A SURVEY OF REDBELLY SNAKES IN THE BLACK HILLS OF SOUTH DAKOTA

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ABSTRACT

The Black Hills redbelly snake (*Storieria occipitomaculata pahasapae*) is an isolated population and has received little study. We captured redbelly snakes in the Black Hills of South Dakota in 2004, 2005 to determine general morphological and population characteristics and to document which habitats were most utilized. We captured 104 redbelly snakes in 2004 (0.34 captures per hour) and 146 redbelly snakes in 2005 (0.45 captures per hour). Redbelly snakes were found an average of 14 m (SD = 20.8 m) from water, usually under cover objects. Females were larger (18.4 cm, SD = 2.45) than males (15.4 cm, SD = 2.22) ($t = 4.37$, df = 148, $P < 0.01$). The sex ratio favored females 3:2 ($\chi^2 = 10.9$, df = 1, $P < 0.01$). More than half of captured snakes (60%) were gray phase vs. 40% as brown phase ($\chi^2 = 4.00$, df = 1, $P < 0.05$). Our capture rate indicates Black Hills redbelly snakes are more common than previously thought. We found more redbelly snakes in the northern portion of the Black Hills which receives more moisture than the southern portion. We found redbelly snakes in wet areas so practices which reduce the abundance of moist habitats (cattle-grazing, construction) could threaten the redbelly snake. Similarly, management which increases such habitat would favor both the snakes and their prey.

Keywords

Black Hills, redbelly snake, *Storeria occipitomaculata pahasapae*

INTRODUCTION

Redbelly snakes (*Storeria occipitomaculata*) are a small, semi-fossorial, viviparous colubrid snake widely distributed over the eastern half of the United States and Canada. Dorsal coloration is usually gray 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 have a red or pink belly, but snakes with a black belly have been reported (Swanson 1952). Three subspecies are recognized; two of which are found in eastern North America. The third is an isolated population found in the Black Hills of southwestern South Dakota and the Bear Lodge Mountains of northeastern

Wyoming (Conant and Collins 1998; Ernst and Ernst 2003). The Black Hills redbelly snake (*S. o. pahasapae*) is the westernmost subspecies and considered endemic to the Black Hills, and is isolated from their eastern relatives by 510 km of prairie habitat (Smith 1963). Intergradation is known between subspecies at the limits of their range. Morphological distinctions between subspecies are minute and are related to the dorsal coloration and scale arrangement (Smith and Stephens 2003). Specimens which appear to be intergrades of Black Hills and northern redbelly snake (*S. o. occipitomaculata*) occur in Minnesota (Ernst 1974), Nebraska, North Dakota, and Manitoba (Conant and Collins 1998).

Throughout their range, the redbelly snake seems uncommon in most areas (Trapido 1944; Swanson 1952; Conant and Collins 1998). They are found in moist woodlands, open wet meadows, sphagnum bogs, and other mesic habitats (Semlitsch and Moran 1984; Conant and Collins 1998; Ernst and Ernst 2003). The activity periods of redbelly snakes vary throughout their range as they emerge from hibernacula in mid-April in Minnesota (Lang 1969) and in late May in Manitoba, Canada (Gregory 1977). In the Black Hills, the earliest date of collection was 12 May and the latest recorded date was 3 October (Peterson 1974). Redbelly snakes tend to return to the same hibernacula in successive winters (Lang 1969) and may hibernate singly (Neill 1948) or in groups (Hamilton and Pollack 1956).

Prey items include slugs (Semlitsch and Moran 1984), earthworms, crickets, soft-bodied insects, larvae, tiny frogs (Linzey and Clifford 1981), small salamanders, and other invertebrates. Predators of redbelly snakes include numerous snake species (Palmer and Braswell 1995) and raptors (Barrett and Villarroul 1994).

The general ecology of the species in South Dakota is poorly known (Smith and Stephens 2003). Very little is known about the movement of Black Hills redbelly snakes, but migratory behavior has been observed and aggregation is also likely (Smith 1963). Redbelly snakes have been found in wet meadows, woodlands, and forest-meadow edge habitats within the Black Hills (Smith 1963; Peterson 1974; Ballinger et al. 2000), but habitat use by redbelly snakes in the Black Hills has not been studied. Black Hills redbelly snakes may be at risk due to loss of mesic habitats, but modification and contamination of habitat by pesticides or other environmental contaminants also is a concern (Smith and Stephens 2003).

The Black Hills redbelly snake is listed as a species of concern in South Dakota and Wyoming and is monitored by the South Dakota Natural Heritage Program. Additionally, within the Black Hills National Forest, the United States Department of Agriculture (USDA) Forest Service designates the snake as a sensitive species. The distribution and habitat use of these snakes are poorly known in South Dakota and the South Dakota Game, Fish, And Parks was interested in obtaining this information. Objectives of this study were (1) to describe the general ecology, such as body size and population characteristics, of the Black Hills redbelly snakes, and (2) to determine distribution and habitat association of Black Hills redbelly snakes.

STUDY AREA

The Black Hills are located in western South Dakota and cover about 485,000 hectares, ranging in elevation from 1,000 to 2,200 m. The climate of the Black Hills is semi-arid continental, characterized by low precipitation and extreme variation in both temperature and precipitation (Froiland 1990). The region is influenced by a mountain climate type, due to the elevation of the Black Hills above the surrounding plains (Froiland 1990). Changes in elevation, aspect and moisture create highly variable growing seasons and temperature regimes (Larson and Johnson 1999). The Black Hills are drained by many small streams originating in the western part of the area and stream flows are greatest where drainage occurs toward the north and the east. No natural lakes occur in the Black Hills, but four large reservoirs result from damming (Froiland 1990).

Vegetation is dominated by Ponderosa pine (*Pinus ponderosa*) coniferous forest, with white spruce (*Picea glauca*), paper birch (*Betula papyrifera*) and aspen (*Populus tremuloides*) on north-facing slopes, around mesic areas, and in higher elevations (Froiland 1990). In riparian areas, American elm, (*Ulmus americana*), cottonwoods (*Populus deltoides*) boxelder (*Acer negundo*), and willows (*Salix* spp.) are common (Larson and Johnson 1999). In the Black Hills, 22 species of herpetofauna, including 7 amphibians and 15 reptiles, have been documented (Peterson 1974; Froiland 1990) compared to 44 species (14 amphibian and 30 reptile) recorded in the entire state of South Dakota (Ballinger et al. 2000).

METHODS

We used a systematic sampling design and focused searches on areas where redbelly snakes were most likely to occur. We searched open areas such as marshes, wet meadows, and forest-meadow edge habitats identified by Gregory (1977) and Smith and Stephens (2003) as suitable redbelly snake habitat. Most sample sites were mesic habitats and immature disturbed forest along creeks or streams with cover objects available for shelter. We also searched ditches, gullies, and fence lines which concentrate snakes or serve as movement corridors. In addition, we searched open prairie areas away from water sources. We searched under cover objects such as rocks and logs as well as potential den sites such as ant mounds, mammal burrows, sawdust piles, and rotting logs (Criddle 1937; Lang 1971; Ernst and Ernst 2003). We captured snakes by hand and recorded captures per person-hour.

We recorded the date and time, GPS coordinates, snout-vent length (SVL), and tail length (TL) for each snake captured. SVL and TL were measured by straightening the snake along a ruler. The SVL was recorded as the measurement from the tip of the snout to the posterior edge of the anal plate and TL was measured as the length from the posterior edge of the anal plate to the tip of the tail (Resources Inventory Committee 1998).

We determined sex by applying pressure on the ventral surface at the base of the tail of each snake. If two hemipenes were everted, the snake was recorded as male (Smith 1963). Color phase (gray or brown) was recorded. A single or double

ventral scale clip was used to mark released snakes. Snakes were assigned a unique field number by excising ventral scutes in distinctive patterns using a small pair of scissors (Resources Inventory Committee 1998).

If a snake was found under a cover object, we recorded the temperature under the cover object to the nearest 0.1 °C with a thermocouple thermometer. We recorded type of cover object and ambient temperature one meter above ground (± 0.1 **°C).** We measured the distance (± 0.1 m) from the point of capture to the edge of the nearest water body. We evaluated ground cover with a Duabenmire scale. We preserved dead redbelly snakes found during field collections as voucher specimens and deposited them at South Dakota State University. All redbelly snakes were taken under License Number 36, Scientific Collector's Permit, South Dakota Department of Game, Fish and Parks. Data were analyzed using t-tests and Chi-square analyses.

RESULTS

Redbelly snakes were captured starting mid-May in 2004 and 2005. In 2004, we collected 104 redbelly snakes (0.34 captures per hour) and in 2005, we collected 146 redbelly snakes (0.45 captures per hour) (Figure 1). Redbelly snakes were active until the last survey date on September 11, 2005. We found most redbelly snakes (93%) between 10:00 am and 6:00 pm. Only 8 captures occurred from 8:00 am to 10:00 am and only 9 captures occurred after 6:00 pm. We did not recapture any previously captured redbelly snakes. Capture rates were higher in the northern portion of the Black Hills (0.59 captures per hour) than in the southern portion of the Black Hills (0.26 captures per hour).

Redbelly snakes were found an average of 14.0 m (SD = 20.8 m) 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 (SD = 4.5), while the ambient temperature averaged 26.3 °C (SD = 6.5). We did not find any snakes in open prairie areas. Forty-three redbelly snakes were found with other redbelly snakes under 20 cover objects. Ten redbelly snakes were found with smooth green snakes (*Opheodrys vernalis*) under seven cover objects and one redbelly snake was found with a common garter snake (*Thamnophis sirtalis*).

Female redbelly snakes (n = 152) averaged 18.04 cm ± 2.45 (SD) cm (range 10.10-26.3 cm) SVL and 4.97 cm ± 0.75 (SD) cm (range 2.0-6.7 cm) TL. Males (n = 98) averaged 15.4 cm ± 2.2 (SD) cm (range 6.7-19.7 cm) SVL and 5.06 cm ± 0.88 (SD) cm (range 2.1-6.8 cm) TL. Females were significantly longer (t = 4.37, df = 248, $P < 0.01$), but there was no difference between female and male tail length (t = 0.115, df = 248, P = 0.095). The sex ratio favored females 3:2 (χ^2 = 10.9, df = 1, $P < 0.01$). More than half of captured snakes (60%) were identified as grey phase vs. 40% as brown phase (χ^2 = 4.00, df = 1, $P < 0.05$). The only young of the year (n = 5) were found August 24, 2004 and August 18, 2005. The young of the year averaged 6.8 cm ± 0.54 (SD) cm SVL (range 6.2-7.6) and 2.0 cm ± 0.3 (SD) cm TL (range 1.7-2.3).

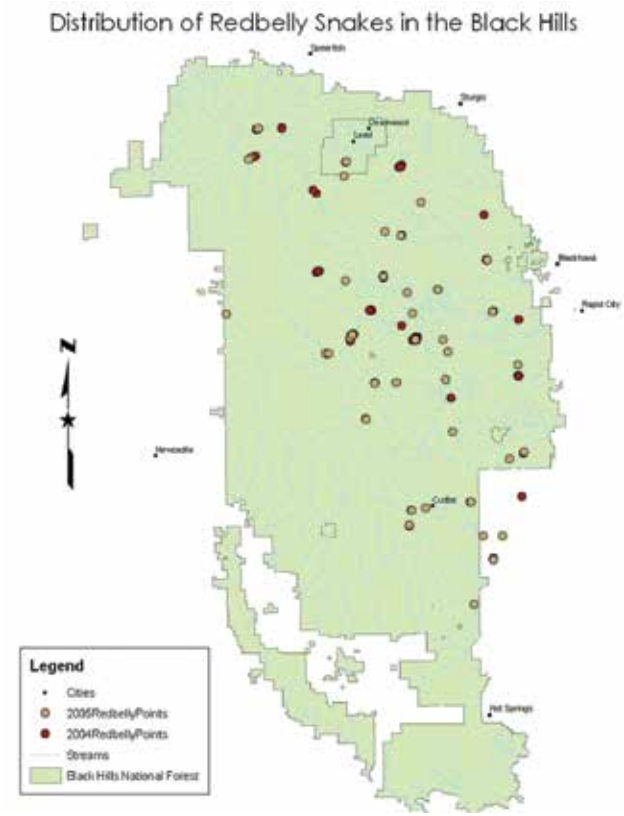

Figure 1. Capture sites of Black Hills Redbelly Snakes in the Black Hills of South Dakota, 2004, 2005.

DISCUSSION

When we initiated this study, there was concern by some biologists as to the number of redbelly snakes we would find, but we captured over 100 each year. We could not find any snake survey to compare our capture rate with, but our rate of capture was fairly high each year (Resources Inventory Committee 1998). However, in a 3-year survey in West Virginia where redbelly snakes are known to reside, none were captured (Griffin et al. 2009). It appears redbelly snakes may be more common in the Black Hills than previously thought probably because of their small size and secretive behavior.

Black Hills red belly snakes were found to be similar in size to previously reports of northern red belly snakes (Blanchard 1937; Semlitsch and Moran 1984). Earlier studies of northern redbelly snakes also found females to be larger than males (Blanchard 1937; Trapido 1952; Fitch 1981; Semlitsch and Moran 1984). More females were caught than males relative to a previous study (Semlitsch and Moran 1984). It is possible our hand capture method was biased

towards the larger females, while Semlitsch and Moran (1984) utilized pitfall traps which may have been less selective for larger individuals.

Gray phase snakes were caught more frequently than brown phase snakes. Previous studies suggest that the proportion of individuals belonging to the two color phases varies (Trapido 1944). Young of the year were found about the same time as previously reported studies (Blanchard 1937) suggesting that females give birth to young in late July or early August, a time of warm temperatures allowing for high rates of growth in young of the year.

The majority of the cover objects utilized by redbelly snakes were rocks which tended to be the dominant cover object in the study area. It is possible that redbelly snakes may prefer rocks over other cover types because rock may allow for greater indirect basking in cool weather as heat from the rock may be more easily transferred to a resting snake, allowing for regulation of body temperature. It was much cooler under the cover objects than the ambient air temperatures. Snakes may use cover such as rocks for relief from direct sunlight during hot weather conditions. Rocks also provide protection from predators.

Redbelly snakes were found predominantly in the northern Black Hills, which receives more precipitation (Wang et al. 2003) relative to the southern Black Hills. Proximity of redbelly snakes to water bodies supports previous studies stating that this species prefers moist habitats (Blanchard 1937). Our habitat and distribution data suggest redbelly snakes utilize habitat areas which are cooler and wetter than the surrounding habitat. These areas are also more likely to hold prey items such as slugs and snails.

In the Black Hills, redbelly snakes were restricted to moist areas since all were found near water, while large areas of dry habitat held no redbelly snakes. The snakes have little reason to venture far from the moist areas as they have plentiful prey and cover there. Thus, a loss of such habitat would put the redbelly snake population at high risk. Therefore, practices which reduce the abundance of moist habitats (cattle-grazing, construction) could threaten the redbelly snake. Similarly, management which increases such habitat would favor both the snakes and their prey.

ACKNOWLEDGMENTS

Funding for this research was provided by South Dakota Department of Game, Fish and Parks (SDGFP), South Dakota State University, and the Federal Aid to Wildlife Fund (Project W-75-R, No.75) administered by SDGFP. This study was approved as #04-A020 by the South Dakota State Institutional Animal Care and Use Committee. We would like to express our gratitude to Meagan Hall and Andrew Kopp for data collection and Silka Kempema for editorial reviews, as well as SDGFP for providing a special permit allowing the collection of snakes.

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