International Journal of Fauna and Biological Studies
Available online at www.faunajournal.com

E-ISSN 2347-2677
P-ISSN 2394-0522
www.faunajournal.com
IJFBS 2022; 9(1): 14-22
Received: 23-10-2021
Accepted: 08-12-2021

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Wildlife species commonly involved in the WVC and roadkill along the roadway in plantation area

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DOI: https://doi.org/10.22271/23940522.2022.v9.i1a.869

Abstract
This paper aimed to discuss wildlife-vehicle collisions along the roadway in Wilayah Jengka, Pahang, Malaysia and provide the data sources for conservation, preservation and mitigation of wildlife. The primary objective of this survey is to reveal and prepare the roadkill inventory of fauna and avifauna mortality in Wilayah Jengka plantation zone due to wildlife-vehicle collisions. Some of the animals are listed under Schedule 1 and others in Schedule 2 of the Act 716. Wildlife-vehicle collisions (WVC) contributes to road mortality of wildlife species in Wilayah Jengka and little is known about roadkill in this area. The highest mortalities include Common Palm Civet (27.41%), Leopard Cat (14.51%), Large Indian Civet & Barn Owl (9.61% each), Clouded Monitor (8.06%), Long-Tailed Macaque & Wild Boar (6.45% each), Monitor Lizard (4.83%), Greater Coucal, Oriental Honey Buzzard & Red Junglefowl (3.22% each), and White-Breasted Waterhen (1.61%).

Keywords: Leopard Cat (*Prionailurus bengalensis)*, Common Palm Civet (*Paradoxurus hermaphroditus*), Large Indian Civet (*Viviera zibetha*), wildlife vehicle collision (WVC), Wilayah Jengka (WJ)

1. Introduction
Wilayah Jengka (WJ), with an estimated size of 64,117.05 hectare, was considered as one of the settlements for residents in the mid-1960s. At that time the forests were cut down and replaced by major crop plantations, such as oil palm and rubber as one of the efforts to boost the privileged people economy. WJ consists of 25 settlements from Jengka 1 to Jengka 25 and other settlements with different names surrounding it. In the past, it was a place for flora, fauna and avifauna because the natural resources of the forest were suitable for their foraging habitats and the nesting grounds and they share the land to raise their family and to stay in a new habitat. The changing of habitat forestry to sub-rural setting can cause mortality to many kinds of fauna due to road accidents and collisions with the various types of vehicle due to the heavy traffic (Ibisch *et al*., 2016) [5]. Unfortunately, the carcasses were left on the roadside for some time until they body decayed and decomposed. Even though the forest has been replaced by major crops, several flaura and fauna are still living in a new place within the new environment without conflicting with the settlers. The other reason for the wildlife species survival in the new changing habitat is because they have less conflict with human wildlife (HWC) and are less hunted by people such as leopard cat (*Prionailurus bengalensis*). However, other species cannot survive because they are hunted by hunters, such as the barking deer *(Muntiacus muntjak)*, sambar deer *(Rusa unicolor)*, lesser mousedeer *(Tragulus javanicus)*, large mousedeer *(Tragulus napu)*, and porcupine *(Hystricidae)*. With time, these species become immune with the changing landscape of their habitats and get normalised with the daily life of the new place until today. Because of the new environment and improved facilities, such as gravel roads for the new paved roadway, the traffic has become slightly busy. This new road networks could affect the wildlife species in regard to habitat fragmentations and mortality due to roadkill (Vidal- Valles *et al*., 2018) [34]. The development of *Bandar Jengka* (Jengka town) from time to time and the opening of the new east coast highway caused much heavier traffic than before, which resulted in the roadkill as the species will cross the roadway to search for prey and food to live. Some of these species are listed under in Act 716 under Schedule 2, which are totally protected while the others are listed under Schedule 1 in the same act.

Roadkill is a fundamental aspect of the wildlife decline, while the traffic volume is a parameter to determine the road impacts (Ozcan & Ozkazanc, 2017; Zhang *et al*., 2018) [23, 35] and it has led to the descendent in animal abundance which resulted in genetic diversity reduction (Cortes & Steury, 2016) [11]. Roadkill can be considered as a new source of fatality (Pandey, 2016) [24] and some countries have considered mitigations to reduce the collisions (Fudge *et al*., 2008) [14]. Globalisation development is demolishing the wildlife habitat (Lin, 2016) [19], while road networks will contribute an impact to habitat fragmentation and mortality (Vidal-Valles *et al*., 2018) [34] and the ecological consequences affect wildlife mortality (Coffin, 2007) [5]. Furthermore, road ecology has been discussed as a major subdiscipline in a variety of conferences (Fahrig & Rytwinski, 2009) [12]. It is predicted that sooner or later many wildlife populations will become threatened and endangered (Tejera *et al*., 2018) [31]. The development and expansion of the road infrastructure from gravel road to the new paved roadway contributed some impact to the wildlife, such as fragmentation and wildlife-vehicle collissions (WVC) by a variety of vehicles. Wildlife vehicle collision (WVC) refers to the event whereby the accident or crash happens between wildlife species and vehicle, causing death (roadkill) or injury to the wildlife species. The number of WVC is immense (Seiler & Helldin, 2006) [29] and it is clear that road matters such as the expansion and infrastructure have contributed to the increasing number of collisions and roadkill of wildlife (Kioko *et al*., 2015; Schwartz *et al*., 2018) [17, 18, 26]. Roadkill has the largest wildlife death, such as among mammals and birds as compared to hunting (Former & Alexander, 1998) [13]. The previous study showed that the factors of wildlife species (such as density, ranging behaviour, diet, body size), road factors (such as type, vehicle speed, traffic volume) and other factors (herbaceous vegetation, pastures, forest, distance of the nearest river & curve, agriculture and urban areas) led to the WVC, accordingly. Mammalian mortality on road commonly happened at night (Caro *et al*., 2000) [8]. Most roadkill cases often occurred in an open bushland habitat than in a closed bushland habitat (Kioko *et al*., 2015) [17, 18]. There was a case whereby the number of roadkill was caused by the presence of grass along the highway (Fudge *et al*., 2008) [14].

This study reveals cases of WVC roadkill in plantation areas. The species can be grouped as nocturnal, crepuscular, and diurnal. According to the Deputy Natural Resources and Environmental Minister of Malaysia, over the five years about 2,130 wildlife were recorded to die in a roadkill by the Department of Wildlife and National Parks Penisular Malaysia PERHILITAN (The Star, 2017). The research objectives are to: (1) investigate the species and sub-species vulnerable in the collision that led to the roadkill and (2) identify the common location of every species killed in collisions along the roadway.

2. Material and Methods

2.1 Species identification

The species involved in a collision and roadkill were identified by using the main reference, which is Wildlife Conservation Act 2010 (*Akta Pemuliharaan Hidupan Liar 2010*) or also known as Act 716. To identify the species more accurately, the Schedule 1 (in Section 3), Part 1 has listed the protected wildlife (hunted species), while Part 2 has others protected wildlife species. Meanwhile Schedule 2 (in Section 3) has listed the totally protected wildlife of Act 716.

Roadkill data were collected during a personal trip along the 28 km route from Bandar Jengka to Kampung Awah between 1 July 2017 and 30 June 2019 within a two-year period. Several species were manually recorded, including nocturnal, crepuscular and diurnal species, as listed in Schedule 1 and Schedule 2 in Act 716. The location and habitat types were oil palm plantation, rubber tree plantation, mixed area, and urban area. The roadkill were recorded by using the smartphone Galaxy J7 Prime model SM-G610F/DS with 720 X 1280 pixels and 13MP/1080p camera. The survey began by driving at normal speed while looking for any injured individual or dead body of the wildlife species along the road. When a carcass or dead body was found on the roadway it will be used as a head count of the roadkill based on the species identified. Photographs were taken but not applied to all carcasses because some were badly decomposed and damaged. Due to time constraint, the photos were only taken during a personal trip along the roadway for personal or official purposes.

2.2 Study area

The study area was the roadway in the Wilayah Jengka (WJ) plantation area, which has a lower average annual daily traffic (AADT). During this study, the roadway was still under construction, whereby the government has planned to widen and upgrade the roadway. The route involved in this study was along 32 km Kg Awah [3.547940, 102.507602] – Bandar Jengka [3.762442, 102.544691], 15 km Simpang Jengka 8 [3.877212, 102.494214] – Bandar Jengka [3.762442, 102.544691], 40 km Bandar Maran [3.588005, 102.763402] – Bandar Jengka (via Kg Kuala Sentul) [3.762442, 102.544691], 40 km Bandar Maran [3.588005, 102.763402] – Bandar Jengka [3.762442, 102.544691] (via FELDA Jengka 2 – Jengka 6). The WJ size is about 64,117.05 hectare, which consists of residential areas, palm oil plantation and rubber plantation which are surrounded by reserved forest in the west, FELDA Sungai Nerek, FELDA Sungai Tekam, FELDA Ulu Jempol, FELDA Lepar Utara. Each FELDA serves as a buffer zone between Wilayah Jengka and the reserved forest. All areas that constitute the FELDA settlement is a non-protected area nor inclusive in the wildlife reserve area. FELDA stands for the Federal Land Development Act which is used to develop the Malaysian economy through the creation of settlements and plantations during the 1960s by the Malaysian Government. The habitat is dominated by the palm oil and rubber plantations. Rainy season is between November and January, and generally the climate tends to increase between March and June. Specifically, the WJ location is shown in the figure 1 below;

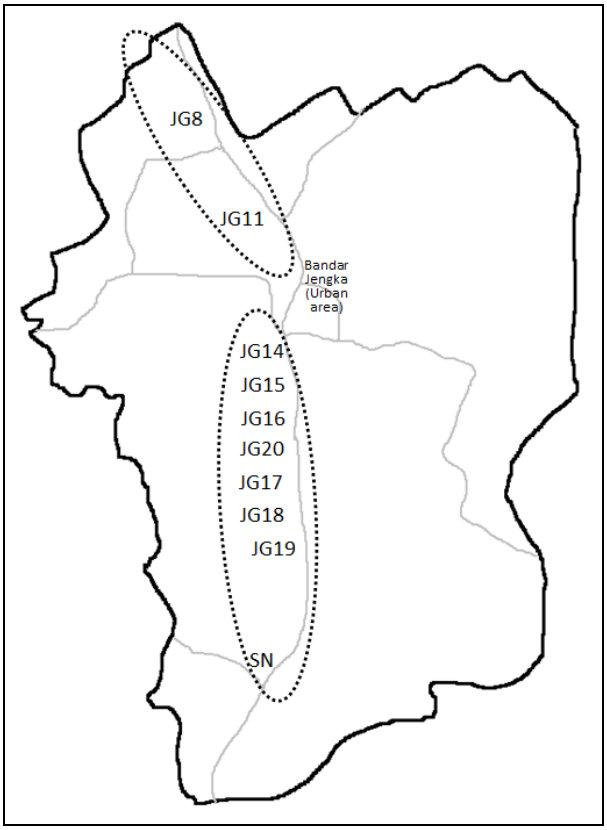

Fig 1: Wilayah Jengka (WJ) territory, showing the common location of roadkill between July 2017 and June 2019. (JG=Jengka, name of the residential settlement and the plantation which consists of Jengka 1 (JG01) to Jengka 25 (JG25). SN refers to locations at Sungai Nerek (local name).

The study did not take into account the smaller species, such as frogs, variety of lizard species, snakes and others. Counting and identifying these species when travelling has a limitation as the smaller species were missed and others misidentified (Brockie *et al*., 2009) [4]. Therefore, the smaller species were avoided in the study according to Brockie (2019). Several species that were recorded during the study are shown in Figure 2. The devastated wildlife body in this study was considered but no photos were taken as the carcasses were damaged and badly spoiled. Figure 2 only shows several species that can undoubtedly still be identified, specifically based on the family and species name and the group they belong to.

Barn Owl (*Tyto Alba)*

Common Palm Civet *(paradoxurus hermaphorditus)*

Oriental Honey Buzzard *(Pernis Ptilorhynchus)*

Large Indian Civet *(Viviera Zibetha)*

Greater Coucal *(Centropus Sinensis)*

Common Palm Civet *(paradoxurus hermaphorditus)*

White Brested Waterhern *(Amaurornis Phoenicurus)*

Oriental Honey Buzzard *(Pernis Ptilorhynchus)*

Leopard Cat *(Prionailurus Bengalensis)*

Monitor Lizard *(Varanus Salvator)*

Monitor Lizard *(Varanus Salvator)*

Large Indian Civet *(Viviera Zibetha)*

Fig 2: Photographs of several wildlife species that are commonly involved in roadkill.

2.3 Limitation

The difficulties in recognising the wildlife were the main limitation as the carcasses were damaged and eaten by scavengers, which particularly led to the problem in detecting the species. Other factors were weather which contributed to the accuracy of the wildlife data because the carcasses were drained by heavy rain and water definitely caused damage to the carcasses. The next limitation was the heavy traffic, in which the vehicle will violate the carcasses because the driver did not spot the carcasses on the road due to the slow moving traffic and the carcasses rapidly disintegrated due to the vehicle violation. Therefore, the carcasses were damaged and unrecognised. Time was another constraint during the survey because the data were only accumulated based on unscheduled trips, information from the social media such as the resident community on Facebook, and verbal communication between researcher and friends who were shuttled to workplace every day.

3. Result

A total of 62 individuals (n=62) were examined during the survey, including leopard cat (*P. bengalensis*) n=9, civet (*P.*

hermaphroditus, n=17 and *V. zibetha*, n=6), macaque (*M. fascicularis*) n=4, monitor (*V. salvator*, n=3 and *V. bengalensis*, n=5), greater coucal (*C. sinensis*) n=2, owl (*T. alba*) n=6, white breasted waterhen (*A. phoenicurus*) n=1, red junglefowl (*G. gallus*) n=2, oriental honey buzzard *(P. Ptilorhynchus)* n=2, black-winged kite (*E. caeruleus)* n=1, and wild boar (*S. scrofa*) n=4. The common palm civet (*Paradoxurus Hermaphorditus*) (N=17) contributed to the large number among other species, followed by leopard cat (*Prionailurus bengalensis*) (N=9), and other species. The result of the survey is shown Table 1.

Table 1: Different species of dead fauna from the study site according to location and abundance (studied from 1 July 2017 until 30 Jun 2019)

No	Common Name (Local Name-LN)	Scientific Name	% Percentage	Location of Discovered	Abundance	Total
Family: *Felidae*						
1.	Leopard Cat LN: Kucing Batu/Rimau Akar	*Prionailurus Bengalensis* (Totally Protected)	14.51%	MA-JG14 MA-JG16 MA-JG18 MA-JG19 MA-SN	U U U U U	2 4 1 1 1
Family: *Viverridae*						
2.	Common Palm Civet LN: Musang Pulut	*Paradoxurus Hermaphroditus* (Protected)	27.41%	MA-JG08 MA-JG11 MA-JG17 MA-JG18 MA-JG19 MA-SN	C C C C C C	2 1 3 5 4 2
3.	Large Indian Civet LN: Musang Jebat	*Viviera Zibetha* (Totally Protected)	9.67%	MA-JG11 MA-JG16 MA-JG17 MA-JG18 RTA-JG20	U U U U U	1 2 1 1 1
Family: *Cercopithecidae*						
4.	Long-Tailed Macaque LN: Monyet/Kera	*Macaca Fascicularis* (Protected)	6.45%	MA-SN MA-JG08	C C	2 2
Family: *Varanidae*						
5.	Monitor Lizard LN: Biawak Air	*Varanus Salvator* (Protected)	4.83%	MA-JG11 MA-SN	C C	1 2
6.	Clouded Monitor LN: Biawak Tikus	*Varanus Bengalensis* (Totally Protected)	8.06%	MA-JG14 MA-JG16 MA-JG17 MA-SN	C C C C	1 1 2 1
Family: *Cuculidae*						
7.	Greater Coucal LN: Burung But-but Carik Anak	*Centropus Sinensis* (Totally Protected)	3.22%	MA-JG14 MA-JG15	C C	1 1
Family: *Tytonidae*						
8.	Barn Owl LN: Burung Jampok Kubur	*Tyto Alba* (Totally Protected)	9.67%	MA-JG11 MA-JG17 RTA-JG20	C C C	1 3 2
Family: *Rallidae*						
9.	White-Breasted Waterhen LN: Burung Ruak-ruak	*Amaurornis Phoenicurus* (Protected)	1.61%	MA-JG19	C	1
Family: *Phasianidae*						
10.	Red Junglefowl LN: Ayam Hutam	*Gallus Gallus* (Protected)	3.22%	MA-JG08 MA-JG18	C C	1 1
Family: *Accipitridae*						
11.	Oriental Honey Buzzard LN: Lang Lebah	*Pernis Ptilorhynchus* (Totally Protected)	3.22%	MA-JG11 MA-JG18	U U	1 1
12.	Black-winged Kite LN: Lang Sayap Hitam/Lang Tikus	*Elanus Caeruleus* *(Totally Protected)*	1.61%	MA-SN	U	1
Family: *Suidae*						
13.	Wild Boar LN: Babi Hutan	*Sus Scrofa* (Protected)	6.45%	MA-JG11 MA-JG14 MA-JG15 MA-JG16	C C C C	1 1 1 1

OPA-Oil Palm Area, RTA-Rubber Trees Area, MA-Mixed Area, UA-Urban Area
JG-Jengka Settlement, SN-Sungai Nerek Settlement
C-Common, U-Uncommon

The result was generated from on-site samplings and not extracted from the survey database. The lowest incidence was 1.61% *Amaurornis Phoenicurus* while the highest was 27.41% *Paradoxurus Hermaphorditus*.

The roadkill hotspots identified in Table 2 were observed by location and settlement. The high number of roadkill was recorded at MA-JG16, MA-JG17, MA-JG18 and MA-SN followed by the second lower of roadkill at MA-JG08, MA-JG11, MA-JG14 and MA-JG19. Meanwhile, the lowest number was recorded at MA-JG15 and RTA-JG20.

Table 2: Roadkill hotspots by location

Location	Species	N	Total, N
MA-JG08	Common Palm Civet (*Paradoxurus Hermaphroditus)* Long-tailed Macaque (*Macaca Fascicularis*) Red Junglefowl (*Gallus Gallus*)	2 2 1	5
MA-JG11	Common Palm Civet (*Paradoxurus Hermaphroditus)* Large Indian Civet (*Viviera Zibetha*) Monitor Lizard (*Varanus Salvator*) Barn Owl (*Tyto Alba*) Oriental Honey Buzzard *(Pernis Ptilorhynchus)* Wild Boar (*Sus Scrofa*)	1 1 1 1 1 1	6
MA-JG14	Leopard Cat (*Prionailurus Bengalensis*) Clouded Monitor (*Varanus Bengalensis*) Greater Coucal (*Centropus Sinensis*) Wild Boar (*Sus Scrofa*)	2 1 1 1	5
MA-JG15	Greater Coucal (*Centropus Sinensis*) Wild Boar (*Sus Scrofa*)	1 1	2
MA-JG16	Leopard Cat (*Prionailurus Bengalensis*) Large Indian Civet (*Viviera Zibetha*) Clouded Monitor (*Varanus Bengalensis*) Wild Boar (*Sus Scrofa*)	4 2 1 1	8
MA-JG17	Common Palm Civet (*Paradoxurus Hermaphroditus)* Large Indian Civet (*Viviera Zibetha*) Clouded Monitor (*Varanus Bengalensis*) Barn Owl (*Tyto Alba*)	3 1 2 3	9
MA-JG18	Leopard Cat (*Prionailurus Bengalensis*) Common Palm Civet (*Paradoxurus Hermaphroditus)* Large Indian Civet (*Viviera Zibetha*) Red Junglefowl (*Gallus Gallus*) Oriental Honey Buzzard *(Pernis Ptilorhynchus)*	1 5 1 1 1	9
MA-JG19	Leopard Cat (*Prionailurus Bengalensis*) Common Palm Civet (*Paradoxurus Hermaphroditus)* White-Breasted Waterhen (*Amaurornis Phoenicurus*)	1 4 1	6
RTA-JG20	Large Indian Civet (*Viviera Zibetha*) Barn Owl (*Tyto Alba*)	1 2	3
MA-SN	Leopard Cat (*Prionailurus Bengalensis*) Common Palm Civet (*Paradoxurus Hermaphroditus)* Long-tailed Macaque (*Macaca Fascicularis*) Monitor Lizard (*Varanus Salvator*) Clouded Monitor (*Varanus Bengalensis*) Black-winged Kite (*Elanus Caeruleus)*	1 2 2 2 1 1	9

Incidence by family in WJ (2017-2019) with number (N) and incidence (I) is shown in Table 3 and Figure 3. The incidence by species determined was between 1 and 17. To classify this number as high, moderate or low, this incidence was categorised as 10 and more than 10 as higher, between six to nine as moderate, five and below as lower.

Table 3: Incidence by family

Family	Common Name	Scientific Name	N	Incidence (H/M/L)
Felidae	Leopard Cat	*Prionailurus Bengalensis*	9	M
Viverridae	Common Palm Civet	*Paradoxurus Hermaphroditus*	17	H
	Large Indian Civet	*Viviera Zibetha*	6	M
Cercopithecidae	Long-Tailed Macaque	*Macaca Fascicularis*	4	L
Varanidae	Monitor Lizard	*Varanus Salvator*	3	L
	Clouded Monitor	*Varanus Bengalensis*	5	L
Cuculidae	Greater Coucal	*Centropus Sinensis*	2	L
Tytonidae	Barn Owl	*Tyto Alba*	6	M
Rallidae	White-Breasted Waterhen	*Amaurornis Phoenicurus*	1	L
Phasianidae	Red Junglefowl	*Gallus Gallus*	2	L
Accipitridae	Oriental Honey Buzzard	*Pernis Ptilorhynchus*	2	L
	Black-winged Kite	*Elanus Caeruleus*	1	L
Suidae	Wild Boar	*Sus Scrofa*	4	L

H-High, M-Moderate, L-Low

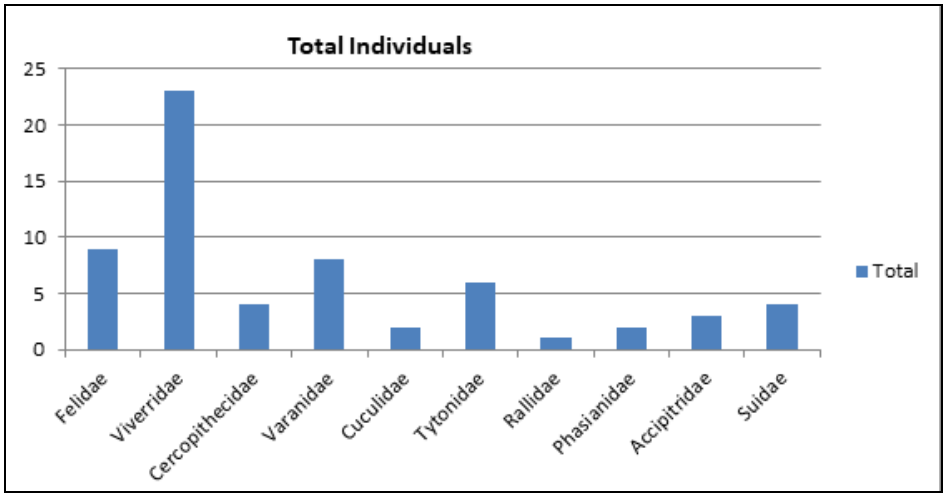

Fig 3: Commonly found dead fauna by family.

4. Discussion

The initial cause of dead wildlife is roadkill (Colino-Rabanal *et al*., 2011) and research in the collisions phenomenon was too little (Fudge *et al*., 2008) [14]. There is a probability that some of the dead wildlife were not recorded in this survey because they moved off and were run over after the collision even if they were injured, and some others were removed by the scavengers and weather. Normally human development affects the ecology system, especially in the road construction networks, which is unprecedented because it leads to increased human invasions into the wildlife habitats and development (Lin, 2016) [19]. Therefore, the common impacts to ecosystems include destruction of wildlife habitat, disturbance to animal, roadkills, and barrier effects (Seiler, 2001) [27]. According to Kioko *et al*. (2015) [17, 18], less roadkill happened in agricultural and urban areas, which consisted of unprotected areas and townships. While Jakobsson *et al*. (2015) [16] stated that most collisions and crashes happened in rural areas on straights road, clear weather, during dawn, dusk and night, paved roadways adjacent to the plantation area, especially in mixed areas, recorded a high number of occurrences. To protect the occurance from being happened, mitigation efforts such as underpasses, overpasses and fences are recommended as it were able to reduce the mortality (Teixiera *et al*., 2017) [32].

Although the WVC in WJ, Malaysia does not contribute too much to casualties and injuries to humans as compared to other countries (Al Shimemeri, 2012) [2], insurance companies need to be aware of this matter. They can take part in preventing the wildlife species from WVC because insurance claims, injury claims and repairing costs due to collision and damage to the wildlife species can be reduced. This is because the claims were reported as steadily rising yearly (Rowden, 2008) [25]. Normally, small species were involved in the roadkill because of their size and which caused motorists to be unaware of their presence and the crossing. Most vehicles intentionally hit the smaller species which caused them less damage, while the big species are more visible, and thus the drivers will actively prevent collisions (Kioko *et al*., 2015) [17, 18]. Previous studies found that the bird roadkill from various countries was recorded as high (Vidal-Valles *et al*., 2018) [34]. In the future, worries should emphasise that the rise in wildlife death is associated with collisions between vehicle and wildlife (WVC).

The vegetative distance which physically covers the roadway contributes to the mortality of wildlife species. In this study, many cases found carcasses at locations which contain a heavy vegetative cover on the left and right sides of the roadway. Several species can be survived with the new habitats due to possible reasons, such as barn owls and oriental honey buzzards which can live as the palm oil plantation provides a variety of small species that can be consumed as food such as rats, snakes, small birds and other small mammals. Roadway provides a clear view to the barn owls while hunting for their prey. Therefore, the tendency for them to be involved in WVC cannot be rejected, where barn owls recorded a high mortality due to roadkill (Loss *et al*., 2014) [20]. Meanwhile, monitor lizards can survive because their habitat did not change drastically, such as the river and the river life. Other reasons for the wildlife survival in the WJ area are proximity to vegetation, water, wetland, open landscapes, road and weather conditions.

The authorised parties are recommended to build wildlife passages, underpass culverts/tunnel, wildlife warning reflectors or wildlife crossing, fencing, wire crossing for primate, cavernous drainage, and this should be built in the beginning of the roadway construction plan. Wildlife volunteers in the selected area is another recommendation in order to create the first responder due to WVC. Even though building the wildlife passage on already built roadway is too expensive (Morelle *et al*., 2013) [22] and there is no relation between WVC with the wildlife warning reflectors and traffic volume (Benten *et al*., 2018) [3], at least the drivers will be alert and more cautious when driving at night, and thus able to minimise the collisions between wildlife and vehicle. Fencing also has disadvantages because it may isolate the wildlife (Seiler, 2005) [36], but it must be built based on the suitability study. Some countries install wildlife crossing structures, which are very effective in reducing roadkill occurrences (Seok & Lee, 2015) [30]. According to Colino-Rabanal *et al*. (2010) and Collinson *et al*. (2017) [7], building roadside fencing and underpass culverts can reduce roadkill. While Christie *et al*. (2003) [10] revealed the factors that contribute to the collisions are breeding activities, animal dispersal, seasonal migration, population, habitat utilisation, feeding habits and animal characteristics such as colouring.

The authorized parties in relation with transportation can also amend or introduce a new syllabus in the driving license classes to educate people with regard to WVC for safe driving because the major concern is definitely the collision with

wildlife and other animals. Other than wildlife, traffic safety and travellers are also threatened by WVCs (Markolt *et al*., 2012) [21]. While insurance companies have to consider and be involved in the conservation and preservation effort to ensure that the wildlife are living in their habitats and therefore the could minimize the collisions accordingly. This can minimise WVC and at the same time reduce accidental claims due to WVC; hence, reducing the accidental costs of the insurance companies. According to Abu Bakar (2019) [1], between 2012 and 2017 a total of 2,444 out of 36 species wildlife were killed in WVC in Peninsular Malaysia. This is a very important fact as other countries have shown that roadkill can reduce the wildlife population (Ozcan *et al*., 2017) [23]. The effort and action towards mitigation are very much important as WJ is like a husbandry for the wildlife. Furthermore, not only fatal WVC contribute to the wildlife decline, but according to De-Carvalho *et al*. (2014) [9] other factors, such as hunting and the pet trade, also cause the populations to decline.

Based on the data collected it is assumed that the number of WVC is still moderate as compared to other developed countries. The high number of WVC that occurred in developed countries as compared to the developing countries is probably because of in developed countries the conservation and preservation efforts are very strong and get full support from the government and public. Moreover, the public awareness is also very high. Even with the full support from the government and public, the number and size of urban area is still increasing from time to time, which has put and forced the wildlife habitat to stay and live with the residential areas which need to face with the roadway network. This situation contributes to the high number of WVC. In addition, the wildlife roadkill generally affects the tourism business. In gazetting the tourism places, especially for bio-diversity tourism, tourism operators and parties who are responsible in tourism will heavily depend on the wildlife density and populations and variety of flora to ensure that the tourism area is attractive for tourists.

5. Acknowledgement

The public and resident who lived in WJ were highly appreciated thank to for providing information with regard to the roadkill and government agencies for their support in the survey.

6. References

1. Abu Bakar MAL. Sikap pemandu dan kadar kematian hidupan liar di musim perayaan. Astro Awani. 2019; http://www.astroawani.com/berita-malaysia/sikap-pemandu-dan-kadar-kematian-hidupan-liar-di-musim-perayaan-209371.
2. Al Shimemeri A, Arabi Y. A review of large animal vehicle accidents with special focus on Arabian camels. Journal of Emergency Medicine Trauma & Acute Care. 2012;21:1-7.
3. Benten A, Hothorn T, Vor T, Ammer C. Wildlife warning reflectors do not mitigate wildlife-vehicle collisions on roads. Accident Analysis and Prevention. 2018;120:64-73.
4. Brockie RE, Sadleir RMFS, Linklater WL. Long-term wildlife roadkill counts in New Zealand. New Zealand Journal of Zoology. 2009;36(2):123-134.
5. Coffin AW. From roadkill to road ecology: A review of the ecological effects of roads. Journal of Transport Geography. 2007;15:396-406.
6. Colino-Rabanal VJ, Lizana M, Peris S. Factors influencing wolf *canis lupus* roadkills in Northwest Spain. European Journal of Wildlife Rescue. 2011;57:399-409.
7. Collinson WJ, Davies-Mostert HT, Davies-Mostert W. Effects of culverts and roadside fencing on the rate of roadkill of small terrestrial vertebrates in northern Limpopo, South Africa. Conservation Evidence. 2017;14: 39-43.
8. Caro TM, Shargel JA, Stoner CJ. Frequency of Medium-Sized Mammal Road Kills in an Agricultural landscape in California. The American Midland Naturalist. 2000;144:362-369.
9. De Carvalho, Bordignon MO, Shapiro JT. Fast and furious: a look at the death of animals on the highway MS-080, Southwestern Brazil. Iheringia, Série Zoologia, Porto Alegre. 2014;104(1):43-49.
10. Christie JS, Nason S. Analysis of vehicle collisions with moose and deer on New Brunswick arterial highways. 31st Annual conference of the Canadian Society for Civil Engineering, Moncton, New Brunswick, June 4-7. University of New Brunswick, Canada. 2003, 1-11.
11. Cortes FE, Steury TD. Factors that influence the risk of carnivore road mortality in Central Alabama. Journal of the Southeastern of Fish and Wildlife Agencies. 2016;3:190-194.
12. Fahrig M, Rytwinski T. Effects of roads on animal abundance: an empirical review and synthesis. Ecology and Society. 2009;14(1):21-41.
13. Forman TTT, Alexander LE. Roads and their major ecological effects. Annual Review of Ecology and Systematics. 1998;29:207-231.
14. Fudge D, Freedman B, Crowell M, Nette T, Power V. Road-kill of mammals in Nova Scotia. The Canadian Field-Naturalist. 2008;121:265-273.
15. Ibisch PL *et al*. A global map of roadless areas and their conservation status. Science. 2016;354:1423-1427.
16. Jakobsson L, Lindman M, Carlsson H, Axelson A, Kling A. Large animal crashes: the significance and challenges. IRCOBI Conference. 2015, 302-314.
17. Kioko J, Kiffne C, Phillips Patterson-Abrolat C, Collinson W, Katers S. Driver knowledge and attitudes on animal vehicle collisions in Northern Tanzania. Tropical Conservation Science. 2015;8(2):352-366.
18. Kioko J, Kiffner C, Jenkins N, Collinson WJ. Wildlife roadkill patterns on a major highway in northern Tanzania. African Zoology. 2015;50(1):1-6.
19. Lin SC. Landscape and traffic factors affecting animal road mortality. Journal of Environmental Engineering and Landscape Management. 2016;24(1):10-20.
20. Loss SR, Will T, Marra PP. Estimation of bird-vehivle collisions mortality on U.S. roads. The Journal of Wildlife Management. 2014;78(5):763-771.
21. Markolt F, Szemethy L, Lehoczki R, Heltai M. Spatial and temporal evaluation of wildlife vehicle collisions along the M3 highway in Hungray. North-Western Journal of Zoology. 2012;8(2):414-425.
22. Morelle K, Lehaire F, Lejeune P. Spatio-temporal patterns of wildlife –vehicle collisions in a region with a high-density road network. Nature Conservation. 2013;5:53-73.

23. Ozcan AU, Ozkazanc NK. Identifying the hotspots of wildlife-vehicle collision on the Cankiri-Kirikkale highway during summer. Turkish Journal of Zoology. 2017;41:722-730.
24. Pandey SK. Loss of wild species in road side accident: An alarming issues in India. Environmental Science An Indian Journal. 2016;12(6):224-226.
25. Rowden P, Steinhardt D, Sheehan M. Road crashes involving animals in Australia. Accident Analysis and Prevention. 2008;40(6):1865-1871.
26. Schwartz ALW, Williams HF, Chadwick E, Thomas RJ, Perkins EE. Roadkill scavenging behaviour in an urban environment. Journal of Urban Ecology. 2018;4(1):1-7.
27. Seiler A. Ecological effects of roads, a review. Riddarhytan: University of Agriculture Sciences. 2001.
28. Reshma Krishnan, Thasniya Mohammed, Gopika S Kumar and Arunima SH. Honey crystallization: Mechanism, evaluation and application. The Pharma Innovation Journal. 2021;10(5S):222-231. DOI: 10.22271/tpi.2021.v10.i5Sd.6213
29. Seiler A, Helldin JO. Mortality in wildlife due to transportation. In John Davenport and Julia L. Davenport (Eds). The Ecology of Transportation: Managing Mobility for the Environment. Springer. Swedish university of Agricultural Sciences, Dept. of Conservation Biology, Grimso Wildlife Research Station, Sweden. 2006, 165-189.
30. Seok S, Lee J. Analyze the impact of habitat patches on wildlife roadkill. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Aciences. 2015;10(2):29-31.
31. Tejera G, Rodriguez B, Armas C, Rodriguez A. Wildlife-vehicle collisions in Lanzarote Biosphere Reserve, Canary Islands. PLoS ONE. 2018;13(3):1-15.
32. Teixeira FZ, Kindel A, Hartz SM, Mitchell S, Fahrig L. When road-kill hotspots do not indicate the best sites for road-kill mitigation. Journal of Applied Ecology. 2017;54:1544-1551.
33. Roadkill incidents take toll on wildlife. The Star Online. https://www.thestar.com.my. 22 November, 2017.
34. Vidal-Valles D, Rodriguez A, Perez-Collazos E. Bird roadkill occurences in Aragon, Spain. Animal Biodiversity and Conservation. 2018;41(2):379-388.
35. Zhang W, Shu G, Li Y, Xiong S, Liang C, Li C. Daytime driving decreases amphibian roadkill. Peer J. 2018;6:e5385:1-18.
36. Seiler A. Predicting locations of moose-vehicle collisions in Sweden. Journal of Applied Ecology. 2005;42:371-382.