LONGTERM MARK-RECAPTURE STUDY OF A SOUTHERN ILLINOIS POPULATION OF TIMBER RATTLESNAKE

FINAL REPORT

by

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OBJECTIVES

1. Summarize eight years of timber rattlesnake natural history data collected at a study site in Jackson County, Illinois, including: weight, length, and sex ratio of neonates; population size, sex ratio, growth, shedding rates, and age at maturity;
2. Collect a ninth year of data by locating, capturing, measuring, weighing, marking, and releasing individuals emerging from and re-entering the same den complex;
3. Locate and capture gravid females and hold them in captivity until they give birth, then weigh, measure, and release each mother and her young where she was captured.

INTRODUCTION

Because of habitat loss and years of persecution by humans, the state-threatened timber rattlesnake (*Crotalus horridus*) has declined in distribution and abundance throughout its range in eastern United States and in Illinois. Many aspects of the snake's biology, including growth and age at maturity, vary geographically. Protection, conservation, and longterm management of timber rattlesnake populations in Illinois will require information on natural history attributes of the species within the state. The following account of field work carried out during 2005-2006 and summary of nine year's worth of information on one population are steps toward those goals.

SUMMARY OF AUTUMN 2005-SPRING 2006 FIELD EFFORT

by

John G. Palis

Using the same methodology as described in the following pages, I captured 21 timber rattlesnakes in 24 field days from 12 August 2005 through 18 April 2006. Meristic data obtained from these individuals are included in the nine-year summary report that follows.

Trip Number	Date	Number of Snakes Captured
1	12 August 2005	0
2	16 August 2005	0
3	24 August 2005	1
4	28 August 2005	0
5	31 August 2005	0
6	5 September 2005	0
7	19 September 2005	1
8	21 September 2005	0
9	30 September 2005	1
10	2 October 2005	1
11	12 October 2005	1
12	18 October 2005	0
13	13 March 2006	1
14	29 March 2006	2
15	31 March 2006	1
16	1 April 2006	0
17	5 April 2006	2
18	7 April 2006	1
19	10 April 2006	4
20	11 April 2006	3
21	12 April 2006	0
22	13 April 2006	1
23	14 April 2006	1
24	18 April 2006	0
Total snakes		21

SUMMARY OF NINE YEARS OF TIMBER RATTLESNAKE NATURAL HISTORY DATA FROM A STUDY SITE IN SOUTHERN ILLINOIS

by

Ronald A. Brandon, Scott R. Ballard, and John G. Palis

METHODS

Study Area

The study area is at the southern end of a forested, rocky ridge above a tributary of the Big Muddy River in Jackson County, Illinois. Near the top of the ridge are rock outcroppings with southern, western, and southwestern exposures. Crevices in these outcrops are used as hibernacula and the exposed rocks serve as basking and birthing sites.

Searching for Rattlesnakes

During the spring, late summer, and autumn, the den complex and adjoining hilltop and hillside were searched for rattlesnakes emerging or basking on the surface of the soil, on rocks, on or within leaf litter, or sheltered beneath protruding rocks or within logs. Sites where pregnant females or newborns were observed were noted and marked. Whenever possible, snakes were captured and examined. Pregnant females found in late summer were kept in captivity until they gave birth, then returned with their young to the spot where captured.

Data Recording

Captured snakes were placed in a 5-gallon plastic bucket with lid or picnic cooler and moved indoors for processing. Except for pregnant females being held in captivity until

giving birth (5 to 36 days), examined snakes were returned to their point of capture within 1-5 days. Mothers and their young were released after the neonates had shed for the first time.

While being examined, snakes were restrained in lengths of plastic tubing of appropriate diameters or held under a flat sheet of clear Plexiglas. Data recorded were sex, relative age, unique identifying mark (if recaptured), length excluding the rattle, and weight. Sex was determined by probing the base of the tail for presence or absence of hemipenes. Relative age was expressed as neonate, juvenile, subadult, and adult. A unique combination of ventral scutes was clipped on each individual for future identification and the basal 1-3 segments of the rattle were painted with fingernail polish. The marked segments allowed us to count the number of sheds between captures, from which we calculated the number of months between sheds. Snake length was measured to the nearest millimeter by gently restraining the animal on a towel under a rigid sheet of clear Plexiglas (0.6 X 0.55 m), tracing its body (excluding the rattle) onto the Plexiglas with a wax pencil, laying dental floss along the waxed line, and then measuring the length of the dental floss on a meter stick or meter tape. Each individual was weighed with a Pesola hanging scale of the appropriate capacity: 50 g (accurate to 0.5 g), 100 g (accurate to 1 g), 500 g (accurate to 5 g), or 2500 g (accurate to 20 g). Some neonates were weighed on an Ohaus electronic balance (accurate to 0.1 g). Information on fecundity was obtained by holding pregnant females in captivity until they gave birth.

RESULTS

Population Size

We observed 170 individual timber rattlesnakes, 30 (17.6%) of them more than once, during the nine years and seven months between September 5, 1996, and April 18, 2006 (Tables 1 and 2). Of the total, 73% were neonates when first observed, 8.2% were juveniles, 3.5% subadults, and 15.3% adults. Ninety-six (77.4%) of the 124 neonates were from ten litters born to females kept briefly in captivity (Table 3) and were released with their mothers; the remaining 28 (22.6%) were first observed in the wild.

Sex Ratio

The overall sex ratio among all observed rattlesnakes was essentially 1:1 (1:1.05 male to female) but skewed toward males (2.3:1) among juveniles and toward females (1:2.7) among adults (Table 1). However, in 28 wild-caught neonates and 96 born in captivity sex ratios were closer to equality (Table 3). The female-bias among adults is likely explained by the relative ease of locating pregnant females. When the nine pregnant females are removed from the sample, the sex ratio among adults (7 males, 10 females) is closer to parity.

Growth

Estimates of rates of growth in body length and in weight were obtained from marked/recaptured individuals (Tables 4 and 5). Twelve growth estimates from eight adult females ranged from -0.33 to 0.97 cm/month (mean = 0.09) over periods of 4 to 60 months (Table 4). Two juvenile males grew 0.21 and 0.52 cm/month (mean = 0.37) (Table 4). Eight individuals marked as neonates grew 0.4 to 3.7 cm/month (mean = 1.3) over periods of 6 to 102 months (Table 5). One exceptional female gained 30.9 g/mo

over 27 months (Table 4). She had regained weight lost after giving birth two years earlier, when she was weighed post-partum. Three other adult females grew -0.5 to 6.0 g/mo (mean = 3.3) over periods of 13 to 48 months. Nineteen weight increases of 17 individuals marked as neonates ranged from -0.6 to 17.6 g/mo (mean = 3.4) over 1 to 102 months (Table 5).

Growth rate varied among age classes. Neonates grew rapidly (an average of 1.3 cm/month), adults grew slowly (0.09 cm/month), and juveniles grew at an intermediate rate (0.37 cm/month). The trend towards reduced growth as snakes mature partially reflects a diversion of energy reserves from growth to reproduction

Activity Season

During the years 1995-2006, rattlesnakes were observed in the vicinity of the dens from March 13 through May 5 and from August 10 through November 17 (Table 6).

Recapture Rates

Of the 30 marked and recaptured individuals, 21 were recaptured once, 8 twice, and 1 three times (Table 2). A striking result is that all recaptured adults were females, whereas neonate males and females were recaptured at equal frequency. Nine recaptured individuals, all of them females, had been marked originally as adults, 1 had been marked as a subadult male, 2 as juvenile males, 9 as neonate males, and 9 as neonate females. Overall, 34.6% of marked adults were recaptured, 16.7% of subadults, 14.3% of juveniles, and 14.5% of neonates. Number of months until recapture ranged from less than one to 96 (mean = 18.2) (Table 2).

Shedding Rates

The basal segments of the rattle had been marked with fingernail polish so that when the snake was examined later the number of rattle segments proximal to the marked segment would represent the number of sheds during the intervening months. Data are available from 20 recaptures after at least one year. The number of months between sheds averaged 9.5 and ranged from 6 to 13 (Table 7). Thus, snakes shed an average of 1.26 times per year (ranging from 1-2 sheds per year).

Age at Maturity

An estimate of age at maturity was obtained for two adult females (#s 20-22 and 24-25). Each snake exceeded 88 cm in length and had complete rattles (7 segments plus a button). Age at maturity for these individuals was approximated using the average shedding rate for our population (once per 9.5 months) and our observation that pregnant females in this population are ≥ 84.7 cm in length. Assuming these two females shed at the average rate for this population, they would have been approximately 66.5 months or 5.5 years old when captured. The previous fall when they could have first bred would make them 5 years old at their first reproductive effort.

Birth Season

Ten females captured and held in captivity for 36 days or less (5-36 days, mean = 19) gave birth between August 31 and September 25 (Table 2).

Litter Size

Litter size of young born in captivity to ten females ranged from 6 to 14 and averaged 9.2 (Table 2).

Length and Weight of Newborn

Neonates ranged in length from 32.4 to 39.4 mm (mean = 35.1) and weighed 20.4 to 34.1 grams (mean = 27.7) (Table 1) and had grown little if any over their first winter. Six neonates observed in March and April were 33.3 to 36.6 (mean = 35.1 mm long and weighed 23.0 to 31.2 (mean = 27.3) g. Neonate males and females did not differ significantly in either length or weight (Table 8).

Table 1. Summary of individual *Crotalus horridus* observed and marked at the study site between September 5, 1996 and April 11, 2006. Lengths and weights shown are those recorded the first time the snakes were examined.

	Total	Males	Females	Sex ratio (M:F)	Length (cm) range (mean, N)	Weight (g) range (mean, N)
Neonates	124	62	62	1:1	32.4-39.4 (35.1, 120))	20.4-34.1 (27.7, 112)
Juveniles	20	14	6	2.3:1	42.9-87.0 (64.3, 20)	50.0-320.0 (166.8, 19)
Adults	26	7	19	1:2.71	81.3-130.0 (102.2, 25)	248-1325 (675.4, 15)
Total	170	83	87	1:1.05		

Table 2. Number of months between first captures and recaptures of 30 timber rattlesnakes observed more than once at the study area between 1996 and 2006. Abbreviations are: adult (A), female (F), pregnant (P), male (M), juvenile (J), subadult (S), and neonate (N).

Animal number	Sex & age	Months to recapture
9	AF	59
		2
		32
14	AF	4
15	AF	60
		12
17	AFP	8
		12
55	SM	1
56	NF	1
57	AF	17
59	AF	59
61	AFP	48
		27
20-21	JM	13
		6
21-23	JM	6
24-25	AF	13
25-27	AF	1
34	NF	12
		1
37	NF	7
		96
40	NM	1
42	NM	7
43	NM	7
56	NF	1
		6
1-10	NM	8
1-11	NF	6
4-5	NF	26
21-29	NF	7
22-26	NF	35
		13
23-30	NM	30
23-40	NF	31
23-44	NM	7
23-46	NM	30
23-53	NM	7
23-54	NM	7

Table 3. Information on 10 litters born to females held in captivity.

Female number	Size of litter	Date female captured	Date offspring born	Males	Females
9	6	8/14/01	9/?/01	3	3
14	10	8/22/97	9/25/97	5	5
16	9	8/30/97	9/18/97	6	3
17	8	8/30/97	9/13/97	5	3
18	6	9/4/97	9/17/97	5	1
19	8	9/4/97	9/13/97	4	4
59	9	9/4/03	9/13/03	4	5
61	14	8/26/99	8/31/99	3	11
61	14	8/10/03	9/14/03	10	4
23-31	8	8/10/03	9/15/03	2	6
Mean =	9.2			49	47

Table 4. Average monthly growth rates in length and weight of marked and recaptured juveniles, subadults, and adults. Individuals are coded as adult females (AF), pregnant female (PF), and juvenile males (JM).

Animal number	Sex	Date marked	Initial length (cm)	Initial weight (g)	Date recaptured	Final length (cm)	Final weight (g)	Length change cm	Weight change (g)	Elapsed months	Growth/mo. (cm)	Growth/mo (g)
9	AF	9/22/96	81.3	-	8/14/01 P	87.3	287.0	6.0	-	59	0.10	-
					4/18/04	93.0	480.0	5.7	193.0	32	0.18	6.0
14	AF	4/11/97	104.1	-	8/22/97 P	103.2	-	-0.9	-	4	-0.23	-
15	AF	4/15/97	101.6	-	4/10/02	109.4	-	7.8	-	60	0.13	-
					4/11/03	107.0	320.0	-2.4	-	12	-0.20	-
17	PF	8/30/97	108.0	742.8	4/19/98 P	105.4	-	-2.6	-	8	-0.33	-
					4/20/99	117.0	-	11.6	-	12	0.97	-
57	AF	4/19/98	98.0	-	9/8/99	98.0	-	0.0	-	17	0.00	-
59	AF	9/25/98	86.6	-	9/4/03 P	102.2	455.0	15.6	-	59	0.26	-
61	PF	8/26/99	120.6	791.3	8/10/03 P	122.5	1005.0	1.9	213.7	48	0.04	4.5
					10/18/05	122.4	1840.0	-0.1	835.0	27	0.00	30.9
20-21	JM	10/12/00	68.3	177.0	10/31/01	71.0	201.0	2.7	24.0	13	0.21	1.8
					4/1/02	-	184.0	-	-17.0	6	-	-2.8
21-23	JM	4/6/01	54.6	112.0	10/21/01	57.7	114.0	3.1	2.0	6	0.52	0.3
24-25	AF	8/22/04	90.0	487.0	9/30/05	92.3	480.0	2.3	-7.0	13	0.18	-0.5
										Mean	0.13	5.7
										Minimum	-0.33	-2.8
										Maximum	0.97	30.9

Table 5. Average monthly growth rates in length and weight of individuals marked as neonates.

Animal nunber	Sex	Date marked	Initial length (cm)	Initial weight (g)	Date recaptured	Final length (cm)	Final weight (g)	Length change (cm)	Weight change (g)	Elapsed months	Growth/mo (cm)	Growth/mo. (g)
25	M	9/13/97	32.5	26.5	9/8/98	-	28.5	-	2.0	12		0.2
34	F	9/13/97	35.0	29.0	9/25/98	58.5	148.0	23.5	119.0	12	2.0	9.9
37	F	9/18/97	32.5	25.0	4/11/98	-	32.0	-	7.0	7	-	1.0
					4/14/06	99.6	470.0	67.1	438.0	95	0.7	4.6
42	M	9/18/97	34.8	25.5	4/11/98	-	30.0	-	4.5	7	-	0.6
43	M	9/18/97	32.8	24.8	4/2/98	-	26.5	-	1.7	7	-	0.2
1-10	M	9/25/97	35.0	28.3	5/5/98	-	38.5	-	10.2	8	-	1.3
1-11	F	9/25/97	38.8	30.8	3/29/98	-	27.5	-	-3.3	6	-	-0.6
56	F	4/11/98	33.9	23.0	5/16/98	-	40.0	-	17.0	1	-	17.0
					10/21/98	56.2	128.0	22.3	88.0	5	3.7	17.6
4-5	F	9/8/99	34.8	26.0	11/17/01	56.1	79.5	21.3	53.5	26	0.8	2.1
21-29	F	9/?/01	33.4	26.5	4/5/02	-	27.5	-	1.0	7	-	0.1
22-26	F	4/1/02	33.3	23.5	4/13/06	51.2	96.0	17.9	72.5	50	0.4	1.5
23-30	M	9/15/03	34.5	23.6	3/31/06	63.0	126.0	28.5	102.4	30	1.0	3.4
23-40	F	9/13/03	36.3	30.9	4/10/06	66.0	143.0	29.7	112.1	31	1.0	3.6
23-44	M	9/14/03	38.2	33.7	4/16/04	-	32.8	-	-0.9	7	-	-0.1
23-46	M	9/14/03	35.6	28.8	3/29/06	58.1	96.5	22.5	67.7	30	0.8	2.3
23-53	M	9/14/03	36.4	26.9	4/7/04	-	25.9	-	-1.0	7	-	-0.1
23-54	M	9/14/03	36.0	31.2	4/7/04	-	29.3	-	-1.9	7	-	-0.3
										Mean	1.3	3.4
										Minimum	0.4	-0.6
										Maximum	3.7	17.6

Table 6 Observations of timber rattlesnakes at the study site by month and age group, including neonates born to females held in captivity.

	Neonate Males	Neonate females	Juvenile males	Juvenile females	Adult males	Adult females
SPRING						
March	1	1	2	1	-	-
April	2	2	9	2	4	6
May	-	-	-	1	-	-
						?
AUTUMN						
August	3	11	-	-	2	5[a]
September	52	41	1	1	1	6[b]
October	1	7	2	-	-	1
November	3	-	-	1	-	-
	62	62	14	6	7	19

[a] 3 were pregnant
[b] 2 were pregnant

Table 7 Information on rate of shedding for 31 recaptured individuals. Abbreviations are neonate (N), juvenile (J), subadult (S), adult (A), and pregnant female (P).

Snake no.	Sex	Age	Date marked	No. rattle segments	Date recaptured	No. months since capture	No. sheds since capture	Months/ shed
9	F	A	9/22/96	5	8/14/01 P	59	6	9.8
					10/21/01	2	0	>2.0
					4/18/04	32	3	10.7
14	F	A	4/11/97	11	8/22/97 P	4	1	4.0
15	F	A	4/15/97	6	4/10/02	60	7	8.6
					4/11/03	12	1	12.0
17	F	A	8/30/97 P	8	4/19/98 P	8	0	>8.0
					4/20/99	12	2	6.0
25	M	N	9/13/97	button	4/8/98	7	0	>7.0
34	F	N	9/13/97	button	9/25/98	12	2	6.0
					10/15/98	1	-	-
37	F	N	9/18/97	button	4/11/98	7	0	>7.0
					4/14/06	95	8	11.8
40	M	N	9/18/97	button	10/20/97	1	0	>1.0
42	M	N	9/18/97	button	4/11/98	7	0	>7.0
43	M	N	9/18/97	button	4/2/98	7	0	>7.0
1-10	M	N	9/25/97	button	5/5/98	7	0	>7.0
1-11	F	N	9/25/97	button	3/29/98	6	0	>6.0
55	M	S	4/6/98	4 + button	4/11/98	1	0	>1.0
56	F	N	4/11/98	button	5/16/98	1	0	>1.0
					10/21/98	6	2	3.0
57	F	A	4/19/98	13	9/8/99	17	2	8.5
59	F	A	9/25/98	4	9/4/03 P	59	?[a]	-
61	M	A	8/26/99 P	13	8/10/03 P	48	4	12.0
					10/18/05	27	3	9.0
4-5	F	N	9/8/99	button	11/17/01	26	3	8.7
20-21	M	J	10/1/00	4 + button	10/30/01	13	1	13.0
					4/1/02	6	0	>6.0
21-23	M	J	4/6/01	2 + button	10/21/01	6	1	6.0
21-25	F	A	8/14/01?	-	4/4/05	44	4	11.0
21-29	F	N	9/1/01	button	4/5/02	7	0	>7.0
22-26	F	N	4/1/02	button	3/9/05	35	?[a]	-
					4/13/06	13	2	6.5
23-30	M	N	9/15/03	button	3/31/06	30	4	7.5
23-40	F	N	9/13/03	button	4/10/06	31	4	7.8
23-44	M	N	9/14/03	button	4/16/04	7	0	>7.0
23-46	M	N	9/14/03	button	3/29/06	30	?[a]	-
23-53	M	N	9/14/03	button	4/7/04	7	0	>7.0
23-54	M	N	9/14/03	button	4/7/04	7	0	>7.0
24-25	F	A	8/22/04	7 + button	9/30/05	13	1	13.0
25-27	F	A	9/19/05	9	10/2/05	<1	0	>1.0
					Mean	18.9	1.6	9.5
					Minimum	<1	0.0	6.0
					Maximum	96	8.0	13.0

[a] Rattle incomplete

Table 8. Comparison of neonate timber rattlesnake lengths and weights by sex.

	Male length (cm)	Female length (cm)	Male weight (g)	Female weight (g)
Mean	35.3	34.9	28.9	27.4
S.E.	0.189	0.234	0.376	0.379
Median	35.0	34.4	28.0	27.2
Mode	35.0	34.4	27.5	26.5
Minimum	32.4	32.4	20.5	20.4
Maximum	38.6	39.4	33.7	34.1
N	56	56	58	62