Report to Illinois Department of Natural Resources

Reproductive Ecology of the Eastern Massasauga Rattlesnake (*Sistrurus c. catenatus*)

Submitted by:

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In Fulfillment of the Requirements of the Wildlife Preservation Fund Contract #03-032W

03-032W

Introduction

Many species exhibit geographic variation in reproductive characteristics with extremes often occurring at the periphery of the distribution. While the eastern massasauga rattlesnake (*Sistrurus c. catenatus*) occupies a broad geographic range that extends from southern Ontario and central New York west to Iowa and eastern Missouri (Conant and Collins, 1991; Ernst, 1992), it is only found in relatively small, disjunct, and isolated populations (Reinert and Kodrich, 1982; Seigel, 1986; Weatherhead and Prior, 1992). Studies on its reproductive potential have revealed considerable variation across its range (Reinert, 1981). For example, the female reproductive cycle has been reported as annual in Illinois and Wisconsin (Bielema, 1973; Keenlyne, 1978) and biennial in Pennsylvania and Missouri (Rienert, 1981; Siegel, 1986) while reports of the average brood size vary from 6.35 in Missouri (Seigel, 1986) to 13.3 in Ontario, Canada (Parent and Weatherhead, 2000).

Carlyle Lake is located in central Illinois and is at the southern range limit for this subspecies. The activity season begins in late March and may extend well into December (C. A. Phillips unpublished data). It can be approximately twice the duration of the northern limit, which occurs in southern Ontario where the activity season generally lasts from May to October (Parent and Weatherhead, 2000). Snakes at the southern range limit therefore have a considerable time advantage in sequestering resources to be allocated toward growth, maintenance and reproduction. Therefore, if the massasauga exhibits differences in reproductive characteristics over its range, these differences should be detectable between populations occurring at the southern and northern range limits.

Like many other pitviper species, habitat destruction and blatant persecution are the primary factors in a range-wide decline of the massasauga (Greene and Campbell, 1992; Szymanski, 1998). It is threatened with extinction in Canada and a candidate for federal listing in the United States (U.S. Fish and Wildlife Service, 1999). Because of its current status the general welfare of this species is cause for concern and measures have been implemented to arrest the decline until effective conservation and recovery programs can be devised. However, little information exists on which to base such programs. Here, I report on average brood size, changes in number of offspring throughout gestation, and gross stages of reproductive development at the southern range limit with the hope it will aid management and conservation measures.

Materials and Methods

We located snakes through random visual searches at potential and known hibernacula during spring egress and incorporated snakes encountered by Illinois Department of Natural Resources (IDNR) and U.S. Army Corps of Engineer (ACE) personnel. Most snakes were processed in the field and released within a few minutes of encounter, however some individuals were held up to forty-eight hours for transmitter implantation. Individuals were sexed by cloacal probing for the presence of hemipenal pockets (Schaefer, 1934). The following morphological variables were recorded for all new individuals encountered and individuals recaptured at least thirty days from their previous capture: snout-vent length (SVL) and tail length (TL) to the nearest mm with a flexible tape, number of subcaudal scales (SSC), number of rattle segments, and mass to the nearest gram with Pesola® pull spring scales or an Ohaus® electronic balance. We individually marked snakes by ventral scale clipping (modified from Brown and Parker, 1976). Snakes with an SVL greater than 20 cm were administered passive integrated transponder (PIT) tags to serve as a permanent source of identification. Photographs of the saddle pattern were taken of each individual to serve as a backup means of identification and the rattle segments were painted with nail polish in unique color combinations to allow identification from a distance without disrupting the individual's behavior. All snakes were released at their point of capture.

We used radiotelemetry to monitor free-ranging massasaugas throughout the activity season, including gravid females. Transmitters were purchased from Holohil Systems Ltd. (model SB-2T). Transmitters accounted for approximately only 3 percent of the snake's mass. Surgical implantations were performed by St. Louis Zoological Park personnel at the park's Animal Hospital generally following the guidelines proposed by Reinert and Cundall (1982). The anesthetic was administered orally as a gas and sterile conditions were maintained throughout the operations. Snakes were administered an antibiotic, held overnight for observation following implantation and released at their point of capture. After release, we used an LA12-Q receiver from AVM instruments with a hand-held three-element collapsible yagi antenna to locate individuals. Individuals were located once daily throughout the activity season. Additionally, gravid females were ultrasonographed by St. Louis Zoological Park approximately twice monthly throughout the gestation period to monitor the number of viable offspring and their stage of reproductive development. We classified four stages of reproductive development (vitellogenic oocytes, heartbeats, skeletal formation - coiled and skeletal formation - elongated) and one non-reproductive stage (non-vitellogenic oocytes). Gravid females were brought into captivity shortly before parturition to obtain the number born and amount of investment.

Results

Gravid females emerged from hibernation in early April with enlarged vitellogenic oocytes (Figure 1). Heartbeats were evident by the end of May (Figure 2). Early skeletal formation (coiled) was observed in early July (Figure 3) and embryos were elongated (Figure 4) and subsequently passed by late July and early August. Estimated brood size at emergence via ultrasound, 7.5 ± 1.7 (n=30), was higher than the actual number born, 6.7 ± 2.9 (n=10) though not significantly so (p=0.428). Females lost an average of 43.6% ± 10% (24.4 – 55.5%, n=9) of their mass after parturition.

Discussion

Gravid females emerge from hibernation in late March and early April with enlarged vitellogenic oocytes. Then sperm deposited from matings in the previous fall is likely used in fertilization. Heartbeats become evident by the end of May. Early skeletal formation (coiled) becomes apparent in early July, and by late July the embryos are elongated. Parturition in occurs in late July and into early August. After parturition females enter a non-reproductive state marked by non-vitellogenic oocytes (Figure 5). A graphical representation of this cycle can be seen in figure 6.

Average brood size at the southern range limit in Carlyle Lake (6.7) was below the species' average (8.8) but is representative of southern populations (Table 1).

Early season brood size estimates via ultrasound were not significantly different than actual brood number, however they were approximately one embryo larger. Possible sources of this discrepancy include technician error and technological limitations, counting unfertilized ova with viable offspring, reabsorbtion of developing offspring and not passing all developed offspring.

Females apportioned nearly half of their body mass to reproduction, approximately 7% per offspring. Such an extreme weight fluctuation has implications for post-parturitional survival. No female was observed to give birth in consecutive years which suggests at least a biennial reproductive cycle.

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Table 1: Geographic comparisons of brood size.

Location	Size	Authority
Ontario, Canada	13.3	Parent and Weatherhead, 2000
Wisconsin	11.1	Keenlyne, 1978
New York	9.8	Johnson, 1995
N. Illinois	9.5	Wright, 1941
Ohio	9.0	Watkins-Colwell, 1995
Indiana	7.0	Adler, 1960
Carlyle	**6.7**	**This Study**
Pennsylvania	6.5	Reinert, 1981
Missouri	6.4	Seigel, 1986
AVERAGE	8.8	

Figure 1: Vitellogenic oocytes

Figure 2: Heartbeats

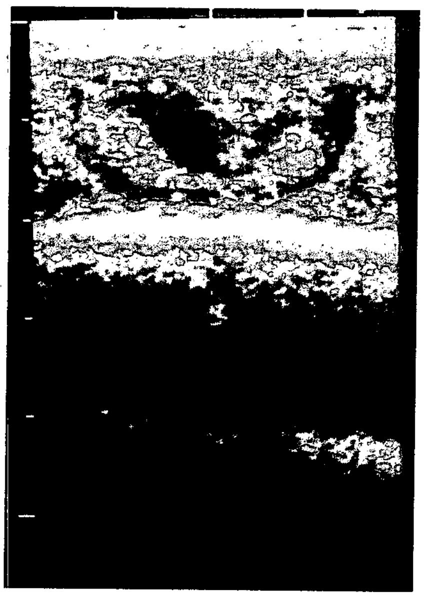

Figure 3: Skeletal (Coiled)

Figure 4: Skeletal (Elongated)

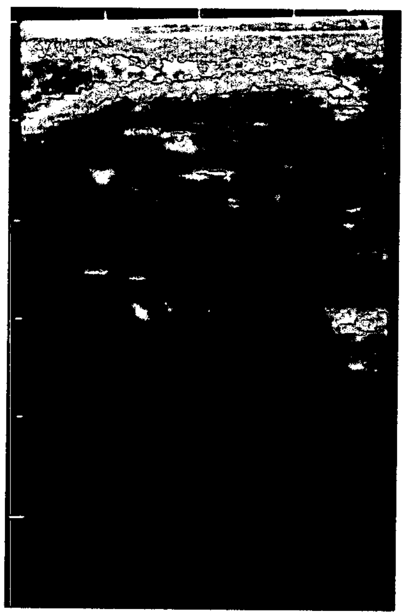

Figure 5: Non-vitellogenic oocytes

Figure 6: Stages of reproductive development