

Chapter 1

HIGH MORTALITY OF AMPHIBIANS AND REPTILES ON PAZAR-HEMŞİN HIGHWAY IN BLACK SEA REGION OF TURKEY

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INTRODUCTION

The transportation related infrastructures affect the structure of ecosystems and the dynamics of ecosystem function ⁽¹⁾. The characteristics of the transportation infrastructures (e.g. road type, traffic patterns and traffic level) have some independent variables that potentially affect amphibians and reptiles, both directly and indirectly. Direct effects consist of injury or mortality, which occurring physical contact with vehicles. Although some studies propound that low traffic volumes may be sufficient to cause high levels of amphibian ^(3, 4) and reptile ⁽⁵⁻⁷⁾ mortality, generally the mortality rate increases with traffic volume. The indirect effects include habitat loss, fragmentation and alteration ⁽²⁾.

Amphibian and reptile species are endangered worldwide and they have been suffering from some important threats such as road kill, habitat modification and habitat fragmentation ⁽⁸⁻¹⁰⁾. The slow moving animals are more exposed to road kills, especially ⁽¹¹⁻¹⁵⁾. The species of amphibian and reptiles are even more susceptible to road kill because of their immobile on the road in response to an approaching vehicle ^(16, 17).

In amphibians, the distribution of essential resources (e.g. food resources) and habitats may result the migrations of them with use the roads. The amphibians that use the transportation infrastructures for migration may stay on the roads for a long time because of their move slowly and this situation increases the mortality rates ^(2, 4, 17-19).

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The potential mortality rates are lower in lizards because of the limited use of the roads for their immigration, their relatively high speed and ability to cross roads faster than amphibian and other reptilian species⁽²⁰⁾.

The records of road kills are very high in snakes^(5, 21-25). The researches over sixty years about road kills of snakes showed that the snakes generally use the road for arriving to wetlands⁽²⁾.

Innately, turtles are slow animals and they spend more time for crossing a road, Thus, they are exposed to more road kills^(18, 23, 26).

In the present study, we aimed to take attention the road kills of amphibian and reptile species in the Rize province of Turkey. Our findings showed that the diversity and relative abundance of species exposed to road kill due to vehicular traffic.

The present study was carried out fifty six localities in Pazar-Hemşin highway, which was located on the Black Sea Region of Turkey (Figure 1). Before starting the present study (in the spring of 2017), we observed a large number of dead individuals of *Bufo bufo* and we encountered a certain amount of carcasses of *Natrix natrix* individuals on the way. Thus, we chose this way to study road kills.



Figure 1. The map showing the localities of the observed individuals exposed to road-kills on Pazar-Hemşin highway in Rize province of Turkey

We performed the field surveys in the activity periods of amphibians and reptiles between 14th April – 21st October of 2018 during the day and night excursions (11.00 a.m. and 10.00 p.m.). One visit per month was determined for Pazar-

Hemşin highway in the Rize province of Turkey. The carcasses of amphibians and reptiles were recorded on the way between the Başköy village (in Pazar District) and Hilal village (in Hemşin District). The cases of the road kills on the highway at 13 km (only departure way) were reported for each month. A total of 91 km-road was studied in seven-month surveys. The observations were performed on the Pazar-Hemşin highway in an area of approximately altitudes of 164-571 m.

The highway consisted of two lanes and the maximum speed limit outside settlement areas are 90 km/h on the highway. The surveys of road kills were conducted by three observers (driver and two passengers) driving a car at slow speed (≤ 40 km/h) as reported in the literature⁽²⁷⁾. After any carcass was detected, the car was stopped and the observations were made by two observers who walked along the road, one on each side, looking for carcasses as stated in the literature⁽²⁸⁾. For each road-killed amphibian and reptilian, the date and geographic coordinates were recorded using a GPS server (GARMIN eTrex 20x). The species were identified based on their morphological characteristics (e.g. webbed feet and absence of temporal band for water frogs, tubercles and color patterns of dorsium for toads, color and pattern characteristics for lizards and snakes). The data were preserved by photographing (Canon EOS 500D) to show the diversity of the species, which exposed to car crashes.

RESULT

During our monitoring of seven months, we recorded 90 individuals which were exposed to road kills (66 amphibians and 24 reptiles) including 11 species. The carcasses belonging to four amphibian species (*Bufo bufo* (65.5%), *Hyla orientalis* (1.1%), *Rana macrocnemis* (4.4%) and *Rana dalmatina* (2.2%)), three lizard species (*Darevskia rudis* (4.4%), *Darevskia clarkorum* (2.2%) and *Anguis fragilis* (1.1%)) and four snake species (*Natrix natrix* (6.6%), *Natrix tessellata* (4.4%), *Zamenis longissimus* (6.6%) and *Zamenis hohenackeri* (1.1%)) on the Pazar-Hemşin highway in Rize Province.

The species which were exposed to road kill are given in Table 1 and status of them were reported according to IUCN criteria. Photos belonged to specimens involved in car crashes, were given in Figures 2-4.

Our records of all months covering the study period indicated that amphibians (73.3%) were killed, more than reptiles (26.6%) on Pazar-Hemşin highway. *Bufo bufo* was the dominating species and the common toad was exposed to road kill throughout the seven months (April-October) on the studied highway. The grass snake (*Natrix natrix*) and Aesculapian ratsnake (*Zamenis longissimus*) were the second species which were most exposed the road kills in our study.

Table 1. List of the amphibians and reptiles exposed to road-kills on Pazar-Hemşin highway.

	Number of female individuals (♀♀)	Number of male individuals (♂♂)	Number of subadult individuals (♀♀)	Number of subadult individuals (♂♂)	Number of juvenile individuals	Number of uncategorized gender individuals	Total number of individuals (n)	The status of the species on IUCN Red List
<i>Bufo bufo</i>	30	28	-	1	-	-	59	LC
<i>Hyla orientalis</i>	-	1	-	-	-	-	1	LC
<i>Rana macrocnemis</i>	2	1	-	-	1	-	4	LC
<i>Rana dalmatina</i>	1	1	-	-	-	-	2	LC
<i>Darevskia rudis</i>	2	1	1	-	-	-	4	LC
<i>Darevskia clarkorum</i>	2	-	-	-	-	-	2	EN
<i>Anguis fragilis</i>	-	-	-	-	-	1	1	LC
<i>Natrix natrix</i>	2	-	-	-	2	2	6	LC
<i>Natrix tessellata</i>	1	-	1	-	-	2	4	LC
<i>Zamenis longissimus</i>	1	1	1	-	-	3	6	LC
<i>Zamenis hohenackeri</i>	-	-	1	-	-	-	1	LC

Table 2. List of the amphibians and reptiles exposed to road-kills by months and genders.

	April	May	June	July	August	September	October
<i>Bufo bufo</i>	15 ♀♀ 16 ♂♂	3 ♀♀ 4 ♂♂	1 ♀ 1 ♂	1 ♀ 1 ♂	1 ♀♀ 1 subadult ♀	3 ♀♀ 1 ♂	6 ♀♀ 5 ♂♂
<i>Hyla orientalis</i>	-	1 ♂	-	-	-	-	-
<i>Rana macrocnemis</i>	-	1 ♀ 1 juvenil	-	-	-	-	1 ♀ 1 ♂
<i>Rana dalmatina</i>	-	-	-	-	-	1 ♀ 1 ♂	-
<i>Darevskia rudis</i>	-	1 ♀ 1 subadult ♀	-	-	1 ♂	-	1 ♀
<i>Darevskia clarkorum</i>	-	-	-	2 ♀♀	-	-	-
<i>Anguis fragilis</i>	-	1 (uncategorized gender)	-	-	-	-	-
<i>Natrix natrix</i>	-	1 ♀ 1 juvenil 1 (uncategorized gender)	-	-	1 juvenil	1 ♀ and 1 (uncategorized gender)	-
<i>Natrix tessellata</i>	-	1 subadult ♀	-	1 ♀	-	-	2 (uncategorized gender)
<i>Zamenis longissimus</i>	-	-	1 (uncategorized gender)	1 ♀	-	-	1 Subadult ♂ 2 (uncategorized gender)
<i>Zamenis hohenackeri</i>	-	-	-	-	-	1 subadult ♀	-

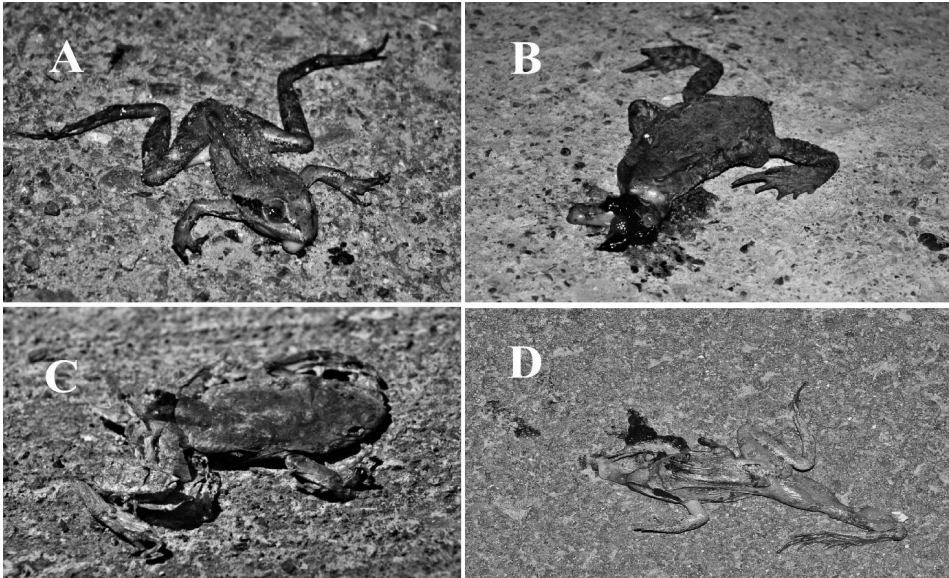


Figure 2. A general view of amphibian carcasses belonging to four different species found on Pazar-Hemşin highway. A- *Rana macrocnemis*, B- *Bufo bufo*, C- *Hyla orientalis* and D- *Rana dalmatina*.



Figure 3. A general view of lizard carcasses belonging to three different species found on Pazar-Hemşin highway. A- *Darevskia clarkorum*, B- *Anguis fragilis* and C- *Darevskia rudis*.

The number of road killed common toads, per 500 m section varied from 0 to 4 in April and October. Although the carcasses belonging to snake species (*Natrix natrix*, *Natrix tessellata*, *Zamenis longissimus* and *Zamenis hohenackeri*) were observed throughout six months (May-October) in our study, the most carcasses belonging to *Natrix natrix* and *Zamenis longissimus* were observed in May and October, respectively (Table 2).

In April, there were no data for amphibians (except *Bufo bufo*), lizards and snakes, which exposed to road kill on the studied highway in our study. In the contrary of April, there was a serious increase in species diversity (*Bufo bufo*, *Rana*

macrocnemis, *Hyla orientalis*, *Anguis fragilis*, *Darevskia rudis*, *Natrix natrix* and *Natrix tessellata*) which were exposed to road kills in May (Table 2).

In June, July and August which covering the summer period, the carcasses belonging to *Darevskia clarkorum* and *Zamenis longissimus* were found on the studied highway, different from the species which were observed in the months of April and May. In June, the carcasses of *Bufo bufo* and *Zamenis longissimus* was detected on the studied highway. In addition to the carcasses of *Bufo bufo* and *Zamenis longissimus* species, the carcasses of *Darevskia clarkorum* and *Natrix tessellata* species were observed in July. The dead bodies of three species were observed in August: *Bufo bufo*, *Darevskia rudis* and *Natrix natrix* (Table 2).

The individuals exposed to road kill in September belong to the species *Bufo bufo*, *Rana dalmatina*, *Natrix natrix* and *Zamenis hohenackeri* while the individuals exposed to road kills in October belong to the species *Bufo bufo*, *Rana macrocnemis*, *Darevskia rudis*, *Natrix tessellata* and *Zamenis longissimus* on the Pazar-Hemşin highway (Table 2).

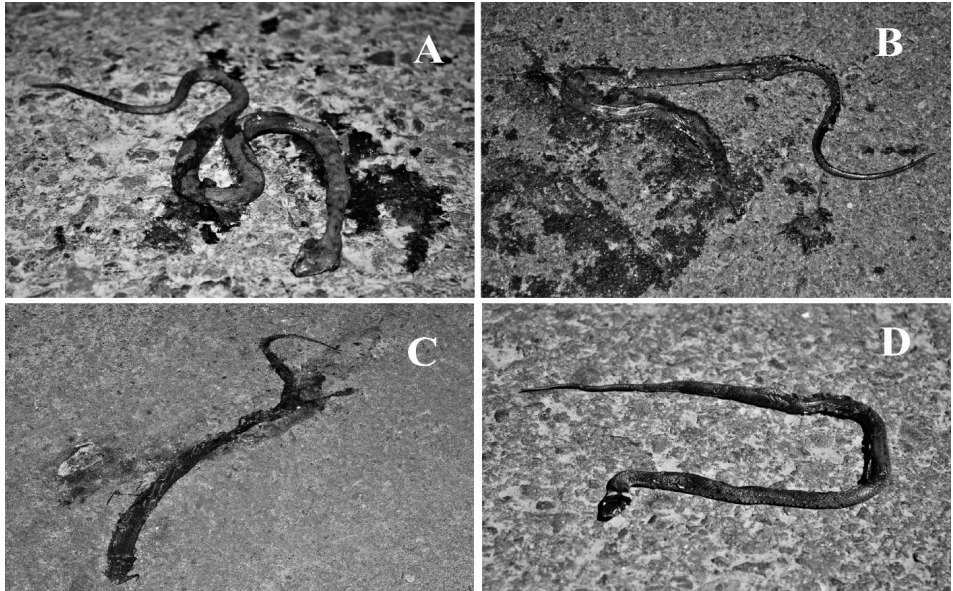


Figure 4. A general view of snake carcasses be found on Pazar-Hemşin highway. **A-** *Natrix tessellata*, **B-** *Zamenis longissimus*, **C-** *Zamenis hohenackeri* and **D-** *Natrix natrix*

Many researchers reported that declining the amphibian and reptile populations in the world ⁽²⁹⁻³¹⁾. One of the important factors in the declining of the amphibian and reptile populations is road kills ⁽¹⁹⁾. However, all taxonomic groups

are not affected from the road kill in the same way. Amphibians are mostly affected by road kill ^(32, 33). The road traffic (low or high) has a severe threat to amphibians, because of their slow capacity of movement ⁽³⁴⁾. Our findings showed that the amphibians (*Bufo bufo*, *Hyla orientalis*, *Rana macrocnemis* and *Rana dalmatina*) were affected more than the reptilians in this study. In parallel with, Smith and Dodd ⁽³⁵⁾ reported that the anurans experienced the greatest road mortality of any vertebrate taxon in Florida.

Bufo bufo has been frequently killed on roads ⁽³⁶⁻³⁸⁾. Incompatible with the literature, the common toad was the most affected species from road mortality in this study. We recorded the carcasses of common toad throughout the seven months (April-October) in the Pazar-Hemşin highway, the reason for this situation may be their long breeding migration routes ⁽³⁴⁾. In addition, the high number of carcasses belongs to *Bufo bufo* were found in April and October. The reasons for this situation may be that the toads become active and begin of the reproductive behavior in April. Similarly, returning from their long breeding migration routes may increase exposure to road deaths in October. The other amphibian species were observed in May (*Rana macrocnemis* and *Hyla orientalis*), September (*Rana dalmatina*) and October (*Rana macrocnemis*). The reason for the increase in species diversity observed on the roads in May may be due to the warmer weather and the more activation of individuals.

In the literature, there are many research about the road kills of snakes ⁽³⁹⁻⁴²⁾. Similarly, the high number of road killed individuals belongs to snake populations on the Pazar-Hemşin highway, after amphibian populations in our study. There are several numbers of snake species (*Natrix natrix*, *Natrix tessellata*, *Zamenis longissimus* and *Zamenis hohenackeri*) exposed to road kill in the studied highway and this situation may be associated with an abundance of the frogs, found in this area ⁽⁴³⁾.

The carcasses of the snakes were detected in the period when the summer temperatures more intensively increase. This situation may be related that the snakes need to arrive to streams for feeding. Among the snake species, *Natrix natrix* and *Zamenis longissimus* were the most affected species from the road kills.

The road mortality studies within lizards are rare in the literature. This lack of the records may be associated with their relatively high speed and ability to cross roads faster than other reptilians ⁽²⁾. Consistent with this finding, the taxon which have lowest species and dead individuals were lizard throughout our study. The carcasses of the lizards were found in the summer when the lizards more active in their breeding activities. We found two dead individuals of *Darevskia clarkorum*

on Pazar-Hemşin highway. *Darevskia clarkorum* is classified in the EN (Endangered) category in the IUCN Red List. If individuals of this species are exposed to a large number of road kills, there may be a threat to the conservation of the species in near future. According to our results, another lizard species, *Darevskia rudis* was the most affected species in Pazar-Hemşin highway. The lizards may have exposed to road kill for they set out to feed.

The present study was performed from April to end of October in Pazar-Hemşin highway from Rize province. Our findings showed that some months when amphibian and reptilian species become active and begin of the reproductive behavior are critical. The species diversity on the Pazar Hemşin highway and the dead specimen frequency are matters of great significance, and may pose a serious threat to the species. The effects of roads may be minimized, at least during the critical periods of amphibians and reptiles. Thus, taking the right measures at the right points has a very important role. In long-term studies, more accurate comments can be made by increasing the number of visits to the studied area and comparing the results of the observations.

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