

Inventory and Monitoring of Two State-listed Snakes (Kirtland's Water Snake and the Eastern Massasauga) in Piatt County, Illinois



**ILLINOIS
NATURAL
HISTORY
SURVEY**

Final Report to the Illinois Department of Natural Resources, for Illinois Wildlife Preservation Fund Contract Number RC06-L18W.

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INTRODUCTION

At the time of European settlement, the Eastern Massasauga Rattlesnake, *Sistrurus catenatus catenatus*, (EMR) was distributed throughout the upper two-thirds of Illinois. Early inhabitants of the state reported seeing up to 20 or more EMR in one season (Hay, 1893). The habitat conversion that followed settlement, such as draining of prairie marshes and intensive agriculture may have contributed to the EMR's decline. As early as 1866, the EMR was noted as declining (Atkinson and Netting, 1927). In 1994 the EMR was listed as an endangered species in Illinois (Herkert, 1994) and is now a candidate for listing at the federal level (USFWS, 1999). The persecution of the EMR by the unenlightened, uninformed human population has led to only a few widely scattered populations remaining. Smith (1961) stated that there were 25 extant populations of the EMR at that time. Recent studies have found that only four to six of the previous 25 still remain (Beltz, 1992). One of these occurs at Allerton Park, near Monticello, Illinois.

The Kirtlands snake, *Clonophis kirlandii*, (KS) also abundant at the time of settlement has suffered serious declines over the past century. The KS is distributed through the middle one-third to the northeast corner of Illinois (Phillips *et al.*, 1999). Garman (1892) stated that tiling, ditching and cultivation of the soil has nearly destroyed its habitat. The KS is listed as threatened in Illinois and Ohio and endangered in Indiana and Michigan. The KS is offered no protection at the federal level. A total of 70 historical localities are known in Illinois; a 1985 survey found individuals in only 20 of these sites (Wilsman and Sellers, 1988). One of these localities is Allerton Park, near Monticello, Illinois.

The objectives of this study were to 1) determine the status of the EMR and KS at Allerton Park through visual encounter searches, 2) estimate home range size and determine habitat utilization of the EMR, 3) determine the composition of other snake species at Allerton Park and 4) offer management recommendations for improving site quality. This report gives the results for the 2005 and 2006 field seasons. Data on snakes encountered in previous years are also given, but are not included in the analyses.

MATERIALS AND METHODS

Study Organisms

Eastern massasauga rattlesnake: The EMR has a range that includes the states of Illinois, Indiana, Iowa, Michigan, Missouri, New York, Ohio, Pennsylvania, Wisconsin, and across the Canadian border into the province of Ontario. Preferred habitat of the EMR ranges from lowland forest and grasslands in the midwestern United States and western Great Lakes to mixed deciduous/coniferous forest in Ontario to peat bogs in New York (Wright, 1941; Smith, 1961; Reinert and Kodrich, 1982; Seigel, 1986; Weatherhead and Prior, 1992; Johnson and Leopold, 1998). The EMR has four activity periods. Emergence (egress) begins when the snake leaves its hibernacula to thermoregulate adjacent to the entrance, occurring late March to mid-April and ending when the snake leaves the vicinity of the hibernacula. The primary activity period begins when the snake moves to its foraging area and ends when the snake moves back to the vicinity of its hibernacula area, approximately mid-October. Entrance (ingress) involves the snake

locating a suitable burrow. The snake may shuttle between several crayfish burrows until a suitable one is found concluding this period. Winter dormancy ends the season for the EMR. During this period the snake remains underground, in the burrow, until mid-March to mid-April. The primary activity period is punctuated by mating season, mid-July through August.

Kirtland's snake: The KS range includes the states of Ohio, Indiana, extreme southern Michigan and extreme northern Kentucky. A disjunct population occurs in western Pennsylvania and northeastern Missouri. The KS historically occurred in open habitats (Conant 1943). This includes wet grasslands, margins of streams, lakes, swamps and meadowlands. Present habitat consists mainly of open low grassy areas at the margins of creeks, ponds or ditches (Bavetz 1994). Populations at the periphery of the range occur in relatively open woods while those in the core are more commonly found in urban or floodplain habitats (Conant 1943). Life history information is lacking on the KS, but what little exists states that the KS is very secretive and most likely nocturnal, possibly aestivating during the hotter part of the summer (Conant 1943, Smith 1961).

Study Site

Allerton Park, located SW of Monticello Il, was donated to the University of Illinois by Robert Henry Allerton in 1946 for use as an educational and research center (Plate 1). The park's 1500 acres contain woodland, riparian and prairie areas of such high quality they have been designated a National Natural Landmark. We searched for snakes at three study sites: Prairie Restoration, Bennett Property, and Old Rt. 47. The Prairie Restoration and Bennett property are reclaimed agriculture fields. The Prairie is managed for grassland habitat while the west portion of the Bennett Property is in the early stages of upland forest restoration, the east portion is left fallow as grassland habitat. Old Rt. 47 is a 40 meter wide power line and abandoned railroad right of way on the north side of Allerton Park that, until 2004, had not been managed for any specific habitat type. It is currently owned by Heartland Pathways, a non-profit organization.

Survey Methods

Snakes were collected using visual encounter surveys throughout the activity season (mid-May to mid-September). Surveyors walked areas at each site checking under cover objects such as logs, grass clumps, and debris. Alternating halves of the Prairie Restoration are burned every other year. The burned area was searched more intensively due to higher detection probabilities in areas where vegetative cover has been removed.

Captured snakes were individually marked by implanting passive integrated transponder (PIT) tags subdermally. Scale clipping (Brown and Parker 1976) was used to mark individuals too small for PIT tags. EMRs were also marked by painting rattle segments with unique patterns to allow identification of recapture without handling. All EMR were photographed and had their saddle descriptions recorded as a precautionary measure in the event the previous marking methods failed. All snakes were sexed by cloacal probing and weighed to the nearest gram with a Pesola spring scale. Snout vent length (SVL) was obtained using the average of three measures within 0.5 cm with a flexible tape. Tail length was determined by measuring to the nearest 0.5 cm with a ruler. For the EMR we

also recorded the number of rattle segments and subcaudal scales. A blood sample was taken from each EMR for future genetic work. Catch per unit effort was also calculated.

For VES snakes, recorded environmental variables were amount of cloud cover and presence/intensity of precipitation, shaded air temperature (to the nearest 0.1 °C), relative humidity and max wind speed were determined with a Kestrel 3000. Substrate temperature ~1cm below the surface (to the nearest 0.5 °C) using a Fieldpiece digital thermometer. All snake locations (sightings or captures) were recorded with a Garmin GPS 3 Plus unit, using map coordinates in UTM-NAD 83.

Telemetry Methods

Temperature sensitive radio-transmitters were surgically implanted into EMRs by Dr. Julia Whittington at the University of Illinois Wildlife Medical Clinic. Snakes were located every other day during the early activity season (late March thru mid-July), every day during the breeding season (mid-July through August), and every other day after the breeding season until winter dormancy. During winter dormancy snakes were checked two to three times monthly. Each time a snake was located, pulse interval in seconds, behavioral observations (rattling or not rattling; coiled or straightened out; moving or not moving; whether it was in shade, partial sun, or full sun; and in burrow or not) and environmental characteristics listed above were recorded. Also, at each snake location we recorded an initial GPS reading and the following habitat measurements: canopy cover using a concave spherical densiometer, distance to the nearest road, and distance to the nearest wooded edge. Within a 500 m radius, we measured the distance to the nearest tree (DBH \geq 7.5 cm) and shrub in the NW, NE, SE, and SW quadrants. I made all distance measurements to the nearest meter using a laser range finder or tape. I scaled the distance to woodland edge as negative values for measurements within woodland boundaries and positive values for measurements outside woodland boundaries. When I did not have direct line of sight, I calculated the road and edge measurements using Arc-View data layers with the Nearest Feature (Jenness, Ent.) extension. I reduced shrub and tree measurements to mean distances by averaging over the four quadrants. To minimize GPS error I recorded a second GPS location during habitat analysis and averaged the two. Individual snake locations were considered unique only if they were greater than one meter from a previous location. For habitat preference I delineated each snake's habitat by buffering all unique locations by the snake's single largest movement. I classified the area within the outer most boundary of all buffers as available habitat. I then divided the available habitat into macrohabitats by habitat type (agriculture, canopy, mowed grass, prairie and road). Macrohabitat preference was determined by calculating the proportion of locations in a particular habitat type. Microhabitat was classified by the environmental habitat variables described above. I recaptured all radio-implanted snakes two times per season (spring and before ingress in September) to record morphological variables. Home range and movement analyses were performed using ARC-View 3.2. All other data were analyzed using Microsoft Excel.

RESULTS

Surveys

Prairie Restoration

2000 – 2004: In June of 2000, a neonate was photographed in the northeast corner of the Prairie Restoration by a graduate student checking small mammal traps. The next year IDNR staff started regular spring surveys at the Prairie, but no EMRs were encountered. In April 2002 searching resulted in one adult male (#001) that became the first study subject of this recent research effort. He was measured, weighed, photographed, and PIT tagged. Two gravid females were encountered mating with 001 and were brought into the lab until they gave birth to 8 and 1 young. Morphological variables were recorded and they were PIT-tagged. No additional EMRs were encountered in searches in 2003 and 2004. Unfortunately, search effort was not recorded for this period.

2005: The south side of the prairie restoration was burned in early March and searching began March 30, 2005. The prairie restoration was searched for a total of 831 minutes during the 2005 season (Table 1). The effort was concentrated on the south side of the prairie restoration due to higher detection probabilities but the unburned north side was searched occasionally. Three juvenile EMRs (2 males and 1 female) were encountered. Appropriate morphological measurements were taken but PIT tags were not injected because they were too small. Crayfish burrows are found throughout the site and are concentrated in the east-central portion of the prairie, two of the three EMRs were located adjacent to burrows. The three EMRs were judged to be of the 2004 cohort based on rattle segments and body size. *Lampropeltis calligaster* (n = 1) and *Heterodon platirhinos* (n = 1) were the only other snake species encountered at the prairie.

2006: The north side of the prairie restoration was burned in early March with searching beginning on March 31, 2006. The prairie restoration was searched for a total of 3,759 minutes with the effort concentrated in the burned area (Table 1). Three EMRs were encountered, two juveniles (1 male and 1 female) and one adult male. Appropriate morphological measurements were taken and PIT tags were not injected in two; one of the males was too small. Other snake species encountered included *Lampropeltis calligaster* (n = 5), *Storeria dekayi* (n = 1), *Thamnophis sirtalis* (n = 11), *Coluber constrictor* (n = 13) and *Heterodon platirhinos* (n = 1).

Old Rt. 47

2004: In April 2004, 0.7 mi of the ROW was burned by IDNR staff. Four EMRs were found on 16 April 2004. One escaped into a crayfish burrow, but was captured on 18 April. The snakes were brought into the lab and the appropriate morphological measurements were taken and PIT tags were injected in all but one, which was too small. Three of the snakes were released at their capture locations on 6 May 2004. Snake #014 underwent implant surgery on 22 April 2004 at UIUC VetMed. She was released at her initial capture point on 12 May 2004 and tracked until 9 July 2004 when she was found dead near the south edge of the right-of-way. It appeared she was struck by a vehicle.

Snake #016 was recaptured and on 28 June 2004 and brought into the lab. She gave birth to a brood of 10 on 22 July 2004. The appropriate morphological measurements were taken on all neonates. The small size of neonates precluded implanting PIT tags, but

each neonate was photographed and written descriptions of the dorsal patterns were recorded. Number 016 was released with her neonates at her most recent capture point on 6 August 2004.

2005: A one mile section of Old Rt. 47 was burned in early March with searching beginning March 30, 2005. The site was searched for 1,616 minutes with all effort contained in the burned area (Table 1). Two EMRs were encountered, one juvenile male and one adult female. Appropriate morphological measurements were taken but the juvenile male was too small for a PIT tag. Other snake species encountered were *Storeria dekayi* (n = 1) and *Elaphe vulpine* (n = 1).

2006: No burning took place in 2006. Searching was impeded by vegetation and detection probability suffered. A total of 4,017 minutes of effort was spent searching with two EMR encounters (Table 1). Both of the snakes encountered were adult female. Other snake species encountered were *Lampropeltis calligaster* (n = 1), *Storeria dekayi* (n = 1), *Elaphe vulpine* (n = 17), *Thamnophis sirtalis* (n = 11) and *Coluber constrictor* (n = 2).

Bennett Property

2005: There have been no prescribed burns at this site; ergo ground vegetation is very dense making searching difficult. A total of 1,273 minutes of effort were spent searching this site with zero EMR encounters. Other snake species encountered were *Storeria dekayi* (n = 9) and *Elaphe vulpine* (n = 2).

2006: As in the previous year no burns took place prior to this field season. A total of 1,293 minutes of effort were spent with zero EMR encounters. Additional snake species encountered were *Storeria dekayi* (n = 14), *Elaphe vulpine* (n = 6), *Thamnophis sirtalis* (n = 6).

Two *Clonophis kirtlandii* were encountered at the Bennett Property in 2004 (Table 3). Despite continued searching, no additional *C. kirtlandii* have been seen since that time.

Telemetry

A total of four EMRs were radio-located from 2002-2006, one male (#001) at the prairie restoration and three females (nos. 014, 032, 033) at old Rt. 47. Male 001 was radio-located 504 days from 2002-2005, female 014 for 37 days in 2004, female 031 for 166 days in 2005 and 2006 and female 032 for 24 days in 2006 (Table 2). The small number of locations for 014 was due to mortality. Snake 014 was located dead in a runway separating the Old Rt. 47 site from an adjacent agricultural field to the south. Snake 032's small number of locations was due to transmitter failure.

Movement

Average daily movement for the male was 59.65 meters and females averaged 26.10 meters (Table 2). All snakes exhibited periods of inactivity lasting 2-14 days. Three of

the snakes made relatively large movements, when compared to their average. Snakes 001, 031 and 032 made movements >100 meters (Table 2). The male snake (001) made the largest maximum movement of 372 m. Large movements such as this are normal for males during the mating season (Phillips et al. 2001; 2002). The male (001) was observed mating in 2002, 2003, and 2004. The females were not observed mating in any year.

Home Range

The MCP for snake 001 was 18.9 ha and 95% Kernel was 19.35 ha, snake 014 had an MCP 0.211 ha and a 95% Kernel of 2.978 ha, 031 MCP was 5.024 ha and a 95% Kernel of 8.01 ha, 032 had an MCP of 0.256 ha and a 95% Kernel of 3.54 ha. The average MCP and 95% Kernel for females was 1.83 and 4.84 ha.

Macrohabitat

A large proportion (>80%) of unique locations were in prairie habitat (Figure 1). The second ranked habitat type was forest and represented <20% of total locations. On average EMR used microhabitats within 14.95 meters of a tree, 0.46 meters of a shrub and average distance to tree and shrub were 18.33 meters and 0.64 meters (Table 4).

Microhabitat

Snakes were on average 21.18 meters from a road, 21.2 meters from an agricultural field, with a canopy cover of 1.61% (Table 4). Snake 001 was an average distance of 44.44 meters from a woodland edge. No woodland habitat occurred in any of the Old Rt. 47 snake's available habitat.

DISCUSSION

Surveys

Prairie Restoration

In the early years of Allerton Park EMRs were frequently encountered in the vicinity of the visitor center and areas of high human traffic on the north side of the Sangamon River. The encountered snakes were collected and moved to the prairie restoration on the south side of the park and released until the mid 1980s when employees and visitors stopped seeing them. It is unknown precisely how many translocations took place but the Prairie Restoration is suitable habitat with an abundance of crayfish burrows for hibernating (Plate 2). Snake 001 hibernated in the northeast corner of the Prairie all winters that it was tracked (Plate 3), this area has the potential to be used by other EMRs at the Prairie and should be searched accordingly. New individuals are encountered every year but the absence of recaptures makes estimating population size impossible. Regardless, the population size is small and suffers the effects, including reduction in heterozygosity through genetic drift and reduction of overall allelic diversity, both of which jeopardize its evolutionary potential.

Old Rt. 47

This site is unique in that it is a 40 m wide, linear strip with agricultural fields and a heavily traveled road directly adjacent (Plate 4). It is composed of mixed grasses, autumn olive and sumac (Plate 5). EMRs were discovered at this site in the fall of 2002 when one was found dead on the road. Burns took place in 2004 and 2005 and subsequent searches have resulted in half (18) of the known snakes at Allerton residing at this site. Rodent burrows are abundant, most likely due to the copious food resource of the crop fields bordering the site. Two of the radio-tagged snakes were observed consuming small rodents that occur at the site (Plate 6); a meadow jumping mouse (*Zapus hudsonius*) and a meadow vole (*Microtus pennsylvanicus*). This large prey base may have aided the EMR in persisting at this small site. With this site being adjacent to a highway it is subject to routine spring and fall mowing to maintain automobile sight lines. There have been instances in the past where the Illinois Department of Transportation (IDOT) mowing crews would, in some places, mow over half the width of the site. After engaging in a dialog with IDOT and describing the nature of the site and the imperiled species that reside there IDOT now notifies us of impending mowing to insure that all radio-tagged snakes are out of harms way. IDOT has also reduced the mowing distance from the shoulder. Also, AmerenIP removed the sumac and autumn olive that had grown up directly under the power lines opening up more of the site. Furthermore, snake 031 spent 15 days in a corn field south of the site during the summer of 2005. Because of this and the death of #014, the University of Illinois stopped production on 9 acres (90 feet wide by 3/4 mile long) adjacent to the site in 2006. It was planted in native prairie grasses in 2006, expanding a portion of the Rt. 47 site by ~40%.

Bennett Property

Because of the 2004 encounters of KS, search effort was focused at this site. A small retention pond in the north central area of Bennett property has drained due to dam erosion (Plate 7). The KS favors wet prairie and the loss of this aquatic environment had a drying affect on the area that may have made the area unsuitable. The only KS encounter since 2004 was a DOR near Willow Branch Creek (Table 4). Amphibians, such as salamanders, frogs and toads were observed reproducing in the pond prior to its drainage. The loss of this breeding site will impact these species the most. To prevent the tree saplings from being overtaken, the west area of the Bennett property is intensely managed by strip mowing and herbicide application to control invasive plant species. It is highly unlikely that EMRs are present in an area with such a high degree of surface activity. Prescribed burns are important in determining the presence of EMRs and should take place in the east area on a rotational basis to perpetuate the grassland habitat.

Telemetry

Movement

The average distance moved per day for the Allerton population differs from the southern Illinois population at Carlyle Lake, which were 11.68 meters for males and 7.3 meters for non-gravid females (Phillips et al. 2003).

Home Range

Estimates of EMR home range are available for a small number of populations, with the nearest being the Carlyle Lake population. Dreslik (2005) states that males at Carlyle Lake have a MCP and 95% Kernel estimate of 1.082 and 0.832 ha and females have MCP and 95% Kernel estimates of 0.641 and 0.506 ha. Snakes 001 and 031 were located >50 times as opposed to 014 and 032 who were located <38 times, this may explain some of the disparity in home range estimates. Thus, comparisons to estimates for other populations are weak due to the small number of locations that we collected. The two-week foray of snake 031 into the agriculture field leads to the conclusion that snakes at this site would range over a much larger area if they were not constrained by a hostile matrix.

Macrohabitat

The EMR used all of the macrohabitats, to some extent, except roads. Each macrohabitat type may contain different levels of required resources that each snake utilizes at different periods of the year. The disproportionately heavy use and preference for grassland macrohabitats is consistent with previous findings for Illinois populations (Wright, 1941; Smith, 1961; Bielma, 1973). At the landscape level, prairie habitats represent the smallest portion of the available habitat in the Allerton Park region. Grassland macrohabitats at each site are small, isolated, fragmented, and bounded by roads and agricultural fields. This is of highest concern for the Old Rt. 47 population, which has frequent automobile and agricultural traffic directly adjacent to both sides. IDOT now mows a five foot wide strip along the Rt. 47 side of the site which creates a buffer of unfavorable habitat that may discourage EMRs from coming in close proximity to the road.

Microhabitat

The majority of activity at Allerton Park was associated with open microhabitats >14 m from the nearest type of overstory. The Prairie Restoration is the only site with established woodland within the snake's available habitat and 001 spent very little time within it. The Old Rt. 47 site contains few, widely dispersed clusters of trees and they too were avoided the majority of the time. Generally EMRs are thought to be prairie species in the Midwest (Smith, 1961) and these individuals support that claim.

RECOMMENDATIONS

At the Prairie Restoration, increasing the level of search effort and continuing to burn while the snakes are still in hibernacula will aid in encountering new EMRs and also recapturing known snakes. Recaptures are important for estimating population size, survivorship and inferring if the population is growing or declining.

At Old Rt. 47 there are numerous burrows for hibernacula and with the decline in the scope of mowing and removal of exotic invasive plant species the site is improving. Prescribed burns should continue to progress east and west in order to determine the total occurrence of EMRs in the strip.

At the Bennett property the retention pond dam should be repaired to restore the aquatic habitat required for amphibian reproduction. Increasing the local soil moisture would be beneficial for both the KS and EMR. Crayfish would increase in the area providing possible EMR with hibernacula and provide the KS with its preferred habitat type. Overall it is recommended that agricultural lands be restored to prairie habitats through conservation easements or outright purchase.

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FIGURES AND TABLES

Figure 1: Proportion of habitat use by individual of *S. c. catenatus* radio-located at Allerton Park, Piatt County, Illinois.

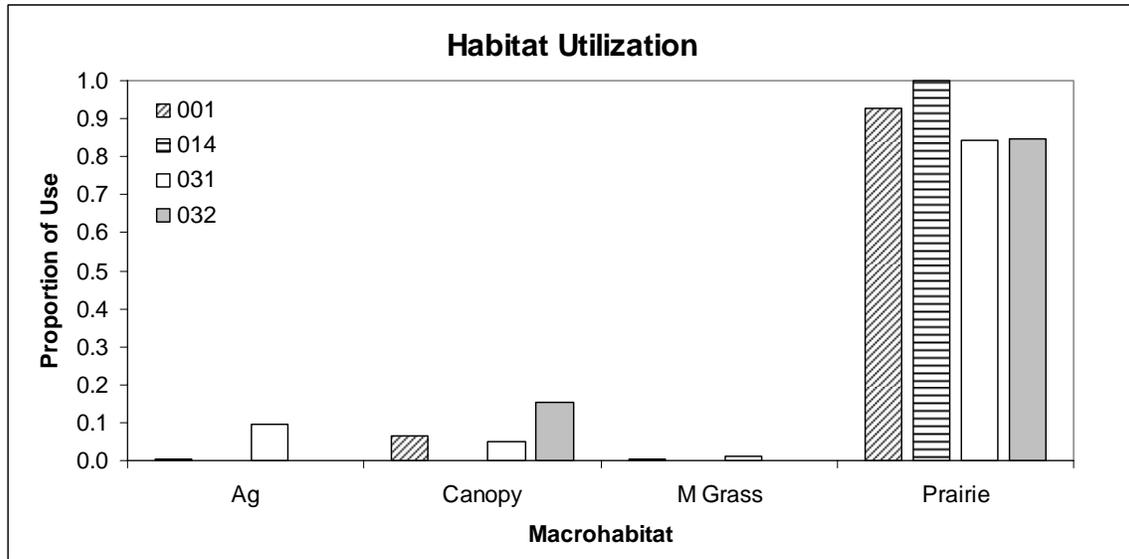


Table 1: Location, Effort per *Sistrurus catenatus* captured and other snake species captured at Allerton Park (LACA: *Lampropeltis calligaster*, STDE *Storeria dekayi*, ELVU: *Elaphe vulpine*, THSI: *Thamnophis sirtalis*, COCO: *Coluber constrictor*, HEPL: *Heterodon platirhinos*).

| | | 2005 | | | | | | | |
|------------------|---------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Site | Effort (min) | SCAT | CPUE | LACA | STDE | ELVU | THIS | COCO | HEPL |
| Old Rt. 47 | 1616 | 2 | 0.0012 | 0 | 1 | 1 | 0 | 0 | 0 |
| Bennett Property | 1273 | 0 | 0.0000 | 0 | 9 | 2 | 0 | 0 | 0 |
| Prairie Rest. | 831 | 3 | 0.0036 | 1 | 0 | 0 | 0 | 0 | 1 |
| Total: | 3720 | 5 | 0.0048 | | | | | | |

| | | 2006 | | | | | | | |
|------------------|---------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Site | Effort (min) | SCAT | CPUE | LACA | STDE | ELVU | THIS | COCO | HEPL |
| Old Rt. 47 | 4017 | 2 | 0.0005 | 1 | 1 | 17 | 11 | 2 | 0 |
| Bennett Property | 1293 | 0 | 0.0000 | 0 | 14 | 6 | 6 | 0 | 0 |
| Prairie Rest. | 3759 | 3 | 0.0008 | 5 | 1 | 0 | 11 | 13 | 1 |
| Total: | 9069 | 5 | 0.0013 | | | | | | |

Table 2: Amount of habitat used and proportion of habitat used relative to available habitat space using 95, 75, and 50% kernel density isopleths (KDI), and the minimum convex polygon (MCP), distance moved per day and per year, maximum distance moved, total and unique locations for *S. c. catenatus* radio-located at Allerton Park, Piatt County, Illinois.

| Snake (M) | KDI(ha) | | | | | | MCP | % | Ava. Hab. | dist/day | dist/year | Max | n All | n U.S. |
|------------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|-------------|-----------|--------------|---------------|--------|-------|--------|
| | 95 | % | 75 | % | 50 | % | | | | | | | | |
| 001 | 19.35 | 15.4 | 6.05 | 4.8 | 1.12 | 0.9 | 18.90 | 15.1 | 125.55 | 59.65 | 4965.76 | 372.09 | 504 | 334 |
| Snake (F) | | | | | | | | | | | | | | |
| 014 | 2.978 | 153.9 | 1.673 | 86.5 | 0.745 | 38.5 | 0.211 | 10.9 | 1.94 | 11.98 | 335.32 | 35.78 | 37 | 29 |
| 031 | 8.01 | 27.2 | 3.85 | 13.1 | 1.66 | 5.6 | 5.024 | 17.1 | 29.42 | 32.53 | 1333.76 | 149.74 | 166 | 83 |
| 032 | 3.541 | 12.0 | 1.144 | 3.9 | 0.532 | 1.8 | 0.256 | 0.9 | 29.42 | 33.80 | 405.56 | 117.27 | 24 | 13 |
| MEAN (F) | 4.84 | 64.39 | 2.22 | 34.48 | 0.98 | 15.32 | 1.83 | 9.62 | | 26.10 | 691.54 | | | |

Table 3: Location, date of capture (DOC), morphological data and capture location of *Clonophis kirtlandii* at Allerton Park.

| SITE | DOC | SEX | SVL | MASS | Initial Capture (UTM) |
|-------------|------------|------------|------------|-------------|------------------------------|
| Bennett | 5/14/2004 | Unknown | 2.9 | 13 | 16 E 0361230 N 4428971 |
| Bennett | 8/5/2004 | F | NT | 38 | 16 E 0361230 N 4428971 |
| DOR | 9/25/2006 | Unknown | NT | NT | 16 E 0355934 N 4429976 |

Table 4: Individual and pooled means for habitat measurements of radio-located *S. c. catenatus* at Allerton Park, Piatt County, Illinois.

| Snake | Nearest Tree | Nearest Shrub | Mean Dist. Tree | Mean Dist. Shrub | Road | Agriculture | Canopy Cover | Wooded Edge |
|-----------------|--------------|---------------|-----------------|------------------|--------------|--------------|--------------|-------------|
| 001 (M) | 20.56 | 0.68 | 39.31 | 1.73 | 245.02 | 253.64 | 10.07 | 44.44 |
| 014 (F) | 3.71 | 0.62 | 4.90 | 0.52 | 30.89 | 8.49 | 0.34 | NA |
| 031 (F) | 23.23 | 0.47 | 30.12 | 0.84 | 21.57 | 22.15 | 4.50 | NA |
| 032 (F) | 17.92 | 0.30 | 19.96 | 0.55 | 11.08 | 32.96 | 0 | NA |
| Mean (F) | 14.95 | 0.46 | 18.33 | 0.64 | 21.18 | 21.20 | 1.61 | |

PLATES

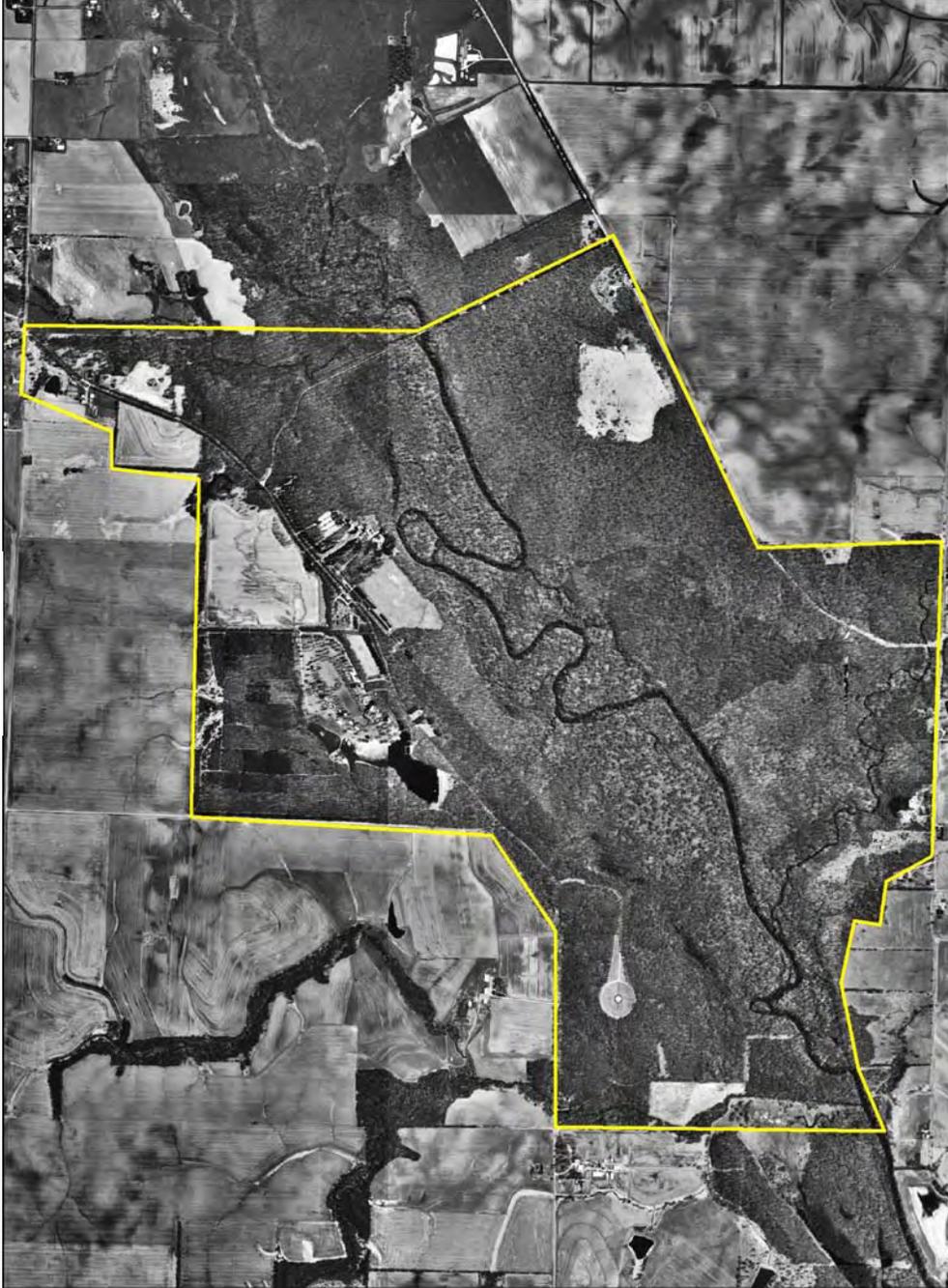


Plate 1: Aerial photo of Allerton Park

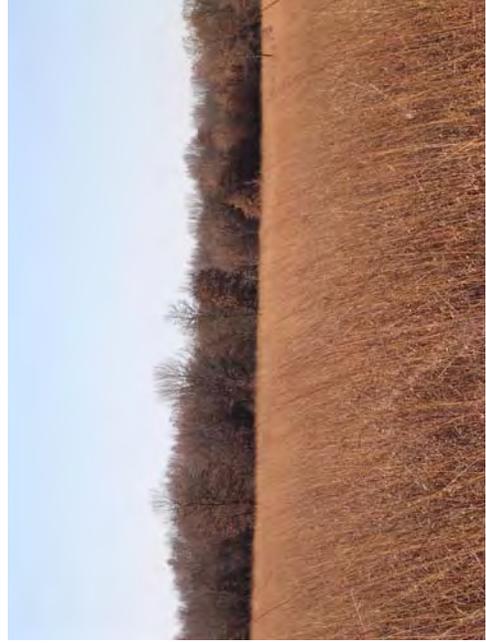
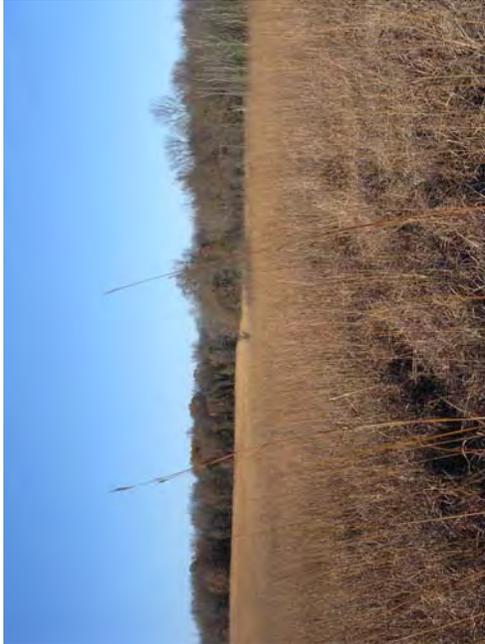


Plate 2: Photographs of suitable foraging and hibernating sites present at Allerton Prairie Restoration.



Plate 5: Photographs of Old Rt. 47 showing vegetation types, foraging and hibernation area.



Plate 6: Photographs of snakes 031 (top left and right) and 032 (bottom left and right) consuming prey.



Plate 8: Photographs of Bennett Property. Top left and right are of the drained pond and eroded dam, bottom left and right represent vegetation and foraging area.

APPENDIX II
Individual Records for All Massasaugas Encountered in Piatt County, Illinois, 2002-2006

Individual Information for Eastern Massasaugas, Piatt County, IL

| | |
|---|--|
| Snake Number <input type="text" value="001"/> | Scale Clip <input type="text" value="001"/> |
| Initial Capture Loc/Site# <input type="text" value="Allerton Prairie Restoration"/> <input type="text" value="001"/> OR Captive Born <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Rattle Color <input type="text" value="BIBIBI"/> |
| Initial Capture UTM <input type="text" value="359993"/> E <input type="text" value="4428599"/> N | PIT Tag <input type="text" value="43287D2D71"/> |
| Initial Contact Date <input type="text" value="4/13/2002"/> | Sex <input type="text" value="M"/> SSC <input type="text" value="27"/> |
| First Release Date <input type="text" value="4/24/2002"/> | Mother Number <input type="text"/> |
| No Days in Captivity <input type="text" value="11"/> | Cohort <input type="text"/> |
| Last Contact Date <input type="text" value="8/9/2005"/> | Photograph <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Blood Sample <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |

| Telemetry Information | Mortality Information |
|--|---|
| Telemetry History <input type="checkbox"/> Current <input checked="" type="checkbox"/> Previous <input type="checkbox"/> Never | Mortality <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Salvaged <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Radio frequency <input type="text" value="150.334"/> | Date of Death <input type="text" value="8/9/2005"/> |
| Date of surgery <input type="text"/> | Mortality Type <input type="text" value="Depredation"/> |
| Status <input type="text" value="Dead"/> | INHS Field <input type="text" value="14364"/> INHS <input type="text" value="19656"/> |

Notes

This snake's radio tunes best on the F&L Electronics receiver (blue box) as 150.336.

After surgery to replace the transmitter on 2-June-03, the frequency is 150.640.

Third transmitter surgery on 4/22/2004, the frequency is best at 150.451.

Posterior 2/3 to 1/2 of AI found in SE tree line of prairie; bite marks on tail, rattle bitten off; remains taken back to survey for preservation and transmitter removal.

Genetic Information

Scu01

Scu05

Scu07

Scu11

Scu16

Scu26

Saddle and Rattle Description

Initial Rattle description 1..plus terminal

Recapture History

| 1999 | 2000 | 2001 | 2002 X | 2003 X | 2004 X | 2005 X | 2006 | 2007 |
|------|------|------|--------|--------|--------|--------|------|------|
|------|------|------|--------|--------|--------|--------|------|------|

Growth Measurements

| Date | 4/13/2002 | 8/13/2002 | 7/8/2003 | 9/12/2003 | 4/8/2004 | 6/30/2004 | 8/4/2004 | 4/4/2005 | 5/17/2005 | 7/22/2005 |
|-------|-----------|-----------|----------|-----------|----------|-----------|----------|----------|-----------|-----------|
| SVL | 58.1 | | | | | | 60.3 | | 59.7 | |
| Tail | 6.3 | 6.9 | | | | | 6.6 | | 6.3 | |
| Total | 64.4 | | | | 68.2 | | 66.9 | | 66.5 | |
| Mass | 237 | 307 | 285 | 297 | 292 | 317 | 337 | 322 | 287.6 | 355 |

Individual Information for Eastern Massasaugas, Piatt County, IL

| | | | | |
|---------------------------|------------------------------|-----|--|---|
| Snake Number | 002 | | Scale Clip | 002 |
| Initial Capture Loc/Site# | Allerton Prairie Restoration | 046 | OR | Captive Born |
| Initial Capture UTM | 360165 | E | 4428406 | N |
| Initial Contact Date | 7/26/2002 | | | |
| First Release Date | 8/20/2002 | | | |
| No Days in Captivity | 25 | | | |
| Last Contact Date | | | | |
| | | | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Rattle Color PPPPPP |
| | | | | PIT Tag 4328253D55 |
| | | | | Sex F SSC 22 |
| | | | | Mother Number |
| | | | | Cohort |
| | | | Photograph <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Blood Sample <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |

| Telemetry Information | Mortality Information |
|---|---|
| Telemetry History <input type="checkbox"/> Current <input type="checkbox"/> Previous <input checked="" type="checkbox"/> Never Radio frequency Date of surgery Status | Mortality <input type="checkbox"/> Yes <input type="checkbox"/> No Salvaged <input type="checkbox"/> Yes <input type="checkbox"/> No Date of Death Mortality Type INHS Field INHS |

Notes

This snake was originally seen on 7/25/02, but escaped. She was within one meter of Snake #001. She gave birth to one dead and one live neonate on 5 August 2002. She had a shot of oxytocin on 6 August 2002 and passed one more dead one. She had a second injection of oxytocin on 7 August 2002 but no more were born. She had surgery to remove dead neonates on 9 August 2002. She ate 2 adult mice (26 Aug & 30 Aug) and 2 fuzzies (9 Sept). She weighed 137 g and was 52 cm SVL, 46 cm tail length) after the second adult mouse (5 Aug). She weighed 147 g at the time of her release (at original capture site-- #46) on 10 September 2002.

Genetic Information

Scu01
 Scu05
 Scu07
 Scu11
 Scu16
 Scu26

Saddle and Rattle Description

on 31-July-03 recapture rattle was 7+ broken terminal, has added three segments since release, repainted all 7 pink

Initial Rattle description 7 segments and broken terminal.....

Recapture History

| | 1999 | 2000 | 2001 | 2002 | 2003 X | 2004 | 2005 | 2006 | 2007 |
|--|------|------|------|------|--------|------|------|------|------|
|--|------|------|------|------|--------|------|------|------|------|

Growth Measurements

| Date | 7/26/2002 | 8/31/2003 | | | | | | | |
|-------|-----------|-----------|--|--|--|--|--|--|--|
| SVL | | 56.18 | | | | | | | |
| Tail | 4.4 | 4.75 | | | | | | | |
| Total | | 60.93 | | | | | | | |
| Mass | 255 | 193 | | | | | | | |

Individual Information for Eastern Massasaugas, Piatt County, IL

| | | | | | | | |
|---------------------------|---|----------------------|--------------------------------------|--------------|---|---------------|--|
| Snake Number | <input type="text" value="031"/> | | | | | Scale Clip | <input type="text"/> |
| Initial Capture Loc/Site# | <input type="text" value="Old Route 47"/> | <input type="text"/> | OR | Captive Born | | Rattle Color | <input type="text" value="OrOrOrOrOrOr"/> |
| Initial Capture UTM | <input type="text" value="0358437"/> | E | <input type="text" value="4431677"/> | N | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | PIT Tag | <input type="text" value="4462482F30"/> |
| Initial Contact Date | <input type="text" value="5/6/2005"/> | | | | | Sex | <input type="text" value="Female"/> SSC <input type="text" value="24"/> |
| First Release Date | <input type="text" value="6/14/2005"/> | | | | | Mother Number | <input type="text"/> |
| No Days in Captivity | <input type="text" value="39"/> | | | | | Cohort | <input type="text"/> |
| Last Contact Date | <input type="text" value="7/31/2006"/> | | | | | Photograph | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| | | | | | | Blood Sample | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |

| Telemetry Information | Mortality Information |
|--|--|
| Telemetry History <input type="checkbox"/> Current <input checked="" type="checkbox"/> Previous <input type="checkbox"/> Never | Mortality <input type="checkbox"/> Yes <input type="checkbox"/> No Salvaged <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Radio frequency <input type="text" value="150.174"/> | Date of Death <input type="text"/> |
| Date of surgery <input type="text" value="7/6/2005"/> | Mortality Type <input type="text"/> |
| Status <input type="text" value="Transmitter Failure"/> | INHS Field <input type="text"/> INHS <input type="text"/> |

Notes

- Found after investigating where a red-tail hawk had been flushed.
 - UTM is where hawk had taken the snake to feed.
 - at capture, rattle had 1 more seg. and button but were broken off while in cage at survey.
 - 38 saddles and 7 tail stripes.
 - mass taken on 6/14/2005 was after she had eaten 3 fuzzy mice: 173 g.
 - Tracked successfully 7/31/2006. Attempted to track on 8/2/2006 but no signal was found. Unsuccessfully searched surrounding area with Eric Smith. Unable to determine if transmitter failed, predation or poaching.

Genetic Information

Scu01
 Scu05
 Scu07
 Scu11
 Scu16
 Scu26

Saddle and Rattle Description

- both head stripes connected to first saddle.
 - 23 dot on right, 24 + 25 connected on right in shape of V, 32 + 33 connected by stripe going from left of 32 to right of 33, 34 + 35 + 36 connected on right, 36 + 37 connected on right.

Initial Rattle description

Recapture History

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 X | 2006 X | 2007 |
|--|------|------|------|------|------|------|--------|--------|------|
| | | | | | | | | | |

Growth Measurements

| | 5/12/2005 | 6/14/2005 | 7/11/2005 | 8/9/2005 | 4/5/2006 | 5/4/2006 | 6/21/2006 | 6/21/2006 | |
|--------------|-----------|-----------|-----------|----------|----------|----------|-----------|-----------|--|
| Date | | | | | | | | | |
| SVL | 49.6 | | | | | 53.75 | | | |
| Tail | 4.8 | | | | | 4.75 | | | |
| Total | 54.4 | | | | | 58.5 | | | |
| Mass | 165 | 173 | 155 | 206 | 242 | 257 | 301 | 294 | |

Individual Information for Eastern Massasaugas, Piatt County, IL

| | | | | | | | |
|---------------------------|---|----------------------|--------------------------------------|--------------|---|---------------|---|
| Snake Number | <input type="text" value="032"/> | | | | | Scale Clip | <input type="text"/> |
| Initial Capture Loc/Site# | <input type="text" value="Old Route 47"/> | <input type="text"/> | OR | Captive Born | | Rattle Color | <input type="text" value="blblblblbl"/> |
| Initial Capture UTM | <input type="text" value="0358268"/> | E | <input type="text" value="4431642"/> | N | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | PIT Tag | <input type="text" value="4327204150"/> |
| Initial Contact Date | <input type="text" value="4/12/2006"/> | | | | | Sex | <input type="text" value="F"/> SSC <input type="text" value="22"/> |
| First Release Date | <input type="text" value="6/20/2006"/> | | | | | Mother Number | <input type="text"/> |
| No Days in Captivity | <input type="text" value="69"/> | | | | | Cohort | <input type="text"/> |
| Last Contact Date | <input type="text" value="6/20/2006"/> | | | | | Photograph | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| | | | | | | Blood Sample | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |

| Telemetry Information | Mortality Information |
|--|--|
| Telemetry History <input type="checkbox"/> Current <input checked="" type="checkbox"/> Previous <input type="checkbox"/> Never | Mortality <input type="checkbox"/> Yes <input type="checkbox"/> No Salvaged <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Radio frequency <input type="text" value="150.023"/> | Date of Death <input type="text"/> |
| Date of surgery <input type="text" value="5/2/2006"/> | Mortality Type <input type="text"/> |
| Status <input type="text" value="Transmitter Failure"/> | INHS Field <input type="text"/> INHS <input type="text"/> |

Notes

Found ~3m N. of Lucky (Q31); named "Karly" by Fran Harty.....

First transmitter (150.946) implanted on 5/2/2006.....

Fed two fuzzy mice and accepted on 4/19/2006 to prepare for release. Transmitter failed before release.....

Second transmitter (150.023) implanted on May 30, 2006.....

Fed 3 fuzzy mice and accepted on 6/2/2006.....

Second release on 6/19/2006.....

Tracked successfully 7/31/2006. Attempted to track on 8/2/2006 but no signal was found. Unsuccessfully searched surrounding area with Eric Smith. Unable to determine if transmitter failed, predation or poaching.....

Genetic Information

Scu01

Scu05

Scu07

Scu11

Scu16

Scu26

Saddle and Rattle Description

19 upward projection on right, 23 backward projection on right, 37 spot on left, 39 saddles including tail bands.....

Initial Rattle description 4+. terminal.....

Recapture History

| 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 X | 2007 |
|------|------|------|------|------|------|------|--------|------|
| | | | | | | | | |

Growth Measurements

| Date | 4/24/2006 | 6/19/2006 | 7/23/2006 | | | | | |
|-------|-----------|-----------|-----------|--|--|--|--|--|
| SVL | 57.5 | | | | | | | |
| Tail | 4.7 | | | | | | | |
| Total | 62.2 | | | | | | | |
| Mass | 205 | 207 | 296 | | | | | |

