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Mortality of Turtles and Snakes on Rural Roads in Southern Illinois

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ABSTRACT

Roads are a significant source of wildlife mortality as a result of vehicle-wildlife collisions. Vehicular mortality may have negative consequences for reptiles such as skewed sex ratios, population isolation, and population reduction. I examined road mortality of turtles and snakes on 30.5-km of hard-surfaced, rural roads in Johnson and Union counties, Illinois, every spring from 2002–2004. I detected 198 road-killed reptiles composed of 84 turtles (five species) and 114 snakes (11 species). Using the observed mortality rate (0.032 road-killed reptiles/km), I estimate that 3097 turtles and snakes are killed each spring on roads in Johnson and Union counties and 9071 turtles and snakes are killed each spring on roads in the 7-county region of southernmost Illinois. Given an adult bias in road-kills observed during the spring breeding season, the observed rate of mortality may be having negative consequences for turtle and snake populations in southernmost Illinois.

INTRODUCTION

An estimated 19% of the United States land area is ecologically affected by 6.2 million kilometers of public roads (Forman 2000). Negative ecological effects of roads include traffic noise; wildlife mortality; impediment of wildlife movement; runoff pollutants such as de-icing salts and heavy metals that can impact soil, vegetation, and adjoining water bodies; soil erosion; and hydrologic alterations (Forman and Alexander 1998, Forman 2000). Of these road effects, perhaps none is more obvious than wildlife mortality. An estimated one million vertebrates are killed on United States roads each day (Forman and Alexander 1998) and hundreds of billions of pollinating insects are estimated to be killed on North American roads each summer (Baxter-Gilbert et al. 2015).

Reptiles are particularly vulnerable to direct roads effects. Roads can interrupt scent trailing of potential mates (Shine et al. 2004), may increase population isolation as a result of road avoidance behavior (Andrews and Gibbons 2005, Paterson et al. 2019), can generate skewed sex ratios due to differential road mortality (Aresco 2005a, Gibbs and Steen 2005, Steen et al. 2006), and may reduce reptile populations through mortality of breeding adults seeking mates or nesting sites (Bonnet et al. 1999, Gibbs and Shriver 2002, Row et al. 2007). Reptiles are particularly vulnerable to vehicular mortality because they move slowly across roads and may immobilize in response to oncoming vehicles (Andrews and Gibbons 2005, Gooley 2010). Furthermore, reptiles may bask on relatively warm paved-road surfaces increasing the chance of vehicular mortality (Meek 2009, Mccardle and Fontenot 2016). Roads constructed between wetlands, in particular, cause significant mortality in reptiles and create barriers to migration and dispersal (Ashley and Robinson 1996, Aresco 2005b).

In North America, including Illinois, the spring months are a time of increased reptile activity (Gibbons and Semlitsch 1987, Shepard et al. 2008, Garrah et al. 2015). Spring movements may be related to emergence from hibernacula, foraging, mate searching, nesting, or delayed exodus of hatchlings from nests (Ashley and Robinson 1996, Haxton 2000, Gibbons 2013). Extensive movements across the landscape, such as occurs in spring, places reptiles at increased risk of road mortality (Roe et al. 2006, Carfagno and Weatherhead 2008, Cureton and Deaton 2012). In Illinois, reptiles hit by automobiles are brought to rehabilitation facilities with greatest frequency during the spring months (Hartup 1996, Rivas et al. 2014).

For three consecutive years I traveled between Anna and Belknap, Illinois, during the spring months, April through June. During these trips I logged my observations of turtles and snakes on roads. Here, I summarize my observations of road-killed turtles and snakes, calculate the road-kill rate for these taxa, and estimate springtime mortality of these taxa on hard-surfaced roads for the two-county survey area and the seven southernmost counties of Illinois.

METHODS

I conducted this study in extreme southern Illinois, at the junction of the Shawnee Hills and Coastal Plain natural divisions in Johnson and Union counties. Both counties are predominantly rural. Land cover in Johnson County is comprised principally of forest (37.7%), grassland (35.2%), and cropland (17.0%) whereas these same land cover types comprise 40.7%, 28.2%, and 20.4% of Union County (Illinois Department of Natural Resources 1996). Land cover proportions in Johnson and Union counties are representative of the seven counties (Alexander, Hardin, Johnson, Massac, Pope, Pulaski, Union) that comprise the unglaciated region of southernmost Illinois (Illinois Department of Natural Resources 1996).

I observed on-road snakes and turtles as I traveled on hard-surfaced (asphalt and oil/gravel) rural roads between the communities of Anna and Belknap. The 30.5-km long transect stretched from U.S. Route 51, south of Anna (37°25′18.9″N, 89°12′09.2″W), to Karnak Road in Belknap (37°19′23.7″N,

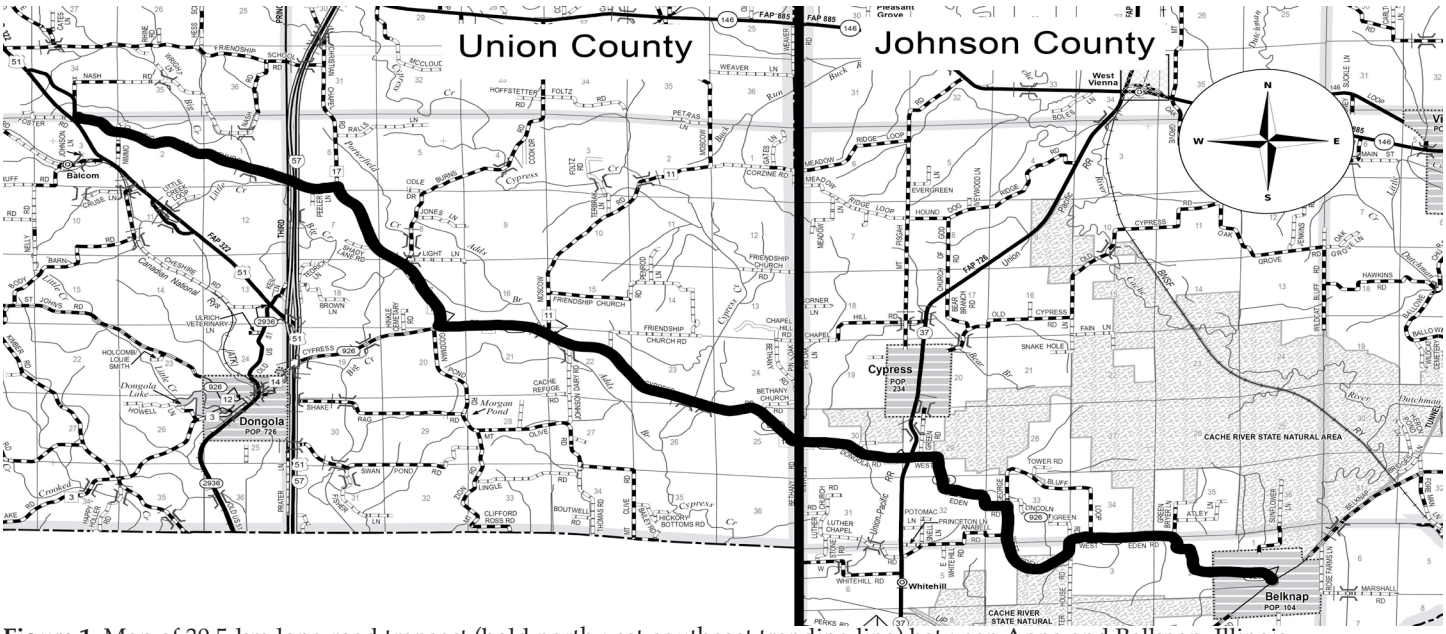

Figure 1. Map of 30.5-km long road transect (bold northwest-southeast trending line) between Anna and Belknap, Illinois.

88°56'22.4"W; Fig. 1). Roads comprising the transect included Big Creek Church Road, Christian Chapel Road, Cypress-Dongola Road, and West Eden Road. Cypress-Dongola Road was 7 m wide; the other roads were 6 m wide. Daily traffic volumes on these roads in 2005 or 2006 ranged from 125-650 vehicles per day (Illinois Department of Transportation 2021; Table 1). Proportions of undeveloped and agricultural land cover types adjacent to the transect differ somewhat from Johnson and Union counties overall, with less forest (13.4%), but more grassland (43.1%) and cropland (37.7%). Grasslands were comprised of pastures, hayfields, fallow fields, and residential lawns whereas croplands included rotations of corn (*Zea mays*), soybeans (*Glycine max*), and wheat (*Triticum aestivum*).

Table 1. Length and traffic volume (2005 or 2006) of road segments comprising the 30.5 km-long transect in Johnson and Union, Illinois. Traffic volume of Cypress-Dongola Road and West Eden Road varied depending upon road section.

Road	Road Segment	Segment Length (km)	Traffic Volume (vehicles/day)
Big Creek Church Rd (BCCR)	U.S. Route 51 to CCR	5.6	250
Christian Chapel Rd (CCR)	BCCR to CDR	4.0	275
Cypress-Dongola Rd (CDR)	CCR to State Route 37	10.4	500-650
West Eden Rd	State Route 37 to Karnak Rd	10.5	125-250

I traveled the route at various times between 0700 and 1910 hr, 1-2 times per day, 10 to 14 consecutive days per month, in April, May, and June 2002, 2003, and 2004, for a total of 203 transects during 108 days (average = 1.88 transects per day). I drove at or below the posted speed limits (≤ 88.5 km/hr). For each road-killed reptile encountered I recorded species, life stage (adult or juvenile based on size as well as color pattern for ontogenetically dimorphic species), and distance from the nearest landmark such as road intersection, stream crossing, or county line. Although I removed some carcasses from the road surface, others were left in place. In the latter case, I used the recorded location of each road-killed reptile to prevent recounting dead animals that remained on the road during subsequent trips. I used chi-square analyses to determine whether road-killed adults or juveniles were encountered equally.

RESULTS

During April through June, 2002 through 2004, I encountered 198 road-killed turtles and snakes over 6191.5 km of road (0.032/km) composed of 84 individuals of five turtle species (0.014/km) and 114 individuals of 11 snake species (0.018/km; Table 2). The most frequently encountered turtles included Eastern Box Turtles (*Terrapene carolina*) and Pond Sliders (*Trachemys scripta*) (combined = 69.0% of all turtles) whereas the most frequently observed snakes included North American Racers (*Coluber constrictor*), Plain-bellied Watersnakes (*Nerodia erythrogaster*), and Gray Ratsnakes (*Pantherophis spiloides*) (combined = 63.1% of all snakes; Table 2). Although road-killed snakes were dominated by adults (86.5%; $X^2 = 61.895$, $p < 0.0001$), juvenile (47.7%) and adult turtles (52.3%) were killed in similar numbers ($X^2 = 0.19$, $p = 0.6625$). The species of turtles and snakes observed dead-on-road included five species not observed alive-on-road (*Agkistrodon contortrix* [Eastern Copperhead], *Nerodia rhombifer* [Diamond-backed watersnake], *Nerodia sipedon* [Common Watersnake], *Storeria dekayi* [Dekay's Brownsnake], and *Thamnophis sirtalis* [Common Gartersnake]).

The estimated daily turtle and snake road-kill encounter rate for the transect is 1.829/day or 166 individuals (70 turtles and 96 snakes) each spring (April through June). Assuming the reptile community in the vicinity of the transect is representative of the area, the daily turtle and snake road-kill rate for 1067 km of hard-surfaced roads in Johnson and Union counties (Illinois Department of Transportation 2016) is estimated at 34.037/day or 3097 individuals (1311 turtles and 1786 snakes) each spring, and 99.687/day or 9071 individuals (3839 turtles and 5232 snakes) each spring for 3125 km of hard-surfaced roads in the seven-county southernmost Illinois region (Illinois Department of Transportation 2016).

Table 2. Number of road-killed turtles and snakes detected on 30.5-km length of rural roads in Johnson and Union counties, Illinois, April–June, 2002–2004.

		Year				
		2002	2003	2004	Total	% Adult
Turtles	*Chelydra serpentina* (Snapping Turtle)	6	3	2	11	72.7
	Chrysemys picta (Painted Turtle)	3	9	2	14	71.4
	Sternotherus odoratus (Eastern Musk Turtle)	0	1	0	1	100
	Terrapene carolina (Eastern Box Turtle)	15	5	9	29	58.6
	Trachemys scripta (Pond Slider)	5	21	3	29	38.1
	Total Turtles	29	39	16	84	52.3
Snakes	*Agkistrodon contortrix* (Eastern Copperhead)	0	1	0	1	100
	Agkistrodon piscivorus (Northern Cottonmouth)	4	1	5	10	80.0
	Coluber constrictor (North American Racer)	24	10	9	43	100
	Lampropeltis nigra (Eastern Black Kingsnake)	1	2	4	7	85.7
	Nerodia erythrogaster (Plain-bellied Watersnake)	6	4	4	14	64.3
	Nerodia rhombifer (Diamond-backed Watersnake)	1	2	0	3	66.6
	Nerodia sipedon (Common Watersnake)	1	1	1	3	100
	Opheodrys aestivus (Rough Greensnake)	7	1	3	11	100
	Pantherophis spiloides (Gray Ratsnake)	9	3	3	15	60.0
	Storeria dekayi (Dekay's Brownsnake)	0	1	0	1	100
	Thamnophis sirtalis (Common Gartersnake)	4	2	0	6	100
	Total Snakes	57	28	29	114	86.8
	Total Reptiles	86	67	45	198	72.2

DISCUSSION

Annual reptile activity is often unimodal or bimodal in temperate North America, with greatest activity typically occurring during the spring months (Gibbons and Semlitsch 1987). Reptiles moving across roads during spring are often dominated by adults (Bonnet et al. 1999). With the exception of Pond Sliders, my springtime observations follow this general pattern with adults dominating the count. Sixty-two percent of Pond Sliders were hatchlings, possibly representing a delayed exodus from nests (Gibbons 2013). When Pond Sliders are removed the calculations, road-killed turtles are dominated by adults ($X^2 = 5.255$, $p = 0.0219$).

Adult road-kill bias can have consequences for reptile populations. For example, turtle populations may be reduced as a result of road mortality (Gibbs and Shriver 2002, Crawford et al. 2014) or male-biased due to greater mortality of nesting females (Aresco 2005a, Gibbs and Steen 2005, Steen et al. 2006). Both chronological road-cruising and modelling suggest that snake populations are also vulnerable to decline as a result of adult road mortality (Rosen and Lowe 1994, Row et al. 2007). Even low-traffic roads (van Langevelde et al. 2009), such as those driven during my study, can have negative impacts to reptile populations (Winton et al. 2020).

For several reasons, my calculated springtime mortality rate for turtles and snakes for Johnson and Union counties, and for the 7-county region, likely underrepresents actual mortality rates. The number of road-killed animals observed is likely underestimated as injured animals may move off the road before they die (Row et al. 2007) or road-killed animals may quickly be scavenged (Hels and Buchwald 2001, DeGregorio et al. 2011). In southern Illinois, road-killed reptiles are scavenged by American Crows (*Corvus brachyrhyncos*) and vultures (*Cathartes aura* and *Coragyps atratus*) by day and Virginia Opossums (*Didelphis virginiana*), Striped Skunks (*Mephitis mephitis*), and Northern Raccoons (*Procyon lotor*) by night (personal observations). In addition, smaller species and individuals (e.g., juveniles) may go undetected from a moving vehicle (Fitch 1949, Dodd et al 1989), thus reducing the total number of road-kills observed. Furthermore, my county and region-level estimates of springtime road-killed turtles and snakes is likely low because it does not include gravel roads.

My calculated reptile road-kill encounter rate of 0.032/km is very similar to rates of other studies of reptile road mortality conducted in Illinois (Tucker 1995: 0.033/km) and Indiana (Glista et al. 2007: 0.095/km and Glista & DeVault 2008: 0.034/km). Whether southern Illinois populations of reptiles have already been reduced or can persist longterm at observed road-kill rates is unknown. However, given the frequency of road-killed adults observed in my study, road mortality may be having adverse effects on turtle and snake populations in southernmost Illinois, at least in the vicinity of roads. My observations may be biased, however, as larger road-killed individuals (i.e., adults) and taxa are more likely to be detected from a moving vehicle than smaller individuals (i.e., juveniles) and taxa (Langen et al. 2007). Potential bias notwithstanding, the number of road-killed individuals encountered—whether adult or juvenile—is cause for concern, especially for long-lived, slow-maturing taxa such as turtles because decreased survival of either adults or juveniles can destabilize turtle populations (Congdon et al. 1993, 1994). My observations suggest that investigating road mortality effects on reptile populations in the region is warranted. Recommendations for further study include employing additional methodologies such as walking-sur-

veys, lengthening the survey period to encompass the entire annual reptile activity period, and investigating reptile abundance at varying distances from roads.

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