Recommended Standard Survey Protocol for the Eastern Massasauga, *Sistrurus catenatus catenatus*

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INTRODUCTION

The eastern massasauga, *Sistrurus catenatus catenatus*, is a small crotaline rattlesnake with a United States range extending north and east from the Missouri River, to central Wisconsin, the northeastern shores of Georgian Bay in Ontario, Canada, and to New York state (Conant and Collins, 1991). It is widely recognized as having undergone significant population declines throughout its range, having been afforded endangered or threatened status in ten of the eleven states and provinces in which it occurs, and is currently classified by the United States Fish and Wildlife Service as a candidate species for listing under the United States Endangered Species Act (Szymanski, 1998; Federal Register, 1999). To properly assess population status and plan recovery efforts, a need exists for standardizing survey effort for comparison among sites, and for a consensus on data interpretation in order to assign recovery resources to those populations best able to benefit from them. For recovery and management recommendations see Johnson et al. (2000).

We address methods for surveying for this subspecies throughout the range defined above. It should be recognized that these techniques are not meant to be applied to populations south and west of the Missouri River (i.e. *Sistrurus catenatus tergeminus* or *S. c. edwardsi*), where significant differences in ecology, habitat use, and behavioral response to temperature and precipitation exist. In the range described here, the eastern massasauga (*Sistrurus c. catenatus*) typically occurs in lowland (usually floodplain) forest, bogs and other wetlands, and mesic to wet-mesic prairies. *Sistrurus c. catenatus* also utilizes upland grassland, savanna, open woodland, prairie, and old fields adjacent to these wetland habitats. In the Georgian Bay area of Ontario, habitat varies from coniferous (Bruce Peninsula) to deciduous (Killbear Provincial Park) forest. Closed canopy is avoided, and in forested habitats canopy openings are preferentially used. For habitat descriptions see: Hutchinson et al. (1993), Johnson (1995), Johnson et al. (2000), King (1997), Kingsbury (1996), Reinert and Kodrich (1982), Maple (1968), Seigel (1986), Smith (1961), Weatherhead and Prior (1992), and Wright (1941).

This recommended survey protocol is a consensus of opinion based on published life history accounts, radio telemetry studies, and the authors' collective field experiences conducting research and surveys for this species. We have provided a sample data form, and an itemized protocol we believe will have utility across the geographic area defined above. We also suggest that prior to surveys, the investigator may find it useful to solicit information through a public notice, such as a newspaper article, with a massasauga photo and a number to call to report sightings. This may lead

the investigator quickly to productive sites for snakes (even if not for *S. catenatus*). Another way to obtain leads is to contact veterinarians and ask if they have treated pets for snake bite. This is something that they are not likely to forget, especially when the massasauga may be the only venomous snake in the area. When utilizing public outreach, however, the investigator should be careful not to give out information on massasauga sites to the public, due to poaching concerns.

Surveyor Qualifications

We recommend that persons conducting surveys have prior experience finding eastern massasaugas in the habitat type and region under investigation. Surveyors should be recognized as competent and qualified by regional peers, who often are persons under which the surveyor has trained. Recognizing that surveyors experienced with *S. catenatus* cannot always be found, we recommend that inexperienced surveyors at least have a reputation as a good field biologist, based on criteria including, but not limited to, letters of recommendation, affiliation with an educational or research institution, government agency, or relevant publication record. Experience and demonstrated competence with other snake species, and especially with state or federally listed amphibian and reptile species (the latter demonstrating trust placed in the individual by county, state or federal agencies), is also highly desirable. We recommend that the surveyor consult with experienced persons prior to and during surveys, and that the first *S. catenatus* specimens encountered by inexperienced surveyors be carefully documented to pass peer review. It is recommended that inexperienced surveyors, as well as seasoned herpetologists without specific experience with *S. catenatus*, acquire some training in field survey techniques specific to *S. catenatus*, by attending state or regional workshops.

Justification

There are two justifications for using highly experienced personnel to conduct surveys. First, the importance of observer skill and experience is illustrated by two examples. In Illinois, a study conducted to detect the presence of massasaugas at a Chicago area site in 1990 and 1991 yielded negative results and concluded that massasaugas were unlikely to be present (Strond, 1992). Yet surveys at the same site undertaken by different, more experienced, personnel in 1993 found numerous individuals (Mauger and Wilson, 2000; Wilson and Mauger, 2000). In Ontario, Black and Parent (1999) obtained capture success rates (snakes caught/person-hour of searching) of 0.017 with minimally experienced personnel (3 days field experience), 0.040 with moderately experienced personnel (at least 100 h field experience), and 0.075 from the highly experienced principle investigator. These examples illustrate the disparity in results which can be attributable to differences in surveyors skills and experience.

Secondly, the eastern massasauga is one of the most often misidentified snake species within its range. Some of us (Anton, Casper, Hay, Parent, and others) estimate that over 80% of eastern massasauga reports from the public, wildlife biologists, and naturalists are misidentifications, based on the error rate of those reports where we were able to examine a specimen or photograph. Species frequently mistaken for eastern massasaugas include northern water snakes (*Nerodia sipedon*), brown snakes (*Storeria dekayi*), milk snakes (*Lampropeltis triangulum*), fox snakes (*Elaphe vulpina*

ssp.) and eastern hognose snakes (*Heterodon platirhinos*).

RECOMMENDED METHODS

Techniques

The recommended survey method is visual searches (Karns, 1986; Heyer et al., 1994). Since there appears to be wide variability in search success relative to habitat, weather and time of day, we recommend that data on these parameters be collected for each search event, and that the following conditions be used as general guidelines:

1. Habitat will vary regionally, but snakes are most often encountered in open to semi-open canopy habitats, in cryptic basking situations, where they are partially concealed under grass or sedge tussocks, or by shrubs. Searches should concentrate on openings in forests, and higher elevations within low wet areas. Most occurrences in the United States are known from habitats associated with fluvial systems, and *S. catenatus* range expansion has been hypothesized as occurring by the gradual colonization of marshes along water courses (Atkinson and Netting, 1927; Gloyd, 1940; Pentecost and Vogt, 1976; Campbell and Lamar, 1989; Johnson, 1993).
2. Weather conditions are best with >50% cloud cover, less than 15 mph breeze, and temperatures between 50 and 80 degrees Fahrenheit.
3. Preferred time is morning and evening.
4. During spring emergence, soil temperatures at a depth of 15 cm (6 inches) should exceed 10º C.
5. The most fruitful survey periods are during spring emergence for all age classes, and during mid-summer for gravid females.
6. If the opportunity arises, surveys should be conducted immediately after a burn.

Massasaugas may be active under very different environmental conditions across their United States range. In general, air temperatures < 60 F, winds > 15 mph, and cold winds depress activity. It is essential that conditions be recorded for all surveys (especially those with negative results so that outside evaluators can determine whether surveys were conducted under appropriate conditions).

Effort

We recognize that effort expended on surveys is often a function of human resource availability. We caution that credible decisions on species or population management cannot be made in the absence of survey data, and that when in doubt one should always err on the side of conservatism, as if the species is present. Initial goals of surveys should be to determine whether or not the species is present at a site in detectable numbers. These data can form the basis of site recovery and management evaluations.

A minimum accumulation of forty person hours distributed over a standard (April-October)

field season is recommended before any evaluations are made regarding the presence/absence of *S. catenatus*. The majority of these hours should be expended in two time windows reflecting presumed maximum activity levels of the massasauga: 1) spring emergence, 2) mid- to late summer basking and birthing period. If massasaugas are found on a site, no further effort is necessary to determine species presence or absence. We recommend continuing this minimum effort for ten years before evaluating the likelihood of population extirpation (see Results and Interpretation).

To evaluate population size and demographics, we recommend mark-recapture studies. To evaluate habitat use and activity range at study sites, radio telemetry is recommended to map activity and movement. Standard statistical significance tests (Parker and Plummer, 1987; Sokal and Rohlf, 1981), and peer review, should be used to evaluate such studies.

Supplemental Technique

One of us (Resetar) has had success trapping *S. catenatus* in funnel traps. Since this technique has not been tried often, we recommend its use as optional and supplemental to visual searches at this time. If further tests of this technique prove fruitful, its use may become warranted as a standard technique. For this technique an aluminum drift fence with a funnel trap at each end is installed. The body of the trap and funnels can be constructed from aluminum window screen or other materials (Karns, 1986). A scythe or clippers should be used to trim vegetation down to about 8 - 12 cm in height, one meter on each side of the fence. Keep the vegetation at this level throughout the collecting period. In northwestern Indiana, Resetar was successful trapping *S. catenatus* with this method during late May, mid-June, and late September. Placement should be along natural habitat edges, which snakes might follow when moving, or randomly within a large contiguous habitat patch (Karns, 1986). Extreme care must be exercised in concealing the fence from human detection whenever possible to avoid poaching or vandalism, and in taking measures to avoid the possibility of snakes over-heating in traps through sun exposure.

Data Collection

In order to facilitate comparison of data among sites, which might be widely separated geographically, we recommend that the following minimum data be collected for each survey period:

1. Contact information for each surveyor
2. Date(s)
3. Survey site location(s)
4. Start and end times
5. Start and end temperature, relative humidity, wind strength, and percent cloud cover
6. Calculation of eastern massasauga rattlesnakes found per person hour

Estimation of crayfish burrow density may also be useful, including identification of burrowing crayfish by species and type (e.g., primary, secondary or tertiary burrower: Hobbs 1989). These data may be helpful in evaluating hibernacula potential on the study site.

Data collected for eastern massasauga rattlesnakes encountered may vary according to whether snake handling will occur.

If snakes are not to be handled, we recommend collecting the following minimum data:

1. exact location (GPS, compass distance and direction from a landmark, legal description, or topographic map mark-up)
2. photograph of animal (see below)
3. snout - vent length estimate
4. general health notes
5. micro and macro habitat descriptions
6. behavioral notes
7. snake detection method (sight, sound)

If the survey allows snake handling, the following additional minimum data should be collected for each snake encountered:

1. sex
2. snout - vent length (SVL)
3. weight
4. reproductive condition
5. collection of blood or tissue samples if possible

Other data may be collected as deemed necessary by the researcher/surveyor, or may be required as part of conditions specified by a contracting local, state, or federal agency. We have provided a sample data form, which may be altered by users to suit their particular needs. The decision to restrain snakes during surveys, in order to acquire more data, should be carefully weighed against potential stress to the animals, and the potential to increase the risk of injury to the snake and to the surveyor. Data on location, habitat use and behavior can be collected without restraint, and restraint may not necessarily improve photographs.

If the survey is part of long term monitoring, we also recommend marking with PIT tags (Jemison et al., 1995). If PIT-tagging is not possible, the application of a small amount of fast-drying, water-resistant paint on a basal rattle segment (UniPaint® oil-base paint markers, Sanford Corporation, Bellwood, Illinois), or fingernail polish, can be used. One drawback to this technique is that it may lead to inaccurate identification of an individual after numerous sheds, as position of the segments may change, or the segments may be eliminated altogether through natural wear and/or breakage. Disturbance of animals through frequent remarking should also be considered.

We recommend collection of blood samples regardless of whether or not these are required for the individual study. Blood samples should be provided to researchers or institutions involved with molecular and parasite studies. Sampling kits can usually be obtained from these same parties.

Documentation

As noted above, we strongly recommend that specimen photographs be taken at all unvouchered localities. Voucher photographs should be made of the first individual snakes discovered at each survey site. Photographs of snakes as encountered *in situ*, as well as habitat photos, are strongly recommended. One copy of each photograph should be provided with the survey report, and a second set deposited into a permanent museum collection for verification. Observations of massasaugas lacking a photographic voucher must be viewed with skepticism, unless the observation was made by an expert on the species, or until a voucher in some form is procured (e.g. photo, shed skin, specimen). Photos of head/neck and full body, the latter being most effective for identification purposes, should be taken from above. We also recommend that all specimen carcasses discovered during surveys be preserved and deposited at a museum collection. Shed skins (from which identifications by individual pattern can be made) and prey items should also be salvaged when possible. Once a site has been vouchered, challenges to opinions on species presence should become moot, and subsequent (or prior) sight reports from qualified personnel are supported by the voucher.

Because of the danger of persecution from collectors and hunters, we strongly recommend that any publication of locality data be non-specific, with a resolution no greater than to county or province. Specific locality data may be provided on a need-to-know basis by the museum institution where the voucher was deposited, or by agencies responsible for disseminating information for environmental reviews, research, and management planning. Reports prepared for government agencies are often considered public information, and authors should discuss this issue with the agency beforehand, so that sensitive information can be deposited where it can be protected from abuse. We recommend omitting specific locality data from public reports, and providing these data separately to agency personnel on a need-to-know, case by case, basis.

Results and Interpretation

We recommend the following data interpretation for surveys performed within the geographic range given above. We recognize that massasauga populations can persist at low densities for long periods of time, and during those periods be very difficult to detect. Instances of massasaugas going undetected for over ten years before resurfacing are known (Casper). Put another way, absence of evidence is not evidence of absence for cryptic, secretive species. Therefore, we recommend that detection thresholds for the purpose of allocating management and recovery resources, be less stringent than thresholds applied to decisions on actual population extirpation, since extirpation determinations will have consequences for protection of a population and its habitat. We also recommend that management resources be applied only to detectable populations, and that non-detectable populations (with demonstrable historic presence) be the subject of long-term, periodic surveys and habitat assessments, before extirpation is assumed. Negative survey results at sites where there are prior records for eastern massasaugas should be a catalyst for ecosystem restoration, with follow-up surveys to detect recovery.

Recommended Data Interpretation and Hierarchy

A) Positive search results should be interpreted as an "extant population." We recommend that extant populations merit four responses:

1. Immediate steps to protect habitat through acquisition and easements;
2. Evaluation of illegal taking and persecution, with subsequent implementation of law enforcement and education programs as needed;
3. Initiation of long term demographic and ecological studies to estimate population size, population trend, and to define population activity range and habitat needs (Parker and Plummer, 1987; Dodd, 1987);
4. Initiation of habitat management based on the results of step 3. Habitat management should consider both vegetation (usually control of woody growth), and hydrology (usually avoidance of winter water level manipulations).

In sum, extant populations merit the most stringent and urgent of recovery, monitoring and research efforts, and the highest resource allocation priority.

B) Negative results for a *single survey period* should be interpreted to mean that the population was undetected during the survey period, due to either low numbers, climatic factors, extirpation, or chance. We recommend that the appropriate management response is continuing surveys.

C) Continuing negative results *after five survey years* (with a minimum effort of 40 person hours per year, appropriately spread throughout the field season of April-October) should be interpreted to mean that the population is "of questionable viability" or "potentially extirpated", with recovery probably dependent upon intensive management to reduce mortality and/or enhance habitat. We recommend that the appropriate management response is to convene a panel of experts to assess habitat quality and any other factors which may be relevant to population declines (such as poaching), and assessment and implementation of appropriate habitat improvement actions, with continuing periodic surveys to detect response to habitat improvements.

D) Continuing negative results *after ten survey years* should be interpreted to mean that the population can be considered "extirpated for management purposes", and that no management response is recommended.

E) Interpretation of continuing negative results *after fifteen survey years* should be made by a panel of experts. We recommend that a determination of permanent population extirpation, with its potential consequences for removing site protection, should require either a minimum of fifteen years of negative survey data, or unequivocal evidence and consensus that habitat losses (complete habitat destruction/development) at the site have been so great that a population could not persist.

A final note of caution

Sistrurus catenatus is a pit viper and must be handled, both in the field and laboratory, with care and respect. Unnecessary handling of adult and juvenile massasaugas should be avoided whenever possible. Russell (1980) reported treating nine bites by *S. catenatus*. Although two patients were not envenomated, all of those that were experienced severe pain, with some additional nausea. Swelling and bleb (fluid-filled blister) formation was noted. All patients took several days to recover, and 4 of the 9 had to receive antivenin. Poticha (1971) also reported on massasauga envenomation in northern Illinois.

A bite involving a field researcher is a serious matter for another reason. Any publicity of such an event is usually sensationalistic, and may have unforeseen consequences. Public concern, often exacerbated by media attention to a snakebite, may hamper or even curtail local efforts to protect massasaugas. Public support for protection of a venomous animal may be tenuous at best, and ramifications of a snakebite accident should be considered by those working with such animals, especially in semi-urban areas.

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DATA FORM - *SISTRURUS CATENATUS CATENATUS*

Date: _____ Start time: _____ Start temp: _____ Start rel. humidity: _____ Start wind (Beaufort) : _____ Start % cloud cover _____

Surveyor(s) name, address, phone, email:_____

Survey #:_____Site location[1]:_____

Lat/Long: _____ GPS: _____ Legal (TRS): _____

Snake								
Spec. #	**Measurements**		**Method**	**Procedure**	**Method**	**Behavior**	**Health/Markings**	
	SVL/total			**Detection/**		**At encounter**	**General health**	
Time	**Weight**			**Marking**			**Markings**	
	Sex			**Blood**		**After encounter**	**Injuries/scars**	
	Reproductive			**Voucher**			**# rattle**	

Location/Habitat				Snake in shade/sun (circle one):	
Exact Location		**Elevation:**		**Habitat**	
Vegetation		**Air temperature**		**Microhabitat**	
Nearest woody veg.		**Water**		**Associated species (A & R, mammals, crayfish, etc.)**	
Freq. of woody veg.		**Type**	**Perm / semiperm /**	**General area**	
Diameter/taxa woody veg.		**Depth**		**Immediate proximity**	
Forbs w/in 2 m.		**Distance from**		**Crayfish burrows**	
Soil		**Temperature**		**Number**	
Type		**Prey item(s)**		**Proximity to snake**	
Temperature		**Identification(s)**		**Voucher depository**	

Conditions					
	Temperature	**Humidity**	**Precipitation**	**Cloud cover**	**Wind**
At capture					
Previous 24 hours					
Following 24 hours					

[1] - compass distances and directions from landmarks or roads, note if topographic map marked

End time: _____ End temp: _____ End rel. humidity: _____ End wind (Beaufort): _____ End % cloud cover _____

Calculation of snakes found per person hour: _____ **Additional notes on reverse?: yes/no**