MURAJ
Minnesota Undergraduate Research & Academic Journal
z.umn.edu/MURAJ

Traffic Volumes Impact Sex Ratios of Painted Turtle Populations in Ramsey County

By Annika Hellerud[1]

[1] *Department of Fisheries, Wildlife, and Conservation Biology, University of Minnesota – Twin Cities*

Abstract: Road mortality is currently one of the biggest threats to freshwater turtle populations. Female turtles cross roads more frequently than male turtles in order to nest, meaning they are more prone to road mortality. Ramsey County is a particularly useful place to study road-induced turtle mortality due to its diverse landscape with a variety of traffic volumes, road densities, and wetland areas. Our goal was to determine the extent to which the sex ratio of Ramsey County painted turtle populations can be explained by the traffic volume of nearby roads. We also asked if these relationships differed with age and distance from habitat to the nearest road. We placed hoop traps in six wetlands, and sampled turtle populations from mid-May through early August. Wetlands near higher traffic volume roads were more likely to have a male-biased sex ratio. Female turtles were found across a greater range of wetlands near roads with higher traffic volumes and across a larger range of distance to nearby habitats. Additionally, sex ratios varied greatly between different ages, with most captured adults being female and most juveniles being male. None of these results were statistically significant, however. Future work should continue to investigate the relationship between sex ratios and traffic volume, as well as the sex ratios within age structures of populations. In order to obtain an adequate sample size, future research should have multiple trapping seasons.

Introduction

One of the most significant threats to turtle populations in Minnesota, and globally, is road mortality (Gibbs and Shriver, 2002). Turtles often cross roads as a part of seasonal migration, or to find nesting sites (Arseco 2005a; Arseco 2005b). Female turtles travel greater distances and are more likely to cross roads than male turtles; as a result, females are more prone to road mortality (Steen & Gibbs, 2004; Steen, 2006). Gibbs and Steen looked at trends in sex ratios of aquatic and terrestrial turtle species from 1928-2003, and found that sex ratios (the proportion of male to female turtles in a population) are more male biased in areas with higher road

densities (2005). The same study found that aquatic turtle species were more prone to male biased populations, because movement differentials between males and females are higher than in terrestrial turtle species. Turtles are key members of the ecosystems they live in as they play crucial roles in trophic structures, mineral cycling, seed dispersal, and soil dynamics (Lovich, 2018). While previous work has assessed the relationship between road density and sex ratios, few authors have assessed the relationship among traffic volume, distance to nearby roads and sex ratio of turtle populations. Additionally, limited research on sex ratios in turtle populations, specifically in relation to road mortality, has been conducted in Ramsey County.

In this study, six hoop traps were set out in wetlands across Ramsey County from May through August 2023. Hoop traps are elongated cylindrical nets supported by two smaller hoops fitted with valves so turtles could passively swim into them, but not exit, and be easily released without harm. Ramsey County has a diverse landscape, with a mixture of traffic volumes, road densities, and wetland areas. Coupled with the fact that limited research has been conducted in this area, Ramsey County is an ideal location to examine sex ratios in turtle populations. This paper asks the extent to which the sex ratio of Ramsey County painted turtle populations can be explained by the traffic volume of nearby roads. Further, we ask if this relationship differs with age and distance from habitat to the nearest road. The findings of our research may lead to conservation actions being taken with these turtle populations in mind. If populations near high-volume roads are male-biased, that information could be used to locate interventions. For example, staff from the Minnesota Zoo are using mitigation measures like U-shaped fences and aquatic culverts to advance turtle conservation. Our research could make their work more effective by identifying landscape and road attributes where mitigation measures would be most productive. Significantly male-biased turtle populations are expected in wetlands close to roads (<100m), and close to roads with high traffic volumes (>5,000 cars/day). We expect habitats close to roads with low traffic volumes (<5,000 cars/day) will have a slight male bias. Additionally, we expect habitats far away from roads (> 100m) with high traffic volumes will have a slight male bias as well. The results of this work will increase our understanding of the relationship between roads, traffic volume, and turtle sex ratios.

Methods

We placed six hoop traps throughout wetlands in Ramsey County at the following locations: Langton Lake Park, Oasis Park, Tony Schmidt Regional Park, Serita Wetlands, Loeb Lake, and Lake Como. The traps were 60cm x 30cm, and the hoop opening was 18cm wide, large enough for an adult painted turtle to enter. Traps were placed in mid-May and were checked once every three days until mid-August. This timeframe was chosen in accordance with turtle's most active season, as well as the breeding season (Congdon, 1983). Approval to live trap turtles and collect associated data was provided by the University of Minnesota - Ramsey County

IACUC office, protocol number 2212-40598A. For each turtle captured, we recorded its GPS location, species, sex, and age (i.e., hatchling, adolescent, adult). Distance to the nearest road was calculated using Google Earth by placing a point on the map where the hoop trap was located, and using the measuring tool to find distance to the nearest road. Sex of each turtle was determined using external sex characteristics like nail length, size, and tail length (Steen and Gibbs, 2004). Age was estimated by overall size, plastron length, and carapace length. Traffic volumes were obtained using the Annual Average Daily Traffic Volume (AADTV) map from the Minnesota Department of Transportation (2022).

Data were stored in Excel and analyzed using R Studio (R Core Team, 2021). We used linear models, as well as Chi-Square tests to investigate relationships among sex ratios of wetlands, traffic volume of nearby roads, and distance to the nearest road. The response variable was sex ratio in each wetland, and explanatory variables were traffic volume (cars per day) of nearby roads and distance to the closest road (meters). Sex ratios were converted to numeric values by assigning males a value of 0 and females a value of 1. Hatchlings were not included in data analysis because external sex characteristics cannot easily be determined. To calculate the average sex ratio of each wetland, the value (0 or 1) for each turtle was added, and then divided by the number of turtles found in that habitat. The resulting value indicates the proportion of the population that was female (i.e., a ratio of 0.4 indicates that 40% of the turtles found in that wetland were female). Scatter plots and bar charts were created to show relationships between sex ratios, traffic volume, and distance to nearby roads. We interpreted relationships as significant when the P value was less than 0.05.

Results

Turtles were only found in three of our six locations (Sarita Wetlands, Oasis Park, and Tony Schmidt Regional Park). We found 20 turtles among all trap checks; however one capture was a snapping turtle that was not included in data analysis. Of the 19 turtles analyzed, 8 were female, 7 were male, and 4 were too young to determine sex. Among these, 7 were adults, 8 were juveniles, and 4 were hatchlings.

Traffic volume and distance to the nearest road were not determined to have a significant impact on the sex ratios of Ramsey County' painted turtle populations (Table 1). The Chi-Square test on the age and sex distributions did not return a significant value ($p>0.05$, Figure 5). Despite the lack of significance, wetlands near lower traffic volume roads had a higher ratio of females than wetlands near higher traffic volume roads (Figure 1). Wetlands closer to roads had a higher ratio of females than wetlands farther from roads (Figure 2). Females were much more likely to be adults, and juveniles were much more likely to be male (Figure 5). Finally, females were more evenly distributed across habitats with varying traffic volumes and distances to the nearest road (Figure 3; Figure 4).

Discussion

From the data, we found that wetlands near lower traffic volume roads were more likely to have a higher ratio of females (Figure1). Females were also found across a wider distribution of traffic volumes and distance to nearby roads (Figure 1; Figure 2). Additionally, we found that adult females were much more common than adult males, and juvenile males were more common than juvenile females (Figure 5). None of these relationships were statistically significant, however.

Most of our results were consistent with previous research findings. For example, Dorland et al. did not find statistically significant evidence that sex ratios were male biased near high traffic road sites (2014). However, there are notable differences in the literature. No papers we could find describe the large differences in sex ratios at different ages in painted turtle populations. These differences could be a misrepresentation of the population, given that the sample size was small. However, it merits further investigation because such differences in sex ratios in the age structure could have implications for the long-term success of painted turtle populations.

One of the primary limitations of this study was the small sample size. In order to achieve an adequate sample size, future research should be conducted over at least three active seasons in order to obtain an adequate sample size for data analysis. While there were trends in this study that suggest traffic volume and distance to roads may impact painted turtle sex ratios, the sample size was too small to support the initial hypothesis. Additionally, more than six sites should be utilized in order to increase sample size. We recommend future research continue to question the relationships among traffic volume, distance to the nearest road and sex ratios of painted turtles. Based on the small sample size collected, we do suggest future work take place over a longer period of time and with more sites. Researchers should also ask if these relationships differ between turtle species (Dupuis-Désormeaux, 2017). Finally, further investigation of the observed differences in sex in the age structure of the population is warranted. Understanding these relationships and structures will help guide future conservation efforts with midland painted turtles, and other species of aquatic and semi-aquatic turtles.

Supplements

Factor(s)	Test Statistic (F)	P Value
Traffic Volume	2.678	0.349
Distance to Nearest Road	1.228	0.467
Traffic Volume and Distance to Nearest Road	1.605	0.425

Table 1. P values and test statistics (F values) calculated from each linear regression model for each factor that could influence the sex ratios of turtle populations. None of the linear regression models returned a significant P value (i.e., $p>0.05$).

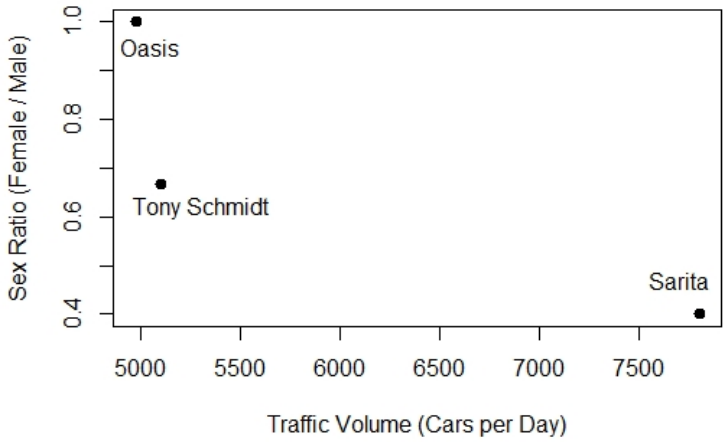

Figure 1. Sex ratios (female/male) at three different wetlands in the Ramsey County area in relation to the traffic volume of the nearest road. The wetland with the highest ratio of females had the highest traffic volume, and the wetland with the lowest ratio of females had the lowest traffic volume.

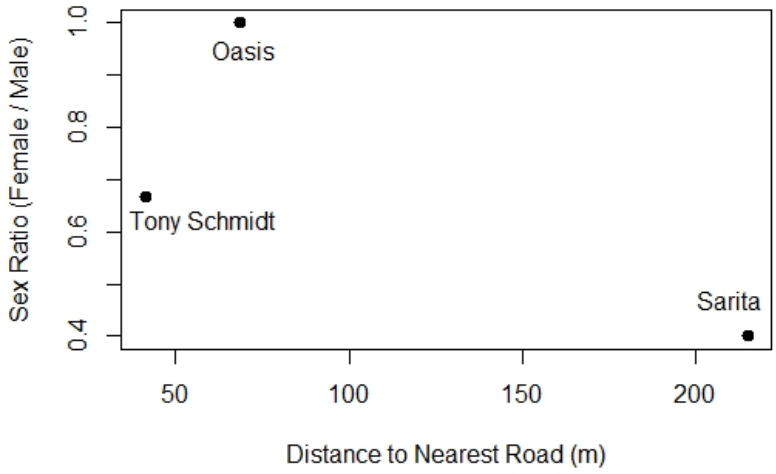

Figure 2. Sex ratios (female/male) at three different wetlands in the Ramsey County area in relation to the distance (in meters) of the nearest road. The wetland that was furthest from a road had the lowest ratio of female turtles.

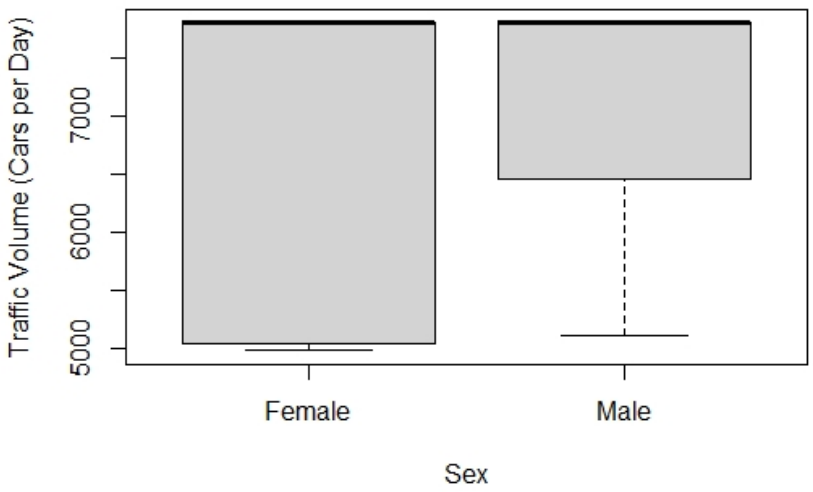

Figure 3. Boxplot showing the distribution of female and male turtles across different traffic volumes. Females were more likely to be found at all traffic volumes, while males were mostly found in areas with higher traffic volumes.

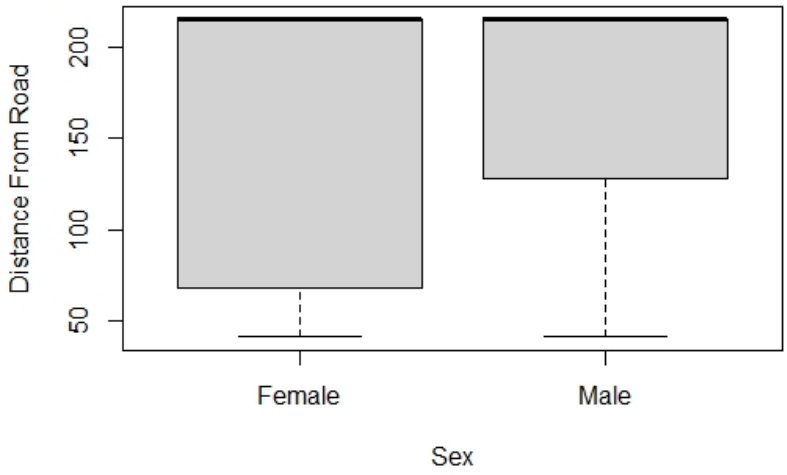

Figure 4. Boxplot showing the distribution of female and male turtles across different distances to nearby roads. Females were more likely to be found at all distances, while males were mostly found in areas that were farther from roads.

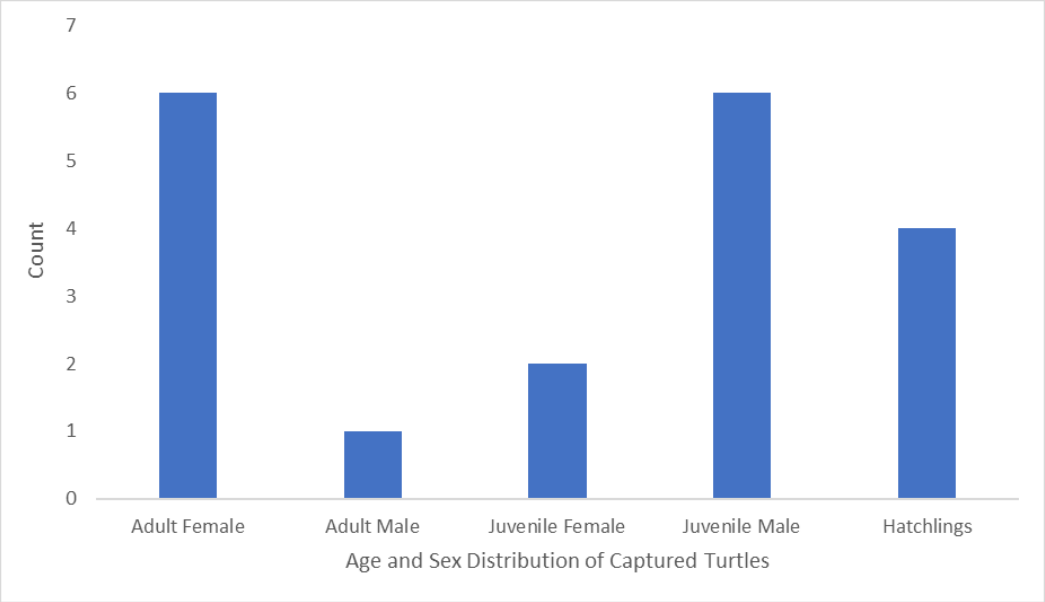

Figure 5. Counts of age and sex for turtles found during surveys. Most adults found were female, and most juveniles found were male. The Chi-Square test conducted to determine if there was a significant difference in age distribution than what would be expected due to chance was found to be not significant, with a P value of 0.242.

References

Aresco, M.J., 2005a. The Effect of Sex-Specific Terrestrial Movements and Roads on the Sex Ratio of Freshwater Turtles. Biological Conservation 123, 37–44. https://doi.org/10.1016/j.biocon.2004.10.006

Aresco, M.J., 2005b. Mitigation Measures to Reduce Highway Mortality of Turtles and Other Herpetofauna at a North Florida Lake. Journal of Wildlife Management 69, 549–560. https://doi.org/10.2193/0022-541X(2005)069[0549:MMTRHM]2.0.CO;2

Congdon, J.D., Tinkle, D.W., Breitenbach, G.L., 1983. Nesting Ecology and Hatching Success in the Turtle Emydoidea blandingi. Herpetologica 39(4), 417-429. https://www.jstor.org/stable/3892538

Congdon, J.D., 1993. Delayed Sexual Maturity and Demographics of Blanding's Turtles (Emydoidea blandingii): Implications for Conservation and Management of Long-Lived Organisms. Conservation Biology 7(4), 826-833. https://www-jstor-org.ezp3.lib.umn.edu/stable/pdf/2386814.pdf?refreqid=excelsior%3A34e260cb305ba264089f8d76233e6739&ab_segments=&origin=&acceptTC=1

Congdon, J.D., Dunham, A.E., Sels, R.C.V.L., 1994. Demographics of Common Snapping Turtles (Chelydra serpentina): Implications for Conservation and Management of Long-lived Organisms. American Zoologist 34, 397–408. https://doi.org/10.1093/icb/34.3.397

Congdon, J.D., Tinkle, D.W., Breitenbach, G.L., 2022. Nesting Ecology and Hatching Success in the Turtle Emydoidea blandingii. Herpetologica 239(4), 417-429. https://www-jstor-org.ezp1.lib.umn.edu/stable/3892538?sid=primo#metadata_info_tab_contents

Dupuis-Désormeaux, M., D'Elia, V., Cook, C., Pearson, J., Adhikari, V., MacDonald, S., 2017. Remarkable Male Bias in a Population of Midland Painted Turtles (Chrysemys picta marginata) in Ontario, Canada. Herpetological Conservation and Biology 12, 225–232. https://www.researchgate.net/publication/316629163_Remarkable_Male_Bias_in_a_Population_of_Midland_Painted_Turtles_Chrysemys_picta_marginata_in_Ontario_Canada

Dorland, A., Rytwinski, T., Fahrig, L., 2014. Do Roads Reduce Painted Turtle (Chrysemys picta) Populations? PLoS ONE 9, e98414. https://doi.org/10.1371/journal.pone.0098414

Gibbs, J.P., Steen, D.A., 2005. Trends in Sex Ratios of Turtles in the United States: Implications of Road Mortality. Conservation Biology 19, 552–556. https://doi.org/10.1111/j.1523-1739.2005.00155.x

Gibbs, J.P., Shriver, W.G., 2002. Estimating the Effects of Road Mortality on Turtle Populations. Conservation Biology 16, 1647–1652. https://doi.org/10.1046/j.1523-1739.2002.01215.x

Lovich, Jeffrey E., et al. "Where Have All the Turtles Gone, and Why Does It Matter?" BioScience, vol. 68, no. 10, Oct. 2018, pp. 771–81. Silverchair, doi:10.1093/biosci/biy095.

Minnesota Department of Transportation, 2022. Annual Average Traffic Volume Map. https://mndot.maps.arcgis.com/apps/webappviewer/index.html?id=7b3be07daed84e7fa170a91059ce63bb.

Moriarty, J.J., 2004. Turtles and Turtle Watching for the North Central States. Minnesota Department of Natural Resources Division of Ecological Services.

R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Steen, D.A., Aresco, M.J., Beilke, S.G., Compton, B.W., Condon, E.P., Kenneth Dodd, C., Forrester, H., Gibbons, J.W., Greene, J.L., Johnson, G., Langen, T.A., Oldham, M.J., Oxier, D.N., Saumure, R.A., Schueler, F.W., Sleeman, J.M., Smith, L.L., Tucker, J.K., Gibbs, J.P., 2006. Relative Vulnerability of Female Turtles to Road Mortality. Animal Conservation 9, 269–273. https://doi.org/10.1111/j.1469-1795.2006.00032.

Steen, D.A., Gibbs, J.P., 2004. Effects of Roads on the Structure of Freshwater Turtle [DJ7] Populations. Conservation Biology 18, 1143–1148. https://doi.org/10.1111/j.1523-1739.2004.00240.