

original article

Relationship between road vehicle traffic and noise pollution of Khojir National Park in the viewpoint of feasibility of fencing and soundproofing

Minoo Moshtaghie, Mohammad Kaboli¹, Pedram Malekpouri²

Department of Environmental Science, Graduate School of the Environment and Energy, Science and Research Branch, Islamic Azad University, Tehran, Iran, ¹Department of Environment, Faculty of Natural Resources, University of Tehran, Karaj, Iran, ²Young Researchers Club, Science and Research Branch, Islamic Azad University, Tehran, Iran

Address for correspondence:

Eng. Minoo Moshtaghie,
Department of Environmental Science,
Graduate School of the Environment and Energy,
Science and Research Branch, Islamic Azad
University, Tehran, Iran.
E-mail: m_moshtaghie@yahoo.com

ABSTRACT

Aims: The main aim of this study was to investigate the relationship between the amount of noise pollution and traffic rates in Khojir National park and regarding that finding a suitable distance for installing fencing according to the standard level of noise pollution.

Materials and Methods: Eight stations located exactly above channels have been selected. In each station, three different substations including near the road, 25, and 50 m from the road were chosen. For determining the essentiality of soundproof installation, noise levels were measured at the opening and in the middle of the channel. Traffic rates have been measured daily from 6 AM to 6 PM for two continuous weeks and noise levels were then determined in three different days according to the traffic peak.

Results: Results obtained showed a significant relationship between traffic rates and noise levels in near-road stations (R^2 linear = 0.341). The relationship between interval and noise level was also significant (R^2 quadratic = 0.701, $P < 0.05$). Furthermore, a distance with 55 dB (A) (i.e., 50 m in this study) was achieved as a proper site for fencing.

Conclusion: Although the amount of noise levels in the middle of channels were less than the standard level, this amount in some channel throats were higher and need to be considered for soundproof installation as well. In addition to finding an area for fencing, using solution(s) for reducing either noise pollution or its impact at this area should be taken into consideration.

Key words: Fencing, Khojir national park, noise pollution, soundproof, traffic rate

INTRODUCTION

Due to the increase in the number of vehicles and traffic volumes in developing countries, the constructions of highways and roads have been broadly expanded during the past decades. Although the constructions of roads are very complex and also necessary for transportation, they are highly contentious from the environmental point of view. It should be considered as a major noise pollution-making source in all countries. These create some issues like noise

Access this article online	
Quick Response Code: 	Website: www.ijehe.org
	DOI: 10.4103/2277-9183.105357

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This article may be cited as:

Moshtaghie M, Kaboli M, Malekpouri P. Relationship between road vehicle traffic and noise pollution of Khojir National Park in the viewpoint of feasibility of fencing and soundproofing. *Int J Env Health Eng* 2012;1:51.

and air pollutions that are not suitable for wildlife as well as humans.^[1,2] It has well evidenced that the majority of noises, which are produced by vehicle transportations, may in turn produce a variety of adverse health effects on animals.^[3,4] Noise pollution appears to be completely the greatest causes of indoor traffic-related annoyance^[5] and is very dangerous due to the production of some unsuitable conditions for all animals and particularly humans.^[6] Therefore, it needs to be addressed more and more.^[7] Precise investigation should be done to elucidate the mechanism and side effect of noise pollution on the physiological condition of animals. In this regard, it has been reported that noise pollution may have effects on heart function,^[8-10] production of stress,^[11] and elevation of blood pressure.^[8]

The direct effects of traffic noise on Willow Warblers (*Phylloscopustrochilus*) have also been reported previously. Furthermore, it was found that the traffic noise may lead to male separation from their same group.^[12] It should be noted that the impact of traffic noise pollutions on mammals have not been investigated as closely as in birds. Few reports have suggested that various mammals avoid being near the roads and in some cases, their dispersion by high amount of noise has been reported.^[13]

The effects of noise pollution on wildlife may be even more significant than on domestic species. Greater behavioral and physiological responses to noises have been reviewed and studied with special emphasis on noise produced by vehicles and also road-building activities.^[14] Another research belongs to a highway near Boston in USA where the traffic density within 34,000 and 50,000 vehicles/day has been reported. In this effect, when the traffic rate was low, some species (moos) came near the highway as close as 100 m distance whereas with increasing traffic rate, species refused to come near the road up to 1 km.^[15] Other investigation also shows the verification of the harmful effects of road traffics and noise pollution from vehicles on species.^[16]

Whilst the standard level of noise for wildlife is dependent on several parameters including the seasons, the kind of species, and the geographic situation, it is preferred that the noise level does not exceed from 55 dB (A).^[17] Equivalent continuous sound level is responded in a logarithmic manner and sound levels are measured on a logarithmic decibel scale (dB (A)).^[7] Noise levels are often weighted. One commonly used is the A-weighting network that assigns weights to noise based on audibility to human hearing (dB (A)). Leq in 30 min (noise equal level) was used in this study because the least error has been detected during the measurement of equivalent sound level.^[7]

Up to our knowledge, no comprehensive investigation has been reported for wildlife management based on the effect of noise pollution related to vehicle traffic on wildlife in Iran. Therefore, the major aim of this project was to find out a safe region which has been not surrounded by traffic noise

in order to fencing in Khojir National Park. Providing some ways for diminishing the likely effects of traffic in the sensitive ecological area was another aim of this project. Previously, Forman indicated that species avoided passing wildlife crossing with extra noise levels^[15] and therefore wildlife species use the water channels for passing through the road in Khojir National Park. In this regard, noise determination levels in channels have been considered as another object of this study.

MATERIALS AND METHODS

Castel 450 (England) has been used for noise level measurements. A GPS (Global Position System) set (60 csx model) was also used for detecting geographical points of each station.

This study was carried out during late 2009 in the eastern part of Tehran, in Khojir National Park. This park, with an area of 11,570 ha, was a protected hunting site since 1944 when Tehran had been introduced as the capital city of Iran. This park is under protection of the Department of Environment at present and its geographic coordinates are 56°9'7"-56°8'0" east longitude and 39°38'-39°44" north latitude [Figure 1].

For determination of day(s) with the higher noise pollution (peak days), the traffic rates have been measured daily during the week (two continuous weeks). The traffic rate was measured by direct observation of 12 continuous hours (6 AM-6 PM). Traffic vehicles were then divided into three different classes including trucks, cars, and motorcycles. Following determination of traffic rate, with regard to their highest weekday's traffic (3 days with maximum traffic), eight stations were then established for noise measurements. All stations were located exactly above the channels, and previously had been built for water drainages and likely used by the animals for moving to the other side of the road (i.e., riverine area). For each station, three separate distances,

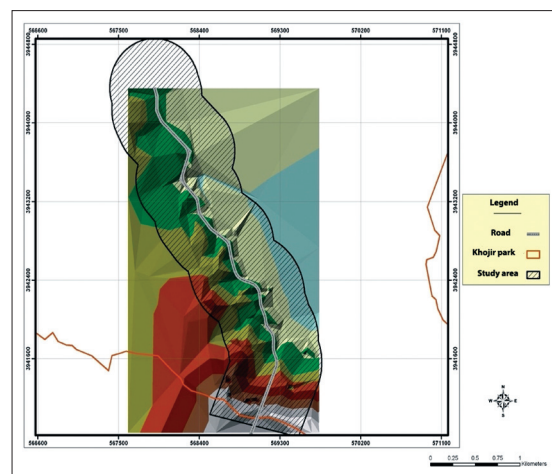


Figure 1: Study area and localization of investigation sites. The geographic characteristic of road has been shown in Khojir National Park

which were near the road, 25, and 50 m from the road have been selected. Noise levels were also measured in channels throat and in the middle of each channel. The determination of noise levels in all measured points (totally 40 points) have been performed on the same day due to climate fluctuations which do not impact noise levels.^[13] Leq 30 min has been spotted for noise determinations for three different times (three replications) in each station. Each replication was at the same duration and carried out in the morning.

The SPSS software (version 18) was employed for data analysis. All data related to Leq were reported as mean ± standard deviation (SD). One-way ANOVA and the complementary Duncan test were used. Regression analysis was also performed for understanding the relationships between noise levels and traffic rates and also the relationship between noise levels and distances. The level of significance in all analyses was less than 0.05 ($P < 0.05$).

RESULTS

The first series of data are related to the traffic rate in Khojir National Park. To do this, most traffic rates have been determined as described in the Methods section. Monday, Wednesday, and Saturday were among the highest measured traffic rate days [Figure 2]. Therefore, the Leq30 has been measured during these days. Table 1 depicts the location of all stations measured using GPS [Table 1].

The determination of a probable relationship between the noise level and traffic rate resulted in a significant linear

relationship between these two mentioned parameters ($P < 0.05$, $R^2 = 0.341$). As can be seen from Figure 3, increasing traffic rate led to a rise in the noise level.

In addition, the amount of noise has also been measured in several distances (i.e., near the road, 25, and 50 m off the road). A significant lessening pattern was detected by comparing noise levels in each interval [Figure 4]. There is an inverse quadratic proportion between Leq30 and distances ($P < 0.05$, R^2 quadratic = 0.701).

The obtained results indicate that the maximum Leq30 has been measured approximately 71 dB (A) among all near-road stations. The lowest Leq30 has been determined to be 48.9 dB (A), which is achieved in a substation of 50 m distance. However, the maximum and minimum amount of noise were measured near the road and at 50 m substations, respectively. Furthermore, the standard level for Leq30 in Khojir National Park was 55 dB (A). This is due to the appearance of governmental passing services and it is conflicting with wildlife habitat.^[17] It has also been found that a distance of approximately 50 m from the road in all stations might be a suitable interval for fencing because this point has a standard level of noise for wildlife [Figure 5]. Data presented in Figure 5 also shows significant differences between all distances of stations 3, 4, 7, and 8 ($P < 0.05$). Although, Leq30 has a downward trend in all stations, any significant difference was not observed in other stations like station number 6.

In the case of channel noise measurement, related results showed that the amount of Leq30 is roughly comparable to the standard level, indicating that approximately 75% of channel's throat pollution was lower than 55 dB (A). On the other hand, from the measurement of Leq30 in the middle of each channel, it is clearly obvious that the noise level was

Table 1: Geographical positions of each station indicated for both near-road and throat points

Stations	Geographic position	Near the road	Channel throat
Station 1	ALTITUDE (m)	1340	1334
	LONGITUDE (° ° ' ")	0567964	0564959
	LATITUDE(° ° ' ")	3944131	3944127
Station 2	ALTITUDE	1308	1305
	LONGITUDE	0568458	0568454
	LATITUDE	3943288	3943287
Station 3	ALTITUDE	1308	1300
	LONGITUDE	0568646	0568645
	LATITUDE	3942919	3942918
Station 4	ALTITUDE	1303	1301
	LONGITUDE	0568743	0568743
	LATITUDE	3942803	3942805
Station 5	ALTITUDE	1303	1299
	LONGITUDE	0568913	0568915
	LATITUDE	3942460	3942460
Station 6	ALTITUDE	1296	1290
	LONGITUDE	0569297	0569293
	LATITUDE	3941941	3941939
Station 7	ALTITUDE	1291	1289
	LONGITUDE	0569459	0569456
	LATITUDE	3941755	3941759
Station 8	ALTITUDE	1290	1287
	LONGITUDE	05695371	05695367
	LATITUDE	3941672	3941670

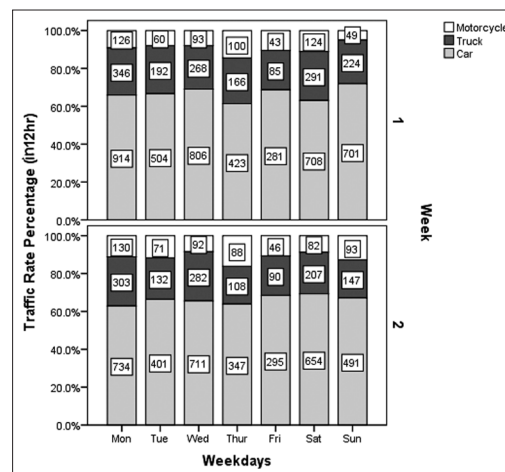


Figure 2: Measurement of vehicles traffic rates in Khojir National Park. The vehicle rate has been measured during all weekdays. The percentage and also total observed number of each vehicle were also expressed by different colors

significantly lower than in the near-road points. The level of noise in the middle of channels was lower than 55 dB (A), which is observed in all stations [Figure 6]. It is apparent from Figure 5 that the amount of noise at the opening of channels is not elevated from the standard level except for station numbers 6 and 8.

DISCUSSION

However, most traffic rates have been observed on Monday, Wednesday, and Saturday, respectively, of which 60% was related to cars passing on all days. The other two cases were related to the truck and motorcycle which have less share in

comparison to cars [Figure 2]. Data of this project indicate that with the increase in the rate of vehicle traffic, the noise equal level is also increased which consequently lead to reducing wildlife from near-road places. The effect of traffic and noise pollution on ecological bird life was reported by Reijnen *et al.* [18] Elevation in traffic noise and escaping of nocturnal birds (Stone curlews) from near the road of approximately 3 km were also reported by Green *et al.* [19] Our findings also show that there is a reverse relationship between the noise equal level and distance ($P < 0.05$), which is naturally due to distance attenuation.

The maximum noise equal levels are related to near-road stations and the minimum level is related to the substation with 50 m distance from the near road. It should be noted that the existence of traffic in Khojir National Park is nearly

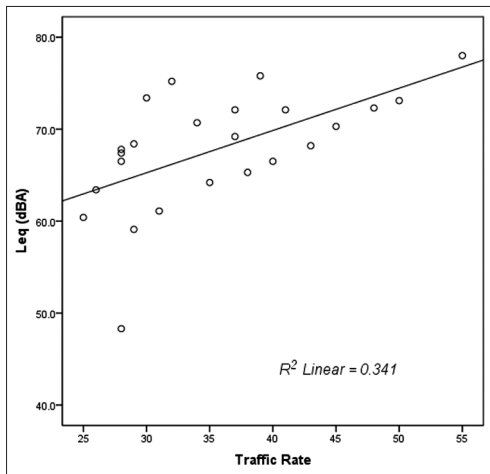


Figure 3: Relationship between traffic rate and Leq30 in near-road points. R^2 for linear regression has been presented. Noise and traffic rate have been measured contemporarily

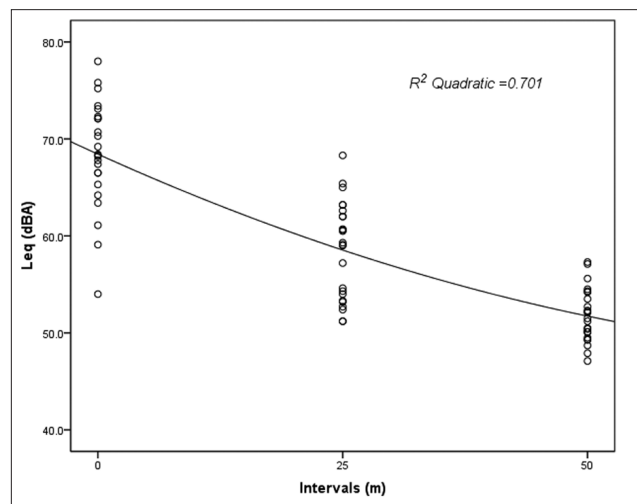


Figure 4: Inverse proportion between distances and Leq30. The amount of R^2 was determined at $P < 0.05$. The total observations were included 24 points

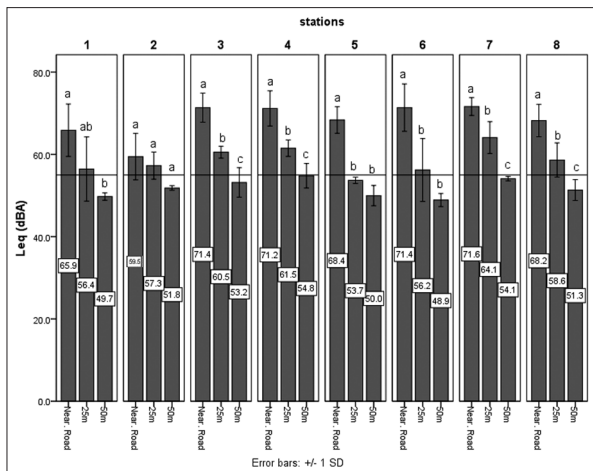


Figure 5: The amounts of Leq30 in each station and related substation (25 and 50 m). Each data expressed as mean and SD. The horizontal line is related to the standard level of Leq for wildlife (55 dB (A)). The alphabetic letters indicate significant differences at $P < 0.05$ for individual stations. In other word, similar letters indicate the same level of Leq in each station. “a” means the highest level and sequentially “b” and “c”.

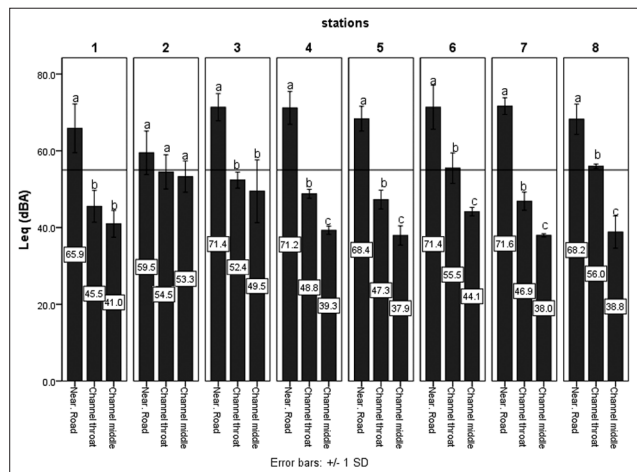


Figure 6: Leq30 in the throat and middle of that for all separated stations. Individual column represented mean and SD for three separated measurements. The standard level for wildlife was also exhibited for comparing each data. The same levels of significance are expressed by same alphabetic letters for each station

due to various vehicles, which belong to the government. The noise standard for this type of area has been already reported to be 55 dB (A).^[17] Figure 5 shows that there is a significant difference between near road and 25 m distance from that whereas no significant difference was found in stations 1 and 2. This discrepancy might be due to more movement of trucks with over-standard speed and can lead to the unusual elevation in the noise level at 25 m distance from the near road. In addition, other factors like topographic conditions and also plant coverage around the road might have a significant effect on noise pollution as mentioned by Czech.^[20] Although some small differences were seen in most stations, the downward trends were seen. Our data showed that the noise equal level near the road is much higher than standard. Forman^[15] reported that wildlife species have a reaction to the high traffic. He also showed a relationship between the noise equal level and distribution of species in grassland birds in Boston, USA. He showed that with increasing noise equal level during daytime, the distribution of bird species from near road will withdraw within the meters.^[16] With increase in traffic and noise pollution, hatching of Bobolink (*Dolichonyx oryzivorus*) will be disturbed.^[21]

Generally, the safe area related to noise pollution was determined to be in 50 m intervals in all measured points and from these findings we may suggest providing multi-size fencing in this distance because of the existence of different size of mammals in Khojir National Park such as *Ovis orientalis*, *Capra aegarus*, *Sus scrofa*, *Canis lupus*, *Felis silvestris*, *Hystrix indica*, *Meles meles*, and *Martes foina*.^[22] It is well evidenced that fencing causes a significant decrease in vehicle collisions with wildlife species.^[23] Karhu and Anderson suggested that fencing construction would be preferred not to be near the trees and hills in order to prevent from jumping movements of various species over the fence.^[24] Moreover, fencing should be inspected regularly following rainy season and renewed if there is any defect on it.

With the exception of first three stations including numbers 1, 2, and 3, there are significant differences ($P < 0.05$) in noise levels between the opening and middle of channels. In most stations, except numbers 6 and 8, the amount of measured noise was lower than the standard level. No exceeded noise above the standard level has been detected in the middle of channels in all stations [Figure 6]. Several investigators have suggested various ways to reduce noise pollution produced from near road. Some environmental ways for diminishing noise pollution could be soundproof walls, mounds, and fencing. These are common ways to implement a noise barrier.^[25-28] Alternatively installing a speed reducer for decreasing noise pollution was suggested by Coelho *et al.*^[29] In confirmation to this idea, we may also propose to install speed reducers in Khojir National Park in order to reduce noise pollution and also reduce noise equal level from near road. This kind of damper needs to be carefully used according to geographical position

and also traffic rate.^[30] In addition to that, designing of speed prevention signs at the entrance of vehicles to the park could be suggested as another way for reducing noise pollution.

CONCLUSIONS

Khojir National Park is located in capital city of Iran. It is a vital region because of containing important species and also having stable ecological conditions. It is therefore necessary to reduce its noise pollution which is produced by vehicles. To protect various species in this park, particularly those genetically important to the ecosystem, various ways should be taken into investigation. According to our findings in this project, the distance of about 50 m seems to be an appropriate distance for fencing. The present situation of this park (concerning to noise disturbances) ensured us not to use soundproofs in the channels. In order to avoid extra noise during the time of mammals' crossing, some environmental methods such as hills, planting, etc. should be applied; we strongly believe that a more suitable project should be made to study some other factors beyond our findings to reduce noise pollution in this park.

ACKNOWLEDGMENT

We gratefully appreciate Professor Ali Asghar Moshtaghie for reviewing this manuscript and also supporting all stages of this project.

REFERENCES

- Hickling R, Surface transportation noise. In: Crocker MJ, editor. Handbook of noise and vibration control. New York: John Wiley and Sons; 1998:897-906.
- Zannin PH, Ferreira AM, Szeremeta B. Evaluation of noise pollution in urban parks. *Environ Monit Assess* 2006;118:423-33.
- Zannin PHT, Diniz FB, Barbosa WA. Environmental noise pollution in the city of Curitiba, Brazil. *Appl Acoust* 2002;63:351-8.
- Ohrström E. Longitudinal surveys on effects of changes in road traffic noise-annoyance, activity disturbances, and psycho-social well-being. *J Acoust Soc Am* 2004;115:719-29.
- Williams ID, McCrae IS. Road traffic nuisance in residential and commercial areas. *Sci Total Environ* 1995;169:75-82.
- Pilcher EJ, Newman P, Manning RE. Understanding and managing experiential aspects of soundscapes at Muir woods national monument. *Environ Manage* 2009;43(3):425-35.
- Chambers JP. Noise pollution. In: Wang LK, Pereira NC, Hung Y-T, editors. *Advanced Air and Noise Pollution Control, Handbook of Environmental Engineering, Volume 2*. Totowa, New Jersey: Humana Press; 2004:441-52.
- Diehl P. Radiotelemetric measurements of heart-rate in singing blackbirds (*Turdus-merula*). *J Fuer Ornithologie* 1992;133:181-95.
- Weisenberger ME, Krausman PR, Wallace MC, De Young DW, Maughan OE. Effects of simulated jet aircraft noise on heart rate and behavior of desert ungulates. *J Wildl Manage* 1992;60:52-61.
- Krausman PR, Wallace MC, Hayes CL, DeYoung DW. Effects of jet aircraft on mountain sheep. *J Wildl Manage* 1998;62(4):1246-54.

11. Owen MA, Swaisgood RR, Czekala NM, Steinman K, Lindburg, DG. Monitoring stress in captive giant pandas (*Ailuropodamelanoleuca*): behavioral and hormonal responses to ambient noise. *Zoo Biol* 2004;23:147-64.
12. Foppen R, Reijnen R. The effects of car traffic on breeding bird populations in woodland. II. Breeding dispersal of male willow warblers (*Phylloscopustrochilus*) in relation to the proximity of a highway. *J Appl Ecol* 1994;31:95-101.
13. Liddle M. Recreation ecology: The ecological impact of outdoor recreation and ecotourism. New York: Chapman and Hall; 1997.639.
14. Delaney DK, Grubb TG, Beier P, Pater LL, Reiser MH. Effects of helicopter noise on Mexican spotted owls. *J Wildl Manage* 1999;63:60-76.
15. Forman RTT. Estimate of the area affected ecologically by the road system in the United States. *Conserv Biol* 2000;14:31-5
16. Forman RTT, Reineking B, Hersperger AM. Road traffic and nearby grassland bird patterns in a suburbanizing landscape. *Environ Manage* 2002;29:782-800.
17. Benson RH. The effect of roadway traffic noise on territory selection by Golden-cheeked Warblers. *J Acoust Soc Am* 1996;99:2575-603.
18. Reijnen R, Foppen R, Meeuwssen H. The effects of car traffic on the density of breeding birds in Dutch Agricultural Grasslands. *Biol Conserv* 1996;75:255-60.
19. Green RE, Tyler GA, Bowden CGR. Habitat selection, ranging behaviour and diet of the stone curlew (*Burhinusoedicnemus*) in southern England. *J. Zool* 2000;250:161-83.
20. Czech B. Elk behavior in response to human disturbance at Mount St. Helens National Volcanic Monument. *Appl Anim Behav Sci* 1991;29:269-77.
21. Forman RT, Sperling D, Bissonette JA, Clevenger AP, Cutshall CD, Dale VH, *et al.* Road ecology: Science and solutions. Covelo, WA, London, UK: Island Press; 2002;481.
22. Monavari M, Mirsaeed SG. Ecological impact assessment of highways on national parks: Tehran-Pardis highway (Iran). *Int J Environ Res* 2008;2:133-8.
23. Clevenger AP, Chruszcz B, Gunson K. Drainage culverts as habitat linkages and factors affecting passage by mammals. *J Appl Ecol* 2001;38:1340-9.
24. Karhu RR, Anderson SH. Evaluation of high tensile electric fence designs on big game movements and livestock containment. (Final report). Laramie, Wyoming: Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming; 2002;31.
25. Sandberg U, Ejsmont JA. Tyre/road noise reference book. In fomex. Sweden: Kisa; 2002;640.
26. Crocker MJ, Li Z, Arenas JP. Measurements of tyre/road noise and of acoustical properties of porous road surfaces. *Int J Acoust Vib* 2005;10:52-60.
27. Morgan SM, Kay DH, Bodapati SN. Study of noise barrier life-cycle costing. *J Transp Eng* 2001;127:230-6.
28. Arenas JP. Use of barriers. In: Crocker MJ, editor. Handbook of noise and vibration control. New York: John Wiley and Sons; 2007;714-24.
29. Coelho IP, Kindel A, Coelho AVP. Roadkills of vertebrate species on two highways through the Atlantic Forest Biosphere Reserve, southern Brazil. *European J Wildl Res* 2008;54:689-99.
30. Li KM, Wong HY. The acoustic performance of a cranked barrier: An approximate integral formulation. *Acta Acustica United with Acustica* 2005;91:680-8.

Source of Support: Islamic Azad University, Tehran, Iran, **Conflict of Interest:** None declared.