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Annual Analyses 2022

09/2021 – 08/2022

Authors: Florian Heigl and Daniel Dörler, University of Natural Resources and Life Sciences, Vienna, Institute of Zoology, Gregor Mendel Strasse 33, 1180 Vienna; office@roadkill.at

Co-designed research question

In the last year, we collected your questions, summarized them to research topics and published them in the basic analyses on our project's website and on Zenodo. In August you were able to vote for one of these research topics. Afterwards, we invited the authors of the topic with the most votes to transform the research topic into a hypothesis together with the project team which forms the basis for our next investigation in the project. And here we proudly present the hypothesis co-developed with citizen scientists:

Due to warmer temperatures in the spring months, the peaks of the roadkill reports shift.

In the upcoming months, we will dive deep into this hypothesis and will investigate if this hypothesis is true or false. The reports in the Roadkill project vary greatly from year to year. In addition, we have only been collecting data for 8 years. This period is not sufficient to analyse the effects of climate change. For amphibian species, a temporal shift in the occurrence of roadkills does not seem to be significant, as an analysis of data from several sources shows (Peer et al. 2021). We will therefore look for additional data sources to test this hypothesis. All results will be published in an open-access and peer-reviewed scientific journal to guarantee highest scientific and ethical standards. If you have a research question in mind, please feel free to send it to us via our online form and get the chance to investigate it together with us.

Where were the top five roadkill species killed?

Besides the above-described hypotheses, 172 participating citizen scientists reported 3175 roadkills in the last year (Sept. 2021 - Aug. 2022). This is an amazing performance, for which we deeply thank all of you! The data will be used for scientific and nature conservation studies and will be made openly available via the world's biggest biodiversity database GBIF (<https://www.gbif.org/>) in the near future to enable researchers and practitioners from all over the world to use it for their research. Roadkill reports from 2014 - 2020 are already published on GBIF and Zenodo (Heigl et al. 2022).

Figure 1 shows that when participating citizen scientists in Project Roadkill are sorted by number of reported roadkills, a small group of ten participants contributed the majority of

data (2012 individuals) and 103 participants reported below 5 individual roadkills. This shows that we have a small but really engaged group of citizen scientists, which are strongly connected to the project and a big group who reports occasionally. These rates are very typical for citizen science projects with many participants (Sauermann and Franzoni 2015). We want to emphasize that no matter if you report regularly or occasionally, we are grateful for every entry, so please keep up the great work!

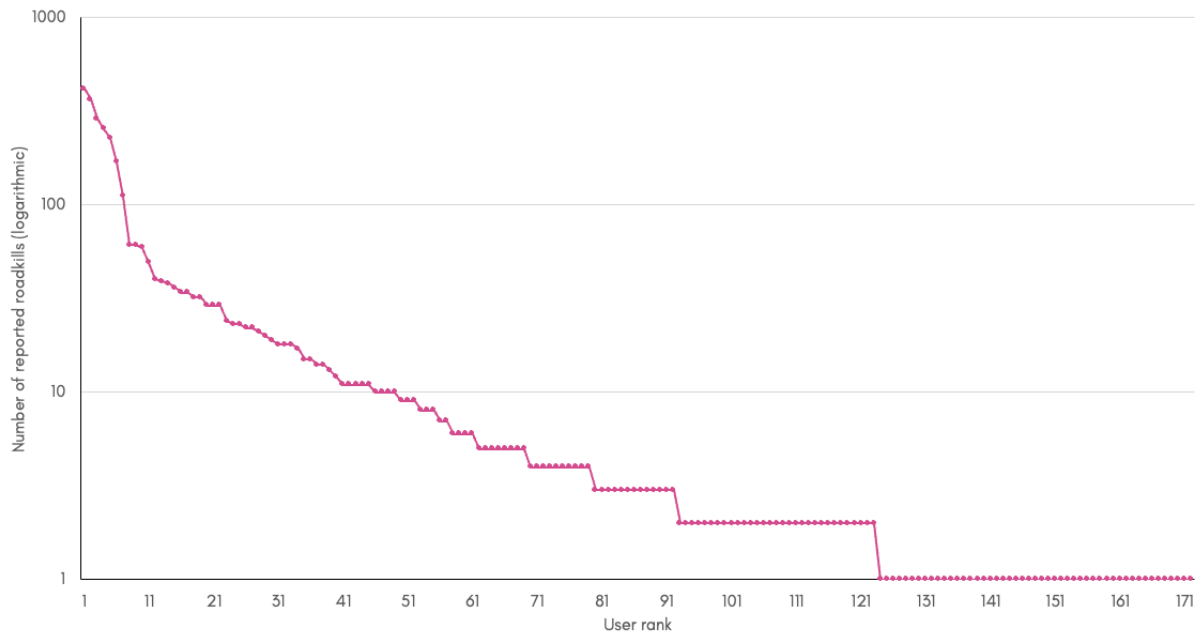


Figure 1: Project Roadkill contributions.

Looking at the distribution of all roadkill reports from Sept. 2021 - Aug. 2022 in our new heatmaps, it is obvious that most roadkills are reported in the eastern parts of Austria (Figure 2). In addition, the seasonal distribution shows several peaks during the year (represented by the red colour in the heatmaps) and a somewhat quieter period from November to February, with an increase in reports in March. This seasonality in roadkill reports is similar to other studies that have investigated the seasonal patterns of roadkill numbers. Most roadkills seem to occur during the mating, breeding and rearing seasons due to higher dispersal activities of animals (Gonçalves et al. 2018; Mayer et al. 2021; Ascensão et al. 2022).

The heatmaps in Figure 2 are screenshots from our online map. You can also create such heatmaps yourself and display them for all or just a selection of animal groups. In addition, you can select individual time periods or even watch a short animation of how the heatmap changes over the course of one year. Just give it a try yourself, it is a really exciting function. More information on creating heatmaps in Project Roadkill can be found in our blog on Österreich forscht (<https://www.citizen-science.at/blog/teamblog/projekt-roadkill>).

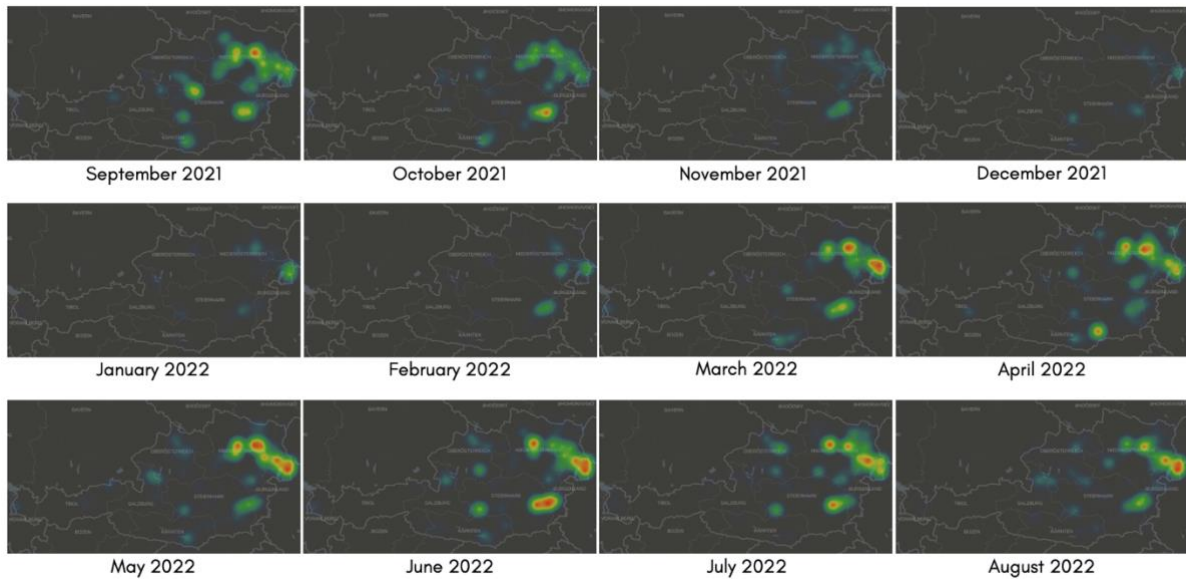


Figure 2: Heatmaps of all reported roadkilled vertebrates per month (screenshots from www.roadkill.at). Colours represent the number of roadkills in a given area (from red = many roadkill reports to blue = only a few roadkill reports).

During the last year, the European hare was the most often reported species (635 individuals), followed by the Common toad (441 individuals) and the hedgehog (401 individuals; see Table 1). The five most frequently reported species account for more than half of all roadkills reported. With the exception of the Spermophilus, these animal species are very common and also occur throughout Austria (Grimmberger 2017; Herpetologische Sammlung and des Naturhistorisches Museum 2022).

Table 1: The 5 most reported roadkills last year (Sept. 2021 - Aug. 2022).

Species	Number
European hare	635
Common toad	441
Hedgehog	401
Red squirrel	161
Spermophilus	138

European hares

European hares were reported from all provinces except Tyrol and Vorarlberg. Most reports were coming from the east of Austria, especially from the north of Burgenland and the east of Lower Austria around Vienna (Figure 3). The surrounding landscape of the roadkill reports on European hares (Figure 8) corresponds exactly to the known habitat needs of this species. European hares are very adaptable and colonise many different habitats, including grasslands, steppes, open woodlands, fields and pastures. They are particularly common in open, flat areas where cereal crops predominate (Grimmberger 2017). Already in 2016, we were able to show that these landscape types are prevalent in road-killed hares, not only when citizen scientists collected the data, but also when hunters collected the data in their hunting grounds (Heigl et al. 2016). European hares are mainly crepuscular and nocturnal. During the breeding

season (January-October), the animals are also diurnal. Males chase each other and fight during this time of year, which unfortunately also results in many roadkill reports when the chase leads over roads. Females give birth three to four times a year. This is also reflected in the reports, which have no clear peak.



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European hare

Lepus europaeus

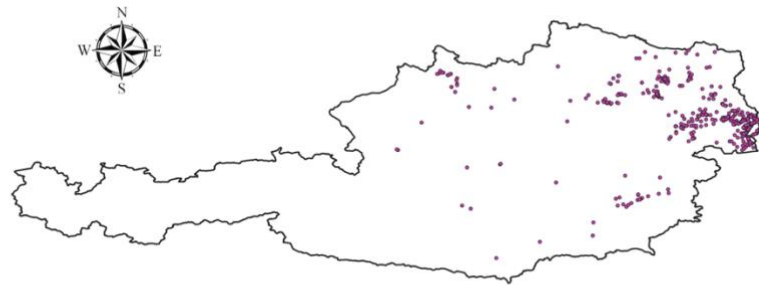


Figure 3: Distribution of reported road-killed European hares in Austria.

Common toad

In contrast to the European hare, Common toads were reported from all provinces, with no significant concentrations (Figure 4). The common toad is also known for its great adaptability and wide distribution. The Common toad prefers rather damp deciduous and mixed forests, but is also frequently seen in gardens or parks. Spawning grounds are mainly larger standing waters (also fish ponds) near forests (Glandt 2018). These habitat requirements are also evident in the landscapes around the roadkill reports (Figure 8). We can see that the landscape around roadkill reports was very diverse, but characterised by open settlements, forests and fields as well as grassland. Roadkilled Common toads were mainly reported during their migration to the spawning grounds. However, since Common toads do not stay at the spawning waters, but can travel long distances in search of food (Schweiger and Grillitsch 2015), many individuals were also reported during wet periods, or on their return to their wintering grounds in autumn.



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Common toad

Bufo bufo

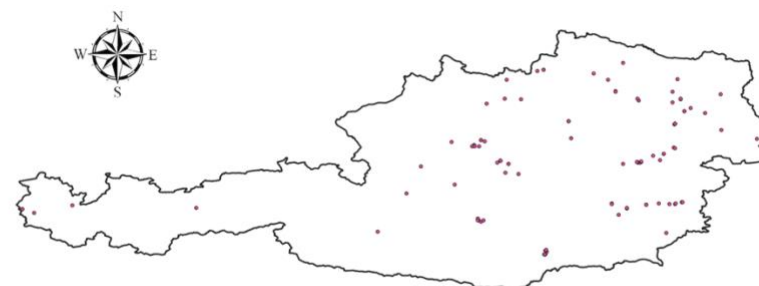


Figure 4: Distribution of reported road-killed Common toads in Austria.

Hedgehog

With the exception of Tyrol, hedgehogs were reported from every province. The majority of reports came from Lower Austria, northern Burgenland and eastern Styria (Figure 5). There are two hedgehog species in Austria, the European hedgehog (*Erinaceus europaeus*) and the Northern white-breasted hedgehog (*Erinaceus roumanicus*, Grimmberger 2017). The two species cannot be distinguished purely by their appearance and have similar habitat preferences. Therefore, we decided to analyse these two species together. Hedgehogs inhabit deciduous and mixed forests, parks and gardens. They usually avoid large fields or wetlands, as well as regions above 1200m above sea level. Hedgehogs are solitary crepuscular and nocturnal animals and can cover several kilometres in one night. These habitat requirements correspond very well with the results of our analyses of landscape types in the area around roadkill reports (Figure 8). Discontinuous urban fabric (suburbs and loose settlements) and non-irrigated arable land account for >60% of the landscape types around reported roadkills. Although hedgehogs avoid larger arable fields as described above, this landscape type occurs in the vicinity of roadkilled hedgehogs, as small-structured fields are very often located at the edge of settlements, which are preferred by hedgehogs. These landscapes are also used primarily for foraging. This is also reflected in the frequency of reported roadkills in summer, when hedgehogs travel long distances searching for food (Raymond et al. 2021).



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Hedgehog

Erinaceus sp.



Figure 5: Distribution of reported road-killed Hedgehogs in Austria.

Red Squirrel

Squirrel reports were reported from every province, with an increased number in eastern Styria. Squirrels are found throughout Austria in mixed and coniferous forests that produce enough tree seeds for food. Squirrels are also found in settlements in parks, cemeteries or large gardens (Grimmberger 2017). The analysis of the surrounding landscape of roadkill reports also shows that mostly loose settlements, forests and fields were found in the vicinity of roadkilled squirrels. Settlements and cities often serve as substitute habitats where squirrels can reach high population densities. Here, however, they are also particularly often roadkilled (Fingland et al. 2022).



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Red Squirrel

Sciurus vulgaris

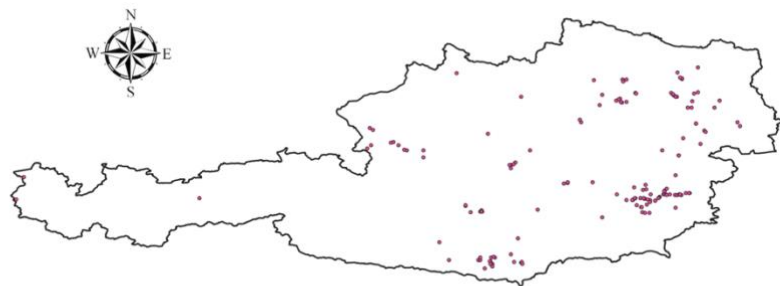


Figure 6: Distribution of reported road-killed Red squirrels in Austria.

Spermophilus

Due to the very restricted distribution area of the European souslik, roadkills were only reported from Lower Austria. European sousliks inhabit dry, warmth-favoured areas with steppe-like, short vegetation, fallow land, field margins and road embankments. Forests are avoided by European sousliks (Grimmberger 2017). This is also reflected in the surrounding landscape of reported roadkills. Loose settlements, fields and vineyards are predominant here. The European souslik is an endangered species according to the IUCN and populations are declining, so the frequency of reported roadkills is of particular concern (Hegyeli, Z 2020).



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Spermophilus

Spermophilus citellus



Figure 7: Distribution of reported road-killed Spermophilus in Austria.

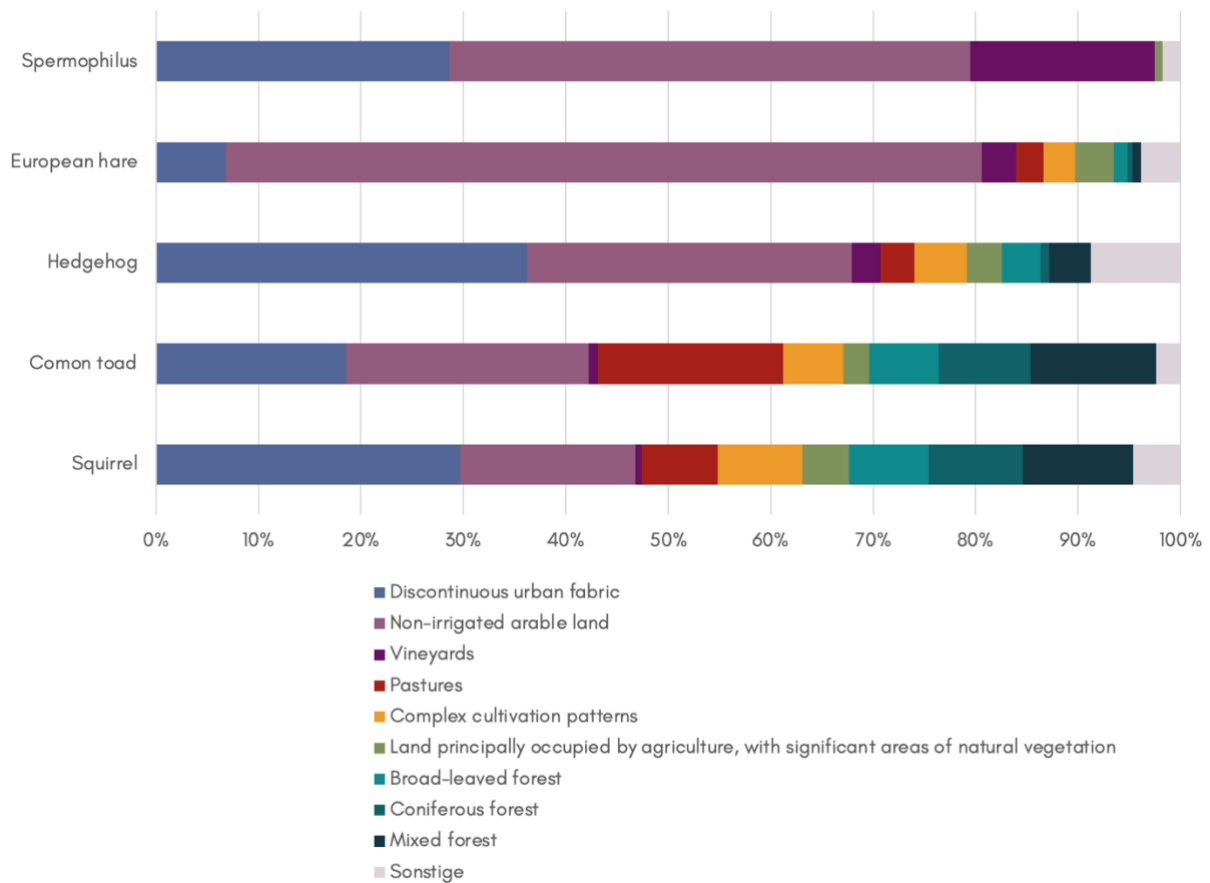


Figure 8: Land cover surrounding road-killed species.

Road types

Most individuals were reported on secondary roads (Landstraßen), followed by primary roads (Bundesstraßen) and tertiary roads (Gemeindestraßen) (Figure 9). We see large species-specific differences in road types. For example, European hares are mainly reported on secondary roads, followed by primary and tertiary roads. Common toads are also mainly reported on secondary roads, but followed by residential and tertiary roads. Hedgehogs and squirrels, on the other hand, are mainly reported on primary roads, followed by secondary and tertiary roads. Most Spermophilus were reported on secondary roads. Canal et al. (2018) also found large differences between different road types in relation to roadkilled animal groups in southern Spain. However, they point out that there can also be differences within road types, depending on the traffic density or other factors on the respective road sections. The road type is therefore rather a rough estimate of the road characteristics and should be analysed in detail in the future.

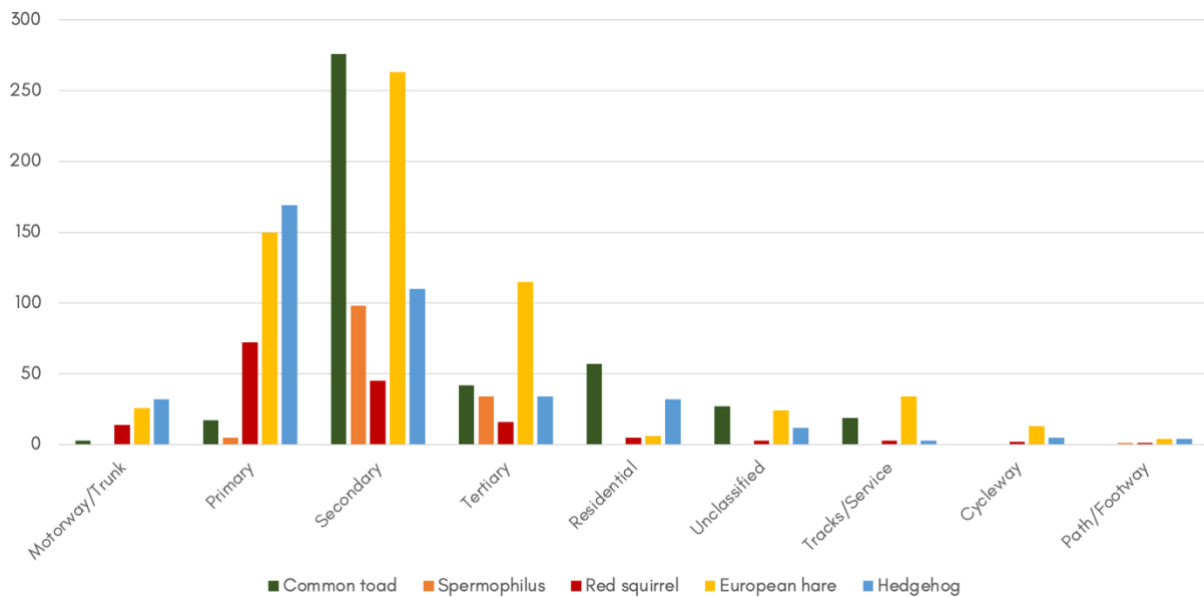


Figure 9: Number of reported roadkills per species and road type.

Based on the analyses presented here, it can be assumed that animal species are roadkilled in areas that correspond to their habitat preferences. It seems that roads are ubiquitous and therefore roadkills occur rather randomly distributed and no currently apparent hotspots emerge. However, when interpreting the results, one must also consider the reporting behaviour of the citizen scientists (e.g. (Johnston et al. 2018)). In Figure 7, we see that most reports were made on secondary roads. On the one hand, one could interpret these results as secondary roads being the road type where most animals are roadkilled, on the other hand, it may also mean that it was easier to detect and report animals on this type of road than on other roads with higher velocity levels.

Again, thank you all very much for contributing to the project by reporting roadkills, identifying species, helping other citizen scientists and asking research questions. We feel very lucky to have all of you on board!

Your Project Roadkill Team

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