a subtle and comprehensive approach. It calls for reevaluating existing wildlife management strategies in Malaysia, considering cultural, socio-economic, and ecological aspects. It also demands innovative tools that are adaptable, integrated, and participatory, reflecting the interconnected wildlife systems and nature of humans.

1.3. Research gap and rationale

This study research gap addresses the limited investigation and understanding of how Hungarian wildlife management strategies, which are noted for their effectiveness and innovation, can be adapted and implemented in the Malaysian context to improve conservation efforts. Despite the critical conservation challenges Malaysia faces, including poaching, human-wildlife conflicts, and habitat loss, there needs to be more in-depth studies identifying the application and customization of conservation tools to its unique cultural, ecological, and socio-economic context. This gap marks a significant opportunity for potentially transformative conservation strategies and tools that could be adapted from European countries like Hungary, which have shown success managing their wildlife in similar areas.

The rationale behind this research stems from the critical need to address the increasing human-wildlife conflicts and the apparent inefficiency of existing wildlife management strategies in Malaysia. Innovative, effective, and culturally sensitive conservation strategies are therefore essential for the nation’s sustainability and the well-being of its local communities. By investigating the adaptation of potential Hungarian management strategies,

this study seeks to introduce some novel perspectives and potentially more effective conservation tools in Malaysia.

1.4. Aim of the study

The primary aim of this study is to assess the efficiency of Hungarian wildlife management strategies and their potential applicability and adaptability within the Malaysian context to improve wildlife conservation tools. Specifically, this study aims to a) conduct an extensive comparative analysis between Hungarian and Malaysian wildlife management strategies (system) to identify unique approaches, challenges, and outcomes; b) investigate the extent of human-wildlife conflicts in Malaysia, mainly focusing on the Asian palm civet conflict, and evaluate the current mitigation strategies employed; c) assess local attitudes towards wildlife and their management methods using newly developed attitude indices, such as WAI (Wildlife Attitude Index) and WMMAI (Wildlife Attitude Management Method Index); and d) introduce Geo Wild System (GWS) as a novel wildlife reporting, monitoring, and analyzing system in Malaysia, serving as the integration and implementation of a customized version of the NGMD (National Game Management Database) system that aligns with Malaysia's ecological, cultural and socio-economic contexts.

1.4.1. Research objectives and questions

Below are the studies identified based on the research problem; each objective is coupled with a research question(s).

(a) To conduct comparative analysis: Conduct a comprehensive comparative study between Hungarian and Malaysian wildlife management strategies to identify unique approaches, challenges, and outcomes.

a_1 – What are the primary differences and similarities between Hungarian and Malaysian wildlife management strategies?

a_2 – Can Hungarian wildlife management strategies be adapted to the Malaysian context?

a_3– What lessons can be learned from each?

(b) To investigate human-wildlife conflicts in Malaysia: Examine the extent of human-wildlife conflicts in Malaysia, particularly on the Asian

palm civet conflict, and assess the efficacy of current mitigation strategies

b_1 – What is the extent of human-wildlife conflict in Malaysia, particularly concerning the Asian palm civet?

b_2 – How effective are the current mitigation strategies?

(c) To assess local attitudes: Understand and evaluate local attitudes towards wildlife and their management in Malaysia using developed attitude indices

c_1 – What are the local attitudes towards wildlife and their management in Malaysia?

c_2 – How can these attitudes be quantitively developed and assessed for better policy formulation?

(d) To introduce technological solutions: Introduce Geo Wild System as a novel tool for wildlife reporting, monitoring, and analyzing system in Malaysia

d_1 – How can the introduced Geo Wild System be integrated into Malaysian wildlife management?

d_2 – What are its potential benefits?

By addressing these objectives and questions, the research aims to provide a comprehensive understanding of the current state of wildlife management in Malaysia, identify new strategies and tools for improvement, and contribute to effective wildlife conservation practices.

1.5. Research significance

This study's significance lies in its potential to transform wildlife management conservation practices in Malaysia. By investigating the adaptation of Hungarian wildlife management strategies, this study aims to develop innovative and effective wildlife conservation tools in a context with unique cultural, ecological, and socio-economic aspects. This study has significant relevance for several reasons:

1. By determining and adapting successful international strategies, Malaysia can improve its conservation efforts, and protect its wildlife and habitats.

2. Addressing the prevalent human-wildlife conflicts involving Asian palm civet, this study can lead to more effective and humane conflict mitigation strategies, benefiting local communities and wildlife populations.
3. Assessing local attitudes towards wildlife and their management methods provides empirical data that can inform decision-makers. One can develop more ecologically and culturally sensitive policies by understanding local aspects and attitudes.
4. Introducing and proposing the Geo Wild System as a novel tool for wildlife reporting, monitoring, and analyzing could revolutionize the wildlife data is collected and used, leading to more informed decision-making and effective conservation strategies
5. This study fosters international collaboration and knowledge exchange, setting a precedent for future cross-country studies and partnerships in wildlife conservation.
6. Effective wildlife management and conservation strategies can contribute to various economic benefits, including sustainable hunting and tourism, local community development, and the protection of livelihoods.

2. LITERATURE REVIEW

Wildlife management and conservation are crucial in Malaysia due to its remarkable ecosystem and biodiversity. However, the effectiveness of existing wildlife management strategies in Malaysia remains a subject of constant improvement and evaluation. This chapter aims to provide an overview of the potential application of the elements of Hungarian wildlife management strategies to improve wildlife conservation tools in Malaysia. It investigates existing scientific research, conservation practices, and key considerations related to this potential integration.

2.1. Introduction to wildlife management and conservation

Wildlife management may be defined as managing wildlife populations in the ecosystem context; the core around which management activities are organized: the manipulation or protection of a population to achieve a goal (Fryxell et al., 2014). To achieve a sound wildlife management, it is central to understand the biology and habitat of the animal and the human dimensions associated with both (Krausman & Cain, 2013). A holistic view considers wildlife a triad of the animal, its habitat, and people, and the interactions between them (Giles, 1978). The animal component addresses all aspects of a species, including its biology, ecology, behavior, genetics, physiology, and life history characteristics, along with other key factors. The habitat component, on the other hand, considers various elements such as vegetation, soils, climate, topography, and the complex interactions within the broader ecological community. Furthermore, human dimensions are vital, reflecting how people value wildlife, their preferences for its management, and the reciprocal influences between human activity and wildlife management decisions (Decker et al., 2001).

Wildlife management and conservation protects wild animal and plant species and their habitats to maintain biodiversity and ensure that the ecosystem function sustainably and healthily (Riley et al., 2002; Zaheer & Tanvir, 2020). Wildlife management is an applied ecological science, techniques and strategies for research and implementation in wildlife conservation (Merkle et al., 2019). Wildlife management is a critical aspect of preserving and conserving wildlife. It involves various strategies to

preserve biodiversity, including regulating and managing habitats, and establishing protected areas such as national parks and wildlife sanctuaries (e.g., Kumar et al., 2020; Hoffman, 2022). In addition, wildlife management and conservation practices often involve breeding and rehabilitation programs for endangered species, as well as ecological research to understand the behavior and needs of wildlife species and their roles within ecosystem (Cristescu & Boyce, 2013; Waples, 2013; Zaheer & Tanvir, 2020).

Globally, wildlife faces unprecedented loss and threats from human-wildlife conflict, climate change, and habitat loss, often resulting in detrimental outcomes (Manfredo, 2008; Kumar et al., 2020; Linuma et al., 2022; Reidinger, 2022). The habitat loss is driven by urbanization (infrastructural development), agricultural expansion, and deforestation (Simkin et al., 2022). It is not merely a local issue but a global challenge that affects species survival, ecological networks, and ecosystem services (Simkin et al., 2022). Climate change further escalates these threats, shifting species distribution, altering habitats and increasing wildlife vulnerability to extreme weather events (Parmesan et al., 2022). Human-wildlife conflict is another pervasive threat as growing human populations encroach on wildlife habitats, leading to negative impacts that often result in economic losses for local communities and wildlife causalities (Linuma et al., 2022). These global issues highlight the need for adaptive and effective management strategies that can mitigate these threats, ensuring the survival of the wildlife species, promote sustainable coexistence, and preserving the natural heritage for future generation (Riley et al., 2002).

In Malaysia, rapid development and economic growth have led to significant environmental changes with large forest areas being converted for urban, industrial, and agricultural use (Begum et al., 2020). This habitat loss and other issues such as illegal wildlife trade and poaching puts intense pressure on the nation's wildlife, contributing to increased human-wildlife conflicts and declining biodiversity (Cardoso et al., 2021). Wildlife conservation issues in Malaysia are hence deeply tied to broader socio-economic developments. To address them, the strategies must be multifaceted, considering the need for economic growth while ensuring

wildlife conservation and sustainable use of natural sources (Riley et al., 2002). Similarly, Hungary, while less biodiverse as Malaysia, holds significant ecological value with its unique species and habitats (Sundseth, 2009; Tucker, 2023). The country has faced its own set of conservation issues but has also been noted for its practical approaches to wildlife management strategies that balance the needs of wildlife and people (e.g. Csányi et al., 2012; Csányi, & Lehoczki, 2010; Kovács et al., 2021). Its successful integration of hunting and conservation under a state ownership for public resource model has been noted for its ability to generate conservation revenue while involving local communities and stakeholders in management decision (Damm, 2008).

Effective wildlife conservation requires collaboration among governments, NGOs, local communities and other stakeholders to create and implement strategies that balance ecological needs with human development and welfare (Riley et al., 2002; Pomeranz et al., 2021). Moreover, international cooperation is also important for wildlife conservation, particularly for migratory species that cross national borders. International agreements like the Convention on International Trade in Endangered Species (CITES) assist in regulating the trade of wildlife and ensure that it does not threaten their survival (Childerhouse & Baxter, 2010). Besides that, technological advances are also playing an increasingly crucial role in wildlife conservation. Tools such as drone surveillance, satellite imaging, satellite telemetry, camera trap, and genetic analysis are becoming indispensable for tracking wild animals, monitoring habitats, and understanding the genetic health of wildlife populations (Decker et al., 2001; Pettorelli et al., 2014; Trolliet et al., 2014; Jiménez López & Mulero-Pázmány, 2019; Schally et al., 2022; Segelbacher et al., 2022)

The introduction to wildlife conservation within this global and dual-country aspect emphasizes the interconnected and multi-layered nature of wildlife issues and the importance of learning from diverse approaches to develop effective management strategies (Riley et al., 2002). Hungary's and Malaysia's experiences, even though different in approaches, provide valuable insights into the complexities of conserving wildlife in the face of socio-economic needs, ecological changes, and development pressures.

Understanding these dynamics is vital for enhancing management strategies that not only address immediate conservation issues but also contribute to long-term sustainability.

2.2. Wildlife management in Hungary

Hungary, a landlocked country in Central Europe, is a member of the European Union (EU). It encompasses an area of 93,000 km2 and is divided into 19 counties with distinct wildlife legislative and management systems (Parry-Jones & Knapp, 2005; Biodiversity Information System for Europe, 2024). Its population is estimated at 9.6 million, with a slight annual decrease of about 0.3% as of 2022. The female population slightly exceeds males, with 4.9 million compared to 4.7 million, respectively (Hungarian Central Statistical Office, 2023). The median age in Hungary is 43.4 years, reflecting a more mature population. The country is divided into three main regions: Central Hungary, which includes the capital Budapest, Transdanubia, and the Great Plain and North as shown in **Figure 1**. Each region differs significantly in terms of human population distribution, socioeconomic activities, and urbanization levels.

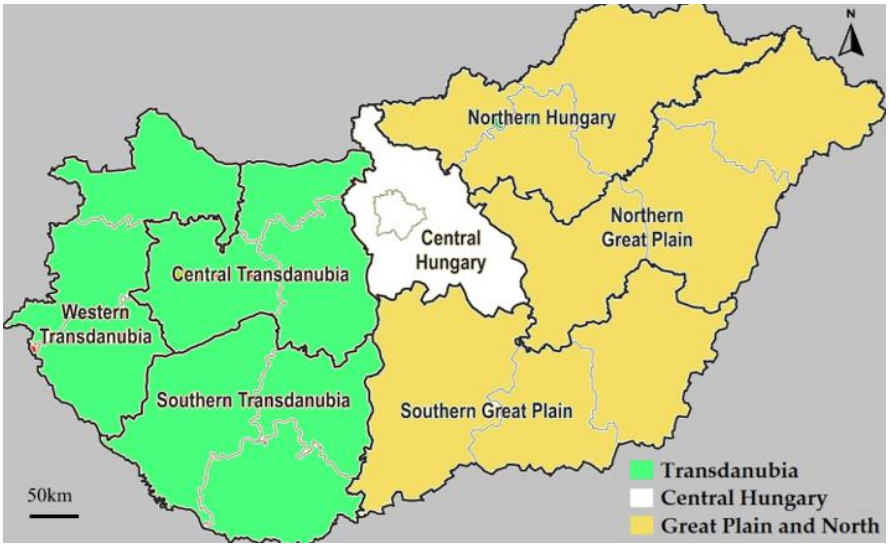

Figure 1. Map of Hungary.

In the rural areas of the Great Plain and North, the population density is much lower than in the highly urbanized Central Hungary, which houses the capital city and the highest percentage of the country's population. The overall population density in Hungary is around 105 inhabitants per square kilometer, with approximately 71.5% of the population living in urban

areas (Hungarian Central Statistical Office, 2023).

Hungary, with its rich history and diverse geographical features, including vast plains, large lakes, and forested hills, is home to various flora and fauna (Tucker, 2023). The country is mainly known for its thermal waters and the extensive cave systems in the karst regions. Hungary's wildlife includes species such as the red deer (*Cervus elaphus*), the roe deer (*Capreolus capreolus)*, the Eurasian lynx (*Lynx lynx*), and numerous bird species like the great bustard (*Otis tarda*) and the saker falcon (*Falco cherrug*), which thrive across its diverse habitats (European Environment Agency, 2022).

Hungary’s approach to wildlife management includes comprehensive strategies such as conservation efforts, sustainable hunting practices, and measures to ensure the well-being of wildlife and their habitats (Myronenko, 2015). Game management and hunting have had a long tradition of legislation, and some elements can be traced back to the 1880s (Csányi, 1994). Moving toward coordinated management of timber and other resource uses in Hungarian forests (Tóth, 1991). A fundamental of these strategies is the state ownership of the public resource model where wildlife is considered a national resource. This model is supported by a regulated hunting system, which plays a crucial role in managing game populations and funding game conservation initiatives (Csányi and Lehoczki, 2010; Myronenko, 2015). Sustainable hunting is fundamental in Hungary as it directly affects game species, and can indirectly affects other wildlife species population trends and densities (Csányi, 1993; Csányi, 1998; Csányi, 1999)

Multiple laws shape Hungary's wildlife management system, each tailored to specific conservation needs. The 'Hunting Law,' Act LV/1996 on Game Conservation, Game Management, and Hunting, is specifically designed for game conservation and hunting, focusing solely on game species. This law delineates sustainable hunting practices, the management of game populations, and the allocation of conservation funding from regulated hunting activities (Csányi and Lehoczki, 2010; Myronenko, 2015). Additional legislative frameworks, including Nature Conservation Act LIII/1996 and Act LVI/2017, support more comprehensive wildlife/nature

conservation efforts, addressing a range of environmental and wildlife management aspects (Biodiversity Information System for Europe, 2024). Collectively, these statutes oversee the management of both game and non-game species, including protected wildlife.

Mandatory hunting licenses, which detail specific species, seasons, and designated hunting grounds (game management units), are essential for this system. This regulatory framework ensures the sustainable management of game species, such as the wild boar (*Sus scrofa*) and various wild ruminant species, namely the red deer (*Cervus elaphus*), fallow deer (*Dama dama*), roe deer (*Capreolus capreolus*), and mouflon (*Ovis gmelini*). This method not only sustains animal populations but also generates significant revenue from selling hunting permits, trophy hunting, and game meat. The income is reinvested into targeted game conservation and management activities, initiatives for these game species, bolstering ongoing management and habitat restoration projects (Janoska, 2008; Csányi & Lehoczki, 2010). Long-term statistical data confirm that Hungarian game management and hunting, in financial terms, is a self-sustaining system, operating without government subsidies or similar external inputs. In this sustainable operation of the Hungarian game system, hunting tourism connected mainly to the big game species, is a crucial element (Csányi & Szemethy, 2015; Csányi et al., 2024).

In Hungary, species protection is governed by EU law, notably through the Habitats Directive (European Communities, 1992) and Birds Directive (European Communities, 1979). The Habitats Directive has a total of 212 species on its list; on the other hand, the Birds Directive specifically protects a total of 232 species of wild birds in Hungary (Biodiversity Information System for Europe, 2024). Specifically, Act LIII of 1996 on Nature Conservation provides the local legal framework that supports their EU directives, ensuring that national policies align with broader European conservation objectives (FAO, 2024). Moreover, Hungary also actively participates in European/global conventions and projects that contribute to conservation initiatives. International collaboration and agreement are crucial for managing migratory species and addressing transboundary environmental challenges.

The Natura 2000 network in Hungary also plays a vital role in nature conservation. It encompasses a diverse range of 444 species and 45 habitats, designated under the EU's nature directives (Biodiversity Information System for Europe, 2024). The number of species and habitats protected in each site varies based on factors such as site location, regional biodiversity, specific designation, and conservation objectives. The Natura 2000 frameworks ensures that activities potentially harming natural habitats and wildlife species are carefully regulated, aiding their conservation and protection (European Communities, 1992).

Hungary's commitment to protecting and preserving its biodiversity is further demonstrated by the extensive network of protected areas, which includes 10 national parks and various protected areas (CBD, 2014). A notable example is Hortobágy National Park, a UNESCO World Heritage Site, spanning approximately 800 square kilometers. This park plays a critical role in safeguarding vulnerable and endangered species such as the Eastern Imperial Eagle (*Aquila heliaca*) and the Great Bustard (*Otis tarda*) (Mari et al., 2015; Gyarmathy & Kolláth, 2017). These national parks are indispensable not only for preserving various species and habitats but also as vital hubs for ecological research and education.

Additionally, Hungary has implemented successful reintroduction programs to restore native species previously extinct in the wild. The Eurasian beaver (*Castor fiber*), for instance, has been reintroduced into areas like Gemenc and Tisza, contributing to the biodiversity of these regions (Bajomi, 2015). The country also emphasizes habitat management involving land-use planning and restoration projects, such as wetland restoration in Kis-Balaton, which are essential for waterfowl conservation, providing crucial resting and breeding sites for various species (Honti et al., 2020).

Despite these efforts, Hungary faces ongoing challenges such as balancing conservation needs with agricultural interests, infrastructure and industrial developments, and addressing the impacts of climate change on wildlife and habitats. To navigate these challenges, continuous adaptive management strategies are emphasized, ensuring the sustainability of Hungary's rich natural heritage (Malatinszky et al., 2013).

2.3. Wildlife management in Malaysia

Malaysia, located in Southeast Asia, covers an area of 329,847 km² and features a national border of 2,019.5 km along with a coastline of 4,675 km (Government of Malaysia, 2024). Administratively, Malaysia is divided into 13 states and 3 federal territories (Government of Malaysia, 2024). Geographically, Malaysia is divided by the South China Sea into two regions: Peninsular Malaysia and East Malaysia, located on the island of Borneo (Government of Malaysia, 2024), as depicted in **Figure 2**.

Figure 2. Map of Malaysia.

Despite being part of the same nation, these regions exhibit significant differences in terms of human population distribution, socioeconomic activities, and the prevalence of human-wildlife conflicts. As of 2022, Malaysia's population is estimated at 32.7 million, with an annual growth rate of 0.2%. The male population totals 16.8 million, exceeding the female population of 15.9 million (Department of Statistics Malaysia, 2022). The median age is 30.3 years. In the Borneo region, 46% of the populations of Sabah and Sarawak reside in rural areas, compared to the national average of 29%. In Peninsular Malaysia, only 20% live in rural settings, reflecting higher urbanization levels. The overall population density in Malaysia is 99 inhabitants per square kilometer, with 78.4% of the population living in urban areas.

Malaysia is renowned for its diverse ecosystems and tropical rainforests,

home to a rich array of flora and fauna (Manokaran, 1992). It is recognized as one of the 17 megadiverse countries globally, home to numerous endemic species. The country hosts iconic wildlife species such as orangutans (*Pongo pygmaeus*), Malayan tigers (*Panthera tigris jacksoni*), Asian elephants (*Elephas maximus*), and numerous species of reptiles and birds (Manokaran, 1992). Wildlife management in Malaysia is specifically designed to address the conservation needs of these diverse ecosystems. Establishing protected areas is a primary strategy in these management efforts (Daim et al., 2012), including locations such as Taman Negara National Park and Kinabatangan Wildlife Sanctuary, which are crucial for providing habitats and maintaining ecological balance (Mardiastuti et al., 2013).

A critical component of wildlife management is the legal framework governing conservation practices. Historically, Malaysian wildlife management stemmed from traditional hunting and gathering practices by indigenous communities (Loke et al., 2020). Formal wildlife management began with establishing of the Taiping Game Reserve in 1878 (Perhilitan, 1990). Additionally, Malaysia is a signatory to CITES (Laws of Malaysia, 2014).

In Malaysia, wildlife management and conservation are guided by laws enacted by both federal and state governments, as outlined in the 1957 Federal Constitution (Government of Malaysia, 2024). In Peninsular Malaysia, the original Protection of Wildlife Act of 1972 was superseded by the Wildlife Conservation Act 2010 and its amendment in 2022, which introduced stricter penalties for wildlife-related crimes, including illegal trade and poaching (Laws of Malaysia, 2022). The Wildlife Conservation Act of 2010 provides a comprehensive legal framework for wildlife management and conservation at the national level (Jayasilan, 2014). In contrast, in East Malaysia, on the island of Borneo, wildlife regulations are overseen by the Sabah Wildlife Conservation Enactment of 1997 and the Sarawak Wildlife Protection Ordinance of 1998 (Jayasilan, 2014).

Furthermore, the Department of Wildlife and National Parks (DWNP) Peninsular Malaysia was established to enforce and manage conservation efforts (Perhilitan, 1990). The evolution of Malaysia's wildlife

management has transitioned from colonial-era game reserves to contemporary conservation practices, supported by stringent wildlife protection laws and international collaborations. Nowadays, hunting is highly regulated in Malaysia, with permits issued only for scientific research or controlled hunting in designated areas. To obtain a license, applicants must meet eligibility criteria, apply to the appropriate wildlife authority, potentially attend a briefing on conservation and hunting regulations, and pay any relevant fees (DWNP, 2023). Strict penalties are imposed for poaching or hunting without a permit (Laws of Malaysia, 2022).

Nature-based tourism, particularly ecotourism and wildlife watching, has emerged as a sustainable alternative to hunting, focusing on observing and conserving wildlife in their natural habitats (Tapper et al., 2006). The revenue from ecotourism supports wildlife conservation, funding scientific research, habitat restoration, anti-poaching initiatives, and species protection (Stronza et al., 2019). For example, the Sepilok Orangutan Rehabilitation Centre in Sabah is a notable ecotourism site that educates visitors about orangutans while supporting their rehabilitation efforts.

Community-based conservation is another approach, which involves local communities in wildlife conservation efforts, acknowledging that their participation and support are crucial for sustainable outcomes (Stronza et al., 2019). This includes integrating indigenous knowledge and practices into the management of conservation areas, contributing to the monitoring and protection of biodiversity (Daim et al., 2012).

Despite these comprehensive strategies, Malaysia continues to face challenges such as human-wildlife conflicts, poaching, and habitat loss, necessitating ongoing adaptation and improvement in management strategies. This includes enhancing monitoring systems, strengthening law enforcement, promoting greater community engagement, and ensuring that ecotourism and development activities are sustainable and protective of wildlife (Kasmuri et al., 2020; Omran et al., 2020; Loh et al., 2022).

2.4. Human-wildlife conflict and coexistence in Malaysia

Human-wildlife conflict and coexistence (HWCC) typically occur when the behavior and needs of wildlife are impacted negatively or when humans negatively affect the wildlife's needs (Sillero-Zubiri & Switzer, 2001). The primary factor of these conflicts is the growing human population adjacent to wildlife habitats (Sukumar, 1989). These conflicts may result when wildlife threatens, injures, or kills human and domestic animals and damages crops and property (Sillero-Zubiri & Switzer, 2001). The damages caused have various impacts on the human livelihoods depending on their livelihood security at the incident time (Mulonga et al., 2003). Various wildlife species cause different types of damage. HWCC includes human safety, welfare, health, social and economic impacts (Ogada et al., 2003). The emphasize on HWCC has often been a wildlife conservation constraint, as conservationists have focused their aim on reducing negative interactions instead of increasing positive relations between wildlife and humans (Chapron & López-Bao, 2020).

HWC in Malaysia is a significant and growing issue, mainly driven by conversion, degradation and loss of habitat due to rapid urbanization, infrastructure development, and agriculture expansion (Lim et al., 2024). This has led to increased interactions between wildlife and humans, especially in areas where wildlife habitats have been encroached upon (Sukumar, 1989). Crop and property damage by wild animals such as wild boars, elephants, monkeys, and Asian palm civets can lead to substantial economic losses for locals, which pushes them into direct conflict with wildlife (Lim et al., 2024).

This conflict is exacerbated by losing food sources for these wild animals, driving them to seek sustenance in human areas. This not only impacts the economic well-being of local communities, especially those reliant on agriculture, but also poses a significant threat to the survival of many wildlife which may be captured in retaliation and killed or as a preventive measure (Mekonen, 2020). The challenge is further complicated by a lack of effective management strategies, insufficient funding and enforcement of wildlife protection laws, and often a need for more education and awareness among local communities about how to coexist with wildlife (DWNP, 2023).

In this aspect, human-wildlife conflict in Malaysia is not just an ecological issue but also a socio-economic one, affecting the well-being of humans and wildlife. Addressing this issue requires a multifaceted approach that includes implementing effective and humane conflict mitigation strategies, local community engagement and education, habitat conservation and restoration, and policy reforms that balance wildlife conservation needs with human development goals (Decker et al., 2001). Reducing HWC is an urgent wildlife conservation priority and key to human-wildlife co-existence in this country.

2.4.1. Human-Asian palm civet conflict in Malaysia

Asian palm civets (APC), also known as Musang Pandan, as they emit the distinctive odor of pandan leaves (*Pandanus amaryllifolius*), are small carnivorous mammals (~2-5kg) and a viverrid that are native to many Southeast Asia countries, including Malaysia (Wilson & Reeder, 2005; Mittermeier & Wilson, 2009). In Malaysia, they are also known as toddy-cat because they also feed on palm flower sap, which, when it undergoes fermentation, becomes a sweet liquor (toddy) (Das & Tamang, 2023). They exhibit a flexible omnivorous diet, mainly consisting of fruits and opportunistically consuming invertebrates and small vertebrates, helping to maintain the ecosystem via seed dispersal (Nakashima et al., 2010). APCs are also primarily arboreal and nocturnal animals that inhibit trees with dense foliage in the daytime, while foraging on trees and the ground at night (Grassman, 1998; Nakashima et al., 2013).

They are also known for their role in producing Luwak coffee, made from coffee beans that have undergone partial digestion and subsequent excretion by civets (Lachenmeier & Schwarz, 2021). Although Luwak coffee has gained popularity in certain parts of the world, there are considerable concerns about the welfare and treatment of civets used for its production (Schmidt-Burbach et al., 2014; Carder et al., 2016). Additionally, the APC is subject to traditional hunting practices by Malaysia's aboriginal communities and falls under specific legal frameworks that accommodate such practices.

Despite the general prohibition on hunting in Malaysia, the Wildlife Conservation Act of 2010, as noted by DWNP (2017), makes exceptions for Aboriginal people. Under this Act, the Aboriginal people are permitted to

hunt for subsistence, but only the ten species listed in Schedule Six (Hussain et al., 2022). By recognizing the traditional rights of the Aboriginal people, the Act seeks to balance the preservation of cultural heritage with national conservation goals, while specifically limiting hunting to subsistence purposes (DWNP, 2017).

Thus, although generally protected, allowances for traditional practices emphasize a nuanced approach to wildlife conservation in Malaysia. While the APC is legally protected in Malaysia due to declining numbers (DWNP, 2017; Perhilitan, 2017), it is globally classified as a "Least Concern" species by the IUCN Red List (Duckworth et al., 2023). This classification reflects their wide distribution and presence in diverse habitats including forests, plantations, and urban areas, demonstrating some tolerance to habitat change (Yasuma & Andau, 2000). However, due to deforestation and increasing urbanization, their natural habitats have been compromised, pushing these animals to adapt to urban environments (Ahmad et al., 2022).

The human-Asian palm civet conflict in Malaysia results from urbanization and the encroachment of human activities into the natural habitats of these wild animals (Yasuma & Andau, 2000; Shevade et al., 2017). While some locals enjoy the presence of these wild animals in their surroundings, others view them as a nuisance (Nowak, 1999). APCs have been known to encroach on fruit trees, attack poultry, and cause damage to local properties such as roofs and basements due to their climbing nature and sharp teeth and claws (Ahmad et al., 2022). In certain situations, they may exhibit aggression towards locals through direct contact especially when they feel threatened and cornered (Kissui, 2008). Consequently, conflict with APC has become a significant local social issue within communities. Generally, the human-wildlife conflict not only causes damage and losses but also can threaten the safety of locals (Hill, 2000; MacDonald & Sillero-Zubiri, 2002; Kissui, 2008). When the conflict exceeds the tolerance level and develops more negative attitudes, it can potentially reduce the local’s enthusiasm for protecting and conserving these species (Gadd, 2005).

Therefore, it is imperative to promptly prioritize the protection, management, and mitigation of the human-Asian palm civet conflict to protect APC. Considering that the local community’s attitude directly influences the

effectiveness of implementing conservation policies and establishing scientific human-wildlife coexistence approaches (Frank et al., 2015), it is necessary to study the relationship between humans and APC.

2.5. Local attitudes toward wildlife and their management methods in Malaysia

Wildlife creates complex social, ecological, economic, and management conflicts involving many stakeholders with various backgrounds and preferences (Nyhus, 2016). The interactions between wildlife and local people's attitudes can be multifaceted, possibly resulting in negative and positive thoughts, feelings, or behaviors (Almeida et al., 2014). This interaction grows the range and number of decision-makers involved in wildlife management. Seeing wild animals in human areas (habitations) and properties may have particular value for local areas portrayed as a natural environment (Hou et al., 2020). However, wildlife may impact local properties and potentially be exposed to a greater risk of acts of cruelty by local people toward them (Nyhus, 2016).

Repeatedly, human-wildlife interactions have generated negative impacts (Madden, 2004; Soulsbury & White, 2016; Reidinger, 2022). Interactions that create negative consequences for either humans or wildlife or both are termed human–wildlife conflict (Nyhus, 2016). Human-wildlife conflict can cause stress on local livelihoods by threatening human life (Macdonald & Sillero-Zubiri, 2002), destroying crops (Hill, 2000), and attacking livestock (Kissui, 2008), often resulting in lost income (McGuinness & Taylor, 2014). These costs can result in negative attitudes toward wildlife management and conservation among locals (Gadd, 2005). Such costs have significant implications for wildlife conservation, but attempting to mitigate them by regulating local activities often results in limited local acceptance of wildlife management initiatives (Naughton-Treves et al., 2005).

Managing wildlife through several methods, such as controlling the number, relocating, or influencing wildlife behavior, is a significant matter of considerable controversy amongst many stakeholders, including the local community (Duboi & Harshaw, 2013). This further increases the range of locals potentially involved in and influencing their management, some may be unfamiliar with "traditional" wildlife management methods, and hence, question their legitimacy. Furthermore, wildlife is being increasingly

encountered in rural and urban areas. The limited space increases these human encounters with wildlife (Soulsbury & WhitePiran, 2016). Human-wildlife conflict can intensify when humans compete for similar resources such as food or space (König et al., 2021), highlighting the need to find ways of co-existence between local people and wildlife (Miller et al., 2002).

In Malaysia, all kinds of wildlife management must significantly consider local needs, opinions, and attitudes. For efficacy in wildlife management and conservation, locals' attitudes toward wildlife must be regarded as (Hariohay et al., 2018). The management of wildlife through various methods, such as habitat management, hunting, euthanasia, education, and capture and relocation, is a conflict issue amongst locals and conservation practitioners who have different opinions and are involved in wildlife management decision-making, e.g., White, 2010; Gebresenbet et al., 2018. Consequently, there is consensus that more than the biodiversity and ecology information alone is needed to understand locals' attitudes and ensure support for wildlife and their management. Therefore, information about local socio-demographics, nature engagement, familiarity (experience), and the influence on attitudes toward wildlife is necessary to develop and improve wildlife management. Socio-demographic factors, such as age, gender, level of education, residential area, and familiarity (experience), are the most frequently cited in the existing literature (Tobias et al., 2021).

Attitudes are essential for assessing conservation performance (He & Wei, 2022) and management practices. Attitudes culminate thoughts, feelings, or opinions about a particular object or personal experience (Perry et al., 2022). Local attitudes toward management efficiency have strongly influenced active participation in management and conservation (Sirivongs & Tsuchiya, 2012). Assessing and understanding local attitudes toward wildlife conservation are growing into an integral component of wildlife conservation and management (Heberlein, 2012; Guerbois et al., 2013). There has been a variety of attitude studies in the previous literature. Yet, most studies did not specify the quantitative evaluation used to measure the locals' attitudes toward wildlife management methods. This study investigated locals' attitudes through a quantitative evaluation using a multi-item index, identifying key factors influencing attitudes toward wildlife and their

management methods, including socio-demographic factors. The research also explored preferences for wildlife management methods in Malaysia and examined how local attitudes affect the acceptability of these methods.

2.6. Technological advancements in wildlife conservation in Hungary and Malaysia

Advances in technology are revolutionizing the wildlife conservation field, offering new and powerful tools to protect, monitor, and study wildlife and their habitats (Casaer et al., 2023). Drones, for example, offer a more localized and powerful tool to patrol remote or inaccessible areas, monitor illegal poaching and logging activities, and track and study wildlife without causing disturbance (Silvy, 2020). These unmanned vehicles have become specifically useful in diverse and hard-to-reach areas, providing a bird's eye view of the landscape and its changes (Jiménez López & Mulero-Pázmány, 2019). Satellite imaging allows conservationists and researchers to monitor changes in land use, habitat fragmentation, and deforestation over large areas and in real-time (Pettorelli et al., 2014). Camera traps can be placed in remote areas and provide continuous monitoring without human presence, capturing images and recording behaviors of nocturnal animals that would otherwise be almost impossible to study (Trolliet et al., 2014). Furthermore, genetic analysis also has opened up new fields in understanding wildlife populations. By analyzing DNA samples, researchers can gain valuable insights into the genetic diversity of wildlife species and track the illegal trade of animal parts (Taberlet et al., 2018; Bruce et al., 2020; Segelbacher et al., 2022). This information is important for breeding and reintroduction program, and ensuring the long-term viability of species.

Moreover, integrating artificial intelligence and big data analytics with these technologies enables processing and interpretation of vast amounts of data more accurately and efficiently. This can lead to predictive modeling of habitat changes, anticipate poaching activities and potential human-wildlife conflict areas (Tuia et al., 2022). Mobile technology also plays a vital role enabling real-time monitoring, rapid data collection and sharing, and increasing local community engagement in wildlife conservation efforts (Mahmoud et al., 2021).

One notable technological advancement in wildlife conservation is

EarthRanger, a software platform developed by Vulcan Inc. that integrates data from various sources, including GPS collars, vehicle trackers, camera traps, and patrol reports, into a unified, real-time visualization and analysis system (Vulcan Inc., 2022). This platform significantly enhances the ability of conservationists to monitor wildlife, manage protected areas, and respond more effectively to incidents such as poaching or human-wildlife conflicts. EarthRanger has been successfully implemented in numerous conservation areas worldwide, demonstrating its potential to bolster conservation efforts (e.g., Docter-Loeb, 2023). Similarly, MammalWeb is an innovative tool that engages citizen scientists in wildlife monitoring by enabling them to upload and identify photos from camera traps (MammalWeb, 2023). This crowdsourced data provides valuable insights into animal populations and behavior, supporting research and conservation strategies (MammalWeb, 2023).

Another significant tool is the National Game Management Database (NGMD) in Hungary, which maintains comprehensive records of game populations, hunting results, and conservation efforts, including game feeding and habitat management. This database facilitates the effective management and monitoring of wildlife resources, ensuring sustainable practices and informed decision-making. Integrating such databases with real-time data from various technological sources can significantly enhance wildlife management strategies (Csányi et al., 2010).

In Malaysia, the Spatial Monitoring and Reporting Tool (SMART) system is essential. SMART is an open-source software used by conservation practitioners to improve the effectiveness of patrols and the management of conservation areas. By collecting and analyzing data on patrol efforts, threats, and biodiversity, SMART enables better resource allocation, planning, and evaluation of conservation strategies (SMART Partnership, 2019).

Technological advances provide researchers and conservationists with an ever-expanding tool that improves their ability to understand, protect, and manage wildlife and their habitats (Tuia et al., 2022). These tools are not just improving traditional conservation methods but are also enabling new forms of research and management strategies, making conservation practices more accurate and effective (Lahoz-Monfort & Magrath, 2021). As technology

advances, its role in wildlife conservation becomes even more significant, offering new solutions for protecting wildlife (Tuia et al., 2022).

In both countries, the effective use of technology, like the National Game Management Database (NGMD) and the Spatial Monitoring and Reporting Tool (SMART) system, can play a vital role in modern conservation practices. Such a system can improve wildlife monitoring and management capabilities, enhance data collection and analysis, and facilitate better decision-making. They also offer the potential to involve local communities and stakeholders more directly in conservation efforts, providing a valuable platform for reporting, sharing information, and raising awareness.

This study's focus on comparing and potentially adapting elements of Hungarian game management strategies to the Malaysian context emphasizes the importance of context-specific, adaptive, and integrated wildlife conservation strategies. It highlights the need for a nuanced understanding of local socio-economic and ecological conditions and the importance of international collaboration and knowledge exchange in addressing the global wildlife conservation challenge. By investigating the successes and challenges of different strategies, the study aims to contribute to developing more effective conservation tools in Malaysia that can ensure the survival and wellbeing of wildlife populations while also meeting human needs and welfare.

2.6.1. National Game Management Database (NGMD) system in Hungary

Hungarian wildlife management system/strategies place a strong emphasis on the conservation and sustainable management of both large mammal (big game) and huntable mammal and bird (small game) populations (e.g., Csányi, 1993; Szabó et al., 2009; Csányi & Lehoczki, 2010; Fehér et al., 2022). An integral component of this strategy is the National Game Management Database (NGMD) system of Hungary. The NGMD was first mandated by the Hunting Law in 1996 and has been conducted under the Institute of Wildlife Conservation, Szent István University (Csányi et al., 2010). It is a complete conservation tool that plays a pivotal role in ensuring the effective conservation and management of wildlife. The NGMD is a centralized and a robust repository of data on Hungary's game populations, game habitat management, and hunting activities (e.g., Barna et al., 2011; Lehoczki et al.,

2011). The database collects, organizes, and manages a wide range of data including population counts, hunting bags, GIS database (distribution maps), and habitat conditions. This data was collected through monitoring programs, field surveys, and reporting from hunters (Csányi et al., 2010; Csányi et al., 2024). This comprehensive tool not only assists in regulating sustainable hunting but also supports scientific research, and foster local engagement, making it an invaluable asset in Hungary's efforts to maintain the ecosystem (Csányi & Sonkoly, 2013).

One of the main aims of the system is to monitor the dynamics and status of wildlife populations, particularly big game species such as wild boar (*Sus Scrofa*), red deer (*Cervus elaphus*), and roe deer (*Capreolus capreolus*) (Csányi & Lehoczki, 2010; Ahl et al., 2021). From population data/information, wildlife managers can make informed decisions about game conservation priorities, hunting quotas, and habitat restoration practices (e.g., Barna et al., 2011; Lehoczki et al., 2011). Besides that, the system is also instrumental in regulating sustainable hunting practices (Csányi, 1998; Csányi, 1999). It provides information on population trends and sizes that help authorities set sustainable hunting quotas (Csányi et al., 2010).

For example, managing the roe deer population, one of Hungary's iconic game species, using NGMD (Csányi & Lehoczki, 2010). The NGMD contains data on game species, the population's status, spatial distribution, and spatiotemporal trends over time (Csányi & Lehoczki, 2010). After each hunting season, data on the number of games taken and trophy characteristics of big game harvested are entered into the system. This information aids in setting sustainable hunting quotas for the next season, ensuring that the hunting activities contribute positively to wildlife conservation (Csányi & Lehoczki, 2010).

Besides that, the NGMD is not just a tool for regulating hunting activities and provides detailed information on species and their habitats (Csányi & Lehoczki, 2010). It helps to identify areas where conservation actions are needed, such as protection measures and habitat restoration (e.g., in Csányi & Lehoczki, 2010). It also allows for adaptive strategies that can respond to new information or changing conditions enabling monitoring of the various management actions' impact (e.g., in Csányi & Lehoczki, 2010). However,

the system's primary purpose is game management, potentially contributing to less emphasis on protecting non-game species and conservation efforts. It also may lack the essential features to address poaching, illegal hunting, and wildlife trafficking effectively. These shortages may impede the use of decision-making and wildlife management (Hemming et al., 2022).

The success of NGMD lies in its systematic and comprehensive approach to data collection and analysis (e.g., Csányi & Lehoczki, 2010; Csányi et al., 2013). It ensures that game management is based on regular information collection and scientific data procession (Csányi et al., 2010; Csányi, 2013; Csányi, 2018), fostering accountability and improving transparency in managing game species. This, in turn, builds public support and trust for wildlife management strategies and policies, which is essential for their effectiveness. The NGMD system exemplifies how data and technology can be harnessed for effective and sustainable wildlife conservation.

2.6.2. Spatial Monitoring and Reporting Tool (SMART) system in Malaysia

The Spatial Monitoring and Reporting Tool (SMART) platform, developed by the SMART partnership was designed to address the issues inherent to monitoring and evaluating the effectiveness of park ranger patrols (Cronin et al., 2021). The SMART aims to enhance the conservation area management effectiveness by providing the technology, skills, and services necessary to make better use of available sources (Cronin et al., 2021). According to Cronin et al. (2021), it is a widely recognized conservation software system used globally to improve conservation in protected areas and across national protected area systems through an adaptive management approach. The system also addresses issues such as illegal wildlife trade and poaching in areas where illegal activities pose a significant threat to wildlife (e.g., Hotte et al., 2016; Critchlow et al., 2017). SMART can also be employed in marine and marine protected area management (Cronin et al., 2021). The system uses technologies such as mobile applications, satellite tracking, software, camera traps and GPS to collect wildlife population data, patrol efforts, illegal activities, and analysis (Cronin et al., 2021). These systems have made mobile data collection in the field much more accessible by combining data collection, storage, and multiple sensors, while providing access to technologies in a resource-limited landscape (Berger-Tal & Lahoz-Monfort,

2018). It assists in monitoring wildlife populations, investigating threats, and making informed decisions regarding law enforcement, resource allocation, and conservation strategies (Stokes, 2010; Marvin et al., 2016). It also helps wildlife conservation agencies and authorities develop and implement conservation and anti-poaching strategies to protect endangered species and combat wildlife crime (Cronin et al., 2021).

In Malaysia, implementing SMART demonstrates a progressive approach to wildlife conservation. SMART, a tool designed to enhance wildlife management and anti-poaching practices, is being utilized in various protected areas nationwide (SMART Partnership, 2019). For example, Belum-Temenggor Tropical Rainforest, one of Malaysia's most biodiverse areas, park rangers use SMART to collect data on wildlife sightings, signs of illegal activities like poaching or logging, and human activities. The system allows for real-time data entry using handheld devices, which are then analyzed to create reports and maps emphasizing patterns of wildlife threat and activity (SMART Partnership, 2019). This information assists the patrol and resources deployment, making conservation practices more efficient (Marvin et al, 2016).

The SMART system has been employed in identifying and monitoring endangered species such as the Malayan tiger (*Panthera tigris jacksoni*) and poaching hotspots (e.g., Hotte et al., 2016). Hotte et al., (2016) mentioned that the system aids in mapping sightings and tracking the movement of these elusive big cats, providing valuable insights into their habitat use, territorial ranges, and key areas that require protection. SMART enables more effective targeted patrol routes in protected areas such as Taman Negara, including the Malayan tiger. If a particular area shows increasing signs of illegal snares, patrols can be intensified in that area, or if a specific patrol route complies with less information over time, it can be adjusted to cover different regions (Berger-Tal & Lahoz-Monfort, 2018).

SMART covers a broader range of wildlife conservation activities including game and non-game species. Moreover, SMART implementation increased learning opportunities, which led to greater technology likelihood adoption and greater engagement among park rangers (Moreto et al., 2016; Sintov et al., 2019). However, the system can be complex to manage and set up. It also

requires a vital learning curve and relying on technology which can pose challenges in areas with limited connectivity and infrastructure (Falzon et al., 2019). Collecting and managing data in real-time may raise concerns about data security and privacy of wildlife data, especially when dealing with sensitive information about endangered species' locations, which could be valuable to poachers (Meek et al., 2014). Ensuring this data security is crucial but can be challenging.

Furthermore, while SMART aids in data collection and analysis, it does not directly address stem causes of threats to wildlife such as habitat loss, human-wildlife conflict, overharvesting, and illegal trade. With comprehensive strategies tackling these broader issues, the impact of SMART can be unlimited. Moreover, the system's aim of patrolling and enforcement might lead to a neglect of local community engagement and alternative wildlife conservation strategies, which are significant for long-term success (Morozov, 2013). There is also a risk that SMART could lead to a technocentric approach to conservation, where community judgement and traditional knowledge are undervalued (Morozov, 2013). The insight of indigenous people and local communities, who deeply understand the local ecology, is invaluable. If using SMART undermines the importance of these insights, it could lead to culturally inappropriate and less effective wildlife conservation practices.

Implementation of the wildlife monitoring system, like SMART, must be carefully managed in Malaysia. It should be integrated into a broader conservation strategy that addresses the root causes of wildlife threats, local community engagement, and respect for the local socio-cultural and ecological context. This balanced approach can ensure that the benefits of the technology are fully utilized while minimizing its drawbacks and ensuring the effectiveness and sustainability of wildlife conservation strategies in Malaysia.

2.6.3. Potential application of Hungarian wildlife management strategies in Malaysia

Malaysia is known for its rich wildlife and biodiversity. Still, it faces unique challenges in conserving its large mammal population such as Malayan tigers

(*Panthera tigris jacksoni*), Asian elephants (*Elephas maximus*), and orangutans (*Pongo pygmaeus*) (Davis et al., 2013; Ten et al., 2021; Lim & Campos-Arceiz, 2022). To address these challenges, Malaysia can potentially draw inspiration from Hungary's tried and tested wildlife management strategies, especially the NGMD system. By adapting and implementing this system, Malaysia can significantly improve its efficiency of wildlife monitoring system. The system can be established to set sustainable hunting quotas and control the fulfilment of the quotas (Csányi et al., 2010). It also can ensure that hunting activities do not jeopardize the long-term viability of target species and are controlled, such as the game species harvested, by using population data (e.g., in Csányi & Lehoczki, 2010). Furthermore, Malaysia can also implement a real-time wildlife monitoring system based on changes in population data. For example, if the system indicates a decrease in a specific species, conservation measures can be intensified to protect the species (Csányi & Lehoczki, 2010).

The system also can be utilized to plan and execute wildlife capture more effectively. Data on wildlife behaviors and movements can help anticipate animal behavior, improving capture efficiency (Rew et al., 2019). The data can guide infrastructure development such as protective fences and wildlife corridors in areas prone to human-wildlife conflicts to reduce such incidents (Buchholtz et al., 2020). Also, Malaysia can enhance local engagement and awareness by making the system accessible to the public. The system's population data can attract tourists who want to learn and observe Malaysia's wildlife. It also can generate income for local communities and promote wildlife conservation (Barna et al., 2011; Ntuli & Muchapondwa, 2018).

However, the system should be flexible enough to accommodate data on a wide array of species that address the diversity of the Malaysian ecosystem. Certain Malaysian regions are also remote and challenging to access (Horn & Rennie, 2018). Wildlife data collection might be more demanding in these areas, which require innovative data collection methods such as local community-based reporting and satellite imagery (Hoffman, 2022).

Moreover, local engagement and management efforts must consider cultural differences between Malaysia and Hungary. Local practices and beliefs related to wildlife also may vary, requiring a culturally sensitive approach

(William et al., 2021). Malaysia also will need to establish and enforce regulations for data reporting, ensuring that researchers, hunters, park rangers, and other stakeholders contribute to the database consistently and accurately. This includes ensuring the individuals' privacy who contribute data (Cremer et al., 2022).

Safeguarding sensitive wildlife data is essential. Robust data security and privacy measures, including encryption, data backup, and, access control, must be in place to protect against potential data theft or breaches (Cremer et al., 2022). By engaging the local and promoting data-driven decision-making (Danielsen et al., 2009; Urbano et al., 2024), Malaysia can strengthen its wildlife conservation strategies and contribute to the protection of its wildlife. The systems can become a powerful tool for sustainable wildlife conservation and effective management strategies in Malaysia with careful consideration of the Malaysian aspects.

The potential application of principles and practices from Hungarian NGMD systems into the newly developing Geo Wild System demonstrates a pioneering fusion of data-driven wildlife management methodologies to improve wildlife conservation. Fundamentally, this integration means adapting NGMD's structured, systematic approach to a broader, possibly more diverse Malaysian socio-cultural and ecological settings.

Comprehensively, this involves adapting NGMD's data collection methods mentioned by Csányi et al. (2010), which rigorously track and monitor wildlife population, habitat conditions, and hunting activities to the Geo Wild system's broader aim, which includes a more comprehensive array of wildlife species and conservation issues. This adaptation would expand the data gathered scope by the Geo Wild system, including not just sightings and incidents but also detailed information on wildlife population dynamics, health, and habitat changes over time (e.g., Csányi & Lehoczki, 2010; Enetwild Consortium et al., 2018; Ahl et al., 2021; Enetwild Consortium et al., 2021).

The Geo Wild System (GWS) could ensure a more comprehensive and inclusive approach by incorporating local communities, hunters, park rangers, and researchers into the conservation and data collection process (Danielsen et al., 2009; Benjamin et al., 2020; Singh et al., 2021). It helps to

foster a conservation culture among those directly interacting with the wildlife. Additionally, the analytical strength of NGMD, especially its ability to process complex data sets to inform management decision (Csányi et al., 2010), could significantly improve the GWS's capabilities. Real-time monitoring, predictive modeling, and trend analysis could become integral features, providing valuable insights for management strategies and policy-making (Urbano et al., 2024).

In conclusion, the potential application selected elements of Hungarian NGMD into the novel GWS offers a path to a more inclusive, sophisticated, and practical approach to wildlife conservation in Malaysia. The adapted system could significantly improve Malaysia's ability to protect and manage its wildlife by combining broad stakeholder engagement, detailed data collection, and comprehensive analysis. However, adapting and implementing this potential requires careful planning, resource allocation, and customization to ensure the system is sustainable and effective in the Malaysian context.

3. MATERIALS AND METHODS

This chapter explores an integrated methodological approach categorized into three parts to achieve the objectives and answer questions raised in chapter 1.4 of this thesis. The methods examined include:

1) Broad Literature Survey: Describes wildlife management strategies in both Malaysia and Hungary.
2) Field-Based Research: Focuses on the human-Asian palm civet conflict and local attitudes towards wildlife and their management methods in Malaysia, utilizing survey and field data collection.
3) Technical-Based Research: Concludes the methodological frameworks with the introduction and initial deployment of a novel "Geo Wild System (GWS)" in Malaysia, a wildlife reporting, monitoring, and analyzing system that utilizes PWA and survey data collection

3.1. Broad literature survey: Wildlife management strategies in Hungary and Malaysia

3.1.1. Literature survey

This study provided a comprehensive assessment to understand the diverse manifestations of wildlife management and its varying impacts on wildlife and local communities. It aimed to identify differences and commonalities in wildlife management across contexts, using Hungary and Malaysia as examples. Given the stark contrasts in wildlife conflicts and socio-economics between these countries, significant differences were expected in all fundamental aspects of wildlife management: what it entailed, why it was necessary, where it was implemented, and how sustainable the strategies were.

A qualitative comparative analysis of national wildlife management strategies in Hungary and Malaysia examined two management strategies characterized by their models, ownership, funding sources, systems, and regulatory frameworks. Despite contextual differences, their effectiveness was compared based on tangible outcomes such as wildlife population trends and economic impacts, along with evaluating each system's strengths and weaknesses.

Both countries selected a 'Big 5' species approach for this comparison. Hungary's Big 5 includes red deer (*Cervus elaphus*), wild boar (*Sus scrofa*), roe deer (*Capreolus capreolus*), fallow deer (*Dama dama*), and the mouflon (*Ovis aries*). In contrast, Malaysia's Big 5 includes the Malayan tiger (*Panthera tigris jacksoni*), Asian elephant (*Elephas maximus*), and Malayan tapir (*Tapirus indicus*), as data for other Big 5 species is undocumented. These species were selected based on their ecological significance, conservation status, and socio-economic relevance.

Three categories of sustainability, ecological, economic, and social, served as the framework for this study. An effective wildlife management strategy was deemed successful if it enhanced wildlife populations, yielded economic benefits that outweighed costs, and delivered positive outcomes for local communities. Wildlife management policies and aspects of protected areas were assessed to provide insights into each country's efforts in supporting wildlife and habitat conservation. These strategies were analyzed individually and comparatively.

The study reviewed policies of wildlife management strategies in Hungary and Malaysia published between 1960 and 2022, focusing on recent and historical wildlife management data to draw parallels with earlier strategies. A comprehensive review of the literature on wildlife management, contextual differences, and outcomes for people and wildlife in these countries was conducted, relying mainly on governmental and academic sources. Key legislation affecting wildlife conservation in each country was identified, linking these policies to the history of wildlife management. A "Triple Bottom Line Analysis" was conducted, ranking the indicators of each strategy within three categories: wildlife, economics, and local community support (Amit et al., 2020).

To understand these wildlife management strategies within such a broad scope, extensive literature citing peer-reviewed articles and official reports was collected between 2021 and 2023 using databases such as Scopus, Google Scholar, and Web of Science. A broad literature search was performed on the Web of Science database, retrieving peer-reviewed articles and official reports published using a combination of keywords in the titles, keywords, and abstracts of potential sources. Peer-reviewed articles and

official reports were prioritized as primary sources. Supplementary insights were drawn from studies referenced within these sources. When access to full-text papers was restricted, the authors were contacted directly to obtain the necessary materials.

3.1.2. Data analysis

An analysis was conducted on the collected literature to extract detailed descriptions and evaluations of wildlife management strategies. Given the limited scope of available reports, the analysis was open to more than specific publication years. This comprehensive review uncovered critical insights into the efficiency and impact of various wildlife management systems, contributing to an extensive comparative analysis that underscores effective practices and highlights potential areas for improvement across the two countries. This approach not only facilitates cross-country comparisons but also promotes collaborative learning.

A qualitative comparative analysis, recommended by Onwuegbuzie & Weinbaum (2017), was employed to categorize the effectiveness of wildlife management strategies into three key areas: (1) wildlife population trends, (2) economic contributions, and (3) local community support. Specific indicators for each category were identified for quantitative comparison across wildlife management strategies. Additionally, the historical and political dimensions of each management strategy were explored to provide comprehensive context. A brief list of the indicators includes:

- *Wildlife*

How is the management affecting large wildlife populations?

-Population trends of selected large mammals

-% of populations currently declining, stable, and increasing for each country according to IUCN status.

- *Economic*

How does wildlife contribute to GDP and employment?

-% GDP from ecotourism

-% GDP hunting

-% Population employed by tourism

-% Population employed by hunting

- *Locals*

Does the management encourage local support for conservation?

-Determine any national policies requiring benefit-sharing with locals

-Determine benefits from conservation (e.g., employment)

-Determine negative costs associated with wildlife (e.g., human-wildlife conflict)

The synthesis of these findings was presented in a Wildlife Management Strategies Indicators table, which ranks each country's performance across three categories using a color-coded system: green for high, yellow for medium, and red for low, based on established metrics from Pack et al. (2013). By examining these systems through diverse lenses such as legal, strategic, financial, and participatory, this analysis facilitates a deeper understanding of the complexities of wildlife management across different geopolitical and socio-economic contexts.

3.2. Field-based research: Human-Asian palm civet conflict

3.2.1. Study area

This study was conducted from August 2021 to the end of December 2022 in 6 villages (Sg. Michu, Sg. Serai, Sg. Semungkis, Sg. Tekali, Jawa, and Dusun Tua) of Hulu Langat (3.1131°N, 101.8157°E) (**Figure 3**). Hulu Langat district is the fifth largest district in Selangor state in Malaysia with an area of 840 sq km and a population of 1,400,461 with a household number of 387,600 (Department of Statistics Malaysia, 2022). The Hulu Langat region geographically encompasses diverse topography, including rolling hills, rivers, dense rainforests, agricultural land, and local settlements (Yusry et al., 2018). The region has various local settlements, ranging from traditional villages to urban townships (Pejabat Tanah Daerah Hulu Langat, 2023). Agriculture plays an important role in this region, with extensive land dedicated to cultivating trees and livestock farms, and is home to an abundance of flora and fauna, including endemic species that live in its unique landscapes (Yusry et al., 2018). The region's climate is categorized as tropical rainforest climate and typically has warm and humid conditions, with average temperatures ranging from 23°C to 32°C (Malaysian Meteorological Department, 2022). November, December, and January have the highest rainfall, whereas June and July are the driest months in Hulu Langat (Malaysian Meteorological Department, 2022). The region experiences an average monthly rainfall (annual) ranging between 1,500-2,000 mm (Malaysian Meteorological Department, 2022).

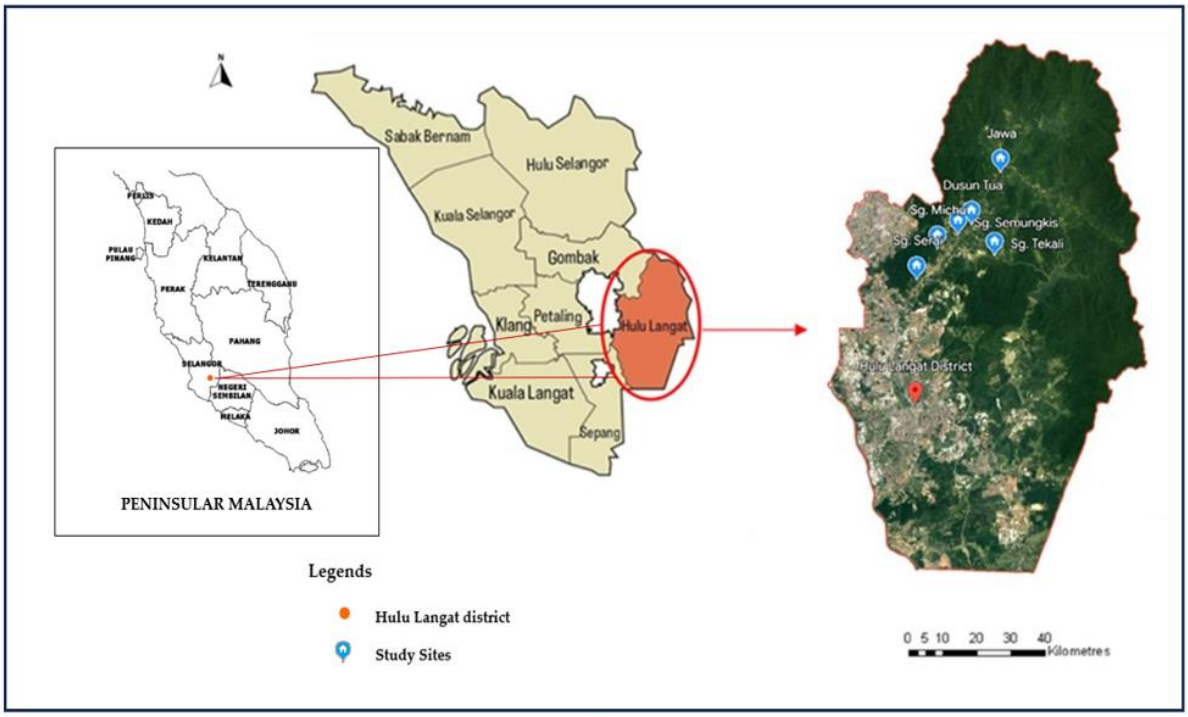

Figure 3. Maps of human-Asian palm civet conflict study area.

3.2.2. Survey data collection

In August 2021, a preliminary survey was conducted in Hulu Langat to identify potential respondents and gather information on the human-Asian palm civet conflict by interviewing locals from eight villages bordering a forest reserve. This initial investigation helped pinpoint potential respondents who were not only familiar with the conflict but also possessed the necessary knowledge and expertise concerning the Asian palm civet (APC) (*Paradoxurus hermaphroditus*). The main goal was to ensure that the selected respondents could provide valuable insights, relevant perspectives, and knowledgeable opinions, thus enhancing the validity and comprehensiveness of the research findings. Based on this investigation, six study areas (Sg. Michu, Sg. Serai, Sg. Semungkis, Sg. Tekali, Jawa, and Dusun Tua) were selected for formal investigation (**Figure 3**). Subsequently, a formal investigation was carried out with local respondents from these target sites from July until the end of August 2022, employing semi-structured interviews and a questionnaire survey as the research methods. Respondents were selected based on the initial survey and local inventories from the target areas, using 2020 population census records (Department of Statistics Malaysia, 2022) and updates from local district administration

representatives at the village level.

The semi-structured interview was designed to establish an overall framework, and open-ended questions were used to encourage respondents' interpretation of the human-Asian palm civet conflict. This approach created an environment where respondents could freely express nuanced responses that encompassed complexity, ambiguity, and uncertainty (Drury et al., 2011; Rust et al., 2017). Subject to the respondents' consent, most of the interviews were recorded. In cases where recording was not feasible, detailed notes were taken. The interviews aimed to outline the causes of the human-Asian palm civet conflict and the challenges encountered in the conflict mitigation process.

Respondents were initially queried about their perceptions of the human-Asian palm civet conflict based on their own experiences. To elicit their initial opinions, the respondents were asked, "What is the relationship between the local community and APC?". Second, they were inquired about the factors they consider when assessing the human-Asian palm civet conflict to gain insight into their objectivity in evaluating the disputes. Third, they were asked to describe the damage and losses caused by the APC incidents. Finally, they were asked about the countermeasures to mitigate and deal with the conflicts.

Besides that, the questionnaire survey method was conducted to identify the locals' attitudes and knowledge of APC accurately. To ensure the questionnaire's quality, individual interviews with locals were conducted. The survey was administered in Malay, the official language, as most of the locals in the study areas are primarily Malay native speakers and the areas are also inhabited by indigenous people. Questionnaires were distributed to respondents over 18 years old and were conducted face-to-face to allow a comprehensive understanding among the locals in a guided and casual manner (Senko et al., 2011). Data were collected confidentially, and none of the respondents' data was recorded (Drury et al., 2011).

A comprehensive questionnaire was constructed considering the various socio-demographic backgrounds that could affect locals' attitudes toward APC. To ensure the content and clarity of the wording, a preliminary survey

was administered to 20 locals in Hulu Langat. Based on the feedback received, necessary adjustments were made before conducting the final survey. The final questionnaire was carefully constructed based on the research objectives. It included an introductory section followed by questions organized into five key sections: (1) demographic backgrounds of the respondents (2) the impact of the human-Asian palm civet conflict on the respondents; (3) respondents' attitudes and knowledge regarding the APC, with additional inquiry into the reasons behind their views; (4) perceptions of the population change of the APC over the last ten years; and (5) the measures taken by respondents to address and mitigate the conflict.

All transcripts of the interviews and surveys were checked to ensure the accuracy and validity of the data. All collected data were analyzed using SPSS (Statistical Package for the Social Sciences) version 27 (SPSS, 2020). The data were analyzed using both descriptive and inferential statistical analysis. Chi-square tests, Tukey's posthoc tests, and univariate analysis of variance (ANOVA) were used to explore patterns, relationships, and significant differences within the dataset

3.2.3. Scats data collection

The food preferences of the APC in the study area were investigated by collecting scat samples between January and December 2022. A total of 57 scat samples, collected opportunistically from the target species during the study period, were analyzed. As the APC is nocturnal and predominantly inhabits dense canopy cover and understory (Nakashima et al., 2013), direct observations of feeding or camera trapping were not feasible. Therefore, to obtain APC scat samples, collections were made from potential areas known to be inhabited by the species. APC scats were identified based on their general appearance (e.g., color, size, and shape), texture, smell, other evidence of APC (e.g., tracks, feeding signs, and location), and information gathered from locals. APC scats are typically tubular or cylindrical, rounded at both ends as shown in **Figure 4**, approximately 0.5-1.0 cm in diameter, and commonly defecated as a single bolus or mass in specific locations (Ahmad et al., 2022).

Figure 4. Asian palm civet scats

These scats were distinguished from those of the leopard cat (*Felis bengalensis*) and leopards (*Neofelis nebulosa*) reported to occur in the study area. Of the 68 scats collected, 11 could not be conclusively assigned to a species and were therefore excluded from the analysis. Collectively, these procedures strongly indicate a low probability of misidentification of APC scats (Zhou et al., 2008).

For each scat sample, the date and location of collection were recorded. All scat samples were air-dried and then stored in airtight bags until analyses were conducted. The scat analyses followed the method of Kruuk and Parish (1981). Scat samples were diluted in distilled water and examined using a dissecting microscope. Food items in the APC scats were taxonomically identified by examining plant materials and chickens' feathers (Perilli et al., 2016) based on the number of paired anatomical elements. Undigested food remains were analyzed by comparing them with reference collections of specimens from the study area (Marassi & Biancardi, 2002).

For analysis of scat samples, the food preferences of APC were expressed as the frequency of occurrence. To determine the frequency of occurrence for each item, the number of scat samples containing a specific food item was counted and then divided by the total number of scat samples collected (Perilli et al., 2016). The components found in the scats were characterized based on their relative frequency of occurrence (%O):

$$Relative\ frequency\ of\ occurrence = \frac{Number\ of\ samples\ containing\ the\ same\ species\ or\ taxonomic\ group}{Total\ number\ of\ scats\ sampled} \times 100$$

The effect of season on the proportion of foods found in scat samples was also examined. The proportional representation of each food item was calculated, and the relative abundance of each food item within the scat samples was recorded. All descriptive analyses were conducted using SPSS software version 27 (SPSS, 2020).

3.3. Field-based research: Local attitudes towards wildlife and their management methods

585 local respondents were selected based on simple random sampling techniques. Vaske (2008) noted that a sample size of 400 is suitable for generalizing a population number at the 95% confidence level with a ±5% margin of error for human dimension studies.

3.3.1. Survey and data collection

The four-page questionnaire was distributed online using the Google Form platform from May 18 to May 23, 2021, among locals living in Malaysia. A total sample of 585 local respondents from all regions was selected (Table 1) based on a combination of multi-stage and simple random sampling techniques (Poate, 1993) for the survey. Local surveys were recorded in each region based on the population and housing census of Malaysia 2020 (Department of Statistics Malaysia, 2022). This resulted in 8.2 million local households forming the sampling frame for this survey. Respondents were then clustered according to sub-areas, with each sub-area allocated a proportion of the survey target based on proportional random sampling. A random sample of 585 respondents was selected from all clusters using a simple random selection technique with a random number table (De Vaus, 1991). The questionnaires were administered to respondents aged over 18 years.

The survey recorded local socio-demographic data and assessed attitudinal responses to 16 Likert items on a five-point Likert scale. For each item, respondents were asked to indicate and rate their level of agreement using 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree (Likert, 1932)

Table 1. Distribution of samples from each region.

Regions	**Land (sq. km) ***	**No. of Sub-Areas**	**Population (Millions)***	**No. of Households (Millions)***	**No. of Respondents**
Peninsular Malaysia	130,590	14	26.16	6.9	476 (81.4%)
Sarawak	124,450	8	2.74	0.6	65 (11.1%)
Sabah	73,620	6	3.80	0.7	44 (7.5%)
Total	328,660	28	32.70	8.2	585(100%)

* Data was obtained from the Department of Statistics Malaysia and the Malaysian Aviation Commission

3.3.2. Design of questionnaire

The questionnaire was constructed based on the scientific literature and guided by the research objectives. A structured questionnaire was designed considering various socio-demographic and cognitive variables, such as knowledge and experience (Tadesse & Kotler, 2016), likely to affect the attitudes of local people toward wildlife and management. Socio-demographic and experience (familiarity) questions were measured on a nominal scale, while respondents' residential area, gender, age, and level of education were measured in continuous quantitative values. Some questions required respondents to indicate their level of agreement with statements concerning their attitudes toward wildlife and management methods using a five-point Likert scale (Likert, 1932).

The four-page final questionnaire was constructed in English and included an introduction page and three pages of questions divided into four sections. The first section contained questions about local experience with wildlife in Malaysia. The second section included nine questions about local attitudes toward wildlife and preferences for different wildlife management methods. The third section comprised five questions regarding locals' attitudes toward wildlife. The fourth section contained seven questions about locals' demographic information.

A preliminary survey was administered to 20 students at the Hungarian University of Agriculture and Life Science in Gödöllő to check for content and clarity. Adjustments were made based on the feedback from the preliminary survey, followed by a pilot study. The pilot study was analyzed using Cronbach's alpha to test the survey's validity and reliability before the final survey was conducted. Questions that did not meet the minimum acceptable Cronbach's alpha value, between 0.60 and 0.70 (Griethuijsen et al., 2014), were removed or adjusted.

3.3.3. Design of attitude indices

The attitude indices were constructed based on Babbie (2014) and guided by the research objectives. To measure attitudes toward wildlife and their management methods in Malaysia, indices for attitudes toward wildlife

(Wildlife Attitude Index, WAI) and attitudes toward wildlife management methods (Wildlife Management Method Index, WMMAI) were developed using 16 Likert-type items. All attitude indices were tested for content validity (the extent to which a measure covers the range of meanings within the concept and if it is published in the scientific literature and pre-survey clearly defining the construct of attitude at the outset of the study); face validity (the extent to which empirical measures may or may not conform to common understanding and individual images concerning a particular concept, measured by working with conservation practitioners and researchers to scrutinize and review the dimensions); and construct validity (referring to the logical relationships among the variables based on statistical analysis) (Babbie, 2014).

In this study, Cronbach's alpha coefficient was used to identify the internal consistency reliability of the scale used. This was constructed using Cronbach's alpha and item analysis, resulting in a single index with a moderate level of reliability (0.7) (Griethuijsen et al., 2014). The two types of indices were computed in SPSS software following Cahyat et al. (2007):

$$Attitude\ Index = \frac{(Average\ of\ item\ set\ scores) - Minimum\ scores}{Maximum\ score - Minimum\ score} \times 100$$

The minimum and maximum scores were derived from the lowest score (1) and the highest score (5) on the 5-point Likert scale, respectively. The attitude indices were scored from 0 to 100, with 0 indicating the most negative attitudes and 100 indicating the most positive attitudes. Scoreboards for each attitude index were created to represent negative, neutral, and positive attitudes. The mean, standard deviation, minimum and maximum scores, and Cronbach's alpha of internal consistency were calculated to demonstrate the reliability of the study scales for attitudes toward wildlife (WAI) and attitudes toward wildlife management methods (WMMAI).

3.3.4. Data analysis

A total of 586 local respondents participated in an online cross-sectional survey; however, one respondent did not complete the questionnaire, leaving 585 for the final analysis. The study compared mean attitude scores for the

WAI and the WMMAI between rural and urban locals and across different regions in Malaysia, with regression models established using various socio-demographic variables as predictors.

Several statistical tests were employed. Chi-square tests were used to examine relations between categorical variables, such as gender (male/female) and attitude categories (like/dislike), using contingency tables and calculating the chi-square statistic based on observed and expected frequencies. Independent sample t-tests compared mean scores between two groups (e.g., rural vs. urban), with Levene's test assessing variance equality to determine the appropriate t-test. Tukey's posthoc tests followed ANOVA to identify specific group differences in WAI and WMMAI scores among different regions. Assumptions for ANOVA, such as normality and homogeneity of variances, were tested, with corrective measures applied when necessary.

Spearman's correlation was used to examine the strength and direction of relationships between non-parametric variables, justified by data distribution. General linear regression models were developed to predict WAI and WMMAI scores using socio-demographic variables, with a stepwise approach and checks for multicollinearity and other assumptions to ensure replicability. All statistical tests were two-tailed with a significance level set at $p < 0.05$, and p-values between 0.05 and 0.1 were considered indicative of trends for further investigation.

3.4. Technical-based research: Geo Wild System

This study examines and highlights the significance of the Geo Wild System (GWS) in the reporting, monitoring, and analysis of wildlife data. It provides a comprehensive overview of the system's deployment, functionality, and analytical capabilities, which were specifically designed to address human-wildlife conflicts in Malaysia. The methodology encompasses the development of the system, data collection processes, GIS-based analysis, and an evaluation of user feedback. The contributions of this study are manifold:

- Introduces a new wildlife reporting, monitoring, and analyzing system in Malaysia, enabling citizens, park rangers, and hunters to collect data effectively.
- Presents an integrated database design that streamlines the registration of human-wildlife conflicts, wildlife trapping, and hunting events, and facilitates seamless data sharing.
- Unveils geographic visualization tools that enhance the analysis of wildlife conflicts, trapping, and hunting distribution.
- Discusses and demonstrates the potential of the GWS to significantly support the roles of citizens, park rangers, and licensed hunters in wildlife conservation efforts through a user feedback study.

3.4.1. Development and functionality of the Geo Wild System

The Geo Wild System, developed in 2024, represents a collaborative effort between author and a technology expert in Malaysia, specifically designed to address the region's unique wildlife management challenges. This initiative was prompted by the urgent need to mitigate escalating human-wildlife conflicts, particularly those involving endangered species like Asian elephants (*Elephas maximus*) and Malayan tigers (*Panthera tigris jacksoni*), which have increased due to habitat encroachment and other environmental pressures (Ahmad Zafir & Magintan, 2016; Ten et al., 2021). The primary aim of the GWS extends beyond merely tracking wildlife; it seeks to engage local communities actively in conservation efforts. By providing real-time data and feedback, the system cultivates a deeper understanding of wildlife behaviours and conservation needs among users, thus enhancing

community-led conservation initiatives. This approach not only helps protect wildlife but also empowers local communities to take an active role in conservation efforts.

The development of the GWS involved creating a comprehensive web database integrated with GIS tools to enhance its functionality. The system leverages a suite of open-source software to ensure reliability and scalability. Specifically, CentOS Linux (https://www.centos.org/) underpins the robust software infrastructure, providing stability and reliability. MySQL (https://www.mysql.com/) manages the database, efficiently organizing and retrieving data to ensure seamless operations. Node.js (https://nodejs.org/) serves as the server, offering scalable and high-performance capabilities to handle user requests effectively. Express.js (https://expressjs.com/) facilitates smooth client and server component communication through its REST API framework. Leaflet (https://leafletjs.com/) is a JavaScript library that enhances mapping capabilities, offering dynamic and interactive maps for user exploration. Additionally, integrating maps from OpenTopoMap (https://opentopomap.org/) and OpenStreetMap (https://www.openstreetmap.org/) provides comprehensive geographic information within the application.

The system offers comprehensive server and database capabilities, handling complex CRUD (Create, Read, Update, Delete) operations efficiently, and excels in batch processing and dynamic report generation (Meghana et al., 2023). The use of ES6 JavaScript enhances the system's modular development approach, which not only increases its flexibility, scalability, and maintainability but also simplifies modifications. Components can be added or removed without affecting the rest of the system, greatly facilitating long-term adaptation and management. Additionally, ES6's modular structure improves code organization and facilitates rapid adaptation to changing requirements through seamless module integration and updates.

Moreover, the GWS operates as a multifunctional Progressive Web Application (PWA), designed to serve a diverse user base, including citizens, licensed hunters, park rangers, and government bodies. The PWA is a single software application that operates efficiently across various operating

systems, such as Android, iOS, and Windows Phones (Khan et al., 2019). This PWA is adept at gathering and processing essential wildlife data, playing a crucial role in wildlife management and conservation efforts by supporting a variety of tasks. It optimizes device memory usage and remains accessible even without an internet connection (Khan et al., 2019). **Figure 5** illustrates the components and workflows of the GWS, highlighting its functionality as a digital platform that facilitates wildlife conservation. The system's architecture, being a PWA, combines the strengths of both web and mobile platforms, enhancing accessibility on devices that support standard web technologies such as JavaScript, CSS, and HTML (Tome et al., 2023). This integration ensures a seamless user experience and broad accessibility, making the GWS an effective tool for all stakeholders involved in wildlife conservation.

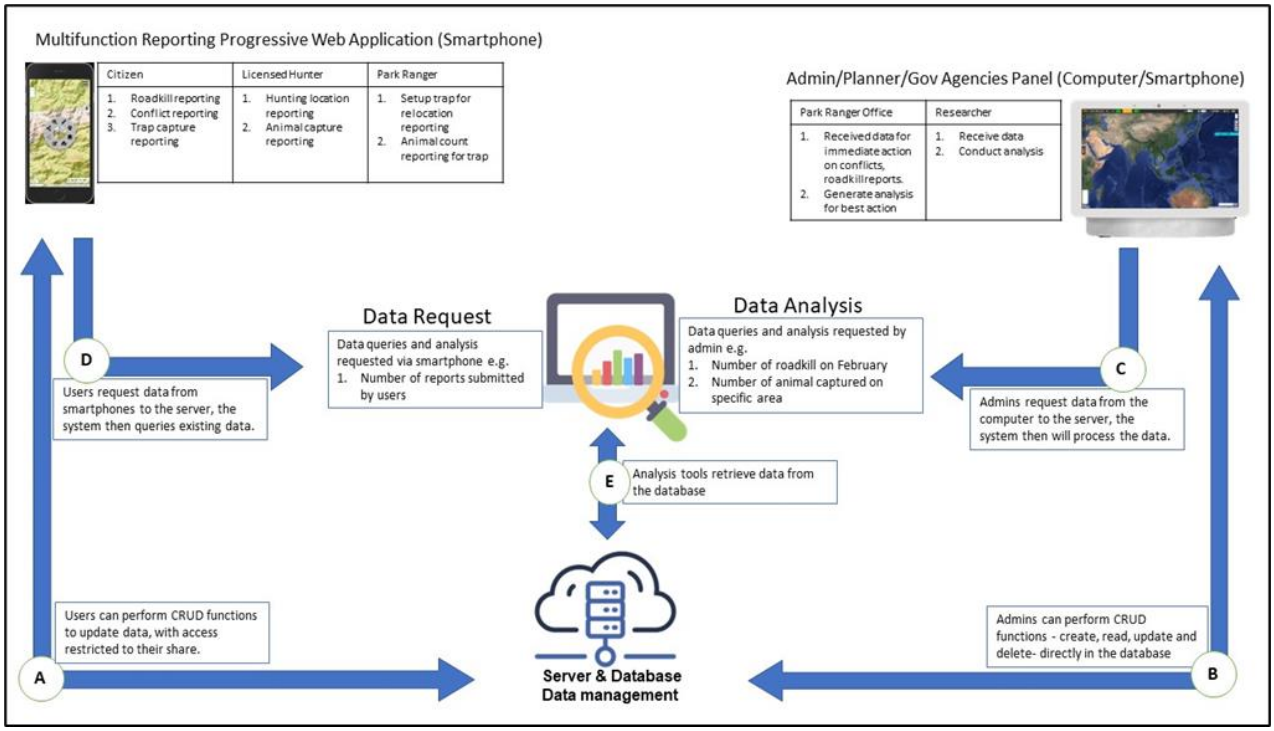

Figure 5. The components and workflows of the Geo Wild System

Complying with Malaysia's Personal Data Protection Regulation Act 2010 (PDPA) (Department of Personal Data Protection, 2010), the system ensures that user profiles are meticulously defined with varying levels of operational access based on the user's role. This hierarchical organization of user roles and data flow not only enhances security and functionality but also ensures that data handling adheres to strict privacy standards.

User Roles and Data Interaction (Section A):

•Citizens are empowered to report wildlife conflicts and incidents such as roadkill, crucial in collecting real-time environmental data.

•Licensed hunters contribute data related to their hunting activities, aiding in the management and sustainability of local wildlife populations.

•Park rangers are responsible for recording detailed information on wildlife populations and trapping activities, essential for maintaining and protecting wildlife habitats.

These user groups interact seamlessly with GWS through the PWA, ensuring a user-friendly experience across various devices without downloading dedicated software. This approach emphasizes the system's commitment to simplicity and accessibility, crucial factors that promote widespread user engagement.

Data Processing and Centralized Management (Sections B & C):

All data collected through the GWS is funneled to a centralized server and database system which undergoes rigorous processing. Administrators and planners have the tools to perform extensive CRUD operations within a structured access framework. This capability ensures data integrity and permits flexible data management by authorized personnel. Moreover, the system is fortified with advanced data analysis tools, essential for deciphering long-term trends and crafting strategic plans for wildlife conservation.

Dynamic Data Interactions (Section D):

This section highlights the dynamic interplay between real-time and existing data. Users can directly request data from mobile devices, facilitating immediate, on-the-spot decision-making. For example, a park ranger might use real-time data on Malayan tiger sightings to determine strategic locations for setting new traps, enhancing the effectiveness of conservation measures.

Analytical Tools and Decision Support (Section E):

GWS is equipped with sophisticated analytical tools designed to retrieve and examine data for various objectives, ranging from monitoring wildlife roadkill incidents to quantifying specific animal populations. These functions are supported by both statistical and GIS software, providing critical insights necessary for wildlife officers and researchers. This group, integral to the Admin/Planner/Gov Agencies Panel, relies on accurate and timely information to address wildlife issues, plan conservation activities, and conduct detailed scientific research.

Additionally, the GWS includes a comprehensive log and notification system that meticulously tracks all data inputs and communicates updates to each user at every level. This feature ensures that all stakeholders are continually informed of any changes or developments within the system, fostering an environment of transparency and continuous engagement.

3.4.1.1. Wildlife Database Management

The GWS employs a meticulously designed database following an Entity-Relationship (ER) model that delineates the organization of data and the relationships between various data entities, as depicted in **Figure 6**. This structured approach compartmentalizes the data into discrete tables, each optimized to handle specific aspects of wildlife conservation such as user profiles, conflicts, hunting activities, and trap data. These tables are intricately interconnected, enabling efficient data reporting and retrieval across the system.

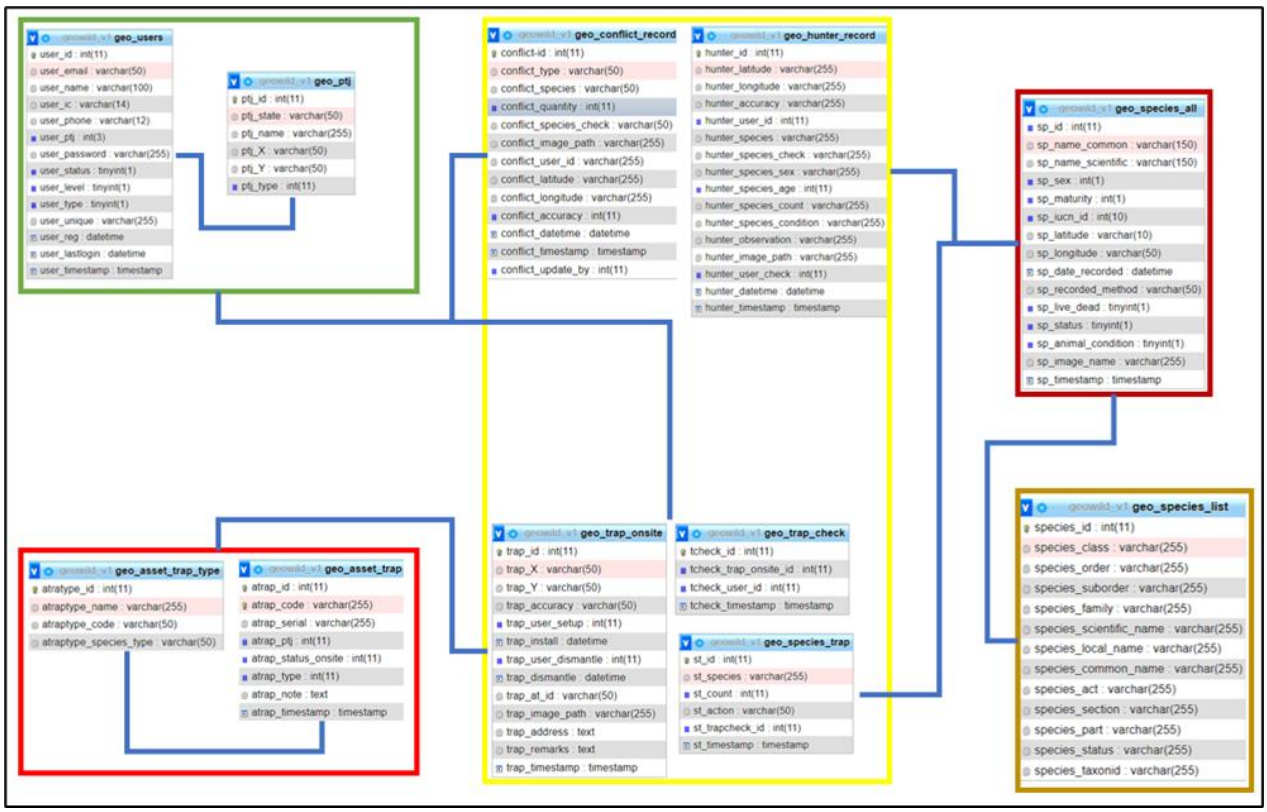

Figure 6. Entity-Relationship (ER) model of Geo Wild database system

The GWS database is segmented into several distinct categories to enhance the system's functionality in effectively managing wildlife data. The User Profiles (Green Box) include personal details and role-based assessments, crucial for enforcing access controls and securely managing user interactions, ensuring that access to sensitive information is tightly controlled based on user roles. The Annotations (Yellow Box) document detailed records of wildlife conflicts, hunting activities, or trapping observations, capturing data on the type of conflict, specifics about the individual animals involved, the time of occurrence, and geographic locations, all of which are vital for real-time responses and ongoing monitoring. The Metadata (Gold Box) enhances the database by providing additional context to the annotations, such as species taxon IDs, which support more complex analyses and comprehensive reporting. Finally, the Compiled Data (Red Box) aggregates and synthesizes information from various reports on conflicts, hunting, and trapping activities, crucial for summarizing diverse observations into comprehensive datasets that enable the system to perform detailed analyses and generate insightful analytical reports. Together, these categories ensure that the GWS protects sensitive

data and processes and utilizes it effectively to bolster robust wildlife management and conservation strategies.

Maintaining the security and integrity of data within GWS is paramount. The database management system incorporates stringent security protocols to thwart unauthorized access and prevent data breaches (Al-Harassi et al., 2023). Regular backups and robust security measures are fundamental to the system's integrity, safeguarding the data against potential risks and threats (Tariq et al., 2023). These measures ensure that the database remains a reliable repository for critical and sensitive data required for effective wildlife monitoring and management.

3.4.1.2. Use of Mobile Application for Wildlife Reporting and Monitoring

The GWS mobile application significantly enhances the flexibility and reach of wildlife reporting. It lets users input data directly from the field, streamlining the registration and reporting processes. The integrated database centralizes information, facilitating more accessible data analysis for wildlife authorities, who can identify trends and make well-informed decisions regarding wildlife management strategies. As depicted in **Figure 7**, the application's interface is designed to maximize user engagement, providing a straightforward way for various stakeholders to contribute to and access valuable wildlife data.

The interface of the GWS App is intentionally user-friendly to encourage public participation in wildlife reporting and monitoring. Users' ability to easily record and upload images increases engagement and enhances the volume of data collected. Each app functionality supports the primary goals of wildlife reporting and monitoring. By collecting data on wildlife conflicts, roadkill incidents, and other occurrences, wildlife conservationists gain a deeper understanding of animal populations, the threats they encounter, and their movement patterns, which are crucial for crafting effective conservation strategies. For example, GWS App is designed to report roadkill incidents (**Figure 7**). Users can specify if they can identify the species, and the quantity, and upload an image for visual verification. The App also displays geolocation data with altitude and accuracy information indicating where the incident occurred. This is important for understanding

the location patterns of roadkill incidents, which facilitates planning interventions to reduce such occurrences.

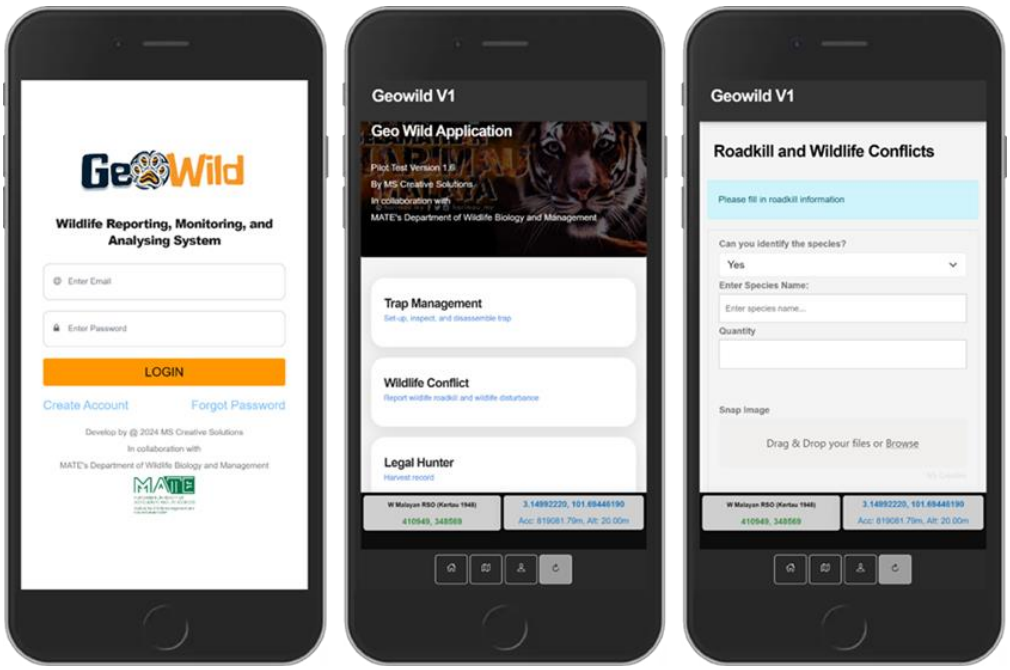

Figure 7. Interface of Geo Wild Application. The first figure (left) displays the login page of the Geo Wild App. The second figure (middle) welcomes users to the Geo Wild App and shows the main menu with options for Trap Management, Wildlife Conflict, and Legal Hunter functionalities. The final figure (right) displays a form that must be filled out to record roadkill incidents, including sections for species identification, quantity, upload image, and geolocation data.

Importantly, when conflicts are reported through the app, such as sightings of potentially dangerous wildlife near human settlements, authorities are alerted and can promptly respond by setting up traps or taking other necessary actions to manage the situation safely. Once the problem is resolved, for example, when the animal is safely relocated, users receive updates directly through the app, confirming that the conflict has been effectively managed. This interactive feedback loop keeps the contributors informed and enhances their sense of participation and impact within the conservation efforts. This approach ensures that the GWS is not just a tool for data collection but also a platform for active and informed engagement in wildlife management.

3.4.1.3. Use of GIS Tools and Kernel Density Estimation in Wildlife Distribution Visualization.

The GWS employs the West Malayan RSO (Kertau 1948) projection coordinate system, tailored specifically for Peninsular Malaysia and favoured by the local government (Hooi, 2009). This geodetic system, known as "Rectified Skew Orthomorphic" with the "Kertau 1948" datum, minimizes regional deformation, providing superior accuracy for navigation and mapping compared to the global WGS48 used by GPS (Hooi, 2009). This precision is vital for accurately reporting and examining wildlife occurrences, which supports effective conservation strategies and conflict mitigation efforts.

GWS also excels in data export, supporting formats like GeoJSON and CSV, which are compatible with various GIS software such as QGIS and ArcGIS (Li et al., 2015). GeoJSON, widely supported by GIS platforms, allows the encoding of various geographic data structures (Li et al., 2015), and users can export this data from GWS, specifying necessary attributes and geometries for their projects. Meanwhile, CSV format, recognized for its simplicity and ability to include latitude and longitude coordinates, facilitates straightforward plotting of points in GIS applications (e.g., Wu et al., 2023). These export functions enhance GWS's interoperability with external GIS applications, extending its utility and improving user experience across different platforms. By facilitating detailed spatial analysis and broadening its application scope, GWS aids in complex data analysis and visualization and promotes citizen science engagement and educational opportunities.

In addition to utilizing GIS tools for elemental mapping and spatial analysis, GWS incorporates advanced techniques such as kernel density estimation to enhance its visualization capabilities. This combination transforms the approach to wildlife distribution visualization, significantly impacting modern conservation strategies in Malaysia. The platform converts raw spatial data into dynamic maps and detailed visualizations, identifying areas of high wildlife occurrence and potential conflict zones, as shown in **Figure 8**.

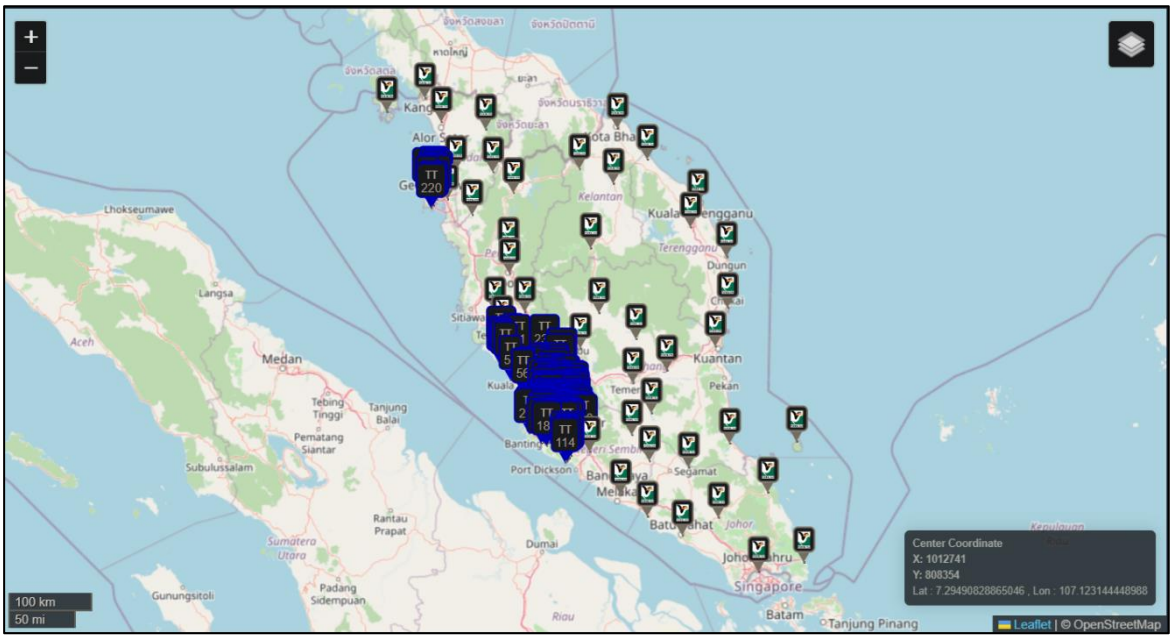

Figure 8. Geographic visualization of tagged traps in the Geo Wild System as of July 2024.

Kernel density estimation is utilized to create heatmaps that identify wildlife conflict hotspots. This spatial analysis technique estimates the density of wildlife conflicts across the study area, enabling the identification of regions with higher incidences of conflicts. The GWS generates a continuous surface representing conflict density by processing geolocation data of reported conflicts using GIS tools. These heatmaps provide a detailed visualization of areas with significant human-wildlife conflicts, which is crucial for implementing targeted interventions and managing wildlife conflicts more effectively.

3.4.2. Initial deployment and data collection

During the study period from January to June 2024, wildlife authorities deployed 117 traps across six districts in Peninsular Malaysia: Shah Alam, Hulu Selangor, Sungai Besar, Hulu Langat, Georgetown, and Seberang Prai. These deployments were in response to wildlife conflict reports submitted by citizens through traditional channels such as phone calls and in-person reports. The traps were strategically placed in high-risk areas identified based on previous conflict reports. The Geo Wild System (GWS) was employed to document detailed information for each trap setup, including

precise GPS coordinates, the species captured, and the date and time of capture. This data was vital for assessing the effectiveness of trapping efforts and for analyzing patterns of wildlife conflicts.

In addition to the official trap data, the GWS also facilitated the collection of real-time monitoring data from citizens, which was crucial for providing a comprehensive understanding of wildlife conflicts across these districts. Between January and June 2024, citizens contributed 24 reports detailing wildlife conflicts they observed, including information on the species involved, the locations of the incidents, and the outcomes. All collected data was systematically uploaded to the GWS, where it underwent a verification process. This process involved cross-referencing the newly recorded data with existing records in the system to ensure consistency and accuracy.

3.4.3. GIS-based data analysis

The GWS employs advanced GIS tools to analyze the spatial distribution of wildlife conflicts and the effectiveness of trapping activities. One of the key analytical methods used is Kernel Density Estimation (KDE), which is particularly useful for identifying areas with high concentrations of wildlife conflicts. This method was employed to generate heatmaps that visually represent the density of conflict incidents, with a specific focus on hotspots involving species such as long-tailed macaques (*Macaca fascicularis*), wild boars (*Sus scrofa*), and Asian palm civets (*Paradoxurus hermaphroditus*).

The GIS analysis process included several critical steps:

- Geocoding: Trap and citizen-reported conflict data were geocoded and processed to create continuous surface maps representing the density of wildlife conflicts across the study area.
- Spatial Analysis: The spatial representation provided by these heatmaps enabled the identification of critical hotspots requiring targeted intervention. The KDE-generated heatmaps served as clear visual tools for decision-making, allowing wildlife authorities to prioritize areas for additional traps and other management actions.
- Species-Specific Analysis: Separate heatmaps were produced for each species reported by citizens, providing insights into the spatial

patterns associated with different wildlife conflicts. These analyses were crucial for understanding the distribution of conflicts and for planning targeted interventions.

3.4.4. User Feedback Evaluation

The evaluation of user feedback was designed to assess the user experience and effectiveness of the GWS Application from the perspectives of its varied user base. Identifying user preferences is essential for enhancing the app's efficiency (Mahmoud et al., 2021). Respondents were carefully chosen from among those who had used the GWS, ensuring that the feedback was based on actual experiences with the system. A three-page questionnaire, developed in English, targeted various cognitive dimensions, including user experience, system functionality, and overall satisfaction (Tadesse & Kotler, 2016). The survey was administered online using Google Forms platform from March 10th to 16th, 2024.

To reach a broad cross-section of GWS users, a simple random sampling technique was employed (Poate, 1993). This approach included citizens, wildlife officers, researchers, and licensed hunter who had interacted with the GWS. In total, 103 responses were collected: 73 citizens, 24 wildlife officers, five researchers, and one licensed hunter. The limited response from licensed hunters was primarily due to their lower engagement, stemming from the GWS not yet being widely introduced or integrated into their routine practices.

Participants first completed a consent form in accordance with our institutional guidelines, granting permission for the use of the data collected through the online survey. The survey was conducted confidentially, ensuring that none of the respondents' personal data was recorded. The questionnaire used a Likert scale (ranging from 1 = strongly disagree to 5 = strongly agree) to rate their experiences across different aspects of the app (Likert, 1932). The survey included questions on the app's usability, data entry processes, and overall effectiveness in supporting wildlife conservation efforts.

To ensure the validity and reliability of the feedback, all survey responses

were thoroughly reviewed and analyzed using descriptive statistics, facilitated by the Statistical Package for the Social Sciences (SPSS) version 27 (IBM, 2020). The analysis employed measures of central tendency (mean, median, mode) and dispersion (standard deviation, range) to identify patterns in user satisfaction, assess functionality ratings, and detect areas for potential improvement. Additionally, comparative analysis across different user roles and outlier detection were conducted to provide a comprehensive understanding of the data, ultimately guiding recommendations for system enhancements.

4. RESULTS

4.1. Literature survey: Wildlife management strategies in Hungary and Malaysia

4.1.1. Comparison of wildlife management strategies in Hungary and Malaysia

The comparison between wildlife management strategies in Malaysia and Hungary reveals distinct approaches shaped by differing objectives, ownership structures, and management practices (**Table 2**).

Table 2. Comparison of wildlife management strategies in Hungary and Malaysia

Variables	Malaysia	Hungary
Ownership of Wildlife	State-owned	Predominantly state-owned; private ownership applicable in enclosed areas.
Purpose of Wildlife Reserves/Areas	Conservation of wildlife, focusing on charismatic animals for ecotourism to generate revenue for conservation purposes.	Many private areas were primarily established for hunting purposes
Sources of Funding	Primarily government allocations and NGO contributions	Wildlife conservation funded by EU funds, NGO contributions, and donations; game management financed through hunting association fees.
Partnership Dynamics and Land Ownership	Partnerships formalized through legal agreements; management by governmental bodies.	Hunting rights and management are maintained by individual landowners.
Management Approach	Hands off, non-interventionist in protected areas, focused on preserving natural habitats for ecotourism and biodiversity.	Hands-on in hunting zones and certain protected areas, with strictly no-management zones in core areas of national parks.
Role of Ecotourism and Hunting	Ecotourism viewed as a secondary benefit of conservation efforts.	Hunting is a primary activity driving conservation effort.
Community Engagement	Limited proactive engagement; relies on formal input for specific projects.	Highly proactive, with hunting fostering substantial local involvement.
Metapopulation Management Strategy	Regular relocations for demographic balance and genetic diversity.	Relocations are uncommon, typically for critical conservation needs only.
Wildlife/Game Damage Costs Paid By	Compensation up to RM20K, covered by the government, limited to fatalities and injuries only.	Individuals or entities holding hunting rights.
System Used for Wildlife Management Data	Spatial Monitoring and Reporting Tool (SMART): Focused on combating poaching, enhancing law enforcement, and managing protected areas.	National Game Management Database (NGMD): Utilized for comprehensive game management, hunting regulation, and conservation strategy development.
Data Accessibility and Reliability	Available with restricted access, reliable but varies by region.	Publicly accessible with restrictions, exceptionally high reliability.
Frequency and Species Coverage in the Database	Systematically conducted for continuous monitoring, includes nationally protected species and IUCN listed species.	Regular continuous monitoring, includes game species.

In Malaysia, wildlife ownership is entirely state-controlled, with conservation efforts primarily focused on charismatic animals to support ecotourism and generate revenue for conservation. Funding for these efforts predominantly comes from government allocations and contributions from non-governmental organizations (NGOs) (DWNP, 2023). Partnerships in Malaysia are typically formalized through legal agreements and managed by governmental bodies, with a hands-off, non-interventionist approach to management in protected areas, aiming to preserve natural habitats for biodiversity and ecotourism. Ecotourism is viewed as a secondary benefit of conservation, and community engagement is generally limited, relying on formal input for specific projects. Wildlife relocations are regularly conducted to maintain demographic balance and genetic diversity. The Spatial Monitoring and Reporting Tool (SMART) is used to combat poaching, enhance law enforcement, and manage protected areas (SMART, 2019). Data from wildlife management efforts in Malaysia is available with restricted access, and while generally reliable, it varies by region. Monitoring is systematically conducted for continuous observation of nationally protected and IUCN-listed species.

In contrast, Hungary's approach to game management involves state-owned wildlife, with private ownership allowed in enclosed areas. Many private reserves (fenced hunting gardens) were established primarily for hunting, central to Hungary's wildlife management and conservation strategies. Game management and hunting are self-sustaining activities, and game management units should conduct a financially viable management of the hunted populations (Csányi & Lehoczki, 2010). The outside financial sources are very limited or connected to special circumstances (like compensations connected to the culling of wild boar to slow down the spread of African Swine Fever). No EU or national subsidies are available for game management units.

Funding for nature conservation (non-game wildlife conservation) in Hungary comes from national budget, European Union (EU) funds, NGO contributions, and donations (Kállai et al., 2016). Unlike Malaysia, hunting rights belong to the landed property, but the individual game management units should be at least 3000 ha to use the hinting rights. Consequently, the

land owners should join groups to exercise hunting rights. The 3,000 ha minimum size is a basis for more professional game management and ensures the financial viability of the game management units (Csányi and Lehoczki, 2010). The minimum size is very effective and the number of game management units in only 1448 with an average around 5,500 ha (Csányi et al., 2024). In theory, the connection between the land-ownership and hunting rights provides a basis for the involvement of local stakeholders. In practice, especially in the case of large game management units, or local interpersonal conflicts, the locals' involvement can be weak or contractionary. The most serious conflicts develop in the case of agricultural damages and their compensation (Katona et al., 2011; Bleier et al., 2012).

Wildlife relocations are less common and typically reserved for critical conservation needs. The National Game Management Database (NGMD) supports comprehensive game management, hunting regulation, and conservation strategy development (Csányi, 1998; Csányi et al., 2010). Aggregated data (national, 19 counties, and 52 game management regions) is publicly accessible with high reliability, and regular, continuous monitoring focuses on game species.

Overall, the management systems in Malaysia and Hungary reflect their unique conservation priorities, with Malaysia emphasizing ecotourism and biodiversity preservation and Hungary integrating sustainable hunting practices within its conservation framework.

4.1.2. Wildlife management strategies indicators in Hungary and Malaysia

Hungary and Malaysia demonstrate different wildlife management strategies that reflect their distinct social, ecological, and economic priorities (**Table 3**).

Table 3. Wildlife management strategies indicators in Hungary and Malaysia

Category	Indicators	Country	Ranking			Sources
			Green	Yellow	Red	
Wildlife	% Selected large mammal species population		High (67-100)	Middle (34-66)	Low (0-33)	Ranking based upon research that states "worldwide", 50% of large mammal species are in decline (Karanth et al., 2010) (**Figure 9 & 10**)
		Hungary				
		Malaysia				
Economic	% GDP from ecotourism		High (>9)	Middle (3-9)	Low (<3)	Based on existence of tourism's total GDP contribution (OECD, 2022)
		Hungary		3		
		Malaysia		6.7		
	% GDP hunting		High (>9)	Middle (3-9)	Low (<3)	Based on existence of hunting's total GDP contribution (OECD, 2022)
		Hungary			0.05	
		Malaysia			<0.01	
	% Population employed by tourism		High (>9)	Middle (3-9)	Low (<3)	Based on existence of national data statistics. (Hungarian Central Statistical Office, 2023; Department of Statistics Malaysia, 2023; DWNP, 2023)
		Hungary	9.5 (421K)			
		Malaysia	10.54 (3.5mil)			
	% Population employed by hunting		High (>9)	Middle (3-9)	Low (<3)	
		Hungary			0.029 (2,786)	
		Malaysia			0.0002 (<1000)	
Locals	% Benefits received by local financially from wildlife conservation		Yes (>50)	Somewhat (25-49)	Generally (0-24)	Based on existence of national policy requirements; In Hungary, "local people" refers to those living in hunting areas, while in Malaysia, it refers to those in protected conservation areas (not empirically verified)
		Hungary				
		Malaysia				
	% Negative costs associated with wildlife		Yes (>50)	Somewhat (25-49)	Generally (0-24)	
		Hungary				
		Malaysia				

In terms of wildlife indicators, Hungary's population of selected large mammal species falls within the middle range (34 to 66%), whereas Malaysia ranks higher in the 67 to 100% range. However, Malaysia's higher ranking reflects a more concerning reality, a significant decline in large mammal populations **(Figure 9**), primarily driven by habitat loss, poaching, and human-wildlife conflict. In contrast, Hungary's middle-range ranking indicates relatively stable or even increasing populations (**Figure 10**). This

stability stands out in the global context, where approximately 50% of large mammal species are experiencing population declines (Karanth et al., 2010), highlighting Hungary's more effective wildlife management strategies.

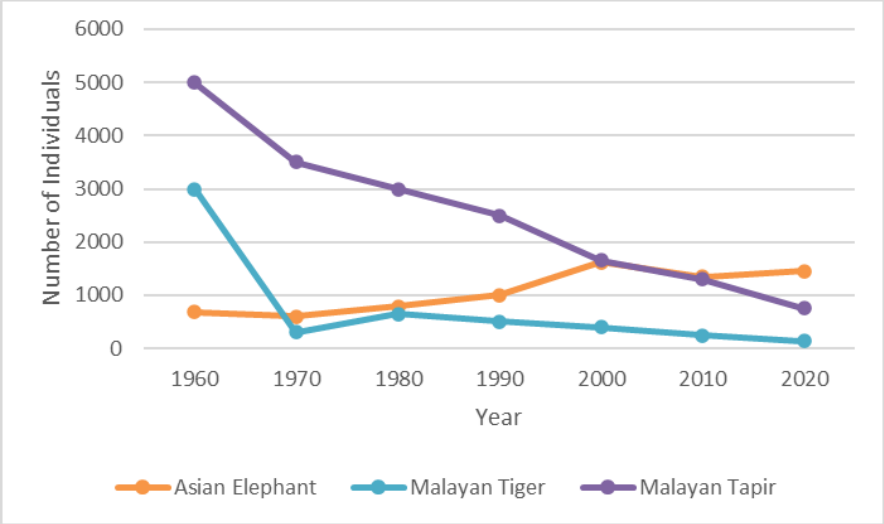

Figure 9. Changes in population sizes of large mammals' species in Peninsular Malaysia (Perhilitan, 2020; DWNP, 2023)

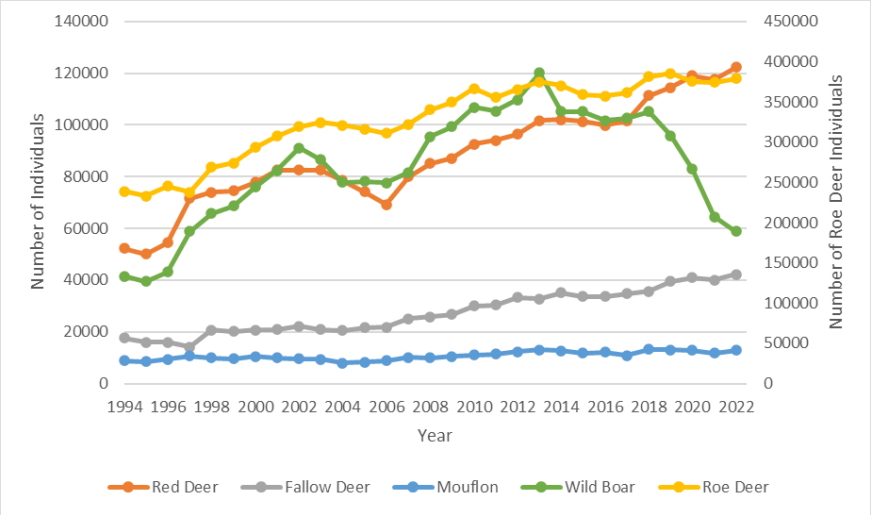

Figure 10. Changes in population sizes of large mammals' species in Hungary (NGMD, 2022)

While Hungary incorporates hunting into its wildlife management strategy, Malaysia relies more on ecotourism as a primary driver of both conservation and economic growth. In Hungary, agriculture contributes 1.12% to the

GDP, with sustainable hunting making up 0.05% of this total, reflecting its integrated role in both economic and conservation efforts. By contrast, Malaysia's hunting sector has a much smaller impact, contributing less than 0.01% to its GDP.

Ecotourism, however, plays a much larger role in Malaysia's economy, contributing 6.7% to the national GDP, compared to 3% in Hungary (OECD, 2022). This demonstrates Malaysia's stronger dependence on ecotourism as a key economic and conservation strategy. Employment data further highlights this difference. In Malaysia, 10.54% of the population (3.5 million people) are engaged in tourism-related jobs, while in Hungary, 9.5% (421,000 people) work in tourism. Meanwhile, Hungary's sustainable hunting sector employs 0.029% of its population, amounting to 2,786 professional hunters, whereas in Malaysia, the hunting sector is significantly smaller, employing fewer than 1,000 individuals, including 661 licensed hunters in Peninsular Malaysia, representing only 0.0002% of its population (Hungarian Central Statistical Office, 2023; Department of Statistics Malaysia, 2023; DWNP, 2023). This reinforces Malaysia's greater conservation and economic focus on ecotourism over hunting.

Valuing wildlife and assessing the economic contributions of game and hunting to local economies are complex. Often, these values cannot be directly quantified in financial terms, and available information sources may be severely limited or biased (Csányi et al., 2014). Both Hungary and Malaysia encounter challenges in accurately measuring the direct financial benefits that local communities derive from wildlife conservation efforts. In Hungary, locals in hunting areas benefit moderately from conservation (25-49%) and experience low negative costs (less than 24%) due to effective game management. In contrast, in Malaysia, locals near conservation areas receive fewer financial benefits (less than 24%) and face moderate negative costs (25-49%) due to frequent human-wildlife conflicts. In both countries, there is a significant lack of detailed, empirically verified data on these benefits, creating a gap in our understanding of the socio-economic impacts of wildlife management strategies. In Hungary, game management has led to substantial agricultural damage costs, estimated at six to eight million euros over recent decades (Csányi, 2018). However, comparable data on

wildlife-related damages in Malaysia is not empirically verified, complicating efforts to measure and address the negative impacts on local communities.

Given these challenges, it is crucial to consider the significant economic and demographic differences between Hungary and Malaysia when analyzing and comparing their wildlife management strategies. As outlined in **Table 4**, these two countries exhibit distinct characteristics, such as variations in population growth rates, GDP per capita, the extent of protected areas, and the proportion of rural populations. These factors play a pivotal role in shaping the strategies and capacities for effective wildlife management in each country.

Table 4. Comparisons of economic and demographic between Hungary and Malaysia

Variables	Hungary	Malaysia
Population Density (pop/km^2)	105.00	101.55
Population Growth Rate (%)	-0.7	1.1
Rural Population (%)	27.76	21.79
Protected Areas (%)	22.20	13.33
GDP Per Capita ($USD)	18,390.18	11,993.19

Source: Department of Statistics Malaysia; OECD, 2022; The World Bank, 2023; Biodiversity Information System for Europe, 2024.

Hungary has a slightly higher population density, with 105.00 people per square kilometer, compared to Malaysia's 101.55 people per square kilometer. However, the population growth rates differ significantly, with Hungary experiencing a negative growth rate of -0.7%, while Malaysia's population is growing at a rate of 1.1%. In terms of rural population, Hungary has a higher percentage of its population living in rural areas, at 27.76%, compared to Malaysia's 21.79%.

Additionally, Hungary has a larger proportion of its land designated as protected areas, covering 22.20% of the country, whereas Malaysia has 13.33% of its land under protection. Economically, Hungary's GDP per capita is higher, at $18,390.18 USD, compared to Malaysia's GDP per capita of $11,993.19 USD. These figures highlight the economic and demographic

contrasts between the two countries, reflecting different levels of development and conservation priorities.

4.2. Field-based research: Human-Asian palm civet conflict

4.2.1. Local socio-demographic information

Among the surveyed respondents, the majority were males (n =172, 81.1%) and more than 60% (n =137, 64.6%) belonged to the 35–55 age (Table 1). Since this study was conducted in the Hulu Langat region, where traditional gender roles and cultural norms often result in a higher proportion of male farmers compared to female farmers, the overrepresentation of male respondents can be attributed to the agricultural demographics of the study area. A total of 157 respondents had at least a primary level of education, and almost half of the respondents engaged in farming activities (n = 105, 49.5%). Besides that, over 75% of respondents (n = 165, 77.8%) reported being familiar with and having experience with wildlife, while the remaining did not have any experience with wildlife (22.2%) as indicated respectively in **Table 5**.

Table 5. Local socio-demographic information of human-Asian palm civet conflict (N = 212).

	Variables	**N**	**%**
Gender	Male	172	81.1
	Female	40	18.9
Occupation	Farmer	105	49.5
	Other	107	50.5
Education	<Primary	55	25.9
	≥Primary	157	74.1
Age	<35 years	47	22.2
	35-55 years	137	64.6
	>55 years	28	13.2
Residence (Villages)	Sg. Michu	29	13.7
	Sg. Serai	37	17.5
	Sg. Tekali	31	14.6
	Sg. Semungkis	35	16.5
	Jawa	41	19.3
	Dusun Tua	39	18.4
Familiarity (experience)	Yes	165	77.8
	No	47	22.2
Damage and Losses	Yes	158	74.5
	No	54	25.5
Knowledge of APC Population	Increase	151	71.1
	Decrease	61	28.8

4.2.2. Types of damage caused by Asian palm civets

The local communities in Hulu Langat suffered losses due to the consumption of cultivated fruits and poultry attacked by APC. Based on the survey from the respondents, the main driver of the conflict was the APC foraging behavior. According to the survey findings, consumption of cultivated fruits (59%), attacks on poultry (19%), agricultural (12%), and property damages (10%) (**Figure 11**).

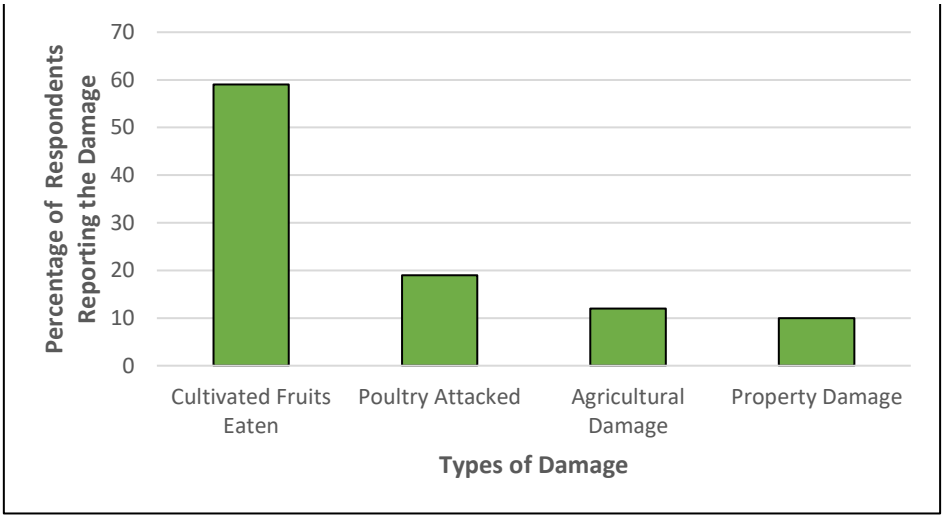

Figure 11. Different types of damage reported by APC in Hulu Langat by respondents.

According to the respondents, poultry attacks predominantly occurred during dawn and dusk. Locals revealed that APC primarily targeted young birds rather than fully grown chickens and preferred consuming chicken eggs. Based on the survey, respondents sighted only chicken feathers as evidence of APC attacking poultry chicken in the local area.

4.2.3. Asian palm civet food preferences

APC feeds at least on 13 types of fruits, rambutan (*Nephelium lappaceum*), mangosteen (*Garcinia mangostana*), mango (*Mangifera indica*), durian (*Durio zibethinus*), papaya (*Carica papaya*), pineapple (*Ananas comosus*), banana (*Musa acuminata*), guava (*Psidium guajava*), wax apple (*Syzygium samarangense*), langsat (*Lansium domesticum*), jackfruit (*Artocarpus heterophyllus*), chempedak (*Artocarpus integer*), and cacao (*Theobroma cacao*). The APC also consumed poultry and rotten fruits (**Table 6).** Rotten

fruits can be visibly differentiated from fresh ones based on the appearances (e.g., soft or mushy spots, discoloration and an off smell).

Table 6. The foods preferences of APC in Hulu Langat, Selangor, Malaysia.

Foods	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Nephelium lappaceum							■	■	■			
Garcinia mangostana							■	■				
Mangifera indica				■	■	■	■	■	■			
Durio zibethinus	■					■	■	■			■	■
Carica papaya			■	■	■	■	■	■	■			
Ananas comosus							■	■	■	■		
Musa acuminata					■	■	■					
Psidium guajava									■	■	■	
Syzygium samarangense					■	■	■	■				
Lansium domesticum							■	■				
Artocarpus heterophyllus							■	■	■			
Artocarpus integer						■	■	■				
Theobroma cacao	■										■	■
Poultry	■	■	■								■	■
Rotten fruits		■								■	■	

Notes: ("grey" is feeding and "blank" is not feeding).

Table 7. Relative frequency of occurrence, (% O) and frequency of occurrence, (FO) of foods found in 57 scats of APC between dry and wet seasons in Hulu Langat, Selangor.

	Wet season, n = 18		Dry Season, n = 39	
Foods	**FO**	**% O**	**FO**	**% O**
Nephelium lappaceum	-	-	8	20.51
Garcinia mangostana	-	-	2	5.13
Mangifera indica	-	-	2	5.13
Durio zibethinus	5	27.77	10	25.64
Carica papaya	-	-	1	2.56
Ananas comosus	-	-	1	2.56
Musa acuminata	-	-	1	2.56
Psidium guajava	3	16.67	-	-
Syzygium samarangense	-	-	2	5.13
Lansium domesticum	-	-	3	7.69
Artocarpus heterophyllus	-	-	2	5.13
Artocarpus integer	-	-	7	17.95
Theobroma cacao	3	16.67	-	-
Poultry	3	16.67	-	-
Rotten fruits	4	22.22	-	-

The APC primarily consumed fruits throughout the year. Among the fruits, durian emerged as the most frequently (more than 25%) preferred and mainly found in the scats in this study for both seasons. Interestingly, this fruit also derives its scientific name, *Durio zibethinus* from this omnivore, "*Zibetha*" (Latin word for civet). According to Linnaeus, (1774), the specific epithet *zibethinus* comes from the name of the Indian owl *Viverra zibetha*, a species of the *Viverridae* family, and these fruits were used to capture it. Between June and August (Southwest Monsoon), which is considered the

fruit season in Malaysia (Malaysian Meteorological Department, 2022), most fruits such as durian, rambutan, mango, papaya, pineapple, wax apple, langsat, jackfruit, and chempedak were consumed by APC. Malaysia has a tropical climate characterized by high temperatures and high humidity throughout the year. This period aligns with the country's dry season, which brings less rainfall and more favorable conditions for fruit production (Malaysian Meteorological Department, 2022). However, during the Northeast Monsoon season between November and January, Selangor typically experiences a relatively wet period (Malaysian Meteorological Department, 2022) and reduced availability of fruit sources. Consequently, when the fruit sources became limited, the APC began preying on poultry and feeding on rotten fruit.

4.2.4. Local attitudes towards Asian palm civets

Most respondents exhibited a positive attitude towards APCs (n = 132, 62.3%) and expressed their preference for maintaining or increasing the number of APCs. Conversely, a few farmers dislike APC (n = 35, 16.5%) and desired a reduction in their population number. The primary reason behind the favorable attitudes of certain locals towards APC roots from their acknowledgement as protected animals with significant environmental value. Oppositely, the negative attitudes of locals towards APC arise from the perception that these animals cause damage and result in losses to locals.

The differences in locals 'attitudes towards APC in various socio-demographic categories were explored using the Chi-Square ($\chi 2$) test. The findings indicated that occupation ($\chi 2 = 7.445$, $p = 0.007$), gender ($\chi 2 = 7.425$, $p = 0.006$), cultivated fruits eaten ($\chi 2 = 17.174$, $p = 0.001$), and familiarity ($\chi 2 = 4.463$, $p = 0.031$) had significantly influenced the locals' attitudes towards APC (**Table 8**). Male respondents displayed more negative attitudes towards APC compared to females. Besides that, respondents who had experienced property damage caused by APC exhibited lower tolerance and a more negative attitude towards them. Locals who had seen and were familiar with APC held more negative attitudes than those who had never encountered them.

Table 8. Differences in local's attitudes towards an APC in socio-demographic.

Variables	Categories	No. of Likes for APC	No. of Dislikes for APC	$\chi 2$	p
Gender	Male	101	71	7.425	0.006**
	Female	31	9	-	-
Age	<35 years	34	13	0.741	0.673
	35-55 years	96	41	-	-
	> 55 years	17	11	-	-
Education	<Primary	37	18	0.179	0.634
	≥Primary	111	46	-	-
Occupation	Farmer	70	35	7.445	0.007 **
	Other	87	20	-	
Familiarity (experienced)	Yes	62	103	4.463	0.031*
	No	41	6	-	-
Cultivated fruits eaten	Yes	69	56	17.174	0.001 **
	No	73	13	-	-
Poultry attacked	Yes	14	16	2.971	0.085
	No	126	46	-	-
Property damage	Yes	19	2	0.037	0.875
	No	148	43	-	-

Note. **Significant at p<0.01, *Significant at p<0.05.

4.2.5. Locals' preference for mitigating measures of human-Asian palm civet conflict

Most locals employed passive methods or chose to leave the APC undisturbed to prevent conflicts between humans and APC both before and after incidents involving the APC (**Figure 12**). Most locals did not take action or implement any measures (pre-measures: n = 97, 45.28%, post-measures: n = 102, 48.11%). For actively engaged methods, most locals chose to drive away APC with firecrackers (n = 47, 22.17%), and almost 10% of respondents decided to set a trap. However, few respondents turned to using the poison method (n = 11, 5.2%) to eliminate the civets, as a last recourse to mitigate economic losses incurred from APC damage and losses to their cultivated fruits, poultry, agriculture, and property. After the APC incidents, most respondents chose to cover fruits (n = 70, 33.02%) and call wildlife control (n = 40, 18.87%) to capture and relocate the problematic civets.

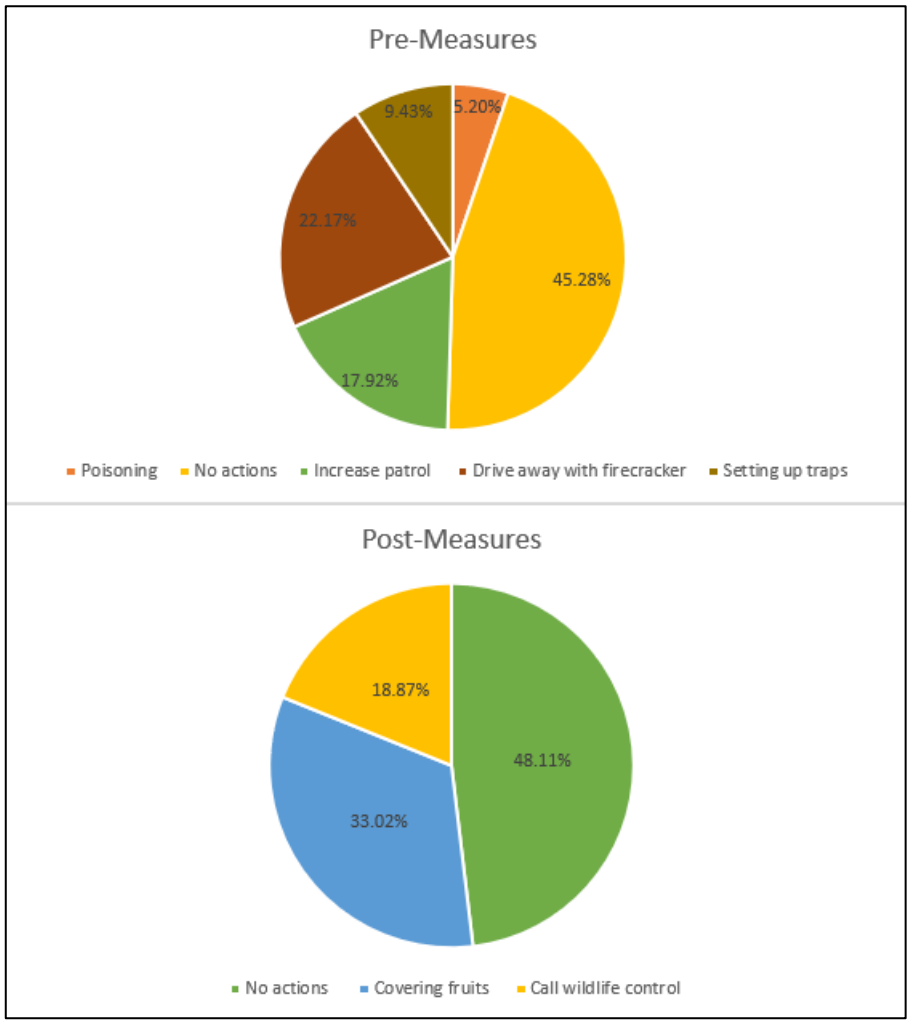

Figure 12. Locals' preferences for mitigating human-Asian palm civet conflicts in Hulu Langat

4.2.6. Locals' knowledge of population changes in Asian palm civets

Many respondents (n = 151, 71.2%) stated that the population of APC had increased over the past decade. On the other hand, a minority of respondents (n = 61, 28.8%) believed that the population of APC had decreased during the same period (**Table 5**). During the survey, locals mentioned that they formed their opinions based on the following evidence, namely: (1) the frequency of seeing APC, (2) the frequency of encountering APC scats, and (3) the occurrence of APC conflicts. The respondents attributed the growth in the APC population to inadequate population control measures and poor wildlife management. Nevertheless, specific data for the APC in Malaysia are currently undocumented. However, globally, according to the IUCN Red Lists data, the population of APC is experiencing a decline (Duckworth et al., 2016).

4.3. Field – based research: Local attitudes towards wildlife and their management methods

4.3.1. Local socio-demographic information

Table 9 presents the socio-demographic information of the surveyed local population. The majority of the surveyed respondents were (N = 317, 54.2%) females; more than 60% (N = 358, 61.2%) belonged to the 25–34 age group, and (N = 122, 20.8%) belonged to the 18–24 age group. This is because our survey was conducted online, and young generations are more connected to the Internet; hence, more young locals participated in this study. A total of 585 respondents participated, 59.8% of whom were urban people (compared to rural), and 41.0% of the respondents had a secondary level of education. Most respondents engaged in hiking activities (N = 397, 68.0%), fishing (N = 159, 27.1%), hunting, and other activities. However, 0.2% (N = 1) of the respondents stated they did not engage in nature-based activities. Some respondents (42.6%) reported having experience with wildlife (familiarity), and others did not have any experience with wildlife (57.4%), as shown in **Table 9**. The vegetation structure in the study area is a typical mosaic habitat, comprising open grassy patches and bushy woody vegetation; ranging from highly dense to less dense shrub covers.

Table 9. Socio-demographic information of the local respondents (*N* = 585).

Variables	*N*	%	Variables	*N*	%	Variables	*N*	%
Gender			**Residential Area**			**Familiarity (experience)**		
Male	268	45.8	Urban	350	59.8	Yes	249	42.6
Female	317	54.2	Rural	235	40.2	No	336	57.4
Age			**Nature Engagement**			**Education**		
18–24 years	122	20.8	Hunting	19	3.2	Primary	10	1.7
25–34 years	358	61.2	Fishing	159	27.1	Secondary	240	41.0
35–44 years	68	11.6	Hiking	397	68.0	Undergraduate	161	27.5
45–54 years	23	3.9	Other	9	1.5	Graduate	174	29.8
55–64 years	7	1.2	None	1	0.2			
>64 years	7	1.2						

4.3.2. Validation of attitude indices

Seven items were directly related to the wildlife management method, while six were associated with wildlife. These items provided valuable information that assessed locals' attitudes toward wildlife and their management methods in Malaysia. The WAI included six items and resulted in a Cronbach's alpha coefficient of 0.71, whilst the WMMAI had seven

items and recorded a coefficient of 0.73, reporting good internal consistency reliability, as suggested by the guidelines of Griethuijsen et al. (2014). Other than that, all the items recorded more than 0.30 scores for inter-item correlation. **Table 10** summarizes the results of the reliability analysis.

Table 10. Reliability analysis for attitude index of wildlife and their management methods.

Items	Mean	*Sd.*	Inter-Item Correlation	(*α*)
Attitude toward wildlife (WAI)				
Wildlife should be conserved for a future generation.	4.69	0.75	0.46	0.71
Wildlife contributes to the local economy.	2.85	1.18	0.83	
Wildlife is not a threat to the local community.	3.42	1.14	0.51	
Wildlife is responsible for more damage to local property than they are worth.	3.17	1.05	0.79	
The risk of being injured by wildlife is high.	3.97	1.16	0.34	
Wildlife is a nuisance.	2.97	1.23	0.37	
Attitude toward wildlife management methods (WMMAI)				
Use regulated hunting to manage wildlife numbers.	3.41	1.26	0.36	0.73
Euthanize wildlife that repeatedly causes problems for people.	2.98	1.21	0.44	
Capture and relocate wildlife from human areas.	3.64	1.02	0.48	
Educate the locals about human–wildlife conflict.	4.66	0.65	0.55	
Remove attractants from human areas (garbage, bird feeder, etc.).	3.71	1.04	0.85	
People do not have to manage wildlife.	3.98	1.07	0.71	
Wildlife is properly managed in Malaysia.	3.18	1.06	0.53	

4.3.3. Local experiences and attitudes toward costs and benefits associated with wildlife

Most of the respondents (93.7%) reported that they are aware and familiar with wildlife present in their local area (**Table 9**), with the majority (54.7%) stating that they had seen wildlife during the past 12 months, relatively more than a quarter of the respondents claimed to have seen multiple wildlife and offspring (34.5%). The responses to a series of statements were designed to draw out attitudes toward wildlife that are present and cause damage to local people's properties (**Figure 13**), further affecting the acceptability of management methods (**Figure 14**). The proportion of rooted cells increased in spring and summer and showed lower values between November and February.

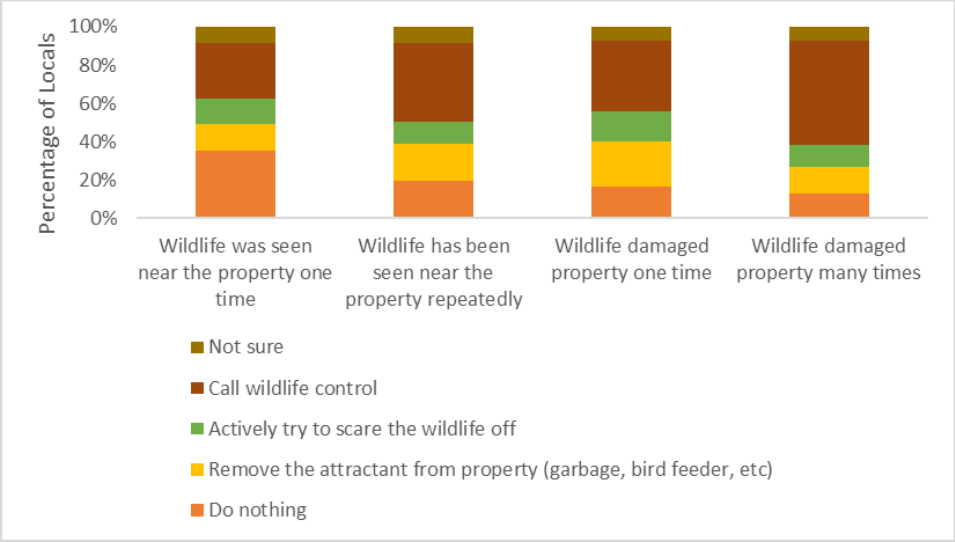

Figure 13. Attitudes toward wildlife on property among locals.

For example, as shown in **Figure 13**, a more significant proportion of local respondents preferred to call wildlife control. It was more likely to agree that wildlife is deserving of wildlife control when found multiple times near locals' property (41.4%) and causing damage either one (37.1%) or multiple times (54.5%) to the property. However, 35% of the respondents agreed they were more likely to do nothing when wildlife was present one time near their property. In addition, less than 10% of the respondents reported having less opinion and were unsure about their response toward wildlife in all four situations, further highlighting the locals' lack of knowledge and awareness on the subject.

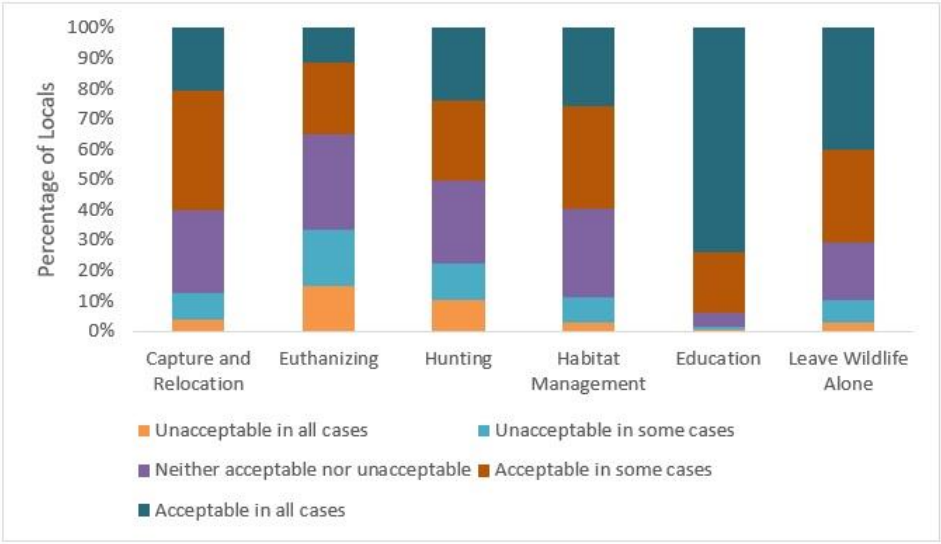

Figure 14: Locals' acceptability of wildlife management methods in Malaysia

However, **Table 11** indicates that more than 40% of the respondents felt that wildlife was responsible for more damage than they were worth. Although more than 97% of the respondents agreed that wildlife should be conserved in Malaysia, 63.8% felt the risk of being injured by wildlife is high. In terms of benefits, more respondents (63%) felt that wildlife does not contribute to the local economy.

Table 11. Locals' attitudes toward wildlife and their management methods.

Items	Agree	Neutral	Disagree
Attitude toward Wildlife (WAI)	**(%)**	**(%)**	**(%)**
Wildlife should be conserved for the future generation.	97.3	2.2	0.5
Wildlife contributes to the local economy.	16.8	20.2	63.0
Wildlife is not a threat to the local community.	72.4	18.3	9.2
Wildlife is responsible for more damage to local property than they are worth.	40.7	28.6	30.7
The risk of being injured by wildlife is high.	63.8	18.2	18.0
Wildlife is a nuisance.	25.8	11.5	62.7
Attitude toward Wildlife Management Method (WMMAI)	**(%)**	**(%)**	**(%)**
Use regulated hunting to manage wildlife numbers.	50.2	27.4	22.5
Euthanize wildlife that repeatedly causes problems for people.	34.8	31.8	33.4
Capture and relocate wildlife from the human area.	59.9	27.6	12.5
Educate the locals about human–wildlife conflict.	93.7	5.0	1.3
Remove the attractant from human areas (garbage, bird feeder, etc.).	59.6	28.9	11.5
People do not have to manage wildlife.	70.9	19.0	10.1
Wildlife is properly managed in Malaysia.	42.7	30.6	28.7

4.3.4. Local acceptability of wildlife management methods in Malaysia

Table 11 also shows that more than 70% (70.9%) of local respondents agreed that people do not have to manage wildlife and that nature should be allowed to take its course. One-tenth (10.1%) disagreed with this statement, while 19.0% were neutral. Concerning the locals' attitude toward (a) supporting or (b) opposing management, five factors were ranked by their level of acceptability. For both issues, humane treatment appeared to be the most crucial factor. Wildlife management methods were also more likely to be accepted if proven effective.

Management methods that do not involve any direct killing (non-lethal), such as education (93.7%), were considered the most acceptable among the locals. In contrast, lethal methods were ranked as the least satisfactory. For example, one-third of the sample population (34.8%) considered euthanasia unacceptable in some or all cases. In comparison, the corresponding figure for using regulated hunting to manage wildlife numbers was only 22.3% (**Figure 14**). Remarkably, hunting was the most acceptable lethal method (50.2%), proving it was almost as adequate as the commonly practised

capture and relocation method, and more satisfactory than the euthanasia of wildlife (34.7%).

4.3.5. Attitudes of locals toward wildlife and their management methods in Malaysia

A linear regression analysis was performed to assess the influences of potential variables on the Wildlife Attitude Index (WAI) and the Wildlife Management Method Attitude Index (WMMAI). The results show that the model with the WAI as the dependent variable was significant (F (4585) = 42.73, $p < 0.001$) with a goodness of fit of 32% of the observed to expected values. Respondents who resided in urban areas and age were the main factors of positive attitudes toward wildlife. In contrast, respondents who lived in rural areas and had more familiarity (experience) with wildlife had increased negative attitudes toward wildlife. This result was expected since most rural areas share a border with the forest in Malaysia. Additionally, rural areas have positive and negative direct interaction (familiarity) with wildlife, and locals have raised problems concerning their experiences with human–wildlife conflicts. **Table 12** summarizes the results of the regression model.

Table 12. Regression analysis of Wildlife Attitude Index (WAI).

Variable	*B*	*SE*	β	*t*	*p*
Wildlife Attitude Index (WAI)	18.76	3.88	0.00	4.72	<0.001
Age	0.83	0.15	0.37	8.80	<0.001
Urban area	6.21	1.60	0.19	3.88	<0.001
Rural area	−3.67	0.85	−0.19	−3.88	<0.001
Familiarity (experience)	−7.26	0.34	−0.62	−21.67	<0.001

Note. $F_{(4585)} = 42.73$, $p < 0.001$, $R^2 = 0.32$.

The WMMAI as the dependent variable recorded a significant relationship (F (7585) = 503.98, $p < 0.001$), with a goodness of fit of 79%. The results (**Table 13**) prove that residing in a rural area, a higher level of education, age, and familiarity with wildlife increased engagement with nature and significantly led to positive attitudes toward wildlife management methods. Contrarily, respondents who resided in urban areas and were highly engaged with nature had lower WMMAI scores.

Table 13. Regression analysis of Wildlife Management Method Attitude Index (WMMAI).

Variable	***B***	***SE***	**β**	***t***	***p***
Wildlife Management Method Index (WMMAI)	8.76	3.84	0.00	4.42	<0.001
Age	1.23	0.05	0.87	42.15	<0.001
Education	2.88	0.56	0.21	5.54	<0.001
Familiarity	1.69	0.38	0.88	4.76	<0.001
Rural area	2.19	0.42	0.09	4.85	<0.001
Urban area	−7.32	−0.37	−0.62	−19.56	<0.001
Gender	−2.32	0.35	−0.20	−8.61	<0.001
Nature engagement	−1.37	0.64	−0.05	−2.24	<0.001

Note. $F_{(7585)} = 503.98$, $p < 0.001$, $R^2 = 0.79$.

4.4. Technical – based research: Geo Wild System

4.4.1. Initial deployment and GIS-based analysis of wildlife conflict hotspots

During the initial deployment of the Geo Wild System (GWS) from January to June 2024, a total of 117 traps were set across the six districts in Peninsular Malaysia: Shah Alam, Hulu Selangor, Sungai Besar, Hulu Langat, Georgetown, and Seberang Prai under study, resulting in the capture of 88 wildlife individuals, including 85 long-tailed macaques (*Macaca fascicularis*), two wild boars (*Sus scrofa*), and one Asian palm civets (*Paradoxurus hermaphroditus*). **Figure 15** details the number of traps set up in each district, while **Figure 16** highlights the species captured, with Macaca fascicularis being the most frequently captured species.

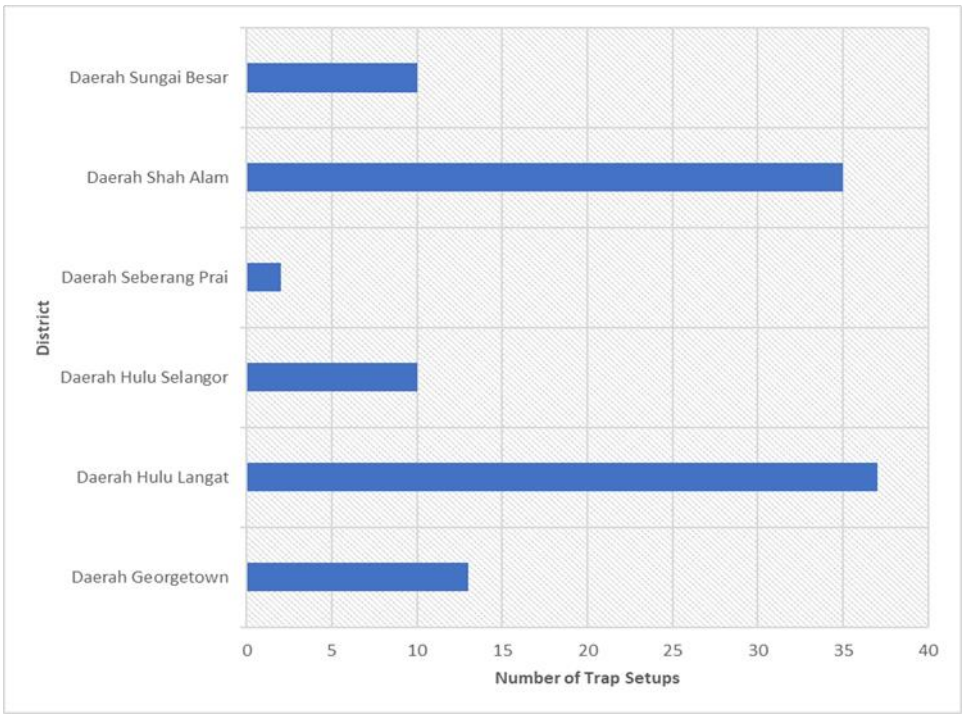

Figure 15. Number of trap setups across six districts in Peninsular Malaysia (January to June 2024)

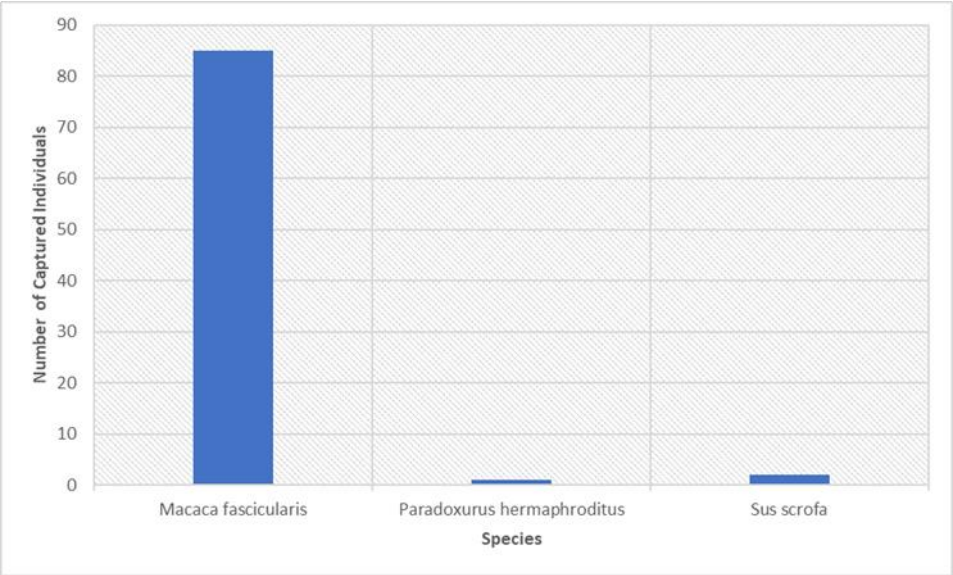

Figure 16. Captures of *Macaca fascicularis*, *Paradoxurus hermaphroditus*, and *Sus scrofa* across six districts in Peninsular Malaysia: Shah Alam, Hulu Selangor, Sungai Besar, Hulu Langat, Georgetown, and Seberang Prai from January to June 2024.

Figure 17 presents a heatmap generated through Kernel Density Estimation (KDE), showing the distribution of *Macaca fascicularis* conflict hotspots. This analysis indicates that areas such as Hulu Langat, and Shah Alam are critical hotspots requiring targeted intervention.

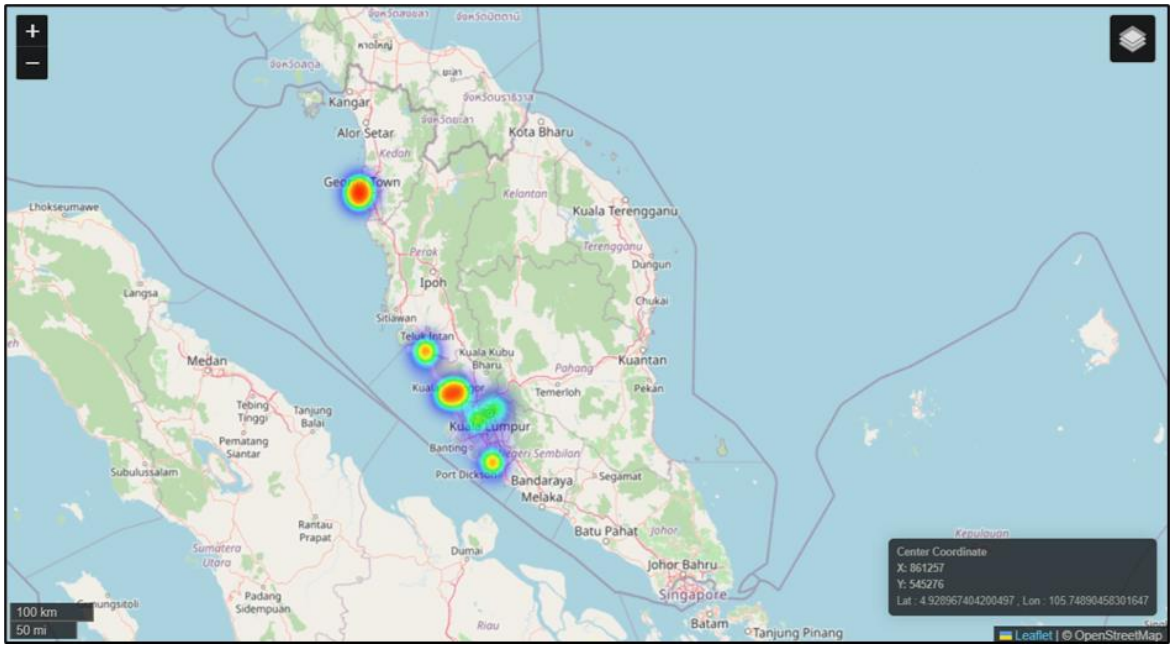

Figure 17. Heatmap of *Macaca fascicularis* (long-tailed macaques) conflict hotspots in Peninsular Malaysia (n=85) generated using Kernel Density Estimation in Geo Wild System from January to June 2024.

4.4.2. Integration of citizen-collected data

In addition to the data from the traps, GWS also gathered real-time monitoring data from citizens, which is essential to providing a comprehensive understanding of wildlife conflict across the studied regions. Between January and June 2024, citizens reported a total of 24 incidents, with the majority involving *Macaca fascicularis* (19 reports), followed by *Sus scrofa* (3 reports), and *Paradoxurus hermaphroditus* (2 reports) (**Figure 18**).

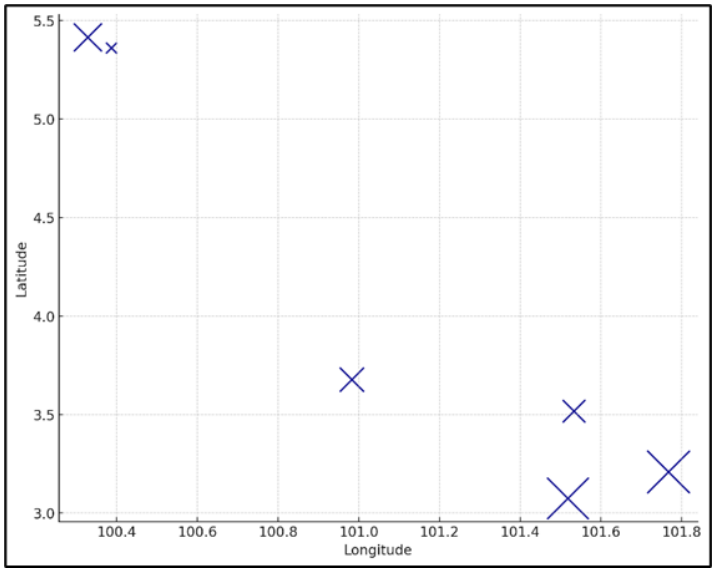

Figure 18. Distribution of citizen-reported wildlife incidents from January to June 2024, with the size of the X's representing the relative frequency of reports at each location in Peninsular Malaysia.

4.4.3. Species-specific heatmap analysis

The citizen-reported data were further analyzed to create heatmaps for each species, providing a clearer view of the spatial patterns associated with different wildlife conflicts. **Figure 19** consolidates these heatmaps into a single comprehensive visualization:

•*Macaca fascicularis*: The KDE analysis revealed high-density areas in urban and suburban regions, particularly in Hulu Langat and Shah Alam, which corresponded closely with the trap data hotspots.

•*Paradoxurus hermaphroditus*: The reports for this species were fewer and more isolated, primarily in Georgetown and Sungai Besar, indicating less frequent conflicts compared to *Macaca fascicularis*.

•*Sus scrofa*: Reports were concentrated in suburban areas, with notable incidents in Hulu Langat and Shah Alam.

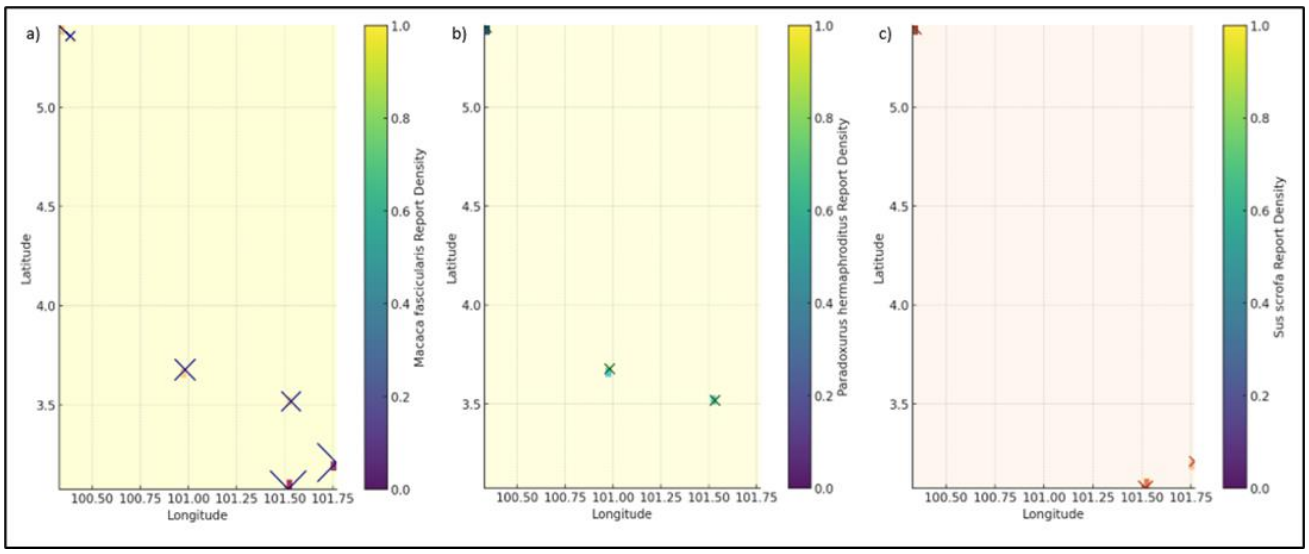

Figure 19. Heatmap of species-specific reported incidents for (a) *Macaca fascicularis*, (b) *Paradoxurus hermaphroditus*, and (c) *Sus scrofa from* January to June 2024, with the size of the X's representing the relative frequency of reports at each location in Peninsular Malaysia.

4.4.4. Correlation of citizen reports with trap data: KDE Analysis

The Kernel Density Estimation (KDE) was used to compare the density of citizen-reported incidents with the locations of traps and captured wildlife. **Figure 20** illustrates this comparison, showing a significant overlap between the high-density areas identified by citizen reports and the locations where traps were most successful. This alignment suggests that citizen data is a reliable source for identifying conflict hotspots and can effectively guide trap placement.

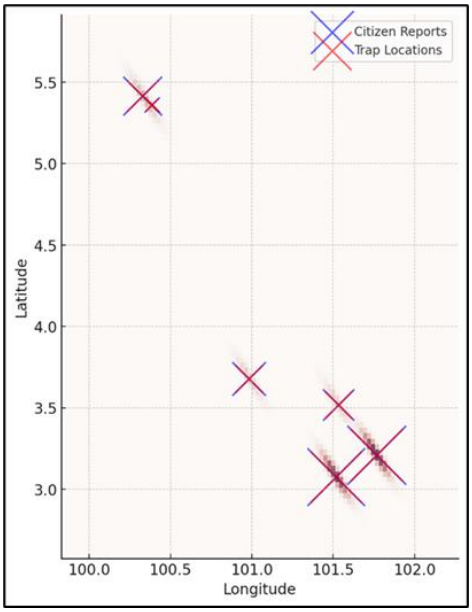

Figure 20. KDE comparison of citizen-reported incidents and trap data from January to June 2024, with the size of the X's representing the relative frequency of reports at each location in Peninsular Malaysia.

4.4.5. User feedback evaluation

The feedback from the Geo Wild System Application users, as shown in **Figure 21**, indicates generally high satisfaction across different aspects of the app, based on responses from 103 participants (73 citizens, 24 wildlife officers, five researchers, and one licensed hunter).

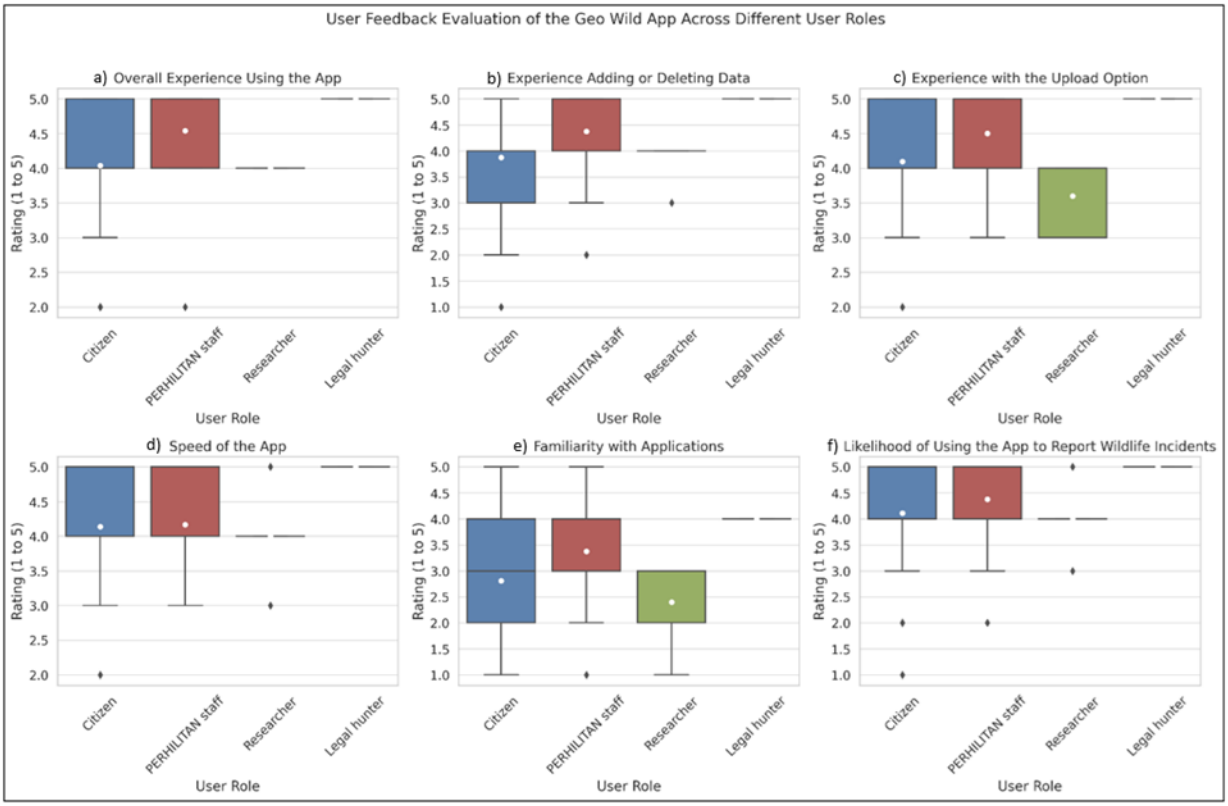

Figure 21. User feedback evaluation of the Geo Wild System App across different user roles, showing: (a) overall satisfaction, (b) ease of data entry, (c) upload functionality, (d) application speed, (e) familiarity with similar applications, and (f) likelihood of future use for wildlife incident reporting.

Overall experience ratings were high among all user groups, particularly among citizens and wildlife officers, with researchers also providing positive feedback. The functionality of adding or deleting data was well-received, especially by wildlife officers, while citizens showed more variability. The upload option also received strong positive feedback, with consistent ratings across user groups. The app's speed was rated favorably, although citizens indicated some variability, suggesting potential areas for performance improvement. Familiarity with similar applications varied, with wildlife officers and researchers generally more comfortable than citizens, highlighting a need for enhanced user training or intuitive design

elements. The likelihood of using the app to report wildlife incidents was rated highly, with both citizens and wildlife officers expressing strong confidence in the app's utility.

5. DISCUSSION

5.1. Literature survey: Wildlife management strategies in Hungary and Malaysia

5.1.1. Comparison of wildlife management strategies in Hungary and Malaysia

Wildlife management strategies in Malaysia are predominantly state-owned, heavy relying on government funding and ecotourism to support conservation efforts. This approach, often involving minimal human intervention, has led to poor in several key areas (DWNP, 2023). The strategy embodies a hands-off method to maintain ecosystems in their natural state. However, the continued decline in populations of large species suggests that these strategies may not be effectively conserving wildlife. Economic sustainability is another primary concern, as conservation funding mainly covers small operational costs and depends heavily on government subsidies (DWNP, 2023). Additionally, the absence of national benefit-sharing policies with local communities exacerbates these challenges.

Ecotourism is crucial in Malaysia, providing employment opportunities and funding for wildlife conservation, particularly in rural areas rich in natural attractions. However, this funding source is often unstable due to inadequate resource management, fluctuating tourist numbers, inconsistent government support, and challenges balancing tourism with conservation needs (DWNP, 2023). Although ecotourism has the potential to generate conservation funding, the financial benefits predominantly favor the government and tourism operators rather than the local communities directly affected by conservation efforts (Samal & Dash, 2023).

Under Malaysia's top-down approach, where the state government owns the wildlife and management system, locals benefit indirectly from tourism and ecosystem services provided by protected areas. Malaysia's Community-Based Tourism (CBT) model has shown some success (Kayat & Zainuddin, 2016). Locals living near ecologically sensitive areas, such as rainforests and reserves, are encouraged to participate in wildlife conservation. They receive a share of the income from ecotourism activities, including handicraft sales, homestays, and guided nature tours (Kayat & Zainuddin, 2016; Kunjuraman, 2020). However, local community engagement tends to be reactive rather than proactive, often limited to formal campaigns and consultations rather

than ongoing, active participation.

This financial incentive motivates locals to protect their natural ecosystems, contributing to reduced habitat degradation and illegal activities. Additionally, they benefit from programs promoting sustainable agriculture and non-timber forest products (NTFPs), which provide financial support to those practising responsible land and resource management (Svarrer & Smith-Hall, 2005). For example, local farmers are incentivized to adopt agroforestry practices, which benefit their economic well-being and help reduce deforestation. Malaysia has also developed certification programs for timber and oil palm production, such as the Forest Management Certification (FMC) under the Malaysian Timber Certification Scheme (MTCS) (JPSM, 2024). These certifications not only stimulate market demand but also provide international recognition of sustainable practices, aiding in wildlife habitat conservation.

Despite its potential benefits, ecotourism often fails to address the socio-political issues contributing to habitat degradation (Shannon et al., 2017). The role of ecotourism in wildlife conservation is a complex socio-ecological system or research-policy interface, requiring insights from both social and natural sciences for effective assessment (Waldron et al., 2013; Karanth & deFries, 2010; Perrings et al., 2011). In situations where threatened wildlife species are adequately covered within existing but underfunded conservation reserves, effective ecotourism can potentially increase the overall net gain of expected survival time (Stronza et al., 2019). However, when species are underrepresented in conservation reserves and threatened by extractive industries, ecotourism can offer only a temporary respite until more protective measures are implemented (Stronza et al., 2019). This reliance on ecotourism for conservation may create a false sense of security and prove insufficient in the long term.

Nevertheless, in many examples, ecotourism has led to conservation benefits that outweigh its impacts, enhancing the survival rates of endangered species such as the Malayan tiger (*Panthera tigris jacksoni*) and the Asian elephant (*Elephas maximus*) (Buckley et al., 2016). For example, the Kuala Gandah Elephant Sanctuary is a notable reserve focusing on the conservation of the

Asian elephant (*Elephas maximus*), which also serves as an ecotourism destination (Saaban et al., 2011). Funding for these conservation practices primarily comes from the government and, in cases where non-profit organizations manage reserves, from donations (DWNP, 2023).

Wildlife conservation areas in Malaysia, categorized as national parks, wildlife reserves, and sanctuaries, are managed and owned in a way crucial for policy discussions distributing benefits from wildlife activities (Korir et al., 2013). The protective impact of ecotourism is based on land conservation and providing incentives for wildlife conservation (Shannon et al., 2017). This approach can offer a long-term, sustainable income source to support habitat conservation for decades, significantly influencing conservation and management policies (Stronza et al., 2019). Regarding metapopulation strategies, Malaysia may relocate wildlife for various reasons, including conflict management, demographic control, or genetic improvement.

Since the late 1970s, Malaysia has experienced a significant decline in wildlife, primarily due to habitat destruction driven by human population growth in natural habitats. Contributing factors such as poaching, habitat loss, and human-wildlife conflict have been exacerbated by the country's growing population. Malaysia's protected areas and forest reserves often suffer from fragmentation due to human settlements, which limits food availability, space, and suitable habitats for wildlife. A stark example is the drastic decline in the population of the Malayan tiger, largely due to poaching and deforestation since the 1970s. As of the latest estimates, only about 138 Malayan tigers remain in the wild (DWNP, 2023), highlighting the critical threat these national animals face.

In contrast to Malaysia's declining wildlife populations due to habitat loss and human encroachment, Hungary employs a more hands-on approach to wildlife management, incorporating sustainable hunting, fee-hunting, and game meat sales as tools to control game populations and generate significant game funding for conservation (Csányi and Lehoczki, 2010; Myronenko, 2015). While Malaysia's strategies emphasize passive conservation with indirect benefits for local communities, Hungary's approach primarily provides direct benefits to sustaining the game

management system, and resulting in long-term sustainable wildlife management. However, the general public in Hungary also benefits indirectly from conservation efforts (Tremblay et al., 2014). Hungary's integration within the EU and eligibility for the Common Agricultural Policy (CAP) provide financial support and subsidies to farmers who adopt environmentally friendly farming practices, aiding habitat maintenance for farmland bird species (Báldi & Faragó, 2007; Kleijn et al., 2009; Hoyk et al., 2022).

Hungary also has a century-old hunting tradition aligned with sustainable conservation practices through regulated quotas and hunting licenses (Tóth, 1991; Csányi, 1994; Myronenko, 2015). The Hungarian system is based on a three-level planning model (Csányi, 1998) and the introduction of 52 game management regions (Csányi, 1993, 1998). Hunters contribute directly to wildlife management and conservation through active participation and paying license fees, with the revenue generated being reinvested into conservation efforts (Csányi & Szemethy, 2015; Neumann & Seidel, 2021). The success of this strategy is maintained by significant contributions from hunters, excise taxes, active hunting participation, public access to wildlife (e.g., wildlife watching), enforcement of hunting regulations, and quota settings based on accurate and reliable population estimates (Abildtrup & Jensen, 2014). However, privatization of wildlife and land poses a threat, as it contradicts the *res communis* status of game/wild animals (Csányi and Lehoczki 2010). In the USA this the common heritage doctrine principle, where the sustainability of funding sources is at risk if non-consumptive users, who do not contribute financially, become more prevalent, especially if hunting participation declines. Introducing a federal funding mechanism for non-consumptive wildlife users could strengthen these strategies. This model is long-established in the USA (Mahoney & Geist, 2019) but differs in its application across European countries (Putman, 2011; Trouwborst & Hackländer, 2018).

Hungary's wildlife management strategies demonstrate high economic, social, and ecological performance, with several game populations remaining stable or growing (being overabundant). However, Hungary also faces challenges with invasive species and expanding populations, such as

raccon dogs (*Nyctereutes procyonoides*), golden jackal (*Canis aureus*), and raccoons (*Procyon lotor*), which can outcompete native species and disrupt local ecosystems (Heltai et al., 2000; Carter & Leonard, 2002; Markolt et al., 2012; Schertler et al., 2020). The increasing populations of cervids and wild boar have led to human-wildlife conflicts, including vehicle collisions (Markolt et al., 2012; Markolt, 2015) and agricultural crop damage (Bleier et al., 2012; Horváth & Tari, 2022). These issues highlight the need to balance conservation practices with local interests and safety.

At the same time, small game populations across Hungary are declining (Faragó et al., 2012; Schally et al., 2022), adding another layer of complexity to wildlife management. This decline contrasts with the increasing numbers of big game, underscoring the diverse impacts of current agricultural environments and game management practices. For example, while the growth in deer populations has been beneficial in terms of conservation status, it has led to more frequent crop raids in agricultural areas. Conversely, the sharp decline in small game species like the grey partridge (*Perdix perdix*), once abundant, highlights a critical area in need of attention and adjustment in management strategies (Faragó et al., 2012; Kuijper et al., 2009; Schöll et al., 2023). Similarly, the Eurasian woodcock (*Scolopax rusticola*) has seen reduced numbers, mainly due to habitat loss and changing land use practices, further illustrating the challenges faced by small game species (Schally et al., 2012; Schally et al., 2022). This situation highlights the importance of a balanced approach to wildlife management that addresses the needs and impacts across different species groups, aligning conservation efforts more closely with local interests and ecological sustainability.

Both Malaysia and Hungary face challenges related to potential fraud and enforcement of regulations, requiring transparency and effective oversight to ensure that economic benefits lead to tangible conservation outcomes. Additionally, these benefits sometimes prioritize short-term gains over long-term wildlife conservation objectives, potentially leading to resource overexploitation. Each country operates within a national legal and policy framework that shapes its wildlife management strategies. Malaysia's laws are geared towards strict protection measures under federal and state

legislation. In contrast, Hungary's laws and policies are intertwined with EU regulations that better facilitate a balance between sustainable use and conservation.

Comparing Malaysia's and Hungary's wildlife management strategies directly is complex due to their distant traditions, customs, differing models and management approaches. In Hungary, wildlife is state-owned (*res communis*) but managed more flexibly, allowing hunting, trapping, and trade with live animals or their meat. Conversely, in Malaysia, wildlife is state-owned, with private ownership being uncommon and often illegal. This analysis does not suggest that Hungary's strategies are superior in generating income or job opportunities compared to Malaysia. Malaysia emphasizes socio-economic benefits and community-based conservation, with indigenous communities playing a vital role. However, the benefits are often passive and indirect, unlike in Hungary, where hunting provides visible direct conservation and economic benefits. The availability of large tracts of accessible public land in Malaysia complicates profitable ecotourism. Despite some mutual benefits between economics and conservation in Malaysia, the economics-based model has limitations. Understanding the multifaceted aspects of each strategy provides a foundation for adopting and adapting the best approaches suited to local needs and conditions.

5.1.2. Technological and community-involvement

In Hungary, potential local community involvement through hunting (local sport hunters and game keepers employed) not only provides economic benefits but is also culturally significant. On the basis of the available information on hunting and game management it is possible to assess active participation. The NGMD, which supports game management decisions through a comprehensive, data-driven approach, can serve this by gathering extensive data on game populations, hunting activities, and habitat changes. This system integrates traditional hunting practices with modern conservation principles, fostering a deep sense of stakeholder ownership and responsibility (Csányi et al., 2010). The local impacts of game populations and game harvests, and financial revenues can be estimated through the reports of the game management units (local information), directly involving the local

hunting units into the data collection and decision-making processes. This involvement enhances the relevance of the data collected, as it reflects local knowledge and immediate observations, potentially leading to more tailored and effective management strategies.

Conversely, Malaysia's use of the SMART represents a different approach. While SMART enhances monitoring and enforcement capabilities against poaching and effectively manages habitat through high-tech, real-time monitoring (Trelstad & Bonnie, 2022), its engagement with local communities is more formal and less frequent. This can limit the effectiveness of conservation practices by reducing local stakeholder buy-in and support. The reliability of SMART data, while beneficial for immediate responses due to its real-time nature, might need to capture the full ecological, biological, and economic context that more comprehensive systems like NGMD provide. The SMART system's data is highly dependent on technology and the expertise of the operators, which can sometimes lead to gaps in data continuity and quality, especially in remote or technologically underserved areas. Additionally, the lack of a centralized national wildlife database in Malaysia is a significant limitation, as it hampers the ability to streamline and integrate data across different regions and conservation initiatives.

Both systems illustrate the need for diverse strategies in wildlife management tailored to specific cultural and regional needs. NGMD's model of integrating traditional practices with modern conservation aligns well with the administrative landscape of Hungary, enhancing a unique stakeholder engagement and sustainability of conservation efforts. In contrast, the SMART system, while effective in immediate threat response, requires improvements to foster better community involvement and data integration to enhance its long-term effectiveness and stakeholder support in Malaysia.

The comparative study highlights that effective wildlife management must balance technological capabilities with extensive community involvement. It is imperative for wildlife monitoring systems, particularly in Malaysia, to evolve beyond merely harnessing technology for conservation. These systems must actively integrate local communities into conservation efforts, fostering deeper engagement and participation. This approach will not only

enhance the technological efficiency of these strategies but also ensure they are socially sustainable and culturally respectful. By doing so, Malaysia can build a more holistic conservation framework that respects and incorporates the insights and traditions of local communities, ultimately leading to more effective and enduring wildlife management practices.

5.2. Field-based research: Human-Asian palm civet conflict

5.2.1. Human-Asian palm civet conflict

The results presented the assessment of the human-Asian palm civet conflict among locals in Malaysia. Over 50% of Hulu Langat locals in this study experienced different types of skirmishes related to APC. Based on the survey findings, locals involved in farming, notably those who had experienced APC damaging their cultivated fruit and are familiar with APC, tend to have more negative attitudes towards APC. Negative attitudes towards APC hinder their protection (Dai et al., 2019), and the social co-existence relationship between the local community and APC could influence this. The primary types of damage caused by APC are consumption of cultivated fruits and poultry attacks. Since farming serves as the primary economic source for most local communities and directly impacts their livelihoods, farmers and locals who have experienced APC damaging their cultivated fruits and attacking poultry are more sensitive to APC damage and thus hold more negative attitudes (Su et al., 2020). For locals who have never encountered or are unfamiliar with APC, their perception tends to remain rooted in the charismatic image (Hasan & Csányi, 2023). However, once they encounter APC, their attitudes shift based on their existent feelings and experiences (Hasan & Csányi, 2023). Therefore, it is crucial to raise awareness and provide education to improve the protection of this species and foster tolerance towards human-Asian palm civet conflict.

5.2.2. Causes of human-Asian palm civet conflict

Most respondents believe that the steady increase in the APC population over the past decade is the leading cause of the human-Asian palm civet conflict. They state that the increasing population trend results from insufficient population control measures and ineffective wildlife management. This perception has led to negative attitudes of locals toward these wild animals as they believe that an abundance of this nuisance animal will bring about more damage and losses to them. However, they are unaware that the global population number of these animals is experiencing a decline (Duckworth et al., 2016). Areas characterized by high conflicts between humans and wild animals are often associated with decreased wildlife population trends

(Michalski et al., 2006; Woodroffe et al., 2022). Urbanization, tourism development, road construction and highways have contributed to the loss of APC habitat (Yasuma & Andau, 2000; Shevade et al., 2017). The loss of habitat and limited resources have created a challenging environment for APCs, pushing them into more frequent conflict with humans. According to Su et al. (2020), conflict between humans and APC becomes inevitable when both entities compete for limited space and natural resources.

Unfortunately, only a few studies have been carried out in Malaysia on the conflict between humans and APC with anthropogenic disturbance and the diet of civets, as traditionally, fruits have been considered the civets' primary food (Wang, 1987). Based on this study, the drivers of the conflicts are the foraging habits of the civets which caused damage to the local property, consumption of cultivated fruits, and predation of domestic poultry. According to Wang (1987), when a civet comes across a tree containing ripe fruits, it develops a preference for revisiting that foraging area.

Additionally, given the comparable results regarding the occurrence of food items in the diet, the frequency of foods consumed during the wet and dry seasons was determined. Remarkable patterns revealed a peak in predation on poultry during the wet season and increased consumption of cultivated fruits during the dry season. The consumption of poultry by APCs in the study area may reflect a decrease in the availability of cultivated fruits during the wet season, as indicated by the amount of fruit produced. These findings suggest that APCs in the study area exhibit opportunistic feeding behavior, adapting their diets in response to changes in the availability of food sources.

5.2.3. Human-Asian palm civet conflict mitigation measures

Currently, most locals in the area prefer passive measures or leave the APC alone to address conflicts between humans and APC. However, it is noteworthy that some locals have resorted to using poison when confronted with such disputes. The enforced shift in their preferred measures may lead to negative attitudes among locals towards these animals, subsequently undermining the effectiveness of APC protection and conservation efforts for APC. While extermination of the APCs may seem like a solution to mitigate

these conflicts, it is essential to consider the broader ecological context and implement a more proactive and sustainable strategy.

In situations where APCs pose an immediate threat to cultivated fruits, poultry, and local property targeted trapping and relocation can be considered. Trapping should be carried out by trained wildlife experts and focus on removing problematic individuals causing the conflict rather than indiscriminate trapping. Relocating captured APCs to suitable habitats away from human areas can help reduce the conflict. Besides that, offering compensation to affected locals is an effective strategy for fostering tolerance towards APC among locals. The compensation mechanism helps minimize the economic losses and damage caused by wildlife and enhances the locals' tolerance toward wildlife (Karamanlidis et al., 2011; Karanth et al., 2013). Therefore, compensation is a significant tool for protecting wildlife and improving local livelihood (Bulte & Rondeau, 2013). However, despite its importance, implementing a compensation mechanism for wildlife damage to crops and properties in Malaysia has not yet been launched.

Nevertheless, in some instances, governments may compensate locals who have suffered injuries and fatalities caused by wildlife. In 2004, the government introduced the implementation of the Wildlife Attack Victims Assistance Fund, which aims to alleviate the financial burden of treatment for victims of wildlife attacks. Compensation amounts for such incidents can vary and are typically determined case-by-case. Various factors include the injury's severity, species, and incident circumstances. According to DWNP (2023), the Federal Government compensates locals injured by wild animals with amounts up to RM 20,000, depending on the reported level of injuries or death confirmed by the medical officer. The Department of Wildlife and National Parks (PERHILITAN) is responsible for assessing incidents, investigating the circumstances, and determining eligibility for compensation (DWNP, 2023).

Unfortunately, several deficiencies in Malaysia's wildlife damage compensation process result in frequent disappointment. Government-run schemes have encountered failures for various reasons including insufficient funds, devious claims, management inadequacies, and practical challenges

(Gao et al., 2023). In addition, the qualitative and quantitative analyses of wildlife damage have proven challenging. According to respondents, compensation mainly covered injuries and fatalities, and the time required to process the claims and provide compensation is also one of the significant factors that cause victims to give up reporting wildlife damage in Malaysia.

Consequently, locals reduce their willingness to protect the APC because they suffer from the damage. Hence, it is crucial to acknowledge the livelihood concerns of the local communities and ensure that they foster positive attitudes towards APC in any initiatives to address these conflicts. Additionally, a collaborative endeavor involving the government, conservation practitioners, and local communities is essential to safeguard the APC population, minimize local damage, and effectively address the issue posed by the human-Asian palm civet conflict.

Besides that, several measures can also be implemented, such as setting up an infrared trigger camera alarm system and establishing a modern defense system to prevent conflict (Ahmad et al., 2022; Montero-Botey & Perea, 2023). A modern defense system could include a variety of measures such as local community education and awareness programs, habitat conservation, and non-lethal deterrents implementation (Baker et al., 2005; Naha et al., 2020; Ahmad et al., 2022; Gebo et al., 2022). These measures can help to reduce the conflict and promote coexistence between humans and APC. To reduce cultivated fruit consumption, locals can adopt tactics that do not involve extermination, such as erecting fences or nets around orchards and using chemical or natural repellents to deter APCs from accessing the fruits. Locals can also provide alternatives food sources to divert APC's attention from valuable fruits and crops. Since APCs are predominantly nocturnal, keeping poultry enclosed in secured structures and employing trained dogs during nighttime can minimize predation risk. Furthermore, APCs can occasionally cause property damage, such as chewing on electrical wiring and nesting in roof spaces (Ahmad et al., 2022). Thus, sealing all entry points to ensure houses and buildings have no gaps or openings that allow APCs to access roof spaces can help prevent damage and conflict.

This study showed that human-Asian palm civet conflict is apparent in the

study area. The conflict primarily arises due to cultivated fruit consumption, poultry predation and property damage caused by APCs. The conflict also becomes the leading cause of the continued survival of APC species in the area. However, this study was carried out in a specific region of Hulu Langat, and the results may not be fully representative of other places with different biological, ecological and socio-cultural aspects. Additionally, the sample size used in this study was small and lacked information on the movement patterns of APC within the study area. This knowledge gap limits the understanding of their territorial behavior, spatial distribution, and potential interactions with human activities. Therefore, while this study provides valuable insights into the dynamics and challenges surrounding the conflict, it is important to acknowledge the limitations that may influence the generalizability and interpretation of the findings to other contexts. For future research, it is recommended to compare the behavior of APC in areas that are remote from human influences and attractions to provide valuable insights into the impact of human activities on the behavior of these wild animals.

5.3. Field-based research: Local attitudes towards wildlife and their management methods

5.3.1. Wildlife experience affects locals' attitudes

This study found that many locals accepted various active wildlife management methods, rather than favoring a passive approach of leaving wildlife alone. Although only a few locals had limited awareness and experience with wildlife in their area, they generally felt that actions should be taken to protect and conserve wildlife fairly. However, a more significant preference divergence was anticipated between those who frequently observed wildlife and those who did not. Direct observation of wildlife significantly influences locals' attitudes toward wildlife (Basak et al., 2022). Frequent encounters with wildlife often fostered positive attitudes toward specific species (Liordos et al., 2020). Familiarity with wildlife proved to be a valuable experience, shaping opinions and increasing tolerance toward wildlife and management methods. According to Pinheiro et al. (2016), interactions with wildlife potentially supported locals' tolerance and fostered positive attitudes by reducing fear.

Conversely, more than half of the respondents lacked experience with wildlife, leading to neutral or negative attitudes and lower tolerance (Kang et al., 2019). Locals with more knowledge and engagement with nature tended to exhibit more positive attitudes. Previous research suggested that experience influenced attitudes toward wildlife conservation (Odebiyi et al., 2015). Those with direct experience with wildlife and conservation generally supported management practices and initiatives. In contrast, individuals from areas with frequent human-wildlife conflicts were likelier to show negative attitudes toward wildlife and its management and conservation (Hart & O'Connell-Rodwell, 2000). The results also indicated that human-wildlife conflicts, especially those involving property damage, significantly affected local attitudes. Rural areas near forests tended to foster negative attitudes, while urban areas, distant from forests, often saw more positive attitudes and support for management. Urban residents typically encountered only urban wildlife species representing all wildlife (Lunney & Burgin, 2004). On the other hand, the "extinction of experience" and "alienation from nature" due to a lack of exposure to wildlife influenced attitudes negatively (Vogel, 1988;

Soga & Gaston, 2016). Thus, increased familiarity with wildlife often motivated locals to shift their attitudes and support wildlife management practices.

Most locals in rural areas, particularly in the Borneo region, frequently interacted with wildlife, making management practices more intuitive. This study indicated that residents of rural areas who lived near forests and large wildlife populations generally exhibited negative attitudes toward wildlife and its management. Existing literature supported this observation, showing that locals closer to forests often held negative attitudes toward conservation and management efforts (Infield, 1988; Newmark et al., 1993; Sirivongs & Tsuchiya, 2012; Odebiyi et al., 2015). These attitudes likely stemmed from direct impacts of human-wildlife conflicts, such as frequent property damage, perceived threats from wildlife, and lack of economic benefits, making these locals less inclined to support wildlife conservation and management activities.

5.3.2. Influential factors on the acceptance of wildlife management methods

The survey revealed that both urban and rural residents in Malaysia generally preferred capture and relocation methods for managing wildlife, indicating a higher tolerance for wildlife in their environment. Despite fewer respondents having direct experience with wildlife, the majority preferred to avoid killing wild animals, opting instead to call wildlife control when issues arose. Similar preferences for non-lethal methods have been reported in other studies (Reiter et al., 1999; Massei et al., 2010). Locals often interpreted capture and relocation as taking wildlife to a zoo rather than returning it to the wild (Asimopoulos, 2016).

According to the Department of Wildlife and National Parks (DWNP) in Peninsular Malaysia, animals' conflicts often stem from human intolerance toward livestock and crop damage. Reports of wildlife roadkills are more common in Malaysia (e.g., Ayob et al., 2020; Kasmuri et al., 2020; Hui et al., 2021), whereas incidents involving human injuries or fatalities from wildlife are relatively less reported. This suggests that some negative attitudes and fears toward wildlife may be unfounded. Locals generally supported resettling wildlife outside their property, primarily due to personal anxiety,

destruction, and intrusion into their homes (Basak et al., 2022). This indicates potential for coexistence with wildlife, provided locals properly understanding of wildlife risks. Since capture and relocation often result in adverse outcomes for certain species, future education on wildlife management should better communicate the humaneness and limitations of these practices to align local views with those of wildlife experts (Dubois & Harshaw, 2013).

Education emerged as the most favored method of wildlife management among respondents with higher education levels and more experience with wildlife. Educational attainment plays a crucial role in shaping attitudes toward wildlife management. While Newhouse (1990) argued that attitudes toward environmental conservation are influenced more by life experiences than formal education, Woodroffe et al. (2005) asserted that education on wildlife conservation could serve as a knowledge platform to shape general attitudes. Nik Mohamad (2011) found that locals' knowledge about the importance of wildlife, as well as their interest and experience, significantly influenced their urban attitudes. Additionally, Pinheiro et al. (2016) found that negative attitudes toward snakes could be linked to the level of education, with increased knowledge dispelling myths related to snakes. Therefore, educating locals about wildlife and management methods is essential for garnering support for wildlife conservation. Higher levels of education are also associated with more positive attitudes toward wildlife, likely due to greater awareness and understanding of wildlife conservation practices (He et al., 2011; Deng et al., 2015).

Locals also strongly favored habitat management methods and the removal of attractants. Most agreed that the availability of garbage and wildlife feeding in human areas could significantly increase the number of wildlife encounters. Wildlife not only utilized food waste but also became over-reliant on these sources, leading to conflicts with humans through direct or indirect feeding (Van Eeden & Newsome, 2017). This reflects locals' desire to avoid human-wildlife conflict while appreciating wildlife in a natural environment. According to Gamborg et al. (2020), stakeholders have emphasized naturalness as a significant value in wildlife management. In this context, the analysis demonstrated that the conservation of wildlife habitat was strongly

supported by females with high levels of education, particularly those from rural areas.

Many studies (e.g., Lauber et al., 2001; Naiyi et al., 2010; Mir et al., 2015) have noted significant differences in attitudes toward lethal methods between male and female respondents. Gender significantly influenced negative attitudes, especially among males in this study. Females tended to be more tolerant and conscious of wildlife and its management, possibly because male respondents were more involved in activities such as fishing and hunting. Historically, young men in Malaysia sometimes hunted wildlife to achieve status, and hunting has formed a part of many cultural beliefs (Bennett et al., 2000). Most Malaysian women, on the other hand, traditionally stayed home to care for the family after marriage, while men engaged more in nature activities like fishing and hunting. Cooper et al. (2015) found that locals interested in wildlife, such as hunters, were 4-5 times more likely than those without such interests to have positive attitudes and behaviors. Furthermore, females' positive attitudes toward wildlife could be attributed to greater awareness of dangerous wildlife species (Kaltenborn et al., 2006) and conservation efforts.

Reiter et al. (1999) found that non-lethal methods were most likely to be seen as humane and were the most accepted. Consequently, only a small number of respondents in this study accepted hunting (a lethal method), as it is considered controversial and inhumane. According to Bennett et al. (2000), hunting most species, even by locals in the Borneo region, is incompatible with wildlife conservation. However, this study identified higher support for hunting among males and the younger generation. The influence of age on locals' attitudes toward wildlife and their management methods was also significant, showing a strong negative correlation. Previous studies suggested that younger local community members are more tolerant of conflict species and have more positive attitudes. This highlights the complex and multifaceted nature of attitudes toward wildlife (Tobias et al., 2021). These findings are perhaps unsurprising and likely more common among females than males (Mir et al., 2015).

In conclusion, the study showed that residential areas and wildlife

experiences are crucial factors in shaping attitudes toward wildlife management methods in Malaysia. The preference for non-lethal methods over lethal options among locals, in contrast to wildlife experts, underscores the disconnect between local perspectives and management approaches to wildlife issues. Although most people consider wildlife conservation important, this importance is influenced by local attitudes toward wildlife and management methods. Increasing local involvement could enhance communication about wildlife management goals and generate greater support for these initiatives (Don Carlos et al., 2009).

5.4. Technical-based research: Geo Wild system

5.4.1. Insights from the initial deployment of the Geo Wild System

From January to June 2024, the initial deployment of the Geo Wild System (GWS) yielded critical insights into its capabilities and effectiveness in tackling wildlife management challenges in Malaysia. This deployment highlighted the pivotal role of citizen science in enhancing these efforts. By harnessing real-time data collection from citizen reports, the GWS effectively pinpointed key wildlife conflict hotspots, notably in Daerah Hulu Langat and Daerah Shah Alam. These regions experienced frequent encounters with long-tailed macaques (*Macaca fascicularis*), highlighting the species' significant role in human-wildlife conflicts. The data gathered not only emphasized the prevalence of these interactions but also affirmed the system's design, demonstrating its robustness as a tool for swiftly collecting and analyzing wildlife data to guide targeted intervention strategies.

Moreover, the system demonstrated its adaptability by effectively managing conflicts involving a variety of species across different ecological contexts. For example, the GWS was instrumental in monitoring and responding to incidents involving the Asian palm civet (*Paradoxurus hermaphroditus*) and wild boar (*Sus scrofa*). This flexibility is crucial, as it indicates that the GWS can cater to the unique behavioral patterns and ecological requirements of different species, enabling wildlife authorities to implement real-time, dynamic management solutions. These early successes highlight the system's potential to significantly reduce both ecological disturbances and socio-economic impacts associated with wildlife conflicts.

5.4.2. Wildlife conflict patterns analysis and species-specific management strategies

The detailed analysis of the GWS data provided further insights into the spatial and temporal patterns of wildlife conflicts across the monitored regions. The Kernel Density Estimation (KDE) heatmaps generated from the data were particularly effective in identifying concentrated areas of conflict (Maciejewski et al., 2010), especially in urban and suburban settings such as Hulu Langat and Shah Alam where long-tailed macaques (*Macaca*

fascicularis) were most active. The persistence of these hotspots in specific urban landscapes suggests that factors such as food availability and habitat encroachment play significant roles in driving these conflicts (Hambali et al., 2012; Schell et al., 2020; Shean Choong et al., 2021). Understanding these patterns is essential for developing more effective, location-specific management strategies.

In addition to this broader analysis, the GWS enabled a more granular, species-specific examination of conflict zones. By generating heatmaps for different species, the system provided wildlife officers with detailed insights into the movement and behavior of species like the wild boar (*Sus scrofa*) and Asian palm civet (*Paradoxurus hermaphroditus*). These insights are crucial for tailoring management approaches to the specific needs of each species. For example, the strategic placement of traps based on this data has proven to be a more effective use of resources, ensuring that interventions are concentrated in areas where they are most needed.

5.4.3. Comparative impact: GWS vs. SMART system in wildlife conservation

The Geo Wild System (GWS) has significantly advanced wildlife conservation efforts in Malaysia by enabling a shift from reactive to proactive management strategies. Unlike the Spatial Monitoring and Reporting Tool (SMART), which primarily focuses on supporting the operational needs of protected area managers and law enforcement through systematic patrol data collection (SMART Partnership, 2019; Cronin et al., 2021), the GWS extends its functionality to include real-time public reporting and community engagement. This broader approach is particularly effective in managing urban wildlife conflicts, where traditional methods often fall short. The involvement of local communities in the GWS has enhanced data accuracy and provided wildlife authorities with real-time insights, allowing for more timely interventions. The system's use of real-time GPS tracking and GIS tools, particularly those utilizing the West Malayan RSO (Kertau 1948) coordinate system, has been instrumental in identifying and managing hotspots involving long-tailed macaques, ultimately leading to a reduction in the frequency and severity of these conflicts.

Furthermore, the GWS's integration of community-driven data collection with advanced spatial analysis tools positions it as a complementary system to SMART. While SMART is highly effective in protected area management, the GWS addresses the broader landscape of human-wildlife interactions, particularly in urban and suburban areas. This comprehensive approach not only enhances the scope of conservation efforts but also promotes coexistence between humans and wildlife by actively involving communities in the management process.

5.4.4. User feedback and pathways for system improvements

User feedback has been invaluable in evaluating the GWS and identifying opportunities for its improvement. The system has received high satisfaction ratings, particularly for its functionality and the ease of data upload, which highlights its user-centric design. However, feedback from a diverse user base, including citizens, wildlife officers, and researchers, pointed to the need for further refinement in the system's user interface. Enhancing the intuitiveness of the interface and providing more comprehensive training resources could significantly improve user experience, particularly for those less familiar with similar applications (Hui & See, 2015). Despite these positives, the engagement and feedback from licensed hunters remains notably low, primarily because the GWS has not been thoroughly integrated into their regular activities. This segment's lower interaction highlights a critical area for targeted outreach and adaptation to increase its utility and relevance for all user groups, which could foster greater involvement and feedback from the hunting community.

Additionally, the administrative verification process, while effective in maintaining the integrity of the data, could benefit from further automation. Implementing automated data validation techniques, such as cross-referencing citizen reports with sensor data or employing machine learning algorithms to detect anomalies, would streamline the verification process and reduce the potential for human error. These enhancements are critical as the system scales and the volume of data increases, ensuring that the GWS continues to provide reliable and actionable information for wildlife management.

5.4.5. Addressing limitations and future directions for the Geo Wild System

While the Geo Wild System has shown significant promise, several limitations must be addressed to fully realize its potential. The findings represent the initial deployment phase of the Geo Wild System, and as such, they may not capture the full range of human-wildlife conflicts across Malaysia. Continuous data collection and system updates are necessary to refine and expand the system's capabilities. Currently, the dataset is limited to Peninsular Malaysia, and efforts should be made to extend the system's coverage to regions beyond its current geodetic limitations. The present geodetic limitation confines the system's applicability to Peninsular Malaysia and excludes Borneo region (Sabah and Sarawak). This restriction arises from Borneo's distinct geodetic frameworks and diverse ecological landscapes, which necessitate tailored approaches for effective wildlife management. Addressing these geodetic and environmental challenges in future updates will be essential to provide a comprehensive wildlife management tool for the country. Additionally, the system's dependency on local geodetic settings could pose challenges when applied globally, requiring adjustments to ensure accuracy and relevance in different geographical contexts.

Another critical limitation is the system's reliance on user-reported data, which, while invaluable for broadening the scope of data collection, also introduces risks of inaccuracies and reporting biases. The current admin verification process mitigates some of these risks, but as the system grows, it will need to evolve. Incorporating more advanced data validation techniques and predictive analytics could enhance the system's ability to anticipate conflict hotspots, allowing for a more preventative approach to wildlife management. By analyzing historical data and applying predictive models, the GWS could transition from a reactive tool to a proactive one, enabling wildlife authorities to implement preventive measures before conflicts arise.

6. CONCLUSION AND RECOMMENDATIONS

This study highlighted the potential for integrating elements of the Hungarian wildlife management strategies, such as the NGMD system, into Malaysian conservation efforts, revealing distinct approaches in each country. While Malaysia primarily utilized state ownership with a no-hunting policy and a focus on ecotourism, Hungary employed state ownership as a public resource, incorporating a hunting model and hunter contributions to conservation. This contrast underscored the need for substantial customization to effectively apply the NGMD system in Malaysia, addressing the significant cultural and ecological differences between the two regions. Such adaptation involved integrating traditional knowledge into management practices, aligning them with local cultural values and social norms, and addressing the specific conservation needs of Malaysian wildlife. Enhanced community engagement and support were crucial for the sustainability of these initiatives.

Building on this need for adaptation, the research also addressed the escalating human-wildlife conflicts in Malaysia, particularly with the Asian palm civet. This situation emphasized the need for humane and innovative conflict resolution strategies. The development of the Wildlife Attitude Index (WAI) and the Wildlife Management Method Attitude Index (WMMAI) provided essential tools for understanding and addressing local attitudes toward wildlife management. Furthermore, the introduction of the Geo Wild System marked a significant technological advancement, offering a sophisticated platform for wildlife reporting, monitoring, and analysis within Malaysia.

These tools paved the way for practical implementation strategies. It was vital to incorporate community and hunter contributions in conservation activities, tailored to non-hunting contexts. Controlled culling programs for specific species could be considered a last resort after exhausting other preventive measures. Enhancements to the Geo Wild System should include integrating advanced GIS tools and real-time data analytics to more effectively identify and respond to wildlife conflict hotspots. Expanding this system to include mobile applications for community reporting could

significantly improve engagement and data collection accuracy.

However, adopting Hungary's commercial hunting model was not advisable due to cultural aversions in Malaysia. Instead, conservation efforts should focus on promoting ecotourism and community-based conservation programs that align with local values and contribute to economic development. Educational campaigns and conflict mitigation strategies, informed by survey results suggesting some acceptance of lethal management, should prioritize educating communities on non-lethal methods such as securing trash and using deterrents, before considering culling as a controlled response.

Finally, continuous international collaboration is essential to refine these adapted strategies and develop more culturally sensitive and ecologically appropriate conservation practices globally. By implementing these strategic measures, Malaysia could develop a more effective and adaptable wildlife management framework that leverages both technological advancements and community-based approaches, ensuring the sustainability and effectiveness of its conservation efforts. This holistic approach not only addressed immediate conservation challenges but also fostered long-term resilience and sustainability in wildlife management practices.

7. NEW SCIENTIFIC RESULTS

- The comparative analysis revealed that Hungary's wildlife management, with state ownership and a kind of active community involvement through hunting, contributed 0.05% to GDP within its agriculture sector (1.12%) and supported 0.029% of local employment, helping to maintain stable large mammal populations. In contrast, Malaysia's ecotourism-focused strategy contributed 6.7% to GDP, higher than Hungary's tourism sector, but involved less community financial involvement and minimal hunting-related employment, correlating with a decline in large mammal species. Malaysia's higher GDP from ecotourism reflects its rich natural resources, but Hungary's model of direct local engagement in wildlife management offers valuable insights into sustainable conservation, suggesting that Malaysia's approach could benefit from enhanced local involvement in broader conservation efforts.
- The field-based research revealed significant human-Asian palm civet conflicts, particularly among male farmers aged 35 to 55, who reported notable agricultural and poultry losses due to the APC's feeding habits. About 59% reported cultivated fruit damage, with durian being the most frequently consumed during its peak season, and 19% noted poultry attacks, mainly on younger birds during twilight hours. Despite these challenges, 62.3% of locals maintained a positive attitude toward Asian palm civets (*Paradoxurus hermaphroditus*), with attitudes influenced by variables like occupation, gender, and direct damage experiences. Conservation attitudes were notably more negative among those who have suffered property damage. Most locals favored non-lethal conflict mitigation, with 45.28% opting not to intervene. Additionally, 71.1% of locals reported an increase in the Asian palm civet population, which contradicts global trends of decline, suggesting either a localized surge or an underestimation of the species' adaptability.
- The field-based research analyzing local attitudes towards wildlife and their management methods in Malaysia incorporated the development of the Wildlife Attitude Index (WAI) and the Wildlife Management Method Attitude Index (WMMAI) with good internal consistency (Cronbach's Alpha coefficients of 0.71 and 0.72). These indices provide a new

structured way to measure local attitudes towards wildlife and management methods, offering a quantifiable measure that can be utilized in future research and policy development. The research revealed that 97.3% of locals support wildlife conservation for future generations, but 63% believe wildlife does not significantly contribute to the local economy. Attitudes toward wildlife as a threat or nuisance varied, influenced by factors such as urban or rural residency, age, and direct encounters with wildlife. Urban residents generally held more positive views, while rural and older individuals, and those with direct wildlife encounters, were more likely to support management interventions such as regulated hunting or relocation. This highlights how demographics and personal experiences shape attitudes toward wildlife management in Malaysia.

- The technical-based research introduced the Geo Wild System (GWS), a new wildlife reporting, monitoring and analyzing tool in Malaysia, combining open-source software with advanced GIS tools. During its initial deployment (January to June 2024), the system recorded and facilitated the setup of 117 traps, resulting in 88 wildlife captures, including 85 long-tailed macaques (*Macaca fascicularis*), two wild boars (*Sus scrofa*), and one Asian palm civet (*Paradoxurus hermaphroditus*). Utilizing GIS-based Kernel Density Estimation (KDE), the system effectively pinpointed wildlife conflict hotspots, enhancing strategic conservation planning. High user satisfaction reflects its success, and further refinements are anticipated to improve wildlife management in Malaysia.

8. SUMMARY

Malaysia faces the critical challenge of conserving and protecting its wildlife amidst threats like poaching, habitat loss, and human-wildlife conflicts. To address these challenges effectively, this research explores how Hungarian wildlife management strategies could potentially improve conservation tools in Malaysia. An integrated approach was adopted, comprising a broad literature survey, field, and technical-based research to meet the objectives.

The literature survey aimed to understand both countries' strategies, challenges, and outcomes of wildlife conservation. Through an extensive review of scientific literature, national legislation, and the impact on locals and wildlife, the strengths and weaknesses of each strategy were identified. Malaysia's approach is characterized by state ownership and a reliance on ecotourism, whereas Hungary employs a hunting area management system with substantial contributions from hunters to conservation funds.

Comparative data indicate Hungary's model, which encourages active local participation, positively affects both GDP and wildlife populations. In contrast, Malaysia's strategy, with less community involvement in financial gains from conservation, is linked to declining wildlife numbers. This research offers valuable insights into the similarities and differences between these systems, proposing that sharing and learning from each other's strategies could foster more adaptive and effective approaches to wildlife management and conservation.

Field-based research focused on human-wildlife conflict, particularly the conflict between humans and the Asian palm civet (APC) in Malaysia. Surveys of 212 locals and analysis of APC scats were conducted to understand their coexistence potential. Findings reveal conflicts arise mainly due to APC's foraging habits, causing damage such as cultivated fruit consumption, poultry predation, and agricultural and property damage. Despite these conflicts, most locals have a positive attitude toward APCs. However, those experiencing more direct losses tend to view APCs negatively. Remarkably, most locals believe APC populations have increased over the past decade, yet few actively engage in conflict mitigation through the use of poison, while most do not take any action. This tolerance

emphasizes prioritizing wildlife management strategies considering social, economic, and ecological factors.

Local attitudes toward wildlife and their management methods in Malaysia were also evaluated. Using indices derived from an online questionnaire with 585 respondents, attitudes and significant determinants such as gender, age, education level, experience (familiarity), and engagement with wildlife were measured. The results yielded two indices of locals' attitudes: the Wildlife Attitude Index (WAI) and the Wildlife Management Method Attitude Index (WMMAI), with Cronbach's alpha coefficients of 0.71 and 0.73, respectively. These indices are crucial for understanding local attitudes and can guide wildlife conservation strategies, highlighting the relationship between management and local demographics. High-scoring individuals are assumed to be more likely to favor wildlife conservation initiatives and activities.

Lastly, technical-based research focused on developing the Geo Wild System (GWS), a novel application for structured wildlife conservation in Malaysia. The GWS marks a substantial leap forward in wildlife conservation technology, successfully involving a broad range of stakeholders. It demonstrated its effectiveness by facilitating the deployment of 117 traps, which led to the capture of 88 wildlife individuals, including 85 long-tailed macaques (*Macaca fascicularis*), two wild boars (*Sus scrofa*), and one Asian palm civet (*Paradoxurus hermaphroditus*). By integrating Geographic Information System (GIS) tools and utilizing Kernel Density Estimation (KDE), the system precisely identified wildlife conflict hotspots, enabling targeted conservation interventions. Despite initial deployment challenges and geodetic limitations, the GWS shows great potential as a vital tool for wildlife management in Malaysia. Continuous user feedback and system refinements will be essential for sustaining and improving its effectiveness.

In conclusion, this comprehensive study highlights the importance of innovative strategies and integrated approaches in addressing wildlife conservation challenges in Malaysia. By comparing with and learning from Hungarian strategies, and through detailed field and technical studies, the

aim is to employ more effective and adaptable wildlife management tools and practices that can protect Malaysia's wildlife for future generations.

9. ÖSSZEFOGLALÁS

Malajzia számára komoly kihívást jelent a vadvilág megőrzése és védelme, olyan okok miatt, mint az orvvadászat, az élőhelyek elvesztése és az ember-vadvilág konfliktusok. E kutatás ezek hatékony kezelése érdekében azt vizsgálja, hogy miként lehet a magyarországi vadgazdálkodási-vadászati rendszert/stratégiát, illetve a természetvédelmi eszközöket Malajziában felhasználni. A lehetőségeket integrált megközelítést alkalmazva vizsgálták, amely átfogó irodalomkutatásból, terepi és technikai alapú kutatásokból tevődött össze.

Az irodalomkutatás célja az volt, hogy megértsék mindkét ország stratégiáit, kihívásait és a vadgazdálkodási-természetvédelmi eredményeket. A szakirodalom, a nemzeti jogszabályok és a helyi lakosokra és a vadvilágra gyakorolt hatások széleskörű áttekintése révén tudták azonosítani az egyes megközelítések (stratégiák) erősségeit és gyengeségeit. Ezeket a kérdéseket Malajzia jellemzően az állami tulajdon és az ökoturizmusra alapján közelíti meg, míg Magyarország a vadgazdálkodásnak egy vadászterületeken alapuló rendszerét alakította ki, ahol a vadászok jelentősen hozzájárulhatnak a természetvédelmi célokhoz is.

Az összehasonlító adatok azt mutatják, hogy Magyarország modellje, amely aktív helyi részvételt is ösztönöz, pozitívan hat a GDP-re és a vadon élő állatok populációira. Ezzel szemben Malajzia stratégiájában a közösségek kevésbé vesznek részt és járulnak hozzá a természetvédelmi pénzügyi kérdésekben; az érdekeltségnek ez a hiánya a vadon élő állatok számának csökkenéséhez is hozzájárulhat. Jelen kutatás betekintést nyújt a két rendszer hasonlóságaiba és különbségeibe. Ez alapján javasolja, hogy a stratégiák megosztása és az egymástól való tanulás a felek számára adaptívabb és hatékonyabb megközelítéseket eredményezhet, mind a vadgazdálkodásban, mind a természetvédelemben.

A terepi kutatás az ember-vadvilág konfliktusra, különösen az emberek és az ázsiai pálmacibet (APC) közötti malajziai konfliktusra összpontosított. 212 helyi lakos megkérdezésével és az APC ürülékek elemzésével próbálták megérteni a problémát és meghatározni az együttélési lehetőségeket. Az

eredmények szerint a konfliktusok alapjában az APC táplálkozási szokásaiból fakadnak, mivel kárt okoznak, például az ültetvényeken a gyümölcsök fogyasztásával, baromfiak prédálásával, valamint mezőgazdasági és vagyoni károkat is okoznak. E konfliktusok ellenére a legtöbb helyi lakos pozitív viszonyul az APC-khez. De azok, akik közvetlenebb veszteségeket szenvednek el, inkább negatívan tekintenek rájuk. Figyelemre méltó, hogy a legtöbb helyi lakos szerint az APC populáció nőtt az elmúlt évtizedben, mégis kevesen használnak mérgeket, hogy a konfliktust csökkentsék, és a többség semmit sem tesz tesz az ACP-k ellen. Ez a tolerancia megerősíti, hogy a vadgazdálkodási stratégiák kidolgozásakor figyelembe kell venni a társadalmi, gazdasági és ökológiai tényezőket.

Értékelték a helyi lakosság hozzáállását a vadon élő állatokhoz és azok kezeléséhez is. Az 585 válaszadó online kérdőíve alapján képzett indexekek segítségével mérték az attitűdöket és azonosították a jelentős meghatározó tényezőket, mint a nem, életkor, iskolai végzettség, tapasztalat (ismeret) és az állatokhoz való viszony. Az adatok alapján alapján két indexet számítottak, amik a a helyi lakosok hozzáállását tükrözték: a Vadvilág Attitűd Indexet (WAI) és a Vadvilágkezelési Módszer Attitűd Indexet (WMMAI), amelyek Cronbach-alfa együtthatója 0,71 és 0,73 volt. Ezek az indexek kulcsfontosságúak a helyi attitűdök leírásához, megértéséhez és irányadóak lehetnek a természetvédelmi stratégiák kialakításában, kiemelve a kezelés és a helyi demográfiai jellemzők közötti összefüggést. Feltételezhető, hogy a magas index-pontszámot elérő személyek nagyobb valószínűséggel támogatják a természetvédelmi kezdeményezéseket és tevékenységeket.

Végül, a technikai jellegű kutatás a Geo Wild System (GWS) fejlesztésére összpontosított, amely egy új alkalmazás lehet Malajziában a vadon élő állatok szervezett védelm. A GWS jelentős előrelépés a vadvédelmi technológia terén, és ezzel az eszközzel az érintettek széles körét sikerült bevonni. Hatékonyságát az is jelzi, hogy 117 csapdát telepítettek a bevonásával és ezek eredményeként 88 vadon élő állatot fogtak el, köztük 85 hosszúfarkú makákót (*Macaca fascicularis*), két vaddisznót (*Sus scrofa*) és egy ázsiai pálmasodrót (*Paradoxurus hermaphroditus*). A Földrajzi

Információs Rendszer (GIS) és a Kernel Density Estimation (KDE) integrálásával a rendszer pontosan jelzi a vadvédelmi konfliktusok forró pontjait, elősegítve ezzel a célzott védelmi beavatkozásokat. A GWS-nek az eredeti telepítési kihívások és a geodéziai korlátok ellenére is nagy a potenciálja arra, hogy, a vadvédelem létfontosságú eszközévé válhassone Malajziában. A folyamatos felhasználói visszajelzések és a rendszer jövőbeni finomításai elengedhetetlenek a hatékonyság fenntartásához és javításához.

Összefoglalva: ez az részletes tanulmány rámutat arra, hogy Malajziában is fontos az innovatív stratégiák és az integrált megközelítések bevezetése a vadvilág megőrzése érdekében. A magyar stratégiák összehasonlításával és a belőlük való tanulással, valamint a részletes terepi és technikai vizsgálatok révén hatékonyabb és alkalmazkodóbb vadgazdálkodási megoldásokat és gyakorlatokat lehet kidolgozni, amik segítségével Malajzia vadon élő állatvilágát sikeresen lehet megőriznia jövő generációi számára.

10. LIST OF PUBLICATIONS

- Publication (Journal Article: Q1 – IF = 3.5) – Peer reviewed

Hasan, S.M., Sainuddin, M., Csányi, S. (2024). The introduction of Geo Wild System (GWS) as a novel wildlife reporting, monitoring, and analyzing system in Malaysia. *Global Ecology and Conservation*. 54, e03183.

- Publication (Journal Article: Q1 – IF = 3.3) – Peer reviewed

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- Publication (Journal Article: Q1 – IF = 2.1) – Peer reviewed

Hasan, S.M., Csányi, S. (2023). Attitude index of local communities toward wildlife and their management methods in Malaysia. *Diversity*, 15(2), 202.

- Publication (Journal Article: Q3 – IF = 1.0) – Peer reviewed

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- Oral Presentation (Conference Abstract)

Hasan, S.M., Csányi, S. (2022). The overharvest of porcupine species for bushmeat and traditional medicine in Malaysia. *19th Wellmann International Scientific Conference*. Hódmezővásárhely, Hungary. 28th April 2022.

- Poster (Conference Abstract)

Hasan, S.M., Csányi, S. (2023). Human–Asian palm civet conflict in Malaysia. *International Symposium on Animal Sciences*. Novi Sad, Serbia. 18 – 20 September 2023

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- Poster (Conference Abstract**)**

Hasan, S.M, Csányi, S. (2021). Dusky leaf monkeys popular on YouTube: rising illegal exotic pet trade on social media in Southeast Asia. *35th Congress of International Union of Game Biologists (IUGB)*. Budapest, Hungary. 21-24 September 2021.

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- Contributing Author: Journal Article

ENETWILD-consortium, Guerrasio, T, Acevedo, P.P., Apollonio, M., Arnon, A., Barroqueiro, C., Belova, O., Berdión, O., Blanco-Aguiar, J.A., Bijl, H., Bleier, N., Bučko, J., Bužan, E.E., Carniato, D., Carro, F., Casaer, J., Carvalho, J., Csányi, S., del Rio, L.L., Del Val Aliaga, H., Ertürk, A., Escribano, F., Duniš, L., Fernández-Lopez, J., Ferroglio, E., Fonseca, C.; Gačić, D., Gavashelishvili, A., Giannakopoulos, A., Gómez-Molina, A., Gómez-Peris, C., Gruychev, G., Gutiérrez, I., Häberlein, V.V., **Hasan, S.M.**, et al. (2023). Wild ungulate density data generated by camera trapping in 37 European areas: first output of the European Observatory of Wildlife (EOW). *EFSA Supporting Publications*. 20, 3.

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12. APPENDICES

Appendix A: Bibliography

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Appendix B: Survey Questionnaires

1) Human-Asian palm civet conflict

Semi-structured questionnaires for the formal survey of human–Asian palm civet conflict.

Coding								Checklist of Questions
Y	N	0	1	2	3	4	5	
								1.1For how long have you lived in this village or in Hulu Langat? [1 = <5 yrs, 2 = >5<10 yrs, 3 = >10 years]
								1.2 What do you do for a living? [1=farming, 2=small business, 3 = civil service, 4 = other (specify)]
								2.1 Are you familiar with the areas outside this village? [Y/N]
								2.2 How about with areas outside this Hulu Langat? [Y/N]
								2.3 Are you also familiar with adjacent forest land? [Y/N]
								2.4 Do you know some of the wildlife that is found in this area? [Y/N].
								2.5 If **Yes**, would you list at least five of them in a declining order of relative importance?
								3.1 How much are you familiar with the wild animal known as 'Asian palm civet' in Hulu Langat? [0 = no idea at all, 1 = very little, 2 = very well]
								3.2 How often do you come across 'Asian palm civet' in your area? [0 = never at all, 1 = very rarely, 2 = quite often]
								3.3 Where do you normally experience seeing the animal 'Asian palm civet'? [0 = in one's own homestead, 1 = elsewhere in one's own village, 2 = in agricultural fields, 3= up in the forested areas, 4 = other (specify)]
								3.4 What is your own observation about the population trend of 'Asian palm civet' in this area? [0 = no idea, 1 = increasing, 2 = no visible change, 4 = declining, 5 = other (specify)]
								3.5 If **declining**, what are the main reasons? [0 = not quite sure, 1 = habitat loss due to deforestation and agricultural expansion, 2 = illegal trappers, who supply the animals to traditional civet keepers, 3 = retaliatory killing by local people, 4 = overhunting by local people for domestic use, 5 = other (specify)]
								4.1 Does 'Asian palm civet' cause any damage to local people's property? [Y/N]
								4.2 If **Yes**, which of the following types of damage does this animal is known to cause? [0 = agricultural field crop, 1 = fruit trees, 2 = small domestic livestock, 3 = attacks people, particularly small children, 4 = other (specify)]
								4.3 If it does, what measures do people take to prevent the damage? [0 = I do nothing, 1 = I use preventive methods, such as guarding, fencing, repellent, firecrackers, 2 = I attempt killing the animal using shooting, 3 = I attempt killing the animal using kill-traps, 5 = I attempt killing the animal by poisoning, 5 = no answer]

Soal selidik separa berstruktur untuk tinjauan rasmi mengenai konflik antara manusia dan musang pandan (*Asian palm civet*).

Kod								Senarai Semak Soalan untuk Penilaian
Y	T	0	1	2	3	4	5	
								1.1Berapa lama anda telah tinggal di kampung ini atau di Hulu Langat? [1 = <5 tahun, 2 = >5<10 tahun, 3 = >10 tahun]
								1.2 Apakah pekerjaan anda? [1 = bertani, 2 = berniaga kecil-kecilan, 3 = kerja kerajaan, 4 = lain-lain (nyatakan)]
								2.1 Adakah anda mengenali kawasan di luar kampung ini? [Y/T]
								2.2 Bagaimana pula dengan kawasan di luar Hulu Langat? [Y/T]
								2.3 Adakah anda juga mengenali kawasan hutan bersebelahan? [Y/T]
								2.4 Adakah anda tahu tentang beberapa hidupan liar yang terdapat di kawasan ini? [Y/T].
								2.5 Jika **Ya**, bolehkah anda senaraikan sekurang-kurangnya lima daripadanya mengikut kepentingan yang menurun?
								3.1 Sejauh mana anda mengenali haiwan liar yang dikenali sebagai 'musang pandan' di Hulu Langat? [0 = tidak tahu langsung, 1 = sangat sedikit, 2 = sangat kenal]
								3.2 Seberapa kerap anda menemui 'musang pandan' di kawasan anda? [0 = tidak pernah, 1 = sangat jarang, 2 = agak kerap]
								3.3 Di manakah anda biasanya melihat haiwan 'musang pandan'? [0 = di kawasan rumah sendiri, 1 = di tempat lain dalam kampung sendiri, 2 = di ladang pertanian, 3 = di kawasan hutan, 4 = lain-lain (nyatakan)]
								3.4 Apakah pemerhatian anda sendiri tentang trend populasi 'musang pandan' di kawasan ini? [0 = tidak tahu, 1 = meningkat, 2 = tiada perubahan ketara, 4 = menurun, 5 = lain-lain (nyatakan)]
								3.5 Jika **menurun**, apakah sebab utamanya? [0 = tidak pasti, 1 = kehilangan habitat akibat penebangan hutan dan pengembangan pertanian, 2 = penangkap haram yang membekalkan haiwan kepada pemelihara musang tradisional, 3 = pembunuhan balas dendam oleh penduduk tempatan, 4 = pemburuan berlebihan oleh penduduk tempatan untuk kegunaan domestik, 5 = lain-lain (nyatakan)]
								4.1 Adakah 'musang pandan' menyebabkan sebarang kerosakan kepada harta benda penduduk tempatan? [Y/T]
								4.2 Jika **Ya**, jenis kerosakan yang manakah diketahui disebabkan oleh haiwan ini? [0 = tanaman ladang, 1 = pokok buah-buahan, 2 = ternakan kecil, 3 = menyerang orang, terutamanya kanak-kanak kecil, 4 = lain-lain (nyatakan)]
								4.3 Jika **Ya**, apakah langkah yang diambil oleh penduduk untuk mencegah kerosakan tersebut? [0 = Saya tidak melakukan apa-apa, 1 = Saya menggunakan kaedah pencegahan seperti mengawal, pagar, mercun, 2 = Saya cuba membunuh haiwan tersebut dengan menembak, 3 = Saya cuba membunuh haiwan tersebut dengan perangkap maut, 5 = Saya cuba membunuh haiwan tersebut dengan racun, 5 = tiada jawapan]

2) Local attitudes towards wildlife and their management methods

Wildlife Conservation in Malaysia

Please take 10-15 minutes of your time to complete this questionnaire. Your responses will facilitate wildlife conservation in Malaysia in the future.

We promise that your data will only be used for academic context in this wildlife research project.
Your response will be kept confidential.
Please mark only one answer for each question

* Indicates required question

Consent Form

1. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I voluntarily agree to take part in this study. *

Mark only one oval.

- ◯ I agree
- ◯ I do not agree

Section I (a)

Your opinion is important. Please tell us about your experiences with wildlife animals. If you have not had any experiences, please complete the items as requested.

Note: Any reference to wildlife in this survey means free-ranging, wild animals and DOES NOT include captive wild animals.

2. 1. Before you received this questionnaire, were you aware that wildlife lives in some areas of Malaysia? *

Mark only one oval.

- ◯ Yes *Skip to question 3*
- ◯ No *Skip to question 8*

Section I (b)

3. 2. Have you seen a wildlife during the past 12 months? *

Mark only one oval.

- ◯ Yes *Skip to question 4*
- ◯ No *Skip to question 7*

Section I (c)

4. 2a. If "Yes" to the previous question, which of the following did you see? (Please check all that apply.) *

Check all that apply.

- ☐ individual wildlife
- ☐ wildlife with young
- ☐ multiple wildlife

5. 2b. How many times have you seen a wildlife(s) during past 12 months? (Please check only ONE response) *

Mark only one oval.

- ◯ once
- ◯ 2-4 times
- ◯ 5+ times

6. 2c. Do you think that you've seen the same wildlife more than once? *

Mark only one oval.

- ◯ Yes
- ◯ No

Section I (d)

7. 3. Which of the following platforms did you seen or received any information about wildlife in Malaysia?(Please check all that apply.) *

Check all that apply.

- [ ] Social Media (Facebook, Instagram, Twitter, etc)
- [ ] Campaign
- [ ] Search engine
- [ ] Television
- [ ] Professional association
- [ ] Word of mouth
- [ ] Newspaper
- [ ] Radio
- [ ] School/University
- [ ] Other: _____

Section II (a)

1. Please give us your views about wildlife conservation. Your views will help us better understand how locals feel about wildlife animals.

Please indicate how strongly you agree or disagree with the following statements.

1: Strongly disagree - 2: Disagree - 3: Somewhat disagree - 4: Unsure - 5: Somewhat agree - 6: Agree - 7: Strongly agree

8. I enjoy seeing wildlife *

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly agree

9. Wildlife is an important part of our ecosystems *

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly agree

10. Risk of being injured by a wildlife is high. *

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly agree

11. Wildlife should be conserved for future generations. *

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly agree

12. Wildlife are not a threat to people. *

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly agree

13. Seeing a wildlife increases my appreciation of nature *

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly agree

14. It is important for me to know wildlife exist, even if I never see one. *

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly agree

15. Wildlife is a nuisance *

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly agree

16. Wildlife is properly manage in Malaysia *

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly agree

17. 2. Which of the following describes how you think wildlife population numbers in Malaysia have changed over the past five years? (Please check ONLY ONE response.) *

Mark only one oval.

- ◯ Decreased
- ◯ Increased
- ◯ Remained the same
- ◯ Unsure

Section II (b)

3. How much do you support the following actions by wildlife management?

Please indicate how unacceptable or acceptable with the following statements.

1: Unacceptable in all cases -2: Unacceptable in some cases -3: Unsure -4: Acceptable in some cases -5: Acceptable in all cases

18. Capture and relocate wildlife *

Mark only one oval.

	1	2	3	4	5	
Una	◯	◯	◯	◯	◯	Acceptable in all cases

19. Euthanize wildlife captured in popular visitor sites *

Mark only one oval.

	1	2	3	4	5	
Una	◯	◯	◯	◯	◯	Acceptable in all cases

20. Educate the public about human-wildlife conflicts *

Mark only one oval.

	1	2	3	4	5	
Una	◯	◯	◯	◯	◯	Acceptable in all cases

21. Use regulated hunting to manage wildlife numbers *

Mark only one oval.

	1	2	3	4	5	
Una	◯	◯	◯	◯	◯	Acceptable in all cases

22. Euthanize wildlife that repeatedly cause problems for people *

Mark only one oval.

	1	2	3	4	5	
Una	◯	◯	◯	◯	◯	Acceptable in all cases

23. Condition wildlife to stay away from popular areas *

Mark only one oval.

	1	2	3	4	5	
Una	◯	◯	◯	◯	◯	Acceptable in all cases

24. Leave wildlife alone *

Mark only one oval.

	1	2	3	4	5	
Una	◯	◯	◯	◯	◯	Acceptable in all cases

Section II (c)

4. Which action would you prefer to take in the following situations if a wildlife was on your property?

(Please choose ONLY ONE response for each statement.)

1: I would not do anything in this situation
2: I would remove the attractant from my property (garbage, bird feeder, etc.)
3: I would actively try to scare the wildlife off my property
4: I would call animal control
5: Not Sure

25. You repeatedly see a wildlife near your home *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

26. A wildlife damages your property one time. *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

27. You see a wildlife near your home one time *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

28. A wildlife repeatedly damages your property. *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

29. 5. Which one of the following BEST describes your overall opinion about regulated hunting as management tool? (Please choose ONLY ONE.) *

Mark only one oval.

- ◯ I approve of regulated hunting.
- ◯ I do not approve of regulated hunting.
- ◯ I am unsure about my opinion toward regulated hunting.

30. 6. Have you ever participated in wildlife hunting? *

Mark only one oval.

- ◯ Yes *Skip to question 31*
- ◯ No *Skip to question 35*

Section II (d)

Please answer the questions below

31. 6a. In what state(s) did you hunt wildlife? *

_____

32. 6b. In what year(s) did you hunt wildlife? *

_____

33. 6c. What wildlife species did you hunt? *

_____

34. 6d. Were you successful in harvesting a wildlife? *

Mark only one oval.

- ◯ Yes
- ◯ No

Section II (e)

35. 7. Which one of the following BEST describes your overall opinion about regulated wildlife hunting? (Please choose ONLY ONE.) *

Mark only one oval.

- ◯ I support wildlife hunting
- ◯ I am opposed to wildlife hunting
- ◯ I am unsure about my opinion toward regulated wildlife hunting.

36. 8. If you OPPOSE regulated hunting of wildlife, which one of the following BEST describes why you are opposed to regulated wildlife hunting? (Please choose ONLY ONE.) *

Mark only one oval.

- ◯ cruel and inhumane
- ◯ unfair to animal being hunted
- ◯ morally wrong
- ◯ unsafe for the public
- ◯ the reason wildlife is rare
- ◯ Other: _____

37. 9. Would you consider hunting wildlife in Malaysia as wildlife management method in the future? *

Mark only one oval.

- Yes
- No

Section III

Please provide us with your attitudes about wildlife by responding to the statements and questions

1. The following statements explore attitudes about wildlife in general. (Please choose ONE number for each statement.)

Please indicate how strongly you agree or disagree with the following statements.

1: Strongly disagree - 2: Disagree - 3: Somewhat disagree - 4: Unsure - 5: Somewhat agree - 6: Agree - 7: Strongly agree

38. Seeing wildlife during my daily routine gives me a positive feeling. *

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly agree

39. It is not important for people to manage wildlife. *

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly agree

40. Wildlife education is important *

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly agree

41. I enjoy learning about wildlife *

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly agree

42. People appreciate wildlife through hunting *

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly agree

Section IV

Please tell us something about yourself. All responses are kept confidential.

43. 1. What state are you from? *

44. 2. How many years have you lived in your current state of residence? *

45. 3. Which of the following activities did you or members of your group participate?(Please check all that apply.) *

Check all that apply.

- [ ] camping
- [ ] wildlife viewing
- [ ] boating/kayaking
- [ ] photographing wildlife
- [ ] hiking
- [ ] hunting
- [ ] fishing
- [ ] Other: _____

46. 4. Please give your age *

Mark only one oval.

- ◯ under 18 years old
- ◯ 18-24 years old
- ◯ 25-34 years old
- ◯ 35-44 years old
- ◯ 45-54 years old
- ◯ 55-64 years old
- ◯ 65 years or older

47. 5. What is your level of education? *

Mark only one oval.

- ◯ Primary
- ◯ Secondary
- ◯ Undergraduate
- ◯ Graduate

48. What is your gender? *

Mark only one oval.

- Male
- Female

49. 7. Which of the following best describes the area where you live? (Please choose one.) *

Mark only one oval.

- City with more than 50,000 residents
- City with less than 50,000 residents
- Town of less than 20,000 residents
- Town of less than 10,000 residents
- Unincorporated area (rural)

THANK YOU FOR YOUR TIME AND ASSISTANCE!

This project is funded by Tempus Public Foundation (Stipendium Hungaricum)

3) Geo Wild System

Geo Wild App Evaluation

We promise that your data will only be used for academic context in this wildlife research project.
Your response will be kept confidential.
Please mark only one answer for each question

* Indicates required question

1. Email *

Consent Form

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I voluntarily agree to take part in this study. *

Mark only one oval.

- ◯ I agree
- ◯ I do not agree

Guidelines Video

Geo Wild App Use Guidelines Video

https://www.youtube.com/watch?v=DCwMS8r--Ho

Watch the video of the Geo Wild App and register on the Geo Wild App before answering this questionnaire. It is recommended to click on the "Watch on YouTube" button to see it in full screen mode.

Link for Geo Wild Application

https://geowild.com.my

User Experience

3. How would you rate the guideline video of the Geo Wild App? *

Mark only one oval.

- ◯ Helpful
- ◯ Not helpful
- ◯ Not applicable

4. When registering to the Geo Wild App, which role did you use? *

Mark only one oval.

- ◯ Researcher
- ◯ Citizen
- ◯ Legal hunter
- ◯ PERHILITAN staff

5. Overall, how was your experience using the Geo Wild App? *

Mark only one oval.

	1	2	3	4	5	
Very	◯	◯	◯	◯	◯	Very easy to use

6. How was your experience adding new data or deleting existing data? *

Mark only one oval.

	1	2	3	4	5	
Very	◯	◯	◯	◯	◯	Very easy to use

7. How was your experience with the editing option? *

Mark only one oval.

	1	2	3	4	5	
Very	◯	◯	◯	◯	◯	Very easy to use

8. How was your experience with the upload option? * *

Mark only one oval.

	1	2	3	4	5	
Very	◯	◯	◯	◯	◯	Very easy to use

9. How do you evaluate the uploading speed of the images? *

Mark only one oval.

	1	2	3	4	5	
Very	◯	◯	◯	◯	◯	Very quick

10. How likely is it that you would use the Geo Wild App to report wildlife conflict incidents? *

Mark only one oval.

	1	2	3	4	5	
Leas	◯	◯	◯	◯	◯	Most likely

Application Rating

11. How likely is it that you would use the Geo Wild App for reporting wildlife disturbances in your area? *

Mark only one oval.

	1	2	3	4	5	
Leas	◯	◯	◯	◯	◯	Most likely

12. How do you evaluate the speed of the Geo Wild App? *

Mark only one oval.

	1	2	3	4	5	
Very	◯	◯	◯	◯	◯	Very quick

13. Would you recommend the Geo Wild App to a friend/colleague? *

Mark only one oval.

◯ Yes
◯ No

14. Would you recommend the Geo Wild App to use as a wildlife reporting tool in Malaysia? *

Mark only one oval.

- ◯ Yes
- ◯ No

15. Did you experience any bugs? If yes, please specify your answer in "other" option *

Mark only one oval.

- ◯ No
- ◯ Other: _____

16. Do you have any suggestions or comments related to the use of the Geo Wild App? *

_____

_____

_____

_____

_____

17. If you could change one thing about the Geo Wild App, what would it be? *

_____

_____

_____

_____

_____

Respondent's Demographic

18. How familiar are you with applications? *

Mark only one oval.

	1	2	3	4	5	
Not	◯	◯	◯	◯	◯	Very familiar

19. Have you participated in any citizen science* wildlife project before? *
*Citizen Science: Collection and analysis of data by members of general public

Mark only one oval.

- ◯ Yes
- ◯ No

20. Have you used any applications for wildlife conservation practices before? If yes, please specify your answer in "other" options *

Mark only one oval.

- ◯ No
- ◯ Other: _____

21. What is the brand and model of your mobile phone or other device you used? *

_____

22. What is your highest level of education? *

Mark only one oval.

- ◯ High school or equivalent
- ◯ Technical or occupational certicate
- ◯ Bachelor's degree
- ◯ Master's degree
- ◯ Doctorate
- ◯ Other: _____