THE STATE UNIVERSITY OF NEW YORK
Potsdam

Final Report: Testing the effectiveness of turtle crossing signs as a conservation measure.

To: Peter O'Shea, St. Lawrence River Research and Educational Fund
cc: Maria Toirac, New York Power Authority

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Introduction

Paved road networks have been implicated in causing declines of many reptile and amphibian populations through habitat fragmentation and direct mortality (Ashley and Robinson 1996, Mitchell and Klemens 2000, Trombulak and Frissell 2000, Carr and Fahrig 2001, Smith and Dodd 2003, Semlitsch 2003). Turtles are notorious for high levels of road mortality caused by terrestrial migrations to breeding, wintering or summering habitat (Aresco 2005, Gibbs and Shriver 2002, Steen and Gibbs 2004, Borman and Sazaki 2006, Beaudry et al. 2008).

Blanding's turtles are currently officially listed as a Threatened Species in New York State and the New York State Department of Environmental Conservation (NYSDEC) is charged with the responsibility to develop recovery plans and identify management needs for Blanding's turtles. This species of large, semi-aquatic turtle appears to be near the limits of its eastward range in northern New York (Petokas and Alexander 1993, Johnson and Wills 1997), where they typically inhabit shrub swamps, including wetlands adjacent to and influenced by the St. Lawrence River and most tributaries in St. Lawrence and Jefferson counties. Nesting occurs in areas with exposed sandy substrates and may be up to 2 km from resident wetlands. Blanding's turtles are late to mature, reaching sexual maturity between 13 and 20 years of age, and may not breed annually, thus limiting their reproductive potential (Congdon *et al*. 1993). Nest success is very low, and in some years up to 90% of nests fail, typically due to predation by

mammalian carnivores (Congdon et al. 1983, Johnson and Crockett 2009). Given these demographic parameters, loss of just a few adult female Blanding's turtles from a local population can have huge negative impacts on population viability.

Mitigation measures designed to reduce the impact of roads on wildlife populations and reduce animal-vehicle collisions, include barriers to prevent movement across roads, ecopassages over or under roads, warning signs designed to alter driver behavior by reducing speed or increasing awareness, and a variety of mechanisms to alter animal behavior, primarily targeted to ungulates (Forman et al. 2003). Here we investigated some aspects of the effectiveness of signs. We installed turtle crossing signs immediately prior to the nesting season for Blanding's turtles when movement rates are high and removed them at the end of the nesting season (about 1 month). It was expected that signs would be a novel feature on the roadway for both regular and occasional drivers of the selected routes, thereby resulting in lower vehicle speeds and decreased turtle mortality.

The major objective of this SLREEF project was to determine the effectiveness of turtle road crossing signs in decreasing both driver speeds and turtle mortality at 3-4 previously-identified hotspots of mortality for Blanding's turtle (*Emydoidea blandingii*) and other turtle species.

Methods

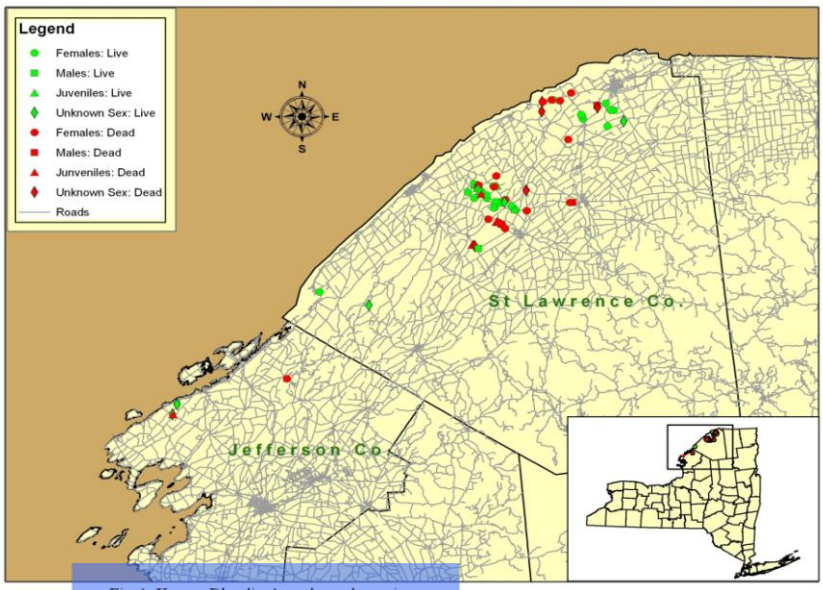

Fig. 1. Known Blanding's turtle road crossings in the North Country of New York State

The study area includes paved roads in St. Lawrence County, NY that were selected for survey based upon the known or purported occurrence (n = 110) of road kill and/or sightings of Blanding's turtles on roads (Fig. 1). Over the period 2008 - 2010, we conducted driving and walking surveys (methodology below) along stretches of 20 routes in

St. Lawrence County where at least one Blanding's turtle mortality had been observed since 2005.

We used two measures to determine the potential influence of turtle crossing signs: (1) road mortality and (2) average driver speed. We collected this information on 9 road stretches in 2008 (a 10th road was added in 2009) prior to signs being erected and again in 2009, when signs were placed along 5 roads. We increased the number of survey route roads to 15 in 2010. Signs (see Appendix) were placed on some routes on 1 June and removed on 31 June. They were set on poles with angled bottoms buried 0.5 m into the soil to discourage removal by vandals. Sign installation was supervised by state or county DOT personnel or town Highway Departments. It was expected that these signs will be a novel feature on the roadscape and this time frame coincides with the maximum movement of female Blanding's turtles in northern New York (Johnson and Crockett 2009). Determination of whether a route will be a signed or unsigned route was determined randomly.

To quantify the magnitude of turtle mortality, we conducted both driving and walking surveys, where all wildlife, dead or alive, encountered on the road was tabulated. The driving surveys were conducted using a defined methodology that Partner T. Langen has devised and tested (Langen et al. 2007; e.g. driving speeds under 45 km/h, two surveyors per vehicle). Dead animals were removed from the roadway to prevent double counting. Driving surveys were conducted daily over the 30 day period, while walking surveys were conducted 1-2 times each week over the period 1 June-1 July. For walking surveys, at each survey point, we delineated a 50 m transect and walked in each direction from the center point, for a total road transect length of 100 m. Survey points at the 10 routes were located at the presumed center of each. Surveyors walked each side of the road, and tabulated any dead reptile or amphibian. For both surveys types, each animal found dead on the road was identified, and the precise location ($\pm$ 5m) was recorded using a Global Positioning System (GPS) with a Wide Area Augmentation System (WAAS) correction (spatial accuracy typically ± 5 m). Living animals detected crossing the road or walking along the roadside verge were also recorded.

Speed surveys were conducted at each route in mid-June in 2008 and 2009, during each of three time periods; 6-8 am, 4-6 pm, 8-10 pm. Speed was determined with a radar gun. In 2009, we also determined average vehicle speed at a point 1- 3 km away from the road stretch with

signs. In 2009 we also conducted speed surveys at each route 14 days after signs were removed.

Comparisons were made of turtle crossing events, average vehicle speed and traffic volume between routes with signs and routes without signs, both within 2009 and 2010 and between data collected over the period 2008 – 2010 to determine the relative effectiveness of Turtle Crossing signs.

Results

2009: Using date from the Driving Surveys, there was no evidence that there was a difference in road mortality, measured as Dead-On-Road (DOR)/km/day, between roads with signs and roads without (Table 1). Using a repeated measures ANOVA, no differences were detected in the interaction of Year and Treatment ($F = 0.00$; $P = 0.990$). Similarly, Walking Surveys (Table 2) also revealed no detectable significant differences in road mortality between roads with signs and road without signs or between years.

We found no differences in average vehicle speed on all roads with signs during the sign period and after the signs were removed; this relationship held between years as well (Fig. 2). Similarly, there was no detectable significant difference between average vehicle speed in the road stretch 2- 3 km before encountering a crossing sign and within the stretch bounded by crossing signs (Fig. 3). Highest average vehicle speed and traffic volumes were observed, as expected, along state highways.

Data collected during the 2008 and 2009 surveys revealed that painted turtles were the most commonly observed turtle species, dead or alive, on both the walking and driving transects. Blanding's turtles were the least common road kill turtle found (Table 1). In 2008, 11 Blanding's turtles (5 DOR) were detected on survey routes and 8 Blanding's turtles (4 DOR) were detected in 2009. At one location, 7 Blanding's turtles were detected, suggesting a hotspot of road crossing.

Turtle crossing signs used for this study were different depending on whether the sign was erected along a county road (allowed use of silhouette) or state highway (did not allow use of silhouette). State highways are restricted to use of signs with Federal Highway Administration approval; the sign with the turtle silhouette was not approved as of June 2009.

At two of the five routes with signs, theft and vandalism was a significant factor in evaluating their effectiveness. At one route (County Route 30) signs were repeatedly stolen and defaced by gunshots despite replacement.

At one survey site (County Route 310 in Norfolk), we detected one hotspot of mortality, where 6 Blanding's turtles were encountered (5 DOR) during the survey period in 2008.

2010:

We found no evidence to detect a difference in Blanding's turtle road mortality, measured as Dead-On-Road (DOR)/km/day, between roads with signs (n = 8) and roads without (n = 9) (Table 3). Using a repeated measures ANOVA, no differences were detected in the interaction of Year and Treatment ($F = 0.00$; $P = 0.910$). Similarly, Walking Surveys (not shown) also revealed no detectable significant differences in road mortality between roads with signs and road without signs or between years. Similar results were detected on 10 routes surveyed in 2009.

We found no differences in average vehicle speed on all roads with signs during the sign period and after the signs were removed except along State Highway 68, where mean speed increased after sign removal (Table 4); this relationship held between years as well. Similarly, there was no detectable significant difference between average vehicle speed in the road stretch 1.0 km before encountering a crossing sign and within the stretch bounded by crossing signs. Highest average vehicle speed and traffic volumes were observed, as expected, along state highways (Table 5). We also found no difference in mean driving speed along control routes without signs except along 3 lightly travelled roads.

Table1. Average hourly traffic volume (measured in 2009) and turtle road mortality measures from driving surveys in 2008 and 2009 in St. Lawrence County, New York.

Route		2008	2008	2008	2008	2009	2009	2009	2009
	Average Hourly Traffic Volume (Car/hr)	DOR All turtles (Blanding's turtles)	Live and DOR	Proportion DOR	DOR/ km/ day	DOR All turtles (Blanding 's turtles)	Live and DOR	Proportion DOR	DOR/km/ day
No Signs									
Irish Settlement	7.0	2 (0)	17	0.12	0.013	5 (0)	23	0.22	0.030
Swamp Rd	12.7	0 (0)	1	0.00	0.000	1 (1)	2	0.50	0.023
CR 27	78.7	1 (0)	1	1.00	0.046	2 (1)	4	0.50	0.088
CR 37	259.3	4 (0)	5	0.80	0.080	3 (0)	4	0.75	0.054
SH 56	93.3	-	-	-	-	5 (0)	5	1.00	0.200
Subtotal		7 (0)	24	0.29		16 (2)	38	0.42	
Sign	**Added**	**2009**							
Potsdam Morley Rd	70.0	1 (0)	3	0.5	0.029	4 (2)	5	0.80	0.107
CR 30	25.7	0 (0)	0	0.0	0.000	0 (0)	0	0.00	0.00
CR 39	42.3	4 (1)	7	0.63	0.055	7 (0)	12	0.58	0.080
SH 68	668.0	12 (1)	13	0.94	0.213	14 (0)	23	0.61	0.231
SH 310	123.3	3 (0)	8	0.46	0.077	1 (0)	2	0.50	0.024
Subtotal		20 (2)	31	0.69		26 (2)	42	0.62	

Table 2. Turtle road mortality measures from walking surveys in 2008 and 2009 in St. Lawrence County, New York.

Route	2008	2008	2008	2008	2009	2009	2009	2009
	DOR All turtles (Blanding's turtles)	Live and DOR	Proportion DOR	DOR/km	DOR All turtles (Blanding's turtles)	Live and DOR	Proportion DOR	DOR/km
No Signs								
Irish Settlement	1 (0)	2	0.50	1.66	0 (0)	3	0.00	0.00
Swamp Rd	1(1)	1	1.00	0.71	0 (0)	0	0.00	0.00
CR 27	0 (0)	0	0.00	0.00	0 (0)	0	0.00	0.00
CR 37	2 (0)	2	1.00	1.43	5 (0)	5	1.00	2.50
SH 56	-	-	-	-	7 (0)	7	1.00	4.38
Subtotal	4 (1)	5	0.80		12 (0)	15	0.80	
Sign	**Added**	**2009**						
Potsdam Morley Rd	1 (0)	1	1.00	1.00	3 (0)	3	1.00	1.66
CR 30	0 (0)	0	0.00	0.00	1 (0)	1	1.00	0.50
CR 39	1 (0)	1	1.00	1.25	4 (0)	9	0.44	2.50
SH 68	4 (0)	4	1.00	5.00	15 (0)	16	0.94	8.33
SH 310	3 (2)	5	0.40	5.00	0 (0)	1	0.00	0.00
Subtotal	9 (2)	11	0.82		23 (2)	30	0.77	

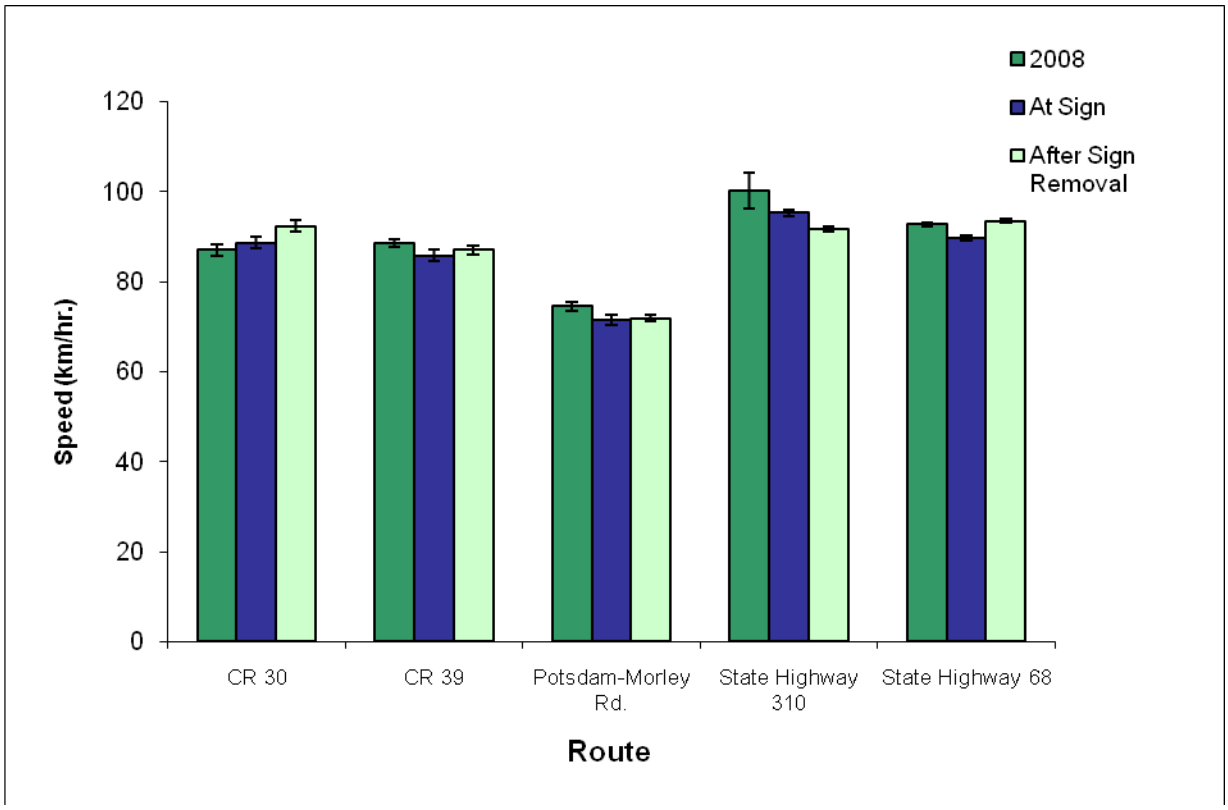

Figure 2. Average driving speed detected along routes with signs installed 1 – 31 June 2009 in St. Lawrence County in June 2008, in June 2009 and July 2009 following sign removal.

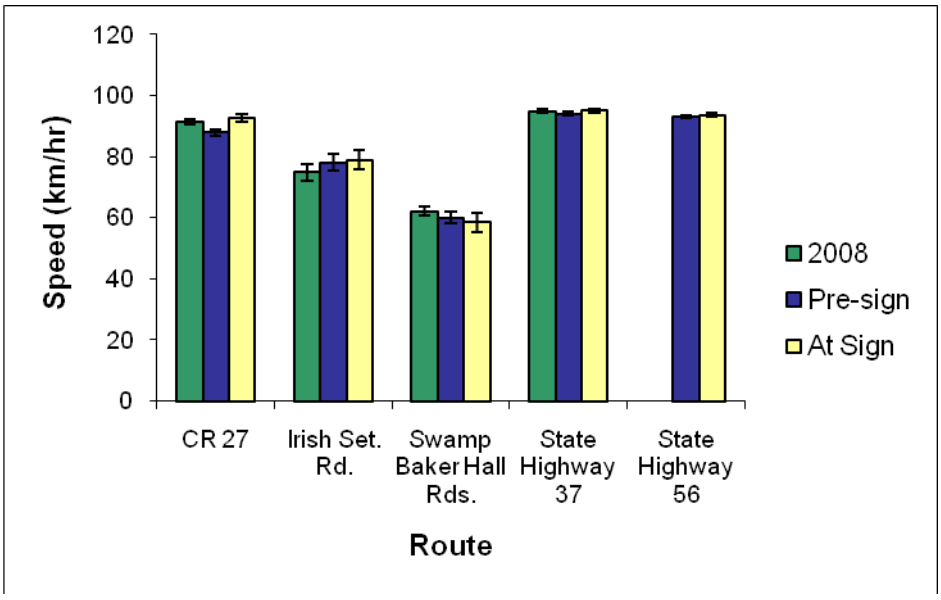

Figure 3. Average driving speed detected along routes without signs installed in St. Lawrence County in June 2008, in June 2009 at intended sign location, and 1-2 km away from the intended sign location.

Table 3. Turtle road mortality measures from Driving surveys in 2010 in St. Lawrence County, New York.

Route	Average Hourly Traffic Volume (vehicles/hr)	DOR all turtles Blanding's	Live and DOR	Proportion DOR	DOR/km/day
No Signs					
Irish Settlement	12.0	3 (0)	7	0.43	0.026
Swamp Rd	14.0	0 (0)	2	0.00	0.000
CR 27 (Lisbon)	56.4	1 (1)	21	1.00	0.036
SH 37	235.3	3 (0)	3	1.00	0.107
SH 56	87.3	8 (2)	10	1.00	0.571
Sykes Road	6.4	0 (0)	1 (BT)	0.00	0.000
Tracey Road	12.3	1 (0)	2	0.50	0.036
SH 131	63.5	1 (0)	2	0.50	0.036
Nation Road	3.1	1 (0)	3 (1 BT)	0.50	0.036
Subtotal		**16 (3)**	**28**	**0.57**	
Sign					
Potsdam Morley Rd	50.6	1 (0)	1	1.00	0.036
CR 30	22.7	1 (0)	1	1.00	0.036
CR 39	26.4	4 (0)	6	0.67	0.049
SH 68	420.0	13 (0)	14	0.93	0.464
SH 310	127.7	4 (2)	4	1.00	0.064
CR 27 (Canton)	258.4	19 (0)	21	0.91	0.679
CR 14	52.3	0 (0)	2	0.00	0.000
CR 34	40.2	0 (0)	0	0.00	0.000
CR 27 Brandy Brk	64.3	0 (0)	0	0.00	0.000
Subtotal		**20 (2)**	**31**	**0.69**	

Table 4. Average vehicle speed detected at St. Lawrence County, New York routes with signs during the period signs were in place (June), when signs were removed (mid-July) and 1 km before signs during the during the period signs were up in 2010.

ROUTES with Signs	At Sign Location		1 Km Before Sign
	Signs Up	Signs Down	
CR 27, Canton	79.8 (0.6)	78.3 (1.1)	81.0 (0.6)
SH 310	95.5 (1.0)	95.3 (0.9)	93.6 (0.9)
SH 68	89.2 (0.5)	92.8 (0.7)	90.0 (0.4)
CR 14	91.1 (0.9)	92.1 (0.5)	88.6 (0.9)
Morley – Potsdam	76.7 (1.0)	76.7 (1.3)	67.3 (1.0)
CR 30	89.3 (1.7)	89.6 (0.9)	86.1 (1.9)
CR 34	91.1 (1.1)	92.1 (0.8)	88.5 (1.7)
CR 39	87.0 (1.4)	-	82.3 (1.5)

Table 5. Average vehicle speed detected at St. Lawrence County, New York routes without signs during the period signs were in place (June) and when signs were removed (mid-July) in 2010.

ROUTES without Signs	Signs Up Period	Signs Down Period
Irish Settlement	70.9 (2.1)	85.7 (3.3)*
Sykes Rd.	59.4 (2.9)	72.3 (3.2)*
Tracey Rd.	89.1 (1.5)	80.9 (3.2)*
SR 37	93.4 (0.5)	91.1 (0.8)
SR 56	92.0 (0.6)	89.9 (0.6)
SR 131	89.2 (0.9)	88.4 (1.2)
Swamp / Hall / Baker Roads	**77.0 (2.0)**	**80.0 (3.5)**

*difference detected

Discussion

In general, warning signs used to increase awareness of motorists to areas of high animal crossing frequently have proven to be largely ineffective, particularly for ungulates, primarily because drivers become accustomed to the signs and pay them less and less attention over time (Putnam 1997, Tanner and Perry 2007). However, installing signs for a limited amount of time may increase their effectiveness, where It is expected that signs will then be a novel feature on the roadway for both regular and occasional drivers of the selected routes; this has been shown effective in deer/car collisions (Sullivan et al. 2004). Additionally, limiting signs to times when turtles are most at risk may also increase their effectiveness (Beaudry, et al. 2009).

Based upon our findings, turtle crossing signs show limited utility in reducing turtle mortality, however they may need to be coupled with an effective outreach program to lead to the desired outcome of increasing driver awareness during critical turtle movement periods. If they can be shown to ultimately be effective then wildlife managers and state and county Departments of Transportation can consider more widespread use of such signs at hotspots of turtle mortality. Enhancement of nesting opportunity shows more promise and our findings suggest that turtles will locate and use these sites. Likely due to the increased solar radiation at enhanced and managed sites, nest success rate were higher than agricultural sites in another project we are working on. In areas where there it has been demonstrated that female turtles cross roads to get to nesting habitat, these movements may be reduced or eliminated if suitable nesting habitat can be designed and placed so that overwintering, summer and nesting habitat is contained on one side of roadways.

In our study, turtle crossing signs appear to provide limited detectable differences in turtle mortality or motorist behavior, as determined by driving speed, after two years of implementation. It is unknown if there was any increase in driver awareness of turtle crossing due to sign placement. We propose to increase the number of survey routes in future years to 1) increase the power of statistical tests and 2) determine if driver awareness, as measured by reduction in turtle mortality rates on roads, will change over multiple years. We encountered chronic sign vandalism (theft, shootings) at two of the five sites, so methods will be explored to reduce this. We were unable to use signs with a turtle symbol on state routes (see photos at left) without Federal Highway Administration approval; we are preparing a proposal to allow their use in future years, as we believe they may prove more effective.

Personnel Involved

1. Glenn Johnson (PI)
2. Summer students

2009

- Abbie Rupp (SUNY Potsdam Research assistant)
- James Flaherty (SUNY Potsdam Research assistant)
- Jing Bi (SUNY Potsdam Research assistant)
- Samantha Bell (SUNY Potsdam Research assistant)

2010

- Jonathan Ashley (SUNY Potsdam Research assistant)
- Erin Farr (SUNY Potsdam Research assistant)
- Bianca Dygert (SUNY Potsdam Research assistant)
- Wilmary Alindato (SUNY Potsdam Research assistant)

Conference Presentations

1. Can turtle crossing signs be an effective tool in reducing turtle road mortality? 11-13 August 2009. Northeast Partners in Amphibian and Reptile Conservation Annual meeting, Watkins Glen, NY.
2. Can turtle crossing signs be an effective tool in reducing Blanding's turtle road mortality? 23-24 March 2010, Social marketing and Chelonian Sustainability Workshop, Toronto, Ontario.
3. Alternatives to barriers and ecopassages in reducing turtle road mortality. 6-9 April 2011. 2011 Northeast Natural History Conference and Founding Meeting of the Association of Northeastern Biologists, Albany, NY.
4. Alternatives to barriers and ecopassages in reducing turtle road mortality. 13-14 April 2011. New York State Wetlands Forum Annual Conference, Lake Placid, NY.
5. Alternatives to barriers and ecopassages in reducing turtle road mortality. 2011 International Conference on Ecology and Transportation (ICOET) 21-25 August 2011, Seattle, Washington.

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APPENDIX 1. Examples of Turtle Crossing Signs

Example of turtle crossing sign used on county and town roads in June 2010. Note use of turtle silhouette. The location of the illustrated sign is along Potsdam Morley Road in the Village of Morley, Town of Canton.

Example of turtle crossing sign used on state roads in June 2009. Use of turtle silhouette was not approved as of June 2009 for these signs. The location of this sign was along SR 68 near Upper and Lower Lakes Wildlife Management Area in the Town of Canton.