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HABITAT UTILIZATION, DIET AND BEHAVIOR OF THE EASTERN MASSASAUGA (*SISTRURUS CATENATUS*) IN SOUTHERN MICHIGAN

by

Lisa Ann Hallock

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ABSTRACT

HABITAT UTILIZATION, DIET AND BEHAVIOR OF THE EASTERN MASSASAUGA (SISTRURUS CATENATUS) IN SOUTHERN MICHIGAN

by

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Radio-tracking was used to observe spatial patterns, behavior, and hibernation sites in massasaugas (Sistrurus catenatus) collected from southern Michigan. A diet analysis of 125 preserved snakes was also preformed. Snakes were found to inhabit upland, grassy habitats in the summer and lowland, poorly drained habitats in the fall. Hibernation sites were located in lowland habitats. All snakes hibernated in mammal burrows. Water-harvesting was observed for the first time in this species. Mammals were found to make up the largest portion of the massasaugas diet (73.3%). Snakes were the second most common item (15.6%) and appear to be an important source of food for newborn snakes. Birds, frogs and insects also make up a small percentage of the diet. Comments are made on interactions between people and the massasauga, as well as on conservation and management of massasauga populations.

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INTRODUCTION

The eastern massasauga, Sistrurus catenatus (Rafinesque), is a small, spotted rattlesnake of the family Viperidae. Adults reach average lengths of 51 to 76 cm (Conant, 1975). As in all members of the subfamily Crotalinae of the Viperidae, the head is distinctly wider than the neck, the pupils of the eyes are vertically elliptical and a heat-sensing facial pit is present on each side of the head between the eye and the nostril. Within the rattlesnakes, the genus Sistrurus is unique in having only nine scales on the crown of the head. While this is common in non-venomous snakes, all other members of the rattlesnake group (genus Crotalus) have a large number of scales of various sizes covering the crown of the head (Conant, 1975; Ernst and Barbour, 1989). The massasauga is a heavy-bodied snake. The ground color is brownish-gray with a prominent row of dark brown spots from the neck to the tail. Three rows of smaller spots are present on the sides. All of the dark brown spots are thinly outlined in yellow or white. At the tail the spots tend to fuse into bands. The ventral surface of the snake is black with small, irregular light blotches.

The current range of the eastern massasauga extends

east into central New York, north into southern Ontario, south to Missouri and west to Iowa (Conant, 1975). Habitat preferences of the eastern massasauga are said to be bogs, swamps, marshes, wet meadows, grasslands and prairies (Wright,1941; Reinert and Kodrich, 1982; Seigel,1986;).

The massasauga is the only venomous snake in Michigan. Adults are the only snakes in Michigan with a rattle. Massasaugas under a year old usually lack a rattle, but a "button" will be present at the tip of the tail (Figure 1). The rattle or button is always present unless the end of the tail has been lost.

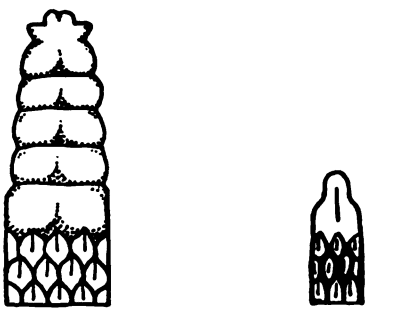

Figure 1. Illustration of a rattlesnake rattle and button.

Records of preserved specimens from Michigan State University and The University of Michigan show that the massasauga has been collected in thirty-six Michigan counties, (Figure 2), all in the Lower Peninsula. Specimens from Mackinaw County are all from Bois Blanc Island.

The massasauga is believed to have been abundant in prairie regions of the Midwest before European settlement (Wright, 1941). Agriculturalization and draining of wetlands has fragmented massasauga populations into isolated habitats (Smith, 1961; Bushey, 1978 as cited in Seigel, 1986). Only five populations of eastern massasaugas are known in Missouri (Seigel, 1986). New York state has only two known populations (Breisch, 1984). The eastern massasauga is considered endangered, threatened or rare in virtually all states where it is found (Seigel, 1986).

The status of the massasauga in Michigan is currently unknown. Ruthven (1911) commented on the massasauga "...becoming yearly more rare in this region" due to draining of swamps and killing of great numbers by farmers. The current concern over the status of the massasauga in Michigan has lead to this study. This is the first study of a Michigan population of massasaugas. In this preliminary study, aspects of movement, diet and behavior were examined.

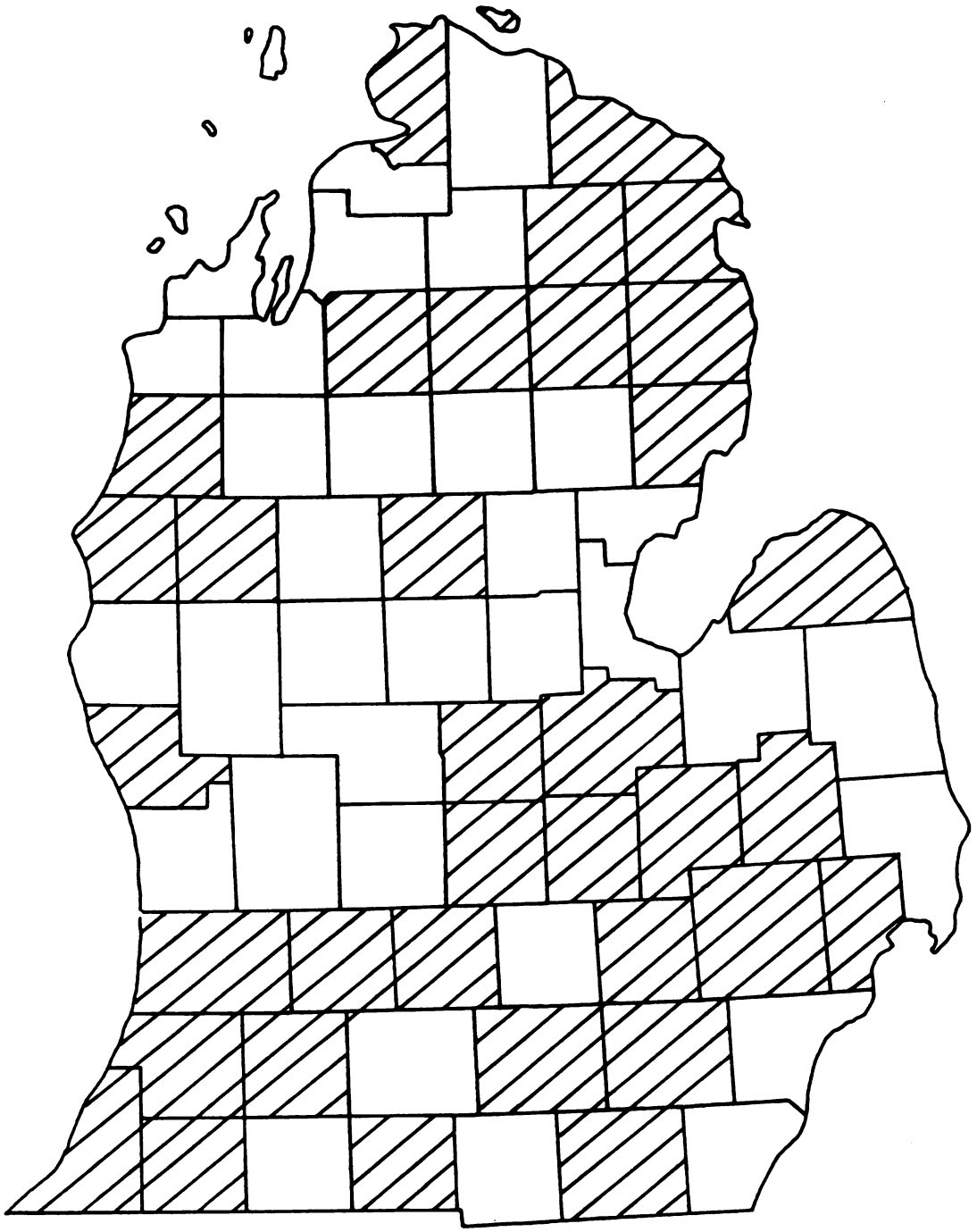

Figure 2. Michigan counties where eastern massasaugas (Sistrurus catenatus) have been collected.

METHODS

Study site

The project was conducted at the University of Michigan Matthaei Botanical Gardens, Ann Arbor, Michigan. Massasaugas were found and studied in the prairie and prairie border habitats of the gardens (Figure 3). The prairie area of the Gardens was established in the fall of 1967 in an attempt to recreate a community resembling a native prairie. Most of the soil of the prairie is classified as Fox sandy loam (Bland, 1970) and is well drained. In a few areas drainage is inhibited by underlying clay lenses. Topographic diversity varies from 0 - 12% slope. The vegetation that surrounds the prairie on the uplands is second growth oak forest, and on the lowland, marsh and fen (Bland, 1970).

Telemetry study

Radio transmitters were placed into three snakes to observe movements, behavior and hibernation sites. Snakes were captured opportunistically as encountered. The snake was placed inside a small styrofoam cooler using Pillstrom tongs and transferred to Michigan State University. Snakes were cooled in a refrigerator for approximately twelve hours at 40° F and later were immobilized as described by

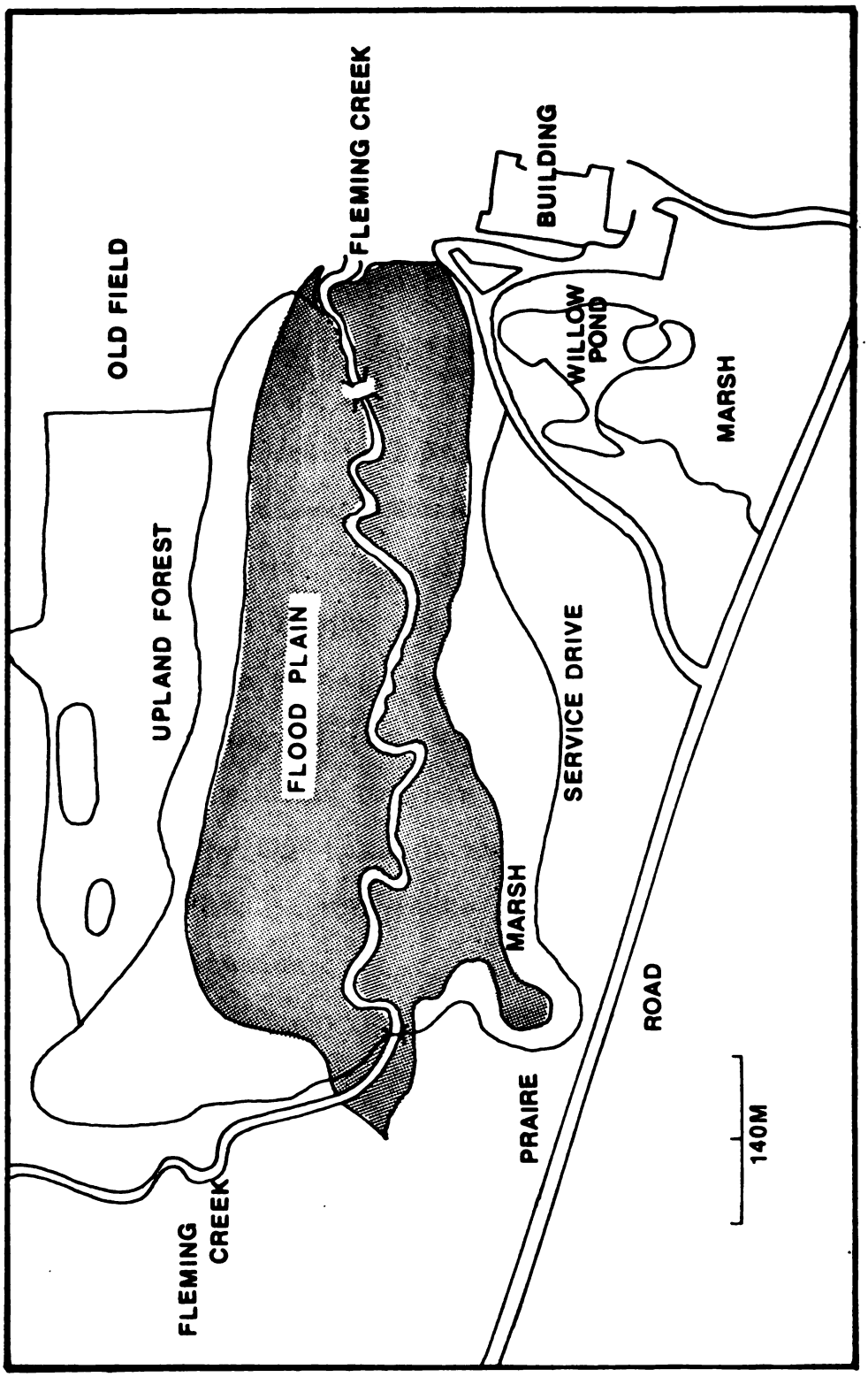

Figure 3. Map of the Matthaei Botanical Gardens, Ann Arbor, Michigan.

Gillingham et al. (1983). A lateral incision of about one centimeter was made just anterior to the cloaca. A probe was used to separate the skin from the underlying connective tissue and muscle. An AVM Instrument Model SM1 mouse-type transmitter covered with beeswax and coated with a thin layer of petroleum jelly was inserted into the incision. The incision was closed with three to four stitches using permanent suture. The surgery took two to three minutes. Snakes were given at least six hours to recover.

Snakes were released at the site of capture and were relocated three times per week using an AVM Model LA12 receiver. Location, weather, temperature and behavior were recorded. Range length was measured as the farthest distance between any two points an individual snake had moved. The mean distance moved per day was calculated by summing the distances between successive locations marked and dividing by the total number of days observed (Reinert and Kodrich, 1982). Habitats were differentiated on the basis of vegetation.

Dietary analysis

One hundred and twenty-five snakes were examined to identify and determine relative frequency of food items. To avoid killing large numbers of snakes, preserved specimens from museums were used. The majority of specimens (116) came from the Herpetological Collection at the Museum of Zoology, University of Michigan, Ann Arbor. Five specimens

came from the Michigan State University Museum, East Lansing. Two other specimens include a road kill and feces from one of the living snakes. All specimens from the University of Michigan were X-rayed to determine if food items were present in the gastro-intestinal tract and to reduce the number of specimens which would have been unnecessarily dissected. The X-rays were also used to measure the body length, to determine sex and examine the number of embryos present in gravid snakes. The X-rays also revealed a parasitic infection in a group of snakes collected from Huron county (Figures 4-6).

Gastro-intestinal contents were removed and stored in alcohol. All specimens were identified to the lowest taxon possible. Dr. J.A. Holman (Michigan State University) identified all reptile and amphibian specimens. Mammal specimens with skulls and teeth present were identified by the author using comparative specimens from the Mammalogy Division of the Michigan State University Museum. Other mammalian material was identified by Dr. A.C. Carmichael (Michigan State University).

Tail length comparison between mature males and females

Measurements of body length (snout-tail) and tail length (length from the first caudal vertebra to the last caudal vertebra) were taken for all X-rayed snakes where possible. The ratio of the body length to tail length was calculated for all mature snakes. Twenty-five females and

Figure 4. Photograph of an X-ray showing food items in a snake. The hemipenes are also visible.

Figure 5. Photograph of an X-ray showing the embryos of a gravid snake.

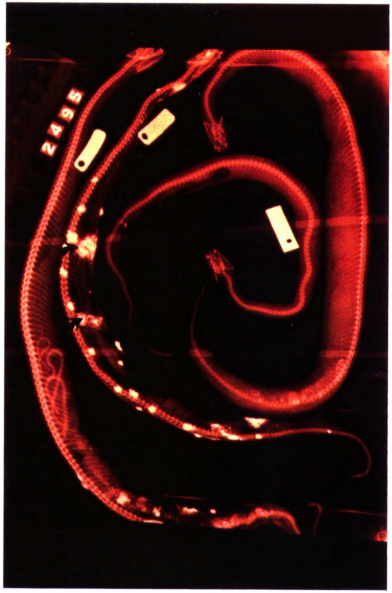

Figure 6. Photograph of an X-ray showing a snake infected with nematodes. The nematodes show as bright spots on the X-ray.

thirty-seven males were used. These numbers were tested, using SYSTAT's Wilcoxon Signed Ranks statistics, to see if tail length varied significantly between male and female snakes.

Field layout of daily snake movements

Snake locations were initially marked with orange flags but these attracted attention from visitors to the gardens. A few weeks into the study I switched to green flagging tape which I tied to tall grasses or plants. All flags were marked with the name and date of the snake site. The distances between flags were regularly measured to ensure the flags had not been moved. Using a Brunton compass and measuring tape, two assistants and I measured the distance from a reference point to all of the sites were the snakes had been located. These measurements were placed on polar co-ordinate paper and transferred to tracing paper. Using an aerial view of the gardens, the reference measurements were enlarged on graph paper to the same dimensions as the prairie section. I then combined the two diagrams into one where I could plot daily movements and range length.

RESULTS

Telemetry study

Three mature (>50cm SVL) snakes were captured and implanted with transmitters. The first snake (S1), a male, was released on July 28, 1990; the second (S2), a gravid female, was released on August 17, 1990 and the third (S3), a male, on October 1, 1990. S1 was located on thirty-three different days over a period of ninety-one days at which point the battery in the transmitter was spent. The transmitter in S2 had a loose connection and at times would not transmit. S2 was located seven times over a fifteen day period but then could not be found for forty-four days. Transmissions from S2 were detected again on October 15, 1990. S2 was then located three times per week until November 1, 1990, but the snake was at its hibernation site and did not leave that area. S3 was located nine times over a period of thirty-three days. This snake was released in the prairie where it had been captured but shortly moved to the area where it would hibernate. Once in this area, little or no movement was observed.

All three snakes were captured in the prairie habitat of the gardens. The dominant vegetation of this habitat are the grasses Andropogon gerardii (big blue stem) and Panicum virgatum (switchgrass). These grasses occur with other

common Michigan prairie plants and at least five species of goldenrod (Solidago spp.). During this study most of the vegetation of the prairie was over two feet tall. Only a few areas of exposed soil were present. Paths, for visitors to the Garden, run through the prairie. These are mowed regularly and represent the major open area in the prairie. During this study three massasaugas were observed sunning on the path. Implanted snakes were usually found loosely coiled either on the ground or a few inches off the ground in the grass. The snakes were extremely difficult to see in this habitat and often were not seen until I was within a half meter of the specimen. The snakes were never found below ground in the prairie habitat. On two occasions S1 was located under grasses from previous years. Usually I was able to approach a snake within a half meter without a response from the snake: no tongue flicking, rattling or movement. When alarmed, a snake would rattle and usually glide away. The snake usually moved only a few meters away. At this distance, the snake stopped rattling. Specific behavior is discussed in a later section. In cases where the snakes were found moving, it was difficult to determine if the movement was due to normal activity or a reaction to my presence.

All three snakes left the prairie and moved into three different habitats in the fall (Figure 7). S1 switched habitats on September 15, 1990; S2 was found in a new habitat when relocated October 15, 1990 and S3 moved to a

Figure 7. Diagram of snake movements during study.

Dark shading indicates the floodplain. Light shading indicates prairie. The white area between the floodplain and the prairie is hardwood forest. Open circles indicate snake 1 (S1), solid circles indicate snake 2 (S2), and open squares indicate snake 3 (S3). Numbering starts from point of capture (1) to the site of hibernation (arrow).

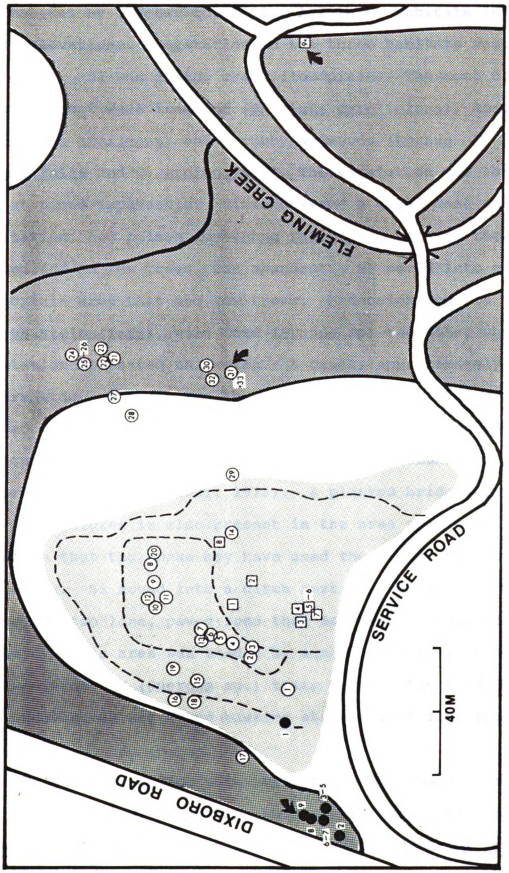

Figure 7.

new habitat by October 10, 1990. All three habitats were at lower elevations. Vegetation in the three habitats was different. S1 was in the creek floodplain. The most common trees present were ironwood (Carpinus caroliniana), American elm (Ulmus americana) and shrubby dogwoods (Cornus alternifolia and C. stolonifera). The vegetation was thick and at times impassable. Vines covered a great deal of the vegetation, and poison ivy (Rhus radicans), both on the ground and in the trees, was abundant. S2 moved into a floodplain area that had few trees. Red-osier dogwood (Conus stolonifera), wild rose (Prunus sp) and other shrubby vegetation dominated this area. A creek, approximately five meters wide, runs between the two habitats inhabited by S2. S2 had to cross this creek in order to enter the lowland habitat. Massasaugas are one of the few rattlesnakes reported to swim (Klauber, 1972). A planked bridge used for service vehicles is also present in the area and it is possible that the snake may have used the bridge to cross the creek. S3 moved into a ditch next to a heavily traveled, two lane, paved road that borders one edge of the Gardens. This area was shaded by sumac (Rhus sp.) as well as two large oak (Quercus sp.) trees next to the road. On one occasion S3 was found basking about a foot from the road.

Once a hibernation site was established the snakes came out to bask but would rarely venture more than a half meter from the entrance of the hibernation site. Near the opening

to the burrow, the snakes were cautious and retreated into the burrow when approached. The snakes appeared cautious when leaving the burrows. At times they were observed to have half of their body out of the burrow and the other half inside. At other times only the head was exposed and a great deal of tongue flicking was observed. The snakes were still coming to the surface on October 31, 1990 on days when the temperature was above 50° F. All three snakes hibernated in mammal burrows. Mammal burrows were distinguished from crayfish burrows by the angle of excavation and the size of the entrance to the burrows. Burrows dug at angles and with openings greater than 7 cm were assumed to be mammal burrows. Only one snake was observed per hibernation site.

The greatest range length was for S2 with a maximum length of 164.0 m. S1 had a maximum range length of 135.0 m and S3 had a maximum range length of 41.8 m. The mean distance moved per day by S1 was 5.63 m. If the calculations are performed separately for the two different habitats in which S1 was found, then the mean distance moved per day in the upland prairie habitat was 7.6 m and the mean distance moved per day in the lowland habitat was 3.32 m. The mean distance moved per day for S2 was calculated only for the first fifteen days of observation and was 4.8 m. S3 had the smallest mean distance moved per day with 1.76 m.

The transmitter in S1 was removed after the battery was spent and the snake was released at the point of capture.

Scar tissue around the transmitter made removal of the transmitter difficult and produced a larger wound than implantation of the transmitter. Because of this and the difficulties involved in removing the snakes from their hibernating sites, transmitters were not removed from S2 and S3.

Dietary analysis

Of the 125 specimens examined, 43 (34.4%) contained one or more food items. The majority of these items were mammals (73.3%). Reptiles (snakes only) made up the next largest group (15.6%). Birds (4.4%) and insects (4.4%) were each found in two specimens. One frog (2.2%) was also found. Of the insects, a beetle was found in one snake which had no other food items in its gut. Another specimen, which had eaten a snake, yielded parts of various insects (an ant head, fruit fly and wing parts) that may have come from the ingested snake (Figure 8).

Of the mammals consumed, microtines made up the largest portion of the diet (54.3%) with Microtus pennsylvanicus the most common species (68.4%) (Figure 9). Two species of Peromyscus, P. leucopus and P. maniculatus), are found in Michigan. The two species could not be differentiated based on the remains found within the gastral-intestinal tract of the snakes. Peromyscus sp. made up 11.4% and zapodids made up 8.6% of the mammals eaten. Soricids (all Blarina brevicauda) made up 11.4% of mammals eaten (Figure 10).

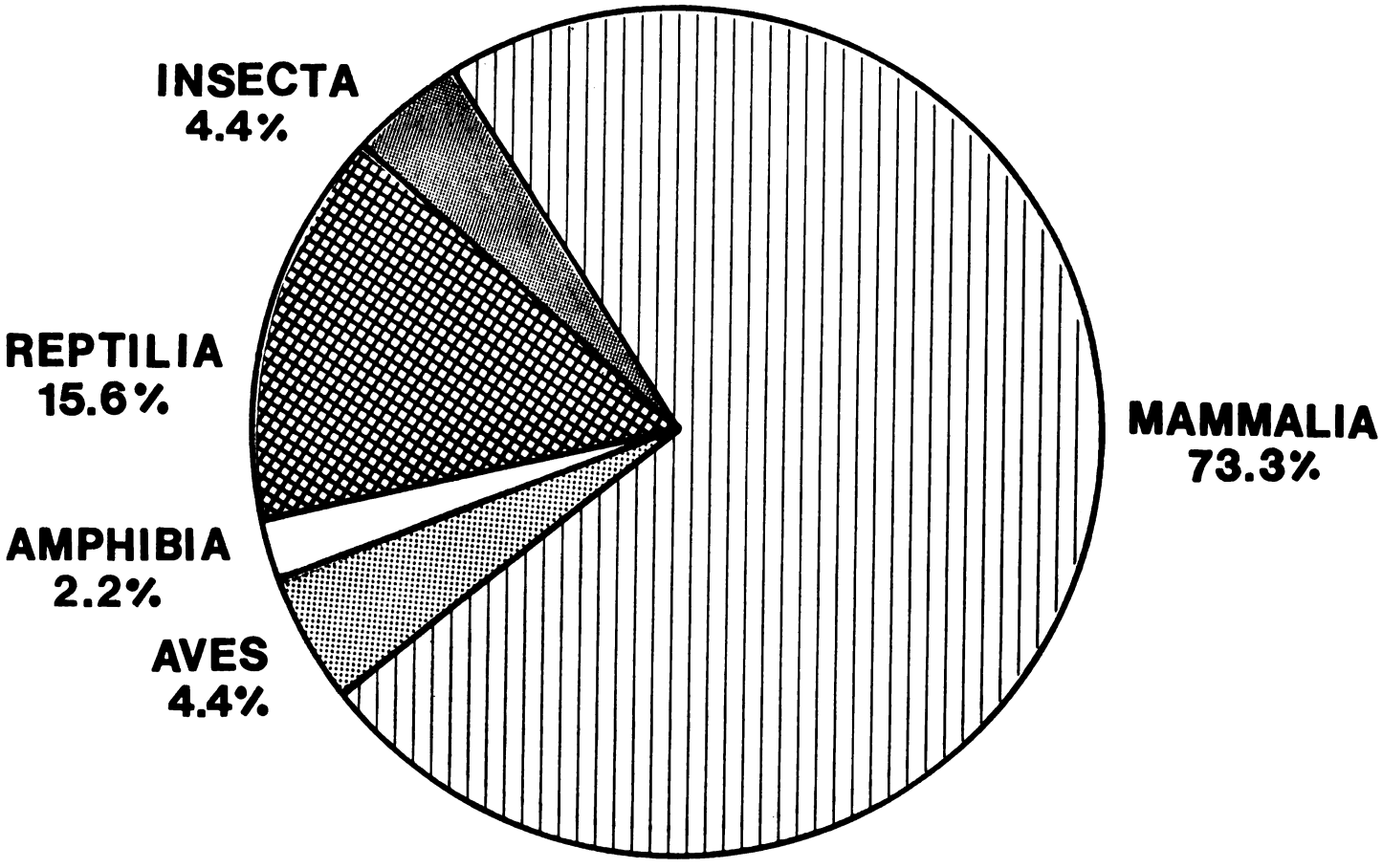

Figure 8. Pie diagram of frequency of all taxa of animals found in the diet of Sistrurus catenatus.

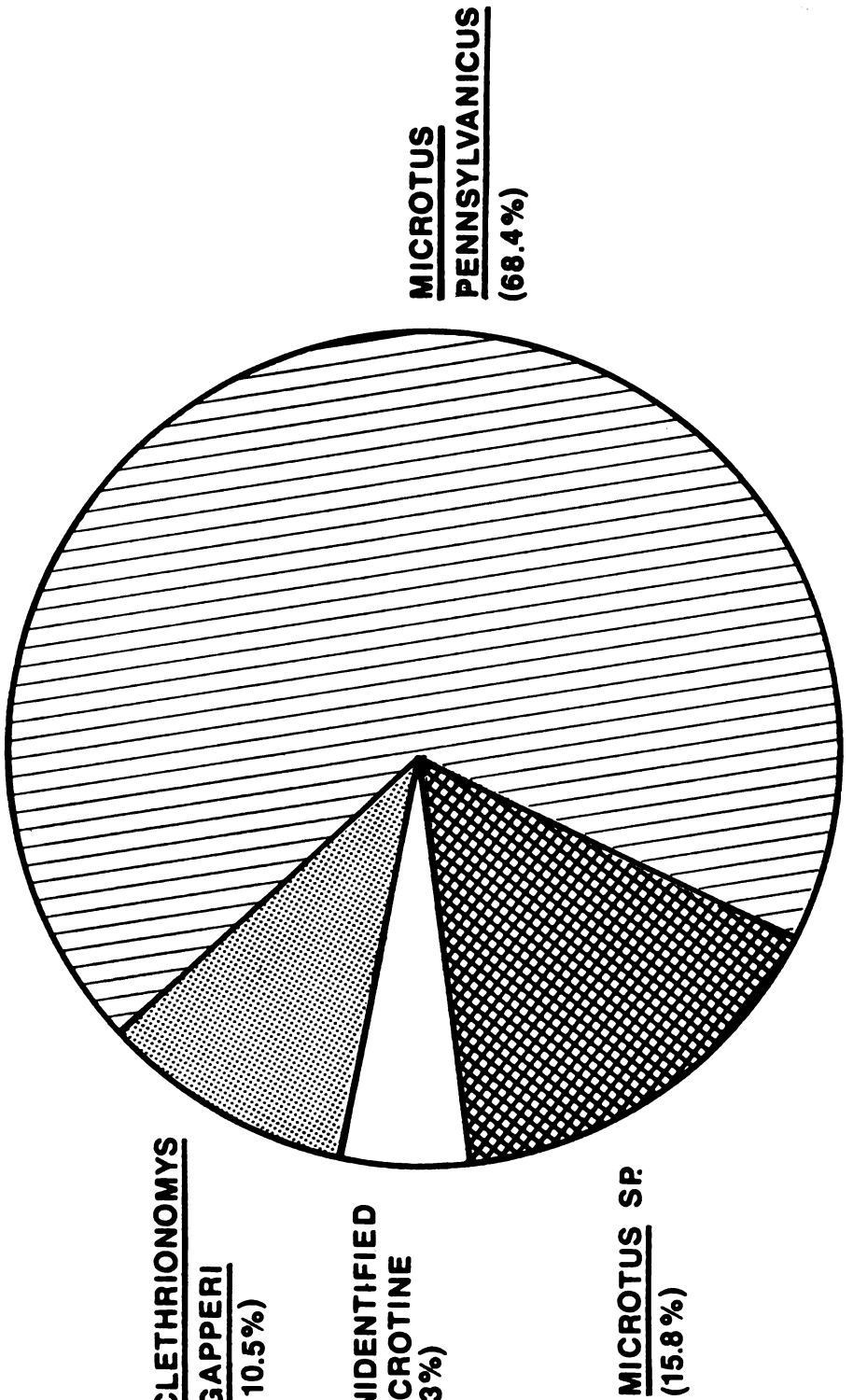

Figure 9. Pie diagram of frequency of microtine rodents found in the diet of Sistrurus catenatus.

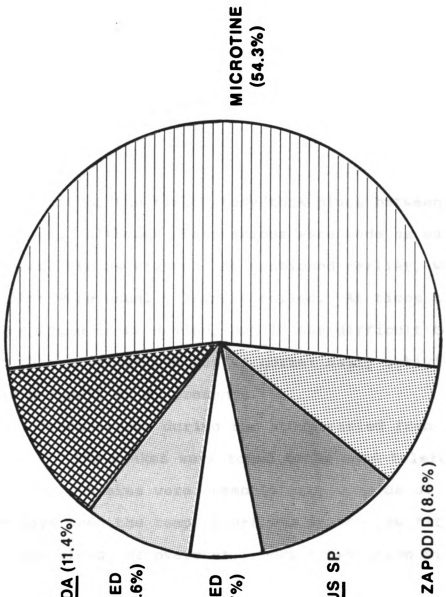

Figure 10. Pie diagram of frequency of mammals found in the diet of Sistrurus catenatus.

Of the snakes consumed, two were Thamnophis sp., one was Sistrurus catenatus, one was Storeia dekayi and three were not identifiable beyond suborder (scales only). Using Seigel's (1986) age distribution, 57.1% of the snakes consumed were eaten by new born young (20-30cm SVL) and yearlings (30-40cm SVL). The rest (42.9%) were eaten by mature (>50 cm SVL) snakes (Figure 11).

Behavior

Most of the field study took place between 10:00 am and 2:00 pm, although observations were made as early as 9:00am and as late as 8:15pm. As mentioned earlier, when located, snakes were usually loosely coiled. At times the snakes were found to be moving, but it was difficult to determine if this movement was due to normal daily activity, or if it was a result of my presence.

Temperatures during the study varied from 45° F to 80° F. The snakes were found to be cold tolerant. During the fall, snakes were commonly seen outside of their burrows on days when the temperature was in the low fifties, even if it was cloudy or overcast. Once hibernation sites were established, the snakes would emerge to bask, but would not leave the area of the burrow. But both S1 and S3 were observed in two or more mammal burrows before establishing permanent hibernacula. Defensive behavior such as coiling, tail-rattling, or rapid gliding varied between individuals. S1 and S3 could be approached within a half meter with no

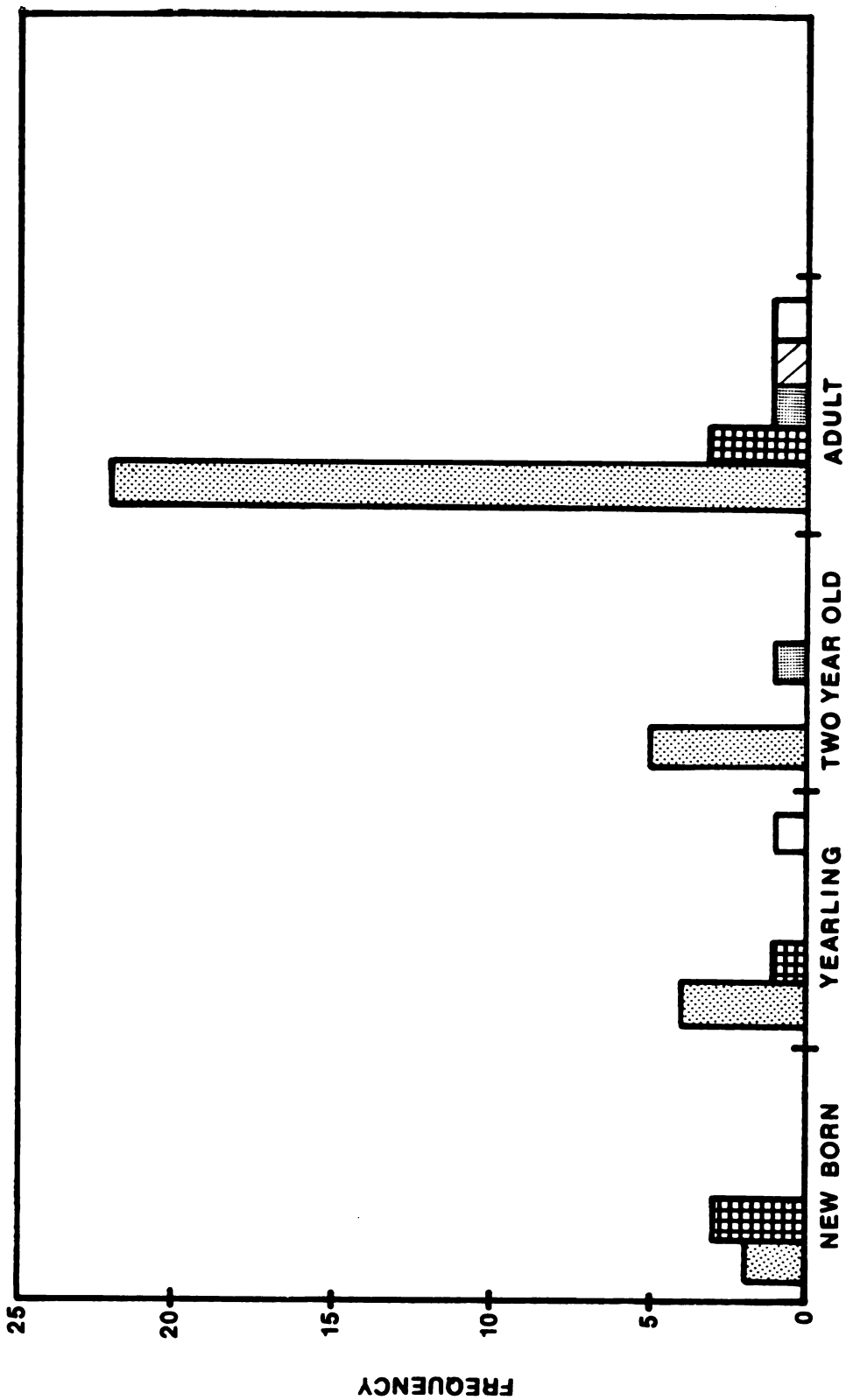

Figure 11. Histogram of frequency of prey taken by age class of Sistrurus catenatus.

apparent reaction. When disturbed, these snakes would rattle while gliding rapidly away. Other massasaugas, too small to be implanted, reacted similarly. Rarely did these snakes coil unless touched and at no point did they strike in the field unless handled.

Behavior which could be interpreted as territorial was observed in one snake. From August 22 to August 29, 1990, S2 remained in the same area. She could not be approached within two meters without rattling. She did not glide away when approached but would coil and rattle until I left the area. On one occasion (August 24) she exhibited offensive, aggressive behavior when I entered the area. I was within three meters of her and she approached me. Her head and upper body were raised above the ground and she was not rattling. If I approached closer than two meters she came forward and if I retreated she would also retreat. The same behavior was encountered two hours later. Because she was gravid when captured, I searched the area for young. No young were found in the area. She may have been about ready to give birth and this might account for all of the above behavior.

On September 6, 1990, while still in the prairie, S1 was observed rain-harvesting from its own body during a heavy downpour. The snake had been located minutes prior to the downpour. As the rain began to fall, the snake, which was already in a tight coil, began to move its head along its body. The labial scales were touching the body and the

muscles of the neck were moving as they do when snakes drink. The downpour lasted for five minutes. The snake continued this behavior after the rain stopped. It moved its head into the grass at one point and it was difficult to see the behavior. It then returned to drinking off its body. Unfortunately the snake suddenly became startled by my presence and glided away. The water harvesting lasted for ten minutes.

Tail length comparison between males and females

Males were found to have significantly ($p<.001$) longer tails than females (Table 1).

Table 1. Wilcoxon signed rank test comparison of mature males and females based on ratio of body length (ST) to tail length (TL).

	Ratio ST/TL	Z	P
Males	8.674 ± 1.022	-3.75	.0001
Females	10.693 ± 1.404		

DISCUSSION

Observations made during this study indicate the massasaugas of this Michigan population are similar in their habits and habitats to populations of eastern massasaugas of other states where similar studies have been done. The seasonal changes in habitat utilization observed in this study have also been observed in Missouri (Seigel, 1986), Ohio (Conant, 1938) and Pennsylvania (Reinert and Kodrich, 1982) populations. In all three studies the snakes frequented low, poorly drained soils in the spring and fall, and upland, dry areas in the summer. Plant species were somewhat different in each study but the general pattern of vegetation in upland and lowland situations was similar. Hibernation sites were always located in the lowland areas. All snakes of the present study hibernated in mammal burrows. Seigel (1986) reports crayfish burrows as the site of hibernation for the Missouri massasaugas. Reinert and Kodrich (1982) indicate both mammal and crayfish burrows, as well as natural fissures, in their study areas.

This study found mammals were the animals most commonly eaten by Michigan massasaugas. Keenlyne and Beer's (1973) study of a population in Wisconsin and Seigel's (1986) study of a population in Missouri also found mammals to make up most of the massasaugas diet, with Microtus pennsylvanicus

the most common species consumed in all three studies. Snakes were the second most common food item and were eaten primarily by new born (<30cm) and yearling (<40cm) snakes. Both Seigel (1986) and Keenlyne and Beer (1973) found massasaugas under 40 cm to be ophiophagous. Birds also appear to make up a small percentage of the massasauga diet (LeRay 1930; Smith, 1961; Keenlyne and Beer, 1973). One frog was present in an adult (>50cm) in this study. Neither Keenlyne and Beer (1973) nor Seigel (1986) found frogs, but many works on the eastern massasauga describe observations of frogs being eaten or found during dissection (Ruthven, 1911; LeRay, 1930; Breisch, 1984.). Possibly the lack of scales and hair in frogs might result in a smaller percent being detected.

The massasauga was found to be cryptic in both habitats. The tall grasses of the upland prairie and the thick shrubby vegetation of the lowlands hid the snakes. The color pattern breaks up the body pattern of the snake and blends into the ground color. The snakes in most cases were slow to rattle or move when approached. This behavior contributed to the crypticity of the snake since rattling and movement immediately drew attention to them.

During the study the prairie had no standing water. Fleming Creek runs through the Gardens but not near the prairie. During the summer the snakes were never found outside the prairie. It is possible that the snakes moved out of the prairie to the creek at night since they are

reported to be nocturnal during the summer (Seigel, 1986). But, this seems unlikely due to the distance involved and the regularity at which it would have to be traveled. Thus, water-harvesting during rainfall could be an important method of obtaining water in this population during the summer. Water-harvesting has not been previously reported in the literature for S. catenatus. Water-harvesting has been reported in lizards (Sherbrooke, 1990), land tortoises (Auffenberg, 1963) and in two species of snakes (Louw, 1972; Miller, 1985). Miller (1985) observed a mangrove water snake (Nerodia fasciata compressicauda) drinking rain water which ran along its body to its mouth. In a laboratory experiment, Miller kept nine mangrove water snakes in an aquarium without food and water for 21 days. Water was then dropped from a pipet above the heads of the snakes. According to Miller's observations, the snakes both caught water droplets in the air and drank the water which had fallen to the ground. The other snake reported to water harvest is the side-winding viper (Bitis peringueyi) of the Namib desert. Louw (1963) kept two side-winding vipers in an enclosure for two months without water and sheltered from fog condensation. The snakes were fed lizards which provided some moisture. When sprayed with water the snakes were reported to coil up and move the head back and forth over the dorsal surface of the body "as the animal licked off the water droplets". Then every few minutes the snakes would raise their heads "some 10 cm above the ground to

assist the flow of water into the digestive tract by gravity". Although Louw's description of this behavior is similar to the observation of water-harvesting in the massasauga, Louw's conclusions must be questioned due to his description of how the snakes were drinking. Snakes drink by sucking water into the mouth. The tongue is a sense organ and is not used to drink. In addition, snakes are capable of swallowing without the assistance of gravity.

Bielema (1973) and Reinert (1978, both as cited in Seigel, 1986) and Seigel (1986) all report males having longer tails than females. This study differed from the above studies because skeletal features were used to determine tail length instead using the vent to tip of tail measure. But the results also showed males to have tails significantly longer than females.

RECOMMENDATIONS

Observations made during this study have lead to the following recommendations.

People and the massasauga

The massasauga is not a threat to the general public. Most residents of the state will never come in contact with the massasauga. The snakes are difficult to see and the preferred habitats, especially in the spring and fall, are arduous and often unpleasant to enter. But people who live, work or hike in areas with grassy uplands and wet lowlands, especially if the massasaugas are known to be present, should wear closed, leather shoes, preferably with a high top and show caution when reaching into vegetation. The danger is minimal since the massasauga rarely strikes unless harassed; usually only if handled or stepped on. The Matthaei Botanical Gardens receive between 400 and 500 visitors per week and massasaugas are common in certain areas that are open to the public. Paths run through the prairie where this study took place. Massasaugas were frequently within a meter or less of the paths and at times were found on the paths. However snake bite is rare at the Gardens. Most snake bites which have occurred were preventable. In 1990, two people were bitten by massasaugas at the Garden. One visitor tried to handle a snake and was

bitten on the hand and another stepped on a snake. The latter was wearing sandals and was bitten on the foot. Hence, even in areas with large numbers of people where massasaugas are common the danger is minimal.

Conservation and management

Habitat destruction appears to be the main factor in the decrease of the eastern massasauga throughout its range (Ruthven, 1911; Wright, 1941; Loomis, 1948; Smith, 1961). The dual habitat preference of the massasauga complicates its conservation and management. The massasauga needs both lowland wet and upland dry habitats. The massasauga has an activity range of less than a hectare (Reinert and Kodrich, 1982) so the two habitats must be close to each other. In addition, roads that separate the two habitats can result in high mortality rates to the snakes. Of 172 snakes collected during Seigel's study, 40 (23.2%) were found dead on the roads in the study area. During my study a housing complex was constructed on the property next to the Gardens. This not only destroyed the habitat within the housing complex, but also created a barrier to any further migration by the massasaugas on that side of their habitat. Due to burgeoning developments, more and more populations of massasaugas are being isolated into small populations. This practice has many ecological consequences.

The eastern massasauga is considered as endangered, threatened or rare in virtually every state where it is

found and in Canada (Ashton, 1976 as cited in Seigel, 1986). Michigan has no policy concerning the massasauga and the current belief is that there are many populations of massasaugas in the state. There is a growing concern that many populations may be decreasing and some may actually be gone due to habitat destruction. More information needs to be collected on current locations of massasauga populations and the abundance of massasaugas within these populations in order to determine the status of the massasauga in Michigan.

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APPENDICES

APPENDIX A

Sex, body length (ST) and tail length (TL) of X-rayed snakes.

Specimen	Sex	ST(cm)	TL(cm)
31451	-	23.81	1.91
31760	F	71.76	8.57
35865	F	61.12	5.72
37631	F	64.14	----
37633	F	56.20	4.60
37634	F	36.83	4.45
37635	F	40.64	4.45
37639	F	67.31	6.67
40872	F	55.72	2.86
43940	F	68.58	5.72
47460	F	65.41	5.87
52226	F	60.01	6.67
58801	F	48.26	4.60
59237	F	56.99	5.08
62622	F	48.26	5.08
64393	F	70.49	6.35
67268	F	57.31	7.14
72447	-	23.97	3.18
74535	-	23.65	2.54
76062	-	29.69	3.02
79232	F	60.17	5.72
79235	F	72.71	6.03
79542	F	41.91	4.60
82088	F	61.75	5.87
82088	F	64.77	6.03
82115	-	26.99	3.18
96494	F	60.33	5.87
96881	-	19.37	2.06
102803	F	31.43	3.49
112364	F	71.76	5.56
116623	-	26.35	3.02
118087	F	59.21	4.45
118650	F	58.42	5.24
118728	F	60.64	5.72
118729	F	35.56	2.54
118731	F	51.44	6.35
118732	F	66.04	6.35
120511	-	26.19	3.18
121678	F	59.69	7.30
122781	F	36.99	2.70

Specimen	Sex	ST(cm)	TL(cm)
123189	-	26.51	2.54
123190	F	39.21	3.81
126753	-	29.85	2.86
127460	-	27.46	2.22
128004	F	42.55	3.65
128635	-	29.37	3.18
133830	-	19.84	2.54
148795	F	69.22	5.56
150064	F	65.72	6.35
156122	-	25.71	3.18
156796	F	33.34	3.81
174105	-	23.02	3.18
190844	-	26.99	3.18
190845	F	53.66	5.40
190851	F	38.10	3.81
30598	M	61.75	7.62
31450	M	78.11	7.94
33771	M	60.96	7.62
36018	M	45.72	4.76
37632	M	59.69	7.62
37636	M	70.17	8.73
37638	M	69.53	6.67
41307	M	63.50	5.72
43938	M	54.61	6.03
47808	M	59.69	7.14
60883	M	66.99	9.21
62621	M	78.11	8.89
63071	M	69.85	7.30
65192	M	76.99	9.05
66776	M	73.66	8.26
67714	M	57.79	7.30
72448	M	59.69	7.62
72449	M	65.25	6.99
72450	M	75.72	8.41
74140	M	82.87	9.68
74491	M	56.04	6.35
74494	M	49.85	6.51
74699	M	52.86	8.57
79233	M	48.90	5.08
79235	M	75.57	8.26
82116	M	70.49	8.26
109215	M	74.61	7.14
110483	M	61.60	6.35
110774	M	71.44	7.94
116302	M	67.95	8.26
118642	M	60.33	7.62
118730	M	57.79	7.46
118731	M	50.00	6.35
120510	M	72.71	6.99
122548	M	62.26	6.67
122549	M	73.03	7.94
125427	M	73.98	8.41

Specimen	Sex	ST(cm)	TL(cm)
127407	M	78.42	9.21
152439	M	33.97	4.45
170373	M	58.42	6.35
173517	M	50.80	7.62

APPENDIX B

Specimen, sex and food item(s) identified in diet annalysis.

Specimen	Sex	Food Item(s)
3177(MSU)	M	Snake
		Insect
3274(MSU)	F	*Microtus pennsylvanicus*
3275(MSU)	M	*Microtus pennsylvanicus*
S1	M	Mammal
Road Kill		Mammal
3176(MSU)	M	Rodent
35865	F	*Microtus pennsylvanicus*
		Microtus sp.
37631		*Rana* sp.
37633	F	*Thamnophis* sp.
37634	F	Insect (Coleoptera)
37635	F	*Thamnophis* sp.
37636	M	*Blarina brevicauda*
37638	M	*Sistrurus catenatus*
41307	F	Bird
43940	F	*Microtus pennsylvanicus*
53021	M	Rodent
59237	F	*Clethrionomys gapperi* (2)
63071	M	*Microtus pennsylvanicus*
62622	F	*Microtus pennsylvanicus*
63989	F	*Microtus pennsylvanicus*
64393	F	*Microtus pennsylvanicus*
66776	M	*Peromyscus* sp.
67714	M	*Microtus pennsylvanicus*
74494	M	*Microtus pennsylvanicus*
74699	M	*Microtus pennsylvanicus*
83985	F	*Blarina brevicauda*
96494	F	*Storeria dekayi*
96881	F	*Blarina brevicauda*
116302	M	Zapodid
118729	F	*Peromyscus* sp.
118731	M	Bird
		Zapodid
118732	F	*Napaeozapus insignis*
120510	M	*Microtus* sp.
120511	F	Snake
122781	F	Mammal
127460	F	*Blarina brevicauda*
152439	F	Microtine
156796	F	*Peromyscus* sp.

Specimen	Sex	Food Item(s)
170373	M	Microtus pennsylvanicus
173517	M	Microtus pennsylvanicus
190851	F	Peromyscus sp.