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Seasonal Activity of Snakes on a Sand Prairie

Dwight R. Platt
Bethel College, North Newton, Kansas

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Dwight R. Platt
Bethel College, North Newton, Kansas 67117

Abstract. Snakes were caught in drift fence traps throughout the season of activity on a 32 ha sand prairie in Harvey County, Kansas, from 1966 through 1974. In these nine seasons, 128,281 trap station days yielded 6,412 captures of the six most common species of snakes: *Pituophis melanoleucus sayi, Coluber constrictor flaviventris, Thamnophis sirtalis parietalis, Thamnophis radix haydeni, Heterodon nasicus,* and *Heterodon platirhinos*. Seasonal activity patterns, although variable from year to year, had a bimodal pattern with a period of low activity in late July or late August. Increases in snake activity resulted from increases in population size due to recruitment of new snakes or from increases in activity of individual snakes. Activity patterns were related to food abundance and reproductive activity.

Key Words. snakes, seasonal activity, sand prairie, Kansas

INTRODUCTION

Snakes are important predators in many prairie communities. They differ from most mammalian and avian predators in having lower and more flexible metabolic demands. Snakes are most active at optimum times for foraging and reproduction but may remain inactive for parts of the summer. Seasonal activity patterns have been considered important characteristics of the ecological niches of snakes and have been studied for more than 60 years (Brimley 1925, Conant 1938, Klimstra 1958). However, most studies have not differentiated variations in snake activity due to changes in population size from those due to changes in activity of individual snakes.

Gibbons and Semlitsch (1987), in a review of more recent studies, reported two distinct patterns in seasonal activity of temperate zone snakes: unimodal patterns with peak activity sometime between late spring and late summer and bimodal patterns with peaks of activity in spring and in fall. However, they also pointed out that determining general patterns is difficult, because the literature contains few geographic comparisons of the same species or local comparisons of a number of species in the same habitat. The present report describes a nine-year study of the seasonal activity of six species of snakes on a sand prairie in south central Kansas. Data from the nine years are combined to detect general patterns in seasonal activity.

METHODS

The study area, Sand Prairie Natural History Reservation, is a 32 ha (80 acre) grassland on wind-blown sand in the Hutchinson Dune Tracts of western Harvey County, Kansas. It is managed as a natural area by the Biology Department at Bethel College. The upland grass communities are dominated by little bluestem (*Andropogon scoparius* Michx.). The unflooded lowlands have dense tallgrass communities dominated by switchgrass (*Panicum virgatum* L.), sand bluestem (*Andropogon hallii* Hack.), indiangrass [*Sorghastrum nutans* (L.) Nash], and prairie cordgrass (*Spartina pectinata* Link). The depressions between dunes are flooded in wet seasons, forming temporary to semi-permanent ponds and marshes.

From 36 to 120 stations with live traps were operated continuously from late April or early May to late October or early November from 1966 through 1974, except that trapping was partially or completely stopped for a few weeks in August in some years. A trap station consisted of a low metal drift fence with a funnel trap fitted on each end, modified from those described by Fitch (1951). A total of 128,281 trap station days was completed in the nine years of study. A trap station day is the use of one trap station for 24 hours.

Many earlier studies did not standardize or quantify capture effort. Since our traps did not attract snakes but merely intercepted moving snakes, capture rates were calculated as a quantitative index of snake activity. Few snakes were caught before the first of May or after the end of October. Each month from May to October was divided into approximately 15-day trapping periods. For each trapping period capture rates were calculated as the number of captures per 1,000 trap station days (TSD), using the total captures and trapping effort in that trapping period in all nine years. Proportions of sexes or age groups in the sample indicated which groups were more active.

Gibbons and Semlitsch (1982) discussed the use of drift fences with pitfall traps to quantitatively sample populations, and many of their comments apply to the trapping methods used in this study. Not all of the population was equally susceptible to capture, since young snakes of some species escape through the 6 mm mesh of the traps. The data collected pertain to the trappable portion of the population.

RESULTS AND DISCUSSION

A total of 6,412 captures was made of the six species of snakes included in this report: bullsnake (*Pituophis melanoleucus sayi*), 683 captures; eastern yellowbelly racer (*Coluber constrictor flaviventris*), 942 captures; red-sided garter snake (*Thamnophis sirtalis parietalis*), 2,179 captures; western plains garter snake (*Thamnophis radix haydeni*), 2,147 captures; western hognose snake (*Heterodon nasicus*), 373 captures; and eastern hognose snake (*Heterodon platirhinos*), 88 captures.

Bullsnake

Total capture rates of bullsnakes had a bimodal seasonal pattern with a moderate peak in June, a low value in late July, and a high peak in late September (Figure 1). However, there was yearly variation in the pattern. Peak summer activity was in June in six of nine years, but in early May, late May, and late July in the other three. Activity was lowest in late July in four years, but in early July or in August in five years. The fall peak in activity was more consistent, being in late September in seven of nine years.

"Adult size" (Figure 1) includes snakes identified as one year old or older on the basis of size. Bullsnakes hatch in mid-August at approximately 350 mm snout-vent length (SVL) and grow to more than 500 mm SVL by late October (Platt 1984). From late August to late October, adult snakes were identified as those exceeding the hatchling size range. From May to early August adults included all that were greater than 850 mm SVL, the average length at one year (Platt 1984). These larger snakes were more constant in activity through spring and summer, showing some decline in activity in late July (Figure 1). The increase in capture rates of adult size snakes from late July through August was due to the recruitment of first-year snakes into the adult size category. After mid-August the adult size category represented the population included in total captures (adult plus first-year) earlier in the summer. Their activity gradually declined through the fall.

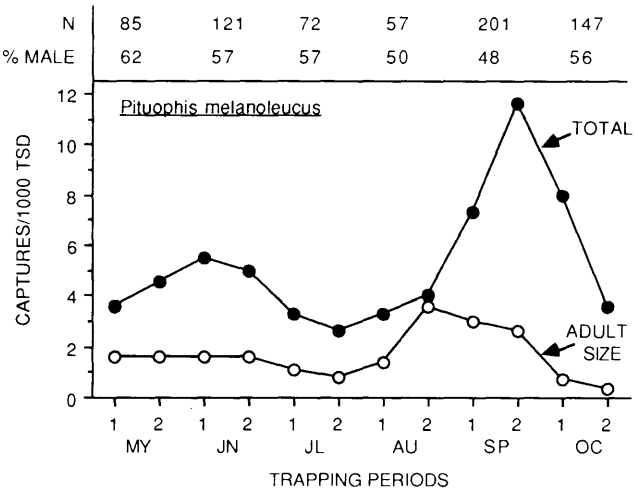

FIG. 1. Capture rates of bullsnakes in half-month trapping periods from May to October averaged over nine years (1966 to 1974). "N" is sample size or total captures in month in nine years. "Adult size" includes snakes one year or older based on size. "TSD" is trap station days.

The fall peak in total captures resulted from the recruitment of hatchlings, which increased the size of the population. These hatchlings were active later in the fall than the older snakes. The peak in June resulted from the activity of first-year snakes that became active later in spring than larger snakes (Figure 1).

The percentages of males in early spring samples of bullsnakes were higher than in later samples (Figure 1), but the difference was not significant (comparison of May sample to July-August sample: Chi-square = 2.45, P = 0.1-0.2). Gibbons and Semlitsch (1987) reported that male snakes are more active in spring when they search for females for mating. However, our research showed little difference between adult and first-year bullsnakes (May: adults 59% males and first-year 65% males; June: adults 62% males and first-year 55% males). Adult females were more active than males in midsummer (July: 38% males), while the percentage of males was higher in the first-year sample (July: 66% males). There was no evidence of increased male activity in the fall. Fitch (1970) reported only spring mating for this snake.

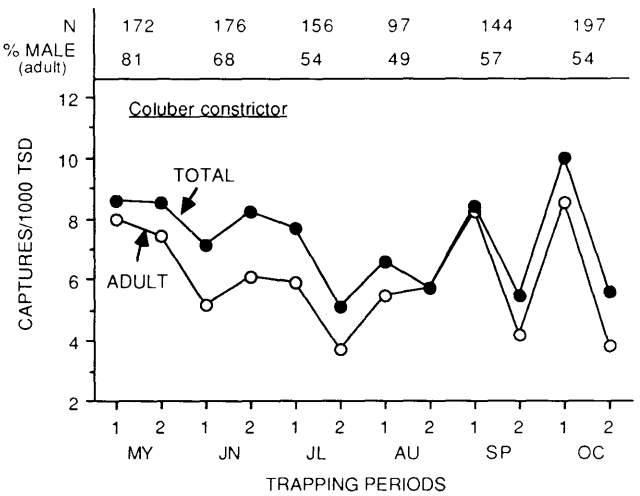

FIG. 2. Capture rates of eastern yellowbelly racers in half-month trapping periods from May to October averaged over nine years (1966 to 1974). "N" is sample size or total captures in month in nine years. "Adult" includes snakes with adult color pattern. "TSD" is trap station days.

Eastern Yellowbelly Racer

Total capture rates of racers had a bimodal seasonal pattern with high numbers in May decreasing to low numbers in late July and August and with high but irregular numbers in the fall (Figure 2). However, in three years capture rates remained high in July and August.

The adult snakes were identified by color pattern which changes gradually from the blotched juvenile to a uniform bluish-gray dorsum at the end of the first year. Young are hatched in late August at approximately 200 mm SVL but are not normally caught in traps until they are more than 300 mm SVL. The total population was often larger than the trappable population that was being sampled.

Few hatchlings were caught in fall, so the high capture rates resulted from high activity of older snakes (Figure 2). Fall is an optimum foraging time because of the abundance of large grasshoppers and crickets, common food items for racers. The decrease in activity in late September occurred in five of nine years, but its meaning is not obvious.

The high capture rate in May resulted in part from high activity of males searching for females (sex proportions in May sample compared to July-August: Chi-square = 56.63, $P < 0.001$). There was no increase in percentage of males in fall samples (Figure 2). Fitch (1970) reported only spring mating for this species.

Garter Snakes

Total capture rates of both species of garter snakes had large seasonal variation (high activity three to seven times low activity) in a bimodal pattern, with peaks in early July and late September or early October and low captures in late August (Figures 3 and 4). However, the plains garter snake had higher activity in early July and less activity in fall.

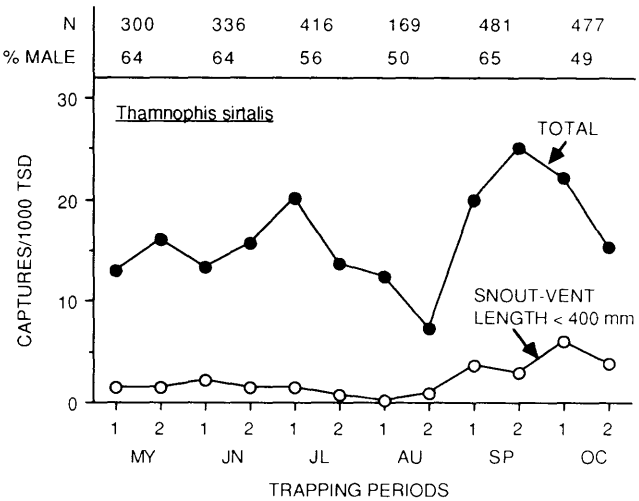

FIG. 3. Capture rates of red-sided garter snakes in half-month trapping periods from May to October averaged over nine years (1966 to 1974). "N" is sample size or total captures in month in nine years. "TSD" is trap station days.

Young garter snakes are 140-179 mm SVL at birth, but few are caught in traps until they are 310-350 mm SVL. Snakes less than 400 mm SVL have recently entered the trappable population. In the red-sided garter snake, some grew to that size by early September, and the high capture rates for this size group were in the fall (Figure 3). Plains garter snakes may be born later and grow more slowly, as young snakes were not caught in substantial numbers until October and were still caught at high rates the following June (Figure 4). Some small snakes were caught throughout the trapping season in both species. Because of variable growth, particularly in different years, first-year snakes cannot be identified in a multi-year sample.

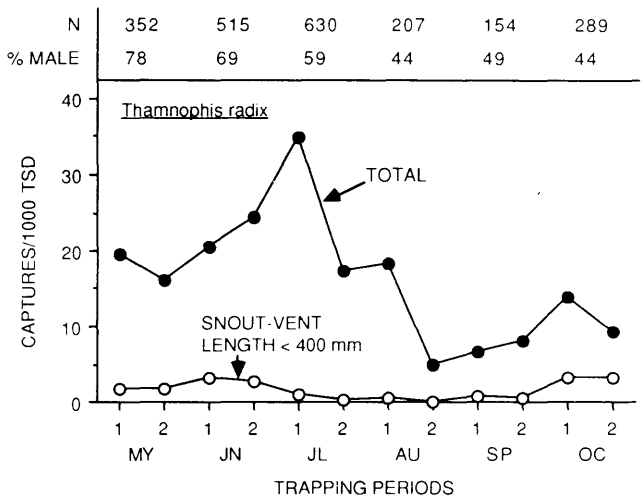

FIG. 4. Capture rates of western plains garter snakes in half-month trapping periods from May to October averaged over nine years (1966 to 1974). "N" is sample size or total captures in month in nine years. "TSD" is trap station days.

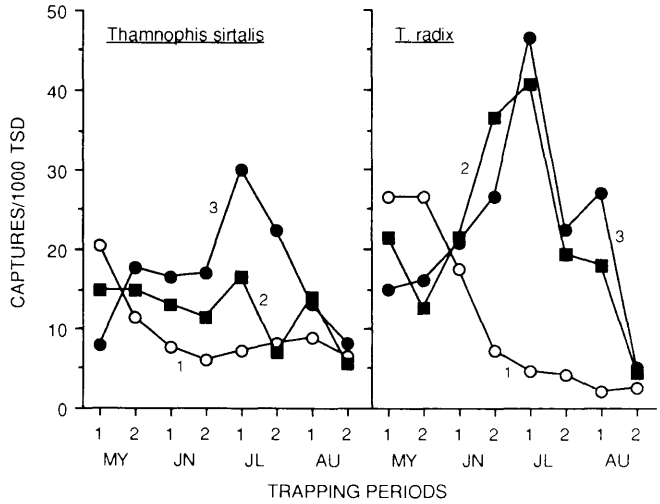

FIG. 5. Capture rates of red-sided garter snakes and western plains garter snakes in three summers (1966, 1967, 1972) with low frog populations (1), in three summers (1968, 1970, 1974) with moderate frog populations (2), and in three summers (1969, 1971, 1973) with very high frog populations (3). "TSD" is trap station days.

The higher percentages of males in samples of red-sided garter snakes from May (comparison of May sample to July-August sample: Chi-square = 11.45, $P < 0.001$), June, and September (comparison of September sample to July-August sample: Chi-square = 22.57, $P < 0.001$) indicate increased male activity and probably both spring and fall mating (Figure 3). Fitch (1970) reported that this species mated in spring and fall. The percentage of male plains garter snakes is significantly higher in May (comparison of May sample to July-August sample: Chi-square = 74.11, $P < 0.001$) but not in fall. Although it has been suggested that these snakes may mate in fall (Fitch, 1970), there is no evidence of fall mating in this study.

The increased activity of red-sided garter snakes in fall resulted from the recruitment of young snakes, causing a larger trappable population, and from increased activity of larger snakes, particularly males. Plains garter snakes showed less activity in fall in this study, because most young snakes were not trappable, and male activity was not increased.

In both garter snakes, the capture rates in early July were variable from year to year (Figure 5). In 1969, 1971, and 1973, precipitation was high, ponds and marshes were flooded for much of the summer, and leopard frog (*Rana blairi*) populations were high (frog captures mid-May to mid-July averaged 1,339 captures per 1,000 TSD). In those years, activity of garter snakes was high in early July when young frogs were metamorphosing and most abundant on the uplands. In 1966, 1967, and 1972, most ponds had dried out by mid-July, and frog populations were low (frog captures averaged 65 per 1,000 TSD). Garter snake activity declined during the summer and was low in early July. The years 1968, 1970, and 1974 were intermediate, with moderate frog populations, but not many on the uplands (frog captures averaged 105 per 1000 TSD). Garter snake activity was high in early July, but less extreme than in the years with abundant frogs. The high activity of garter snakes in early July in most years resulted from increased populations due to immigration (from adjoining lands with less frog habitat) and from increased activity of foraging individuals.

Hognose Snakes

Activity of western hognose snakes was relatively constant from late May to late September, except for a period of low activity in late July (Figure 6). In the years 1959 to 1963, when western hognose snakes in a similar sand prairie habitat were more abundant, the period of low activity was in late August, and less activity occurred in the fall (Platt 1969).

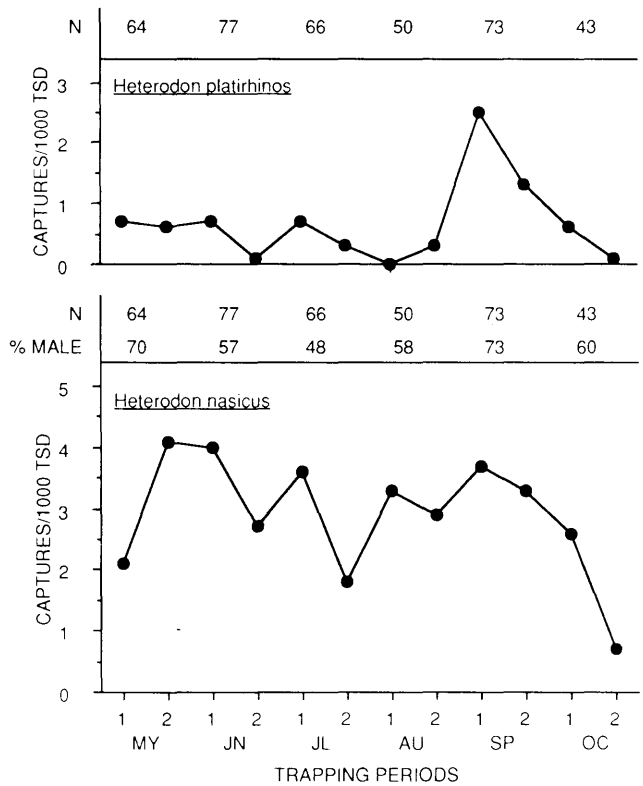

FIG. 6. Capture rates of eastern hognose snakes and western hognose snakes in half-month trapping periods from May to October averaged over nine years (1966 to 1974). "N" is sample size or total captures in month in nine years. "TSD" is trap station days.

Young western hognose snakes are small (approximately 150 mm SVL) at hatching, are seldom caught, and grow slowly. They are recruited into the trappable population over a long period. Snakes less that 250 mm SVL were 10% of the samples caught in September and October, 15% of the sample caught in June, and 2-3% of the samples caught in other months.

Males comprised a significantly greater proportion of the sample in May (comparison of May sample to July-August sample: Chi-square = 8.15, $P < 0.005$) and September (comparison of September sample to July-August sample: Chi-square = 11.71, $P < 0.001$), indicating the probability of both spring and fall mating (Figure 6), as suggested by Platt (1969).

The samples of eastern hognose snakes were too small to determine the summer activity patterns. However, unlike the western species, an activity peak occurred in September. Hatchling eastern hognose snakes are larger (approximately 190 mm SVL) and grow faster (Platt 1969) than hatchling western hognose snakes, and they comprised a sizeable proportion of the fall samples (52% in September and 77% in October).

The samples were too small to reliably determine differential activity of the sexes in spring and summer, but 17 of 23 (74%) large snakes caught in fall were males. Platt (1969) reported evidence of eastern hognose snakes mating in both spring and fall.

CONCLUSIONS

The following general conclusions can be drawn from a comparison of activity patterns of the six species:

1) Different patterns of activity occurred in different species in the same local habitat. These patterns were often related to food abundance and/or reproductive activity.

2) The five species for which there was sufficient data had some modification of a bimodal activity pattern, with a period of low activity in late July in three species and late August in the two garter snakes. The amount of fall activity varied in different species. Fall activity peaks were due mainly to the activity of hatchling bullsnakes but were due to increased activity of both young and old snakes in most other species. Differences were partly caused by trapping methods which did not capture young snakes of some species.

3) In most species, variations occurred from year to year in the pattern of activity. In garter snakes much of this variability was due to changes in prey abundance. Activity patterns adjusted each year to environmental conditions.

4) The more extreme peaks in capture rates were due to increased population size from recruitment of young snakes or immigrants. Resident adult snakes had less variable activity.

5) Male activity was higher in the spring in the five species with large samples, and female activity increased in the middle of the summer. The red-sided garter snake, western hognose snake, and probably eastern hognose snake also had increased male activity in the fall.

6) In bullsnakes and probably in other species, young snakes remained active longer in the fall but resumed activity later in the spring than adults.

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