# Results of Surveys for Eastern Massasaugas *(Sistrurus catenatus catenatus)* in Houston, Winona, and Wabasha Counties, Minnesota, 1993

Final Report to the
U.S. Fish and Wildlife Service

submitted by the
Minnesota County Biological Survey
Department of Natural Resources
500 Lafayette Road
St. Paul, Minnesota 55155

August, 1994

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## CONTRIBUTORS TO THE MASSASAUGA SURVEY

Funding for this project came from the Minnesota Department of Natural Resources and the U. S. Fish and Wildlife Service Endangered Species Program. John P. Levell worked under contract with the Minnesota County Biological Survey (MCBS), Department of Natural Resources, to conduct surveys for massasaugas in southeastern Minnesota. Under the agreement, he reviewed the literature and searched for all available records on the occurrence of massasaugas in southeastern Minnesota and adjacent portions of Wisconsin and Iowa. Mr. Levell conducted field searches and prepared a report of his findings. This final report is an edited version of his summary.

The MCBS contributed staff time and equipment to the assist Mr. Levell with massasauga surveys. Carol Dorff, MCBS herpetologist, worked closely with Mr. Levell to plan and execute survey activities. Jeff Davis, temporary herpetological assistant for the MCBS, assisted with establishing and checking the snake sampling transects. Gerda Nordquist, MCBS animal survey coordinator, oversaw the progress of the survey and prepared the edited version of this final report.

## INTRODUCTION

The eastern massasauga rattlesnake *(Sistrurus catenatus catenatus)* has long been considered a component of southeastern Minnesota's herpetofauna. Although rarely documented in the state, numerous authors have included Minnesota in the geographic distributions of this species in North America. The lack of information on the status and distribution of massasaugas in Minnesota has severely hampered efforts to determine whether this species warrants inclusion among Minnesota's endangered and threatened species. Massasaugas appear to be declining throughout the species' range due to human persecution and habitat destruction. The eastern massasauga is legally protected in one Canadian province and several states, and is currently listed as a federal candidate (Category 2) species (Table 1). This underscores the need to better understand the status of this species in Minnesota.

Table 1. Status of the eastern massasauga throughout its range (as of March 1994).

| State/Province | Status | Current protection |
|---|---|---|
| Illinois | Endangered | State law |
| Indiana | Threatened | State law |
| Iowa | Endangered | State law |
| Michigan | Special Concern | State law |
| Minnesota | Special Concern | None |
| Missouri | Endangered | State law |
| New York | Endangered | State law |
| Ohio | Special Interest | None |
| Ontario | Threatened | Provincial law |
| Pennsylvania | Endangered | State law |
| Wisconsin | Endangered | State law |

## NATURAL HISTORY

Identification: The eastern massasauga is a small to medium-sized snake, reaching an average adult maximum length of 46-76 centimeters (18-30 inches). The dorsal ground coloration is gray to brown with a series of dark brown to black dorsal blotches or saddles. Ventral scales are heavily mottled with dark pigment, giving the belly an overall black coloration. Breckenridge (1944), Christiansen and Bailey (1990), and Vogt (1981) describe specimens from populations in Minnesota, Iowa, and Wisconsin, respectively.

Massasaugas can be readily distinguished from the timber rattlesnake *(Crotalus horridus)*, the only

other crotalid snake in Minnesota, by their smaller size, darker coloration, and the presence of nine enlarged head scales or plates. Several non-venomous snake species native to Minnesota are occasionally misidentified as massasaugas. These include milk snakes *(Lampropeltis triangulum)*, fox snakes *(Elaphe vulpina)*, and western and eastern hognose snakes (*Heterodon nasicus* and *H. platyrhinos*, respectively). None of these species possess a tail rattle, a feature present in all but newly born or mutilated massasaugas.

Distribution: Three subspecies are recognized for the massasauga, the eastern massasauga *(Sistrurus catenatus catenatus)* which occurs in the upper midwest, and two westerly-distributed subspecies, the western massasauga *(S. c. tergeminus)* and the desert massasauga *(S. c. edwardsi)* (Fig. 1). The distribution of eastern massasaugas extends from central New York and western Pennsylvania, westward through southern Ontario, northern and central Ohio, lower Michigan, Indiana, Illinois, southern Wisconsin, southeastern Minnesota, eastern Iowa, and northeastern Missouri.

Minnesota clearly lies at the northern limit of the massasauga's range and inclusion of the state in the species' North American distribution is based on only a few records. Ditmars (1936) included Minnesota among the states inhabited by this species, however, no specific records were cited. Breckenridge (1938) was the first to report a specimen taken from Minnesota (Bell Museum of Natural History (MMNH) specimen #142). Gloyd (1940) and apparently all subsequent accounts that included Minnesota in the distribution of this species were based on Breckenridge's record. One notable exception was Schmidt and Davis (1941), who excluded Minnesota from the geographic range of the eastern massasauga in North America. They reported the species as extending "from central New York and western Pennsylvania west through Ontario, lower Michigan, north and central Ohio and Indiana, Illinois, southern Wisconsin, eastern and southern Iowa, Missouri, extreme southeastern Nebraska, extreme eastern Kansas, and extreme northeastern Oklahoma".

It is unlikely that Schmidt, a personal friend of Howard Gloyd and the herpetological editor of Copeia from 1937-1949, could have overlooked the previously published references to eastern massasaugas in Minnesota. The omission of Minnesota from Schmidt's range account suggests that he felt the existing evidence was insufficient to warrant inclusion of massasaugas among the recorded herpetofauna of Minnesota.

Habitat: Sometimes referred to as the "swamp rattler", a review of the literature reveals that the habitat preferences of massasaugas are quite broad. Wetland habitats are mentioned in most regional accounts of eastern massasaugas (Swanson 1930, Wright 1941, Mierzwa 1993), however, massasaugas have been recorded from numerous other habitat types, as well. These include old fields and deciduous woods (Seigel 1986), coniferous forests (Weatherhead 1991), pastures (Bielema 1973), an abandoned parking lot reverting to second growth forest adjacent to a prairie remnant (Anton 1991), and airport runways (Jeff Davis personal communication). The two western subspecies, have been found in prairies and plains (Evans and Gloyd 1948), and deserts or desert grasslands (Gloyd 1955).

It appears that the massasauga is essentially a grassland species, and Schmidt (1938) postulated that massasaugas and other western prairie herpetofauna expanded their ranges northward and eastward with the spread of grasslands following the end of the last glacial period. Atkinson and Netting (1927) speculate that the disjunct distribution of northeastern populations of massasaugas, and their occurrence in wetland habitats, is the result of isolation to marginal habitats due to the encroachment of deciduous woodlands on formerly prairie habitats. There are indications that in at least some

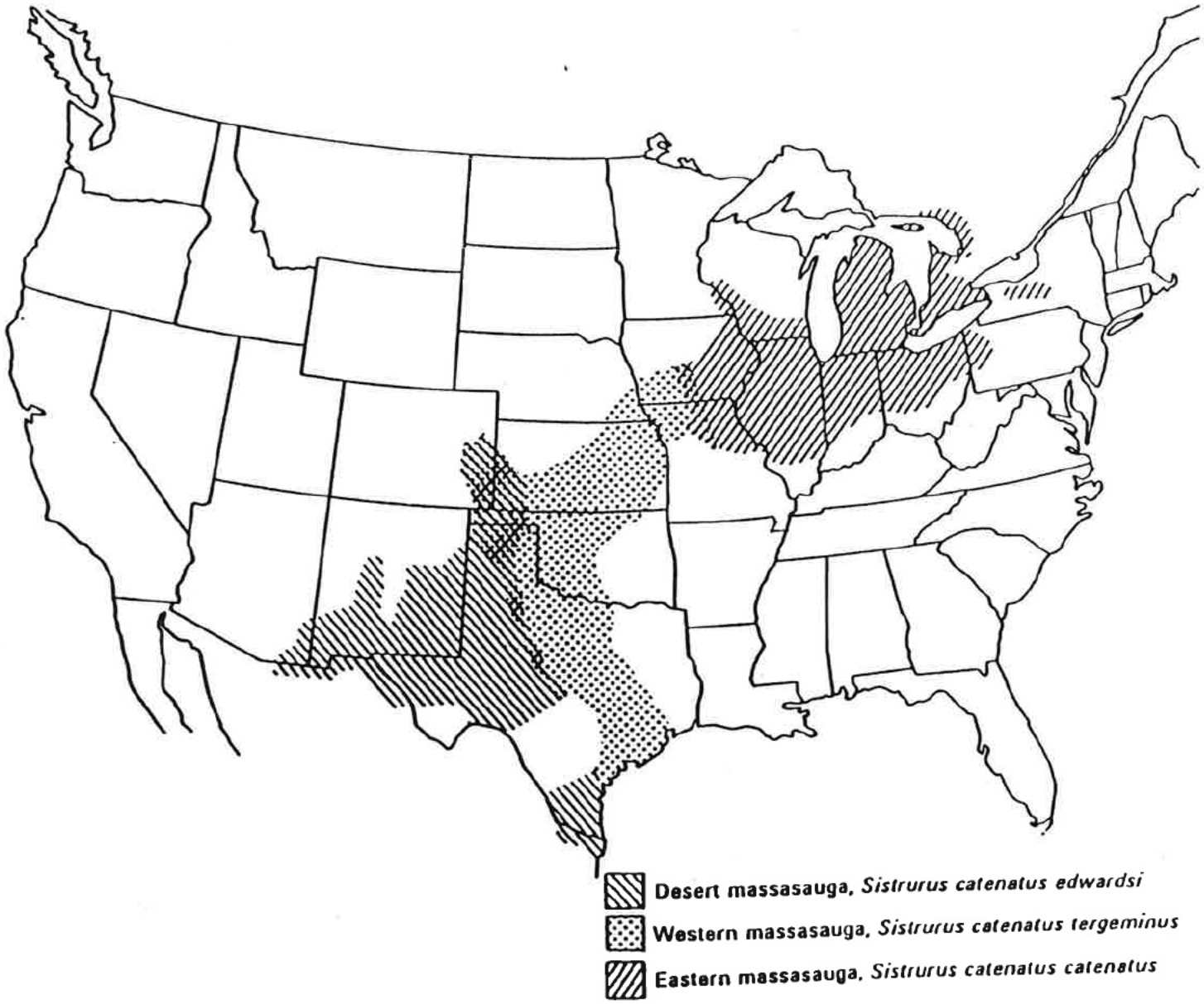


Fig. 1. Distribution of the massasauga in the United States (from Russell 1983).

areas, eastern massasaugas exhibit a seasonal shift in their utilization of available habitats. Seigel (1986), reporting on a population from the Squaw Creek National Wildlife Refuge in Missouri, noted a shift from lowland prairie areas in the vicinity of crawfish burrows, that the snakes occupied during spring, to drier upland areas, including old fields and deciduous woods, in the summer. In the fall, massasaugas returned to the spring season habitats. A similar pattern of habitat utilization has been reported for populations in Ontario (Parsons 1984, Weatherhead 1991), Michigan (Moran 1993), and Pennsylvania (Reinert and Kodrich 1982). A preference for ecotones, such as the transition between grasslands and woodlands, has also been noted by several authors (Gloyd 1955, Parsons 1984, Mierzwa 1993).

During winter, massasaugas have been reported to select rock crevices, rodent and crawfish burrows, old stumps, and rotten logs as over-wintering sites (Ernst 1992). In western Pennsylvania, Reinert and Kodrich (1982) found that massasaugas over-wintered most often in low, wet habitats. In Ontario, Parsons (1984) noted preference for wet areas and depressions in the vicinity of tree roots. Maple and Orr (1968) reported over-wintering massasaugas in crawfish burrows below the frost line in northeastern Ohio. Rock crevices were reported as over-wintering sites in Iowa (James Christiansen personal communication).

Diet: Frogs are considered the principal prey of massasaugas (Ditmars 1936, Wright and Wright 1957, Klauber 1972). However, captive massasaugas are unreceptive to frogs when offered as food (Keenlyne and Beer 1973, John Levell personal observation). From an examination of the stomach contents of 91 massasaugas collected by Keenlyne (1968) from Buffalo County, Wisconsin, not a single frog was recorded. Over 94 percent of the stomach contents contained warm-blooded prey, mostly meadow voles *(Microtus pennsylvanicus)*. The only ectothermic prey was the eastern garter snake *(Thamnophis sirtalis)* that were consumed by young-of-the-year massasaugas. That juvenile massasaugas may be primarily ophiophagous is supported by Seigel (1986) who recorded brown snakes *(Storeria dekayi)* and eastern garter snakes among the stomach contents of young specimens. Feeding experiments conducted by Keenlyne (1968) found that captive juvenile massasaugas readily consumed small garter snakes, further supporting this conclusion.

Mortality: Significant levels of mortality may be attributed to humans, either by directly hunting them or indirectly by destruction critical habitat. Natural predators that normally include snakes in their diets, likely also take massasaugas when encountered. These predators include ophiophagous snakes, hawks, herons, other predatory birds, raccoons, opossums, foxes, cats, and feral hogs (Klauber 1972, Bushey 1976).

## METHODS

Background information: A preliminary search of the literature was conducted for historical records of massasaugas in Minnesota. Institutions with sizeable herpetological collections or smaller regional collections were contacted concerning their holdings of massasauga specimens from Minnesota or adjacent states. Amateur herpetologists, collectors, and former rattlesnake bounty hunters familiar with the area were consulted for their first-hand knowledge with massasaugas in Minnesota, as well as undocumented reports of this species. In portions of southeastern Minnesota containing habitat suitable for massasaugas, landowners and other long-term residents, including commercial fisherman and mushroom hunters, were interviewed whenever possible for massasauga sightings.

Field inventories: Based on the information collected about massasauga sightings in Minnesota, 23 potential search areas were identified as likely to have massasaugas (Table 2). These areas contained suitable habitat and were distributed along the Mississippi River from the city of Wabasha to the Iowa border, a distance of over seventy miles. Each area was searched at least once for massasaugas and most were repeatedly visited. Due to weather and time constraints, equal search time for each area was not possible. Areas that appeared to offer the best habitat or from which massasauga sightings had been reported were more intensively surveyed. All MCBS staff assigned to herpetological surveys participated in various aspects of the massasauga survey, however, most of the field searches were performed by John Levell, massasauga survey contractor.

Table 2. Potential search areas for massasaugas along the Mississippi River in southeastern Minnesota (search area numbers correspond to those in Table 4 and Appendix 1).

| County | Mississippi River Pool # | Potential Search Area (#) |
|---|---|---|
| Wabasha | Pool 4 (south of Wabasha) | [redacted] |
| | Pool 5 (east of Kellogg-Weaver) | |
| Winona | Pool 5A (Winona) | |
| | Pool 6 | |
| Houston | Pool 8 (south of La Crescent) | |
| | Pool 8-9 (south of Reno) | |

Active field searches for massasaugas in Minnesota were conducted from April 14 through June 23, and briefly in August, 1993. This effort involved (1) terrestrial "flip" searches, and (2) establishment and monitoring of "snake sampling transects" in areas of suitable habitat for massasaugas. All herpetofauna encountered during searches were hand-captured, identified, and processed in the field.

Terrestrial flip searches were conducted at selected search areas and involved actively searching a particular habitat or area for massasaugas. Logs, rocks and ground debris are were turned over to check for concealed snakes. Basking surfaces or rock crevices were also examined for massasaugas.

Snake sampling transects (SST) were established at selected sites. Each transect included four or five "snake sampling stations" (SSS), that were composed of three 20-inch by 4-foot pieces of "slab wood" (the outer remnants of milled logs). Two slabs were placed approximately four inches apart and capped by the third piece. In some cases, a piece of plywood (2-foot by 2-foot) was used in place of the 3 pieces of slab wood. The purpose of these stations was to introduce structures that would create microhabitats attractive to snakes. Many snake species, including massasaugas, are frequently found under logs, rocks, or other debris. Providing exposed basking surfaces, as well as cover habitat, was intended enable snaked to thermoregulate using these structures. Determination of transect locations were based on the presence of potential massasauga habitat and reports of massasaugas in the area. For each transect, snake sampling stations were placed in representative examples of habitat types, conditions, and transition zones present at that location.

Use of the slab wood technique was partly experimental and was selected after consultation with Robert Hay, cold-blooded animal specialist for the Bureau of Endangered Resources, Wisconsin Department of Natural Resources. Wisconsin was establishing similar transects for massasaugas as a means of long-term monitoring of known populations. By utilizing similar techniques in Minnesota, it was hoped that comparable information could be obtained from both sides of the Mississippi River.

## RESULTS

No massasaugas were found during the survey. The unusual weather conditions during the spring and summer of 1993 included two late snowfalls in April and extreme flooding along the Mississippi River which greatly hampered survey activities. Many of the areas identified as prime habitat for massasaugas were inundated for most of the field season and some of the SSTs were destroyed or washed away by the flooding.

Background information--verified records: Twenty-two institutions with herpetological collections responded to inquiries concerning massasauga specimens from Minnesota (Table 3). Only the Bell Museum of Natural History at the University of Minnesota in St. Paul had any massasaugas from Minnesota. This is a single specimen (MMNH 142).

Tag information associated with this specimen reads "Wabasha, Brackett, June 15 1936". Breckenridge (1938) provided the following information about the specimen, "Sterling Brackett, collecting for the University Museum, and Everett Lorenz, a local collector, secured a male specimen, measuring 419 mm., in the grassy bottom lands just below Wabasha, Wabasha Co., on June 15, 1936". However, Sterling Brackett (personal communication) now states that he was not present at the time the animal was collected and that he had actually purchased the specimen from "a local rascal" (presumably Lorenz), who was actively involved in the bounty hunting of rattlesnakes. When Mr. Brackett inquired where the specimen originated from, this "local rascal" would say only that "it was captured on a secret tributary on this (Minnesota) side of the Mississippi River."

The southeastern counties of Minnesota paid a bounty on both massasaugas and timber rattlesnakes up until 1986. It is common knowledge that many of the massasaugas turned in for bounty were actually

captured on the Wisconsin side of the Mississippi River, where a fairly large population existed at the mouth of the Chippewa River. In fact, some old-time rattlesnake bounty hunters, contacted during this survey, were of the opinion that massasaugas did not occur in Minnesota.

Whether Breckenridge's 1938 description of massasauga specimen #142 is more accurate than the recollections of Brackett some 58 years later cannot be resolved. However, this specimen represents the only vouchered proof of the occurrence of massasaugas in Minnesota.

Table 3. List of museums and academic institutions contacted concerning holdings of massasauga specimens from Minnesota. Individuals consulted are in parentheses.

| |
|---|
| American Museum of Natural History, New York, New York (Dr. Daryl Frost) |
| Bell Museum of Natural History, University of Minnesota, St. Paul, Minnesota (John Moriarty) |
| Burpee Museum of Natural History, Rockford, Illinois (Mike Henderson) |
| Carnegie Museum of Natural History, Pittsburgh, Pennsylvania (Helen Censky) |
| Chicago Academy of Sciences, Chicago, Illinois (Ron Vasile) |
| Drake University, Des Moines, Iowa (Dr. James Chistiansen) |
| Field Museum of Natural History, Chicago, Illinois (Thomas Anton) |
| Illinois Natural History Survey, Urbana, Illinois (Chris Phillips) |
| Illinois State Museum, Springfield, Illinois (Rick Purdue) |
| Iowa State University, Ames, Iowa (Bruce Mensal) |
| Milwaukee Public Museum, Milwaukee, Wisconsin (Gary Casper) |
| North Dakota State University, Fargo, North Dakota (Dr. James Grier) |
| Philadelphia Academy of the Natural Sciences, Philadelphia, Pennsylvania (Ted Daeschler) |
| South Dakota State University, Brookings, South Dakota (John Heartel) |
| Southern Illinois University, Carbondale, Illinois (Dr. Ron Brandon) |
| U.S. National Museum, Washington D.C. (Ron Crombie) |
| University of Kansas, Lawrence, Kansas (Dr. Bill Duellman) |
| University of Michigan, Ann Arbor, Michigan (Greg Schneider) |
| University of North Dakota, Grand Forks, North Dakota (Dr. Jeff Lang) |
| University of Northern Michigan, Marquette, Michigan (Jeff Davis) |
| University of South Dakota, Vermillion, South Dakota (Brent Graves) |
| University of Wisconsin, Madison, Wisconsin (Frank Iwan) |

Background information--unverified reports: Despite the lack of specimen records, sightings of massasaugas from the southeastern counties of Minnesota have been reported from the 1930's up to the present, usually from Houston and Wabasha counties. Many of these reported sightings have come from very reliable sources, however, all remain unverified by either a specimen or a photograph. These sightings are summarized below. Unfortunately, some of these reports have been incorporated into publications on the distribution of massasaugas, such as Fig. 2 (taken from Beltz 1992). Beltz further states that"faunal surveyors have found individuals in both known counties recently", when in fact no verified record has been obtained since MMNH #142. Publishing undocumented reports as verified specimens confuses our understanding of the present-day distribution and abundance of massasaugas. The Minnesota distribution of massasaugas is more accurately represented by range map in Oldfield and Moriarty (in press), where Wabasha County contains a pre-

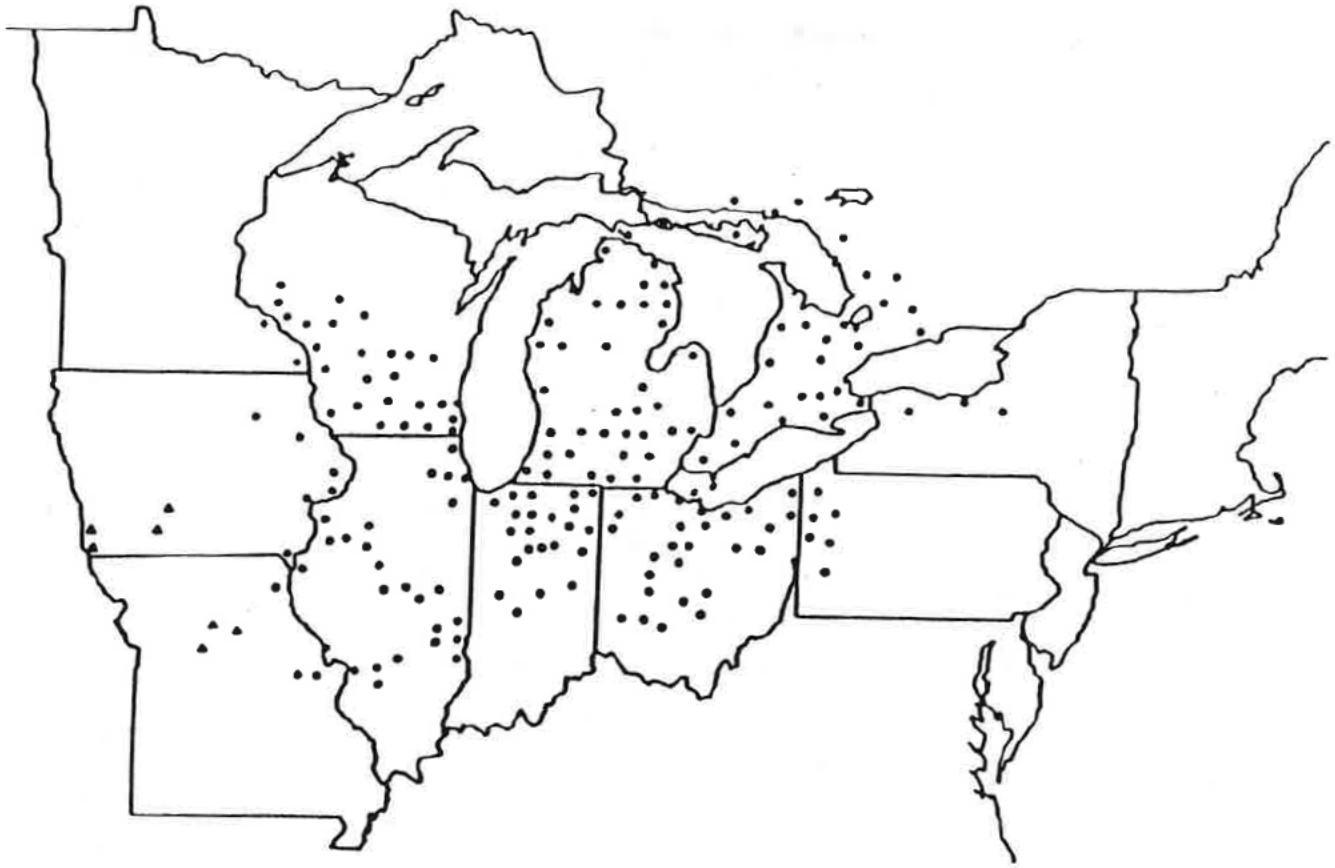

Fig. 2. Distribution of massasaugas in eastern North America. Each location was placed at the approximate geographic center of counties of occurrence and may represent more than one population. (dots represent *Sistrurus catenatus catenatus*, triangles represent intergrades of *S. c. catenatus* x *S. C. tergeminus*; taken from Beltz 1992).

1960 vouchered record and Houston County is identified with a sight or literature record.

Reports of massasauga sightings obtained during the survey are presented below.

Wabasha County reports:
The second known report of massasaugas in Minnesota was from Breckenridge (1944) who states "the Minnesota distribution is based on two records from Wabasha County--specimen 142 and a specimen taken in June 1937 by E. L. Lawrence and sent alive by Rene B. Stiles to the Staten Island Zoo." Dr. Breckenridge (personal communication) was unable to recall any details concerning this particular massasauga or of Mr. Lawrence. Although the records of the Staten Island Zoo indicate that the institution did receive a massasauga in the summer of 1937, the place of origin of the specimen or where it might be now, if preserved, are unrecorded.

Lang and Karns (1988) reported two specimens observed by Bill Stark during 1969 in the Zumbro River drainage, south of Wabasha. Stark (personal communication) was not certain that these snakes represented a resident population in Minnesota. He suggested that they may have rafted across the Mississippi River from Wisconsin. He also identified the area around [redacted] as potential massasauga search areas, implying that he may have observed massasaugas at these locations in the past. Mr. Stark is an expert herpetologist and his observations should be considered highly reliable.

Eric Thiss (personal communication) reported collecting a massasauga about 10-12 years ago [redacted] Thiss is highly knowledgeable with herpetofauna and misidentification is unlikely.

A massasauga was reported by an unidentified individual [redacted] It is possible that an individual might raft across the Mississippi River and reach Minnesota at this point.

Massasauga sightings have been reported from [redacted] Other long-time residents report that massasaugas were never found in the area, although they know the species occurs across the river in Wisconsin. Madeleine Linck (personal communication) reported similar comments from local residents regarding massasaugas. [redacted]

Houston County reports:
The only known sightings of massasaugas in Houston County were [redacted] John Meltzer (personal communication) reported seeing massasaugas in this area on two separate occasions, including a copulating pair in 1986.

Winona County reports:
No sightings of massasaugas have been reported from Winona County. It is possible that some of the massasaugas reported by Kruger (see Other reports, below) represent Winona localities, but this

cannot be verified.

Other reports:
Willis Kruger, formerly a Conservation Officer with the U.S. Fish and Wildlife Service, reported seeing one or two massasaugas each year in the Minnesota backwaters of the Mississippi River. The area of the river patrolled by Mr. Kruger extended from Wabasha County to the Iowa border, so it is uncertain exactly where these sightings occurred. Unfortunately, Mr. Kruger is now deceased and more specific locality information is not available.

Bob Duerr (personal communication) reported massasaugas from the Cannon River bottoms in northeastern Goodhue County. This report represents the most northern sighting of the species in Minnesota and is possibly further north than any documented Wisconsin population. No Wisconsin populations exist in the vicinity of this report to explain this occurrence as a rafting individual. Mr. Duerr is a very capable field herpetologist, and if not for the reliability of Duerr, this sighting would be disregarded.

The approximate locations of all the above reported massasauga sightings, with the exception of those of Kruger, are shown in Fig. 3.

Field inventories--terrestrial searches: Terrestrial searches were conducted on 18 search areas (see Appendix 1). These included some of the 23 potential search areas identified before the field season, as well as additional areas where massasauga sightings were obtained as the field season progressed. Although no massasaugas were found, a total of 21 species of amphibians and reptiles were documented from these sites (Table 4, Fig. 4).

Field inventories--snake sampling transects: The snake sampling transects were established at 19 locations (Appendix 2). The snake sampling stations were utilized by few herpetofauna during the 1993 field season, and no snakes were found in association with the slab wood stations. Possible factors limiting the effectiveness of the snake sampling stations were the excess dampness beneath the slabs throughout the field season. This condition was also encountered by the survey team in Wisconsin (Hay and Kopitzke 1993). Snakes seldom utilize cover objects in which the underling soil is damp. Whether the unusual amount of rainfall received during 1993 was responsible for these damp conditions, or whether the slab wood produced unsuitable cover needs to be further examined. Other materials may produce more satisfactory cover. Plywood, corrugated sheet metal, and roofing paper located along transects and elsewhere during the 1993 field season had fox snakes, northern water snakes, and eastern garter snakes utilizing the material for cover and thermoregulation.

It is thought by a number of herpetologists that cover objects introduced into the environment require a long period of "seasoning" before becoming effective snake shelters. The slab wood used for the snake sampling stations may need to decay or settle into the substrate more before they are more attractive to snakes. However, J. Lang (personal communication) stated that corrugated sheet metal, when placed in proper habitats, can be effective as herpetofaunal shelters within days. The MCBS plans to return to southeastern Minnesota to conduct herpetological surveys beginning 1995. At this time, the snake sampling stations will be revisited and their usefulness for long-term snake monitoring will be further evaluated. In addition, several types of cover objects will be installed this fall, in preparation for the 1995 field season and to test the relative effectiveness of these materials.

Fig. 3. Approximate locations of reported massasauga sightings in southeastern Minnesota.

Table 4. Herpetofauna found during terrestrial searches of potential massasauga habitats (search areas are described in Appendix 1).

| Species | Search Area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| American toad *(Bufo americana)* | ● | | | | | | | | |
| Eastern gray treefrog *(Hyla versicolor)* | ● | | | | | ● | | ● | ● |
| Spring peeper *(Pseudacris crucifer)* | | | | | | | | | ● |
| Chorus frog *(Pseudacris triseriata)* | ● | | | | | | | ● | ● |
| Bullfrog *(Rana catesbeiana)* | | | | | | | | | |
| Green frog *(Rana clamitans)* | ● | | | | | | | | |
| Northern leopard frog *(Rana pipiens)* | ● | | | | | ● | | | |
| Spiny softshell turtle *(Apalone spinifera)* | ● | ● | | | | | | | |
| Snapping turtle *(Chelydra serpentina)* | ● | | | | ● | | ● | | |
| Painted turtle *(Chrysemys picta)* | ● | | | | ● | | ● | | |
| Blanding's turtle *(Emydoidea blandingii)* | | | | ● | ● | | | | |
| Map turtle *(Graptemys geographica)* | ● | ● | | | | | ● | | |
| False map turtle *(G. pseudogeographica)* | ● | | | | | | | | |
| 6-lined racerunner *(Cnemidophorus sexlineatus)* | | | | | | | | | |
| Racer *(Coluber constrictor)* | | | | | | | | | |
| Fox snake *(Elaphe vulpina)* | | | ● | | | ● | | | |
| Eastern hognose snake *(Heterodon platyrhinos)* | ● | | | | | | | ● | |
| Northern water snake *(Nerodia sipedon)* | ● | | | | | | | | |
| Gopher snake *(Pituophis melanoleucus)* | ● | | | | ● | | | | |
| Brown snake *(Storeria dekayi)* | | | | | | | | | |
| Eastern garter snake *(Thamnophis sirtalis)* | ● | ● | | | ● | ● | ● | ● | ● |

Table 4. continued.

| Species | Search Area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| American toad *(Bufo americana)* | | | ● | | | ● | | | |
| Eastern gray treefrog *(Hyla versicolor)* | | | ● | | ● | ● | ● | | |
| Spring peeper *(Pseudacris crucifer)* | | | | ● | | | | | |
| Chorus frog *(Pseudacris triseriata)* | | | ● | ● | | ● | | | |
| Bullfrog *(Rana catesbeiana)* | | | | | | ● | | | |
| Green frog *(Rana clamitans)* | ● | | ● | | ● | ● | ● | ● | |
| Northern leopard frog *(Rana pipiens)* | | | ● | | ● | | ● | | |
| Spiny softshell turtle *(Apalone spinifera)* | | | ● | | ● | | | | |
| Snapping turtle *(Chelydra serpentina)* | | ● | ● | | ● | | | | |
| Painted turtle *(Chrysemys picta)* | ● | ● | ● | | ● | ● | ● | ● | ● |
| Blanding's turtle *(Emydoidea blandingii)* | | | | | | | | | |
| Map turtle *(Graptemys geographica)* | | | | | ● | | | | ● |
| False map turtle *(G. pseudogeographica)* | | | | | ● | | | | |
| 6-lined racerunner *(Cnemidophorus sexlineatus)* | ● | | | | ● | | | | |
| Racer *(Coluber constrictor)* | | | | | | | ● | | |
| Fox snake *(Elaphe vulpina)* | | | | | ● | ● | ● | | |
| Eastern hognose snake *(Heterodon platyrhinos)* | | | | | | | | | |
| Northern water snake *(Nerodia sipedon)* | ● | | | | ● | | ● | | |
| Gopher snake *(Pituophis melanoleucus)* | | | | | | | | | |
| Brown snake *(Storeria dekayi)* | ● | | | | | ● | | | |
| Eastern garter snake *(Thamnophis sirtalis)* | ● | ● | ● | | ● | ● | ● | ● | ● |

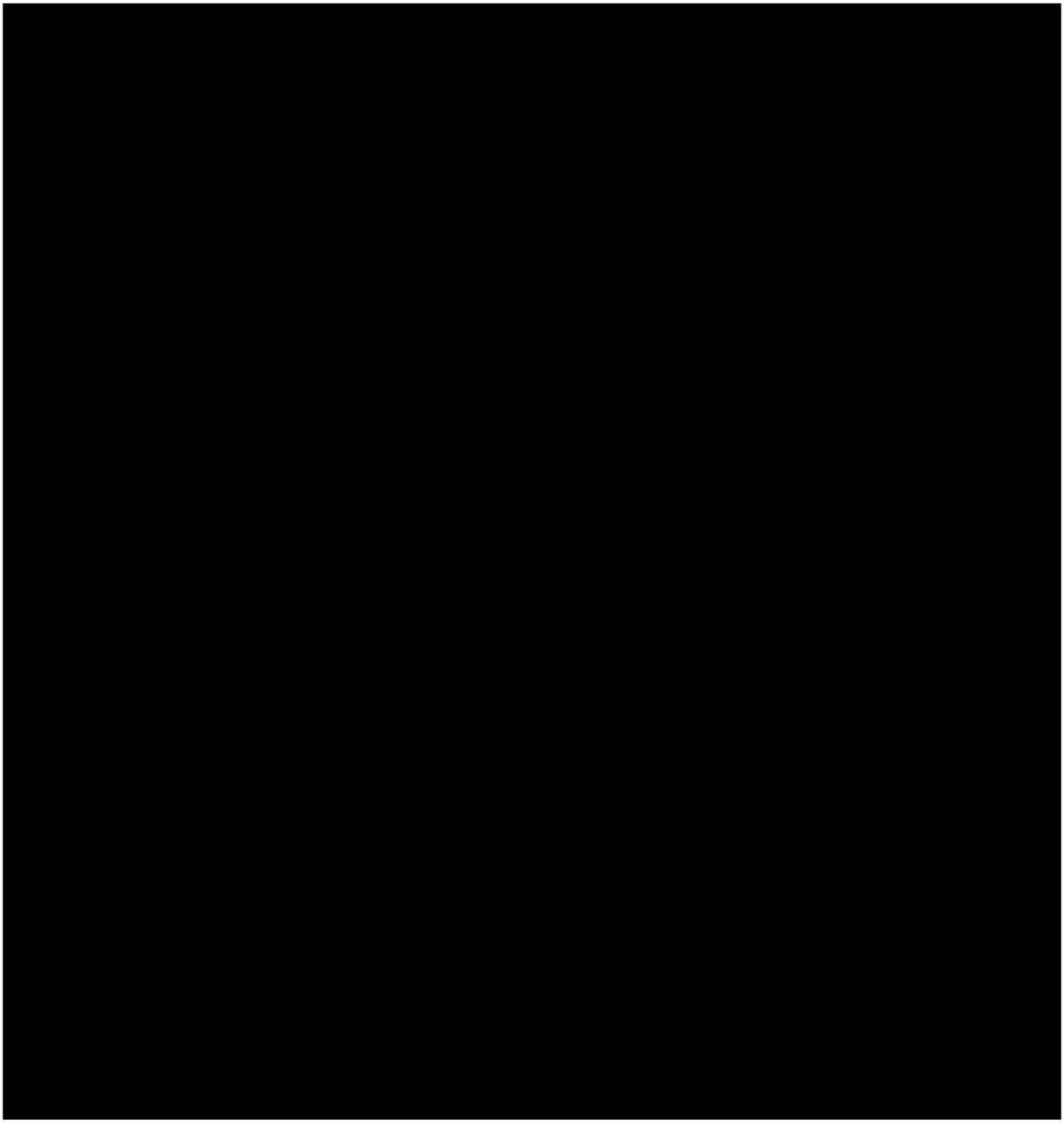

Fig. 4. Locations of terrestrial search areas.

## DISCUSSION AND RECOMMENDATIONS

Evaluation of the status of massasaugas in Minnesota is difficult on the basis of a single field season in which no massasaugas were found. This secretive species is difficult to find even from areas in which they are known to occur. This difficulty was evident from the results of the 1993 massasauga survey results in Wisconsin. Only nine specimens, including four from one site, were documented from a minimum of 15 locations with known massasauga populations (Hay and Kopitzke 1993). Both T. Anton (personal communication) and K. Mierzwa (personal communication) report a 3-year time span between the initial massasauga sightings and actual confirmation of its presence in northeastern Illinois. C. Phillips (personal communication) reports a 6-year time lapse between report and confirmation of massasaugas from a site in central Illinois where reliable historical records of the species exist. From the experiences of the 1993 field season, it is clear that a single survey effort is not sufficient to locate such a rare and elusive animal as the massasauga. Potential habitat needs to be more intensively surveyed and sites should be repeatedly visited, both during a single field season and over several years. The MCBS intends to focus on the massasauga in future survey efforts in southeastern Minnesota, beginning fall 1994. Survey efforts will continue on the sites targeted for the 1993 field season and expand to additional sites in northern Wabasha County. Hopefully the weather conditions will be more conducive for field surveys than those of 1993.

The probability of a viable population of massasaugas existing in Minnesota is relatively high. The area of potential massasauga habitat in southeastern Minnesota is quite extensive. Much of the prime habitat is difficult to access, even during non-flood years. It is entirely possible that small populations of massasaugas may reside in these more remote areas along the Mississippi River. Future field searches for massasaugas should include areas of suitable habitat, not only within the Mississippi River floodplain, but also further west along smaller tributary rivers and creeks.

The more people alerted to the possible presence of this species, the greater likelihood one will be sighted. Not only should land managers be familiar with the appearance and habits of massasaugas, but informational brochures and posters could be an effective way to inform the general public to the importance of documenting this species in Minnesota.

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