FINAL PERFORMANCE REPORT

State: South Dakota **Project No. T-7**
Segment No. 1

Project Title: Ecology of the Black Hills redbelly snake (*Storeria occipitomaculata pahasapae*) with emphasis on food habits.

Objectives:
1. Determine the distribution, habitat association, body size, reproductive characteristics, and population characteristics of the Black Hills redbelly snake.

2. Determine if there is an association between prey selection and abundance of prey and whether prey abundance is influencing the population size of the Black Hills redbelly snake.

Narrative: Redbelly snakes (*Storeria occipitomaculata*) are a small (150-230 mm snout vent length, maximum 400 mm total length), semi-fossorial, viviparous colubrid snake widely distributed over the eastern half of the United States and Canada. Dorsal coloration is usually grey or brown with a light middorsal stripe bordering a pair of dark longitudinal stripes. The head is dark to black with some light spotting behind the head and on the neck. Redbelly snakes usually display a red or pink belly but snakes with a black belly have been reported (Swanson 1952; Wright and Wright 1957). Three subspecies are recognized; two of which are found in eastern North America. The third is an isolated population of the Black Hills and Bear Lodge Mountains of western South Dakota and eastern Wyoming (hereafter collectively referred to as the Black Hills) (Conant and Collins 1998; Ernst and Ernst 2003).

Smith (1963) first distinguished *S. o. pahasapae* from the nominate race and described them as endemic to the Black Hills. The three light colored blotches at the nape of the snake's neck may be small or absent in the Black Hills population, with no spot on the fifth upper labial scale. Additionally, 72% of the 20 specimens examined had six or fewer infralabial scales on at least one side (Smith 1963). Trapido (1944) analyzed the variation of *S. o. occipitomaculata*, but examined only one specimen from the Black Hills (Hill City, Pennington Co.). It is possible that the subspecies could not be distinguished by the examination of a single specimen. The Black Hills redbelly snake is

the only endemic subspecies in South Dakota and is monitored by the South Dakota Natural Heritage Program.

Research on the subspecies is limited to its description by Smith (1963), a survey by Peterson (1974), and a conservation assessment by Smith and Stephens (2004). The distribution and food habits of these snakes are poorly known. Due to the lack of data on this subspecies, the South Dakota Department of Game, Fish, and Parks (SDGFP) initiated a study of the ecology of these snakes in 2004. Data gathered in 2004 and 2005 will be used by the SDGFP to manage Black Hills redbelly snakes in the Black Hills of South Dakota.

Results: In summer 2004, 104 redbelly snakes, 125 terrestrial garter snakes (*Thamnophis elegans*), 74 smooth green snakes (*Opheodrys vernalis*), 15 common garter snakes (*Thamnophis sirtalis*), and one milk snake (*Lampropeltis triangulum*) were collected in 310.4 hours of hand collection along creeks and reservoirs. Captures per unit effort were 1.03 snakes/person-hour with 0.34 redbelly snakes/person-hour. In summer 2005, 146 redbelly snakes, 174 terrestrial garter snakes (*Thamnophis elegans*), 212 smooth green snakes (*Opheodrys vernalis*), 25 common garter snakes (*Thamnophis sirtalis*), one milk snake (*Lampropeltis triangulum*), three Eastern yellowbelly racers (*Coluber constrictor*), and 7 prairie rattlesnakes (*Croatalus viridis*) were collected in 322.7 hours of hand collection. Captures per unit effort were 1.76 snakes/person-hour with 0.45 redbelly snakes/person-hour. Two-hundred and fifty redbelly snakes were found over the two field seasons.

Black Hills redbelly snakes were found on average 14.0 ± 20.77 m (SD) from water (range 0.5-152.7 m). Ninety-seven percent of all redbelly snakes were found shading (73.5% under rocks and 23.5% under wood). Six snakes were found foraging and one was found basking. Mean temperature under cover objects was 17.2°C ± 4.5°C, range 4.1 – 33.6°C. Ambient temperature averaged 26.3°C ± 6.5°C, range 11.5-40.6°C. Forty-three redbelly snakes were found with other redbelly snakes under 20 cover objects. Ten redbelly snakes were found with *O. vernalis* under 7 cover objects and one redbelly snake was found with *T. sirtalis*.

Female redbelly snakes (n=107) averaged 180.4 mm ± 24.5 (SD) mm (range 101.0-263.0 mm) snout-vent length (SVL) and 49.7 mm ± 7.5 (SD) mm (range 20.0-67.0 mm) tail length (TL). Males (n=87) averaged 153.7 mm ± 22.2 (SD) mm (range 67.0-197.0 mm) SVL and 50.6 mm ± 8.8 (SD) mm (range 21-68 mm) TL. Females were significantly longer ($p<0.05$), but there was no significant difference between female and male tail length. The female to male ratio was 1.2:1. More than half of captured snakes (59.9%) were identified as grey phase vs. 40.1% as brown phase. The only young of the year (n=5) were found August 24, 2004 and August 18, 2005. The young of the year averaged 67.8 mm ± 5.4 (SD) mm SVL (range 62.0-76.0) and 20.0 mm ± 2.8 (SD) mm TL (range 17.0-23.0).

Because an invertebrate survey of the entire Black Hills was not feasible, we modified the second objective to focus on prey selection of Black Hills redbelly snakes. Potential prey items such as earthworms, slugs, and snails were abundant in redbelly snake habitats. In order to determine redbellied snake food habits, we removed stomach items from snakes captured in the field. We then conducted feeding trials and prey extract swab tests on redbellied snakes in a laboratory setting. The feeding trials were conducted at Black Hills State University included 48 redbelly snakes longer than 135 mm SVL. I fed the snakes every 2-3 days, offering them earthworms, slugs (*Arion fasciatus* or *Deroceras leave*), or snails (*Nesovitria binneyana* or *Oreohelix* spp.) collected in various parts of the Black Hills. The snakes were offered two items (e.g. 1 slug and 1 worm or 1 snail and 1 slug, etc.) per feeding. Redbelly snakes consumed 50.9 percent of slugs offered (377/741), 34.3 percent of earthworms offered (319/928) and less than one percent of snails offered (2/207). Slugs were the most important item in redbelly snake's diet (54 percent of items consumed by redbelly snakes), followed by earthworms (45.7%) and snails (0.3%).

Thirty-six of the forty-eight snakes were used in the prey extract trials. I prepared prey skin substance extracts by combining six grams of the living intact animal with 40mL of distilled water. Eight extracts were prepared: earthworm (Lumbricid), two types of slugs (*Arion fasciatus* and *Deroceras leave*), two types of snails (*Oreohelix* spp. and *Nesovirtria binneyana*), fathead minnow (*Pimephales promelas*), roly-poly (*Armadillium*

vulgare), and distilled water for a control. All of theses animal specimens were harvested from habitats occupied by redbelly snakes throughout the Black Hills.

Swab extract tests were initiated on July 31, 2004, and I conducted them every three days until August 27. I presented snakes with two swabs one cm from the nose for two minutes. One swab contained a random extract and the other was a control. The number of flicks directed toward each individual swab was recorded for one minute, or until the snake bit the applicator. Latency to bite was recorded.

Tongue-flick was significantly higher towards earthworm, the two types of slug and one of the snails (*N. binneyana*) compared to the distilled water control ($p<0.05$). However, the snakes significantly tongue-flicked towards non-prey (*P. promelas*) and did not significantly tongue-flick to known prey (*Oreohelix* spp.). From this data, there is no indication that prey availability in the Black Hills is having any negative effects on the population of redbellied snakes.

All snakes in the lab trials were preserved as voucher specimens with 10 percent formalin solution. Male snakes were injected at the base of the hemipenes to evert these organs. Each snake was coiled after injection and soaked in a 10 percent formalin solution for a week. I transferred the snakes to 70 percent ethyl alcohol solution for permanent storage (Karns 1986; RIC 1998). All laboratory procedures were supervised and approved by the IACUC at Black Hills State University.

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Principal Investigator: Dr. Charles Dieter, Professor, Department of Biology and Microbiology, South Dakota State University, Box 2207B, Brookings, SD 57007, tel. (605) 688-4555.

Prepared by: Meagan A. Hall, Graduate Research Assistant, Department of Biology and Microbiology, SDSU Box 2207B, Brookings, SD 57007, tel. (605) 688-4557.

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