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A NON-DISRUPTIVE ASSESSMENT OF A SOUTHERN ILLINOIS SNAKE DEN 60 YEARS AFTER CONWAY

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ABSTRACT. The composition of a snake community and the rate at which snakes were observed at a southern Illinois den complex was examined during autumn 2003–2008. These observations were compared with the snake community and rate at which snakes were observed in autumn 1946. On 18 October 1946, 113 snakes, comprised of eight species, were observed at a rate of 3.76 snakes per person-hour. During eight visits from 1 October through 3 November 2003–2008, 251 snakes, comprised of 11 species, were observed at an average rate of 4.71 snakes per person-hour. Three species: cottonmouth (*Agkistrodon piscivorus*; 49.8%), rough green snake (*Opheodrys aestivus*; 15.9%), and gray ratsnake (*Pantherophis spiloides*; 10.7%) comprised 76.5% of snakes encountered from 2003–2008. Cottonmouths were also abundant in the 1940s. Although the snake detection rate between 1946 and 2003–2008 was similar, estimation—and thus comparison—of historic and contemporary snake population sizes was not possible.

Keywords: Snakes, snake den, hibernaculum, Illinois, cottonmouth, *Agkistrodon piscivorus*

In the northern hemisphere, especially at higher elevations or latitudes, snakes often congregate at communal dens for hibernation (Gregory 1984). Dens are frequently used by a mixed-species assemblage (Woodbury 1951; Carpenter 1953; Parker & Brown 1973), and individual snakes often exhibit den fidelity, returning to the same den in successive years (Woodbury 1951; Brown & Parker 1976). Snakes congregating at communal dens are vulnerable to over-collection (Galligan & Dunson 1979; Furman 2007) and persecution by humans (Cagle 1942; Klauber 1972; Parker & Brown 1973). In addition, snake dens have been subject to destructive activities such as blasting with explosives or burying with fill (Klauber 1972; Yeo & Peterson 1998).

Communally-denning snakes typically congregate in dens on rocky west- or south-facing slopes (Klauber 1972). Dens can also include burrows made by invertebrates (Carpenter 1953; Kingsbury & Coppola 2000) and mammals (Carpenter 1953; Klauber 1972), or human structures such as old building foundations and garbage dumps (Woodbury 1951; Keller & Heske 2000). In southern Illinois, snake dens occur on rocky slopes throughout the Shawnee Hills Natural Division which stretches westward from the Ohio River to the Mississippi River floodplain (Schwegman 1973). Although historic data are not available for the majority of dens, historic accounts of snake dens in Union and Jackson counties are provided by Cagle (1942), Conway (1978), Ditmars (1937), Minton & Minton (1969), and Oliver (1958). From the 1920s to at least the early 1940s, unknown (but, presumably large) numbers of snakes were removed from these dens by collectors or killed by hunters (Cagle 1942; Oliver 1958; Minton & Minton 1969; Conway 1978). Quantitative descriptions by Cagle (1942) and Conway (1978) indicate the extent of persecution of snakes at dens during this time period. In September 1940, 57 snakes were shot at dens by hunters during a two-hour period (Cagle 1942) and in spring 1945, 200 snakes died during transport to St. Louis following collection at dens (Conway 1978). Cagle (1942) suggested that, as a result of human persecution, snake populations at dens under his observation were severely depleted by the late 1940s.

Cagle (1942) did not provide quantitative data on snake populations at dens other than to describe the extent of the slaughter. Conway (1978), however, provided enough quantitative data to make contemporary comparative snake observations possible. Conway (1978) described a snake-collecting trip he and two companions made on 18 October 1946. He provided a partial

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list of snake species observed, the total number of snakes seen, and amount of time he and his colleagues conducted their search.

The purposes of my study were: 1) use a repeatable, non-disruptive visual encounter technique to determine the contemporary snake observation rate and snake community composition at the same den complex surveyed by Conway in 1946, and 2) compare—where possible—my observations with the historic observations of Conway (1978). Due to gaps in Conway's (1978) data and differences in survey methodology, comparisons between his observations and mine are limited principally to snake observation rate.

METHODS

The study site occurs at the junction of the Lower Mississippi River Bottomlands and the Shawnee Hills natural divisions within the Shawnee National Forest, southwestern Illinois (detailed site information is withheld to prevent exploitation or persecution of snakes). Here, the Lower Mississippi River Bottomlands are characterized by relatively flat topography, periodic flooding, and bottomland forest, whereas the Shawnee Hills are characterized by rugged topography, exposed sandstone bedrock, and upland forest. The den complex occurs at the base of an approximately 91 m tall sandstone bluff adjacent to a forested river floodplain. Snakes hibernate within crevices in the base of the bluff and within the steep, rocky slope immediately below the base of the bluff.

I surveyed snakes occupying the den complex during autumn, one-two times per year, from 2003–2008, either alone or with one or two companions. Due to the sporadic and unpredictable nature of snake activity patterns (Parker & Plummer 1987), as well as variations in weather, the dates of visitation varied from 1 October to 3 November during the six-year study period (median survey date = 14 October). I selected days with a high likelihood of encountering basking snakes (i.e., cloudless, warm days having little or no wind, after a succession of similar days). I surveyed by slowly walking northward along the length of the bluff base, visually scanning the surface (e.g., soil, leaf litter, bluff face, boulders, and tree trunks) for snakes. Because I walked in one direction, snakes were counted only once per survey. I detected cryptic snakes (i.e., hidden within the gap between the soil and the downslope side of boulders or in cracks in, and at the base of, the bluff) with the aid of a flashlight. Due to the sensitive nature of snake dens and the location of the den complex within a protected area, I did not disturb the habitat by lifting cover objects (e.g., logs, rocks; Ministry of Environment, Lands, and Parks 1998). Furthermore, I did not capture snakes, because handling can result in future avoidance of the capture site by snakes (Brown 1993; Diller & Wallace 2002). In addition to searching for basking snakes, Conway (1978) and his companions turned cover objects. They also captured several venomous snake specimens for display at the St. Louis Zoo (Conway 1978). I recorded the time at the initiation and termination of each survey and air temperature (± 1 °C) in the shade at the beginning of each survey. I identified each snake to species and tallied each snake as it was encountered.

Using total search time, number of searchers, and number of snakes encountered, I calculated an hourly per-person snake observation rate for each visit. I used Chi-square analysis to compare the average contemporary snake observation rate with that of Conway (1978). I used Pearson correlations to examine associations between the hourly per-person snake observation rate among years and among surveys and the air temperature at the initiation of each survey, and the hourly per-person snake observation rate among years and among surveys and the mean daily high temperature (Carbondale, Illinois airport) for the five-day period preceding each survey (determined at www.wunderground.com accessed 17 November 2009). Prior to performing analyses among years, I deleted one visit the two years (2007 and 2008) I surveyed the den complex twice. I randomly deleted one 2007 survey (7 October) and, because it was the only survey I conducted by myself, I deleted the 3 November 2008 survey.

RESULTS

Timed searches, conducted by one-to-three individuals, lasted 2.75–5.0 hours (mean = 3.25 hours) or three to ten person-hours (mean = 6.75 person-hours; Table 1). Searches began between 1130–1445 h CT (median = 1240 h CT) and ended by 1430–1745 h CT (median = 1620 h CT). Air temperature at the start of each survey ranged from 20–30 °C (mean = 24.5 °C).

A total of 251 snakes of 11 species was observed during eight fall surveys from 2003–

Table 1.—Number of snakes observed during autumn 2003–2008 surveys at a den complex in southwestern Illinois.

Species	19-Oct-03	24-Oct-04	14-Oct-05	1-Oct-06	7-Oct-07	21-Oct-07	11-Oct-08	3-Nov-08	Total	% of total
Agkistrodon contortrix (copperhead)	2	1	0	1	0	0	0	0	4	1.59
Agkistrodon piscivorus (cottonmouth)	11	8	12	22	11	9	38	14	125	49.8
Coluber constrictor (racer)	2	5	1	0	1	4	3	2	18	7.17
Crotalus horridus (timber rattlesnake)	2	1	4	1	0	3	1	2	14	5.57
Nerodia erythrogaster (plainbelly water snake)	3	1	0	0	0	0	0	0	4	1.59
Nerodia sipedon (northern water snake)	0	0	0	0	0	1	0	0	1	0.4
Opheodrys aestivus (rough green snake)	13	1	6	5	3	2	7	3	40	15.93
Pantherophis spiloides (gray ratsnake)	9	2	2	3	0	2	3	6	27	10.75
Storeria dekayi (brown snake)	4	0	0	0	0	0	0	0	4	1.59
Thamnophis proximus (western ribbon snake)	2	3	2	1	0	0	1	0	9	3.58
Thamnophis sirtalis (common garter snake)	0	4	0	0	0	1	0	0	5	1.99
										Mean
Total individuals	48	26	27	33	15	22	53	27	251	31.37
Survey hours	3	3.5	5	3.75	2.75	3	2.75	3	26.75	3.25
Snakes per hour	16	7.43	5.4	8.8	5.45	7.33	19.27	9		9.38
Total person-hours	6	7	10	7.5	5.5	6	8.25	3	53.25	6.65
Snakes per person-hour	8	3.71	2.7	4.4	2.73	3.67	6.42	9		4.71
Total snake species	9	9	6	6	3	7	6	5	11	6.37
Air temp @ start (°C)	25	24	20	26	30	25	24	21		24.37

2008 (Table 1). A total of 15–53 snakes was observed per survey (mean = 31.4), comprised of 3–9 species (mean = 6). The snake per-hour observation rate varied from 5.4–19.27 (mean = 9.38), whereas the snake per person-hour observation rate ranged from 2.7–9.0 (mean = 4.71). Conway and two companions observed 113 snakes in 10 hours of snake hunting at this den complex on 18 October 1946, yielding a snake observation rate of 3.76 snakes per person-hour. The contemporary per-person snake observation rate did not differ from the historic per-person snake observation rate ($X^2 = 0.104$, df = 1, $P = 0.747$). The contemporary per-person snake observation rate was not correlated with air temperature at the beginning of each survey among years ($r = 0.472$, $P = 0.345$) or among surveys ($r = -0.392$, $P = 0.337$), nor was it correlated with the preceding five-day mean high temperature among years ($r = -0.032$, $P = 0.951$) or among surveys ($r = -0.411$, $P = 0.312$).

Nearly half ($n = 125$, 49.8%) of all snakes observed were cottonmouths (*Agkistrodon piscivorus*), and cottonmouths comprised 22.9–73.3% of snakes detected on any given survey (Fig. 1). Other frequently observed species include rough green snake (*Opheodrys aestivus*; $n = 40$, 15.9% of total snakes observed) gray ratsnake (*Pantherophis spiloides*; $n = 27$, 10.7%), racer (*Coluber constrictor*; $n = 18$, 7.2%), and timber rattlesnake ($n = 14$, 5.6%). The least frequently encountered species was the northern water snake (*Nerodia sipedon*; $n = 1$, 0.4%). Cottonmouths and rough green snakes were observed during every survey; racers, timber rattlesnakes, and gray ratsnakes were detected during seven surveys (87.5% of surveys); western ribbon snakes (*Thamnophis*

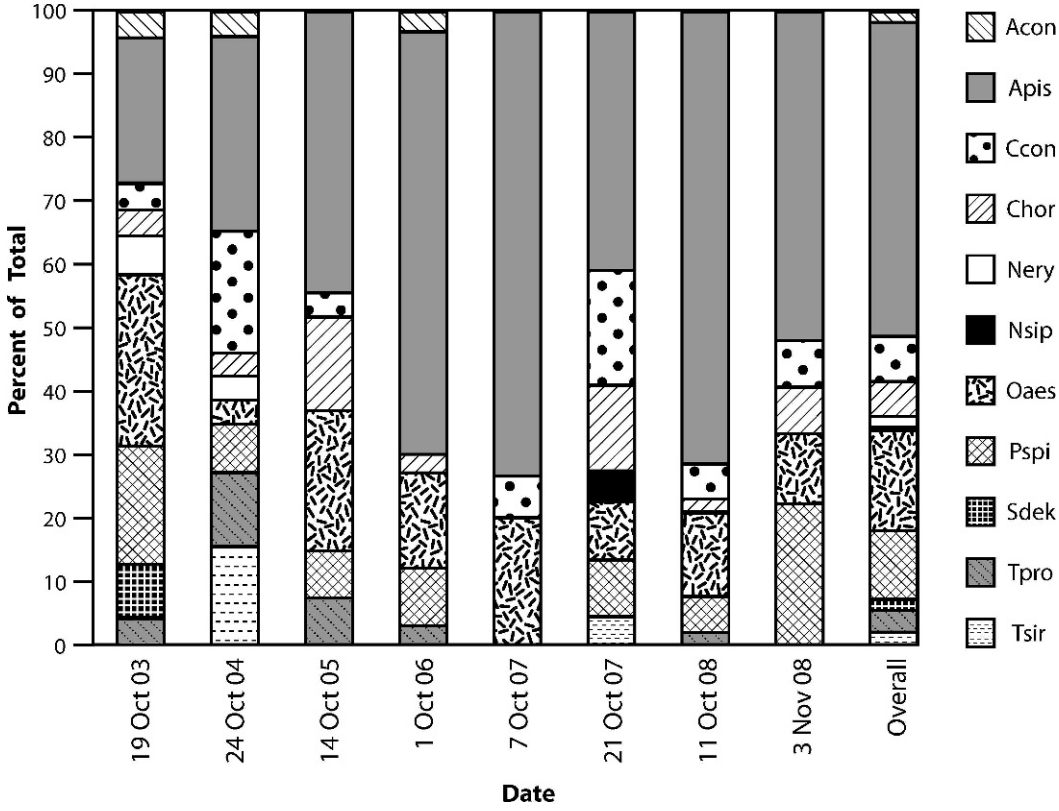

Figure 1.—Percentage of each snake species observed during autumn 2003–2008 surveys at a den complex in southwestern Illinois. Acon = *Agkistrodon contortrix*, Apis = *Agkistrodon piscivorus*, Ccon = *Coluber constrictor*, Chor = *Crotalus horridus*, Nery = *Nerodia erythrogaster*, Nsip = *Nerodia sipedon*, Oaes = *Opheodrys aestivus*, Pspi = *Pantherophis spiloides*, Sdek = *Storeria dekayi*, Tpro = *Thamnophis proximus*, Tsir = *Thamnophis sirtalis*.

proximus) were sighted during five surveys (62.5%); copperheads (*Agkistrodon contortrix*) were encountered during three surveys (37.5%), plainbelly water snakes (*Nerodia erythrogaster*) and common garter snakes (*Thamnophis sirtalis*) were detected during two surveys (25%); and brown snakes (*Storeria dekayi*) and a single northern water snake were sighted during one survey (12.5%).

DISCUSSION

Accurate comparison of the snake community structure between the two time periods is not possible. Although Conway (1978) states that eight snake species were observed, he mentions only six by name: cottonmouth, copperhead, timber rattlesnake, gray ratsnake, water snake (*Nerodia* sp.), and red milk snake (*Lampropeltis triangulum syspila*). In addition, Conway did not present data on numbers of each species observed. However, several statements by Conway (1978) suggest that cottonmouths were abundant then, as they are now (e.g., "during the next hour we counted 39 cottonmouths."). The visual dominance of cottonmouths at this site was echoed by other early observers (Cagle 1942; Oliver 1958). Red milk snakes were not encountered during recent surveys. This is probably best explained by survey methodology. Red milk snakes are highly secretive and are typically found beneath cover objects (Phillips et al. 1999). In addition to visual surveys, Conway & colleagues (Conway 1978) turned cover objects.

Cagle (1942) and Conway (1978) described cottonmouths as abundant at this den complex in the 1940s. The cottonmouth was also the most frequently observed species during my study, and multiple individuals were observed every visit. Rough green snakes, the second

most-frequently observed species, were also detected every visit. The perceived abundance of these two species is likely due to two factors. Both species inhabit wetlands and wetland edges (Anderson 1965; Gloyd & Conant 1990) and the extensive forested river floodplain provides seemingly ideal habitat. In addition, both species were relatively conspicuous while at the den complex. Cottonmouths basked in the open, atop leaf litter or boulders, and rough green snakes were prominent against the bluff face or on bare soil at the bluff base. Three other relatively abundant and frequently observed (i.e., during 7 of 8 surveys) species (racer, gray ratsnake, timber rattlesnake) were also conspicuous as they openly basked atop leaf litter or rocks.

The remaining six species were observed less frequently (1–5 surveys) and in low numbers (1–9 individuals; Table 1). The low detection rate of plainbelly water snakes, northern water snakes, western ribbon snakes, and common garter snakes is perplexing. Like the two most abundant species, these four species utilize wetland and wetland edge habitat. The perceived scarcity of these species may be due to behavioral attributes or seasonal activity patterns. These species may be less likely to bask in the open when at dens than the most frequently observed species. Furthermore, because ribbon snakes and garter snakes are relatively cold-tolerant (Rossman et al. 1996), they may not arrive at the den complex in large numbers until later in the fall. In addition, because these species are capable of hibernating in lowlands (Rossman et al. 1996; Kingsbury & Coppola 2000), many individuals may not overwinter at the den complex. The small number of brown snake observations is likely a function of their diminutive size and, perhaps, their proclivity to remain hidden beneath cover. The dearth of copperhead sightings may be attributable to the paucity of upland habitat near the den complex or to their relative scarcity in southwestern Illinois (Gloyd & Conant 1990). Because Conway (1978) and I focused our efforts on conspicuous individuals (i.e., openly basking) and venomous species, we may have overlooked other snake species that over-winter at this den complex.

The total number of snakes observed by Conway (1978) in mid-October 1946 is 2.1–7.5 times greater than the numbers observed during mid-October surveys 2003–2008. By this metric, it would appear Conway et al. were superior snake spotters or the snake population at this den complex has declined considerably in the intervening 60 years. The similar per-person snake observation rate between the two periods, however, suggests neither is true. Assuming that snake observation rate at dens can be used to estimate snake population size (e.g., Brown 1993), then the snake population has not demonstrably changed at this location from 1946 to the present. However, given the tremendous disparity in the total number of snakes observed (n = 15–53) and snake observation rate (2.7–9.0 per person-hour) during contemporary surveys, despite an effort to keep environmental conditions similar, it appears that snake encounter rate cannot be used as an accurate correlate of snake population size at this den complex. Sizable variation in number of snakes detected and snake observation rate was observed within the same year. In 2008, the number of snakes observed during one survey was nearly double that of the other, and the snake observation rate differed by nearly three snakes per person-hour (Table 1). The cause(s) of variation in the number of snakes observed on or near the surface on any given day is unknown. Because the relationship between the number of snakes observed and actual snake population size is not known, comparison of the size of the historic and contemporary snake populations at this location cannot be made.

This study provides evidence that the snake encounter rate at a southern Illinois den complex has not changed between 1946 and the present. It also provides quantitative data with which to make future comparisons. Snake encounter rates, collected over an extended period of time, can yield valuable estimates of snake population size in certain species (Brown 1993). More precise estimates of snake population sizes at dens, however, are best obtained by enclosing dens with drift fences (e.g., Brown & Parker 1976). An investigation at this southern Illinois den complex that combines the visual encounter technique employed in my study with trapping at drift fences could potentially yield a relationship between snake encounter rate and actual snake population size for select species (e.g., cottonmouth). This relationship could then be used to accurately compare snake population sizes over time using the less intrusive visual encounter technique.

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