

Characterisation of Human-Wildlife Conflict and Casualties Caused by Wildlife Attacks in Peninsular Malaysia

Xin LQ^a, Assyuhada MGSN^a, Rasudin NS^a, Ghafar NA^a, Haslindawaty ARN^a, Ten DCY^b, Saaban S^c, Edinur HA^a, Abdullah MT^d

^aSchool of Health Science, Universiti Sains Malaysia, Health Campus, Kelantan, Malaysia.

^bDepartment of Wildlife and National Parks Pahang, Jalan Kompleks Tun Razak, Bandar Indera Mahkota, Pahang, Malaysia.

^cDepartment of Wildlife and National Parks Johor, Blok B, Wisma Persekutuan, Johor Bahru Malaysia.

^dFaculty of Fisheries and Food Science, Universiti Malaysia Terengganu, Terengganu, Malaysia.

ABSTRACT

INTRODUCTION: This study examines human-wildlife conflict (HWC) in Peninsular Malaysia, a consequence of human population expansion, natural resource demand, deforestation, resettlement, infrastructure development, urbanization, and agricultural land growth. We analyze HWC incidents and human casualty statistics from wildlife attacks recorded by the Department of Wildlife and National Parks, Peninsular Malaysia, between 2011-2018 and 2008-2019, respectively. **MATERIALS AND METHODS:** Data were collected on HWC cases reported to the Department of Wildlife and National Parks, Peninsular Malaysia (locally known as PERHILITAN), from 2011 to 2018. This data underwent processing, analysis, and presentation in tables and bar charts. **RESULTS:** There was an increasing trend in reported HWC cases from 2012 to 2018 (5,602 to 7,967 cases). The majority of these incidents in Peninsular Malaysia involved mammalian species such as the long-tailed macaque (*Macaca fascicularis*), wild boar (*Sus scrofa*), elephant (*Elephas maximus*), civets (*Viverridae* family), and pig-tailed macaque (*Macaca nemestrina*), totaling 33,198, 6,614, 3,797, 3,219, and 2,232 cases respectively. Notably, snakes accounted for over 80% of fatalities and injuries. **CONCLUSION:** This report is the first to provide a comprehensive overview of HWC cases and casualties due to wildlife attacks in Peninsular Malaysia. Our findings highlight the urgent need for policy evaluation and improved inter-agency coordination for effective HWC management, wildlife conservation, and reduction of wildlife attack casualties.

Keywords

Anthropogenic activity, conservation, casualties, endangered wildlife species, mammals.

Corresponding Author

Assoc. Prof. Dr Edinur Hisham Atan
Forensic Science Programme,
School of Health Science,
Universiti Sains Malaysia, Health Campus,
16150 Kubang Kerian, Kelantan, Malaysia

E-mail: edinur@usm.my

Received: 9th February 2023; Accepted: 22nd November 2023

Doi: <https://doi.org/10.31436/imjm.v23i01>

INTRODUCTION

The Malaysian rainforest biome, pivotal for its rich biodiversity, is increasingly degraded by land use for industrial agriculture, manufacturing, infrastructure, human resettlement, urbanization, and unsustainable logging practices.¹ Such socio-economic activities have led to significant disasters, including a landslide in Ampang, Selangor in March 2022, and the 2014 major flood on the east coast of Peninsular Malaysia, exacerbating the scarcity of vital resources for wildlife survival such as breeding, shelter, and forage.²⁻⁴ This encroachment triggers conflicts as humans and wildlife vie for limited resources, often resulting in incidents like predation on livestock, poultry, and crops, and subsequent retaliatory actions by farmers.⁵ Human-

wildlife conflict (HWC) thus not only endangers both humans and animals, potentially causing injuries or fatalities,⁶ but also influences community attitudes towards wildlife coexistence. Current mitigation strategies by authorities often miss addressing the root causes, focusing predominantly on conservation.⁷ For example, HWC interventions typically aim to remove wildlife from human-populated areas.⁸ Consequently, Peninsular Malaysia's HWC conceptual frameworks, including the National Tiger Action Plan,⁹ National Elephant Conservation Action Plan,¹⁰ and Macaque Human Conflict Management Manual,¹¹ emphasize harmonious coexistence, as illustrated in Figure 1.

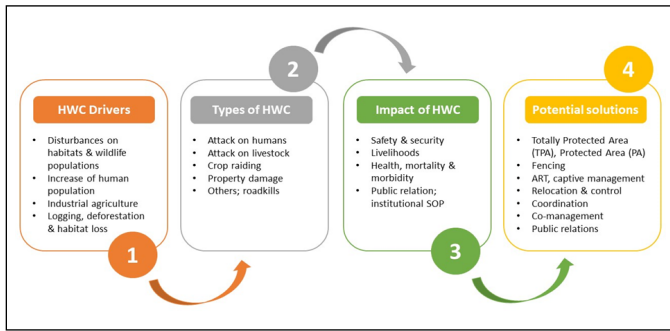


Figure 1: Conceptual framework of HWC.

In this study, we present the first comprehensive dataset on human-wildlife conflict (HWC) and associated human casualties due to animal attacks in Peninsular Malaysia, covering the periods 2011-2018 for HWC incidents and 2008-2019 for human casualties. These datasets are invaluable for assessing the effectiveness of current policies and collaborative efforts between various agencies and institutions. They provide a critical foundation for enhancing HWC management, wildlife conservation, and reducing the risk of casualties from wildlife attacks in the region.

MATERIALS AND METHODS

This study was conducted retrospectively and data were collected from HWC cases in 2011 to 2018 reported to Department of Wildlife and National Parks (DWNP) of Peninsular Malaysia (locally known as Jabatan Perlindungan Hidupan Liar dan Taman Negara: PERHILITAN). Parts of these HWC statistics were previously appeared in PERHILITAN Annual Reports (2011, 2012, 2013, 2015, 2016, 2017 and 2018)^{8,12-17}, while others (e.g., details of species involved in HWC in 2014 and 2018 and casualties due to wildlife attacks from 2008 to 2019) were only made available in this study. These raw data were then processed, analysed and tabulated as tables and bar chart.

RESULTS

A total of 54,224 HWC cases were reported from 2011 to 2018 (Table I and Figure 2). The number was highest in 2011 (8,031) while the lowest was recorded in 2012 (5,602). Overall, the reported HWC cases showed an increasing pattern from 2012 until 2018 (5,602 to 7,967 cases, refer to Figure 2).

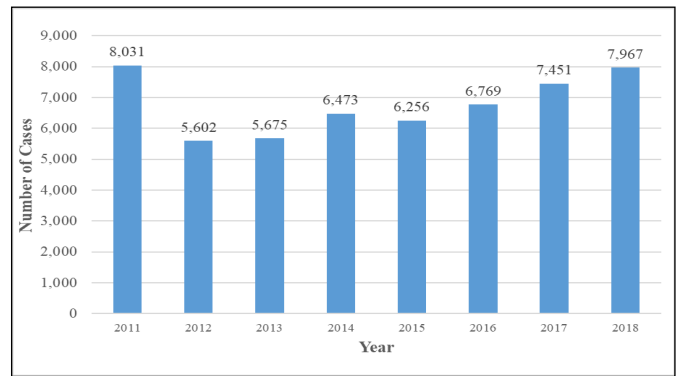


Figure 2: Patterns of HWC cases in Peninsular Malaysia from 2011 until 2018.

There were 15 mammals, four reptiles and three bird taxa involved in HWC (Table I). The results however showed that mammals have a higher tendency to be involved in this event, especially carnivores and omnivores. The top five taxa were the long-tailed macaque (*M. fascicularis*), wild boar (*S. scrofa*), elephant (*E. maximus*), civet (*Viverridae* family) and pig-tailed macaque (*M. nemestrina*) with 33,198, 6,614, 3,797, 3,219 and 2,232 cases, respectively. A detailed description of HWC cases in each state of Peninsular Malaysia are shown in Table II and Figure 3. From 2011 until 2017, the highest HWC cases were reported in Selangor (8,664 cases), with the mean value of 1,444 cases annually. Johor is second with 6,650 total cases and having an average of 1,108 cases per year. Perak is third with 4,168 total cases and 694 cases per year.

Table II: Total human-wildlife conflict cases for each state in Peninsular Malaysia from 2011 to 2013 and from 2015 to 2017.

State	Total Number of Cases	Mean	Percentage (%)
Selangor	8,664	1,444	21.78
Johor	6,650	1,108	16.72
Perak	4,168	694	10.48
Pahang	4,167	694	10.47
Kedah	2,924	487	7.35
Negeri Sembilan	2,635	439	6.62
Pulau Pinang	2,525	421	6.35
Terengganu	2,415	403	6.07
Wilayah Persekutuan	1,808	301	4.54
Melaka	1,640	273	4.12
Kelantan	1,613	269	4.05
Perlis	575	96	1.45
Total	39,784		100.00

A total 1,908 casualties due to wildlife attacks were reported from 2008 to 2019 (Table III). Most of the wildlife attacks contributed to human injuries (97%) involving snakes, wild boar and primates. Even though cases involving bees were lower than those reported for the snakes, wild boar and primates, they caused the highest fatalities in Peninsular Malaysia.

Table I: Types of species involved in HWC from 2011 until 2018.

English name Order/family/ species	Year								Total	Percentage (%)
	2011	2012	2013	2014	2015	2016	2017	2018		
Mammals										
Long-tailed Macaque <i>Macaca fascicularis</i>	4,913	3,235	3,195	3,926	3,915	4,237	4,927	4,850	33,198	61.22
Wild Boar <i>Sus scrofa</i>	737	549	681	782	778	911	902	1,274	6,614	12.20
Elephant <i>Elephas maximus</i>	754	608	562	408	347	328	342	448	3,797	7.00
Civet Viverridae	544	377	392	481	331	308	330	456	3,219	5.94
Pig-tailed Macaque <i>Macaca nemestrina</i>	279	231	225	234	320	330	320	293	2,232	4.12
Leaf Monkey <i>Trachypithecus</i> spp.	111	85	76	119	148	170	144	142	995	1.83
Malayan Sunbear <i>Helarctos malayanus</i>	32	38	35	39	51	46	52	76	369	0.68
Malayan Tiger <i>Panthera tigris</i>	62	65	69	38	29	28	35	31	357	0.66
Other mammals	88	47	47	28	22	49	22	23	326	0.60
Malayan Tapir <i>Tapirus indicus</i>	34	17	39	23	30	24	43	29	239	0.44
Bat Chiroptera	8	10	10	28	14	0	21	23	114	0.21
Black Panther <i>Panthera pardus</i>	0	0	0	36	0	18	19	31	104	0.19
Leopard <i>Panthera pardus</i>	30	18	26	0	29	0	0	0	103	0.19
Clouded Leopard <i>Neofelis nebulosa</i>	11	11	9	9	3	9	4	7	63	0.12
Otter Lutrinac	15	7	8	5	2	9	5	5	56	0.10
Leopard Cat <i>Prionailurus bengalensis</i>	7	3	4	2	5	0	2	3	26	0.05
Reptiles										
Python Pythonidae	125	74	73	61	44	39	42	45	503	0.93
Other Snakes	59	50	51	60	48	84	51	49	452	0.83
Monitor Lizard <i>Varanus</i> spp.	45	43	42	67	57	57	68	63	442	0.82
Cobras Serpentes	62	52	39	34	23	34	28	27	299	0.55
Crocodile <i>Crocodylidae</i>	13	17	8	9	12	28	25	22	134	0.25
Birds										
Owl Strigiformes	44	26	23	34	20	21	30	33	231	0.43
Other birds	32	22	45	33	20	33	23	19	227	0.42
Eagle <i>Aquila</i> <i>Haliaeetus</i> spp.	24	17	9	15	6	6	16	14	107	0.20
Swallow <i>Apus affini</i>	2	0	7	2	2	0	0	4	17	0.03
TOTAL	8,031	5,602	5,675	6,473	6,256	6,769	7,451	7,967	54,224	100.00

DISCUSSION

Deforestation for development and agriculture purposes or excessive logging and mining activities caused large scale of wildlife habitat loss. Consequently, animals search for new habitat, including areas populated by humans and consequently causing HWC.¹⁸ In our opinion, this may explain the frequent HWC cases in highly developed states like Johor and Selangor. Animals involved in HWC were also shown to be geographically specific.¹⁹ For example, long-tailed macaque (*M. fascicularis*), wild boar (*S. scrofa*), elephant (*E. maximus*), civet (Viverridae) and pig-tailed macaque (*M. nemestrina*) were commonly reported in Malaysia while HWC cases in African countries were

dominated by deadly carnivore species attack like crocodile (*Crocodylus niloticus*), lion (*Panthera leo*), elephant (*Loxodonta africana*) and hippopotamus (*Hippopotamus amphibius*).²⁰ A recent study by Sáenz-Bolaños et al. described the species involved in HWC in the indigenous territory of East Central Costa Rica such as jaguars (livestock and pig predators), hawks and opossums (poultry predators), and collared peccaries (crop damage).⁵ Thus, appropriate strategies with high efficacy should be designed and implemented based on the types of animal species and the factors which prompt them to be involved in a conflict with human. For example, deterrents like

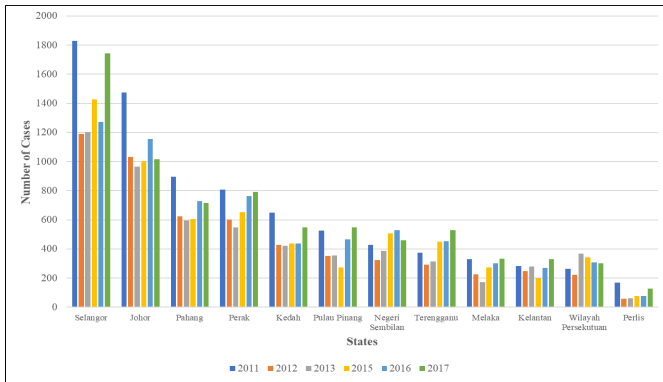


Figure 3: Human-wildlife conflict occurred at different states in Peninsular Malaysia from 2011 to 2013 and from 2015 to 2017.

fencing barriers, alarms, animal repellents, and systematic guarding were effective in reducing crop destruction by primates.²¹ In Malaysia, many local people only own small plots for agriculture and they cannot afford the expensive cost of fencing, alarm system, etc. Therefore, DWNP as a leading enforcement agency has initiated various programmes to minimise the burden of HWC

Table III: Human injuries and fatalities associated with wildlife attacks in Peninsular Malaysia from 2008 to 2019.

Group of Species	Status of Victims				Total	Total (%)
	Injury	Injury (%)	Fatality	Fatality (%)		
Snakes	1,499	78.56	15	0.79	1,514	79.35
Wild Boar	133	6.97	8	0.42	141	7.39
Primates	143	7.49	3	0.16	146	7.65
Elephant	18	0.94	12	0.63	30	1.57
Bees and Hornets	22	1.15	19	1.00	41	2.15
Tiger	3	0.16	0	0	3	0.16
Malayan Sun Bear	11	0.58	1	0.05	12	0.63
Panther	2	0.11	0	0	2	0.11
Gaur	2	0.11	1	0.05	3	0.16
Crocodile	4	0.21	0	0	4	0.21
Other species	9	0.47	3	0.16	12	0.63
Total	1,846	96.75/3	62	3.25	1,908	100

managements on our local farmers. These include culling of long-tailed macaques and wild boar, Community Elephant Electric Fencing System (SPEGKOM) and habitat enrichment programme (HEP). The HEP (e.g., maintenance of grazing field and providing artificial salt licks) and SPEGKOM in particular not only protect crops but also provide a good supply of nutritious food to wildlife and source of income to local people.¹⁷ Other approaches including installation of GPS collar around the neck of elephant group leaders can be considered as an early warning system in Peninsular Malaysia for

monitoring human-elephant conflict (HEC), as previously adopted by the Biodiversity Conservation Agency (BKSDA) and Conservation Response Unit (CRU) in Aceh, Indonesia.¹

Wildlife attacks in Peninsular Malaysia are often reported among indigenous people including Orang Asli Semang, Senoi and Proto-Malays, who normally live in forest fringes or deep within the jungle.²² As shown in Table III, snakes were the frequent species that cause injury while bees and hornets cause the most fatality to human. Incidence involving deadliest animals like tiger, Malayan sun bear and panther were rare, which may also reflect their small number in the wild.²³ Voluntary relocation or translocation of animals could be considered as parts of mitigation strategies to reduce risk of wildlife attack.²⁴ However, translocation of animals need to be conducted by highly trained and competent personnel to avoid injuries and death. In Peninsular Malaysia, translocation operations (e.g., tapir and elephant) are carried out by the personnel from the Wildlife Conservation Division, DWNP.¹⁷ Furthermore, the local community awareness on the wildlife conservations could be improved through incentives, educations and campaigns. This is important to avoid retaliatory killings of endangered animal species by the community as a result of the animal attacks and economic losses.²⁵

Deforestation is highly linked to increase HWC incidence and the emergence of zoonotic diseases.²⁶ The latter should be given serious consideration as the majority of pathogens that cause human diseases in the past several decades originated from wild or domesticated animals.²⁷ Malaysia lost more than 0.86 million hectares of tropical rainforest for the last three decades.²⁸ There are national and state parks (Table IV) in this region where natural resources including wildlife species are protected and preserved. This is not to say that these parks are highly “secured and protected” because there were several occasions where their status or parts of the gazetted area were proposed for development; e.g., plan for degazettement of more than 10% of Selangor State Park for construction of highways²⁹ and a proposed gold mine at Sokor Taku Permanent Forest Reserve in Kelantan.³⁰ Therefore, a clear policy should be established to prevent

major developments close to their boundaries. This is of top priority because such development could increase HWC, zoonotic disease transmission, the possibility of introduction of invasive species and provide easy access to wildlife criminals.^{26,31-33} Data show that wildlife crimes in Peninsular Malaysia continue to increase even with the enactment of a stricter law, i.e., Wildlife Conservation Act 2010.^{34,35}

DWNP and Ministry of Energy and Natural Resources should identify several regional protected areas to be fenced. This initiative is needed for better conservation of endangered species such as elephants, tapirs, Malayan tigers and seladang as well as to reduce wildlife roadkills.^{44,45} Other technologically advance and systematic approaches including unmanned aerial vehicles and geographic information system can also be considered.^{34,46} Both, unmanned aerial vehicles and

geographic information system were not only shown to be cost-effective and practical in mitigating HWC (e.g., for monitoring and mapping wildlife in human settlements), but also for tracking ecosystem changes and law enforcement (illegal activities in protected areas). Zoonotic diseases surveillance and health risk assessment have never been done in HWC areas in Peninsular Malaysia and can be included as part of their HWC preventive measures (Figure 1).

CONCLUSION

Human-wildlife conflict (HWC) is an increasingly alarming issue in Peninsular Malaysia, with an upward trend in cases since 2012, resulting in 1,846 injuries and 62 fatalities from 2008 to 2019. The Department of Wildlife and National Parks (DWNP) plays a crucial role in mitigating the impacts of HWC. Although their efforts might not directly reduce the number of HWC cases, they

Table IV: List of national and state parks in Peninsular Malaysia.

National Park	Location	Year of Establishment	Purpose	Size (ha)	References
Taman Negara National Park	Kuala Tahan, Pahang Tanjung Mentong, Terengganu Kuala Koh, Kelantan	1939	To preserve the biodiversity of one of the oldest primary rainforests	434,300	PERHILITAN ¹⁷ , FDPMP ³⁶
Endau Rompin National Park	Mersing, Johor Rompin, Pahang	1993	To preserve the biodiversity of the oldest rainforest	48,905	PERHILITAN ¹⁷ , FDPMP ³⁶ , JPNJ ³⁷ , JPNP ³⁸ ,
Pulau Kukup National Park	Kukup Island, Johor	1997	To preserve one of the largest mangrove islands in the world	647	PERHILITAN ¹⁷ , FDPMP ³⁶ , JPNJ ³⁷
Tanjung Piai National Park	Pontian, Johor	1997	To conserve the mangrove forest due to the erosion issues as it is located at the southernmost point of mainland Asia	325	PERHILITAN ¹⁷ , FDPMP ³⁶ , JPNJ ³⁷
Penang National Park	Teluk Bahang, Pulau Pinang	2003	To preserve the unique biodiversity on both land and sea, including landscapes like meromictic lake, beaches, mangrove forests and dipterocarp forests.	2,540	PERHILITAN ¹⁷ , FDPMP ³⁶ , Penang State Forestry ⁴²
Gunung Ledang National Park	Tangkak, Johor	2005	To preserve the biodiversity of the tropical rainforest	8,611.9	FDPMP ³⁶ , JPNJ ³⁷
State Park	Location	Year of Establishment	Purpose	Size (ha)	
Perlis State Park	Wang Kelian, Perlis	1996	To preserve the unique limestone vegetation and semi-deciduous forest	5,015	Kasim ⁴⁰
Selangor State Park	Gombak, Selangor	2007	To conserve the water catchment forest for water supplement	108,000	FDPMP ³⁶
Gunung Stong State Park	Dabong, Kelantan	2007	To preserve the tropical rainforest and limestone vegetation as the other surrounded forest reserves provide a natural buffer against encroaching development	21,950	Maseri et al. ⁴¹
Royal Belum State Park	Hulu Perak, Perak	2007	To allow the <i>in situ</i> conservation of biodiversity to be conducted at this lowland dipterocarp, hill dipterocarp and lower montane forest	117,500	FDPMP ³⁶
Kenyir State Park	Hulu Terengganu, Terengganu	2007	To preserve the biodiversity in the lowland and hill dipterocarp forest so that poaching and illegal land used could be reduced	30,000	FDPMP ³⁶ , JPNT ³⁹
Kenaboi State Park	Jelebu, Negeri Sembilan	2008	To preserve the rich biodiversity of the lowland and hill dipterocarp rainforest	9,420	FDPMP ³⁶ , Syahida-Emiza et al. ⁴³
Bukit Panchor State Park	Nibong Tebal, Pulau Pinang	2008	To preserve the rich biodiversity in this lowland dipterocarp forest and for potential eco-tourism activities	445	FDPMP ³⁶
Setiu Wetlands State Park	Setiu, Terengganu	2015	To reduce the excessive land usage and preserve the variety ecosystems, including marine, rivers, sandy beaches, estuaries, islands, mudflats, a lagoon, freshwater swamps, and mangroves.	1,520	FDPMP ³⁶ , JPNT ³⁹ ,
Melaka State Park	Sedanan, Melaka	-	To preserve the biodiversity of the lowland dipterocarp forest	-	FDPMP ³⁶

are instrumental in minimizing injuries and fatalities arising from these conflicts. Addressing the escalating number of HWC cases requires a multi-faceted approach that extends beyond the scope of the DWNP. Involving a diverse range of stakeholders, including planning agencies, law enforcement, and local communities, is essential to tackle the root causes of HWC, such as deforestation and habitat loss. Moreover, the effectiveness of current wildlife disturbance management methods and techniques should be regularly reviewed to minimize the impact of HWC.

CONFLICT OF INTEREST

The authors declare is no conflict of interest.

ACKNOWLEDGEMENT

This study received financial support from Ministry of Energy and Natural Resources Malaysia via National Conservation Trust Fund for Natural Resources (Grant no: 304/PPSK/6150219).

REFERENCES

1. Qamariah IN, Rahmi T, Said Z, Wijaya, A. Conflict between human and wild Sumatran Elephant (*Elephas maximus sumatranus* Temminck, 1847) in Aceh Province, Indonesia. *Biodiversitas* 2019;20(1):77-84.
2. Bernama. Landslide in Ampang claims four lives. *Malaysiakini*; 2022. [online]. Available from <https://www.malaysiakini.com/news/613951>. Accessed October 10 2022.
3. Davies R. Malaysia – Deadly Landslide in Kuala Lumpur. *FloodList*; 2022. [online]. Available from <https://floodlist.com/asia/malaysia-landslide-ampang-kuala-lumpur-march-2022>. Accessed October 10 2022.
4. Ismail WR, Haghroosta T. Extreme weather and floods in Kelantan state, Malaysia in December 2014. *Res Marine Sci.* 2018;3(1):231-44.
5. Sáenz-Bolaños C, Fuller TK, Sievert L, Carillo E. Human-wildlife conflict in indigenous communities of the Nairi Awari Indigenous Territory of East Central Costa Rica. *Biodiversitas* 2022;23(4):2238-2244.
6. Baral K, Sharma HP, Kunwar R, et al. Human Wildlife Conflict and Impacts on Livelihood: A Study in Community Forestry System in Mid-Hills of Nepal. *Sustainability* 2021;13(23):13170.
7. Gross E, Jayasinghe N, Brooks A, et al. Chapter 3: The Global Impact of Human-Wildlife Conflict. In: *A Future for All: The Need for Human-Wildlife Coexistence*. Switzerland: WWF; 2021. p. 23-41.
8. PERHILITAN. Annual Report 2011. Kuala Lumpur, Malaysia: Department of Wildlife and National Parks, Peninsular Malaysia; 2011.
9. Department of Wildlife and National Parks Peninsular Malaysia (DWNP). National Tiger Action Plan for Malaysia 2008-2020. Kuala Lumpur, Malaysia: Department of Wildlife and National Parks Peninsular Malaysia; 2008.
10. Department of Wildlife and National Parks Peninsular Malaysia (DWNP). National Elephant Conservation Action Plan: Blueprint to Save Malaysian Elephants. Kuala Lumpur, Malaysia: Department of Wildlife and National Parks Peninsular Malaysia; 2013.
11. Department of Wildlife and National Parks Peninsular Malaysia (DWNP). Manual Pengurusan Konflik Manusia-Kera di Semenanjung Malaysia (Human-Monkey Conflict Management Manual in Peninsular Malaysia. Kuala Lumpur, Malaysia: Department of Wildlife and National Parks Peninsular Malaysia; 2006.
12. PERHILITAN. Annual Report 2012. Kuala Lumpur, Malaysia: Department of Wildlife and National Parks, Peninsular Malaysia; 2012.
13. PERHILITAN. Annual Report 2013. Kuala Lumpur, Malaysia: Department of Wildlife and National Parks, Peninsular Malaysia; 2013.
14. PERHILITAN. Annual Report 2015. Kuala Lumpur, Malaysia: Department of Wildlife and National Parks, Peninsular Malaysia; 2015.
15. PERHILITAN. Annual Report 2016. Kuala Lumpur, Malaysia: Department of Wildlife and National Parks, Peninsular Malaysia; 2016.
16. PERHILITAN. Annual Report 2017. Kuala Lumpur, Malaysia: Department of Wildlife and National Parks, Peninsular Malaysia; 2017.

17. PERHILITAN. Annual Report 2018. Kuala Lumpur, Malaysia: Department of Wildlife and National Parks, Peninsular Malaysia; 2018.
18. Bodo T, Gimah BG, Seomoni KJ. Deforestation and habitat loss: human causes, consequences and possible solutions. *Journal of Geography Research*, 4(2), 22-30.
19. Nyhus PJ. Human-wildlife conflict and coexistence. *Annu Rev Environ Resour*. 2016;41(1):143-71.
20. Dunham K, Ghiurghi A, Cumbi R, Urbano F. Human-wildlife conflict in Mozambique: A national perspective, with emphasis on wildlife attacks on humans. *Oryx* 2010;44(2):185-93.
21. Hill CM, Wallace GE. Crop protection and conflict mitigation: reducing the costs of living alongside non-human primates. *Biodivers Conserv*. 2012;21:2569-87.
22. Norhalifah HK, Syaza FH, Chambers GK, Edinur HA. The Genetic History of Peninsular Malaysia. *Gene* 2016;586:129-35.
23. Department of Wildlife and National Parks Peninsular Malaysia (DWNP). Red List of mammals for Peninsular Malaysia. Kuala Lumpur, Malaysia: Department of Wildlife and National Parks Peninsular Malaysia; 2010.
24. Kasumovic MM, Jordan LA. Social factors driving settlement and relocation decisions in a solitary and aggregative spider. *Am Nat*. 2013;182(4):532-41.
25. Subedi P, Joshi R, Poudel B, Lamichhane S. Status of Human-Wildlife conflict and Assessment of Crop Damage by Wild Animals in Buffer Zone Area of Banke National Park, Nepal. *Asian J Conserv Biol*. 2020;9(2):196-206.
26. Mishra J, Mishra P, Arora NK. Linkages between environmental issues and zoonotic diseases: with reference to COVID-19 pandemic. *Environmental Sustainability* 2021;4(3):455-67.
27. Meurens F, Dunoyer C, Fourichon C, et al. Animal board invited review: Risks of zoonotic disease emergence at the interface of wildlife and livestock systems. *Animal* 2021;15(6):100241.
28. Begum RA, Raihan A, Mohd Said MN. Dynamic Impacts of Economic Growth and Forested Area on Carbon Dioxide Emissions in Malaysia. *Sustainability*. 2020;12(22):9375.
29. Coalition for the Protection of the Selangor State Park. Protect Selangor State Park. 2014. [online]. Available from <https://www.malaysiakini.com/letters/255385>. Accessed October 10 2022.
30. Razak A. Mining in K'tan tiger habitat may also cause 'catastrophic' floods – EIA – Malaysiakini. 2022. [online]. Available from <https://m.malaysiakini.com/news/618446>. Accessed October 10 2022.
31. Pires SF, Moreto WD. Preventing Wildlife Crimes: Solutions That Can Overcome the 'Tragedy of the Commons'. *Eur J Crim Pol Res*. 2013;17(2):101-23.
32. Parry L, Barlow J, Pereira H. Wildlife Harvest and Consumption in Amazonia's Urbanized Wilderness. *Conserv Lett*. 2014;7(6):565-74.
33. Freund C, Rahman E, Knott C. Ten years of orangutan-related wildlife crime investigation in West Kalimantan, Indonesia. *Am J Primatol*. 2016;79(11).
34. Edinur HA, Hajar CGN, Abdullah MT. COVID-19 treatment may impact sun bear. *J Sustain Sci Manag*. 2022;17(3):1-5.
35. Xin LQ, Mat-Ghani SNA, Rasudin NS, et al. Prevalence of wildlife crimes in Peninsular Malaysia. *Malayan Nat J*. 2022;74(3), in-press.
36. FDPM. Annual Report 2020. Kuala Lumpur, Malaysia: Forestry Department of Peninsular Malaysia; 2020.
37. JPNJ. Laporan Tahunan 2020. Johor, Malaysia: Jabatan Perhutanan Negeri Johor, Malaysia; 2020.
38. JPNP. Laporan Tahunan 2021. Pahang, Malaysia: Jabatan Perhutanan Negeri Pahang, Malaysia; 2021.
39. JPNT. Laporan Tahunan 2020. Terengganu, Malaysia: Jabatan Perhutanan Negeri Terengganu, Malaysia; 2020.
40. Kasim O. The Management of Perlis State Park. Kangar, Malaysia: Perlis State Forestry Department, Malaysia, 2003.
41. Maseri NM. Gunung Stong State Forest Park: A Guidebook. WWF-Malaysia, 2009.
42. Penang State Forestry. Laporan Tahun 2013. Pulau Pinang, Malaysia: Jabatan Perhutanan Negeri Pulau Pinang, Malaysia; 2013.
43. Syahida-Emiza S, Sam YY, Siti-Munirah MY. Two new species of *Codonoboea* (*Gesneriaceae*) from Kenaboi State Park, Peninsular Malaysia. *PhytoKeys* 2020;165(2):51-62.

44. Abdullah MT, Daim MS, Zainuddin ZZ. Capture, immobilization and translocation of an elephant from Pulau Ubin, Singapore to Endau-Rompin State Park, Johore, Malaysia. Asian Elephant Specialist Group Newsletter. 1992;8:34-7.
45. Van Der Ree R, Gagnon JW, Smith DJ. Chapter 20: Fencing, a valuable tool for reducing wildlife-vehicle collisions and funnelling fauna to crossing structure. In: Van Der Ree R, Smith DJ, and Grilo C, editors. Handbook of Road Ecology. United Kingdom: John Wiley & Sons, West Sussex; 2015. p. 159-71.
46. Lopez JJ, Mulero-Pazmany M. Drones for conservation in protected areas: present and future. Drones 2022;3(1):10.