Georgia Journal of Science

Volume 77 No. 2 *Scholarly Contributions from the Membership and Others*

Article 3

2019

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Recommended Citation

Ogletree, Kori A.; Mead, Alfred J.; and Boitet, Evan R. (2019) "Identifying Roadkill Hotspots Using a Running Average," *Georgia Journal of Science*, Vol. 77, No. 2, Article 3.
Available at: https://digitalcommons.gaacademy.org/gjs/vol77/iss2/3

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Acknowledgements
Dennis Parmley, Heidi Mead, and Melony Mead provided helpful comments on earlier drafts of this manuscript. This manuscript benefited from critical reviews by two anonymous reviewers.

IDENTIFYING ROADKILL HOTSPOTS USING A RUNNING AVERAGE

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ABSTRACT

The identification of roadkill hotspots is necessary prior to the consideration of wildlife road mortality mitigation measures. In a previous study, 178 roadkill specimens were tallied via a driving survey along 21.4 km (13.3 mi) on three connected roadways in Baldwin County, Georgia. Roadkill locations were recorded to the nearest 0.16 km (0.1 mi) using the vehicle odometer. In the current study, location data were used to generate three graphical displays of roadkill distribution: 1) a linear graph of roadkills per 0.16 km (0.1 mi) bin; 2) a linear graph of roadkills per 0.8 km (0.5 mi) bin; and 3) a linear graph with a continuous running average incorporating 0.48 km (0.3 mi). The number and position of the peaks on each graph were compared in relation to roadway features that may influence animal movement and mortality such as vegetative boundaries, stream crossings, hills, and curves. The running average plot provided the best visual illustration of roadkill hotspot locations in relation to roadside features. The running average is a good technique to quickly and accurately identify hotspot locations and could help resource managers plan mitigation strategies to decrease wildlife road mortality.

Keywords: roadkill hotspots, wildlife road mortality

INTRODUCTION

An increase in urban sprawl and highway traffic volume is taking a heavy toll on wildlife populations (Alexander et al. 2005; Forman and Alexander 1998; Trombulak and Frissell 2000). Road locations with abnormally high wildlife mortality are classified as roadkill hotspots. The number of roadkills in a hotspot may vary with time of day, season of the year, or long-term changes in roadside habitat (Clevenger et al. 2001; Conard and Gipson 2006). Factors shown to contribute to an increase in wildlife mortality in these hotspots include vegetative boundaries, landscape features, and road topography (Caro et al. 2000; Coffin 2007; Cristoffer 1991; Jaarsma et al. 2006; Langen et al. 2009). Roadkill hotspots have been observed in both natural and heavily urbanized areas (Boitet and Mead 2014; van Langevelde et al. 2009). Documenting hotspots and correlating their position to a physical feature is the first step in the mitigation process.

In many studies, the identification of roadkill hotspots has focused on specific habitat types. Clevenger et al. (2003) and Kanda et al. (2006) used logistic regression to analyze road mortality in relation to specific habitat types. Conard and Gipson (2006) observed roadkill distribution within defined land cover types and tested the significance of the correlation using a standard chi-square test. They also employed the seasonal movement patterns of animals to predict roadkill hotspots. Neumann et al. (2012) recorded time of day and season to assess hotspot locations. A general additive model was used to statistically determine where these hotspots may occur. Inbar and Mayer (1999) plotted roadkill data points by the length of the roadway in relation to time in a study with a limited number of roadkill. Only a small number of hotspots were found relating to season and time of day, probably due to the small amount of data gathered.

An alternative way of analyzing roadkill data is to calculate the number of roadkill per defined length of roadway (observational bins). This tends to work when there is a large number of observations and a long length of roadway, but tends to not work as effectively with a smaller pool of data with any length of roadway (de Carvalho et al. 2014; Malo et al. 2004). Several studies have used bins of various distance: 0.5 km bins, McShea et al. (1997); 0.8 km bins, Main and Allen (2002); 1.0 km bins, Malo et al. (2004); 1.6 km bins, Inbar and Mayer (1999); and 10.0 km bins, de Carvalho et al. (2014). In each study, the researchers generated line graphs and used peaks to indicate the location of roadkill hotspots. This method appears to work well in correlating roadkills to large scale variables such as habitat type but may be too coarse and fail to identify smaller variables such as changes in road topography or physical roadside features. Additionally, considering bins as separate entities may overlook the clustering of roadkills along the boundary between two adjacent bins. Depicting the roadkill data as a running average may alleviate these two problems. A thorough literature review suggests that this technique has not been used previously to depict roadkill occurrences. Here we consider the usefulness of plotting roadkill data in linear graphs with defined bins or as a continuous running average.

MATERIALS & METHODS

In the current study, a set of 178 roadkill records (93% mammals, 5% birds, and 2% herpetofauna) from a previous study (Boitet and Mead 2014) was used to produce linear graphs of roadkill distribution along the defined survey route. In the aforementioned study, conducted seven years prior to the current study, roadkill locations were recorded via vehicle odometer to the nearest 0.1 mile. To avoid skewing the data with rounding during conversion, distance in the current study was kept in miles due to the use of a standard odometer when initially surveying for roadkill. The study route consisted of three connected roadways (13.3 miles beginning on Highway 212 [4.8 miles], to Lowe-Meriwether Road [4.2 miles], to Highway 441 [4.3 miles]; see Figure 1 in Boitet and Mead 2014) in Baldwin County, Georgia, and observations were made for one year. We constructed three linear graphs with 0.1 mi (0.16 km) bins, 0.5 mi (0.8 km) bins, and as a linear graph with a continuous 0.3 mi (0.48 km) running average (before, at, after). For example, the value calculated for the 0.7 mi point would be the average of roadkills observed from 0.6–0.8 mi. The peaks on the graphs were used to determine the relationship between roadkill location and roadway features such as vegetative boundaries, stream crossings, hills, and curves. Using the road mileage corresponding to the peaks, we observed roadway features by redriving the study route. Since seven years elapsed between studies, historical aerial photographs of the study area were examined for new construction and major vegetational change (Google Earth Historical Images 1/2012 and 3/2018).

RESULTS

The three linear graphs depicting the distribution of the 178 roadkills are shown in Figure 1. The number of peaks varies considerably between the 0.1 mi bins (Figure 1A; *n* = 36) and 0.5 mi bins (Figure 1B; *n* = 6), and between the 0.5 mi bins (Figure 1B; *n* = 6)

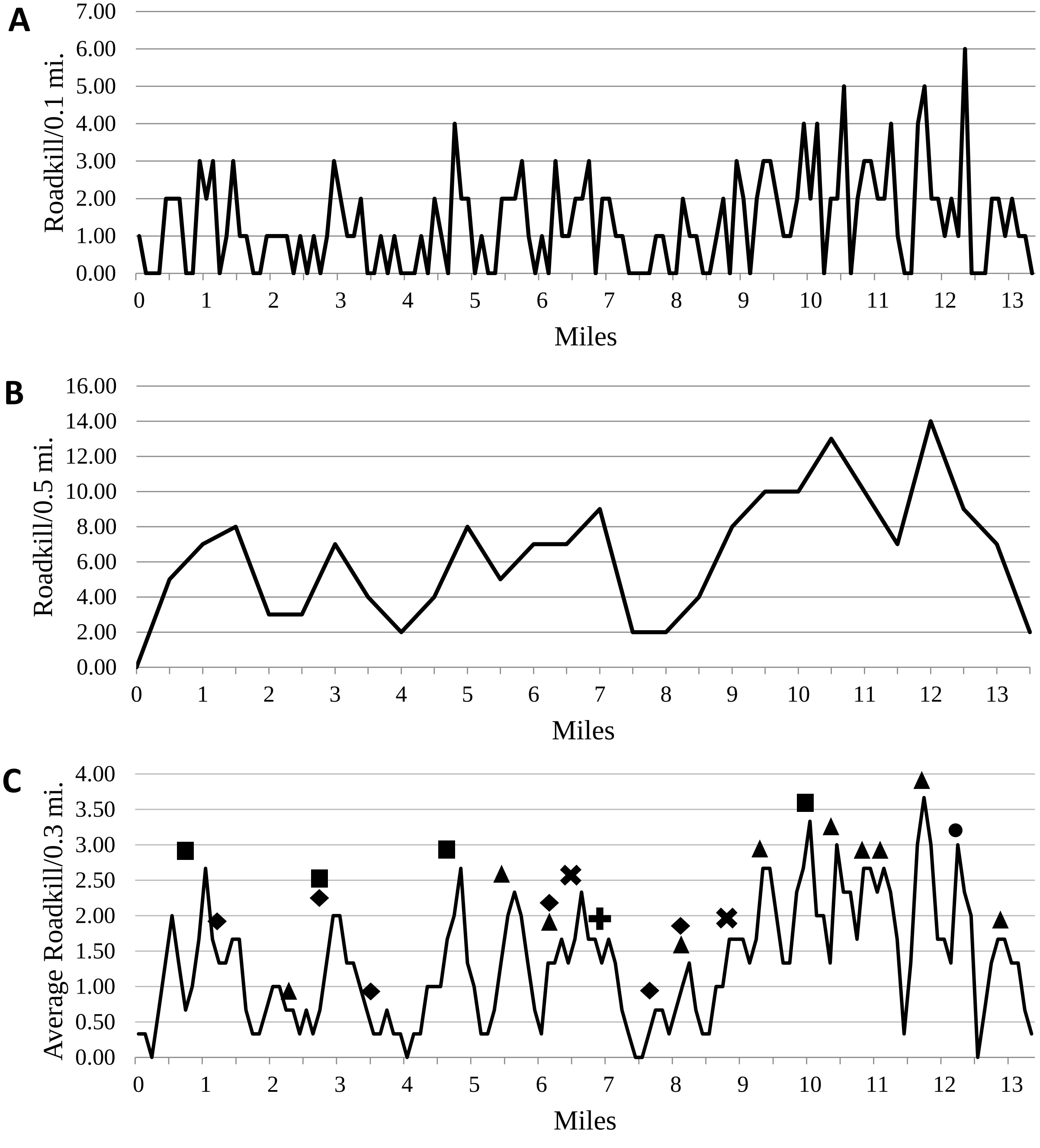

Figure 1. Line graphs depicting roadkill locations along portions of Highway 212, Lowe-Meriwether Road, and Highway 441 in Baldwin Co., Georgia (see Boitet and Mead 2014). Observed roadkill locations are plotted in A) 0.1 mi bins, B) 0.5 mi bins, and C) as a 0.3 mi running average. Symbols indicate the location of road features: ▲ = culvert associated with permanent or ephemeral stream, ◆ = curve, ■ = hill, ✚ = trash dump, ● = pasture/woodland transition, ✕ = no obvious road feature.

and the 0.3 mi running average (Figure 1C; n = 23). By averaging adjoining values, the 0.3 mi running average graph smooths out the 0.1 mi graph and reduced the number of peaks by approximately 40% (Figure 1C and 1A). The location of roadside features correspond most clearly with peaks in the running average graph compared with the 0.1 and 0.5 mi bins. In the 0.5 mi plot, of the six peaks evident in Figure 1B, only half correspond with discernable influencing features. None of the peaks correspond with culverts associated with permanent or ephemeral streams. By contrast, for the running average plot, twenty-one of the twenty-three peaks align with discernable road features. Ten of the hotspots were located where permanent or ephemeral streams crossed under the roadway, three were associated with either side of a hilltop, three were at curves, two were located near culverts on curves, one was located at a curve on a hill, one was located at a small trash dump, one was located at a pasture/woodland edge, and two displayed no noticeable roadside features. Comparisons of the aerial photographs of the study area indicate three large tree-lots were harvested after the initial study and prior to the current study. However, these areas do not correspond to hotspot peaks for which we saw no obvious influencing road feature.

DISCUSSION

Previous studies have demonstrated the association of roadkill hotspots to roadside features. Places where streams go under the roadway have been shown to be primary areas of wildlife-vehicle collisions (Boitet and Mead 2014). Oversized culverts have been used as mitigation techniques to reduce roadkills at these locations, however Aresco (2005) found that most animals try to cross the road instead of using culverts. Curves and hills are secondary factors leading to roadkill hotspots. These locations prevent drivers from seeing animals in the road due to the limited line of sight, especially in the evening and night hours. Likewise, some animals are more likely to be hit at the bend of a curve, rather than before or after a curve (Clevenger et al. 2003). With the two features combined, the assumption can be made that a curve and hill combination is dangerous for wildlife.

Plotting the roadkill data in 0.1 mi bins produced the highest number of peaks. However, this method appeared to produce many peaks in locations that do not correlate directly with noticeable road or landscape features. This may be a reflection of a relatively small number of roadkills spread over a relatively long length of road. Additionally, roadkill occurrence may be higher on either side of a road feature, such as a stream or hill, rather than directly at the feature. If this occurs, the graph would show two peaks, and therefore two influencing features, when only one road feature is actually present. For example, in Figure 1A, two peaks are evident at 1.0 mi and 1.2 mi. The top of a steep hill is located in between at 1.1 mi. On this stretch of road, as vehicles crest the top of the hill at night, their headlights are directed above the upcoming section of road, decreasing the likelihood of detecting wildlife in the roadway.

Plotting the roadkill data in 0.5 mi bins greatly reduced the number of peaks. However, it appeared to be too coarse of an analysis to pick up on the influence of road features such as stream crossings, hills, and curves. Plotting the roadkill data in a 0.3 mi running average produced a graph with the highest number of peaks that correspond with influencing road features. This analysis illustrates that the running average is a good technique to accurately and efficiently identify hotspot locations. No prior knowledge of GIS or advanced statistics is needed to create a running average plot. Easily correlating roadkill hotspots with roadway features may help resource managers decide where to implement mitigation techniques to decrease wildlife mortality.

ACKNOWLEDGEMENTS

Dennis Parmley, Heidi Mead, and Melony Mead provided helpful comments on earlier drafts of this manuscript. This manuscript benefited from critical reviews by two anonymous reviewers.

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