# Home range and activity patterns of the eastern hognose snake, *Heterodon platyrhinos*, in Upton Ecological Reserve at Brookhaven National Lab

Stephen E. Goodyear

Office of Science, Student Undergraduate Laboratory Internship (SULI)

University of Texas at Austin

Brookhaven National Laboratory

Upton, New York

August 13, 2004

Prepared in partial fulfillment of the requirements of the Office of Science, DOE Science Undergraduate Laboratory Internships (SULI) Program under the direction of Jeremy A. Feinberg in the Environmental and Waste Management Services Division (EWMS) at Brookhaven National Laboratory.

Participant: _____

Signature

Research Advisor: _____

Signature

## Table of Contents


| | |
|---|---|
| Abstract | 3 |
| Introduction | 4 |
| Methods | 5 |
| Results | 7 |
| Discussion and Conclusions | 8 |
| Acknowledgements | 11 |
| References | 11 |
| Tables | 13 |
| Figures | 14 |

**ABSTRACT**

Home range and activity patterns of the eastern hognose snake, *Heterodon platyrhinos*, in Upton Ecological Reserve at Brookhaven National Lab. STEPHEN E. GOODYEAR (University of Texas, Austin, TX 78712) JEREMY A. FEINBERG (U.S. Fish and Wildlife Service and Brookhaven National Laboratory, Upton, NY 11973).

Once thought to have been extirpated from Long Island, viable populations of eastern hognose snakes, *Heterodon platyrhinos*, were rediscovered at Brookhaven Nation Lab in 2001. Since their recent discovery at Brookhaven, intense surveys have extrapolated many valuable data on population size estimates, home ranges, and densities. In this study we used radio telemetry to track and record movements of 12 snakes during two years, movements were mapped using GPS and GIS. In addition to tracing movements, we recorded weekly measurements of weight, snout-vent length, and total length for each snake. Our results confirm that home ranges of individual hognose snakes are extensive and that movement patterns show trends regarding daily and yearly cycles. Estimates of home range sizes are needed to determine the amount of land and types of landscapes necessary to manage viable populations of *H. platyrhinos*. As destructive development continues, intense conservation techniques will be needed to protect *H. platyrhinos* in Pine Barrens habitats of the Northeast USA.

## INTRODUCTION

The genus *Heterodon* (Latreille 1801) includes three species, all which occur only in North America. The eastern hognose snake occurs throughout most of the eastern half of the USA, except for northern New England and most of New York State [1]. Hognose snakes are usually inconspicuous in their grassy or brushy habitat, but when spotted they can perform a rather flamboyant act. Disturbing a hognose snake will usually cause it to fan its neck and hiss loudly, replicating the act of a cobra (except the hognose is, as Abbott wrote, “wholly unable to inflict the slightest injury”) [2]. If harmed or aggravated for long enough the hognose snake will coil, flip belly side up, defecate all over itself and gape its mouth with its tongue left to hang out. The adaptation of death feigning behavior remains unclear, but may have to do with toxins from toads in the feces that protect the snake from predators [3]. Literature on eastern hognose snake behavior and activity is scarce, with most research concentrated in the Midwest (Kansas, Arkansas) [4], [5] and Southern New England [6]. More research must be done, especially in understudied areas (North and Southeast USA), to develop a better understanding of the habitat type and habitat size necessary to sustain viable populations.

Activity patterns and habits are described in several papers [4], [5], [7], [8]. Abbott described *H. platyrhinos* as a “lover of high, dry and dusty fields” [9](1882) as did at least twenty-five other field researchers cited in Platt’s thurough natural history of the hognose snakes [4]. Others have described activiy in *H. platyrhinos.* Platt [4] and Gibbons and Semlitsch [7] described activity patterns of *H. platyrhinos* to be bimodal with peak activity occuring in the spring and fall. Macartney et al. [8] compared home ranges of 33 snakes species and showed the

home range size of *H. platyrhinos* to be the second largest of all North American snakes, next to *Cotalus horridus* (timber rattlesnake). Platt [4] showed the mean distance between captures for *H. platyrhinos* to be more than double compared to the western species, *H. nasicus* (682±100 feet; 277±47, respectively).

In this study we used radio telemetry, GPS and GIS to track and record movements for twelve hognose snakes over two years. Analysis reavealed information on habitat usage, movement patterns and home range. Additionally, conclusions were drawn from this information regarding nesting and hibernation activity. Effective conservation and land management techniques used to protect species such as *H. platyrhinos* rely on basic reasearch in ecology, home ranges and population dynamics, as are revealed in this research.

## METHODS

Research was conducted at the U.S. Department of Energy's Brookhaven National Laboratory in Suffulk Co., New York. The 5,265 acre site is located on Long Island, approximately 100 km east of New York City and mid latitude on the island, 16 km from either the Atlantic Ocean or the Long Island Sound. While these were the limits of our study area, the majority of radio tracking took place within a 1 km radius of the center of the RHIC ring (Relativistic Heavy Ion Collider). The RHIC is a 4 km circumference ion accelerator whose construction from the mid-1970's to early 1990's caused the destruction of many acres of dense pine forests, creating open, sandy, rolling hillside habitats suitable for *H. platyrhinos*. Above the

RHIC ring there is an approximately 10 m high man made berm with some young pines, but mostly thick grass and shrubs. The outside of the ring is encircled by either paved or gravel roads extending into dense pine forests. A paved road circles the central interior of the ring and dense pine forest fills the interior with some dirt roads transversing throughout. The snakes that weren't captured at the RHIC were found either near a dry recharge basin or a wide dirt road/firebreak. Vegatation at the Brookhaven campus reflects that of the Central Pine Barrens, with forests dominated by mature pitch pines (*Pinus rigida*) and oaks (*Quercus* spp.); scrublands dominated by young pitch pines, sensitive fern (*Onoclea sensibilis*), and scrub oaks; and grasslands dominated by various grass species.

Transmitters (Holohil SB-2) were implanted into five snakes in 2003 and nine snakes in spring 2004, including two snakes used in a radio telemetry study in 2003, follwing the procedures of Reinert and Cundall [10] and Raphael et al. [11]. All transmitters were less than 6.1% of each snakes body weight. Snakes were kept for no more than 14 days after transmitter implantation. Snakes were tracked most days, and never left more than two days unattended, during the active season. At each snake's location we plotted a GPS point and recorded time, general location, specific habitat, whether we saw the snake, its activity if any, estimated cloud cover, and climatic conditions (temperature, relative humidity, wind speed). Morphological measurements (weight, length) were taken opportunistically, but no more than once a week per snake. Gut contents, if expelled, were measured, recorded and preserved.

In June 2003 five snakes were implanted with transmitters and released into their respective locations and were thereafter tracked on a daily basis until October 2003. Two snakes

that were tracked in 2003 were recaptured in February 2004 and refitted with new transmitters with fresh batteries. Additionally, seven new snakes were captured between April and May of 2004 and implanted with transmitters, making nine snakes total that were tracked in 2004. Due to casualties involving vehicles, mammals and snakes becoming seperated from their transmitters only three snakes were left by the end of the 2003 tracking season and five snakes by the end of 2004.

GPS points were plotted in ARC View 3.2 GIS software. Home range and movement data compared between male and female snakes were analyzed using a T-test.

## RESULTS

Table 1 presents raw morphometric data, number of days tracked, home range, movement activity and fate for every snake tracked in 2003 and 2004. Snakes are color coded to show those tracked only in 2003, only in 2004 and in both 2003 and 2004. Between the two tracking seasons two snakes were killed, two snakes became separated from their transmitters, two snakes had failing transmitters and the other six snakes were tracked through the entire season without incident.

A map of the research site in [Fig. 1] shows home ranges in minimum convex polygons (MCP) for each snake tracked in 2003 and 2004. Snakes tracked in 2003 are shown with yellow MCPs and snakes tracked in 2004 are shown in red MCPs. All snakes are labeled with their

home ranges shown in hectares. The difference in home range sizes between male and female snakes showed no significant difference (>p = 0.05). The amount of movement as shown in meters moved per active day, not counting days of zero movement, compared between the sexes also showed no significant difference.

Morphometric data collected throughout the summer is plotted on a graph showing weight fluctuations, but only for snakes that survived the entire tracking season of 2004 [Fig. 2]. Overall each snake's weight increased throughout the summer. Hognose snake captures and sighting from reliable sources collected from April 2003 – July 2004 are shown in a histogram in [Fig. 3]. All hognose snake sightings come from April, May, June, September and October. No hognose snakes have ever been captured or sighted in July, August or during the winter at BNL.

Habitat type used by snakes can be shown graphically as in [Fig. 4]. Snakes used open grassy or hillside habitats more than half (55%) of the entire active season in 2004. Other types of habitats including; brush or grass in dense forests, burrows, rocks and man made structures are used almost equally. Habitat usage near man made structures such as building, c-containers, or gas tanks, but not including rip rap, are used the least (8%).

## DISCUSSION AND CONCLUSION

Our data on hognose snake behavior confirms that which is described by Platt [4] and Gibbons and Semlitsch [7] that activity is bimodal with peak activity occuring in spring and fall.

In May of 2003 and 2004, eighteen snakes were captured or sightings confimred, but no snakes were captured or seen in July or August of either year [Fig. 3]. Activity is strongly correlated with mating and hibernacula seeking activity occuring in spring and fall, respectively.

Approximately weekly weight and length measurements taken from each snake show an overall increase in weight during the summer [Fig. 2]. Recording weights was motivated by the possibility of discovering nesting time since females should drop a significant amount of weight if they have laid eggs. None of the female snakes dropped a significant amount of weight to confirm nesting. All weight drops were within the range of the weight of one or two toads in the gut.

The home range map in [Fig. 1] shows the extent of land used by some snakes, including snake I.D. #2 that covered the largest range of 33.8 hectares. The snakes with the four smallest home ranges were tracked for less than 30 days, causing a gross underestimate of their home ranges and the amount of land needed to support an entire life cycle. Their large home range sizes and extensive movements mean that habitats with known *H. platyrhinos* populations need be large and have a diverse landscape. Additionally, habitats must have an abundance of large open spaced grassy fields and slopes, which were shown to be the most preferred habitats [Fig. 4]. Such information on land and habitat usage can be applied to manage and protect sites with known *H. platyrhinos* populations.

This project suffered two confirmed mortalities, two transmitter failures and two incidents of transmitters becoming separated from their respective snakes. Mortalities were

caused by a large truck hitting one of the snakes near a construction site just 28 days after its release and another incident of a mammal or mammals predating on a snake in its burrow just 38 days after its release. Twice in 2003, transmitters failed during the middle of the active season, those snakes were never recaptured. The most inconclusive and confusing failures in the project came from the two incidents of finding clean, unmarked transmitters buried in pine needles or leaf litter without any trace of a snake. We speculated several causes; predation (most likely from an avian predator), expulsion from the incision wound, or most likely absorption and expulsion through the digestive track as described by Pearson and Shine in carpet pythons (*Morelia spilota*) [12]. The loss of snake I.D. #3 was severely detrimental to this project being that it was one of only three males and one of only two snakes that were tracked in both 2003 and 2004.

One obscure side note must be mentioned in regards to this project involving examination of gut contents. During a weekly examination to record weight and length one of the snakes regurgitated a live and healthy spadefoot toad (*Scaphiopus h. holbrookii*) at 1500 h in the afternoon. This finding confirms that *H. platyrhinos*, a diurnal species, is foraging for *S. h. holbrookii*, a nocturnal species, in burrows and under coverboards during the day rather than hunting at night for active *S. h. holbrookii.* The spadefoot toad is still alive and well in a terrarium two weeks since being swallowed by a hognose snake.

## ACKNOWLEDGEMENTS

I thank the U.S. Department of Energy for giving me the opportunity to participate in the SULI program and for providing funding for this research. I am especially grateful to my advisors, Jeremy Feinberg of U.S. Fish and Wildlife and Tim Green of BNL for offering their knowledge, skills and labor to benefit this project. Additionally, I thank all the other SULI or CCI interns in EWMS for spending hot, sunny days in tick infested woods of BNL searching for new snakes. Also, the volunteer surgeries performed by Drs. Paul Calle, Robert Moore and Bonnie Raphael at the Bronx Zoo were imperative to this research project.

## REFERENCES

[1] Conant, Roger and Joseph T Collins. 1998. *Petersons*: Reptile and Amphibians: Eastern and Central North America. Third Edition. pp. 326-328. Houghton Mifflin Company, New York.

[2] Abbott, Charles C. 1884. Science, Vol. 3, No. 56, pp. 253-256.

[3] Zug, G.R., L.J. Vitt, J.P. Caldwell. 2001. Herpetology: An Introductory Biology of Amphibians and Reptiles. Second Edition. pp. 228-229. Academic Press, San Diego, CA.

[4] Platt, D. R. 1969. Natural history of the hognose snakes *Heterodon platyrhinos* and *Heterodon nasicus*. Univ. Kansas Publ. Mus. Nat. Hist. 18:253-420.

[5] Plummer, Michael V. and Nathan E. Mills. 2000. Journal of Herpetology, Vol. 34, No. 4, pp. 565-575.

[6] Michener, Martin C. and James D. Lazell, Jr. 1989. Journal of Herpetology, Vol. 23, No. 1, pp. 35-40.

[7] Gibbons, J.W. and R.D. Semlitsch. 1987. Activity patterns. In R.A. Seigel, J.T. Collins, and S.S. Novak (eds.), Snakes: Ecology and Evolutionary Biology, pp. 396-421. MacMillan, New York.

[8] Macartney, J.M., P.T. Gregory, K.W. Larsen. 1988. A tabular survey of data on movements and home ranges of snakes. J. Herpetol. 22:61-73.

[9] Abbott, Charles C. 1882. Notes on the Habits of the "Savannah Cricket Frog." The American Naturalist. Vol. 16, No. 9.

[10] Reinert, H.K. and D. Cundall. 1982. An improved surgical implantation Method for radiotracking snakes. Copeia, 3: 702-705.

[11] Raphael, B.L., Calle, P.P., Karesh, W., Rivas, J. A., and D. Lawson. 1996. Technique for surgical implantation of transmitters in snakes. Proceedings of the Wildlife Disease Association. 1996: 82.

[12] Pearson, David J. and Richard Shine. 2002. Expulsion of Intraperitoneally-Implanted Radiotransmitters by Australian Pythons. Herpetological Review. Vol. 33, No. 3, pp. 261-263.

## Tables

Table 1 Shows general information for individual snakes. Snakes 2 and 3 have two sets of movements and home ranges for both (2003) / (2004). SVL, total length and weight are taken from measurements at the time of transmitter implantation.

| Snake I.D. | Sex | SVL (cm) | Total Lg. (cm) | Weight (g) | Dates monitored | Movement (m/d) | Home range (ha) | Days tracked (d) | Fate |
|---|---|---|---|---|---|---|---|---|---|
| 1 | F | 51 | 61 | 129 | 6/9/2003 - 10/7/2003 | 60.6 | 10.5 | 121 | hibernated |
| 5 | F | 66 | 79 | 282 | 6/9/2003 - 6/30/2003 | 87 | 1.3 | 22 | lost, transmitter failure |
| 6 | F | 56 | 66 | 227 | 6/18/2003 - 7/14/2003 | 41.5 | 0.8 | 27 | lost, transmitter failure |
| 2 | F | 67 | 80 | 338 | 6/9/2003 - 10/30/2003 and 2/1/2004 - 7/30/2004 | 106.9 / 139.4 | 8.2 / 33.8 | 324 | active |
| 3 | M | 61 | 75 | 241 | 6/9/2003 - 10/30/2003 and 2/1/2004 - 6/22/2004 | 86.1/ 68.4 | 23.3 / 0.4 | 286 | transmitter found without snake |
| 15 | M | 44 | 59 | 135 | 4/27/2004 - 6/1/2004 | 284.6 | 10.1 | 36 | transmitter found without snake |
| 16 | F | 56 | 65 | 196 | 5/4/2004 - 7/30/2004 | 78.9 | 3.6 | 88 | active |
| 17 | F | 68 | 82 | 299 | 5/4/2004 - 7/30/2004 | 98.2 | 12.6 | 88 | active |
| 18 | M | 43.5 | 56 | 82 | 5/7/2004 - 7/30/2004 | 101.7 | 8.2 | 85 | active |
| 21 | F | 43 | 51 | 101 | 5/7/2004 - 7/30/2004 | 100.5 | 6.1 | 85 | active |
| 22 | F | 65 | 72 | 213 | 5/19/2004 - 6/25/2004 | 83.4 | 3.1 | 38 | eaten by mammal(s) |
| 24 | F | 56.8 | 67.4 | 243 | 5/25/2004 - 6/21/2004 | 80.5 | 1.8 | 28 | run over by large truck |

Snakes tracked in 2003
Snakes tracked in 2003 and 2004
Snakes tracked in 2004

## Figures

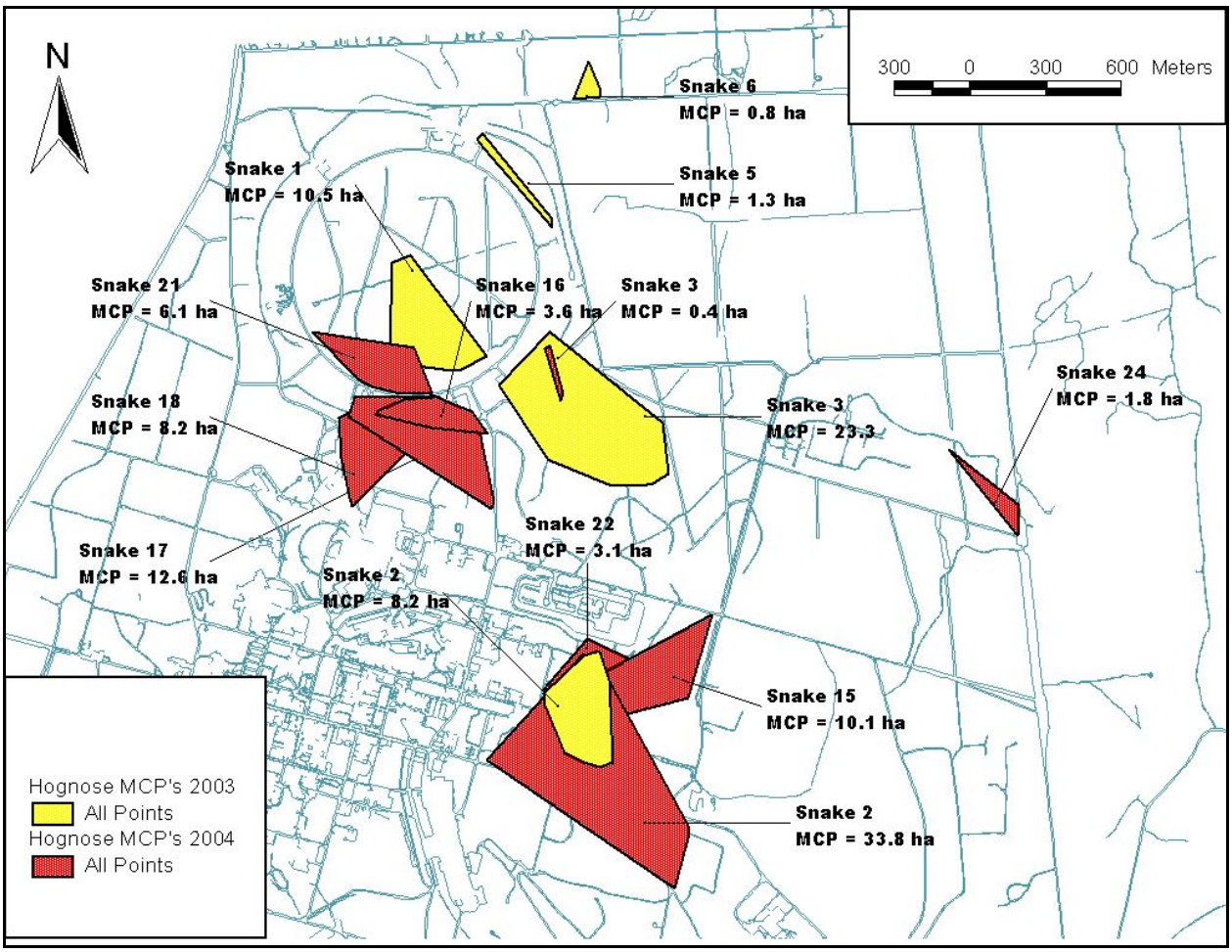


Fig. 1 Shows home ranges including the minimum convex polygon (MCP) for each snake. Map shows the Northwest corner of the research site at Brookhaven National Laboratory. Snake home ranges from 2003 are differentiated from those of 2004.

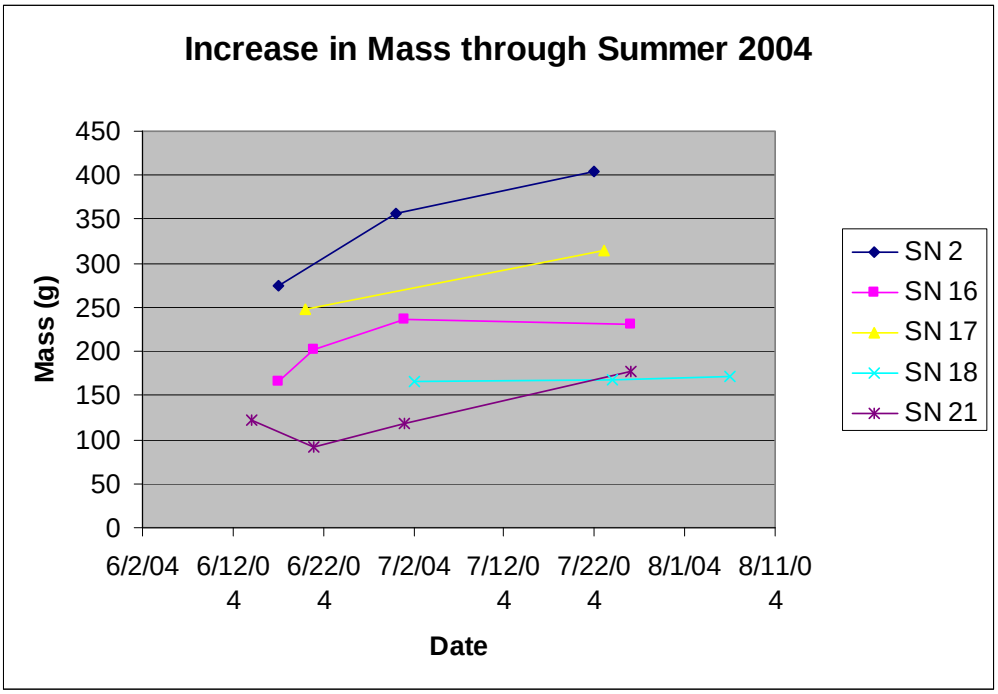


Fig. 2 Shows increase in mass for each individual snake during the 2004 summer. Only snakes that survived the entire tracking season are shown.

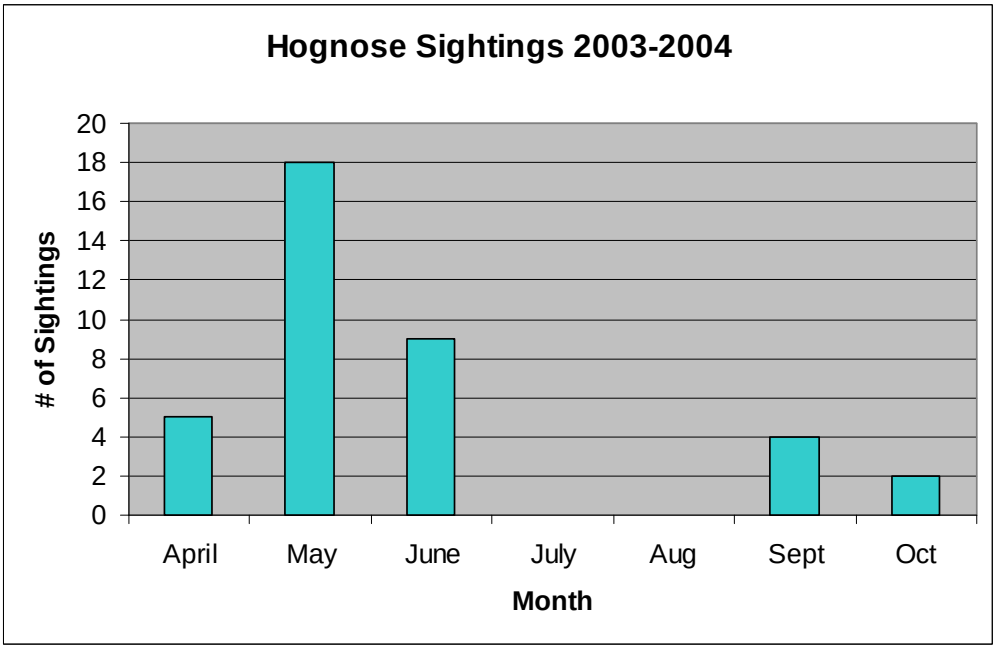


Fig. 3 Shows hognose snake sightings or captures in 2003 and 2004 combined. Mating occurs in April and early May.

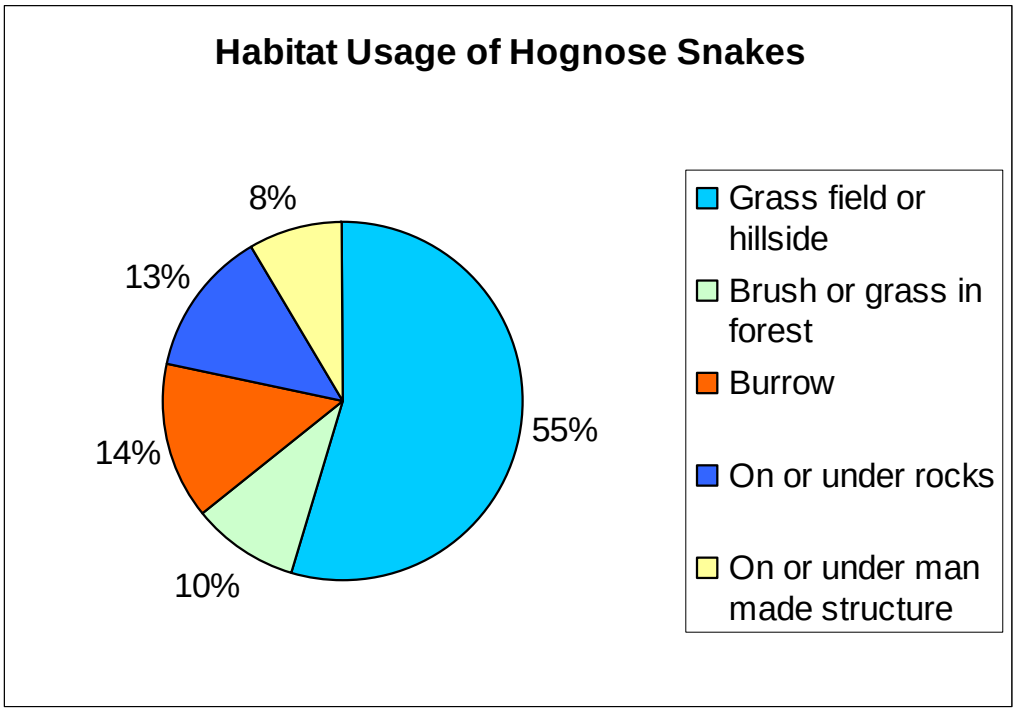


Fig. 4 Shows types of habitats used by hognose snakes. Data taken only from snakes that survived the entire 2004 active season.