The mortality rate in a hedgehog population: The relative importance of road kills

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Abstract

In 1994 56 hedgehogs (Erinaceus europaeus) were captured, marked and released in a 150 ha study area near Elburg, the Netherlands.
In 1995 34 of these animals were still alive and present in the study area. Of the other 22 animals 12 emigrated, 3 died (one was a traffic victim), and the fate of the remaining 7 is unknown. Of all deaths in the hedgehog population, road mortality accounted for 6-33%. Of all hedgehogs in a population, 2% may become a road kill each year. These values suggest that road kills may be an important cause of death. Whether or not this affects population survival remains to be investigated. It can not be ruled out that the size or age-structure of Dutch hedgehog populations is affected by traffic.

Introduction

Hedgehogs *Erinaceus europaeus* are a very common road kill in the Netherlands (Meijer & Smit 1995). It may be that these numbers simply reflect the presence of large, thriving populations (Reeve 1994). Nevertheless, Dutch hedgehogs are generally confronted with high road densities, and an impressive traffic intensity. Other habitat fragmentation processes seem to be less important for this habitat generalist (Mulder 1996, Reeve 1994). The high amount of infrastructure and traffic may lead to a situation where not only individual hedgehogs are killed, but the size and presence of entire populations may be affected too. Data on the relative importance of road mortality, when compared to other mortality factors and population size, are relatively scarce (Reeve 1994). Therefore we estimated the mortality rate of a hedgehog population along a busy two-lane highway and a paved country road. This paper describes the capture-mark-recapture technique that was used and discusses the preliminary results.

Methods

Study area

Our 150 ha study area was located near Elburg, The Netherlands. A busy two-lane highway (N309) and a paved country road (Laanzichtsweg) were located within the area (Fig. 1). The landscape is dominated by relatively small scale pastures, hay meadows, some arable land and woodlots on relatively dry sandy soils. The woodlots are interconnected by linear wooded elements that separate the grasslands and arable land. The area was divided into three adjacent sections of 50 ha each (1000 m x 500 m).

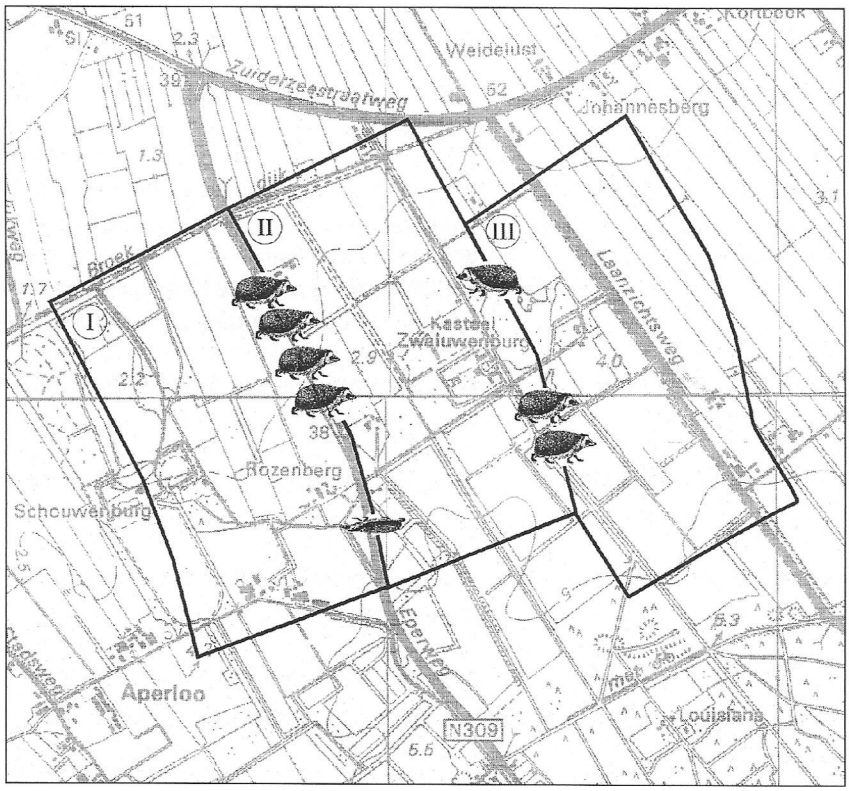

Figure 1.
The study area: location of the three sections (1000 m x 500 m each), the highway (N309), and the paved country road (Laanzichtsweg). The hedgehog symbol that is depicted flat and upside down, indicates the exact location of the road kill. The other hedgehogs indicate the number and direction of migrating animals within the study area.

Captures

In 1994 and 1995 hedgehogs were trapped in wooden boxes baited with dog-food. Ninety traps (30 in each section) were placed throughout the area. They were mostly located in the linear wooded elements and woodlots and on the edge of grasslands or arable land. However, some traps were situated in the open field, along a ditch, or under a solitary tree. The traps were prebaited during one week preceding the capture, which consisted of two consecutive trapping nights. Between the captures the traps were relocated within the sections. In 1994 seven captures, about one month apart, were carried out between May and November. Between May and July 1995 four captures took place, each three weeks apart. Hedgehogs were also captured by hand when encountered in the field.

The animals were classified into juveniles (young of the year) and (sub)-adults (≥ 1 hibernation) based upon their size, weight and colour. Unmarked individuals were anaesthetized using Halothane, after which they were individually marked. Since both eartags and colour marking of the spines were used, it is unlikely that a marked individual would not be recognized as such.

(Road) mortality
All roads in and around the study area were inspected intensively (nearly every day) for traffic victims. Accidental reports of dead hedgehogs, both road kills and ones that died of other causes, were also recorded. Therefore it is highly unlikely that marked hedgehogs that were killed by traffic, were not found.

Analysis
All animals that were captured and marked in 1994 in the study area as a whole (M) were included in the analysis. Our aim was to determine how many of these individuals made it into the active season of the next year. We were specifically interested in the number of hedgehogs that died, and how many of those deaths were caused by traffic. To achieve this, a number of demographic parameters had to be determined.

Based on recaptures in 1995, the minimum number alive (MNA) was determined. Known deaths (D) were split into road kills (Dr) and other causes (Do). An estimate for emigration (E) was obtained by analyzing migration between the three sections within the study area. We assumed a uniform emigration to all directions. The demographic parameters described above form the following equation: M=MNA+D+E+U. U represents the number of individuals whose fate is unknown.

If all hedgehogs who emigrated or whose fate is unknown (E+U) are still alive, a maximum survival rate of (MNA+E+U)/M is obtained. This results in a minimum mortality (D), of which a relatively high proportion is accounted for by traffic (Dr/D). On the other hand, if all these animals are dead, the calculations result in the opposite. Survival rate is then MNA/M, mortality is D+E+U, and the proportion of traffic related deaths is Dr/(D+E+U). The road mortality rate of the population is Dr/M.

Results

In 1994 57 hedgehogs were captured in total: 55 during the seven captures trapping scheme, and two through accidental encounters. One animal is most likely to have died of a trapping related incident and is not included in the following. The total minimum number of hedgehogs still alive in 1995 was found to be 34 (Table 1). Recaptures in the trapping scheme (four captures) accounted for most of them: all of the four juveniles, and 27 of the (sub)adults. The remaining three (sub)adults were captured by hand.

Table 1.
Demographic parameters of a hedgehog population in 1994-1995 near Elburg, The Netherlands.
*1 proportion and number of juveniles catched, marked and released were too low to obtain accurate estimates.
*2 estimates not given because of the possible influence of the low number of juveniles.

demographic variable	Juveniles	(Sub)adults	Total
captured, marked and released in 1994 (M)	8	48	56
minimum number alive in 1995 (MNA)	4	30	34
known deaths			
• road kills (Dr)	0	1	1
• other causes (Do)	0	2	2
emigration (E)	0	12	12
unknown (U)	4	3	7
survival rate	*1	0.63-0.94	*2
road mortality rate of total deaths	*1	0.06-0.33	*2
road mortality rate of population	*1	0.02	*2

Three animals are known to have died before the end of April 1995. One adult male was killed by traffic on the main road (N309) on the night of July 22nd-23rd 1994 (Fig. 1). Two animals died of other causes: the remains of an adult female were found in a water hole (January 5th 1995). Finally a subadult male was found dead on the premises of a farm (June 6th 1994).
Only (sub)adults were found to emigrate between the three individual sections. Four emigrated from section 1 to section 2, two from section 2 to section 3, and one from section 3 to section 2 (Fig. 1). This resulted in an estimate of 12 for emigration (Table 1).

Table 1 also shows the minimum and maximum values of the survival-, and relative road mortality of total deaths rate. For juveniles these rates were not estimated because of insufficient numbers. Because of their possible influence on the rates for the population as a whole, an estimate for the latter group is also not given. The survival rate of the (sub)adults was 0.63-0.94. The relative road mortality rate of total deaths ranged from 0.06-0.33. For the population this value was estimated at 0.02.

Discussion

In order to be able to make accurate estimates of the demographic parameters a large proportion of the hedgehog population had to be captured, marked and released. Nolet & Meuwissen (unpublished) estimated that 41-43 (sub)adult hedgehogs used section 1 and 2 at any time between May and November 1994. In 1994 38 (sub)adult animals were captured and marked in the section 1 and 2 combined. This gives us an estimate of 88-93% of the (sub)adult population being captured and marked in 1994. The estimate includes possible non-residents that consequently had a relatively low chance of being captured. Since the 1995 captures were very intensive also, we think that our estimates of the demographic parameters of the (sub)adult population are fairly accurate. In this part of the Netherlands one can expect that juveniles are first caught around the middle of August at the earliest. Combined with the fact that the activity of hedgehogs decreases in autumn as they go into hibernation, the juveniles had considerably

less chance of being caught than the (sub)adults. The proportion of juveniles captured and marked in 1994 can only be calculated based on a long series of assumptions (e.g. no. of pregnant females, no. of young per female, survival of young until they become 'catchable') and is therefore not given. However, based on the captures in 1995, this proportion must have been rather low. The absolute number of juveniles captured and marked in 1994 was too low to be able to lead to accurate results. Our emigration estimate assumed that emigration over distances greater than 1000-1500 metres was absent. This is supported by the fact that all migration between the sections covered a distance less than 1000 metres.

An annual survival rate of 0.63-0.94 for the (sub)adults is similar to the range of most other studies in north-western Europe: 0.53 in Sweden (Kristiansson 1990), 0.70 in England (Morris 1991), and 0.60-0.80 in southern Germany (cited by Hoeck 1987). It is apparent that survival rates may vary considerably from year to year.

The values of relative road mortality of total deaths of the (sub)adults ranged from 0.06 to 0.33. These figures are of course greatly influenced by the local conditions (e.g. habitat quality, road density, traffic intensity, and possible ecological and physical barriers along the road). Although the number of hedgehogs killed per km road is related to the nature of the landscape along the road, probably through varying population densities (e.g. Mulder 1992; 1996; Reichholf & Esser 1981), the number of road kills on a fairly short section of road is a matter of chance. One has to keep this in mind when making comparisons with other studies. Nevertheless, the results of our study are of the same magnitude as the few other studies that addressed this subject. Reeve (1981) reported a road mortality rate of 0.18 of all known deaths in Britain. Because this result is only based on the active season of the hedgehog, the yearly rate is most likely to be lower. Other British studies revealed a rate of 0.33 and 0.08-0.27 (Doncaster 1992, 1994). Because observations in Doncaster's studies were only made during two months in the active season, the annual rate could be either higher or lower. However, it has to be stated that the animals of the latter study had been transplanted and may have been more vulnerable to traffic because of unfamiliarity with their new environment and subsequent migration.

Where the road mortality rate of the population is concerned, we found a rate of 0.02 for (sub)adults. The studies by Doncaster (1992, 1994) indicated higher values: 0.05-0.13 and 0.03-0.10, and a Norwegian study reported a rate of 0.18 (Strøm Johansen 1995). The high rates of the British and Norwegian studies may well have been caused by different study methods. The animals were all equipped with a radio-transmitter and the British hedgehogs were also introduced to a new environment. It is quite possible that such animals had a higher risk of becoming a road victim than the animals in our study.

Conclusion

Of all deaths in a hedgehog population, road mortality accounted for 6-33%.

Of all hedgehogs in a population, 2% may become a road kill each year. These values suggest that road kills may be an important cause of death. Whether or not this affects population survival remains to be investigated. Due to local circumstances generalizations should be met with great care. It can not be ruled out that the size or age-structure of Dutch hedgehog populations is affected by traffic. We hope to address this question in the near future.

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