Original Article	*Curr. Appl. Sci.*, **2024**, *2*(2):109-118 DOI:10.22034/cas.2024.432100.1033	Current Applied Sciences

Diversity, Seasonality, and Distribution Patterns of Mammalian Roadkill in Ilam Province, West of Iran

Hamid Darvishnia

Department of Biology, Payame Noor University (PNU), Tehran, Iran

Corresponding author's e-mail: *darvishnia_h@pnu.ac.ir*

Article Information

Received: 24 December 2023
Revised: 30 January 2024
Accepted: 01 February 2024
Published online: 7 November 2024

Keywords

Mammals
Wildlife
Road mortality
Species distribution
Decline.

Abstract

The destruction and disintegration of wildlife habitats are primarily caused by roads, and wildlife-vehicle collisions, are triggered by the close interaction between humans and wildlife habitats around the globe. This study examines all identifiable road collisions of animals in Ilam Province from 2017 to 2022, with the aim of examining variety, seasonality, and the pattern of mammalian roadkill. A total of 317 mammals belonging to 13 species were killed in collisions with vehicles. The highest total number of roadkills was recorded for dogs, jackals, and foxes, which collectively accounted for more than 73% of all recorded accidents. The road mortality rate of mammals at 5 km, the entrance and exit of residential areas, was higher than in other areas. The incidence of road accidents during the cold seasons was slightly higher than during the warm seasons, and this disparity in the average road casualties between seasons may be attributed to the dearth of food resources, the type of diet, and the extent of its availability. The roadkill of wildlife can alter the demographic characteristics of the species, diminish genetic variety, and pose a threat to the survival and longevity of populations. Information regarding the type and quantity of road-killed animals can be utilized in cases such as obtaining information on species distribution and conducting short and long-term surveys of population trends. Also, identifying the environmental factors that influence the frequency and pattern of accidents, particularly those of endangered species, can aid in the implementation of appropriate strategies to mitigate road casualties.

1. Introduction

Over the past century, a multitude of alterations resulting from human-caused events have resulted in the degrading, diminution, or disappearance of biodiversity throughout the globe. The development of human societies

is greatly impacted by roads, which are one of the most important man-made phenomena [1]. Road network expansion is a serious, comprehensive human need for development, and on the other hand, it is a serious threat to the population of the species that live on the sides of the roads [2]. Vehicles colliding with various animal species is recognized as a major conflict between humans and wildlife. The increase in road congestion and intercity trips, as well as the collision of animals with vehicles, is considered a big challenge for those responsible for protecting animals. [3]. The environment can be affected by roads due to their ability to remove habitat, create ecotones, and act as corridors for certain animals, resulting in noise pollution, increasing road deaths through vehicle accidents, and creating barriers to movement, thereby limiting or interrupting gene flow between populations. Although roads possess advantages such as the maintenance of vegetation and the transportation of seeds, roads often impact the quality and quantity of wildlife habitats by fragmenting them, impacting the integrity of the landscape, and transforming internal habitats into marginal habitats [4]. This process can lead to the fragmentation of large populations and the isolation of small populations, which can lead to further extinctions. Due to the uncontrollable growth of roads, it's not surprising that there will be an increase in collisions between wildlife and vehicles [5]. The road mortality of various animal groups has been the subject of numerous studies worldwide, which mainly includes large mammals such as red deer, moose deer, American black bear, lynx, leopard, and badger [6-9]. It is almost impossible to manage the protection of all roads, which is a difficult, costly, and almost impossible task. It is advised to prioritize the identification of hot spots for wildlife road accidents, identifying these points is crucial in determining the appropriate strategies to reduce road casualties [2, 10]. The research on wildlife mortality on the roads is mostly descriptive and includes the number of animals killed, age, gender, and time patterns of accidents [11]. The data on the factors that influence the distribution and density of the population living in the habitats surrounding the roads and the distribution pattern of accidents can be modeled through the geographic locations of the accidents and the factors affecting them, such as the volume of traffic, the direction of the road and the topography of the roadside [12]. Human development impact in wildlife habitats is considered as one of the destructive consequences of road accidents in our country. Reports of the amount of wildlife road accidents in recent years have been reported from Iran [13-16]. It appears that roads have many advantages in different human societies during the development process. Considering that roads play an important role in threatening or sustaining the populations of various wildlife species, it is important to prioritize planning to conserve biodiversity and protect wildlife, as well as finding ways to reduce the adverse effects of roads. Wildlife road accidents have been reported from some parts of the country, however, despite a higher abundance and diversity of wildlife species in Ilam province, there has been no study on the diversity, frequency, temporal and spatial patterns of these accidents in Ilam province so far. This study seeks to identify the types, frequencies, and hot areas of road accidents, as well as the temporal and seasonal patterns of road casualties of mammals on the main and secondary roads of Ilam province.

2. Materials and Methods

Ilam province, with an area of 20,150 km2, is the 22nd largest province in Iran. It is located between 31°58″ and 34°15″ N latitude, 45°24″ and 48°10″ E longitude. The region is bounded by the provinces of Kermanshah in the north, Khuzestan in the south, and Lorestan in the east, and the neighboring country, Iraq in the west (as shown in Figure 1).

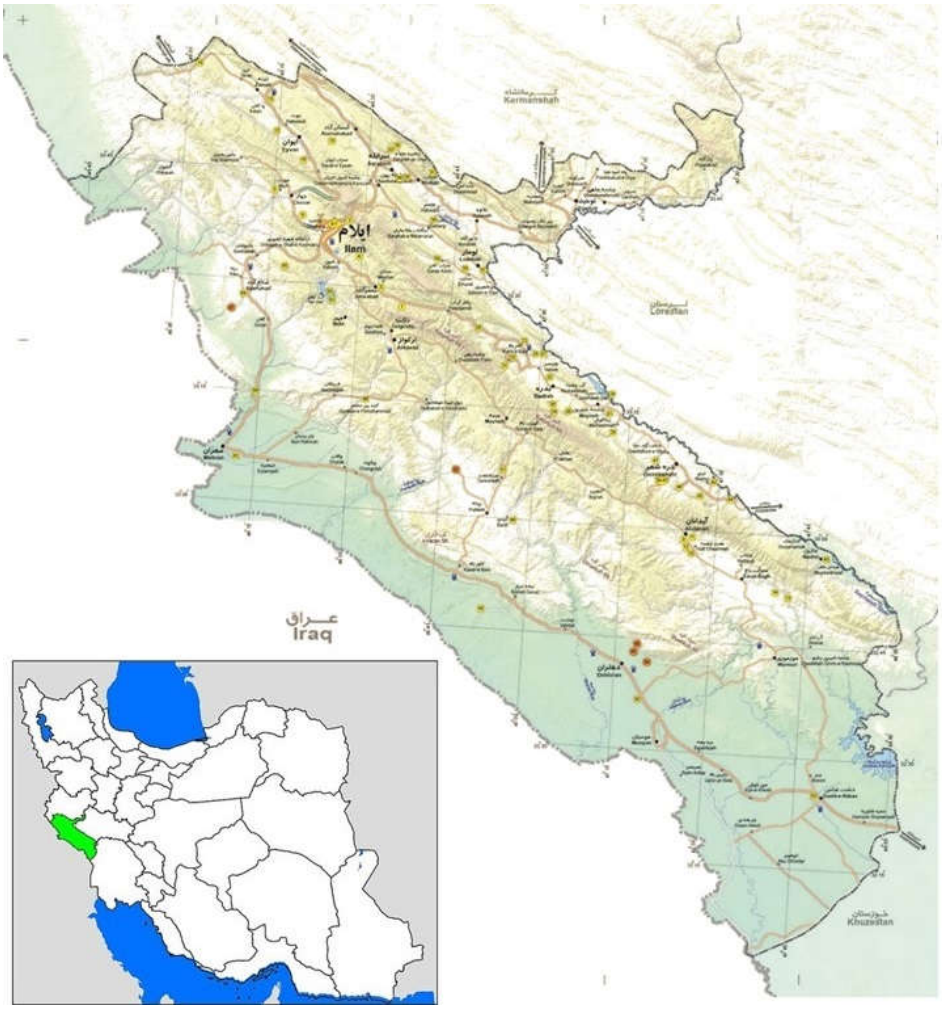

Figure 1. A: location of Ilam province in Iran, B: a detailed road map of Ilam province.

Due to its location in the Zagros mountain range, a large part of Ilam province is mountainous. Kan Saifi in Kabirkoh is the highest point of the province, at 3062 meters above sea level, and Hasan Qandi in Dehloran is the lowest point (40 m a.s.l.). The northern and northeastern parts of Ilam province are mountainous and covered in high peaks, while the western and southwest parts are covered in lowlands. This condition of the region has created numerous natural attractions in it. In this province, there are two types of climate zones: a moderate mountain climate (semi-humid) and a dry climate. The mountainous regions and the northeast have cold and wet winters and hot summers, and at very high altitudes, a cold mountain climate is observed. There are relatively mild winters and very hot and dry summers in the western and southern regions of the province [17]. Geographical location, favorable natural conditions, and the diversity of habitats in Ilam province contribute to its incredible animal diversity. Thus far, a total of 44 species of mammals belonging to the orders of insectivores, lagomorphs, rodents, carnivores, artiodactyls, and others have been reported in Ilam province. This province also has 200 species of birds, 40 species of fish, and 42 species of reptiles and amphibians. There exist four protected areas in Ilam province, namely Manesht-Qalarang area, which covers a total area of 33 thousand hectares, Kabirkoh with a total

area of 20 thousand hectares, Dinarkoh with a total area of 30 thousand hectares, and Koleg protected area, which covers a total area of 58 thousand hectares [18].

Unfortunately, in this province, like in other parts of the country, the expansion of road construction is considered to be a factor of conflict for wildlife species. This study sought to collect preliminary data on animal-vehicle collisions on main and secondary roads in Ilam province based on direct observations by the author, reports of citizens, and information from the environment department of Ilam province. During the process of photographing and recording the location information and geographical coordinates of animals killed by a vehicle, the precise time of observation (hour, day, month, season, and year), gender of animals, name of animal species, type of land, location of the accident, and other necessary information were recorded.

3. Results and Discussion

In total, 317 roadkills belonging to 13 species of mammals were recorded through opportunistic sampling methods and reported by citizens and related organizations (Table 1).

Table 1. The name of the species and the number of road-killed mammals along roads in Ilam Province from 2017 to 2022.

Scientific name	**Common name**	Number of roadkills recorded			
		Opportunistic sampling	**Report of citizens**	**Report of related organization**	**Total number**
Canis aureus	Jackal	83	6	-	89
Vulpes vulpes	Fox	28	9	-	37
Canis lupus	Wolf	3	6	2	11
Hyaena hyaena	Striped hyena	-	1	1	2
Lepus europaeue	Rabbit	2	3	-	5
Sciurus anomalus	Persian squirrel	13	4	-	17
Hystrix indica	Porcupine	1	3	-	4
Hemiechinus auritus	Hedgehog	3	2	-	5
Canis familiaris	Domestic dog	98	9	-	107
Felis silvestris	Wildcat	20	6	-	26
Meriones persicus	Persian Jird	4	1	-	5
Herpestes edwardsii	Grey mongoose	3	5	-	8
Mellivora capensis	Honey badger	-	1	-	1
Total number		258	56	3	317

The animals include the jackal (*Canis aureus* Linnaeus, 1758), common fox (*Vulpes vulpes* (Linnaeus 1758)), wolf (*Canis lupus* Linnaeus, 1758), dog (*Canis familiaris* Linnaeus, 1758), cat (*Felis silvestris* Schreber, 1777), hyena (*Hyaena hyaena* (Linnaeus, 1758)), grey mongoose (*Herpestes edwardsii* É. Geoffroy Saint-Hilaire, 1818), porcupine (*Hystrix indica* Kerr, 1792), hedgehog (*Hemiechinus auritus (*Gmelin, 1770)), Persian jird (*Meriones persicus* (Blanford 1875)), honey badger (*Mellivora capensis* (Schreber, 1776)), rabbit (*Lepus europaeue* Pallas, 1778) and Persian squirrel (*Sciurus anomalus* Gmelin, 1778). The highest number of road accidents in Ilam province was recorded by dogs, with 107 observations (33% of all recorded), jackals with 89 observations (28%) and foxes with 37 observations (12%). During this study, 258 cases were from the author's direct observation (81%), 56 cases were public reports (18%) and 3 cases (1%) were reports from environmental departments. The total number of animals that died while crossing the road consisted of 171 females, 143 males, and 3 cases that were difficult to identify due to the severity of their injuries (Figure 2).

Figure 2. The roadkill species recorded in Ilam Province. 1. *Canis lupus*; 2. *Mellivora capensis*; 3. *Herpestes edwardsii*; 4. *Vulpes vulpes*; 5. *Meriones persicus*; 6. *Sciurus anomalus*; 7. *Canis aureus*; 8. *Hystrix indica*

The exact time of the occurrence of accidents was not available due to lack of imaging facilities and constant monitoring of the road; only the time of observation was used. The observed times revealed that the highest number of animal casualties occurred between 6 and 9 am (47%), while the lowest number occurred between 2 and 6 pm (8%). The occurrence of accidents that occur at night may be responsible for the highest number of road casualties observed in the early morning. During the nighttime, when it is dark, the number of road casualties caused by jackals and foxes is consistently increasing, especially in urban and rural areas. Another possible reason for nighttime road casualties is the lack of lighting on the roads and, in some cases, the drivers not turning on the lights

of the car in the evening and at night. Furthermore, the presence of automobile lights during times of darkness can result in temporary blindness for the animal, and while stationary, the animal stares at the illumination of the vehicle lights, resulting in a collision with the animal [4].

Dog road accidents were usually observed at all hours. During the study, the majority of road casualties were attributed to the cold months of the year, specifically February and January, whereas the lowest number of road casualties was attributed to spring and summer. The average number of deaths due to accidents in winter was higher than in other seasons, but it was not significantly different among various months or seasons (Table 2). The outcomes of this investigation revealed that the majority of road fatalities for the jackal and fox species occurred within a 5-to-10-kilometer radius from the entry or exit of residential areas. With regards to the forest habitat of the squirrel, it has been observed that all road accidents involving this species have occurred on the mountain roads connecting Darreh Shahr to Ilam, and within the forest area of oak trees.

Table 2. The monthly number of road-killed mammals on the road in Ilam Province from 2017 to 2022

Scientific name	Number of roadkills recorded in each month											
	January	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Canis aureus	13	11	7	5	2	6	3	6	9	8	9	10
Vulpes vulpes	5	7	3	2	-	2	1	3	1	3	5	5
Canis lupus	2	1	-	1	1	1	-	1	3	1	-	-
Hyaena hyaena	-	1	-	1	-	-	-	-	-	-	-	-
Lepus europaeue	2	1	-	-	1	-	-	-	-	1	-	-
Sciurus anomalus	1	3	-	1	4	2	-	1	1	2	-	2
Hystrix indica	-	1	-	-	-	1	-	1	1	-	-	-
Hemiechinus auritus	1	2	-	-	-	-	1	-	-	-	1	-
Canis familiaris	11	9	7	10	8	12	6	3	10	7	12	12
Felis silvestris	2	6	-	2	2	3	1	2	3	-	3	2
Meriones persicus	0	1	-	-	1	-	-	-	1	1	-	1
Herpestes edwardsii	2	-	-	1	-	2	-	-	1	1	-	1
Mellivora capensis	-	-	-	-	-	-	1	-	-	-	-	-

In this study, it was determined that dogs, jackals, and foxes were responsible for the highest number of road deaths in the last five years. One of the significant factors influencing wildlife road casualties is the behavior of each animal and its abundance in the region [19]. Two species of jackal and fox are among the species with high abundance and wide distribution in Ilam province, according to the author's field observations and the reports of relevant organizations (Figure 3). This indicates a correlation between high losses and their abundance in the study area. The higher number of dog casualties observed in this study could be explained by their greater number and proximity to residential areas and road traffic. In the case of jackals and foxes, the diet of these animals, particularly during the cold seasons of the year when food sources in their natural environment are limited, has resulted in their proximity to human settlements. As a result of this proximity to roads, the number of road casualties during the winter season and autumn has increased. This is due to the availability of sufficient and suitable food sources in these seasons near human settlements and around roads [20].

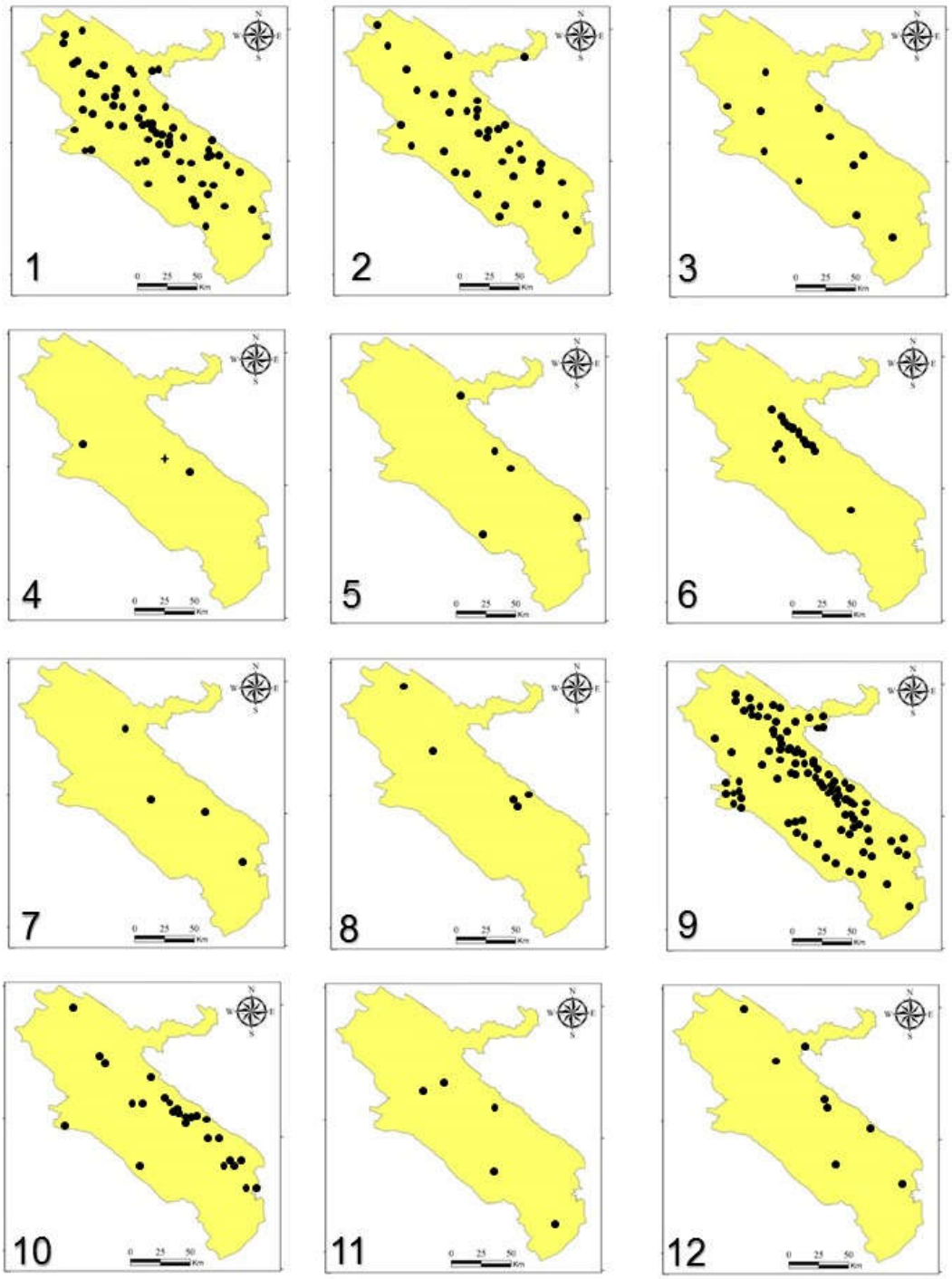

Figure 3. Maps showing localities of the recorded roadkill in Ilam Province. 1. Jackal; 2. Fox; 3. Wolf; 4. Striped hyena & honey badger; 5. Rabbit; 6. Persian squirrel; 7. Porcupine; 8. Hedgehog; 9. Domestic dog; 10. Cat; 11. Persian jird; 12. Grey mongoose.

Tourani et al. demonstrated that the highest number of road casualties observed in Portugal were attributed to the common fox species, which was attributed to the greater abundance of this species in their study area. Furthermore, the high incidence of road casualties of hyenas was attributed to hyenas' carrion-eating behavior and

the potential for them to consume road casualties' carcasses, resulting in their demise [21]. The highest number of mammal road deaths were observed on byroads with less traffic, after which the most road casualties were observed on mountain and forest roads from Darreh Shahr to Ilam. In general, the lower the traffic rate of vehicles on the road, the greater the level of confidence the animal possesses when entering the roadway. Hence, the rate of road fatalities on low-traffic roads is higher than that on high-traffic roads [22]. Their study showed that animal road losses are more related to changes in vehicle traffic rates than to population density. This is consistent with the present study.

Because road casualties can reflect population density, biodiversity data can be used to investigate long-term and short-term changes in population trends. Roads may also have a positive or negative effect on the behavior of animals. This information can be used to estimate species trends without the need to watch live animals and also to look at differences in population density in different areas. For instance, a persistent decline in the populations of porcupines in England was inferred from research conducted on the road basis of road casualty records [23].

4. Conclusions

Data on road-killed animals is needed for the assessment of the impact of roads on biodiversity. The proportion of road-killed animals that correlated with the nearby supply of wild animals allows us to track long-term shifts in criminal behavior by following road-killing incidents. Roadkill records can be utilized to fill in gaps in species distribution maps, particularly in instances where living animals are rarely observed. Although considerable data has been collected and exists about roads in the world and Iran, it is still difficult to estimate the amount of wildlife loss caused by these roads.

Conflicts of Interest

The author declares that there are no conflicts of interest regarding this article.

Acknowledgements

The author would like to express his gratitude to all those who contributed to this study.

References

1. Silva I, Crane M, Savini T. High roadkill rates in the Dong Phayayen-Khao Yai World Heritage Site: conservation implications of a rising threat to wildlife. *Anim*. *Conserv*., 2020, 23(4):466-478.
2. Ramp D, Caldwell J, Edwards KA, Warton D, Croft DB. Modelling of wildlife fatality hotspots along the snowy mountain highway in New South Wales, Australia. *Biol*. *Conserv*., 2015, 126(4):474-490.
3. Snow NP, Williams DM, Porter WF. A landscape-based approach for delineating hotspots of wildlife-vehicle collisions. *Landsc*. *Ecol*., 2014, 29(5):817-829.
4. Forman RT, Sperling D, Bissonette JA. Road ecology: Science and solutions, 2003, Washington: Island Press.
5. Litvaitis JA, Tash JP. An approach toward understanding wildlife-vehicle collisions. *Environ*. *Manage*., 2008, 42(4):688-697.

6. Seiler A, Helldin JO, Seiler C. Road mortality in Swedish mammals: results of a drivers' questionnaire. *Wildlife Biol*., 2004, 10:225-233.

7. Clevenger AP, Huijser MP. Wildlife crossing structures handbook: design and evaluation in North America, 2011, 70-100.

8. Cervinka J, Riegert J, Grill S, Salek M. Large-scale evaluation of carnivore road mortality: the effect of landscape and local scale characteristics. *Mammal Res*., 2015, 60(3):233-243.

9. Angelici FM, Rossi L. Problematic Wildlife II. 2020, Berlin: Springer International Publishing.

10. Gunson KE, Ireland D, Schueler F. A tool to prioritize high-risk road mortality locations for wetland-forest herpetofauna in southern Ontario, Canada. The North-West. *J. Zool.*, 2012, 8:409-413.

11. Clevenger AP, Chruszcz B, Gunson KE. Spatial patterns and factors influencing small vertebrate fauna road-kill aggregations. *Biol. Conserv*., 2003, 109:15-26.

12. Gunson KE, Mountrakis G, Quackenbush LJ. Spatial wildlife-vehicle collision models: A review of current work and its application to transportation mitigation projects. *J. Environ. Manage*., 2011, 92:1074-1082.

13. Hemami MR, Salyari J, Esmaeili S. Diversity and pattern of wildlife roadkills in Golestan national park. *Environ. Res*., 2017, 7(14):215-224.

14. Mahdavi A, Tabatabaei Yazdi F, Mohammadi AR, Khani A. Identifying hot spots of carnivorous road collisions prioritizing them in Khorasan Razavi province. *J. Anim. Environ*., 2022, 13(4):27-34.

15. Parchizadeh J, Adibi MA. Distribution and human-caused mortality of Persian leopards *Panthera pardus saxicolor* in Iran, based on unpublished data and Farsi gray literature. *Ecol. Evol*., 2019, 9:11972–11978.

16. Asgari M, Abdi E, Alizadeh Shabani A. Assessing road kills rate of animals in countryside (Case study: Southern ring road of Robat Karim town). *J. Anim. Environ*., 2021, 13(1):19-26.

17. Iran's Statistics Center. Statistical Yearbook of Ilam Province, 2019, Iran's Statistics Center, Tehran.

18. https://www.ilam.doe.ir/

19. Barthelmess E, Brooks M. The influence of body size and diet on road-kill trends in mammals. *Biodivers. Conserve*., 2010, 19:1611-1629.

20. Mohammadi A, Almasieh K, Clevenger AP, Fatemizadeh F, Rezaei A. Road expansion: A challenge to conservation of mammals, with particular emphasis on the endangered Asiatic cheetah in Iran. *J. Nat. Conserv*., 2018, 43:8-18.

21. Tourani M, Moqanaki EM, Kiabi BH. Vulnerability of Striped Hyaenas, *Hyaena hyaena*, in a human-dominated landscape of Central Iran. *Zool. Middle East*, 2012, 56(1):133-136.

22. Bright PW, Balmforth Z, Macpherson JL. The effect of changes in traffic flow on mammal road kill counts. *Appl. Ecol. Environ. Res*., 2014, 13(1):171-179.

23. Pettett CE, Johnson PJ, Moorhouse TP, Macdonald DW. National predictors of hedgehog Erinaceus europaeus distribution and decline in Britain. *Mamm*. *Rev*., 2018, 48(1):1-6.

How to cite this article: Darvishnia H. Diversity, Seasonality and Distribution Patterns of Mammalian Roadkill in Ilam Province, West of Iran. *Curr. Appl. Sci.*, 2024, 2(2):109-118. https://doi.org/10.22034/cas.2024.432100.1033