

# Monitoring Mechanism for Effective Management of Wildlife Meat Resources and Markets in Sabah, Malaysia

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The relationship between humans and wildlife has existed for thousands of years, with hunting being the most fundamental aspect. Borneo, especially Sabah, is known to be one of the hotspots for legal and illegal wildlife trade and consumption. In 2016, the Sabah Wildlife Department (SWD) introduced the wildlife market logbook for wildlife meat suppliers. Data from the West Coast (WCD) and Interior Division (IRD) wildlife market logbooks from 2016 to 2019 were analysed to examine the status of the wildlife market in terms of wildlife meat species and the temporal patterns of supply and demand in the different areas. Until now, there has been no proper centralised system for the baseline data to monitor the trend of legal wildlife markets in Sabah. A total of 122.4 tonnes of wildlife meat was extracted from the forests, primarily comprising bearded pigs (*Sus barbatus*) and sambar deer (*Rusa unicolor*) for a duration of four years (2016 to 2019). In the WCD, the largest amount of game meat was bought in May and December, while IRD was in February and April. This shows that there is always a supply when there is a demand, even outside of the festive months. This study showed that the logbook is an important tool in monitoring the legal wild meat market, but its effectiveness depends on data management conducted by the SWD. In conclusion, this highlights the intricate dynamics of human-wildlife interactions and the challenges inherent in monitoring the trade in wildlife in Sabah.

**Keywords:** wildlife; market; wild meat; logbook; west coast; interior division

## I. INTRODUCTION

The interactions between humans and animals were established thousands of years ago, and each region developed them differently (Alves, 2012; Alves & Souto, 2015). Terrestrial to aquatic and, invertebrate to vertebrate animals have been utilised by humans as part of their daily consumption (Emery, 2007). Hunting is one of the earliest interactions between humans and animals, primarily involves the pursuit and capture of animals for protein sources (Alves, 2012). The hunting pressure became more alarming as the human population rocketed and the

technologies advanced, mostly affecting large-bodied animals with low fecundity rates (Bennett & Rao, 2002; Robinson & Bennett, 2000b).

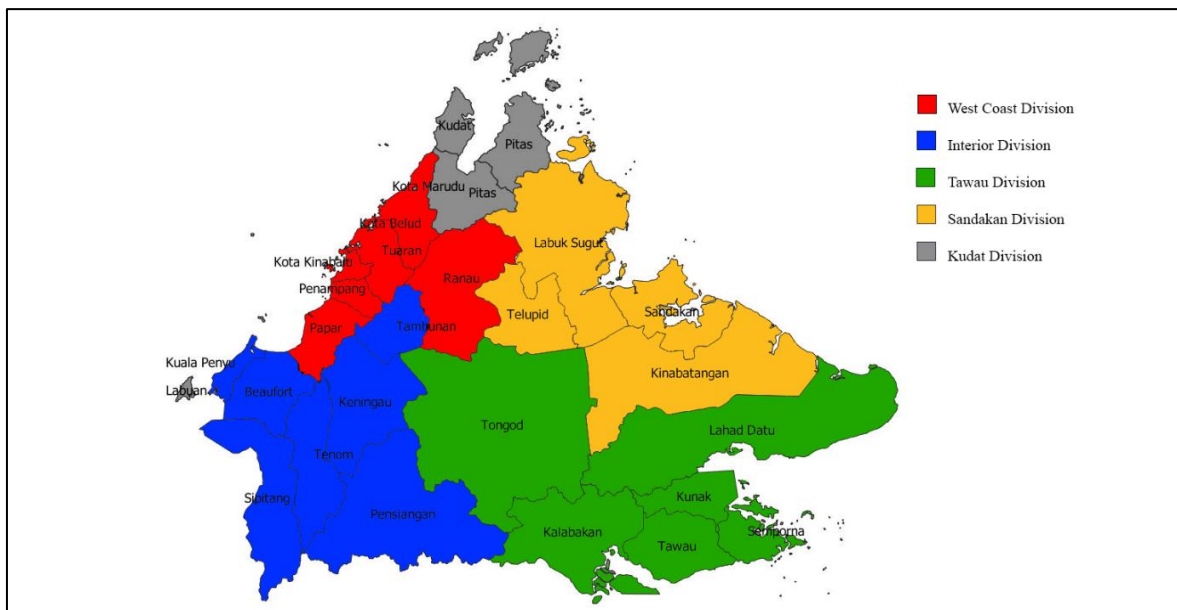
As one of the world's most important strongholds for biodiversity, Southeast Asia also shares a similar fate with the Neotropics and Africa as one of the hotspots for legal and illegal wildlife trade and consumption (Harris *et al.*, 2015). There is a chance that these activities, which includes traditional hunting practices and subsistence activities carried out by the indigenous communities, are underrated or poorly documented in Borneo, especially in Sabah, which is

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beyond the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) jurisdiction as Sabah has a degree of autonomy in managing its own natural resources and wildlife. Charismatic species such as the Sunda pangolin (*Manis javanica*) (Vallianos, 2015; Jones *et al.*, 2023; Panjang *et al.*, 2024) and the Bornean banteng (*Bos javanicus*) (Lim *et al.*, 2021) could be facing a similar fate as the Sumatran rhinoceros (*Dicerorhinus sumatrensis*), which recently became extinct in Malaysia due to habitat loss and illegal hunting for the trade of its horn (Payne *et al.*, 2025).

In Malaysia, different regions have their own wildlife protection laws, with Sabah being governed by the Sabah Wildlife Conservation Enactment 1997 (SWCE 1997) under the Sabah Wildlife Department (SWD). This law is crucial for safeguarding the region's wildlife. It strictly prohibits hunting any animals listed as Schedule 1 of the Totally Protected Species of Animals and Plants (Part 1) in the enactment, ensuring these creatures are safe from harm. For other species, hunting is only allowed with a license and within strict quotas. The enactment also categorises hunting licenses into three different types: animal kampung (for the indigenous communities to hunt and manage their hunting area), sports, and commercial purposes, with fees varying depending on the type of license and species involved.

In addition, SWCE 1997 supports the creation of wildlife sanctuaries and takes strong action against illegal wildlife trade, reflecting Sabah's commitment to preserving its rich biodiversity. The ongoing efforts to balance sustainable development, species survival, and the shift towards a green economy consistently impact wildlife conservation initiatives in Sabah (Goossens & Ambu, 2012). The development of technologies, infrastructure, and transportation, such as logging roads, has opened large areas in Sabah and Sarawak, which makes it easier for hunters to access them (Bennett *et al.*, 2000). The SWD focuses on enforcing laws to ensure sustainable hunting practices. According to Part Four of the Sabah Wildlife Conservation Enactment (SWCE) 1997, Section 25(1) states that no one is allowed to hunt species listed in Schedule 1 (Totally Protected Species) with or without a licence. Section 15(2) prohibits hunting species listed in Schedules 2 and 3 without a licence, and section 26 restricts the number of animals that can be hunted according to the licence. Schedules 2 consist of 229 species of animals (ranging from mammals to insects) and 13 species of plants, while Schedule 3 mainly consist of nine animal species namely, large flying fox (*Pteropus vampyrus*), island flying fox (*Pteropus hypomelanus*), Common Porcupine (*Hystrix brachyura*), bearded pig (*Sus barbatus*), lesser mousedeer (*Tragulus javanicus*), greater mousedeer (*Tragulus napu*), common barking deer (*Muntiacus muntjac*), Borneon yellow muntjac (*Muntiacus atherodes*) and sambar deer (*Cervus unicolor*).



D Figure 1. The map of Sabah's divisions.

Once the licence quota is reached, it must be renewed. The Wildlife Regulations 1998 under SWCE 1997 divide hunting licences into three categories: Animal Kampung, Sporting, and Commercial. Each animal species in Schedules 2 and 3 has a specific fee per head, varying between Sporting and Commercial licences. This study reviews the effectiveness of the SWD logbook in monitoring wildlife meat and also the temporal trend of the wildlife meat sales in West Coast (WCD) and Interior Division (IRD).

**II. MATERIALS AND METHODS**

The logbook of the wildlife market from SWD was used to study its effectiveness in monitoring the legal wild meat markets in the West Coast (WCD) and Interior Division (IRD) of Sabah. In addition, the data from the logbooks was also used to study the annual and monthly trends of the wild meat markets in both divisions. WCD and IRD consist of 13 districts (Figure 1 and Table 1), and both manage their logbook separately.

Table 1. List of districts in the WCD and IRD of Sabah

West Coast Division	Interior Division
<i>Papar</i>	<i>Keningau</i>
<i>Penampang</i>	<i>Tambunan</i>
<i>Kota Kinabalu</i>	<i>Tenom</i>
<i>Tuaran</i>	<i>Sipitang</i>
<i>Ranau</i>	<i>Kuala Penyu</i>
<i>Kota Belud</i>	<i>Nabawan</i>
	<i>Beaufort</i>

*A. Logbook of Wildlife Market*

The study used data from the wildlife market logbooks (Figure 2) collected by SWD between 2016 and 2019. These logbooks were introduced to monitor wildlife hunting in Sabah, with full implementation beginning in 2015 across all districts. Vendors with a commercial licence are required to fill out these logbooks annually, providing details such as their business location, licence number, species name, and the quantity of wildlife bought or sold.

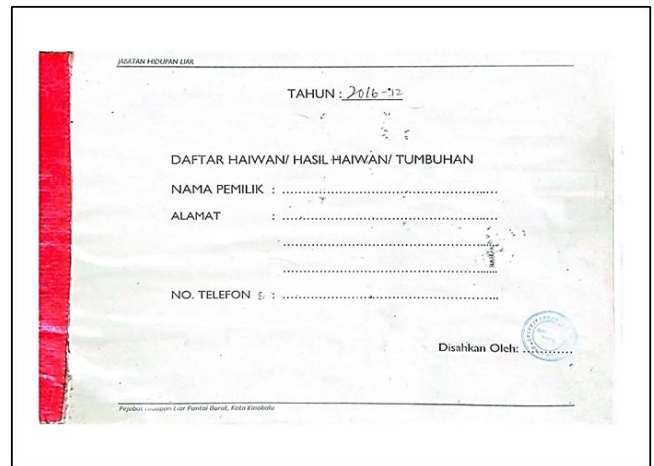


Figure 2. Front cover of the official physical logbook from the WCD.

In SWCE 1997, applicants must complete specific forms, declare any firearms they will use, and specify the species, number of animals, and hunting area to apply for a commercial hunting licence. Separate licences are needed for different hunting areas, and licences must be renewed once they expire, or the quota is fulfilled. There is no logbook directly mentioned in the SWCE, however in Section 35 of the SWCE 1997 stated that a hunting licence required to keep the record of all animals killed, wounded, or captured together with the ammunition usage and maps of hunting areas. The licence holder must update these records within 48 hours after hunting.

*B. Cataloguing and Transcribing Process of the Logbook*

A total of 839 logbooks from the SWD were collected, 706 from IRD and 133 from WCD with the permission of the head of the Law Enforcement Unit (reference letter: JHL.10-7/27). The record contains information such as the name of the vendors, the address of the market, the animal species, the weight of the meat (Figure 3). In addition, the logbook contains receipts for the game meat purchased, indicating the price of the meat sold per kg, the parts of the animal sold and the name of the supplier (Figure 4). All the records are from the official logbook issued by the SWD and this includes the receipts and licences.



Shop Name	SUM of Buy(kg)	SUM of Sell(kg)	Differences	Differences %
Tuck Kok Restaurant	128.4	374.2	-245.8	-191%
Sikol @ Josie Ejot Bin Takun	105	280	-175	-167%
Muntiri Bin Ambulul	220	404	-184	-84%
Daily Kondong	121	166	-45	-37%
Yitah Bin Gontul	361	492	-131	-36%
D C Enterprise	510	663.2	-153.2	-30%
Usaha Harapan Enterprise	100	130	-30	-30%
Wolsen Bin Kundol	270	335	-65	-24%
Pangie Enterprise	1951.9	2308.9	-357	-18%
Alex Bin Gikit	123.5	140.857	-17.357	-14%
Sylvester Stephen Kondu	1110	1260	-150	-14%
DC Enterprise	557	622	-65	-12%
Urun @ Saimon Bin Batah	990	1071	-81	-8%
April Johnny	422.5	456.1	-33.6	-8%
Rosni Binti Maharan	357	377	-20	-6%
Savi @ Sylvester Bin Ulah	367.1	386.5	-19.4	-5%
Lawerinis Bin Albert	7114.4	7370.2	-255.8	-4%
Double Luck Restaurant	1163.7	1200.8	-37.1	-3%
Sariah Binti Ahunang	1642	1678	-36	-2%
Clare Nain	1060	1080	-20	-2%
Herena Binti Galin	1132	1148	-16	-1%
Anduul Bin Ekup	7417	7452	-35	0%
Lian Heng 2	3900	3918	-18	0%
Iuprin Bin Ansiew	310	311	-1	0%
Restoran Garden 33	20	20	0	0%
Kurian Binti Anusuk	24.8	24.8	0	0%
Milus Bin Rimeh	48	48	0	0%
Ratali Bin Parimin	60	60	0	0%
Rinie Petrus	93	93	0	0%
Aloysius Lajawon @ Aloysius Livinus	120	120	0	0%
Yunos Jimpin	120	120	0	0%
Amimpin Soromon	130	130	0	0%
Maidin Lantap	150	150	0	0%
Malip Bin Ubin	180.9	180.9	0	0%
Judi Bin Dunggu	230	230	0	0%
Kolong Bin Pamiang	231.1	231.1	0	0%
Ailin Binti Imon	240	240	0	0%
Allisus @ Alisius Bin Maning	308.9	308.9	0	0%

Figure 7. The shops in the red box are the shops that have a 1 to 5% difference between the wildlife meat bought and sold.

### D. Analysis

#### 1. Summary of wildlife meats by division

Pie charts were produced to summarise the total quantity of wildlife meat extracted for each species from 2016 to 2019 and to see which species were the most preferred by each division. A Venn diagram was created to visualise the wildlife meat species shared between WCD and IRD.

#### 2. Summary of wildlife meats trend in each division

The shops that only completed three to four annual logbook data from 2016 to 2019 consecutively were selected. Shops that have two years of consecutive annual logbook data were also selected as there is not enough data chosen to do the trend analysis. The data on wildlife meat was plotted into a line graph for the yearly trend of wildlife meat markets in both divisions. Afterward, the data was used to plot a histogram to see the trend of wildlife meat by month in each division.

## III. RESULTS AND DISCUSSION

A total of 15,923 data entries from the wildlife market logbooks were extracted and transcribed into an Excel spreadsheet, 2,500 from WCD and 13,423 from IRD. Four

hundred and fifty-five markets were identified, 90 in WCD and 365 in IRD. No significant difference was found after the data-cleaning process.

### 1. Wildlife meat species status

There were six species of wildlife listed in the logbook that were being sold, namely bearded pig (*Sus barbatus*), large flying fox (*Pteropus vampyrus*), mouse deer (*Tragulus spp.*), barking deer (*Muntiacus spp.*), sambar deer (*Rusa unicolor*), and saltwater crocodile (*Crocodylus porosus*). According to the SWCE 1997, only one species of wildlife is in Schedule 2 of the Protected Species of Animals and Plants, which is the saltwater crocodile, and the rest is in Schedule 3. Bearded pigs, sambar deer, and barking deer are the common species in both divisions, while saltwater crocodiles were only sold in WCD, while large flying foxes and mouse-deers were in IRD (Figure 8).

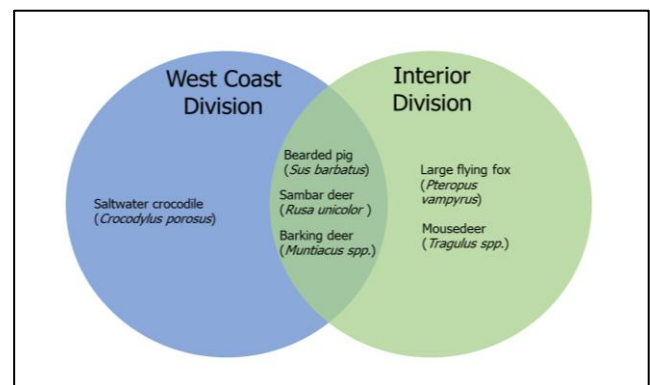


Figure 8. Wildlife species have been sold in the wildlife meat markets across WCD and IRD.

Table 2. The total amount of wildlife meat extracted from the forest over four years, in tonnes.

Species	IRD	WCD
Bearded pig	130.73	158.45
Large flying fox	0.00	0.00
Mouse deer	0.00	0.00
Muntjac	0.07	0.10
Sambar deer	5.18	2.51
Saltwater crocodile	0.00	0.00
Unknown	4.27	0.00
Total	140.24	161.06

A total of 301.30 tonnes of wildlife meat has been extracted from the forest, 140.24 tonnes in IRD and 161.06 tonnes in

WCD. The most preferred wildlife meat species was the bearded pig, with 289.18 tonnes, followed by the sambar deer, with 7.68 tonnes (Table 2). An adult male bearded pig can reach a maximum of 50 to 120kg, and a female can be slightly smaller (Francis & Barrett, 2008). Their size depends on the availability of food sources and the level of competition for the resources around the forest (Wong *et al.*, 2005). According to the pigs' maximum weight in Luskin & Ke's study in 2017, approximately 1,089 individuals of bearded pigs were extracted from the forest.

Bearded pigs migrate in response to the mass fruiting event in the forest for food sources. Still, due to the expansion of oil palm plantations and habitat fragmentation, they shift towards utilising the food resources in the oil palm plantation (Love *et al.*, 2017). Their high reproductive rate and availability through most of the landscape make them the most preferred wildlife meat by Borneo's Indigenous people, Kadazandusun-Murut Rungus (KDMR) communities in Sabah and Iban communities in Sarawak (Yi & Mohd-Azlan, 2020; Kurz *et al.*, 2023; Bansa *et al.*, 2025).

Table 3. Average price of the wildlife meat in WCD (MYR per kilo).

Year	Bearded pig	Sambar deer	Barking deer
2016	MYR7.88	MYR17	0
2017	MYR8.06	MYR16.35	0
2018	MYR8.59	MYR19.91	0
2019	MYR9.35	MYR20.42	MYR20

The table above shows the trend changes in the price per kilo of the bearded pig in the WCD. The price range was obtained in the receipts that were attached in the logbook. However, only the WCD logbook has this price range information, and none can be found in the IRD logbook. The price increased over four years. In 2017, the cheapest price it could get was MYR6 per kilo, which is the price for the internal organ of the bearded pig. The most expensive price was also from 2017, with MYR10. In the Schedule 2 (Fees) of the Regulation 1998 (SWCE 1997), the commercial licence price for one individual bearded pig and sambar deer was MYR50 and MYR150 respectively, this is without any limit on the maximum weight of the hunted pig (Table 4). The

commercial price was not regulated and not standardised throughout WCD and IRD.

Table 4. Price per Head for Commercial Licences for Each Species in the Schedule 3 of the Protected Species.

Species	Price per head (MYR)
Large flying fox	5MYR
Common porcupine	10MYR
Bearded pig	50MYR
Sambar deer	150MYR
Lesser mousedeer	35MYR
Greater mousedeer	35MYR
Common barking deer	75MYR

### 2. Wildlife meat market trend

Only 35 wildlife meat markets, 24 shops from WCD, and 11 shops from IRD were selected to analyse the trend in the wildlife meat market. These markets were selected using the criteria mentioned in the method.

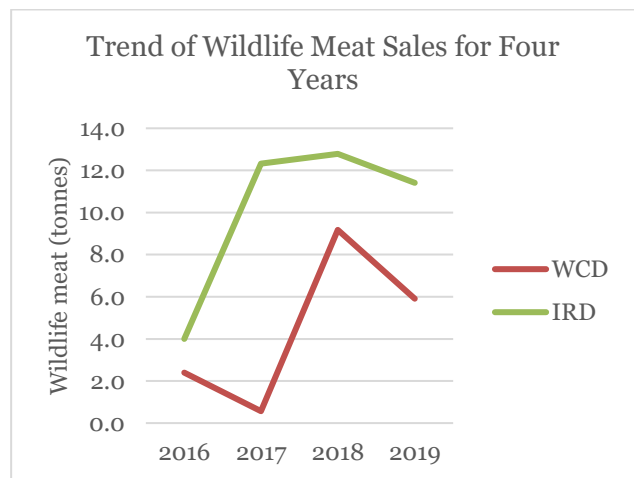


Figure 9. The yearly trend of wildlife meat extracted from forests from 2016 to 2019.

Throughout the four years from 2016 to 2019, there were differences in the trends of wildlife meat sales in WCD and IRD (Figure 9). With 82.1 tonnes, IRD had the most wildlife meat, followed by 40.3 tonnes from WCD. WCD sales dropped to 0.6 tonnes in 2017 after a sluggish start in 2016 at roughly 2.4 tonnes. In contrast, sales of wildlife meat increased dramatically in 2018—9.2 tonnes were sold. Then, with sales of 5.9 tonnes of wildlife meat in 2019, it fell again.

The IRD's sales growth trajectory, on the other hand, was more consistent and noteworthy than WCD's. Starting at 4.0 tonnes in 2016, sales in 2017 tripled to 12.3 tonnes, and in 2018, sales slightly increased by 12.8 tonnes, the highest sales year in four years. However, in 2019, they dropped only marginally to 11.0 tonnes. IRD generally indicated a more stable and long-term demand for wildlife meat, whereas the WCD's sales varied more.

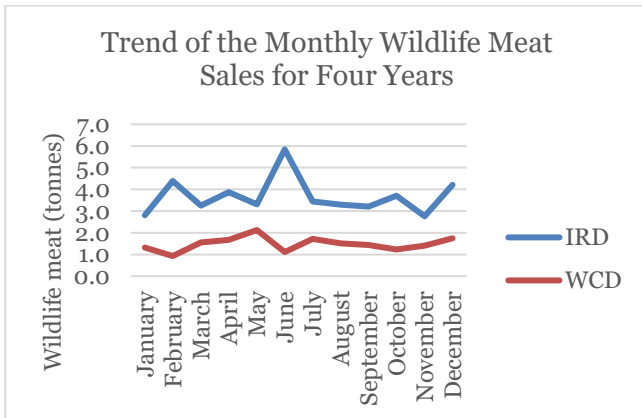


Figure 10. The monthly trend of wildlife meat extracted from forests from 2016 to 2019.

There were also no similarities between the monthly trends of wildlife meat sales between WCD and IRD. Figure 10 reveals distinct patterns that highlight the difference in market dynamics and consumer behaviour. In IRD, the trend fluctuates significantly throughout the months. There is a noticeable peak in February, June, and December, with the highest being 5.8 tonnes of wildlife meat sales in June. Conversely, the WCD shows a more stable trend in sales patterns, indicating a steady demand for wildlife meat supplies. The highest peak of wildlife meat was in May, with 2.1 tonnes, while April, July and December share the second-highest sales in WCD.

In WCD, the two peak months, May and December, are the months of Sabah's most important cultural celebrations. The harvest festival called Kaamatan is held in May and is celebrated by KDMR people, and the non-muslims celebrate Christmas in December. These celebrations involve a lot of traditional and cultural activities. At the same time, this celebration increases the consumption of local foods, leading to a spike in wildlife meat sales. WCD of Sabah is the most urbanised division among the others, and it is where the

capital city of Sabah, Kota Kinabalu, is located. In the urban areas, wildlife meat was not a necessary primary protein source as various commercially sold goods, such as domestic pork, beef, poultry, etc., were available all year round. Hence, the demand for game meats was low in the West Coast Divisions, and the reliance on game meats has become less in the urban areas than in the interior areas (Kurz *et al.*, 2021; Bennett & Robinson, 2000). There is a cultural preference for wildlife meat among those living in rural areas, who tend to eat it despite having accessible, ready-available meat alternatives (Bennett & Rao, 2002).

The trends from IRD and WCD show that when people demand wildlife meat, there will always be supplies to fulfil the demand, even if it is outside of the festive season. People who live in rural areas, like in the IRD, depend on hunting wildlife meat for protein and income. Meanwhile, in urban areas, they have more accessible readily available protein sources, such as domestic poultry and livestock, which they don't have to rely on hunting to provide the protein source (Kurz *et al.*, 2021; *Global Panel on Agriculture and Food Systems for Nutrition*, 2017; Sukhatme, 1970). The city can offer many job opportunities that can provide a more stable income than from wildlife meat sales (*Global Panel on Agriculture and Food Systems for Nutrition*, 2017).

## 2. Wildlife meat market after COVID-19 and African swine fever (ASF)

This study uses logbooks from 2016 to 2019 mainly because there were only a few of the year 2020 logbooks of the wildlife market being sent to the SWD before the COVID-19 pandemic started. SARS-CoV-2 virus, which caused the COVID-19 pandemic in 2020, had a negative impact on the world economy (Naseer *et al.*, 2022). Most countries have implemented complete or partial lockdowns to prevent the virus from spreading. Malaysia's government, especially Sabah, implemented a Movement Restriction Order (MCO) that banned interdistrict travel and closed all shops except those that provide essential services and items (Tang, 2022). This restriction impacted Sabah's wildlife meat markets, forcing all market vendors to close their doors temporarily.

The SWD also stopped issuing licences, including those for sporting and commercial hunting as well as wildlife meat dealer licences. All hunting and the sale of wildlife were

suspended for two years and did not resume until March 2022. However, bearded pigs were banned from hunting due to the recent outbreak of African Swine Fever (ASF), which primarily affected Sabah's domestic and wild boar populations.

The African Swine Fever (ASF) outbreak, like the COVID-19 pandemic, has altered wildlife meat markets and consumption patterns in Sabah, Malaysia (World Wildlife Fund, 2021; Neimi). The Movement Control Order (MCO) following the COVID-19 pandemic resulted in the closing of the wildlife meat markets- the supply chains were cut off and knocked the livelihood of local vendors selling exotic meats (Macaranga, 2022). This disruption was compounded by the ASF outbreak, which necessitated the culling of domestic pigs and wild boars, further reducing the availability of wildlife meat in local markets (Sabah Wildlife Department, 2023). Consumption of wildlife might thus have declined during the pandemic as consumers sought more conventional food sources (van Vliet *et al.*, 2022). Furthermore, due to COVID-19, awareness of zoonotic diseases has been heightened, and this probably impacted public perception about the consumption of wildlife, thus greater scrutiny and changes in dietary habits by local inhabitants (Goh *et al.*, 2021; Shankar, 2021). The coincidence of the twin crises of COVID-19 and ASF has brought about a relationship between the public health of individuals and the economic muscle of locals in Sabah through wildlife conservation.

The synergy of the COVID-19 pandemic and the ASF outbreak has created a challenging environment in which to flourish, given that the wildlife meat markets in Sabah have their traditional patterns of consumption disrupted due to the closure of markets and culling of affected animals. This situation raises concerns over the sustainability of wildlife resources. Recovery must, therefore, be underpinned by strategies of economic regeneration that include ways in which wildlife is managed more sustainably. Overcoming such challenges will require comprehensive measures for

balancing public health with ecological integrity, hence enabling local communities to negotiate the crises in the future while preserving their cultural practices and biodiversity.

#### IV. CONCLUSION

Monitoring of wildlife meat resources and markets in Sabah is essential for assessing the dynamics of human-wildlife interactions and ensuring that the practice is done sustainably. This study analyses the data from SWD's logbooks of the wildlife market. It shows that from 2016 to 2019, a total of 301.30 tonnes of game, mostly from bearded pigs and sambar deer, were extracted from forests. The results showed a significant temporal pattern in supply and demand, peaking when the sale of wildlife meat coincides with the time of cultural celebrations, especially in WCD.

These markets were disrupted by the COVID-19 pandemic and ASF outbreak that included temporary market closures and a decline in the availability of wildlife meat. Such twin crises have increased public awareness of zoonotic diseases, with public perception and changes in the wildlife consumption habits (Goh *et al.*, 2021; Shankar, 2021). Hence, sustainability in wildlife resources is threatened and requires holistic approaches balancing economic recovery and effective management of wildlife. While the logbook is an essential tool for monitoring, the management of the logbook data system need to be improved for it to be more effective in the conservation of Sabah's rich biodiversity (Hinsley *et al.*, 2024).

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