COMMITTEE ON THE
STATUS OF ENDANGERED
WILDLIFE IN CANADA

OTTAWA ON K1A 0H3
(819) 997-4991

COMITÉ SUR LE STATUT
DES ESPÈCES MENACÉES
DE DISPARITION AU
CANADA

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STATUS REPORT ON THE EASTERN MASSASAUGA RATTLESNAKE *SISTRURUS C. CATENATUS* IN CANADA

BY

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AND

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STATUS ASSIGNED IN 1991
THREATENED

REASON: RESTRICTED RANGE, HISTORICAL POPULATION DECLINING, HUMAN PERSECUTION.

OCCURRENCE: ONTARIO

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1 REVIEWED, REVISED AND EDITED (1991) BY FRANCIS R. COOK (THEN CHAIR, COSEWIC REPTILES AND AMPHIBIANS SUBCOMMITTEE).

Committee on the Status of Endangered Wildlife in Canada

Comité sur le statut des espèces menacées de disparition au Canada

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SISTRURUS C. CATENATUS

IN CANADA

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THREATENED

Contents

Abstract -- The Eastern Massasauga, Sistrurus c. catenatus, occurs in Canada only in Ontario. It occurs north to the Sudbury District, west to Cockburn Island (west of Manitoulin Island at the Michigan border) and east to include the western three-quarters of the Parry Sound District south of Lake Nipissing. There are questionable reports from Haliburton, Victoria, Northumberland and Prince Edward counties. Even within its well-documented range the Massasauga appears to have been eradicated from some localities since European settlement. It is still frequently reported along Georgian Bay and on the Bruce Peninsula, but in extreme southwestern Ontario the species may remain only as small remnant populations in the Windsor prairies and in the Niagara Peninsula at Wainfleet Bog. These rattlesnakes are commonly perceived by the general public to be a greater threat to human life than the two recorded deaths in Ontario warrant. The killing of snakes and destruction of their habitat through development and wetland drainage are major causes in their reduction. Although this species was given protection by Ontario in May 1990 under the Game and Fish Act, positive public awareness and management programs like those carried out by the Canadian Parks Service and promoted by the Metro Toronto Zoo need to be continued and expanded and additional natural reserves set aside if the species is to be conserved within the remnants of former range that it still occupies. Massasaugas are clearly endangered in southwestern Ontario but there seem to be sufficient populations remaining in the Georgian Bay - Bruce Peninsula area to give it a status of Threatened for Ontario as a whole. Their dependence on active conservation programs is acute enough for them to be considered more than vulnerable.

Foreword

In 1979, Parks Canada (now the Canadian Parks Service) sponsored an initial status report on the Massasauga in Canada by Harold Parsons. This synthesized the available information on its range and included some data on its biology obtained through the then newly initiated tagging program on Beausoleil Island, Georgian Bay Islands National Park.

In 1986, Wayne Weller, funded by World Wildlife Fund Canada, produced a revised and expanded report with new data on distribution based, in part, on his extensive interviews and other new sources, including the accumulating records of the Ontario Herpetofaunal Summary. In addition, because the Massasauga research on Beausoleil Island by the National Parks Service had continued and broadened in scope, more data became available from the staff and contractors involved.

Additional revision has been extensive after review by the Subcommittee on Amphibians and Reptiles and comments on that revision by the staff of the Ontario Ministry of Natural Resources and others.

The Massasauga suffers due to its negative image in the public mind. Not only is it a snake, but it is a poisonous one that has caused two recorded fatalities (one in 1956 and one in 1962) in Ontario. It would be hard to rationalize its restoration to all of its former range or abundance. Nevertheless, if it is not actively protected in the remaining fragments

of its range, the pro-eradication view could eventually succeed, certainly outside of parks and conservation areas.

Canadian Parks Service studies both at Georgian Bay Islands National Park and Bruce Peninsula National Park have been important conservation initiatives. Under these programs, staff and contractors have been aided by a public whose sympathy and understanding was solicited through carefully thought-out and well-managed programs. Ontario Provincial Parks have also taken a positive approach to the conservation of this species.

Many individuals have worked to improve public attitudes, dating back at least to writings of the late E. B. Shelley Logier and the late George C. Toner. The Canadian Amphibian and Reptile Conservation Society (and particularly Barbara Froom in her books pamphlets and media interviews) and, later, the Ontario Herpetological Society, have made important contributions to a more positive public view, as have the Reptile Breeding Foundation of Picton, Ontario, and, most recently, the Metro Toronto Zoo. On 17 May 1990 (filed 18 May 1990), the Eastern Massasauga was protected by Ontario Regulation 397/84 made under the Game and Fish Act.

Bob Johnston (1989a) stated the universally valid argument for saving, at the very least, representative populations of all things on earth, even of the Massasauga : "We are as diminished by a loss in the diversity in the natural world as we are by a loss in our own diversity."

Francis R. Cook
Subcommittee Chairman, Amphibians and Reptiles

This document has been in limbo from 1991-1997 when it was subjected to further editing to produce this Final Draft. In that interim, there have been several relevant publications and studies on the biology and status of the Eastern Massasauga Rattlesnake (Johnson and Menzies, 1992; Prior and Weatherhead, 1995; Weller, Weatherhead, Willson, Parent, pers. comm.). These studies indicate that the Massasauga range continues to decline, but there still have not been rigorous studies of population trends. Nevertheless, this species should probably have an updated status report to incorporate new data by 2000. More up-to-date references may be found in Prior and Weatherhead (1995).

Ronald J. Brooks
Subcommittee Co-Chair, Amphibians and Reptiles

Introduction

The Massasauga is a stocky, blotched snake with a relatively small, but well-developed, rattle at the end of a short tail. Although the Massasauga is the largest of the three recognized species its genus, it reaches its maximum recorded length of 100 cm, much less than either of the other two species (both in the genus Crotalus) of rattlesnakes which occur in Canada. The Timber Rattlesnake (C. horridus), now extirpated from southern Ontario and perhaps southern Quebec, reaches a maximum length of 188 cm (Conant 1975). The Western Rattlesnake (C. viridis), attains 162 cm (Stebbins 1985) and has two subspecies in Canada: the Prairie Rattlesnake (C. v. viridis) in southern Saskatchewan and Alberta and

the Northern Pacific Rattlesnake (C. v. oreganus) in southern British Columbia. Most adult Massasaugas are between 51 and 76 cm (Conant 1975). They generally have a greyish background colour with rather circular, darker-edged large blotches down the centre of the back. Three rows of smaller, alternating, blotches are present along each side. The tail is banded. Occasionally all-black individuals occur. The head is not as strongly triangular in outline as in many pit-vipers, but it shares their other structural characteristics. A heat-sensitive pit is present on each side of the head between the nostril and the eye. A pair of recurved, hollow, hypodermic needle-like fangs is positioned at the front of the mouth. These can be erected for a strike when the jaws are opened, but are folded back against its roof when the mouth is closed. The poison glands are situated at the back of the head and are connected to the fangs by ducts. The poison of the Massasauga is potent (Elliott 1978; Glenn and Straight 1982) but, due to the snake's size, only a comparatively small amount is delivered with a strike. Gloyd (1940), Klauber (1972), and Minton (1983) provide more extensive descriptions and citations to the literature on this species.

Distribution

North America

Three subspecies of the Massasauga are generally recognized (Figure 1): the Eastern Massasauga (Sistrurus c. catenatus) in the mid-western states of Iowa and Missouri eastward to western Pennsylvania, western New York, and southern Ontario; the Western Massasauga (S. c. tergeminus) southwestward to central Texas and the Gulf of Mexico; and the Desert Massasauga (S. c. edwardsi) from western and southern Texas to northern Mexico (Conant 1975).

Canada

Massasaugas have been recorded in Canada only in southwestern and west-central Ontario. However, maps presented by Logier (1958), Conant (1975), Minton (1983) and Cook (1984) which depict a continuous range around the northern shore of Georgian Bay and lakes Huron and Erie are misleading as the actual occurrence of the species seems to be fragmented within these areas. In contrast, maps of individual records in Logier and Toner (1955, 1961) and the one in Froom (1972) based on them, may be incomplete as they often included only selected records judged to define the boundaries of the range of a species (see Logier and Toner 1955, page 4; Logier and Toner 1961, pages 1 and 6). The post-glacial invasion of the Massasauga was likely from the southwest during a eastern steppe, or prairie peninsula, expansion (Schmidt 1938; Bleakney 1958) 5 to 7 thousand years ago. The species spread northeastward into the Bruce Peninsula, north along Georgian Bay and beyond, and east at least to the Niagara Peninsula. These snakes are associated with mesic prairie habitats and wetlands that were once more extensive in Ontario (Bardecki 1984). Reduction of the Massasauga's range dates at least from the clearing and draining for agriculture begun by the first Europeans to settle in the province, a process continuing to the present.

The earliest reliable published statements document a range that was already shrinking. Garnier (1881) recorded seeing the remains of a Massasauga (as Crotalophorus tergemina) at "Tilberry Marsh" [Essex County] and commented that the species was "Not

rare formerly along Lake Erie, although now exceedingly scarce." Stejneger (1895) cited a specimen from Point Pelee [Essex County]. Nash (1905) stated: "This species formerly occurred in the meadow lands at the western end of Lake Erie, and has long been found from there north to the Georgian Bay. It is now nearly extinct." Miner (1930) added a report from Kingsville, Essex County, near the western end of Lake Erie.

LeRay (1930) summarized the range, based on specimens, as including "Bruce peninsula, the Georgian bay district at least as far north as the French river and a large peat bog near Wainfleet, Welland county." Klauber (1936) included a report from Port Hope, Northumberland County. Logier (1939) characterized it as "Not now plentiful in Ontario. Still fairly common in Bruce peninsula and not rare along the eastern shore of Georgian Bay and some of the adjacent islands; found occasionally in the general vicinity of Lake Erie. It probably occurs along the whole Georgian Bay - Lake Huron - Lake Erie shoreline, thinning out and disappearing inland. All of our positive records are within about 20 miles of this shoreline. We have reports from further east, the most easterly being from Prince Edward County. We have recently had a report at Colbalt." The Colbalt and Prince Edward County reports were dropped in subsequent publications (Logier and Toner 1955, 1961). Gloyd (1940) cited a specimen from Lucknow, Bruce County (USNM [United States National Museum] 12752), but a Massasauga from there was likely donated by Garnier, and designation may refer to the origin of the shipment rather than the site of the collection (Garnier lived at Lucknow, and had not mentioned the occurrence of Massasaugas there in his earlier publications).

The report from Prince Edward County at the eastern end of Lake Ontario was based on local recollections of past sightings (Logier 1941). Although there is a population in the United States just south of Lake Ontario (see Conant 1975), neither a detailed herpetofaunal survey in 1979, nor observations throughout the 1980s, have provided any verification of its presence in Prince Edward County (Tom Huff, Reptile Breeding Foundation, personal communication).

Fox (1948) extended the "twenty" mile limit from lakes Huron and Erie. He commented: "the Press recently carried the story that a specimen had been seen at Gravenhurst, the most southerly point on Lake Muskoka, which is in a direct line at least 25 miles distant from the nearest spot on the Georgian Bay". He also reported a rattlesnake killed and deposited in the collection of the University of Western Ontario, London, that had bitten a two-and-half year old boy in October 1947 at Newbury, "which is 25 miles from Lake Erie". (The boy recovered without treatment.) Newbury is at the eastern end of a narrow swampy depression, "Skunk's Misery", that covers several miles in western Middlesex and eastern Kent counties.

Fox (1951) later reported that "more than a hundred years ago the first settlers of Glencoe, five miles east of Newbury, frequently came across specimens of the species there." He added that a Massasauga had been killed by a farmer living mid-way between Clifford and Mount Forest in Minto Township in the extreme northwestern corner of Wellington County, a locality 42 miles from both Kincardine on Lake Huron, and from Owen Sound. One also was reported from two miles south of Mount Forest. Although no specimens were saved from either locality, Fox interviewed the observers at length and was convinced of the authenticity of the reports. He noted that both localities were "associated with the upper

waters of the Saugeen River" and that the "last reach of the Saugeen forms the western boundary of the Bruce Peninsula". A relatively large Massasauga population existed on this peninsula. Toner (undated) stated that records existed from along the Lake Huron shoreline between Southampton (southern Bruce County) and south to Sarnia, but that the species was rare throughout the area, and seemed to have always been so. Compilation and analysis of literature together with additional reports and interviews yielded a total of over 550 records which can be grouped into three periods for comparison. Prior to 1962 the confirmed a range centred on Georgian Bay and the Bruce Peninsula, extreme southwestern Ontario, and southeastern Niagara Peninsula. Previously unrecorded reports from elsewhere included Beverley Swamp, Luther Marsh, Long Point, and Turkey Point (Craig A. Campbell, personal communication).

Over 120 records from 1962-1976 suggest that little change in distribution had occurred in the Georgian Bay and Bruce Peninsula areas but that the Massasauga may have disappeared from southwestern Ontario except in the vicinity of Windsor (Anonymous 1976). It continued to be reported from the southeastern part of the Niagara Peninsula near Port Colborne.

Over 350 records from 1977-1986 included extensive interviews with outdoor enthusiasts in 1985 and 1986, most conducted at the Canadian National Sportsmen's Show in Toronto. Again, no change was indicated for Georgian Bay and Bruce Peninsula, but new reports came from the following areas: Lake Huron in southern Bruce County; islands along the north shore of Manitoulin Island; near Espanola; inland areas south of Lake Nipissing; and Victoria and Haliburton counties. In southwestern Ontario, Massasaugas were still reported only from the Windsor prairie and Port Colborne areas. A rattlesnake bite which occurred in September 1987 in Sandwich West Township, near Windsor, of a 9-year old boy (who was treated and discharged) provided confirmation that the populations there had not yet been extirpated.

Records from these analyses, others included in the Ontario Herpetofaunal Summary reports (Oldham and Sutherland 1986; Weller 1988; Villeneuve 1988; Oldham and Weller 1989), and subsequent records to the Summary files are given in Figure 2. Peripheral records at the northern and eastern edges of the range are listed in Table 1.

An effort was made to screen all reports carefully and to discard all those where a "rattler" was heard but not seen, or those where the snake was seen but no rattle was observed. However, some doubt must remain attached to all records without specimen or photographic verification. Reports from Haliburton, Victoria, and Northumberland are from or near localities where the Eastern Hognose Snake, Heterodon platyrhinos, has been collected or reported. This heavy-bodied, blotched, wide-headed snake with a habit of hissing and spreading its neck menacingly is easily mistaken for a poisonous species by those unfamiliar with it and is often called a "puff-adder".

Other harmless snakes that occur within and beyond the Massasauga's range in Canada also have patterns of dorsal and lateral blotches and will vibrate their tails vigorously, coil, and strike menacingly when nervous or threatened. The Milk Snake, Lampropeltis triangulum, and the Fox Snake, Elaphe vulpina, are commonly misidentified by casual observers of this behaviour. The Fox Snake has also been called a "hardwood rattler" (because of the noise of its tail vibrating in dry leaves on the ground beneath

deciduous forest) and "dumb rattler" (because it lacks rattles).

Additional reports of "rattlesnakes" also occur even farther east but have never been accepted as part of Massasauga range. In the Ottawa area of eastern Ontario and western Quebec such reports for which a specimen could be examined have turned out to be based on Milk Snakes, Lampropeltis triangulum (F. R. Cook, personal communication).

In view of the general pattern of declines elsewhere, it is improbable that the peripheral reports represent recent natural expansions of the range. Although it is occasionally speculated that new occurrences could be due to accidental transport, no authenticated case of this is known. Reports backed by specimen evidence (rattles collected: Sudbury and Parry Sound districts) are from localities that are joined by possible natural dispersal corridors (waterways) with areas where there are previously accepted records and most likely are previously unreported natural populations.

Protection

United States

In 1976, the Eastern Massasauga was listed as endangered, threatened or rare in 9 of the 10 states in which occurred (Ashton 1976), with only Michigan not included at that time. Since then, concern has intensified and this is reflected in recent state designations (Table 2). Its decline has been related to both habitat destruction and commercial exploitation. In some states a bounty was formerly paid for rattlesnakes. Recommendations on effective conservation measures for the species vary among the states; in some there is local limitation on types of agricultural practices or other land uses permitted where Massasaugas exist. The U. S. Department of the Interior and U. S. Wildlife listing Endangered and Threatened Wildlife and Plants, 50 CFR 17.11 & 17.12 (dated 15 April 1990) does not, however, include the Massasauga at the federal level, and it is not protected under the U.S. Threatened and Endangered Species Act of 1973 (J. A. MacLean, personal communication, 23 January 1991).

Canada

In 1990, Ontario amended Regulation 397/84 of the Game and Fish Act to add the Eastern Massasauga as the 19th reptile protected in the province (Ontario Gazette Volume 123-22, Saturday, June 2nd, 1990, Ministry of Government Services, Dennis P. Caplice, Queens Printer for Ontario, Toronto. Page 3118). Previously, both individuals and their habitats received protection only within provincial parks (e.g., Fathom Five, Cyprus Lake (now within Bruce Peninsula National Park), Killarney, Grundy Lake, Sturgeon Bay, Killbear, Oastler Lake, Six Mile Lake and the Ojibway Prairie Nature Reserve), in National Parks (Georgian Bay Islands and Bruce Peninsula), and along the Trent-Severn Waterway administered by Parks Canada.

Population Size and Trends

There has been a popular conception that Massasaugas are increasing or spreading north, or both, in the Georgian Bay area and beyond. However, the apparent increase in records is more likely simply a reflection of the increase in tourism and development in the area since the 1960s (D. Cuddy via J. A MacLean, personal communication, 23 January

1991).

In field studies on Beausoleil Island (1100 ha), part of the Georgian Bay Islands National Park complex in southeastern Georgian Bay, 338 individuals were recorded in the 10 years between 1978 and 1987 (D. A. Rivard, personal communication). The necessary relocation of individual rattlesnakes away from campsites where they were first captured, however, biases recapture data and makes it difficult to use this for any additional analysis of population size and trends.

Massasaugas reports in southwestern Ontario now average less than one per year This contrasts with the late 1960s when an average of over 15 were reported killed each year in the La Salle area south of Windsor (J. Larson, personal communication, 28 October 1986).

No estimates are available for the population in the Wainfleet Bog on the Niagara Peninsula near Port Colborne. Local Ontario Ministry of Natural Resources staff in the Niagara Peninsula area report, however, that the rattlesnake population is expanding beyond Wainfleet Bog into adjacent agricultural areas, probably by way of the feeder canals. Requests are sometimes received for the removal of rattlers from woodsheds and even chicken coops. Massasaugas are also found under hay stooks in nearby farmers' fields. One was reported from approximately 40 km from the Bog on east side of the Welland Canal (J. A. MacLean, personal communication, 23 January 1991).

Habitat

Critical Habitat

Eastern Massasaugas are generally associated with mesic prairie wetland (Wright 1941; Wright and Wright 1957; Klauber 1972; Conant 1975) and river bottomland (Vogt 1981). Their name is Chippewa for "great river mouth" (Vogt 1981).

Many reports seem to indicate a seasonal movement from wet areas to drier ones in the summer (e.g., Reinert and Kodrich 1982; Johnson 1987. Vogt (1981) suggests that these snakes move to high ground during flooding and then back to low areas later. This may reflect a behavioural adaption to seasonal changes in natural prairie habitats. A preference for low, wet habitats for hibernation may lessen the risk of desiccation during winter. Vogt (1981) suggests that flooding of their hibernation sites is the signal for spring emergence.

In Ontario, typical habitat was present in Essex and adjacent counties, remnants of the tall grass prairie which was a vestige of the former prairie peninsula. To the east, these snakes are still associated with the Wainfleet Bog on the Niagara Peninsula. Recent reports of their occurrence beyond the bog (see Population Trends and Numbers) may reflect the normal seasonal spring-summer movement from wet to drier areas. To the north, in the absence of prairie conditions, they are found in wetlands associated with rock outcrops. They have been most intensively studied there on Beausoleil Island in Georgian Bay (Weatherhead and Hutchinson 1984; Linke 1985; see Table 3).

In the northern portion of their range Massasaugas appear to over-winter individually in rodent burrows at the base of trees in rock outcrop areas adjacent to wetlands. This has been verified on Beausoleil Island (Villeneuve and Rivard 1985) and is also indicated by casual observations of Massasaugas in early spring in rocky areas throughout the Georgian Bay and Bruce Peninsula areas.

Within this northern area, winter survival is likely also enhanced by the influence of Lake Huron in moderating temperatures and in inducing heavy snowfalls which provide an insulation during the coldest months.

In contrast to the extensive outcrops which occur throughout the Precambrian Shield of the Georgian Bay area, in southwestern Ontario only the elevated Niagara Escarpment, which is not Massasauga habitat, has extensive rocky areas. In the more moderate climate in the southwestern part of the province, the need for deep crevices may not be as critical to winter survival. In northeastern Ohio and Wisconsin, Massasaugas apparently hibernate singly and in crayfish burrows (Maple and Orr, 1968; Vogt, 1981).

Distribution of Critical Habitat

Wetlands and associated rock outcrops are widespread in the Georgian Bay and Bruce Peninsula areas. Large wetlands once occurred widely in southern Ontario between Georgian Bay and Lake Erie (Bardecki 1984) but are now rare features with four major exceptions: Walpole Island, Lambton County; Skunks Misery, Middlesex County; Point Pelee, Essex County; and Wainfleet Bog, formerly Welland County.

Protection of Critical Habitat

Only a small portion of the historic Canadian range of the Massasauga is within provincial or national parks. A larger, but undetermined percentage, is on Crown Land.

At Wainfleet Bog on the Niagara Peninsula, the area continues to be commercially exploited for peat, but extraction is occurring at a much more limited scale than in the past, and the Ontario Ministry of Natural Resources now owns 618.52 acres of a total of 2,543.6 acres; 512 acres of this MNR property comprise an "Area of Natural and Scientific Interest (ANSI)" which is situated in the most natural, undisturbed part of the bog. Nevertheless, habitats are reported to be changing rapidly as a result of pst drainage practices (J. A. MacLean, personal communication, 23 January 1991).

General Biology

Reproductive Capability

Seven litters of females from the Georgian Bay area contained from 8-16 individuals (Table 3). This range falls within the 2-19 young for 54 litters recorded from the United States (Fitch 1970). The average of 12.4 young per litter in Canada is larger than that of 8.2 young reported for United States populations (Fitch 1970). For Wisconsin, however, Vogt (1981) gave 8 to 20, usually about 15. In Missouri, Johnson (1987, citing Seigel 1981, 1983, both unpublished reports) stated that Sistrurus had 4 to 10 young, and that maturity is at 3-4 years. Breeding may occur both in the spring and the fall (Vogt 1981). The young are born in late summer (late August in Wisconsin according to Vogt 1981; mid-August to mid-September according to Keenlyne and Beer 1973, based on Wisconsin samples and a survey of the literature) at a size of 19 to 24 cm (Conant 1975), 20 to 25 cm (Vogt 1981), or 18.6 to 25.2 (Keenlyne and Beer 1973a), the last two figures for Wisconsin. It is uncertain if northern females have young every year or alternate years. Sistrurus catenatus is recorded to have lived 14 years in captivity (Bowler 1977); one from the Windsor prairie lived more than 8 years in captivity (P. D. Pratt, personal communication).

Daily Activity and Movements

S. catenatus at two Pennsylvania sites had an average daily movement of only 9 m (Reinert and Kodrich, 1982). Over 50 days, activity ranges and linear range lengths averaged 9794 sq. m and 89 m respectively. Although no differences could be demonstrated when males and all females were compared, gravid females had a significantly shorter range length (40 m) than males.

In Missouri, Johnson (1987, citing Siegel 1981,1983, unpublished) reported that Massasaugas bask on sunny spring days and that the species "is primarily diurnal but becomes nocturnal during July and August".

In Ontario however, Linke (1985) found that Massasaugas generally remained inactive from dusk to sunrise, possibly reflecting a different activity pattern because of either the northern or the less disturbed character of the area. Individually-tagged snakes on Beausoleil Island wandered throughout suitable habitats in the northern section of the island. On 47% of 204 occasions during July to early September, four radio-transmitter equipped snakes moved on average less than 10 m between observation periods. Mean distance travelled per observed movement (>10 m distance) was 42.6 m. Maps showing recapture locations (see Linke 1985) suggest that Massasaugas move within 10-50 ha plots, and do not move linearly over great distances. Individuals of the western subspecies, were strongly nocturnal in the hotter drier climate of Texas and Kansas (Knoff and Tinkle 1961; Greene and Oliver 1965).

Behaviour and Adaptability

Massasauga populations apparently have a some tolerance of human activity provided that habitat destruction and killing of individuals is not at critical levels. This is indicated by their success in the Georgian Bay and Bruce Peninsula areas. Where suitable habitat still exists, even in some densely settled areas like the Windsor prairie, some rattlesnakes survive despite past attempts to eradicate them.

This species does well in captivity; but, because it is poisonous, it should be kept only under conditions where safety precautions are assured both in caging and handling routines.

Food

Massasaugas feed primarily on mice (Conant 1951), although Ruthven (1911) reported frogs as the major food in Michigan. Occasionally other snakes, insects, crayfish, fish (Wright and Wright 1957) and birds (Smith 1961). Johnson (1987) stated that, in Missouri, voles and deer mice are primary prey, but that brown snakes [Storeria dekayi] were an important prey of juveniles. Keenlyne and Beer (1973) found that the "only food item in wild young-of-the year Massasaugas ... was young-of-the year garter snakes". These authors reported 91 food items from 323 specimens examined from Wisconsin. The percentage of food items was vole 85.7, deer mouse 4.4, Eastern Garter Snake 4.4, jumping mouse 2.2, shrew 1.1. No frogs had been eaten. Vogt (1981) states that all the individuals he had "captured and maintained contained mammal hair in their feces" and that he had "maintained captives that refused everything but mice; even newborn massasaugas would eat only newborn mice. A diet of cold-blooded prey seems to be restricted to young massasaugas or to those living in areas where mammal populations are low." Johnson (1987), however,

reports that young Massasaugas attract frogs by "caudal luring" : slightly moving their tail which is yellow-tipped at birth.

Limiting factors

In the United States, destruction of habitat for agriculture and manipulation of wetlands have been identified as contributing declines in the Massasauga. Collecting of snakes for commercial markets, and general harassment as "sport" and from fear also reduce numbers of this species (Ashton 1976). Information on natural predation is scarce, but Vogt (1981) suggests that they are "probably preyed upon by hawks, skunks, raccoons and foxes". However, he adds that "humans are primarily responsible for their decline" in Wisconsin.

In Ontario, the Massasauga reaches its northern limit, and presumably is restricted by climate (progressively colder winters causing hibernation failures and shorter summers not providing sufficient heat over a long enough period for completion of embryonic development). Habitat destruction has likely been a major factor in reduction of southern Ontario populations. Killing of snakes because they are poisonous and/or for rattles as souvenirs also contributes to the Massasauga's decline throughout its range. Road traffic losses may also be significant. Commercial collecting has not been documented for Ontario populations.

Fluctuations in numbers in response to prey abundance have not been determined. Local increases or declines in the abundance of mice and frogs can, however, be reasonably anticipated to promote an increase or decrease in rattlesnake numbers but the time lag before this would be evident is unknown.

Special Significance of the Species

Rattlesnakes are unique among pit vipers (Crotalinae) of the family Viperidae because of their rattle, and occur only in the New World (nearctic and neotropics). Rattles apparently serve to signal the presence of the snake to other animals (Fenton and Licht 1990). The Massasauga is a member of Sistrurus, a genus containing three distinctive species of rattlesnakes. The two others are S. miliarus in the southeastern United States and S. ravus in Mexico (Klauber 1972). All other rattlesnakes (28 species) are placed in Crotalus, which is widespread over North, Central and South America. The presence of 9 large head scales, rather than many small ones, and morphological characters of the hemipenes, traditionally distinguish Sistrurus and Crotalus (Klauber 1972). However, Brattstrom (1964) and McCranie (1988), on the basis of comparative studies of osteology and hemipenes, respectively, relate S. ravus closely to Crotalus and question the validity of Sistrurus as a distinct genus. Stille (1987) used electron microscopy to study dorsal scales and also concluded the traditional generic division did not fit the variation observed.

The Massasauga has received considerable public attention in Ontario and is potentially life-threatening, especially to children and pets. The incidence of bites is not available however, because the Poison Control Centres reporting to Health and Welfare Canada do not record snake bites separately from wasp and bee stings. Antivenin is generally stocked by health centres, including hospitals, within or near the known distribution of the Massasauga in Ontario.

Negative attitudes to the Massasauga in Ontario probably reached their highest point

in the 1950s and 1960s. During this period rattlesnake bites were frequently publicized, particularly two cases in the Georgian Bay area which resulted in fatalities: a 48-year-old women in 1956 and a 9-year-old girl in 1962, This increase in encounters corresponded to a rise in the numbers and mobility of people in search of cottages and outdoor recreation. The fatalities, particularly, prompted suggestions that the provincial government inaugurate a bounty to exterminate the species in Ontario (Orillia Packet and Times, 24 July 1962; Ottawa Journal, 16 July 1963), but this was not done. Public efforts to eradicate Massasaugas in the Windsor area were widespread in the mid to late 1960s. Brush fires were set annually in fields where Massasaugas occurred in an attempt to eradicate the species (J. Larson, personal communication, 28 October 1986).

The subsequent decline in publicity presumably indicates that the rattlesnakes are now regarded as less of a threat. They are also less numerous. The publicity for and against rattlesnakes has likely caused people to be more cautious, and more newcomers to rattlesnake areas are now nature-literate than was the case previously. Attitudes towards Massasaugas have since improved. Many people interviewed by Weller claimed that they no longer kill Massasaugas they encounter, but instead leave them alone or relocate them to distant areas. In November 1989, the Metropolitan Toronto Zoo in conjunction with conservationists interested in the preservation of the Massasauga in Ontario, launched a twice-yearly publication, Rattlesnake Tales, to actively promote the dissemination of information and foster a more positive public attitude toward the conservation of the Massasauga.

Research conducted by Parks Canada on Beausoleil Island in southern Georgian Bay has provided the only detailed information on the biology of this species in Canada to date, but studies have been initiated at Bruce Peninsula National Park and Killbear Provincial Park as well. The Parks programs in these areas are outstanding examples of effective public awareness and research programs and are models of how these can be effectively initiated and maintained.

The Ontario Ministry of Natural Resources has also issued a pamphlet "When snakes become a nuisance" which is a positive aid to the public fearful of snakes in general and Massasaugas in particular. This most effectively discusses the beneficial aspects of snakes and the need for their conservation while proposing alternatives to their destruction. It also lists where antivenin is available in the province. A list of depots and general information on rattlesnakes ("Rattlesnakes in Ontario") is also available from the Ontario Ministry of Health.

Evaluation

A reduction of its former range in Ontario clearly marks the Massasauga for concern. Although its range in the Georgian Bay and Bruce Peninsula areas seems to be relatively unchanged since European settlement, its numbers in the area may be declining. No sound judgments on local declines are possible, however, because there are only anecdotal historical observations to compare with recent studies. Even the latter do not adequately fill the need for accurate population estimates or recent fluctuations.

In extreme southwestern Ontario and the Niagara Peninsula this snake has been eradicated or substantially reduced in range and numbers have certainly declined as a

consequence. The tradition of killing rattlesnakes on sight coupled with extensive habitat destruction through draining of wetlands, primarily for agricultural purposes, have all contributed to the decline. Despite the legal protection now given in Ontario, attitudes towards Massasaugas specifically, and towards wetlands values generally, must continue to improve or the long-term prospects for this species will be dim, even in the Bruce Peninsula and Georgian Bay areas. Even in these areas, the Massasauga could still be jeopardized by increasing human recreational use of the area unless public awareness and management programs by the National Parks Service are continued and enacted by others.

The Massasauga is clearly endangered in southwestern Ontario though habitat loss and continued persecution. Its overall designation for Canada should be Threatened.

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Literature Cited

Anonymous. 1976. Insight - Ojibway Park and Ojibway Prairie Provincial Nature Reserve. Prepared for Ontario Ministry of Natural Resources, Toronto, and City of Windsor, Department of Parks and Recreation, Windsor, Ontario.

Anonymous. 1982. New York revises state list of endangered and threatened species. Herpetological Review 13(2): 35.

Ashton, R. E., Jr., Compiler. 1976. Endangered and threatened amphibians and reptiles in the United States. Society for the Study of Amphibians and Reptiles, Miscellaneous Publications, Herpetological Circular No. 5. April, 1976. 65 pages.

Bardecki, M. J. 1984. Wetland Conservation Policies in Southern Ontario: A Delphi Approach. Geographical Monographs No. 16, Atkinson College, York University, Downsview, Ontario. 275 pages.

Bleakney, J. S. 1958. A zoogeographical study of the amphibians and reptiles of eastern Canada. National Museum of Canada Bulletin 155 (Biological Series 54). 119 pages.

Bowler, J. K. 1977. Longevity of reptiles and amphibians in North American collections as of 1 November, 1976. Society for the Study of Amphibians and Reptiles, Miscellaneous Publications, Herpetological Circular No. 6. 32 pages.

Brattstrom, B. H. 1964 Evolution of the pit vipers. Transactions of the San Diego Society of Natural History 13: 185-268.

Conant, R. 1951. The reptiles of Ohio. Second edition with revisionary addenda. University of Notre Dame Press, Indiana. 284 pages.

Conant, R. 1975. A field guide to reptiles and amphibians of eastern and central North America. Second edition. Houghton Mifflin. 429 pages.

Cook, F. R. 1984. Introduction to Canadian amphibians and reptiles. National Museum of Natural Sciences, National Museums of Canada, Ottawa, Ontario. 200 pages.

Elliot, W B. 1978. Chemistry and immunology of reptilian venoms. Pages 163-436 in Biology of the Reptilia, Volume 8, Physiology B. Edited by C. Gans and K. A. Gans. Academic Press, London and New York.

Fenton, M. B., and L. E. Licht. 1990. Why rattle snake ? Journal of Herpetology 24(3): 274-279.

Fitch, H. S. 1970. Reproductive cycles in lizards and snakes. Museum of Natural History, University of Kansas. Miscellaneous Publications No. 52. 247 pages.

Fox, W. S. 1948. The Swamp Rattlesnake in inland southwestern Ontario. Canadian Field-Naturalist 62(5): 160 - 161.

Fox, W. S. 1951. The Little Swamp Rattlesnake in inland Ontario. Canadian Field-Naturalist 65(1): 39.

Froom, B. 1972. The snakes of Canada. McClelland and Stewart Limited, Toronto, Ontario. 128 pages.

Garnier, J. H. 1881. List of Reptilia of Ontario. Canadian Sportsman and Naturalist (Montreal) 1(5): 37-39.

Genoways, H. H., and F. J. Brenner. Editors. 1985. Species of special concern in Pennsylvania. Special Publication of Carnegie Museum of Natural History 11.

Glenn, J. L., and R. C. Straight. 1982. The rattlesnakes and their venom yield and lethal toxicity. Pages 3-119 in Rattlesnake venoms: their actions and treatment. Edited by

Anthony Tu. Marcel Dekker, New York.

Gloyd, H. K. 1940. The rattlesnakes, genera Sistrurus and Crotalus. Chicago Academy of Sciences Special Publication 4. vii + 266 pages.

Greene, Harry W., and George V. Oliver, Jr. 1965. Notes on the natural history of the Western Massasauga. Herpetologica 21(3): 225-228.

Johnson, T. R. 1987. The amphibians and reptiles of Missouri. Missouri Department of Conservation, Jefferson City, Missouri.

Johnson, B. 1989a. Familiar amphibians and reptiles of Ontario. Natural Heritage/Natural History Inc., Toronto. 168 pages.

Johnson, B., Coordinator. 1989b. Rattlesnake tales. Metropolitan Toronto Zoo, Toronto, Ontario, 1(1): 1-4.

Johnson, B., and V. Menzies. 1992. (eds.). International symposium and workshop on the conservation of the Eastern Massasauga Rattlesnake (Sistrurus catenatus catenatus). Metropolitan Toronto Zoo, Toronto, Ontario. 141 pages.

Keenlyne, K. D., and J. R. Beer. 1973. Food habits of Sistrurus catenatus catenatus, Journal of Herpetology 7(4): 382-384.

Klauber, L. M. 1936. Key to the rattlesnakes with summary of characteristics. Transactions of the San Diego Society of Natural History 8(20): 185-276.

Klauber, L. M. 1972. Rattlesnakes - Their habits, life histories, and influence on mankind. 2 Volumes. Second Edition. University of California Press. Berkeley and Los Angeles. 1533 pages.

Knoff, Gary N., and Donald W. Tinkle. 1961. The distribution and habits of Sistrurus catenatus in northwest Texas. Herpetologica 17(2): 126-131.

LeRay, W. J. 1930. The Rattlesnake (Sistrurus catenatus) in Ontario. Canadian Field-Naturalist 44(9): 201-203.

Linke, T. 1985. The summer movements and habitat preferences of the Eastern Massasauga (Sistrurus catenatus catenatus) on Beausoleil Island. Report prepared for Sir Sanford Fleming College (Lindsay), and Georgian Bay Islands National Park (Honey Harbour). 44 pages.

Logier, E. B. S. 1939. The reptiles of Ontario. Royal Ontario Museum Handbook No. 4. 63 pages.

Logier, E. B. S. 1941. The amphibians and reptiles of Prince Edward County, Ontario. Pages 93-106 in A faunal investigation of Prince Edward County. By L. L. Snyder, E. B. S. Logier, T. B. Kurata, F. A. Urquhart, and J. F. Brimley. University of Toronto Studies, Biological Series No. 48.

Logier, E. B. S. 1958. The snakes of Ontario. University of Toronto Press. 94 pages.

Logier, E. B. S., and G. C. Toner. 1955. Check-list of the amphibians and reptiles of Canada and Alaska. Royal Ontario
Museum of Zoology and Palaeontology Contributions 41: 1-88.

Logier, E. B. S., and G. C. Toner. 1961. Checklist of the amphibians and reptiles of Canada and Alaska. Royal Ontario Museum, Life Sciences Division, Contribution 53. 92 pages.

Maple, W. T., and L. P. Orr. 1968. [Abstract] Overwintering adaptations of Sistrurus c. catenatus in northeastern Ohio. Journal of Herpetology 2(3-4): 179-180.

McCranie, James R. 1988. Description of the hemipenes of Sistrurus ravus (Serpentes: Viperidae). Herpetologica 44(1): 123-126

Miner, J. 1930. Interfering with nature. Oologist 47(5): 50-53.

Minton, S. A. 1983. Sistrurus catenatus. Pages 332.1 - 332.2 in Catalogue of American Amphibians and Reptiles. Edited by L. D. Wilson. Society for the Study of Amphibians and Reptiles.

Nash, C. W. 1905. Batrachians and reptiles of Ontario in Checklist of the vertebrates and catalogue of specimens in the biological section of the Provincial Museum. Department of Education, Toronto. 32 pages.

Oldham, M. J. Editor and Compiler. 1988. 1985 Ontario herpetofaunal summary. Ministry of Natural Resources, London, Ontario. 206 pages.

Oldham, M. J., and D. A. Sutherland. Compilers. 1986. Ontario Herpetofaunal Summary 1984. Essex Region Conservation Authority, Essex, Ontario and World Wildlife Fund Canada, Toronto, Ontario. 214 pages.

Oldham, M. J., and W. F. Weller. 1989. Ontario Herpetofaunal Summary 1986 Technical Supplement. Ontario Field Herpetologists, Cambridge, Ontario. 197 pages.

Prior, R. A., and P. J. Weatherhead. 1995. National recovery plan for the Eastern Massasauga Rattlesnake (Sistrurus catenatus catenatus) in Canada. Draft prepared for Ontario Ministry of Natural Resources. Nov. 1995. 66 pages.

Reinert, H. K., and W. R. Kodrich. 1982. Movements and habitat utilization of the Massasauga, Sistrurus catenatus catenatus. Journal of Herpetology 16(2): 162-171.

Ruthven, A. G. 1911. A biological survey of the sand dune region on the south shore of Saginaw Bay: Amphibians and reptiles. Michigan Geological and Biological Survey Publication 4, Biological Series 2. Pages 257-272.

Schmidt, K. P. 1938. Herpetological evidence for the post-glacial extension of the steppe in North America. Ecology 19(3): 396-407.

Smith, P. W. 1961. The amphibians and reptiles of Illinois. Illinois Natural History Survey Bulletin 28 (1): 1 - 298.

Stebbins, Robert C. 1985. A field guide to western reptiles and amphibians. Second edition, revised. Houghton Mifflin Co,, Boston, Massachusetts. xiv + 332 pages.

Stejneger, L. 1895. The poisonous snakes of North America. United States National Museum Annual Report for 1893. Pages 337-487.

Stille, B. 1987. Dorsal scale microdermatoglyphics and rattlesnake (Crotalus and Sistrurus) phylogeny (Reptilia: Viperidae: Crotalinae). Herpetologica 43(1): 98-104.

Toner, G. C. undated. The range of the Massasauga in Ontario. Canadian Amphibian and Reptile Conservation Society Bulletin. 2 pages.

Villeneuve, M. 1988. Eastern Massasauga -- Massasauga (Sistrurus catenatus). Pages 159-161 in Ontario herpetofaunal summary 1986. Edited by W. F. Weller and M. J. Oldham. Ontario Field Herpetologists, Cambridge, Ontario. 221 pages.

Villeneuve, M., and D. H. Rivard. 1985. Massasauga Rattlesnake management at Georgian Bay Islands National Park, Ontario, Canada. Paper presented at The Massasauga Rattlesnake symposium, Pennsylvania Department of Environmental Resources, Bureau of State Parks, Jennings Environmental Education Centre, Slippery Rock, Pennsylvania. 22-23 August 1985.

Vogt, R. C. 1981. Natural history of amphibians and reptiles of Wisconsin. Milwaukee Public Museum, Milwaukee, Wisconsin.

Weatherhead, P. J., and B. Hutchinson. 1984. Resource management study of the Massasauga Rattlesnake in Georgian Bay Islands National Park: data analysis and interpretation. Report prepared for Parks Canada, Contract GB 84-14, Ontario Region, Cornwall, Ontario. 20 pages.

Weller, W. F. 1988. Massasauga (Sistrurus catenatus). Pages 195-197 in Ontario Herpetofaunal Summary 1985. Compiled by M. J. Oldham. World Wildlife Fund (Canada), Toronto: Essex Region Conservation Authority, Essex; and Ontario Ministry of Natural Resources, London. 206 pages.

Weller, W. F., and M. J. Oldham. Editors. 1988. Ontario herpetofaunal summary 1986. Ontario Field Herpetologists, Cambridge, Ontario. 221 pages.

Wright, A. H. and A. A. Wright. 1957. Handbook of snakes of the United States and Canada. 2 volumes. Comstock Publishing Associates, a Division of Cornell University Press, Ithaca, New York. 1105 pages.

Wright, B. A. 1941. Habitat and habitat studies of the Massasauga Rattlesnake (Sistrurus catenatus Raf.) in northern Illinois. American Midland Naturalist 25: 659 -672.

Fig. 1. Distribution of the Massasauga, Sistrurus catenatus, in North America. Solid shading shows the geographic range of the Eastern Massasauga, S. c. catenatus. Dotted area shows that of the Western Massasauga, S. c. tergeminus, and the diagonally hatched area that of the Desert Massasauga, S. c. edwardsi. (Based on Minton 1983).

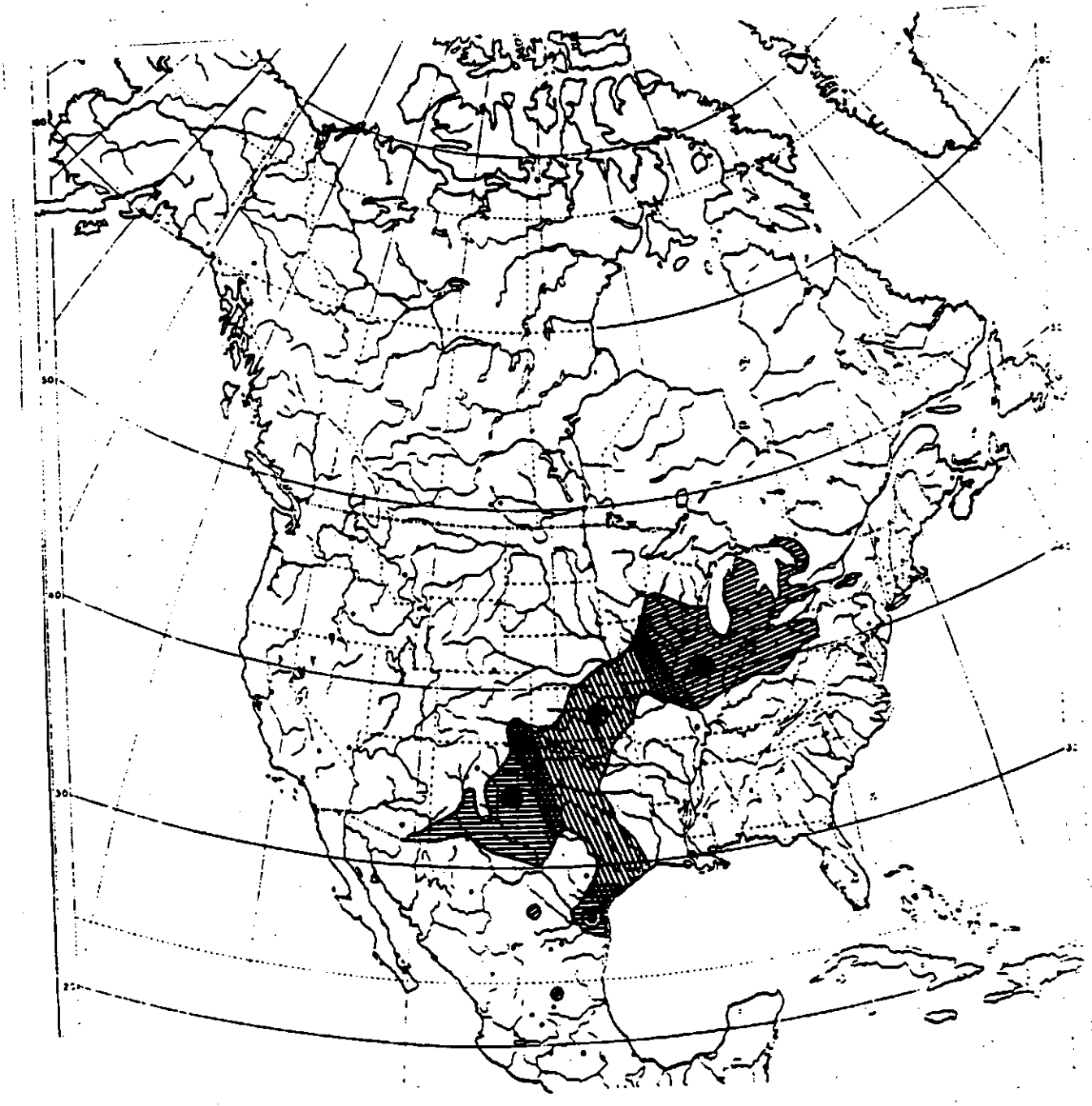

Fig. 2. Distribution records for the Massasauga in Ontario. (Based on records of the Ontario Herpetofaunal Summary) (Oldham, 1988; Weatherhead and Oldham, 1988).

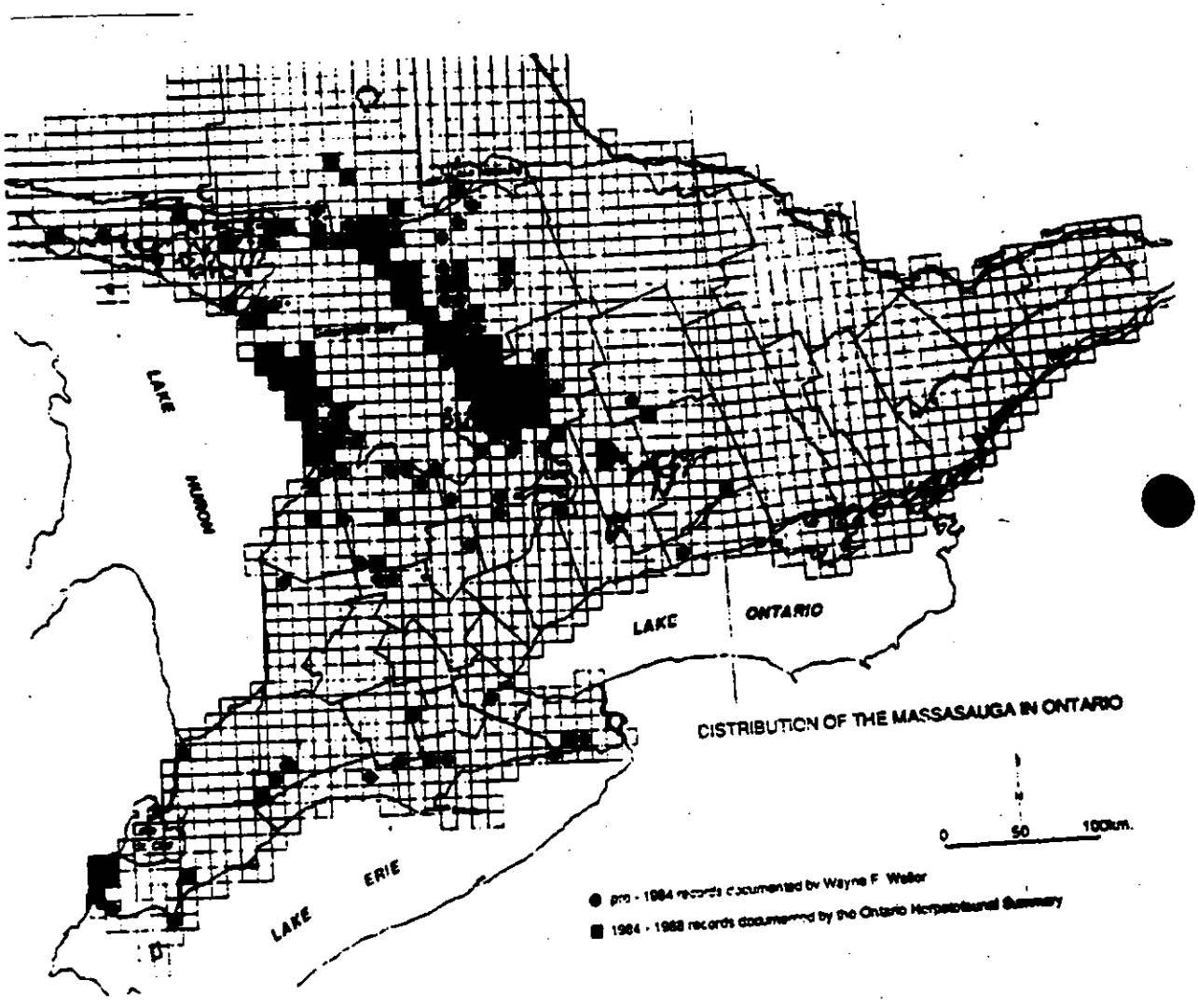

Table 1. Peripheral records for the Massasauga in Ontario.

Locality	Specimen/Date	Source
SUDBURY DISTRICT		
Long Lake, 5 miles south of Lively	33 inch specimen; killed; 9 rattles 19 August 1987	A. Zimmerman Sudbury (PC: M. J. Oldham)
Millard Lake, north end	individual killed August 1985	A. Zimmerman, Sudbury (PC: M. J. Oldham)
PARRY SOUND DISTRICT:		
Latchford, south of Lake Nipissing	one juvenile seen summer 1983	J. Denholm Tillsonburg
Restoule Lake	killed; rattle kept summer 1978	J. Nowak Kitchener
5 km N of Nagnstawen	1 seen September 1984	D. Sangster Toronto
HALIBURTON COUNTY:		
9 km NE of Minden	one dead on road 1955	G. Armstrong Trenton
Irondale	one seen summer 1984	R. Craig Oshawa
VICTORIA COUNTY:		
15 km SW of Coboconk	one seen summer 1985	McGrattan Mississauga
12 km W of Coboconk	one killed August 1984	W. McNeill Scarborough
NORTHUMBERLAND COUNTY:		
Port Hope	1 killed, 1890	Klauber 1936
Hastings	pre-1962	Toronto Star

Table 2. Status of the Eastern Massasauga in the United States as of December 1990.

Illinois:	on the state "Watch List" used only to track potential candidates for listing as endangered or threatened and lacks any statutory authority: John Buhnerkempe, Illinois Department of Conservation, 19 November 1990.
Indiana:	Listed in: Indiana's Rare Plants and Animals: A checklist of Endangered and Threatened Species: Indiana Department of Natural Resources (May 1990).
Iowa:	listed as an endangered species in Iowa (Iowa Administrative Code, Chapter 77): Daryl L. Howell, Iowa Department of Natural Resources, 15 November 1990.
Michigan:	status: "special concern" but not given protection under Endangered Species Act Michigan Natural Heritage Program database maintains records: 88 from 36 counties: George E Burgoyne, Jr. Wildlife Division, State of Michigan Department of Natural Resources, 3 December 1990
Minnesota:	designated as a special concern species under Minnesota Statute 84.0895, but not protected by law. The right of counties to offer a bounty for rattlesnakes was, however, rescinded in 1989: Bonita Eliason, Minnesota Department of Natural Resources, 26 November 1990.
Missouri:	all state populations listed as Endangered in State Rare and Endangered list: all species listed are protected by having a closed season: Tom R. Johnson, Missouri Department of Conservation, 3 December 1990.
New York:	listed as an Endangered species since 1983 under the Environmental Conservation Law (ECL 11-0535: Alvin Breisch, New York State Department of Environmental Conservation, 30 November 1990.
Ohio:	listed by Ohio Department of Natural Resources as a species of "special interest" not included in "Endangered" category, the only category with force of law behind it: Charles Manger, Ohio Department of Natural Resources, 26 November 1990.
Pennsylvania:	Endangered under Pennsylvania Fish Commission Regulations 1990: Penalty for violation is a fine of not less than $250 nor more than $5000, or imprisonment not exceeding 90 days, or both. An additional fine of $10 per each animal illegally taken, caught, possessed, or sold may be levied: Clark N. Shiffer, Pennsylvania Fish Commission, 6 December 1990. A survey in 1978 found that populations still existed in only 3, possibly 4, of 6 counties where it had been historically recorded (Genoways and Brenner 1985).
Wisconsin:	Placed on Endangered Species List in October 1975: Robert W. Hay, Wisconsin Department of Natural Resources, 26 November 1990.

Table 3. Percent distribution of Massasauga observations by habitat type on Beausoleil Island, 1984 and 1985.

Year	Wetland	Rock Outcrops	Closed Forest	Total observations
1984+	42.3	33.3	24.3	111
1985	52.0	36.3	11.8	204

+ 1984 data based on four individuals, summer (Weatherhead and Hutchinson 1984); 1985 data based on four individuals, July to September 1985 (Linke 1985).

Management Recommendations

- ON FILE WITH RANGE JURISDICTION -