FINAL REPORT

State: South Dakota Grant Number: T-57-R-1

Project Title: Threats, management, and suggested harvest and collection policy for herpetofauna of South Dakota

Period Covered: September 1, 2011 through August 30, 2012

Objectives: By September 1, 2012:

1. Provide recommendations on take allowances.
2. Provide data to justify the amount of take, both commercially and via fishing licenses.
3. Identify best management practices which could be implemented for herpetofauna during construction projects.
4. Identify general threats to reptiles and amphibians in South Dakota.
5. Provide a final report with data supported recommendations to South Dakota Game, Fish and Parks (SDGFP) which could be implemented in management decisions.

Accomplishments:

See the attached report, which fulfills project objectives.

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Threats to South Dakota Amphibians and Reptiles

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Introduction

The purpose of this document is to define the threats endangering populations of amphibians and reptiles in South Dakota, and to propose potential solutions to address those threats. We not only discuss threats that may cause declines at the species level within our state, but also those that may impact only a few populations of otherwise common and widespread species. It is our contention that it is not only important to conserve species that are on the brink of extinction in South Dakota, but also to keep common species common. It is far easier and less expensive to maintain healthy populations by addressing today the factors that threaten them than it is to allow their decline to a critical level, and only then attempt recovery. With this philosophy, we define threats and propose ways to address them, not only for rare species in our state (such as lined snakes, eastern hog-nosed snakes, and false map turtles), but also for those that are common and widespread (such as painted turtles, gophersnakes, and Boreal chorus frogs).

We utilized the literature, our own experiences, and the expertise of others to define threats to our state's amphibians and reptiles, and to propose solutions to ameliorate those threats. This document is divided into four additional sections or electronic folders. These folders are:

1. Species Profiles: Individual accounts are presented for each of the 46 amphibian and reptile species in our state, describing taxonomy, identifying characteristics, population/protection status, distribution, population trend, key habitat, threats and issues in South Dakota, recommended conservation and research actions, and policy recommendations.
2. State Rules and Regulations Regarding Amphibians and Reptiles: This brief overview not only outlines the legal protection certain amphibians and reptiles receive, but also defines which species are left unprotected.
3. Bag Limits: A discussion about the need for bag limits with amphibians and reptiles is presented, along with recommendations of what such bag limits should be for each species.
4. South Dakota Herpetological Literature: Included in this folder is a list of publications involving South Dakota amphibians and reptiles, along with electronic copies of many. Publications listed utilized (totally or in part) South Dakota specimens. Additionally included are works which did not utilize specimens, but focused on South Dakota herpetofauna. Types of documents included are: 1) published research papers appearing in peer-reviewed journals, 2) popular and scientific articles appearing in non-peer reviewed publications, 3) published or unpublished reports to or from governmental agencies, and 4) published or unpublished theses or dissertations.

November 2012

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Tiger salamander complex.

Scientific Name: *Ambystoma mavortium* (barred tiger salamander), *Ambystoma tigrinum* (eastern tiger salamander).

Taxonomic note: The taxonomic status of the tiger salamander, *Ambystoma tigrinum*, has been in flux for some time. Relevant recent papers addressing the situation include Shaffer and McKnight (1996) and Weisrock et al. (2006). One of the more robust findings of Shaffer and McKnight (1996) was that the barred tiger salamander, *A. mavortium*, was distinct from the eastern tiger salamander, *A. tigrinum*. Both species may exist in South Dakota. However, Shaffer and McKnight (1996) used only one South Dakota specimen in their work, which was collected in Butte County near the Wyoming border and assigned to *A. mavortium*. The specimen they examined that was collected closest to the eastern border of South Dakota was taken in Woodbury County, Iowa, >700 km to the east of the Butte County specimen, and this was assigned to *A. tigrinum*. Shaffer and McKnight (1996) stated there is a broad hybrid zone of 50 – 100 km between the eastern and barred tiger salamanders throughout much of the range. In their study data were not collected on a fine enough scale within South Dakota to determine where this putative hybrid zone might be located. *Ambystoma mavortium* may be the commonly observed species throughout the state, with *A. tigrinum* found only in the Missouri River bottomlands of the far southeast corner, but further work is needed. Of importance to this species account, the various species of tiger salamanders of North America are all part of a very recent evolutionary radiation (Shaffer and McKnight 1996) and their natural history should be very similar if not identical. Tiger salamanders within the state can therefore be managed as if they were one species, except for issues regarding conservation genetics. Genetic studies in the state are recommended to resolve the status of tiger salamanders in South Dakota, but this would not affect management of the species.

Description: The tiger salamander (*Ambystoma* sp.) is South Dakota's only native salamander, although *Necturus maculosus* (the mudpuppy) has also been recorded from the state, without good evidence. (See the *N. maculosus* account for further discussion of this species.) At this time, the identity and range of tiger salamanders in the state is not thoroughly understood, but two very similar species occur and may hybridize in the state. They are treated together here. The interested reader can refer to the Taxonomic Note within this account for further discussion. For decades tiger salamanders have been considered to be a single species with considerable variation in coloration across the range. Tiger salamanders are large (6 – 8 ½ inches), robust salamanders, mottled black and olive across the body, with olive coloration reduced to mere spots in some specimens of eastern tiger salamanders (Petranka 1998). Tiger salamanders are the state's only terrestrial salamander, so terrestrial forms cannot be confused with anything else. However, a paedomorphic form also exists within the state. Paedomorphic tiger salamanders are sexually mature specimens with larval morphology. They can be found in

various permanent and semi-permanent wetlands. They are often larger than the terrestrial forms, but are gilled larval forms that do not leave the water. They can metamorphose and leave ponds based on cues that are incompletely understood. Paedomorphic tiger salamanders can be differentiated from mudpuppies based on the reddish coloration of the gills of mudpuppies (they are dark in paedomorphic tiger salamanders) and the fact that mudpuppies have four toes on each foot, rather than the five of paedomorphic tiger salamanders.

Population/protection Status (*A. mavortium*)

- IUCN: Not assessed.
    - IUCN population trend: Not assessed.
- USFWS: Not listed.
- State: Not listed. This species may be taken under the authority of a state fishing license and has a bag limit of 24 daily, with a maximum possession of 24. It may also be taken with a commercial bait dealer's license with no limit on take.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): Not considered as a part of the herpetofauna of South Dakota.

Population/protection Status (*A. tigrinum*)

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species may be taken under the authority of a state fishing license and has a bag limit of 24 daily, with a maximum possession of 24. It may also be taken with a commercial bait dealer's license with no limit on take.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S5.

Distribution

- Global: Lannoo and Phillips (2005) did not recognize barred and tiger salamanders as separate species, and present a range map for tiger salamanders (*A. tigrinum*) that extends from Montana, Wyoming, Utah and Arizona east to the east coast, with gaps in the range in Missouri, Arkansas, Louisiana and Mississippi. Petranka (1998) considered the barred tiger salamander to be a subspecies of tiger salamander, extending from Nebraska south through the Great Plains to the Mexican border. Data presented in Weisrock et al. (2006) suggest that the barred tiger salamander is the salamander of the western part of the tiger salamander's range, from the eastern edge of the Great Plains to the western border of the range as presented in Lannoo and Phillips (2005).
- South Dakota
    - Historical: Weisrock et al. (2006) imply that the barred tiger salamander occurs throughout the state except the Missouri River bottomlands in the southeastern corner of South Dakota, from the Missouri River to the Big Sioux River, where it is replaced by the eastern tiger salamander. Kiesow (2006) treats tiger

salamanders as a single species that occurs statewide, with three subspecies occurring in the state. This concurs with older literature (Shaffer and McKnight 1996, Petranka 1998). Lannoo and Phillips (2005) did not differentiate subspecies in their range map. Shaffer and McKnight (1996) present a range map that is at a scale too large to be useful to determine the range within the state.

- Current: Kiesow (2006) does not comment on the tiger salamander's current range in South Dakota, and I am not aware of any literature addressing its current range in South Dakota, but see "Population Trend", below.

Population trend: Petranka (1998) stated that the tiger salamander is the most widely distributed salamander in North America and that it occurs in a diverse array of habitats, from sea level to 3350 m elevation, except for streams. It has also been widely introduced as bait for anglers (Petranka 1998). Deutschmann and Peterka (1988) found that it could reach very high densities (to 5000 individuals/hectare) in ponds in North Dakota, but their work was completed more than 20 years ago. Smith et al. (1996) found tiger salamanders could be extremely abundant in some ponds in the Black Hills region of South Dakota, but only found them in 3 of 46 ponds that were surveyed. Peterson (1974) found them moderately abundant in the Black Hills. Although easily found and netted in ponds as larvae and as paedomorphs, tiger salamanders are secretive as terrestrial adults and can be difficult to find in most situations (but see Kolbe et al. 2002). Lannoo and Phillips (2005) noted that their current rangewide distribution is similar to their historical distribution, and they are still abundant in many areas, but precipitous population declines have occurred in portions of the range. Harte and Hoffman (1989) found declines greater than 65% at their study site in Colorado. Semlitsch et al. (1996) also found that populations were declining at their study sites. Anecdotal evidence in South Dakota (personal observations) hints that they are still abundant, at least in parts of the state, but definitive studies are lacking.

Key Habitat

- Key Habitat Description: Tiger salamanders have an aquatic larval stage, an adult terrestrial phase, and a paedomorphic phase, which is a sexually mature form that retains larval morphology and is permanently aquatic. Paedomorphosis in tiger salamanders is facultative, meaning that tiger salamanders may become paedomorphs or may metamorphose into an adult form as the occasion warrants (Whiteman 1994). Sexually mature paedomorphs can also metamorphose and leave ponds as fully terrestrial adults, depending on cues that are poorly understood. Tiger salamander adults and larvae may be found in almost any kind of habitat across the range of tiger salamanders (Petranka 1998), and that is my experience in western South Dakota as well. However, tiger salamanders avoid breeding in ponds with introduced predatory fish (Petranka 1998). Paedomorphs only occur in permanent ponds, but they can transform into terrestrial adults and leave the ponds at any point if the ponds dry. Paedomorphs are common in springs and other permanent bodies of water (except streams; tiger salamanders are poor swimmers) in the Black Hills region (unpublished observations). McAllister et al. (unpublished manuscript) found that terrestrial adult

tiger salamanders in the Black Hills were more likely to occur in ponds: 1) with high heat load indices (an indicator of pond temperature; higher heat load indices lower larval development time), 2) that were man-made, 3) that persisted longer but that were not permanent (otherwise the population within the pond would be paedomorphic), and 4) that had an unconsolidated bottom (i.e., lacked emergent vegetation). They also found that roads and trails inhibited migration of adults across the landscape and served to isolate ponds in some cases. Streams may serve as migration corridors (McAllister et al. unpublished manuscript).

- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Eastern Prairie Tall-grass Subregion, Missouri River Ecoregion, Great Plains Steppe Ecoregion, Black Hills Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Southern Dark Brown Glaciated Plains (53C), Rolling Soft Shale Plains (54), Central Black Glaciated Plains (55B), Southern Black Glaciated Plains (55C), Red River Valley of the North (56), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Black Hills (62), Northern Rolling Pierre Shale Plains (63A), Southern rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand hills (65), Dakota-Nebraska Eroded Tableland (66), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand Moreau, Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara, Red and Minnesota River, Heart.

Threats and Issues in South Dakota: Smith (2003) wrote an extensive conservation assessment of the tiger salamander, concentrating on the Black Hills region of South Dakota. This is the most detailed summary of conservation threats facing the tiger salamander in South Dakota. The following discussion borrows extensively from this document, with updated references as appropriate. Lannoo and Phillips (2005) also summarized the biology and conservation of this species.

- Acidified waterways: Whiteman et al. (1995) reported that tiger salamanders avoid waters with low pH, and in waters of pH 4.2, 50% of embryos died. In acidified ponds, tiger salamanders have longer larval periods and grow more slowly (Kiesecker 1996).
- Agrochemicals: Agricultural chemicals are used in 80 – 90% of agricultural lands in the northern Great Plains, and these chemicals are likely to have significant effects on tiger salamanders (Larson et al. 1998). Atrazine is the most commonly detected agricultural pesticide in the United States (Gillion et al. 2007). It has a number of effects on amphibians, including feminization of males, malformations, disruption of the immune system, abnormalities in growth and metamorphosis, lethality, and impaired adrenal function (Bishop et al. 2010). Additionally, atrazine decreases survivorship of salamanders exposed to *Ambystoma tigrinum* virus (Kerby and Storfer 2009). Bishop et al. (2010) reviewed the effects of atrazine in amphibians and reptiles.

- Buffer zones (also known as core habitat areas) around breeding ponds: Tiger salamanders are largely terrestrial for their adult life except during breeding season and during the cold season in some populations. They use aquatic habitat in which to breed but then migrate into surrounding uplands to forage for the active season (Madison and Farrand 1998, Semlitsch 1998). At his study sites in Georgia, Semlitsch (1998) determined that a buffer zone of 164.3 m is needed around each wetland to protect at least 95% of the breeding population of a pond, based on movement data collected on six species of ambystomatid salamanders (the salamander family Ambystomatidae includes tiger salamanders, although they were not a species studied by Semlitsch 1998). Tiger salamanders are also known to hibernate on land within a few meters of breeding ponds (Reese 1969).
- Disease: A ranavirus called *Ambystoma tigrinum* virus (ATV) is a lethal disease isolated from tiger salamanders in populations in southern Arizona (Jancovich et al. 1997, 2001). ATV can cause mass die-offs (Jancovich et al. 2001). ATV has been found at sites near Vermillion (Kerby personal communication). Additionally, the pesticides atrazine and chlorpyrifos, commonly found in waterways in South Dakota, increase susceptibility of tiger salamander larvae to ATV infection and lead to decreased survival when ATV-infected larvae are exposed to either of these pesticides (Kerby and Storfer 2009).
- Habitat disruption: McAllister et al. (in preparation) found that roads and trails negatively affected site connectivity in tiger salamanders, i.e. the more roads and trails separated breeding ponds, the more isolated those ponds became. Petranka (1998) noted that deforestation has negatively affected population densities of tiger salamanders in the southeast and Midwest.
- Introduced predatory fish: It has been known since 1953 that introduced predatory fish can cause declines of tiger salamanders (Carpenter 1953). More recent studies have reached the same conclusion (Espinoza et al. 1970, Collins et al. 1988, Travis 1992).
- Road runoff: Lefcort et al. (1997) studied the effects of motor oil, silt, and the water mold *Saprolegnia parasitica* on larval ambystomatids, including the tiger salamander. Motor oil and silt affected the growth of larval tiger salamanders. Ponds with high concentrations of these pollutants produced smaller salamanders that weighed less than those produced from unpolluted ponds. Presence of these pollutants also increased the susceptibility of tiger salamanders to the parasitic water mold *S. parasitica*. *Saprolegnia parasitica* has been linked with amphibian declines in the Pacific Northwest (Blaustein et al. 1994).
- Tiger salamanders introduced as bait: In some parts of the range, tiger salamanders introduced as bait have compromised the genetic integrity of native tiger salamanders occurring at the sites of introduction (Fitzpatrick and Shaffer 2007). Fitzpatrick and Shaffer (2007) showed that introduced alleles were more common in permanent wetlands that had been altered by human activity, whereas introduced allele frequencies were lower in relatively pristine seasonal ponds. It is hard to tell how this phenomenon would affect South Dakota populations, but in the Californian populations studied by Fitzpatrick and Shaffer (2007) these introduced alleles are changing the gene pool of an endemic subspecies of tiger salamander.

Recommended Conservation and Research Actions:

- Agrochemicals: Use of agrochemicals should be limited near tiger salamander populations, especially around breeding ponds.
- Atrazine: Atrazine is a pesticide that is well known to adversely affect amphibians and reptiles (Bishop et al. 2010). It also decreases survivorship of *Ambystoma tigrinum* larvae infected with *Ambystoma tigrinum* virus (Kerby and Storfer 2009). Its use should be limited around breeding ponds.
- Habitat disruption: Roads and trails limit gene flow in tiger salamanders in the Black Hills. This should be considered as new roads and trails are built, but without more detailed study it is difficult to provide guidance in regards to siting of new roads and trails.

Policy Recommendations:

- Buffer zones: Consider establishing buffer zones up to 150 – 200 m around breeding ponds to protect the critical upland foraging habitat for tiger salamanders.
- Introduced fish: Consider limits on introduction of non-native predaceous fish, such as trout, pike and others.
- Agrochemicals: Restrict use of agrochemicals in and around tiger salamander habitat, especially around breeding ponds.
- Habitat disruption: Limit construction around breeding ponds, and consider where roads are placed within the landscape. Be mindful that roads built between breeding ponds may reduce or cut off gene flow among breeding ponds. Road runoff also affects larval tiger salamanders. Wherever possible roads should avoid proximity to breeding ponds.
- Bag limits: Although bag limits have been instituted for the general public using a fishing license (take of 24 daily, with maximum possession of 24), there are no data on whether these bag limits are suitable. Bag limits should be determined using basic data on life history parameters (reproduction and recruitment). Such studies should be undertaken and bag limits should be reviewed based on these data. Bait dealer's licenses have no bag limits, and tiger salamander populations can be overexploited as a result. This situation should be remedied by establishing provisional bag limits for bait dealers equivalent to those placed on anglers by a state fishing license, until studies of life history parameters can be completed.

Comment: Joseph McAllister, working with Garth Spellman and myself, recently completed a master's thesis at Black Hills State University on tiger salamander landscape genetics. This manuscript will be submitted for publication sometime in November or December 2012.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station; David Swanson, University of South Dakota.

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Literature Cited

Ahne, W., M. Bremont, R. P. Hedrick, A. D. Hyatt, and R. J. Whittington. 1997. Iridoviruses associated with epizootic haematopoietic necrosis (EHN) in aquaculture. World Journal of Microbiology and Biotechnology 13:367-373.

Alford, R. A. 2010. Declines and the global status of amphibians. Pp. 13 – 45 in Ecotoxicology of Amphibians and Reptiles, 2nd ed., Sparling, D. W., G. Linder, C. A. Bishop, and S. K. Krest, eds. CRC Press, New York, New York.

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Bishop, C. A., T. V. McDaniel, and S. R. de Solla. 2010. Atrazine in the environment and its implications for amphibians and reptiles. Pp. 225-259 in Sparling, D. W., G. Linder, C. A. Bishop, and S. K. Krest, eds., Ecotoxicology of Amphibians and Reptiles, 2nd ed. CRC Press, New York, New York.

Blaustein, A. R., D. G. Hokit, R. K. O'Hara, and R. A. Holt. 1994. Pathogenic fungus contributes to amphibian losses in the Pacific Northwest. Biological Conservation 67:251-254.

Carpenter, C. C. 1953. An ecological survey of the herpetofauna of the Grand Teton-Jackson Hole area of Wyoming. Copeia 1953:170-174.

Collins, J. P., T. R. Jones, and H. J. Berna. 1988. Conserving genetically distinctive populations: The case of the Huachuca tiger salamander (Ambystoma tigrinum stebbensi Lowe). Pp. 45-53 in Szaro, R. C. K. E. Severson, and D. R. Patton (Technical Coordinators), Management of Amphibians, Reptiles, and Small Mammals in North America. U. S. D. A. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Crother,B. I., Committee Chair. 2011. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, Edition 6.1. http://www.ssarherps.org/pages/comm_names/Index.php. Accessed 2 July 2012.

Deutschman, M. R., and J. J. Peterka. 1988. Secondary production of tiger salamanders (*Ambystoma tigrinum*) in three North Dakota prairie lakes. Canadian Journal of Fisheries and Aquatic Sciences 45**:**691–697.

Espinoza, F. A., Jr., J. E. Deacon, and A. Simmin. 1970. An economic and biostatistical analysis of the bait fish industry in the Lower Colorado River. University of Nevada, Las Vegas, Special Publication, Las Vegas, Nevada.

Fitzpatrick, B. M., and H. B. Shaffer. 2007. Introduction history and habitat variation explain the landscape genetics of hybrid tiger salamanders. Ecological Applications 17:598-608.

Gillion, R. J., J. E. Barbash, C. G. Crawford, P. A. Hamilton, J. D. Martin, N. Nakagaki, L. H. Nowell, J. C. Scott, P. E. Stackelberg, G. P. Thelin, and D. M. Wolock. 2007. The quality of our nation's waters: Pesticides in the nation's streams and ground water 1991 – 2001. U. S. Geological Survey Circular 1291. U. S. Department of the Interior.

Harte, J., and E. Hoffman. 1989. Possible effects of acidic deposition on a Rocky Mountain population of the tiger salamander *Ambystoma tigrinum*. Conservation Biology 3:149-158.

Jancovich, J. K., E. W. Davidson, J. F. Morado, B. L. Jacobs, and J. P. Collins. 1997. Isolation of a lethal virus from the endangered tiger salamander *Ambystoma tigrinum stebbinsi*. Diseases of Aquatic Organisms 31:161-167.

Jancovich, J. K., E. W. Davidson, A. Seiler, B. L. Jacobs, and J. P. Collins. 2001. Transmission of the *Ambystoma tigrinum* virus to alternative hosts. Diseases of Aquatic Organisms 46:159-163.

Kerby, J. L., and A. Storfer. 2009. Combined effects of atrazine and chlorpyrifos on susceptibility of the tiger salamander to *Ambystoma tigrinum* virus. EcoHealth 6:91-98.

Kiesecker, J. M. 1996. pH-mediated predator-prey interaction between *Ambystoma tigrinum* and *Pseudacris triseriata*. Ecological Applications 6:1325-1331.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Kolbe, J. J., B. E. Smith, and D. M. Browning. 2002. A large aggregation of tiger salamanders (*Ambystoma tigrinum melanostictum*) at a black-tailed prairie dog (*Cynomys ludovicianus*) town in southwestern South Dakota. Herpetological Review 33:95-99.

Lannoo, M. J., and C. A. Phillips. 2005. *Ambystoma tigrinum*. Pp. 636-639 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

Larson, D. L., S. McDonald, A. J. Fivizzani, W. E. Newton, and S. J. Hamilton. 1998. Effects of the herbicide atrazine on *Ambystoma tigrinum* metamorphosis: Duration, larval growth, and hormonal response. Physiological Zoology 71:671-679.

Lefcort, H., K. A. Hancock, K. M. Maur, and D. C. Rostal. 1997. The effects of used motor oil, silt, and the water mold *Saprolegnia parasitica* on the growth and survival of mole salamanders (genus *Ambystoma*). Archives of Environmental Contamination and Toxicology 32:383-388.

Madison, D. M., and L. Farrand, III. 1998. Habitat use during breeding and emigration in radio-implanted tiger salamanders, *Ambystoma tigrinum*. Copeia 1998:402-410.

Peterson, C. R. 1974. A preliminary report on the amphibians and reptiles of the Black Hills of South Dakota and Wyoming. M. S. Thesis, University of Illinois, Urbana-Champaign. 59 pp.

Petranka, J. W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D. C.

Reese, R. W. 1969. The taxonomy and ecology of the tiger salamander (*Ambystoma tigrinum*) of Colorado. Ph. D. dissertation, University of Colorado, Boulder.

Semlitsch, R. D. 1998. Biological delineation of terrestrial buffer zones for pond breeding salamanders. Conservation Biology 12:1113-1119.

Semlitsch, R. D., D. E. Scott, J. H. K. Pechmann, and J. W. Gibbons. 1996. Structure and dynamics of an amphibian community: Evidence from a 16-year study of a natural pond. Pp. 217-248 in Cody, M. L., and J. A. Smallwood, eds. Long-term Studies of Vertebrate Communities. Academic Press, San Diego, California.

Shaffer, H. B., and M. L. McKnight. 1996. The polytypic species revisited: Genetic differentiation and molecular phylogenetics of the tiger salamander *Ambystoma tigrinum* (Amphibia: Caudata) complex. Evolution 50:417-433.

Smith, B. E. 2003. Conservation Assessment of the Tiger Salamander in the Black Hills National Forest, South Dakota and Wyoming. Report submitted to the U. S. Forest Service, Black Hills National Forest, May 2003. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm9_012538.pdf. Accessed 1 July 2012.

Smith, B. E., D. M. Browning, E. Taylor, R. S. Ferguson, and K. Yturralde. 1996. Herpetofaunal surveys of the Fall River Ranger District, U. S. Forest Service, southwestern South Dakota and Badlands National Park. Unpublished report submitted to the U. S. G. S./Biological Resources Division, Northern Prairie Wildlife Research Center, Jamestown, North Dakota. 27 pp.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Travis, J. 1992. Eastern tiger salamander. Pp. 70-76 in P. E. Moler, ed., Rare and Endangered Biota of Florida Volume III: Amphibians and Reptiles. University Press of Florida, Gainesville, Florida.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Weisrock, D. W., H. B. Shaffer, B. L. Storz, S. R. Storz, and S. R. Voss. 2006. Multiple nuclear gene sequences identify phylogenetic species boundaries in the rapidly radiating clade of Mexican ambystomatid salamanders. Molecular Ecology 15:2489-2503.

Whiteman, H. H. 1994. Evolution of facultative paedomorphosis in salamanders. The Quarterly Review of Biology 69:205-221.

Whiteman, H. H., R. D. Howard, and K. A. Whitten. 1995. Effects of pH on embryo tolerance and adult behavior in the tiger salamander, *Ambystoma tigrinum tigrinum*. Canadian Journal of Zoology 73:1529-1537.

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South Dakota Distribution Map:

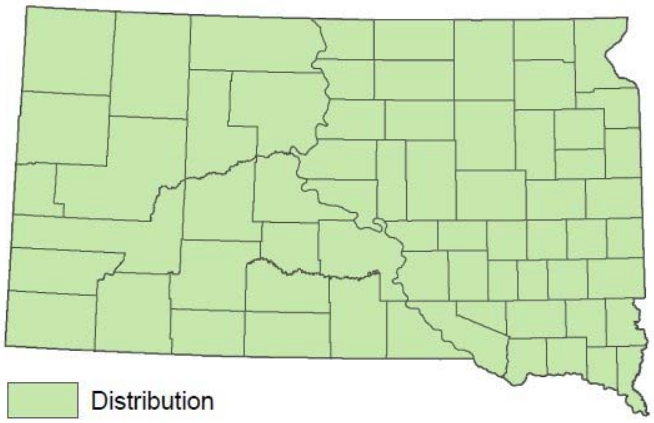

Photo:

Eastern Tiger Salamander Michael Graziano

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Mudpuppy.

Scientific Name: *Necturus maculosus.*

Description: The mudpuppy is a large aquatic salamander with large, feathery, and reddish external gills. When adult, it looks similar to a paedomorphic tiger salamander (see tiger salamander account) but is larger (from 8 – 13 inches when fully grown, Conant and Collins 1998). Its overall color is drab grayish or brownish with various mottling across the body and a dark stripe through the eye. Its most distinguishing characteristic is its feet, all four of which have only four toes. This distinguishes it from larval and paedomorphic tiger salamanders, which have five toes on each foot. This is a neotenic salamander; i.e., during its evolutionary history, its adult terrestrial phase has been lost. It becomes sexually mature in a larval form and maintains a permanently aquatic lifestyle, including external gills that are typical of larval salamanders (although the mudpuppy also has lungs). The mudpuppy is nocturnal and occurs only in permanent bodies of water. There is nothing else in the state quite like the mudpuppy in form or habit. The name "mudpuppy" is sometimes incorrectly applied to larval tiger salamanders. Mudpuppies are also commonly referred to as "water dogs" in the southern United States.

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): SH.

Distribution

- Global: The mudpuppy is found throughout all or most of the states of Wisconsin, Michigan, New York, Illinois, Indiana, Ohio, Kentucky, Tennessee, and Arkansas. It is also found in southern Manitoba, Ontario, and Québec. Additionally, it is found in parts of Missouri and Minnesota. Far eastern North and South Dakota is the western boundary of its range. Petranka (1998) provides the best map of global distribution and Matson (2005) the best map of its range in the United States.
- South Dakota
    - Historical: Over (1943) reported finding one dead adult mudpuppy at South Waubay Lake in 1927, which he presumed had been killed by a gull. He stated that anglers "frequently" caught mudpuppies in the northeastern part of the state but gives no evidence that he ever examined these specimens. Apparently no South Dakota specimens exist in any natural history collections. A note in the

state's Natural Heritage Database states that the mudpuppy may have been extirpated from East Waubay Lake in the 1930s due to drought, without evidence. One other specimen in the Natural Heritage Database is recorded based on a "note in correspondence file", with no further documentation. Mudpuppies are of questionable occurrence in South Dakota.

- Current: Unknown.

Population trend: Matson (2005) lists a variety of older literature reporting that the mudpuppy was common rangewide at one time, but few recent studies have been done. Those that have been done have noted declines in various parts of the range (Pfingsten and White 1989, Harding 1997).

Key Habitat

- Key Habitat Description: Mudpuppies have very broad habitat requirements, but are always found in permanent water bodies. They may be found in sluggish streams, reservoirs, and muddy canals (Petranka 1998). Matson (2005) reports that they can be found in clear or muddy lakes, canals, ditches, and streams, and will live in vegetation-choked water or in water with no vegetation whatsoever. They are known to dive deeply; up to 27 m in one case (Reigle 1967).
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Tall-grass Subregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Red River Valley of the North (56), Rolling Till Prairie (102A).
- Aquatic Drainage Units (Annis et al. 2010): James, Red and Minnesota River.
- Note: Conclusions on the occurrence of mudpuppies in these Ecoregions, Land Resource Areas, and Aquatic Drainage Units assume presence of the species in the state based on Over's (1943) record.

Threats and Issues in South Dakota: Unknown.

Recommended Conservation and Research Actions:

- Surveys: This species' occurrence and distribution in the state is unclear. Over (1943) is the only published report of a mudpuppy from South Dakota, but this record was not vouchered with a museum specimen. Notes in the state's Natural Heritage Database do not clarify the mudpuppy's status. The veracity of these records is impossible to establish. There appear to be no museum specimens from South Dakota. However, museum records in Minnesota show that the species occurs in the Minnesota River drainage (Oldfield and Moriarty 1994). Over's (1943) record is from a Prairie Coteau lake with internal drainage, but is close to the Minnesota River drainage basin. If this species is native to South Dakota, based on known specimens from Minnesota it is most likely to occur in the Minnesota and Red River drainages. Permanent water bodies in these drainages could be surveyed to establish whether the species occurs in South Dakota. Based on Over (1943), permanent water bodies in the Prairie Coteau region

could also be surveyed. Drought in the 1930s (Over's report dates from 1927) would have dried all but the largest permanent water bodies in the area. Ponds and lakes that failed to dry up then are most likely to still harbor mudpuppies. If the fate of individual ponds and lakes in the 1930s can be established, then this could focus survey efforts.

Policy Recommendations:

- Bag limits: If this species occurs in South Dakota, populations may be few and population sizes low. If found, mudpuppies should not be collected until population numbers and sizes are established and life history parameters (reproduction and recruitment) are determined. After these studies are undertaken, it may be possible to establish sustainable harvest levels based on these data.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station

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Literature Cited

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Harding, J. H. 1997. Amphibians and Reptiles of the Great Lakes Region. University of Michigan Press, Ann Arbor, Michigan.

Matson, T O. 2005. *Necturus maculosus*. Pp. 870-871 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

Oldfield, B., and J. J. Moriarty. 1994. Amphibians and Reptiles Native to Minnesota. University of Minnesota Press, Minneapolis, Minnesota.

Over, W. H. 1943. Amphibians and Reptiles of South Dakota. University of South Dakota Natural History Studies No. VI, Vermillion, South Dakota.

Petranka, J. W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D. C.

Pfingsten, R. A., and A. M. White. 1989. *Necturus maculosus* (Rafinesque), mudpuppy. Pp. 72-78 in Pfingsten, R. A., and F. L. Downs, eds., Salamanders of Ohio. Ohio Biological Survey, Volume 7, Columbus, Ohio.

Reigle, N. J., Jr. 1967. The occurrence of *Necturus* in the deeper waters of Green Bay. Herpetologica 23:232-233.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Photo:

Mudpuppy Michael Graziano

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Blanchard's cricket frog.

Scientific Name: *Acris blanchardi*

Taxonomic note: Gamble et al. (2008) recently revised the taxonomy of the genus *Acris*. They elevated the northern subspecies of *Acris crepitans*, *A. c. blanchardi*, to full species status, *A. blanchardi*. Most or all regulatory agencies refer to this species using its old name, *A. crepitans*. The herpetofaunal species list for the state of South Dakota should be changed to reflect the new taxonomy.

Description: This is a small (⅝ – 1 ½ inches) frog that is warty and stocky in appearance. Coloration ranges from light brown to gray. Frogs with which this frog could be confused are the boreal chorus frog (*Pseudacris maculata*) and gray treefrog (*Hyla chrysoscelis/versicolor*) (see the species accounts for each of these three species; *Hyla chrysoscelis* and *H. versicolor* are discussed in a single account). To distinguish Blanchard's cricket frog from the boreal chorus frog, keep in mind that Blanchard's cricket frog only occurs in the southeastern corner of the state, whereas the boreal chorus frog occurs statewide. Blanchard's cricket frog is generally uniformly colored with a dark triangle between the eyes. The boreal chorus frog is about the same size but lacks the dark triangle. Boreal chorus frogs also have a series of dark longitudinal stripes along the lateral and dorsal portion of the body, and they do not have many tubercles on their back. The gray treefrog is similar in size, build, and background color to Blanchard's cricket frog and their ranges may overlap. The gray treefrog is uniformly colored and lacks the prominent dark triangle found between the eyes of Blanchard's cricket frog. Also, it is often found in low bushes and on trees, whereas Blanchard's cricket frog is solely terrestrial. The voice of Blanchard's cricket frog sounds like the rapid clicking of pebbles knocking against each other. Breeding season lasts from mid-May to mid- to late-July in South Dakota (Burdick and Swanson 2010).

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): NatureServe does not recognize this species in South Dakota, although it does occur here.

Distribution

- Global: Distributed roughly across the eastern half of the United States, from the northern border of Nebraska across most of Kansas, Oklahoma, and roughly the eastern

two-thirds of Texas, northern Arkansas northwards through Iowa, all of Indiana and Illinois, and the western half of Ohio (Gray et al. 2005). The northern edge of its range is in the southern half of Wisconsin and Michigan and into parts of far southern Canada. The northern boundary of its distribution may be limited by overwinter mortality (Swanson and Burdick 2010).

- South Dakota
    - Historical: Once common across south-central to southeastern South Dakota, mostly along the border with Nebraska in south-central South Dakota, and throughout the southeastern corner of South Dakota, from the Missouri River to the Big Sioux River (Kiesow 2006). This corner of the state consists of Missouri River bottomlands, similar to habitat in adjacent Iowa where the frog also occurs. Many herpetofauna of the southeastern and eastern United States reach their northwestern range limit in this region, including the Blanchard's cricket frog.
    - Current: Kiesow (2006) stated that it has disappeared completely from Tripp and Gregory counties and is now only found in the southeastern corner of the state. Burdick and Swanson (2010) provide the most up to date map of the current and historical range of the frog within South Dakota, noting that it occurs along the James and Big Sioux Rivers, and Emanuel Creek in Bon Homme County, all in the southeastern corner of the state.

Population trend: Wright and Wright (1949) state that this was the most abundant amphibian in many regions at that time. It may still be common in central (Gray et al. 2005) and southern (Kerby personal communication) parts of the range. Gray et al. (2005) stated that a "trend toward extinction" is underway for this species, but that the causes of the declines are not clear. The decline has been ongoing since the 1970s, and is especially dramatic across the northern and western parts of the range (Baker 1997, Gray and Brown 2005, Hammerson and Livo 1999, Hay 1998, Lannoo 1998, Lehtinen 2002, Lehtinen and Skinner 2006, Vogt 1981). Lannoo et al. (1994) found that they had disappeared in Dickinson Co., Iowa, sometime between 1923 and 1993. The species is listed as endangered, threatened, or a species of special concern in Wisconsin, New York, Indiana, Michigan, West Virginia, and Minnesota (Brodman and Kilmurry 1998, Oldfield and Moriarty 1994, Ramus 1998). They are also listed as endangered in Canada and the province of Ontario (Weller and Green 1997).

Population trends in South Dakota are unclear. Kiesow (2006) states that this frog was formerly common throughout its range within South Dakota but that numbers have declined. Fischer et al. (1999) reported that Blanchard's cricket frogs were either very rare or extirpated in South Dakota. Burdick and Swanson (2010) found them to be absent at various historical localities in western portions of their range in South Dakota, but still seasonally common in other areas within the state. They found that Blanchard's cricket frogs were seasonally common along the James River and Big Sioux River and along Emanuel Creek for 11 km upstream from its confluence with the Missouri River, all in the southeastern corner of the state. Fogell (personal communication) found them in similar areas (see also Fogell 2003).

Key Habitat

- Key Habitat Description: In South Dakota, Burdick and Swanson (2010) found them on mud, vegetation, and mud-vegetation substrates at an average of < 50 cm from the water's edge. Gray et al. (2005), in a general summary of *A. crepitans* habitat (published when *A. blanchardi* was still considered a subspecies of *A. crepitans*), stated that individuals are found near or in virtually all bodies of water except for large lakes, rivers, and polluted areas. They live along the water's edge on floating vegetation or debris, including floating debris over deeper water, or on the shore at the edge of water bodies (Smith et al. 2003). They can also be found in cattail thickets and other sorts of shoreline vegetation, and in flood plain forests under cover items on moist soil (Gray et al. 2005).
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Tallgrass Subunit.
- Major Land Resource Areas (United States Department of Agriculture 2006): Southern Black Glaciated Plains (55C), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): Big Sioux/Vermillion, Little Sioux/Niobrara.

Threats and Issues in South Dakota

- Chytrid fungus: Infection by the chytrid fungus, *Batrachochytrium dendrobatidis*, has been documented in South Dakota populations (Kerby unpublished data). Hill et al. (2011) reported that chytrid fungus has also been found in the closely related northern cricket frog, *A. crepitans*. Chytrid fungus is a sometimes lethal disease that has been tied to declines of frogs and toads worldwide (Alford 2010).
- Decline: Gray et al. (2005) and other authors state that Blanchard's cricket frog is in dramatic decline across the northern and western parts of its range (see "Population Trends" and references therein, above), but reasons for the decline are not known. Burdick and Swanson (2010) found that they were not necessarily declining in South Dakota (see "Population Trends", above), but were absent from some historical collecting localities.
- Overwintering mortality: Burdick and Swanson (2010) found that overwintering mortality may be high at the northern range boundary and might limit cricket frogs from expanding their range northward. Overwintering physiology is closely influenced by moisture levels and temperature, both factors influenced by ongoing climate change.

Recommended Conservation and Research Actions

- Monitoring: A monitoring program is recommended to determine long-term status and range of the species.
- Surveys: Surveys of historical localities to determine whether Blanchard's cricket frog still occurs there are recommended. Burdick and Swanson (2010) show that it is still present in some of these localities but gone from others. Surveys should utilize detection probability based methods with sufficient effort achieved to eliminate false absences (MacKenzie et al. 2002). A season or two of negative data may not be sufficient to detect amphibians in areas where they still occur.

- Chytridiomycosis: Further studies of chytridiomycosis in this species in South Dakota are recommended, considering Kerby's unpublished results cited elsewhere in this account.

Policy Recommendations

- Taxonomy: The Natural Heritage Database for the state of South Dakota should refer to this species as *Acris blanchardi*, not *A. crepitans*, to reflect taxonomic revisions.
- Bag limits: This species' range in South Dakota is small, with isolated populations. There is some question as to whether this species is in decline in the state. Collection of this species is not regulated. Until data can be collected to institute science based bag limits on this species based on life table parameters, establish a bag limit of 24 daily, with a maximum possession of 24. This is the current bag limit for leopard frogs and tiger salamanders in South Dakota, and until life table parameters (reproduction and recruitment) can be defined so sustainable harvests can be estimated for *Acris blanchardi*, these provisional bag limits can be used. If surveys show that the species is in decline or is otherwise rare in the state, bag limits should be revised.
- Conservation status: After completion of basic survey work (see "Recommended Conservation and Research Actions", above), a reevaluation of its conservation status may be warranted.

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Literature Cited

Alford, R. A. 2010. Declines and the global status of amphibians. Pp. 13 – 45 in Ecotoxicology of Amphibians and Reptiles, 2nd ed., Sparling, D. W., G. Linder, C. A. Bishop, and S. K. Krest, eds. CRC Press, New York, New York.

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Baker, R. J. 1997. Revising Minnesota's list of endangered and threatened species: Amphibians and reptiles. Pp. 11 – 14 in Moriarty, J. J., and D. Jones, eds., Minnesota's Amphibians and Reptiles: Their Conservation and Status. Serpent's Tale Natural History Book Distributors, Lanesboro, Minnesota.

Brodman, R., and M. Kilmurry. 1998. Status of amphibians in northwestern Indiana. Pp. 125-136 in Lannoo, M. J., ed., Status and Conservation of Midwestern Amphibians. University of Iowa Press, Iowa City, Iowa.

Burdick, S. L., and D. L. Swanson. 2010. Status, distribution, and microhabitats of Blanchard's cricket frog *Acris blanchardi* in South Dakota. Herpetological Conservation and Biology 5:9-16.

Fischer, T. D., D. C. Backlund, K. F. Higgins, and D.E. Naugle. 1999. A field guide to South Dakota amphibians. South Dakota Agricultural Experiment Station, Bulletin Number 733, South Dakota State University, Brookings, South Dakota, USA.

Fogell, D. D. 2003. Amphibian and reptile surveys of southeast South Dakota with an emphasis on the state-endangered lined snake (*Tropidoclonion lineatum*) May 2002 – June 2003. Unpublished report submitted to the South Dakota Department of Game, Fish, and Parks.

Gamble, T., P. B. Berendzen, H. B. Shaffer, D. E. Starkey, and A. M. Simons. 2008. Species limits and phylogeography of North American cricket frogs (*Acris*: Hylidae) Molecular Phylogenetics and Evolution 48:112-125.

Gray, R. H., L. E. Brown, and L. Blackburn. 2005. *Acris crepitans*. Pp. 441-443 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

Hammerson, G. A., and L. J. Livo. 1999. Conservation status of the northern cricket frog (*Acris crepitans*) in Colorado and adjacent areas at the northwestern extent of the range. Herpetological Review 30:78-80.

Hay, R. 1998. Blanchard's cricket frogs in Wisconsin: A status report. Pp. 79-82 in Lannoo, M. J., ed., Status and Conservation of Midwestern Amphibians. University of Iowa Press, Iowa City, Iowa.

Hill, R. L., M. G. Levy, E. K. Timpe, and J. B. Kaylock. 2011. Additional reports of the amphibian chytrid fungus *Batrachochytrium dendrobatidis* from Georgia, USA. Herpetological Review 42:376-378.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Lannoo, M. J., K. Lang, T. Waltz, and G. S. Phillips. 1994. An altered amphibian assemblage: Dickinson Co., Iowa, 70 years after Frank Blanchard's survey. American Midland Naturalist 131:311-319.

Lannoo, M. J. 1998. Amphibian conservation and wetland management in the upper Midwest: A catch-22 for the cricket frog? Pp. 330-339 in Lannoo, M. J., ed., Status and Conservation of Midwestern Amphibians. University of Iowa Press, Iowa City, Iowa.

Lehtinen, R. M. 2002. A historical study of the distribution of Blanchard's cricket frog (*Acris crepitans blanchardi*) in southeastern Michigan. Herpetological Review 33:194-197.

MacKenzie, D. I., J. D. Nichols, G. B. Lachman, S. Droege, J. A. Royle, and C. A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83:2248-2255.

Oldfield, B., and J. J. Moriarty. 1994. Amphibians and Reptiles Native to Minnesota. University of Minnesota Press, Minneapolis, Minnesota.

Ramus, E., ed. 1998. 1998 – 1999 directory: The herpetology sourcebook. Reptile and Amphibian Magazine, Pottsville, Pennsylvania.

Smith, G. R., A. Todd, J. E. Rettig, and F. Nelson. 2003. Microhabitat selection by northern cricket frogs (*Acris crepitans*) along a west-central Missouri creek: Field and experimental observations. Journal of Herpetology 37:383-385.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Swanson, D. L., and S. L. Burdick. 2010. Overwintering physiology and hibernacula microclimates of Blanchard's cricket frogs at their northwestern range boundary. Copeia 2010:247-253.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Vogt, R. C. 1981. Natural History of Amphibians and reptiles of Wisconsin. The Milwaukee Public Museum, Milwaukee, Wisconsin.

Weller, W. F., and D. M. Green. 1997. Checklist and current status of Canadian amphibians. Pp. 309 – 328, in Green, D. M., ed. Amphibians in Decline: Canadian Studies of a Global Problem. Herpetological Conservation, No. 1, Society for the Study of Amphibians and Reptiles, St. Louis, Missouri.

Wright, A. H., and A. A. Wright. 1949. Handbook of Frogs and Toads of the United States and Canada. Comstock Publishing Company, Ithaca, New York.

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South Dakota Distribution Map:

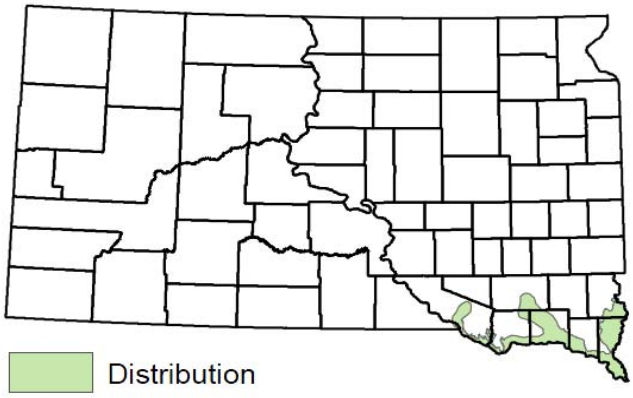

Photo:

Blanchard's Cricket Frog Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: American toad.

Scientific Name: *Anaxyrus americanus.*

Taxonomic Note: Frost et al. (2006) re-examined the taxonomy of anurans. The genus *Bufo*, long the generic name used to refer to all species of toads found in South Dakota, was changed to *Anaxyrus*, e.g., the American toad, *Anaxyrus americanus* (Crother 2011). Field guides may refer to this species as *Anaxyrus americanus* (Kiesow 2006) or *Bufo americanus* (Conant and Collins 1998). Prior to and even after 2006, authors referring to the American toad may be using either generic name, *Anaxyrus* or *Bufo*.

Description: Toads have dry skin covered in "warts", which are actually glands containing a toxin that is an anti-predator defense. Toads in the genus *Anaxyrus* are difficult to tell apart. All of them are similar in color and in size, about 2 – 3.5 inches length. In South Dakota, the American toad is only found east of the Missouri River, where the three other species of *Anaxyrus* found in the state (Canadian, Great Plains, and Woodhouse's toads) are also found. West of the Missouri River in South Dakota, a toad in the hand is not an American toad. Most field guides refer to the shape of the bosses and glands on the head to distinguish the many North American species of *Anaxyrus*. In particular, the shape of the parotoid glands (large glands on the postero-lateral edge of the skull) and their connection to ridges on the dorsum of the head are critical in identifying these species (see Conant and Collins 1998). The Great Plains toad is distinguished by a mottled color pattern quite different from the other toads (Conant and Collins 1998) so it typically can be distinguished, but American, Canadian, and Woodhouse's toads are similar to each other. Also, many species of *Anaxyrus* hybridize and the hybrids can have morphology intermediate between that of the two parent species. The calls of toads sound like buzzes or trills, but should not be used to distinguish toads in the genus *Anaxyrus*, because their calls are somewhat similar. For further discussion and identification aids, see Conant and Collins (1998).

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): SU.

Distribution

- Global: Green (2005) provided the best map of the species' distribution in the United States. It is found across the eastern United States from the eastern Great Plains to the

Atlantic shore, but is not present across much of the southeast. Louisiana, Alabama, Mississippi and Georgia have populations in the northern half of the state, which is the southern terminus of the range of the American toad. It is also found throughout most of the provinces of Ontario, Quebec, New Brunswick and Nova Scotia, to the southern part of Newfoundland.

- South Dakota
    - Historical: Across the eastern half of the state east of the Missouri River (Green 2005).
    - Current: Green (2005) stated that the range of the American toad has not changed in at least 50 years, and that it is probably essentially the same as it was prior to European arrival in North America. Kiesow (2006) did not mention any change to its range in South Dakota.

Population trend: Wright and Wright (1949) noted that this toad was common, as do many other authors stretching from Wright and Wright (1949) throughout the remainder of the 20th century (Green 2005 summarizes some of this literature). There is no reason to suspect any recent declines, but no population data exist from which to evaluate trends.

Key Habitat

- Key Habitat Description: American toads can be found in all sorts of natural and altered habitats (Green 2005 and references included therein), including urban settings, as long as there is water to breed in and invertebrates to eat (Conant and Collins 1998). They prefer seasonal and temporary ponds for breeding but will also use permanent lakes and streams. In South Dakota they can be found just about anywhere within their range east of the Missouri River.
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Eastern Prairie Tall-grass Subregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Southern Dark Brown Glaciated Plains (53C), Central Black Glaciated Plains (55B), Southern Black Glaciated Plains (55C), Southern rolling Pierre Shale Plains (63B), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Bad/Choteau, Red and Minnesota River.

Threats and Issues in South Dakota

- Acid precipitation: Clark (1986) found that acid precipitation negatively affects American toads.
- Agrochemicals: Green (2005) noted that this was one of the few factors that could affect American toads. Green (2005), citing a large number of references, lists a number of compounds used in agriculture that have lethal and sublethal effects on American toads, including benzopyrene, methoxychlor, toxaphene, endrin, glyphosate, and lead and ammonium nitrate. Tadpoles in particular are at risk. For further details, see Clark

and Diamond (1971), Hall and Swineford (1979, 1981), Bracher and Bider (1982), Steele et al. (1991, 1999), Hecnar (1995), Jofre and Karasov (1999), Harris et al. (2000), and Edginton et al. (2004). Additionally, Relyea (2005) found that Roundup® killed 100% of American toad tadpoles and 86% of juveniles.

- Atrazine: Concentrations of atrazine found in the field may not typically be high enough to affect American toads (Allran and Karasov 2001).
- Chytridiomycosis: Longcore et al. (2007) found that American toads were the least likely toads to be infected with chytridiomycosis in the northeastern United States.
- Habitat fragmentation: Given the wide range of habitats this species tolerates, including anthropogenically altered habitat, American toads are unlikely to be very affected by habitat fragmentation. Hager (1998), Kolozsvary and Swihart (1999), and Lehtinen et al. (1999) all found that they are tolerant of habitat fragmentation. They are also known to quickly reinvade areas that have been clearcut and/or burned (Blymyer and McGinnes 1977, Kirkland et al. 1996).
- Purple loosestrife: This invasive weed negatively effects tadpoles of the American toad, although the mechanism is not clear (Brown et al. 2006). The South Dakota Department of Agriculture is working to control purple loosestrife.

Recommended Conservation and Research Actions:

- Agrochemicals: Agrochemicals are potentially a problem for American toads. Exposure to agrochemicals including benzopyrene, glyphosate (the active ingredient in Roundup®), methoxychlor, toxaphene, endrin, and lead and ammonium nitrate should be limited, especially at breeding ponds. Tadpoles are the life stage most susceptible to lethal and sublethal effects from agrochemicals. Whenever possible, breeding ponds should be protected from contamination by these compounds, especially when amphibian larvae are present.

Policy Recommendations:

- Agrochemicals: Exposure to agrochemicals should be limited, although data are lacking as to the amount of agrochemicals American toads can be subjected to without detrimental effects to populations. It is clear there are detrimental effects in laboratory experiments. Tadpoles are at particular risk, and breeding ponds should be protected. Roundup® could be particularly lethal (Relyea 2005).
- Bag limits: Collection of this species is not regulated. Until data can be collected to institute science based bag limits on this species based on life table parameters (reproduction and recruitment), establish a bag limit of 24 daily with a maximum possession of 24. This is the current bag limit for leopard frogs and tiger salamanders in South Dakota, and until life table parameters can be defined so sustainable harvests can be estimated for *Anaxyrus americanus*, these provisional bag limits can be used.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station; David Swanson, University of South Dakota.

Account author: Brian Smith, Department of Biology, Black Hills State University.

Literature Cited

Allran, J. W., and W. H. Karasov. 2001. Effects of atrazine on embryos, larvae, and adults of anuran amphibians. Environmental Toxicology and Chemistry 20:769-775.

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Blymyer, M. J., and B. S. McGinnes. 1977. Observations on possible detrimental effects of clearcutting on terrestrial amphibians. Bulletin of the Maryland Herpetological Society 13:79-83.

Bracher, G. A., and J. R. Bider. 1982. Changes in terrestrial animal activity of a forest community after an application of aminocarb matacil. Canadian Journal of Zoology 60:1981-1997.

Brown, C. J., B. Blossey, J. C. Maerz, and S. J. Joule. 2006. Invasive plant and experimental venue affect tadpole performance. Biological Invasions 8:327-338.

Clark, K. L. 1986. Distributions of anuran populations in central Ontario relative to habitat acidity. Water, Air, and Soil Pollution 30:727-734.

Clark, H. F., and L. Diamond. 1971. Comparative studies on the interaction of benzopyrene with cells derived from poikilothermic and homeothermic vertebrates. Part 2. Effect of temperature on benzpyrene metabolism and cell multiplication. Journal of Cell Physiology 77:385-392.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Crother,B. I., Committee Chair. 2011. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, Edition 6.1. http://www.ssarherps.org/pages/comm_names/Index.php. Accessed 2 July 2012.

Edginton, A. N., P. M. Sheridan, G. R. Stephenson, D. G. Thompson, and H. J. Boermans. 2004. Comparative effects of pH and Vision herbicide on two life stages of four anuran amphibian species. Environmental Toxicology and Chemistry 23:815-822.

Frost, D. R., T. Grant, J. Faivovich, R. H. Bain, A. Haas, C. F. B. Haddad, R. O. De Sá, A. Channing, M. Wilkinson, S. C. Donnellan, C. J. Raxworthy, J. A. Campbell, B. L. Blotto, P. Moler, R. C. Drewes, R. A. Nussbaum, J. D. Lynch, D. M. Green, and W. C. Wheeler. 2006. The amphibian tree of life. Bulletin of the American Museum of Natural History 297:1-370.

Green, D. M. 2005. *Bufo americanus*. Pp. 386-390 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

Hager, H. A. 1998. Area-sensitivity of reptiles and amphibians: Are there indicator species for habitat fragmentation? Ecoscience 5:139-147.

Hall, R. J., and D. M. Swineford. 1979. Uptake of methoxychlor from food and water by the American toad (*Bufo americanus*). Bulletin of Environmental Contamination and Toxicology 23:335-337.

Hall, R. J., and D. M. Swineford. 1981. Acute toxicities of toxaphene and endrin to larvae of 7 species of amphibians. Toxicology Letters 8:331-336.

Harris, M. L., L. Chora, C. A. Bishop and J. P. Bogart. 2000. Species- and age-related differences in susceptibility to pesticide exposure for two amphibians, *Rana pipiens*, and *Bufo americanus*. Bulletin of Environmental Contamiknationand Toxicology 64:263-270.

Hecnar, S. J. 1995. Acute and chronic toxicity of ammonium nitrate fertilizer to amphibians from southern Ontario. Environmental Toxicology and Chemistry 14:2131-2137.

Jofre, M. B., and W. H. Karasov. 1999. Direct effect of ammonia on three species of North American anuran amphibians. Environmental Toxicology and Chemistry 18:1806-1812.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Kirkland, G. L., Jr., H. W. Snoddy, and T. L. Amsler. 1996. Impact of fire on small mammals and amphibians in a central Appalachian deciduous forest. American Midland Naturalist 135:253-260.

Kolozsvary, M. B, and R. K. Swihart. 1999. Habitat fragmentation and the distribution of amphibians: Patch and landscape correlates in farmland. Canadian Journal of Zoology 77:1288-1299.

Lehtinen, R. M., S. M. Galatowitsch, and J. R. Tester. 1999. Consequences of habitat loss and fragmentation for wetland amphibian assemblages. Wetlands 19:1-12.

Longcore, J. R., J. E. Longcore, A. P. Pessier, and W. A. Halteman. 2007. Chytridiomycosis widespread in anurans of northeastern United States. Journal of Wildlife Management 71:435-444.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Relyea, R. A. 2005. The lethal impact of Roundup© on aquatic and terrestrial amphibians. Ecological Applications 14:1118-1124.

Smith, P. W. 1947. The reptiles and amphibians of eastern central Illinois. Chicago Academy of Science Bulletin 8:21-40.

Steele, C. W., S. Strickler-Shaw, and D. H. Taylor. 1991. Failure of *Bufo americanus* tadpoles to avoid lead-enriched water. Journal of Herpetology 25:241-243.

Steele, C. W., S. Strickler-Shaw, and D. H. Taylor. 1999. Effects of sublethal lead exposure on the behaviors of green frog (*Rana clamitans*), bullfrog (*Rana catesbeiana*) and American toad (*Bufo americanus*) tadpoles. Marine and Freshwater Behavior Physiology 32:1-16.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Wright, A. H., and A. A. Wright. 1949. Handbook of Frogs and Toads of the United States and Canada. Comstock Publishing Company, Ithaca, New York.

South Dakota Distribution Map:

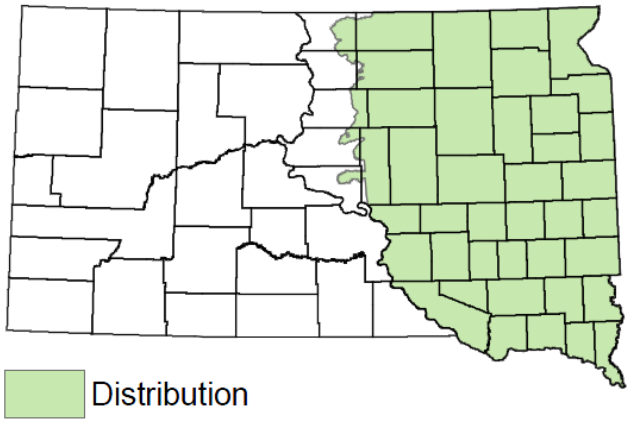

Photo:

American Toad Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Great Plains toad.

Scientific Name: *Anaxyrus cognatus.*

Taxonomic Note: Frost et al. (2006) re-examined the taxonomy of anurans and changed the generic name *Bufo*, long used to refer to all species of toads found in South Dakota, to *Anaxyrus*. The standard scientific name for the Great Plains toad is now *Anaxyrus cognatus* (Crother 2011). Field guides may refer to this species as *Anaxyrus cognatus* (Kiesow 2006) or *Bufo cognatus* (Conant and Collins 1998). Prior to and even after 2006, authors referring to the Great Plains toad may use either generic name, *Anaxyrus* or *Bufo*.

Description: Toads have dry skin covered in "warts", which are actually glands containing a toxin that is an anti-predator defense. Toads in the genus *Anaxyrus* can be difficult to tell apart. The Great Plains toad is found throughout South Dakota, and overlaps the ranges of the three other species of *Anaxyrus* found in the state (American, Canadian, and Woodhouse's toads), so mistakes in identification can be made. Many field guides refer to the shape of the bosses and glands on the head to distinguish the many North American species of *Anaxyrus*, including the Great Plains toad. In particular, the shape of the parotoid glands (large glands on the postero-lateral edge of the skull) and their connection to ridges on the dorsum of the head are critical in identifying these species (Conant and Collins 1998). However, in South Dakota the Great Plains toad is the only toad that is distinctively mottled across its sides and dorsum. Coloration of other toads in the state is highly variable but is not so distinctively mottled. The calls (buzzes or trills) of many toads are similar and should not be used to distinguish toads in the genus *Anaxyrus*.

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Unknown.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S5.

Distribution

- Global: Graves and Krupa (2005) provided the most accurate range map for this species. It is found throughout the Great Plains of the United States, from northern Texas through all but the northernmost counties of North Dakota. Its range also encompasses the plains of Arizona and New Mexico, the Trans-Pecos region of Texas, the eastern plains of Montana, and far southern Alberta and Saskatchewan, Canada.
- South Dakota

- Historical: Statewide (Kiesow 2006), except the higher elevations of the Black Hills (ca. 1500 m and higher, unpublished data).
- Current: There are no recent statewide surveys of the species.

Population Trend: The Great Plains toad is an explosively breeding amphibian, meaning that they will come out in large numbers to breed for only a few days following heavy rainfall (Krupa 1994). Otherwise they are primarily fossorial and difficult to find. Environmental conditions have to be "just right" to observe them, and false absences are common in survey work. As a result, we know little about population fluctuations or long-term trends in abundance of Great Plains toads. However, Graves and Krupa (2005) stated that they were likely to still be relatively common. Declines may have occurred at the northern edge of their range in Alberta, and James (1998) considered them endangered in that province. Subsequent reassessment by Alberta's Endangered Species Conservation Committee concluded that insufficient data exist to determine their conservation status in Alberta (Alberta Department of Environment and Sustainable Resource Development 2012). In Manitoba, they are considered to be threatened (Manitoba Conservation Wildlife and Ecosystem Protection Branch 2012). In Montana, they are a "species of concern" (Werner et al. 2004). They are primarily fossorial except during breeding bouts, which occur for a few days around heavy rainfall, so it is difficult to detect them during dry periods (James 1998 and personal observations).

Long-term monitoring is necessary to track changes in abundance of Great Plains toads, and population surveys must be completed within a few days of heavy rainfall during the active season. In drought years they may not be observed at all, yet can be relatively common in non-drought years following heavy rains (personal observations). A common misconception is that the species only breeds following heavy summer rains in relatively warm weather. In fact, they appear to breed anytime during the active season, either in the few days following heavy summer rains, such as summer thunderstorms, or any period of soaking rainfall anytime during the active season (personal observations). For example, I have found them breeding in late spring in water temperatures of 3°C (unpublished data).

Key Habitat

- Key Habitat Description: The Great Plains toad is endemic to the Great Plains of North America. Within the Great Plains, it can be found in all types of prairie habitat (Wright and Wright 1949), and can even be found in agricultural lands (Wright and Wright 1949, Degenhardt et al. 1996) and urban areas (Krupa 1994). They can be very common in arid parts of South Dakota such as Badlands National Park (Smith et al. 1998a), but may not be seen for years. I have also found them to be abundant at Wind Cave National Park (Smith et al. 1998b), again with long periods of apparent inactivity. They are associated with temporary water bodies in roadside ditches, where they congregate to breed (unpublished data). At Wind Cave National Park, they were found in breeding choruses in a large seasonal pond and in bison wallows (Smith et al. 1998b). They probably avoid wooded areas and marshy wetlands (Ewert 1969). Werner et al. (2004) reported that the Great Plains toad occurred in temporary ponds and ditches, similar to my experience in South Dakota.

- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Eastern Prairie Tall-grass Subregion, Missouri River Ecoregion, Great Plains Steppe Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Southern Dark Brown Glaciated Plains (53C), Rolling Soft Shale Plains (54), Central Black Glaciated Plains (55B), Southern Black Glaciated Plains (55C), Red River Valley of the North (56), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Northern Rolling Pierre Shale Plains (63A), Southern rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand hills (65), Dakota-Nebraska Eroded Tableland (66), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand Moreau, Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara, Red and Minnesota River.

Threats and Issues in South Dakota

- Graves and Krupa (2005) reported no significant threats to the species, but they also point out that little is known about their natural history.

Recommended Conservation and Research Actions

- Monitoring and survey work: A statewide monitoring protocol should be developed, taking into account suitable weather conditions for surveys (i.e., after soaking rains or heavy thunderstorms). Other species of explosive breeding amphibians, such as plains spadefoots, could be monitored at the same time. Field personnel must be flexible to respond to the unpredictability of suitable weather conditions, and be able to identify toads. State Game, Fish, and Parks employees and other wildlife managers are present at field sites during their ordinary course of work and can be trained to identify plains spadefoots and Great Plains toads. This can be used to advantage to monitor and survey these two species during unpredictable weather conditions.

Policy Recommendations:

- Bag limits: Collection of this species is not regulated. Until data can be collected to institute science based bag limits on this species based on life table parameters (reproduction and recruitment), establish a bag limit of 24 daily with a maximum possession of 24. This is the current bag limit for leopard frogs and tiger salamanders in South Dakota, and until life table parameters can be defined so sustainable harvests can be estimated for *Anaxyrus cognatus*, these provisional bag limits can be used.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station; David Swanson, University of South Dakota.

Account author: Brian Smith, Department of Biology, Black Hills State University.

Literature Cited

Alberta Department of Environment and Sustainable Resource Development. 2012. Great Plains toad *(Bufo cognatus)*. http://www.srd.alberta.ca/FishWildlife/WildSpecies/Amphibians/Toads/GreatPlainsToad.aspx. (Accessed 3 September 2012.)

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Crother,B. I., Committee Chair. 2011. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, Edition 6.1. http://www.ssarherps.org/pages/comm_names/Index.php. Accessed 2 July 2012.

Degenhardt, W. G., C. W. Painter, and A. H. Price. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico.

Ewert, M. A. 1969. Seasonal movements of the toads *Bufo americanus* and *B. cognatus* in northwestern Minnesota. Ph.D. dissertation. University of Minnesota, Minneapolis, Minnesota.

Frost, D. R., T. Grant, J. Faivovich, R. H. Bain, A. Haas, C. F. B. Haddad, R. O. De Sá, A. Channing, M. Wilkinson, S. C. Donnellan, C. J. Raxworthy, J. A. Campbell, B. L. Blotto, P. Moler, R. C. Drewes, R. A. Nussbaum, J. D. Lynch, D. M. Green, and W. C. Wheeler. 2006. The amphibian tree of life. Bulletin of the American Museum of Natural History 297:1-370.

Graves, B. M., and J. J. Krupa. 2005. *Bufo cognatus*. Pp. 401-404 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

James, J. D. 1998. Status of the Great Plains toad (*Bufo cognatus*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, and Alberta Conservation Association. Wildlife Status Report, Number 14. Edmonton, Alberta.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Krupa, J. J. 1994. Breeding biology of the Great Plains toad in Oklahoma. Journal of Herpetology 28:217-224.

Manitoba Conservation Wildlife and Ecosystem Protection Branch. 2012. Manitoba's species at risk: Great Plains toad (*Bufo cognatus*). http://www.gov.mb.ca/conservation/wildlife/sar/pdf/gp_toad.pdf. (Accessed 3 September 2012.)

Smith, B. E., D. M. Browning, E. Taylor, R. S. Ferguson, and K. Yturralde. 1998a. Herpetofaunal surveys of the Fall River Ranger District, U.S. Forest Service, southwestern South Dakota and Badlands National Park. Unpublished report submitted to the Northern Prairie Wildlife Research Center, U.S. Geological Survey, Biological Resources Division. Jamestown, North Dakota.

Smith, B. E., J. J. Kolbe, and R. S. Ferguson. 1998b. A herpetological survey of Wind Cave National Park, South Dakota. Unpublished report submitted to the Northern Prairie Wildlife Research Center, U.S. Geological Survey, Biological Resources Division. Jamestown, North Dakota.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Werner, J. K., B. A. Maxell, P. Hendricks, and D. L. Flath. 2004. Amphibians and Reptiles of Montana. Mountain Press Publishing Company, Missoula, Montana.

Wright, A. H., and A. A. Wright. 1949. Handbook of Frogs and Toads of the United States and Canada. Comstock Publishing Company, Ithaca, New York.

South Dakota Distribution Map:

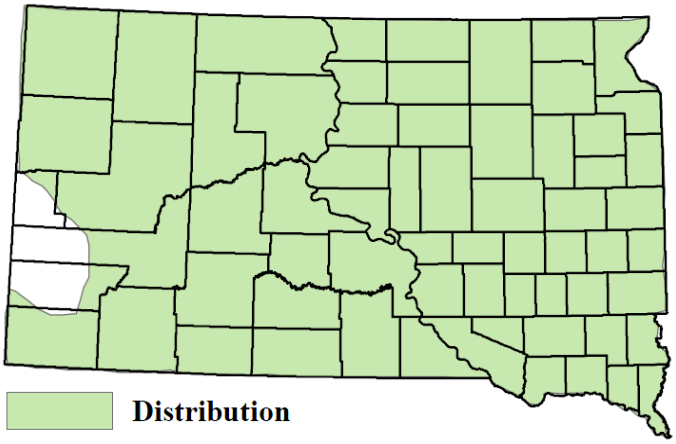

Photo:

Great Plains Toad Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Canadian toad.

Scientific Name: *Anaxyrus hemiophrys.*

Taxonomic Note: Frost et al. (2006) re-examined the taxonomy of anurans and changed genus *Bufo* to *Anaxyrus*. The standard scientific name for the Canadian toad is now *Anaxyrus hemiophrys* (Crother 2011). Field guides may refer to this species as *Anaxyrus hemiophrys* (Kiesow 2006) or *Bufo hemiophrys* (Conant and Collins 1998). Prior to and even after 2006, authors referring to the Canadian toad may use either generic name, *Anaxyrus* or *Bufo*.

Additionally, the Wyoming toad of Albany County, Wyoming, was considered for many years to be an isolated population of *B. hemiophrys*. In 1968, Porter described this population as a subspecies of the Canadian toad, *B. h. baxteri*. Later, Smith et al. (1998) elevated this species to full specific status, *B. baxteri* (now *A. baxteri*).

Description: Toads have dry skin covered in "warts", which are actually glands containing a toxin that is an anti-predator defense. Toads in the genus *Anaxyrus* can be difficult to tell apart. Most are roughly 2 – 3.5 inches in length. The Canadian toad is found throughout much of the eastern third of the state, and its range is overlapped by the three other species of *Anaxyrus* found in the state (American, Great Plains, and Woodhouse's toads), so mistakes in identification can be made. Great Plains toads can be separated based on color pattern (see the species profile for Great Plains toads). Many field guides refer to the shape of the bosses and glands on the head to distinguish the many North American species of *Anaxyrus* (i.e., Conant and Collins 1998). Unlike the other toads of the state, the Canadian toad has a pronounced boss on the dorsum between the eyes, and the paratoid glands have no connection to it. Additionally, there are no lateral ridges on the dorsum of the skull immediately behind the eyes. Identification should not be made based on the call alone, because the calls of many toads are similar and sound like nondescript buzzes or trills.

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Decreasing.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G4.
- State Rank (NatureServe): SU.

Distribution

- Global: The Canadian toad is widely distributed in the Canadian provinces of Alberta (across the eastern half of the province), Saskatchewan, and Manitoba (in the

southwestern part of the province). In the United States it is found across the eastern half of North Dakota, the northwestern corner of Minnesota, and the eastern third of South Dakota.

- South Dakota
    - Historical: The eastern third of the state.
    - Current: Kiesow (2006) did not mention any changes in range within the state. Ewert and Lannoo (2005) discussed declines in abundance in Alberta but did not note any other declines and did not mention any recent changes in the range of Canadian toads.

Population Trend: Ewert and Lannoo (2005) reviewed the literature on population status of the Canadian toad and found no widespread evidence of population declines or changes in the range. However, Roberts (1992) had concerns about their decline in Alberta. More recently, Hamilton et al. (1998) reported some declines in Alberta, but no cause to consider the species in widespread decline there. The Canadian toad has not been studied in South Dakota.

Key Habitat

- Key Habitat Description: Canadian toads favor mesic prairies and savannas (Roberts and Lewin 1979), and especially wet prairies and prairie pothole habitat (Ewert and Lannoo 2005). Conant and Collins (1998) state that they are "considerably more aquatic" than most toads. They are particularly associated with aspen parkland habitat in Canada (Hamilton et al. 1998). In South Dakota, their range is restricted to the prairie pothole country of eastern South Dakota and the wetter prairie habitats of southeastern South Dakota (see range map in Ewert and Lannoo 2005).
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Eastern Prairie Tall-grass Subregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Southern Dark Brown Glaciated Plains (53C), Central Black Glaciated Plains (55B), Southern Black Glaciated Plains (55C), Southern Rolling Pierre Shale Plains (63B), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): James, Big Sioux/Vermillion, Little Sioux/Niobrara, Bad/Choteau, Red and Minnesota River.

Threats and Issues in South Dakota: None known, but the toxicology of Canadian toads has not been studied. Fortunately for the species, it is most commonly found in the prairie pothole region, where numerous national wildlife refuges and waterfowl production areas exist that protect resident bird populations, and this is doubtless to the Canadian toad's benefit (Ewert and Lannoo 2005). In addition to these federal lands under management, numerous other lands under state management occur throughout the prairie pothole region of South Dakota, including state parks and waterfowl production areas.

Recommended Conservation and Research Actions:

- Surveys: Surveys are needed to establish habitat linkages (refer to "Linkage to Ecosystem Diversity" above).
- Indicator species: Because this species may be a prairie pothole endemic, it may serve as an indicator species to assess the quality of such habitat. To my knowledge, there is no amphibian under management in the prairie pothole region that serves such a role. Yearly presence/absence surveys at designated state and federal lands may be a simple way to monitor the basic health of the prairie pothole region.

Policy Recommendations:

- Bag Limits: Collection of this species is not regulated. Until data can be collected to institute science based bag limits on this species based on life table parameters (reproduction and recruitment), establish a bag limit of 24 daily with a maximum possession of 24. This is the current bag limit for leopard frogs and tiger salamanders in South Dakota, and until life table parameters can be defined so sustainable harvests can be estimated for *Anaxyrus hemiophrys*, these provisional bag limits can be used.

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Ewert, M. A., and M. J. Lannoo. 2005. *Bufo hemiophrys*. Pp. 412-415 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

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Hamilton, I. M., J. L. Skilnick, H. Troughton, A. P. Russell, and G. L. Powell. 1998. Status of the Canadian Toad (*Bufo hemiophrys*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, and the Alberta Conservation Association, Wildlife Status Report No. 12, Edmonton, AB.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Porter, K. R. 1968. Evolutionary status of a relict population of *Bufo hemiophrys* Cope. Evolution 22:583-594.

Roberts, W. 1992. Declines in amphibian populations in Alberta. Pp. 14-16 in C. A. Bishop and K. E. Pettit, eds., Declines in Canadian Amphibian Populations: Designing a National Monitoring Strategy. Canadian Wildlife Service, Occasional Paper No. 76. Ottawa, Ontario, Canada.

Roberts, W., and V. Lewin. 1979. Habitat utilization and population densities of the amphibians of northeastern Alberta. Canadian Field-Naturalist 93:144-154.

Smith, H. M., D. Chiszar, J. T. Collins, and F. van Breukelen. 1998. The taxonomic status of the Wyoming toad, *Bufo baxteri* Porter. Contemporary Herpetology 1, http://dataserver.calacademy.org/herpetology/herpdocs/ch/1998/1/index.htm.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

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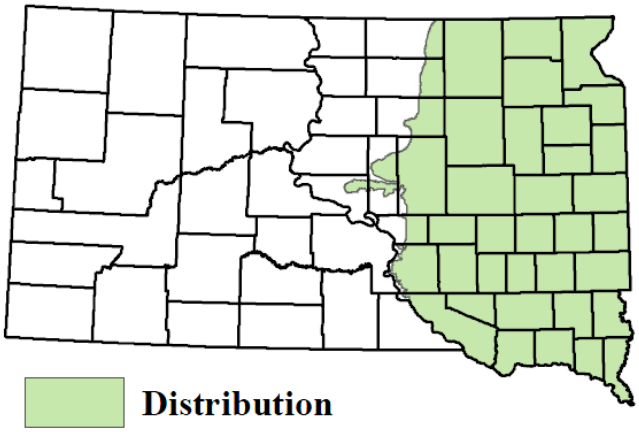

Photo:

Canadian Toad Jeffrey B. LeClere

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Woodhouse's toad.

Scientific Name: *Anaxyrus woodhousii.*

Taxonomic Note: In 2006, Frost et al. proposed assigning many North American species of the genus *Bufo* to the genus *Anaxyrus*. The generally accepted standard scientific name for Woodhouse's toad is now *Anaxyrus woodhousii* (Crother 2011). Field guides and other publications may refer to this species as *Anaxyrus woodhousii* (Kiesow 2006) or *Bufo woodhousii* (Conant and Collins 1998). Additionally, the former subspecies *A. w. fowleri* (Conant and Collins 1998) is now recognized as a distinct species, *A. fowleri* (Sullivan et al. 1996, Green 2005, Crother 2011).

Description: Toads have dry skin covered in "warts", which are actually glands containing a toxin that is an anti-predator defense. Toads in the genus *Anaxyrus* can be difficult to tell apart, but all range from 2 – 3.5 inches in length. Woodhouse's toad is found statewide, and its South Dakota range is overlapped by three other species of *Anaxyrus* (American, Canadian, and Great Plains toads). The Great Plains toad can be recognized by its distinctive coloration (see the Species Profile for the Great Plains toad). Identification of the other three species can be difficult. Identifying characters include the shape of the bosses and glands on the head, which distinguish many North American species of *Anaxyrus*, (see Conant and Collins 1998). Identification of Woodhouse's toad is best accomplished by eliminating other species based on physical characters. In South Dakota, the Great Plains toad can be identified by its marbled coloration (see the Great Plains toad species profile), the Canadian toad by the placement of the bosses between the eyes, and the American toad by the lack of a prominent mid-dorsal light stripe. See these species accounts for further information. The mid-dorsal light stripe is usually distinct in Woodhouse's toad. Identification should not be made based on the call alone, because the calls of many toads are similar and sound like nondescript buzzes or trills.

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S5.

Distribution

- Global: Woodhouse's toad has a range similar to the Great Plains toad, but the range of Woodhouse's toad extends into the drier parts of the intermountain west. It is found from North Dakota (except the northeastern quarter) throughout the plains states to

Texas, as well as eastern Texas and Louisiana. In the intermountain west, it is found in the eastern two-thirds of Montana, most of Wyoming, and virtually all of Arizona, Colorado, New Mexico, and Utah, except for the higher mountainous region of Colorado (Sullivan 2005). In fact, its range appears to be expanding (Sullivan 2005, see below). Although Conant and Collins (1998) show the range of Woodhouse's toad extending throughout most of the eastern third of the United States (as the subspecies *A. w. fowleri*), Green (2005) considered their taxonomy outdated, and pointed out that Sullivan et al. (1996) considered that *A. w. fowleri* was properly termed *Bufo* (now *Anaxyrus*) *fowleri*. See the taxonomic note for further details.

- South Dakota
    - Historical: Statewide (Kiesow 2006). However, Sullivan (2005) shows them absent in five counties in north-central South Dakota; Corson, Dewey, Campbell, Walworth, and Potter counties. They do not occur in the Black Hills above about 1500 m (Smith, unpublished data).
    - Current: Kiesow (2006) does not mention any changes in the range within South Dakota. Sullivan (2005) found that Woodhouse's toad is actually expanding its range and could be responsible for recent declines of some species of toads in Arizona, Colorado, and California.

Population Trend: Woodhouse's toads are thought to be expanding their range and may be contributing to declines of various other species of toads (Hammerson 1982; Sullivan 1986, 1993). They are also tolerant of disturbed areas (Hammerson 1982). No population trend data are available for South Dakota.

Key Habitat

- Key Habitat Description: Woodhouse's toads are found primarily in the prairies in South Dakota. They favor riparian strips in oxbow lakes, where they breed in the summer. Wright and Wright (1949) stated that they were found in almost any habitat with sufficient moisture within their range. They are considered a habitat generalist and tolerant of disturbance.
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Eastern Prairie Tall-grass Subregion, Great Plains Steppe Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Southern Dark Brown Glaciated Plains (53C), Rolling Soft Shale Plains (54), Central Black Glaciated Plains (55B), Southern Black Glaciated Plains (55C), Red River Valley of the North (56), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Northern Rolling Pierre Shale Plains (63A), Southern Rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand Hills (65), Dakota-Nebraska Eroded Tableland (66), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand Moreau, Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara, Red and Minnesota River.

Threats and Issues in South Dakota:

- Toxicology: Boone and Semlitsch (2002) and Boone et al. (2004) found that carbaryl did not affect Woodhouse's toad survival. Otherwise, the toxicology of Woodhouse's toad has been little investigated.
- Other data summarized above (see "Population Trend") indicate that there is little conservation concern for Woodhouse's toads at this time.

Recommended Conservation and Research Actions: None.

Policy Recommendations:

- Bag limits: Collection of this species is not regulated. Until data can be collected to institute science based bag limits on this species based on life table parameters (reproduction and recruitment), establish a bag limit of 24 daily with a maximum possession of 24. This is the current bag limit for leopard frogs and tiger salamanders in South Dakota, and until life table parameters can be defined so sustainable harvests can be estimated for *Anaxyrus woodhousii*, these provisional bag limits can be used.

Account author: Brian Smith, Department of Biology, Black Hills State University

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station; David Swanson, University of South Dakota.

Literature Cited

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Boone, M. D., and R. D. Semlitsch. 2002. Interactions of an insecticide with competition and pond drying in amphibian communities. Ecological Applications 12:307-316.

Boone, M. D., R. D. Semlitsch, J. F. Fairchild, and B. B. Rothermel. 2004. Effects of an insecticide on amphibians in large-scale experimental ponds. Ecological Applications 14:685-691.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Crother,B. I., Committee Chair. 2011. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, Edition 6.1. http://www.ssarherps.org/pages/comm_names/Index.php. Accessed 2 July 2012.

Frost, D. R., T. Grant, J. Faivovich, R. H. Bain, A. Haas, C. F. B. Haddad, R. O. De Sá, A. Channing, M. Wilkinson, S. C. Donnellan, C. J. Raxworthy, J. A. Campbell, B. L. Blotto, P. Moler, R. C. Drewes, R. A. Nussbaum, J. D. Lynch, D. M. Green, and W. C. Wheeler. 2006. The amphibian tree of life. Bulletin of the American Museum of Natural History 297:1-370.

Green, D. M. 2005. *Bufo fowleri*. Pp. 408-412 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

Hammerson, G. A. 1982. Amphibians and Reptiles in Colorado. Colorado Division of Wildlife Publication, DOW-M-I-27-82. Denver, Colorado.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Sullivan, B. K. 1986. Hybridization between the toads *Bufo microscaphus* and *Bufo woodhousei* in Arizona: Morphological variation. Journal of Herpetology 20:11-21.

Sullivan, B. K. 1993. Distribution of the southwestern toad (*Bufo microscaphus*) in Arizona. Great Basin Naturalist 53:402-406.

Sullivan, B. K. 2005. *Bufo woodhousii*. Pp. 438-440 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

Sullivan, B. K., K. B. Malmos, and M. F. Given. 1996. Systematics of the *Bufo woodhousii* complex (Anura: Bufonidae); advertisement call variation. Copeia 1996:274-280.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Wright, A. H., and A. A. Wright. 1949. Handbook of Frogs and Toads. Comstock Publishing Co., Ithaca, New York.

South Dakota Distribution Map:

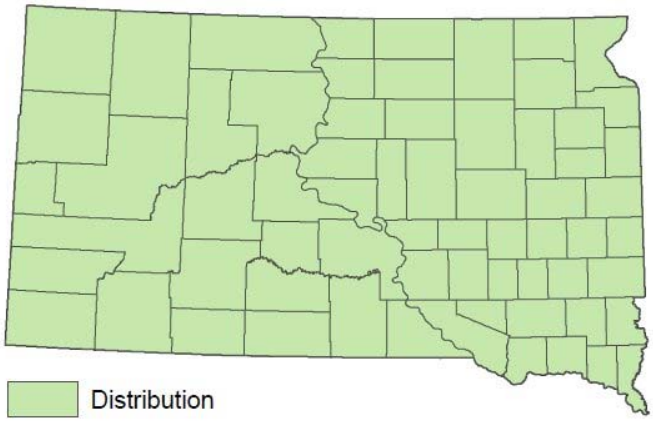

Photo:

Woodhouse's Toad Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Gray treefrog.

Scientific Name: *Hyla chrysoscelis/versicolor.*

Taxonomic note: These two species (*H. chrysoscelis* and *H. versicolor*) are, for all practical purposes, indistinguishable except by call and chromosome number. They are members of a diploid-tetraploid species complex. *H. chrysoscelis* is diploid (there are two sets of chromosomes in each cell, a typical chromosome count for most species) and *H. versicolor* is tetraploid (there are four copies of each chromosome in its cells). *H. versicolor* probably originated from *H. chrysoscelis* at least three separate times (Ptacek et al. 1994). They cannot be separated morphologically. Calls differ but vary according to body temperature (Gerhardt 2005) such that some overlap may occur, limiting use in identification. However, the species maintain separate identities and ranges (Ptacek et al. 1994). Status of the two species in South Dakota remains unresolved. Conant and Collins (1998) treat the two species in a single account, and Kiesow (2006) and Fischer et al. (1999) in two accounts, with no chromosome or call analyses available. Ptacek et al. (1994) and Ptacek (1996) have found that natural history attributes of these two species are virtually identical, and treating the two species as one (at least in basic descriptions of natural history) is justified. Ptacek et al. (1994) found that gray treefrogs in Minnesota (their closest sampling site to South Dakota) were *H. versicolor*. Genetic data can be used to sort out the species' ranges (Ptacek et al. 1994, Espinoza and Noor 2002). Detailed accounts of each species are found in Cline (2005a, 2005b).

Description: This small frog (1 ¼ to 2 inches SVL) is found in isolated pockets in South Dakota (see "Distribution" below), so in most parts of the state can be eliminated from consideration when identifying small frogs. It is highly variable in pattern and can be any shade from gray to brownish to olive. Individual frogs can also change color somewhat depending on their activity. The back is covered with tubercles that are somewhat prominent, but not as prominent as those covering toads. Concealed surfaces of the hind legs are orange to yellow in coloration, mottled with black. Unlike any other frog or toad native to South Dakota, this frog will often forage in vegetation so will typically be found in trees and bushes and not on the ground.

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S2.

Distribution

- Global: The eastern United States, from the eastern borders of North and South Dakota, Nebraska, Kansas, Oklahoma, and the eastern half of Texas to the Atlantic shore. *Hyla versicolor* is found throughout New England (Cline 2005b). It is also present in southern Manitoba and Quebec.
- South Dakota
    - Historical: Disjunct populations in far northeastern and far southeastern South Dakota.
    - Current: In 2003 a population was found near Oahe Dam, a range extension of over 300 km (200 miles) to the northwest of the known range in South Dakota. This locality is reported in Kiesow (2006); specific locality data are in the South Dakota Natural Heritage Database. Otherwise, Kiesow (2006) mentions no change in its range.

Population Trend: Cline (2005b) reported that both *Hyla chrysocelis* and *H. versicolor* remained common, but many of the works he cited were very old (dating to 1932 and before). Cline (2005b) stated that in his personal experience both species were still common. The species is found infrequently at few locations in South Dakota. Due to its restricted range in the state, the state monitors the species.

Key Habitat

- Key Habitat Description: Little seems to be known about the favored habitat of these species. They are tree frogs and are seldom found on the ground, although they hibernate on land under woody debris, leaf litter, and amongst roots (Harding 1997). Wright and Wright (1949) stated that were found in trees and wooded areas along creeks and rivers. They are freeze tolerant (Schmid 1982, Storey and Story 1986, Costanzo et al. 1992, Irwin and Lee 2003), so they can remain in a frozen state for some period of time. Aquatic habitat is required for breeding, usually vegetated but fish-free ephemeral or semi-permanent ponds and wetlands (Cline 2005a,b).
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Tall-grass Subregion, Missouri River Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Southern Dark Brown Glaciated Plains (53C), Rolling Till Prairie (102A), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): Middle Missouri, Big Sioux/Vermillion, Little Sioux/Niobrara, Bad/Choteau.

Threats and Issues in South Dakota:
Agrochemicals: Relyea (2005) found that Roundup® reduced survivorship of *Hyla versicolor* tadpoles raised in a laboratory mesocosm from 75% to 2%. Atrazine had limited effects on *H. versicolor* tadpoles (Diana et al. 2000). Relyea (2009) found that a mixture of several kinds of contaminants did not affect *H. versicolor* tadpoles. Available literature suggests that Roundup® constitutes a danger to the species but other toxins have limited effects.

Recommended Conservation and Research Actions:

- Monitoring: Continued monitoring of the species in South Dakota.
- Surveys: Surveys of the populations should be undertaken and critical habitat delineated. Species that occur in small populations that are widely separated and highly localized are often at risk should development or natural disasters affect one of the few populations. It is important to know where these populations are and to monitor the populations on a regular basis.
- Species identification: Determine which species occur in South Dakota (*Hyla chrysocelis* or *H. versicolor*) by karyotyping.
- Agrochemicals: Roundup® should be used sparingly near populations. Biocides and fertilizers should be kept out of breeding wetlands.

Policy Recommendations:

- Bag limits: Few populations of this species are known in South Dakota, and collections could easily cause population declines. Bag limits should restrict collection to sustainable levels. Collection of this species is not regulated. Until data can be collected to institute science based bag limits on this species based on life table parameters (reproduction and recruitment), establish a bag limit of 24 daily with a maximum possession of 24. This is the current bag limit for leopard frogs and tiger salamanders in South Dakota, and until life table parameters can be defined so sustainable harvests can be estimated for *Hyla chrysoscelis/versicolor*, these provisional bag limits can be used.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station; David Swanson, University of South Dakota.

Account author: Brian Smith, Department of Biology, Black Hills State University

Literature Cited

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Cline, G. R. 2005a. *Hyla chrysoscelis*. Pp. 449-452 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

Cline, G. R. 2005b. *Hyla versicolor*. Pp. 458-461 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Costanzo, J. P., M. F. Wright, and R. E. Lee, Jr. 1992. Freeze tolerance as an overwintering adaptation in Cope's grey treefrog (*Hyla chrysocelis*). Copeia 1992:565-569.

Diana, S. G., W. J. Resetarits Jr., D. J. Schaeffer, K. B. Beckman, and V. R. Beasley. 2000. Effects of atrazine on amphibian growth and survival in artificial aquatic communities. Environmental Toxicology and Chemistry 19:2961-2967.

Espinoza, N. R., and M. A. F. Noor. 2002. Population genetics of a polyploid: Is there hybridization between lineages of *Hyla versicolor*? Journal of Heredity 93:81-85.

Gerhardt, H. C. 2005. Advertisement-call preferences in diploid-tetraploid treefrogs (*Hyla chrysoscelis* and *Hyla versicolor*): Implications for mate choice and the evolution of communication systems. Evolution 59:395-408.

Harding, J. 1997. Amphibians and Reptiles of the Great Lakes Region. University of Michigan Press, Ann Arbor, Michigan.

Irwin, J. T., and R. E. Lee, Jr. 2003. Geographic variation in energy storage and physiological responses to freezing in the gray treefrogs *Hyla versicolor* and *H. chrysoscelis*. Journal of Experimental Biology 206:2859-2867.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks, Pierre, South Dakota.

Ptacek, M. B. 1996. Interspecific similarity in life-history traits in sympatric populations of gray treefrogs, *Hyla chrysoscelis* and *Hyla versicolor*. Herpetologica 52:323-332.

Ptacek, M. B., H. C. Gerhardt, and R. D. Sage. 1994. Speciation by polyploidy in treefrogs: multiple origins of the tetraploid, *Hyla versicolor*. Evolution 48:898–908.

Relyea, R. A. 2005. The lethal impact of Roundup on aquatic and terrestrial amphibians. Ecological Applications 15:1118-1124.

Relyea, R. A. 2009. A cocktail of contaminants: How mixtures of pesticides at low concentrations affect aquatic communities. Oecologia 159:363-376.

Schmid, W. D. 1982. Survival of frogs in low temperature. Science 215:697-698.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Storey, K. B., and J. M. Storey. 1986. Freeze tolerance and intolerance as strategies of winter survival in terrestrially-hibernating amphibians. Comparative Biochemistry and Physiology A 83:613-617.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Wright, A. H., and A. A. Wright. 1949. Handbook of Frogs and Toads. Comstock Publishing Company, Ithaca, New York.

South Dakota Distribution Map:

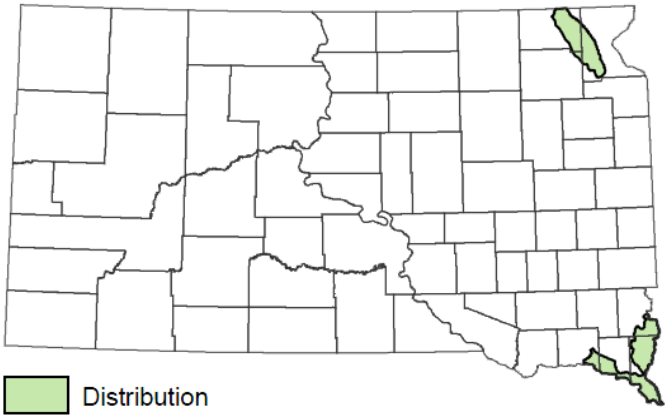

Photo:

Gray Treefrog Carol Hall, Minnesota DNR

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Plains leopard frog.

Scientific Name: *Lithobates blairi.*

Taxonomic Note: Many North American species formerly known as *Rana* sp. are now known as *Lithobates* sp., including *L. blairi* (Frost et al. 2006). In the literature, they may be referred to as *L. blairi* (Kiesow 2006) or *R. blairi* (Conant and Collins 1998).

Description: Plains and northern leopard frogs (*Lithobates pipiens*) are very similar and may hybridize (Cosineau and Rogers 1991, Baness 1997). Apparent hybrids have been found in South Dakota (Dunlap and Kruse 1976, Di Candia and Routman 2007, Smith personal observations). Both frogs are roughly the same size, 2 – 3 ½ inches, with several round spots on a greenish or brownish background. The plains leopard frog can be distinguished using two characters: 1) Dorsolateral folds running the length of the body are broken and inset medially (they are continuous in the northern leopard frog, see Conant and Collins 1998); and 2) The plains leopard frog's tympanum has a central white spot, which is absent in the northern leopard frog. For illustrations of the tympanum see Conant and Collins (1998). Intermediates exist; dorsolateral folds can be indistinctly broken, for example. The central white spot on the tympanum can be absent from frogs that otherwise appear to be plains leopard frogs. These could be hybrids, but data are lacking to say definitively that this is the case. Plains leopard frogs (and putative hybrids) seem to be absent from forested elevations in the Black Hills. Frogs that appear to be northern leopard frogs, based on morphology, extend to the highest elevations in the Black Hills. See South Dakota Range (below) for more information on the two species' ranges that can assist in identification.

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Decreasing.
- USFWS: Not listed.
- State: Not listed. This species may be taken under the authority of a state fishing license, and has a bag limit of 24 daily, with a maximum possession of 24. It may also be taken under the authority of a bait dealer's license, with no limit on take.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S3S4.

Distribution

- Global
- South Dakota
    - Historical: The range of the plains leopard frog is difficult to determine from available literature and uncertainty over possible hybrids between plains and

northern leopard frogs in western South Dakota. The range map in Kiesow (2006) is probably inaccurate and apparently follows Dunlap and Kruse (1976). The range map in Crawford et al. (2005) may not be accurate based on observations of hybrids in South Dakota. Maps in Di Candia and Routman (2007) are based on their molecular data. These maps do not agree with those in Dunlap and Kruse (1976), Crawford et al. (2005), and Kiesow (2006), and appear to radically redraw the distribution of both species, not only in South Dakota, but in other parts of the range of plains and northern leopard frogs (see their fig. 5, p. 572). More sampling is needed within South Dakota to clarify the distribution of both species in the state and to delineate zones of hybridization, if they occur here. My best estimate of the range of the plains leopard frog includes the counties immediately north of the Missouri River along the border of Nebraska, westwards to about midway across the state. West of this, I and others have seen specimens that appear to be intermediate in morphology between plains and northern leopard frogs.

- Current: Unknown since distribution and hybridization are not completely understood within South Dakota.

<u>Population Trend</u>:

- A number of workers have noted declines in many parts of the range (summarized in Crawford et al. 2005). McLeod (2005) reported its decline across Nebraska. Brown and Morris (1990) never found plains leopard frogs in cultivated fields. Hammerson (1999) noted that plains leopard frogs were scarce in areas where bullfrogs (*Lithobates catesbeianus*) were common. Introduced populations of bullfrogs can be significant predators on frogs and have been blamed for some frog declines (Alford and Richards 1999, Hecnar and M'Closkey 1997, Kats and Ferrer 2003), but bullfrogs are native to South Dakota, and plains leopard frogs probably evolved along with them. Habitat destruction as a result of cultivation may cause plains leopard frog declines in South Dakota, given the work of Brown and Morris (1990) in Illinois.

<u>Key Habitat</u>

- <u>Key Habitat Description</u>: The plains leopard frog is the leopard frog of the warmer prairies of North America (Conant and Collins 1998). It is considered to be a frog primarily of the grasslands of the Great Plains but can also be found in oak forests of various types (Brown 1992). It is more drought tolerant than the northern leopard frog (Gillis 1979), which replaces it in the cooler northern Great Plains. It breeds in a variety of water bodies such as ditches, ponds, river sloughs, streams, temporary pools, marshes, and other wetlands (Crawford et al. 2005). The plains leopard frog may be at the limit of its thermoregulatory tolerance in South Dakota.
- <u>Ecoregions</u> (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Eastern Prairie Tall-grass Subregion, Missouri River Ecoregion, Great Plains Steppe Ecoregion, Black Hills Ecoregion.
- <u>Major Land Resource Areas</u> (United States Department of Agriculture 2006): Southern Black Glaciated Plains (55C), Till Plains (102B), Loess Uplands (102C).

- Aquatic Drainage Units (Annis et al. 2010): James, Big Sioux/Vermillion, Little Sioux/Niobrara.

Threats and Issues in South Dakota:

- Habitat destruction: In an extensive review of its biology, Smith and Keinath (2005) summarized the conservation of the plains leopard frog, but very little is known. The greatest threat to plains leopard frogs in South Dakota may be habitat destruction for cultivation, as Brown and Morris (1990) found in Illinois.
- Pesticides: Boone and Semlitsch (2002) reported little effect of carbaryl on plains leopard frog tadpoles. However, Kleeraway®, a pesticide similar to Roundup® (the active ingredient in Kleeraway®, as in Roundup® and Touchdown®, is glyphosate), caused significant mortality in larval plains leopard frogs (Boone and Semlitsch 2002).

Recommended Conservation and Research Actions:

- Hybridization and range delineation: Probably the most pressing need is to determine the range of plains and northern leopard frogs in South Dakota and settle hybridization questions. Genetic studies will be necessary. While there have been periodic proposals (northern leopard frog) or recommendations (plains leopard frog) to list both of these species as threatened or endangered, it is necessary to know the ranges and hybrid status of these two species in South Dakota before status and listing needs can be finalized.
- Climate change: As the climate warms, this species could extend its range further north into South Dakota. Extralimital occurrences in South Dakota may indicate that it is expanding its range as a result of climate change.

Policy Recommendations:

- Bag limits: Although bag limits have been instituted for the general public using a fishing license (take of 24 daily, with maximum possession of 24), there are no data on whether these bag limits are suitable. Bag limits should be determined using basic data on life history parameters (reproduction and recruitment). Such studies should be undertaken, and bag limits should be reviewed based on these data. Bag limits with a bait dealer's license do not exist, which allows for overexploitation. This situation should be remedied by establishing provisional bag limits for bait dealers equivalent to those placed on anglers by a state fishing license.
- Agrochemicals: The use of glyphosate, the active ingredient in Kleeraway®, Roundup® and Touchdown®, should be limited near breeding ponds.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station; David Swanson, University of South Dakota.

Account author: Brian E. Smith, Department of Biology, Black Hills State University

Literature Cited

Alford, R. A., and S. J. Richards. 1999. Global amphibian declines: A problem in applied ecology. Annual Review of Ecology and Systematics 30:133 – 165.

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Baness, E. 1997. The distribution and hybridization of the leopard frogs, *Rana pipiens* and *Rana blairi* in Iowa. M. S. Thesis, Drake University, Des Moines, IA.

Boone, M. D., and R. D. Semlitsch. 2002. Interactions of an insecticide with competition and pond drying in amphibian communities. Ecological Applications 12:307-316.

Brown, L. E. 1992. *Rana blairi*. Pp. 536.1 – 536.6. Catalogue of American Amphibians and Reptiles. Society for the Study of Amphibians and Reptiles, St. Louis, Missouri.

Brown, L. E., and M. A. Morris. 1990. Distribution, habitat, and zoogeography of the plains leopard frog (*Rana blairi*) in Illinois. Illinois Natural History Survey Biological Notes, No. 136. Champaign, Illinois.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Cousineau, M., and K. Rogers. 1991. Observations on sympatric *Rana pipiens*, *Rana blairi*, and their hybrids in eastern Colorado. Journal of Herpetology 25:114-116.

Crawford, J. A.,, L. E. Brown, and C. W. Painter. 2005. *Rana blairi*. Pp. 532-534 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

Di Candia, M. R., and E. J. Routman. 2007. Cytonuclear discordance across a leopard frog contact zone. Molecular Phylogenetics and Evolution 45:564-575.

Dunlap, D. G., and K. C. Kruse. 1976. Frogs of the *Rana pipiens* complex in the northern and central Plains states. Southwestern Naturalist 20:559-571.

Frost, D. R., T. Grant, J. Faivovich, R. H. Bain, A. Haas, C. F. B. Haddad, R. O. De Sá, A. Channing, M. Wilkinson, S. C. Donnellan, C. J. Raxworthy, J. A. Campbell, B. L. Blotto, P. Moler, R. C. Drewes, R. A. Nussbaum, J. D. Lynch, D. M. Green, and W. C. Wheeler. 2006. The amphibian tree of life. *Bulletin of the American Museum of Natural History* 297:1-370.

Gillis, J. E. 1979. Adaptive differences in the water economies of two species of leopard frogs from eastern Colorado (Amphibia, Anura, Ranidae). Journal of Herpetology 13:445-450.

Hammerson, G. A. 1999. Amphibians and Reptiles in Colorado, 2nd ed. University of Colorado Press, Niwot, Colorado.

Hecnar, S. J., and R. T. M'Closkey. 1997. Changes in the composition of a ranid frog community following bullfrog extinction. American Midland Naturalist 137:145-150.

Kats, L. B., and R. P. Ferrer. 2003. Alien predators and amphibian declines: Review of two decades of science and the transition to conservation. Diversity and Distributions 9:99-110.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

McLeod, D.S. 2005. Nebraska's declining amphibians. Pages 292-294 in M. Lannoo, editor, Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley, CA.

Smith, B. E., and D. A. Keinath. 2005. Plains Leopard Frog (*Rana blairi*): A Technical Conservation Assessment. Unpublished Report. http://www.fs.fed.us/r2/projects/scp/assessments/plainsleopardfrog.pdf. Accessed 23 September 2012.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

South Dakota Distribution Map:

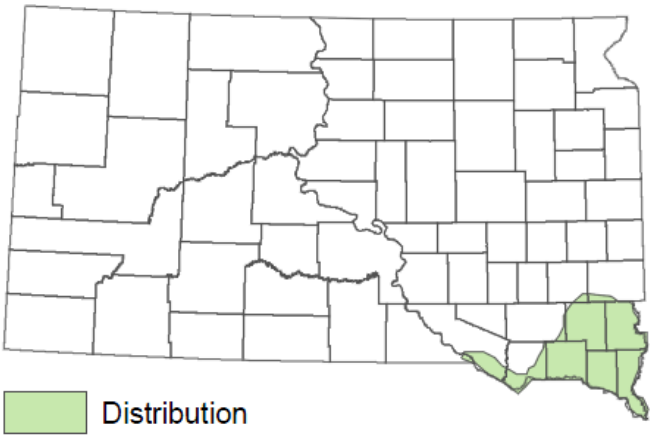

Photo:

Plains Leopard Frog Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: American Bullfrog.

Scientific Name: *Lithobates catesbeianus.*

Taxonomic Note: Many North American species formerly known as *Rana* sp. are now known as *Lithobates* sp., including *L. catesbeianus*. In the literature, they may be referred to as *L. catesbeianus* (Kiesow 2006) or *R. catesbeiana* (Conant and Collins 1998).

Description: American bullfrogs (bullfrog hereafter) range from 3½ to 6 inches as adults, with a record size of 8 inches (Conant and Collins 1998). They are a solid green on the dorsum, with few or no other markings. They lack dorsolateral ridges on the trunk, unlike northern and plains leopard frogs. When adult, this frog cannot be confused with any other frog in the state due to its size alone. Smaller bullfrogs can be distinguished by their plain coloration, prominent temporal fold, and lack of dorsolateral ridges on the trunk.

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Increasing.
- USFWS: Not listed.
- State: Not listed. This species may be taken under the authority of a state fishing license, and has a bag limit of 15 daily, with a maximum possession of 30.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S5.

Distribution

- Global: Their native range extends across eastern North America up to and along the Canadian border (Casper and Hendricks 2005). They are largely absent from Minnesota but are found in Wisconsin (Casper and Hendricks 2005). They are found throughout much of Nova Scotia (Conant and Collins 1998). The western extent of their native range may be the western border of the Great Plains, north to the southern border of South Dakota and south through the plains region of Texas. Their native range may also include northern Mexico. However, because they have been widely introduced as a food source the western edge of their range cannot be determined with confidence (Bury and Whelan 1984). Scattered populations exist well west of their natural range and are found in all the western states west of the Great Plains. They have also been introduced outside of North America, such as Europe, South America, and the Caribbean (Casper and Hendricks 2005).
- South Dakota
    - Historical: Known historically only from the southern tier of counties in South Dakota. United States Forest Service files indicate that introductions have been

attempted in South Dakota north of this range (see discussion below) but these populations may not have become established.

- Current: As far as can be determined, there has been no change in bullfrog distribution in South Dakota, although they may have displaced northern cricket frogs in the Keya Paha River (Kiesow 2006). Records from the U.S. Forest Service, Buffalo Gap National Grasslands, Fall River Ranger District, in Hot Springs, South Dakota, state that large numbers of bullfrogs were introduced across the Buffalo Gap National Grasslands in the 1960s. Bullfrogs have been found in areas in the vicinity (unpublished data), but it is unclear whether these come from U.S. Forest Service introductions, are native, or arrived via some other mechanism. Bullfrog tadpoles require up to three years to develop (Collins 1979, Bury and Whelan 1984), hence cold weather may limit their northern range in South Dakota. The larval period shows a negative correlation with the frost-free period, lengthening the larval period in northern parts of the range to multiple years (Collins 1979). Additionally, preferred body temperatures of 26 – 33°C (Lillywhite 1970) and inactivity below water temperatures of 15°C (Harding 1997) probably restrict summer activity, which could also affect the northern range limit in South Dakota. Therefore cold winter temperatures and relatively cool summers may both contribute to range limitation at the northern boundaries of the range. Bullfrogs are known from Cold Brook Reservoir and the town of Hot Springs (Smith et al. 1998). One specimen was collected within 2 km of Oral, South Dakota (Smith et al. 1998). But extensive work on the Buffalo Gap National Grasslands turned up few bullfrogs (Smith et al. 1998). They have also been found in an artificial pond in Rapid City (Smith, unpublished data). Due to the artificial nature of this pond, this population was probably introduced and it seems unlikely it could survive a winter. As climate change proceeds, bullfrogs could shift their range north. Observations of bullfrogs should be reported to the South Dakota Department of Game, Fish, and Parks.

Population trend: Due to widespread introductions the global range of bullfrogs has expanded, but this does not imply that population sizes have overall increased. To the contrary, Casper and Hendricks (2005) summarized an extensive literature showing declines in much of the native range. This has been blamed on wetland loss, habitat destruction, and overharvesting (Casper and Hendricks 2005). In South Dakota, no data are available to evaluate population trends. However, Kiesow (2006) suggests populations have increased in the Keya Paha River. Range limits and population sizes could change as climate warming advances. Bullfrogs could be an indicator species affected by climate warming.

Key Habitat

- Key Habitat Description: Ponds and areas in rivers and streams with sluggish current. Bullfrogs prefer high body temperatures (Lillywhite 1970) and may spend considerable time basking in ponded or sluggish water in streams and rivers, where water temperatures can be higher than air temperatures. Harding (1997) found that water

temperatures need to reach 15°C before adults will be active. Breeding activity is limited to permanent water bodies, owing to a multi-season tadpole stage.

- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Eastern Prairie Tall-grass Subregion, Missouri River Ecoregion, Great Plains Steppe Ecoregion, Black Hills Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Southern Black Glaciated Plains (55C), Pierre Shale Plains (60A), Northern Rolling Pierre Shale Plains (63A), Southern Rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand Hills (65), Dakota-Nebraska Eroded Tableland (66), Till Plains (102B), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara.

Threats and Issues in South Dakota:

- Climate change: Population dynamics can be affected by local weather, especially at the range limit of the species. It is difficult to know if climate change will have a positive or negative effect on bullfrogs. Warmer weather and longer growing seasons could be favorable, while drier conditions could reduce the number of suitable habitat areas.
- Habitat conversion and wetland loss: Casper and Hendricks (2005) list a number of factors that may be causing declines in bullfrog populations rangewide. Of these, habitat conversion and wetland loss could be issues causing declines in South Dakota but no formal assessment has been performed.
- Agrochemicals: In four studies, carbaryl lowered survival of bullfrog tadpoles (Boone and Semlitsch 2003; Relyea 2003, 2006; Puglis and Boone 2007). Atrazine is an endocrine disruptor in bullfrogs (Goulet and Hontela 2003). Relyea (2005) found that Roundup® dramatically reduced survival in bullfrogs. Survival was moderately to significantly reduced by malathion (Fordham et al. 2001, Relyea 2004).

Recommended Conservation and Research Actions:

- Monitoring: Monitoring of populations is recommended, especially to track potential range expansions correlated with climate change. Bullfrogs are relatively easily monitored through calling surveys and shoreline searches.

Policy Recommendations:

- Bag limits: Although bag limits have been instituted for the general public using a fishing license (take of 15 daily, with maximum possession of 30), there are no data on whether these bag limits are suitable. Bag limits should be determined using basic data on life history parameters (reproduction and recruitment). Such studies should be undertaken, and bag limits should be reviewed based on these data.
- Agrochemicals: The use of various agrochemicals (see above) should be limited around bullfrog breeding ponds.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station

Account author: Brian E. Smith, Department of Biology, Black Hills State University

Literature Cited

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Boone, M. D., and R. D. Semlitsch. 2003. Interactions of bullfrog tadpole predators and an insecticide: Predation release and facilitation. Oecologia 137:610-616.

Bury, R. B., and J. A. Whelan. 1984. Ecology and management of the bullfrog. U. S. Fish and Wildlife Service, Resource Publication Number 155. Washington, D. C.

Casper, G. S., and R. Hendricks. 2005. *Rana catesbeiana*. Pp. 540-546 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

Collins, J. P. 1979. Intrapopulation variation in the body size at metamorphosis and timing of metamorphosis in the bullfrog, *Rana catesbeiana*. Ecology 60:738-749.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Fordham, C. L., J. D. Tessari, H. S. Ramsdell, and T. J. Keefe. 2001. Effects of malathion on survival, growth, development, and equilibrium posture of bullfrog tadpoles (*Rana catesbeiana*). Environmental Toxicology and Chemistry 20:179-184.

Frost, D. R., T. Grant, J. Faivovich, R. H. Bain, A. Haas, C. F. B. Haddad, R. O. De Sá, A. Channing, M. Wilkinson, S. C. Donnellan, C. J. Raxworthy, J. A. Campbell, B. L. Blotto, P. Moler, R. C. Drewes, R. A. Nussbaum, J. D. Lynch, D. M. Green, and W. C. Wheeler. 2006. The amphibian tree of life. *Bulletin of the American Museum of Natural History* 297:1-370.

Goulet, B. N., and A. Hontela. 2003. Toxicity of cadmium, endosulfan, and atrazine in adrenal steroidogenic cells of two amphibian species, *Xenopus laevis* and *Rana catesbeiana*. Environmental Toxicology and Chemistry 22:2106-2113.

Harding, J. H. 1997. Amphibians and Reptiles of the Great Lakes Region. University of Michigan Press, Ann Arbor, Michigan.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Lillywhite, H. B. 1970. Behavioral temperature regulation in the bullfrog, *Rana catesbeiana*. Copeia 1970:158-168.

Puglis, H. J., and M. D. Boone. 2007. Effects of a fertilizer, an insecticide, and a pathogenic fungus on hatching and survival of bullfrog (*Rana catesbeiana*) tadpoles. Environmental Toxicology and Chemistry 26:2198-2201.

Relyea, R. A. 2003. Predator cues and pesticides: A double dose of danger for amphibians. Ecological Applications 13:1515-1521.

Relyea, R. A. 2004. Synergistic impacts of malathion and predatory stress on six species of North American tadpoles. Environmental Toxicology and Chemistry 23:1080-1084.

Relyea, R. A. 2005. The lethal impacts of Roundup and predatory stress on six species of North American tadpoles. Archives of Environmental Contamination and Toxicology 48:351-357.

Relyea, R. A. 2006. The effects of pesticides, pH, and predatory stress on amphibians under mesocosm conditions. Ecotoxicology 15:503–511.

Smith, B. E., D. M. Browning, E. Taylor, R. S. Ferguson, and K. Yturralde. 1998. Herpetofaunal surveys of the Fall River Ranger District, U.S. Forest Service, southwestern South Dakota and Badlands National Park. Unpublished report submitted to the Northern Prairie Wildlife Research Center, U.S. Geological Survey, Biological Resources Division. Jamestown, North Dakota.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

South Dakota Distribution Map:

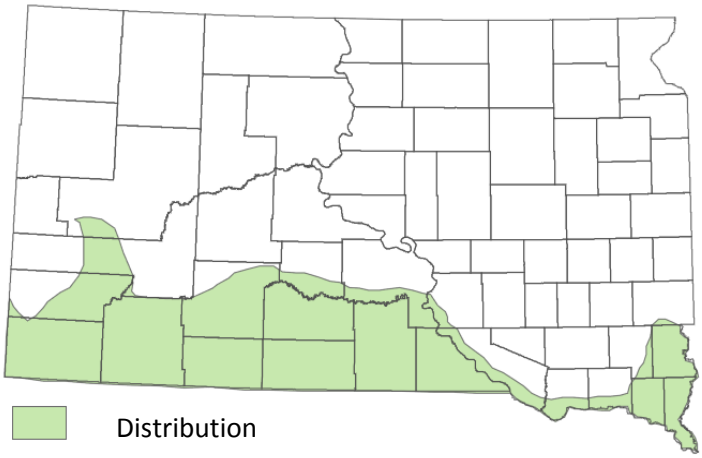

Photo:

American Bullfrog Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Northern leopard frog.

Scientific Name: *Lithobates pipiens.*

Taxonomic Note: Many North American species formerly known as *Rana* sp. are now known as *Lithobates* sp., including *L. pipiens* (Frost et al. 2006). In the literature, they may be referred to as *L. pipiens* (Kiesow 2006) or *R. pipiens* (Conant and Collins 1998).

Description: The northern and plains (*Lithobates blairi*) leopard frogs are difficult to tell apart, and the two species hybridize (Cosineau and Rogers 1991, Baness 1997). Apparent hybrids have been found in South Dakota (Dunlap and Kruse 1976, Di Candia and Routman 2007, Smith personal observations). Both frogs are roughly the same size, 2 – 3 ½ inches, with several round spots on a greenish or brownish background. The northern leopard frog can be distinguished using two characters: 1) Dorsolateral folds running the length of the body are unbroken (they are broken and inset medially in the plains leopard frog); and 2) the northern leopard frog's tympanum has no central white spot, unlike the plains leopard frog, which has a prominent white spot in the center of the tympanum (Conant and Collins 1998). The central white spot on the tympanum may be present in frogs that otherwise appear to be northern leopard frogs. These could be hybrids, but data are lacking. Northern leopard frogs extend to the highest elevations in the Black Hills, but putative "hybrids" have not been found there (personal observations). There are two color morphs found in South Dakota. The *burnsi* morph mostly lacks spots except along the hind legs. The *kandiyohi* morph lacks spots altogether and is mottled black and green. See Kiesow (2006) for photographs of these color morphs, which were formerly described as different species.

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Decreasing.
- USFWS: Not listed.
- State: Not listed. This species may be taken under the authority of a state fishing license, and has a bag limit of 24 daily, with a maximum possession of 24. It may also be taken under the authority of a bait dealer's license, with no limit on take.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S5.

Distribution

- Global: The northern leopard frog was once one of the most widely-ranging frogs in North America, occurring throughout Montana north into eastern Alberta, throughout Saskatchewan and the southern two-thirds of Manitoba, throughout Ontario, the southern half of Québec, and throughout New England, Pennsylvania, Ohio, northern

Indiana, Michigan, Wisconsin, northern Iowa, and Minnesota. Its historical range also included all of the Dakotas, northern Nebraska, all of Wyoming, southern Idaho, and throughout Utah, most of Nevada, the Rocky Mountains of Colorado and New Mexico, and the northern half of Arizona. It has undergone declines throughout much of its range, primarily in the western United States (Rorabaugh 2005). In 2009, the United States Fish and Wildlife Service proposed listing western populations of the northern leopard frog as a threatened species, but this proposal was declined in 2011.

- South Dakota
    - Historical: Statewide.
    - Current: Statewide.

Population trend: Although it has declined across much of its range (Rorabaugh 2005), this frog still appears to be common across South Dakota (personal observations and reports from numerous correspondents from the Dakota Amphibian and Reptile Network). Kiesow (2006) makes no mention of population declines in South Dakota.

Key Habitat

- Key Habitat Description: Merrell and Rodell (1968) characterized three habitat types that were necessary for long-term northern leopard frog survival: Lakes in which adult frogs overwinter, upland habitat in which adult frogs feed during summer, and tadpole/breeding habitat, in which adults breed and tadpoles spend up to three months developing. Northern leopard frogs are also known to overwinter in streams, ponds, and rivers (Emery et al. 1972, Cunjak 1986, Hammerson 1999, Ultsch et al. 2000). In South Dakota this frog occurs in many types of upland habitat. It seems to favor permanent and semi-permanent ponds and protected areas around lakes for breeding, but is typically not found breeding in seasonal and temporary ponds. Most breeding ponds are semi-permanent to permanent ponds with emergent vegetation surrounding the edges of the ponds. They also occupy some parts of manmade lakes, where relatively dense emergent vegetation exists that may reduce the risk of predation on the tadpoles. These anecdotal observations in South Dakota concur with studies of the northern leopard frog in many parts of its range (Merrell 1968, 1977; Collins and Wilbur 1979; Corn and Livo 1989; Hammerson 1999). Historically, adults selected fish-free ponds in which to breed (Kruse and Francis, 1977; Hecnar and M'Closkey, 1998; Werner and Glennemeier, 1999). Introduced predaceous fish are probably serious predators on the tadpoles. For example, Collins and Wilbur (1979) found northern leopard frogs breeding in fish-free ponds and ponds with fish; subadults were never found in ponds with fish. Bovberg (1965) studied a pond in Iowa at which the entire population of northern leopard frogs was eliminated by introductions of predaceous fish. In sum, northern leopard frogs require a complex mix of habitats in which to thrive: overwintering habitat (permanent lakes, streams, ponds, and rivers), fish-free semi-permanent to permanent ponds in which to breed, and upland habitat surrounding breeding ponds in which to forage following the breeding season. Of these habitat types, breeding habitat may be the most poorly characterized. It may be important to

conserve a mixture of habitat for northern leopard frogs to thrive. Wright and Wright (1949), Werner and Glennemeier (1999), Pope et al. (2000), and Mazarole (2001) found that adults would not use as upland foraging habitat areas that had been converted to mowed lawns, cultivation, or that were heavily grazed by livestock. However, even with considerable habitat conversion in South Dakota, no literature indicates serious declines in populations anywhere in the state. Smith (2003) provided an extensive summary of northern leopard frog habitat and natural history in a conservation assessment for the United States Forest Service, Black Hills National Forest, which is particularly relevant to northern leopard frogs in South Dakota.

- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Eastern Prairie Tall-grass Subregion, Missouri River Ecoregion, Great Plains Steppe Ecoregion, Black Hills Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Southern Dark Brown Glaciated Plains (53C), Rolling Soft Shale Plains (54), Central Black Glaciated Plains (55B), Southern Black Glaciated Plains (55C), Red River Valley of the North (56), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Black Hills (62), Northern Rolling Pierre Shale Plains (63A), Southern Rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand Hills (65), Dakota-Nebraska Eroded Tableland (66), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand/Moreau, Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara, Red and Minnesota River, Heart.

Threats and Issues in South Dakota:

- Habitat conversion: Many authors (Wright and Wright 1949, Werner and Glennemeier 1999, Pope et al. 2000, and Mazzarole 2001) have pointed out that foraging adults were scarce in upland habitats that had been converted to mowed lawns, cultivation, or that were heavily grazed by livestock.
- Pesticides: Table 6.1, pp. 170 – 187, in Lehman and Williams (2010), lists >35 studies on pesticides and northern leopard frogs published between 2000 and 2010. Pesticides known to negatively affect northern leopard frogs include atrazine, which feminizes frogs (Hayes et al. 2002), impairs their immune system (Brodkin et al. 2007), increases trematode infection rates (Rohr et al. 2008), and reduces feeding rates in tadpoles (Allran and Karasov 2001). However, atrazine is not known to cause direct mortality of northern leopard frogs (Allran and Karasov 2000, 2001). Carbaryl reduces growth rates of tadpoles (Relyea 2004). Endosulfan is highly toxic to northern leopard frogs (Jones et al. 2009, Relyea 2009), as is Roundup® (i.e., glyphosate, Relyea 2005). Malathion affects growth and development of northern leopard frog tadpoles (Relyea and Diecks 2008, Relyea and Hoverman 2008). Many of these pesticides are the most commonly used agricultural pesticides in the country. For further details of the effects of pesticides on northern leopard frogs, see Lehman and Williams (2010).

- Fertilizers: Hecnar (1995) found that northern leopard frog tadpoles suffered severe weight loss and death at relatively low dosages of nitrogenous fertilizers.
- Introduced predaceous fish: Introduced predaceous fish will eat northern leopard frogs (Emery et al. 1972, Relyea 2001), and may have been responsible for complete extermination of a northern leopard frog population in Iowa (Bovbjerg 1965). Introduced predaceous fish are common across South Dakota and could impact frog populations where no fish-free retreats are available.

Recommended Conservation and Research Actions:

- Hybridization and systematics: A pressing need is genetic studies of hybridization and hybrid zones between the northern and plains leopard frogs in South Dakota. This is important because there have been proposals (northern leopard frog) or recommendations (plains leopard frog) to list both species as threatened or endangered. Proactively, it is necessary to define the ranges of these two species and putative hybrid zones in South Dakota should either species be proposed for protection under the Endangered Species Act.

Policy Recommendations:

- Agrochemicals: There is considerable evidence that agrochemicals have a multitude of effects on northern leopard frogs. Limiting use near northern leopard frog breeding habitat, uplands foraging habitat, and overwintering habitat would convey conservation benefits. Alternative practices should be developed for farming near frog habitat.
- Introduced predaceous fish: Predaceous fish are commonly stocked across South Dakota, both by agencies and by private individuals. Given that this supports a tourism and sporting industry in the state, it is unlikely to stop. Once hybridization issues have been resolved and ranges of *L. pipiens* and *L. blairi* are defined, some important frog conservation areas could be left unstocked to support high quality frog habitat.
- Bag limits: Although bag limits have been instituted for the general public using a fishing license (take of 24 daily, with maximum possession of 24), there are no data on whether these bag limits are suitable. Bag limits should be determined using basic data on life history parameters (reproduction and recruitment). Such studies should be undertaken, and bag limits should be reviewed based on these data. Bag limits with a bait dealer's license do not exist, and there is a potential for overexploitation. This situation should be remedied by establishing provisional bag limits for bait dealers equivalent to those placed on anglers by a state fishing license.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station; David Swanson, University of South Dakota.

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Literature Cited

Allran, J. W. and W. H. Karasov. 2000. Effects of atrazine and nitrate on northern leopard frog (*Rana pipiens*) larvae exposed in the laboratory from posthatch through metamorphosis. Environmental Toxicology and Chemistry 19:2850-2855.

Allran, J. W. and W. H. Karasov. 2001. Effects of atrazine on embryos, larvae, and adults of anuran amphibians. Environmental Toxicology and Chemistry 20:769-775.

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Baness, E. 1997. The distribution and hybridization of the leopard frogs, *Rana pipiens* and *Rana blairi* in Iowa. M. S. Thesis, Drake University, Des Moines, IA.

Bovbjerg, R. V. 1965. Experimental studies on the dispersal of the frog, *Rana pipiens*. Proceedings of the Iowa Academy of Science 72:412-418.

Brodkin, M., H,., Madhoun, M. Rameswaran, and I. Vatnik. 2007. Atrazine is an immune disruptor in adult northern leopard frogs (*Rana pipiens*). Environmental Toxicology and Chemistry 26:80-84.

Collins, J. P., and H. M. Wilbur. 1979. Breeding habits and habitats of the amphibians of the Edwin S. George Reserve, Michigan, with notes on the local distribution of fishes. Occasional Papers of the Museum of Zoology, University of Michigan. No. 686:1-34.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Corn, P. S., and L. J. Livo. 1989. Leopard frog and wood frog reproduction in Colorado and Wyoming. Northwestern Naturalist 70:1-9.

Cousineau, M., and K. Rogers. 1991. Observations on sympatric *Rana pipiens*, *Rana blairi*, and their hybrids in eastern Colorado. Journal of Herpetology 25:114-116.

Cunjak, R. A. 1986. Winter habitat of northern leopard frogs, *Rana pipiens,* in a southern Ontario stream. Canadian Journal of Zoology 64:255-257.

Di Candia, M. R., and E. J. Routman. 2007. Cytonuclear discordance across a leopard frog contact zone. Molecular Phylogenetics and Evolution 45:564-575.

Dunlap, D. G., and K. C. Kruse. 1976. Frogs of the *Rana pipiens* complex in the northern and central Plains states. Southwestern Naturalist 20:559-571.

Emery, A. R., A. H. Berst, and K. Kodaira. 1972. Under-ice observations of wintering sites of leopard frogs. Copeia 1972:123-126.

Frost, D. R., T. Grant, J. Faivovich, R. H. Bain, A. Haas, C. F. B. Haddad, R. O. De Sá, A. Channing, M. Wilkinson, S. C. Donnellan, C. J. Raxworthy, J. A. Campbell, B. L. Blotto, P. Moler, R. C. Drewes, R. A. Nussbaum, J. D. Lynch, D. M. Green, and W. C. Wheeler. 2006. The amphibian tree of life. *Bulletin of the American Museum of Natural History* 297:1-370.

Hammerson, G. A. 1999. Amphibians and Reptiles in Colorado, 2nd ed. University Press of Colorado and Colorado Division of Wildlife, Niwot, Colorado. 484 pp.

Hayes, T., K. Haston, M. Tsui, A. Hoang, C. Haeffele, and A. Vonk. 2002. Feminization of male frogs in the wild. Nature 419:895-896.

Hecnar, S. J. 1995. Acute and chronic toxicity of ammonium nitrate fertilizer to amphibians from southern Ontario. Environmental Toxicology and Chemistry 14:2131-2137.

Hecnar, S. J., and R. T. M'Closkey. 1998. Species richness patterns of amphibians in southwestern Ontario ponds. Journal of Biogeography 25:763-772.

Jones, D. K., J. I. Hammond, and R. A. Relyea. 2009. Very highly toxic effects of endosulfan across nine species of tadpoles: Lag effects and family-level sensitivity. Environmental Toxicology and Chemistry 28:1939–1945.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Kruse, K. C., and M. G. Francis. 1977. A predation deterrent in larvae of the bullfrog, *Rana catesbeiana*. American Fisheries Society Transactions 106:248-252.

Lehman, C. M., and B. K. Williams. 2010. Effects of current-use pesticides on amphibians. Pp. 167-202 in Sparling, D. W., G. Linder, C. A. Bishop, and S.K. Krest, eds., Ecotoxicology of Amphibians and Reptiles, 2nd ed. CRC Press, Boca Raton, Florida.

Mazerolle, M. J. 2001. Amphibian activity, movement patterns, and body size in fragmented peat bogs. Journal of Herpetology 35:13-20.

Merrell, D. J. 1968. A comparison of the estimated size and the "effective size" of breeding populations of the leopard frog, *Rana pipiens*. Evolution 22:274-283.

Merrell, D. J. 1977. Life history of the leopard frog, *Rana pipiens*, in Minnesota. Bell Museum of Natural History Occasional Papers No. 15:1-23.

Merrell, D. J., and C. F. Rodell. 1968. Seasonal selection in the leopard frog, *Rana pipiens*. Evolution 22:284-288.

Pope, S. E., L. Fahrig, and H. G. Merriam. 2000. Landscape complementation and metapopulation effects of leopard frog populations. Ecfology 81:2498-2508.

Relyea, R. A. 2001. The relationship between predation risk and antipredator responses in larval anurans. Ecology 82:541-554

Relyea, R. A. 2004. Growth and survival of five amphibian species exposed to combinations of pesticides. Environmental Toxicology and Chemistry 23:1737–1742.

Relyea, R. A. 2005. The lethal impact of Roundup on aquatic and terrestrial amphibians. Ecological Applications 15:1118-1124.

Relyea, R. A. 2009. A cocktail of contaminants: How mixtures of pesticides at low concentrations affect aquatic communities. Oecologia 159:363-76.

Relyea, R., and N. Diecks. 2008. An unforeseen chain of events: Lethal effects of pesticides at sublethal concentrations. Ecological Applications 18:1728-1742.

Relyea, R., and J. Hoverman. 2008. Interactive effects of predators and a pesticide on aquatic communities. Oikos 117:1647-1658.

Rohr, J. R., A. M. Schotthoefer, T. R. Raffel, H. J. Carrick., N. Halstead, J. T. Hoverman, C. M. Johnson, L. B. Johnson, C. Lieske, M. D. Piwoni, P. K. Schoff, and V. R. Beasley. 2008. Agrochemicals increase trematode infections in declining amphibian species. Nature 455:1235-1240.

Rorabaugh, J. C. 2005. *Rana pipiens*. Pp. 570-577 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

Smith, B. E. 2003. Conservation Assessment of the Northern Leopard Frog in the Black Hills National Forest, South Dakota and Wyoming. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm9_012268.pdf. Accessed 30 September 2012.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

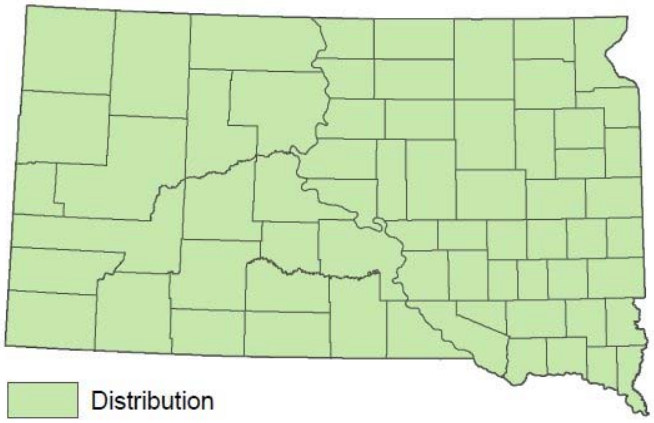
Ultsch, G. R., T. E. Graham, and C. E. Crocker. 2000. An aggregation of overwintering leopard frogs, *Rana pipiens*, and common map turtles, *Graptemys geographica*, in northern Vermont. Canadian Field-Naturalist 114:314-315.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Werner, E. E., and K. S. Glennemeier. 1999. Influence of forest canopy cover on breeding pond distributions of several amphibian species. Copeia 1999:1-12.

Wright, A. H., and A. A. Wright. 1949. Handbook of Frogs and Toads of the United States and Canada. Comstock Publishing Company, Ithaca, New York.

South Dakota Distribution Map:



Photos:

Northern Leopard Frog Doug Backlund

Burnsi color morph Mick Zerr

Kandiyohi color morph Jodi L. Massie and Ben G. Blake

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Wood frog.

Scientific Name: *Lithobates sylvaticus.*

Taxonomic Note: Many North American species formerly known as *Rana* sp. are now placed in *Lithobates* sp., including *L. sylvaticus*. In the literature, they may be referred to as *L. sylvaticus* (Kiesow 2006) or *R. sylvatica* (Conant and Collins 1998, Stebbins 2003, Redmer and Trauth 2005).

Description: Conant and Collins (1998) call this "the frog with the robber's mask", with good reason. The frog has a dark patch along the upper lip, running from the snout across the lower half of the eye towards the back of the skull, rounding posterior to the tympanum to connect with the posterior-most part of the lip. Otherwise, the frog can be highly variable in background coloration, although background coloration is almost always uniform in color. This small frog (1 ⅜ – 2 ¾ inches SVL) is readily distinguished from the other small frogs of South Dakota by the prominent "robber's mask" and white lip line.

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S1.

Distribution

- Global: Wood frogs are the most widespread species of anuran in North America (Martof 1970). Their distribution is primarily boreal (Martof 1970). They are found across North Dakota, except for the southwestern corner of the state, and across Minnesota, Wisconsin, Michigan, Indiana, Kentucky, eastern Tennessee, and throughout much of the Appalachians and northeastern United States (Redmer and Trauth 2005). There are isolated populations in the Rocky Mountains of Colorado and Wyoming (Redmer and Trauth 2005). In Canada they extend throughout Manitoba east to the Atlantic and north to Hudson Bay, most of Alberta and Saskatchewan except the far southern reaches of the provinces, the southwestern corner of Nunavut, all of Yukon Territory, and most of British Columbia east of the Coast Mountains (Stebbins 2003, Matsuda et al. 2006). They are also found throughout the southern two-thirds of Alaska (Stebbins 2003, Redmer and Trauth 2005). The northern extent of their range lies at the southern border of the tundra ecoregion in Alaska (Stebbins 2003).
- South Dakota

- Historical: Roberts County and Day County, in far northeastern South Dakota. The Day County specimens are not reported in the state's Natural Heritage Database, but there are five specimens from Day County in the U.S. National Museum, collected in 1929 (data accessed through the HerpNET data portal [www.herpnet.org] on 3 November 2012).
- Current: Roberts County (Fischer 1998, Backlund 2005).

Population Trend:
Redmer and Trauth (2005) stated that population trends range-wide were difficult to assess, because the data were insufficient. Wood frog numbers may have declined in South Dakota, but this is unclear. Specimens held at the U.S. National Museum were collected in Day County in 1929, where wood frogs may no longer exist. Over (1943) stated that they were "common" in Roberts County. However, at some point since the 1940s the species may have gone extinct in the state (Fischer 1998, Backlund 2005). It is difficult to assess long-term trends in the state since no quantitative data exist. The state monitors this species (Kiesow 2006).

Key Habitat

- Key Habitat Description: Wood frogs are found in a wide variety of habitats range-wide, including tundra, boreal forest, woodlands, wet meadows, bogs, and temperate forests (Redmer and Trauth 2005 and references therein). They are associated with prairie potholes in South Dakota (Backlund 2005). Ephemeral wetlands are a critical habitat component required for breeding.
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Tall-grass Subregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Red River Valley of the North (56), Rolling Till Prairie (102A).
- Aquatic Drainage Units (Annis et al. 2010): Red and Minnesota River.

Threats and Issues in South Dakota:

- Peripheral species and population declines: Any species with a very limited range within the state is at risk if any of the few established populations disappear, and based on Over (1943) and Kiesow (2006) wood frogs may have disappeared in the state at some point, only to be rediscovered. Peripheral populations can also harbor unique genetic variation due to local adaptation, although wood frogs are known to have little genetic variation across ponds in North Dakota (Newman and Squire 2001). These attributes (small range, few populations, important local genetic adaptation) make wood frog survival especially precarious in South Dakota.
- Pesticides: Relyea (2003, 2004, 2005) and Comstock et al. (2007) found that carbaryl, malathion, and Roundup® could cause up to 100% mortality of tadpoles depending on concentrations and interspecies interactions. Storrs and Kiesecker (2004) found that atrazine also caused mortality of wood frog tadpoles.
- Climate change: This species is one of the most northerly ranging frogs in the world. Since it appears to be at its southern range limit in South Dakota, climate warming could eliminate it in the state.

Recommended Conservation and Research Actions:

- Monitoring of populations: The wood frog is at the southern periphery of its range in South Dakota. Although wood frogs are relatively common across their global range, South Dakota populations are at the periphery of their range and might harbor unique genetic variants as a result. Little time and effort would be needed to design a program to monitor this species in South Dakota. Reference sites could be selected at known recent localities and at historical collecting localities. These could be visited annually or semi-annually to record chorusing during the spring breeding season. Simple presence or absence could be recorded as a simple technique to monitor continued presence at these sites.
- Pesticides: Wood frogs are susceptible to a wide range of toxins (atrazine, carbaryl, malathion, and Roundup®; Storrs and Kiesecker 2004; Relyea 2003, 2004, 2005; Comstock et al. 2007) and their use should be restricted around breeding ponds.
- Protection of breeding sites: Given the restricted distribution, the breeding sites and adequate terrestrial buffers (up to 1,000 ft from breeding ponds) should be protected from development through acquisition or conservation easement.

Policy Recommendations:

- Bag limits: Due to their limited numbers in the state, South Dakota populations could be harmed by collectors. Collection of this species is not regulated. Until data can be collected to institute science based bag limits on this species based on life table parameters (reproduction and recruitment), establish a bag limit of 24 daily with a maximum possession of 24. This is the current bag limit for leopard frogs and tiger salamanders in South Dakota, and until life table parameters can be defined so sustainable harvests can be estimated for *Lithobates sylvaticus*, these provisional bag limits can be used.
- Restriction of pesticide use: Pesticide use should be restricted around wood frog breeding populations because of their sensitivity to these chemicals.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station

Account author: Brian E. Smith, Department of Biology, Black Hills State University

Literature Cited

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Backlund, D. 2005. South Dakota statewide herpetology survey 2004. South Dakota Department of Game, Fish, and Parks, unpublished report, Pierre, South Dakota.

Comstock, B. A., S. L. Sprinkle, and G. R. Smith. 2007. Acute toxic effects of Roundup herbicide on wood frog tadpoles (*Rana sylvatica*). Journal of Freshwater Ecology 22:705-708.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Crother,B. I., Committee Chair. 2011. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, Edition 6.1. http://www.ssarherps.org/pages/comm_names/Index.php. Accessed 2 July 2012.

Fischer, T. D. 1998. Anura of eastern South Dakota: Their distribution and characteristics of their wetland habitats, 1997 – 1998. M. S. Thesis, South Dakota State University.

Frost, D. R., T. Grant, J. Faivovich, R. H. Bain, A. Haas, C. F. B. Haddad, R. O. De Sá, A. Channing, M. Wilkinson, S. C. Donnellan, C. J. Raxworthy, J. A. Campbell, B. L. Blotto, P. Moler, R. C. Drewes, R. A. Nussbaum, J. D. Lynch, D. M. Green, and W. C. Wheeler. 2006. The amphibian tree of life. *Bulletin of the American Museum of Natural History* 297:1-370.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Martof, B. S. 1970. *Rana sylvatica*. Pp. 86.1 – 86.4. Catalogue of American Amphibians and Reptiles. Society of the Study of Amphibians and Reptiles, St. Louis, Missouri.

Matsuda, B. M., D. M. Green, and P. T. Gregory. 2006. Amphibians and Reptiles of British Columbia. Royal B. C. Museum, Victoria, British Columbia, Canada.

Newman, R. A., and T. Squire. 2001. Microsatellite variation and fine-scale population structure in the wood frog (*Rana sylvatica*). Molecular Ecology 10:1087-1100.

Over, W. H. 1943. Amphibians and Reptiles of South Dakota. University of South Dakota Natural History Studies Number VI.

Redmer, M., and S. E. Trauth. 2005. *Rana sylvatica*. Pp. 590-593 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

Relyea, R. A. 2003. Predator cues and pesticides: A double dose of danger for amphibians. Ecological Applications 13:1515–1521

Relyea, R. A. 2004. Synergistic impacts of malathion and predatory stress on six species of North American tadpoles. Environmental Toxicology and Chemistry. 23:1080–1084.

Relyea, R. A. 2005. The lethal impacts of Roundup and predatory stress on six species of North American tadpoles. Archives of Environmental Contamination and Toxicology 48:351-357.
Stebbins, R. C. 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton Mifflin Co., New York.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Stebbins, R. C. 2003. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Company, New York, New York.

Storrs, S. I., and J. M. Kiesecker. 2004. Survivorship patterns of larval amphibians exposed to low concentrations of atrazine. Environmental Health Perspectives 112:1054-1057.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

South Dakota Distribution Map:

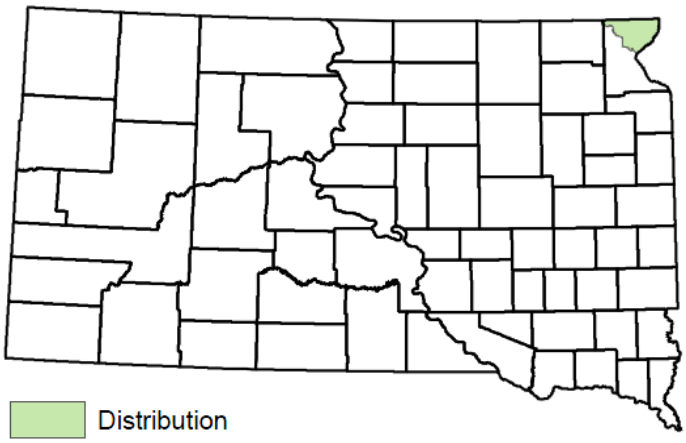


Photo:

Wood Frog Carol Hall, Minnesota DNR

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Boreal chorus frog.

Scientific Name: *Pseudacris maculata.*

Taxonomic Note: The systematics of the chorus frogs of the *Pseudacris triseriata* complex have long been in flux, with differing interpretations of range limits based on differing phylogenies. In Wright and Wright (1949), *P. triseriata* was considered a subspecies of *P. nigrita*, yet another species of chorus frog. From the time of Wright and Wright (1949) through to the writings of Lemmon et al. (2007), the taxonomy of chorus frogs changed several times. Conant and Collins (1998) treated the complex as a single species with four subspecies. Prior to this, Platz and Forester (1988) and Platz (1989) had raised these subspecies to specific status, but these species were not recognized by Conant and Collins (1998). Moriarty and Cannatella (2004) recognized that distributions as constituted at that time did not reflect range limits that corresponded to evolutionary lineages. Moriarty and Lannoo (2005) concluded that there were insufficient data to delineate species and used *P. triseriata* to refer to the four subspecies of Conant and Collins (1998). In 2007, Lemmon et al. recognized nine separate evolutionary lineages of *P*. "*triseriata*", where previous authors had described four subspecies. The most recent phylogeny and range map can be found in Lemmon et al. (2007), also followed by Crother et al. (2011). Given this state of flux, and the close relatedness and ecological similarity of the taxa, the content of this account should be viewed as applying to the boreal chorus frogs of South Dakota regardless of their ultimate classification within the species complex.

Description: A small frog, ranging in size from ¾ to 1 ½ inches. Coloration can vary. Its basic background color is typically some shade of olive. It has a prominent dark longitudinal stripe through the eye that continues along its side to its hind leg. It also has a dark dorsolateral streak on each side of the body, running from the back of the head to the hind leg. It can be distinguished from the similarly-sized northern cricket frog by the boreal chorus frog's dorsolateral stripes and its lack of a dark triangle between the eyes. Additionally, the northern cricket frog is found only in the far southeastern corner of the state, where it co-occurs with the boreal chorus frog. Across the rest of the state, the boreal chorus frog is the most abundant small frog, and cannot be confused with other frogs. It usually breeds earlier than any other frog in the state. Its voice sounds like a thumb being run along a comb. Large choruses are deafening.

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.

- State Rank (NatureServe): S5.

Distribution

- Global: Under the arrangement of Lemmon et al. (2007), in Canada the boreal chorus frog ranges across Saskatchewan, Alberta, Manitoba and Québec. It is found throughout the central United States, from the eastern two-thirds of Montana east throughout Wisconsin and Illinois and west through Missouri and across Kansas and Colorado, including all of the Dakotas, Nebraska, Minnesota and Iowa. Parts of southern Idaho, Utah, and Arizona are also within the range, as well as the northwestern half of New Mexico.
- South Dakota
    - Historical: Statewide. Their range includes the highest elevations of the Black Hills.
    - Current: Statewide.

Population trend: This is probably the most abundant amphibian in the state. I have found it breeding in large numbers in almost any standing water, from temporary ponds in drainage ditches and bison wallows to ponds of all sizes up to and including manmade lakes in the Black Hills (unpublished data). Moriarty and Lannoo (2005) reported some declines in the northeastern United States for the species complex, but concluded that overall trends were unknown. Surveys for this species are best undertaken during the breeding season in late winter and early spring when they are easily detected by their calls. After breeding, adults leave breeding sites and become difficult to find, while tadpoles rapidly develop and leave ponds (unpublished data). In mid-summer adults may enter an inactive state similar to torpor (see "Key Habitat"), although isolated calling can be heard throughout June and even July in the Black Hills in colder and rainier weather (unpublished data).

Key Habitat

- Key Habitat Description: Moriarty and Lannoo (2005) summarize habitat preferences for the species complex. Due to the long history of taxonomic uncertainty, it is difficult to sort out habitat preferences for the boreal chorus frog as it is now understood. The species in general prefers grassy habitats, including grassland, savanna and prairie, and sometimes bogs and marsh, for its terrestrial life history. In the Black Hills, its habitat includes forested areas, wet meadows, and highland ponds and lakes. Critical breeding habitat is temporary fish-free wetlands, and often includes roadside ditches. In South Dakota, I have found these frogs in virtually every habitat. Basically, if still water exists suitable for breeding, there will almost always be chorus frogs present. After breeding these frogs become very difficult to find, being small and cryptic in their summer foraging habitat. Mid-summer torpor, or aestivation, may occur, especially during hot and dry periods. For example, I collected a boreal chorus frog in mid-summer beneath a rotting log. To all outward appearances, it seemed to be in a state of torpor. It was alive but completely inactive, even when handled.

- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Eastern Prairie Tall-grass Subregion, Missouri River Ecoregion, Great Plains Steppe Ecoregion, Black Hills Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Southern Dark Brown Glaciated Plains (53C), Rolling Soft Shale Plains (54), Central Black Glaciated Plains (55B), Southern Black Glaciated Plains (55C), Red River Valley of the North (56), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Black Hills (62), Northern Rolling Pierre Shale Plains (63A), Southern Rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand Hills (65), Dakota-Nebraska Eroded Tableland (66), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand Moreau, Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara, Red and Minnesota River, Heart.

Threats and Issues in South Dakota:
Agrochemicals: Endrin and glyphosate are toxic to frogs of the *Pseudacris triseriata* complex (Sanders 1970, Smith 2001). Otherwise, there is little information on conservation threats faced by species within the *P. triseriata* complex (Moriarty and Lannoo 2005).

Recommended Conservation and Research Actions:
- Agrochemicals: Chorus frogs are susceptible to mortality from agrochemicals (Sanders 1970, Smith 2001) and their use should be limited near breeding ponds.

Policy Recommendations:
- Bag limits: Collection of this species is not regulated. Until data can be collected to institute science based bag limits on this species based on life table parameters (reproduction and recruitment), establish a bag limit of 24 daily with a maximum possession of 24. This is the current bag limit for leopard frogs and tiger salamanders in South Dakota, and until life table parameters can be defined so sustainable harvests can be estimated for *Pseudacris maculata*, these provisional bag limits can be used.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station

Account author: Brian E. Smith, Department of Biology, Black Hills State University

Literature Cited

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Crother,B. I., Committee Chair. 2011. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, Edition 6.1. http://www.ssarherps.org/pages/comm_names/Index.php. Accessed 23 September 2012.

Lemmon, E. M., A. R. Lemmon, J. T. Collins, J. A. Lee-Yaw, and D. C. Cannatella. 2007. Phylogeny-based delimitation of species boundaries and contact zones in the trilling chorus frogs (*Pseudacris*). Molecular Phylogenetics and Evolution 44:1068-1082.

Moriarty, E. C., and D. C. Cannatella. 2004. Phylogenetic relationships of the North American chorus frogs. Molecular Phylogenetics and Evolution 30:409-420.

Moriarty, E., and M. J. Lannoo. 2005. *Pseudacris triseriata* complex. Pp. 485-488 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

Platz, J. E. 1989. Speciation within the chorus frog *Pseudacris triseriata*: Morphometric and mating call analyses of the boreal and western subspecies. Copeia 1989:704-712.

Platz, J. E., and D. C. Forester. 1988. Geographic variation in mating call among the four subspecies of the chorus frog: *Pseudacris triseriata* (Wied). Copeia 1988:1062-1066.

Sanders, H. O. 1970. Pesticide toxicities to tadpoles of the western chorus frog *Pseudacris triseriata* and Fowler's toad *Bufo woodhousii fowleri*. Copeia 1970:246-251.

Smith, G. R. 2001. Effects of acute exposure to a commercial formulation of glyphosate on the tadpoles of two species of anurans. Bulletin of Environmental Contamination and Toxicology 67:483-488.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Wright, A. H., and A. A. Wright. 1949. Handbook of Frogs and Toads. Comstock Publishing Company, Ithaca, New York.

South Dakota Distribution Map:

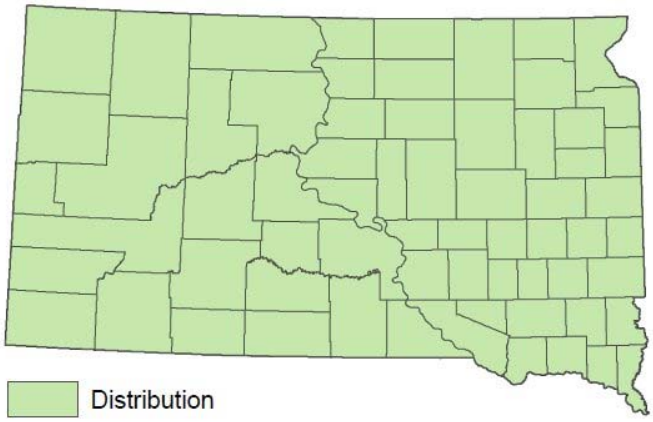


Photo:

Boreal Chorus Frog Dan Fogell

Ventral surface Aaron Gregor

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Plains spadefoot.

Scientific Name: *Spea bombifrons.*

Taxonomic Note: Conant and Collins (1998) recognize this species as *Scaphiopus bombifrons*, but this is an outdated generic name. The long-established correct scientific name is *Spea bombifrons* (Tanner 1989, Wiens and Titus 1991, Kiesow 2006, Crother 2011).

Description: The Plains spadefoot is a moderately sized frog averaging ca. 2.5 inches with a superficial similarity to toads (hence the common name, "spadefoot toad"). It is readily distinguished from true toads by its vertically elliptical pupils, and distinctive "spade", a keratinized tubercle on the hind feet (Conant and Collins 1998). Its call is also distinctive and consists of a snoring or bleating sound, unlike any other South Dakota anuran. An explosively breeding amphibian, they can sometimes be heard calling in large numbers after heavy summertime thunderstorms or during soaking spring rains.

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S5.

Distribution

- Global: This is a Great Plains endemic, found in the Great Plains from Texas through North Dakota and into southern portions of Alberta and Saskatchewan and the far southwestern corner of Manitoba (Conant and Collins 1998). Its range covers the western halves of North and South Dakota to and along both banks of the Missouri River (Farrar and Hey 2005). South of South Dakota, it ranges throughout most of the states of Nebraska, Kansas and Oklahoma. It is also found in the eastern two-thirds of Montana, most of Wyoming, east of the Rocky Mountains in Colorado, and throughout New Mexico and the Trans-Pecos region of Texas (Farrar and Hey 2005). It also ranges into the northeastern quarter of Arizona.
- South Dakota
    - Historical: The Plains spadefoot ranges across the western part of the state to the Missouri River and to counties along the eastern bank of the Missouri River (Farrar and Hey 2005, Kiesow 2006). It is not found in the Black Hills but can range up to the lower reaches of the ponderosa pine forest, at about 1500 m elevation (Smith, unpublished data).

- Current: There are few data on the current distribution of the Plains spadefoot due to its secretive nature. An explosively breeding amphibian, it spends long periods underground and may be active in South Dakota on the surface only after soaking spring rains or heavy summer thunderstorms (Smith et al. 1998, 2012). Neither Farrar and Hey (2005) or Kiesow (2006) note population declines or range expansions or contractions.

Population Trend: Farrar and Hey (2005) noted that the species' secretive habits render it difficult to survey. Essentially nothing is known about population trends. They can be very abundant after soaking spring rains and heavy summer thunderstorms (Smith et al. 1998, 2012), and are occasionally found abroad at other times (Smith et al. 2004).

Key Habitat

- Key Habitat Description: Working in Iowa, Christiansen and Bailey (1991) stated that Plains spadefoots are found in loose, well-drained soils in prairies. In South Dakota and Nebraska, they have been found in mixed- and short-grass prairie (B. Smith, unpublished data). Plains spadefoots are also known to frequent prairie dog burrows (Hoogland 1995). Critical breeding habitat is temporary wetlands (Kiesow 2006). Little else is known about their habitat needs.
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Eastern Prairie Tall-grass Subregion, Missouri River Ecoregion, Great Plains Steppe Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Southern Dark Brown Glaciated Plains (53C), Rolling Soft Shale Plains (54), Southern Black Glaciated Plains (55C), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Northern Rolling Pierre Shale Plains (63A), Southern Rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand Hills (65), Dakota-Nebraska Eroded Tableland (66), Till Plains (102B), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand Moreau, Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara, Red and Minnesota River.

Threats and Issues in South Dakota: Plains spadefoots are so poorly known that it is difficult to assess threats. In a recent compendium of ecotoxicological studies on amphibians completed from 2000 – 2009 (Lehman and Williams 2010), the four species of *Spea* are not mentioned. Bishop et al. (2010) found that atrazine lowered hatching success in the closely related *Spea intermontana*. Loss of the temporary wetlands the species depends on for breeding is a likely threat.

Recommended Conservation and Research Actions:

- Surveys and incidental encounters: More comprehensive surveys are recommended, with methods taking into account the explosive breeding events tied to local weather patterns. Plains spadefoots are found in similar weather as Great Plains toads; during

and after soaking rains and following heavy thunderstorms. To learn more about these two species, surveys should take advantage of these infrequent weather events, which are the only time adults are readily detectable. Surveys focusing on larvae may be more successful, as they remain detectable in temporary wetlands for a longer period of time than adults. Research to develop effective detection probability based survey methods is needed. Surveyors should be able to identify plains spadefoots and Great Plains toads, and be available when weather conditions allow for valid surveys. Trained personnel working on state and federally managed land can be tremendously helpful by submitting incidental observations of this cryptic species. They can also be trained to identify and survey plains spadefoots and Great Plains toads in appropriate and unpredictable weather events.

- Training: State and federal wildlife managers should be trained to identify this species (and Great Plains toads) so they can submit incidental encounters of these rarely encountered species.

Policy Recommendations:

- Bag limits: There are few data on population numbers or sizes, yet collection of this species is not regulated. Until data can be collected to institute science based bag limits on this species based on life table parameters (reproduction and recruitment), establish a bag limit of 24 daily with a maximum possession of 24. This is the current bag limit for leopard frogs and tiger salamanders in South Dakota, and until life table parameters can be defined so sustainable harvests can be estimated for *Spea bombifrons*, these provisional bag limits can be used.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station

Account author: Brian Smith, Department of Biology, Black Hills State University.

Literature Cited

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Bishop, C. A., S. L. Ashpole, A. M. Edwards, G. Van Aggelen, and J. E. Elliott. 2010. Hatching success and pesticide exposures in amphibians living in agricultural habitats of the South Okanagan Valley, British Columbia, CA (2004 – 2006). Environmental Toxicology and Chemistry 29:1593-1603.

Christiansen, J. L., and R. M. Bailey. 1991. The salamanders and frogs of Iowa. Iowa Department of Natural Resources, Nongame Technical Series, Number 3, Des Moines, Iowa.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Crother,B. I., Committee Chair. 2011. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, Edition 6.1. http://www.ssarherps.org/pages/comm_names/Index.php. Accessed 2 July 2012.

Farrar, E., and J. Hey. 2005. Pp. 513-514 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of North American Species. University of California Press, Berkeley, California.

Hoogland, J. L. 1995. The Black-Tailed Prairie Dog: Social Life of a Burrowing Mammal. University of Chicago Press, Chicago, Illinois.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Lehman, C. M., and B. K. Williams. 2010. Effects of current-use pesticides on amphibians. Pp. 167 – 202 in Sparling, D. W., G. Linder, C. A. Bishop, and S. K. Krest, eds., Ecotoxicology of Amphibians and Reptiles, 2nd ed. Society of Environmental Toxicology and Chemistry, Pensacola, Florida.

Smith, B. E., J. J. Kolbe, and R. S. Ferguson. 1998. A herpetological survey of Wind Cave National Park, South Dakota. Unpublished report submitted to the Northern Prairie Wildlife Research Center, U.S. Geological Survey, Biological Resources Division. Jamestown, North Dakota.

Smith, B. E., J. L. Massie, and B. G. Blake. 2004. Inventory of Reptiles and Amphibians at Seven National Park Service Units in the Northern Great Plains from 2002-2003. Unpublished report submitted to the Northern Great Plains Inventory and Monitoring Coordinator, National Park Service, Mt. Rushmore National Memorial.

Smith, B. E., C. Vanderheide, J. McAllister, and J. Holmes. 2012. Herpetofaunal Inventory of the Grand River National Grasslands, South Dakota, Summer 2008 and 2010. Unpublished report submitted to the United States Forest Service.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Tanner, W. W. 1989. Status of *Spea stagnalis* Cope (1875), *Spea intermontanus* Cope (1889), and a systematic review of *Spea hammondii* Baird (1839) (Amphibia: Anura). Great Basin Naturalist 49:503-510.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Wiens, J. J., and T. A. Titus. 1991. A phylogenetic analysis of *Spea* (Anura: Pelobatidae). *Herpetologica* 47:21–28.

South Dakota Distribution Map:

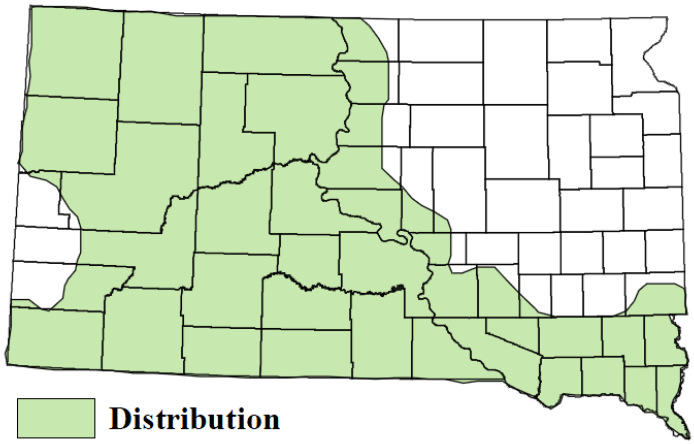


Photo:

Plains Spadefoot Jeffrey B. LeClere

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Smooth Softshell

Scientific Name: *Apalone mutica*

Taxonomic Note: Two subspecies of this species are recognized, and the one found in South Dakota is *Apalone mutica mutica*, the midland smooth softshell (Iverson et al. 2008, 2012).

Description: This species has a leather-like carapace (top shell) that is smooth, without any spines, bumps or sandpapery projections (as occur in the spiny softshell, which is also found in South Dakota). Also, it has no ridges projecting into the nostrils from the septum (unlike the spiny softshell) (Conant and Collins 1991, Ernst and Lovich 2009).

Population/protection Status:

- IUCN: Least Concern
    - Population trend: Unknown
- USFWS: Not listed
- State: This species may be collected under the authority of a state fishing license, and has a bag limit of two daily, with a maximum possession of four. No commercial activity is permitted regarding smooth softshells. This species may not be shot with a firearm.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S2

Distribution:

- Global: This species is found in the greater Mississippi River basin from Louisiana to North Dakota, Minnesota and western Pennsylvania, as well as the Colorado, Brazos, Sabine, and Pearl Rivers, and the Alabama and Escambia River systems (Webb 1973, Iverson 1992, Conant and Collins 1991, Ernst and Lovich 2009).
- South Dakota
    - Historical: Over (1923) reported that this species was found along the Missouri River and eastward, but was not common in South Dakota. Later, Carr (1952) showed it ranging in the southeastern quadrant of the state.
    - Current: Smooth softshells occur in the Missouri River and are also reported from portions of the Big Sioux, Grand, and Cheyenne Rivers (Backlund 2004, Ballinger et al. 2000, Kiesow 2006). Bandas (2003) and Bandas and Higgins (2004) reported this species from the western counties of Butte, Meade, Pennington and Fall River in addition to counties along the Missouri River.

Population Trend: While smooth softshells can be abundant within certain parts of their extensive range (Plummer 1977), they can be rare in others (Bodie et al. 2000). In South Dakota they have been reported as common in the Missouri River and associated large reservoirs, but

at lower densities in tributaries (Ballinger et al. 2000, Timken 1975). However, Jessen (2005) found this species abundant in the lower James River valley, and Backlund (2004) reported records from the Missouri and lower Big Sioux Rivers. Bandas (2003) noted specimens from 17 South Dakota counties, and including four western counties not adjoining the Missouri River. However, Bandas and Higgins (2004) noted that in their 2002 and 2003 surveys, no smooth or spiny softshells were captured north of Oahe Dam on the Missouri river, citing that the dam, which was built in the late 1950s, may have created a barrier to their movement up the Missouri River. While the dam may currently restrict movement up and down the river, it seems likely that this species occured in the upper Missouri River prior to dam construction. This is supported by its presence in Butte, Meade, Fall River, and Pennington Counties, areas that would have been colonized through the Cheyenne River, the confluence of which to the Missouri River is north of the Oahe Dam. Lake Oahe may simply not be preferred habitat for this species, as it may be too deep and cold (Doug Backlund personal communication). In all, this species appears to be locally abundant within certain portions of South Dakota, especially in the southeastern sector of the state, but its distribution and abundance in northern and also western South Dakota are poorly known.

As mentioned above, early reports indicate the historic distribution may have been confined to the eastern portion of the state, indicating the range has expanded since that time. However, such a conclusion should be drawn with caution, as early range estimates may have been based on little data.

Key Habitat:

- Key Habitat Description: This species typically occurs in medium-sized to large rivers with moderate to fast currents, but also occurs in standing water bodies like lakes, ponds and marshes as long as these are connected to a river, at least during floods. Soft bottomed aquatic habitats are preferred, and accessible sandbanks must be present for basking and nesting (van Dijk 2011).
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Missouri River, Eastern Prairie, and Great Plains Steppe Ecoregions.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Southern Dark Brown Glaciated Plains (53C), Southern Black Glaciated Plains (55C), Northern Rolling Pierre Shale Plains (63A), Southern rolling Pierre Shale Plains (63B), Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Bad/Choteau, White.

Threats and Issues in South Dakota:

- Habitat alteration
    - Lack of nesting and basking sites: Smooth softshells nest and bask on sparsely vegetated beaches and sandbars (Dixon 2009, Ernst and Lovich 2009). Although such habitat is prevalent in certain parts of this species' South Dakota range, it is disappeared along the Missouri River since the construction of its four dams in the mid-1900s. The stabilization of the Missouri River by the Missouri River

Reservoir System has practically eliminated downstream flooding. Prior to this, frequent floods produced ample sandbars and sand beaches with sparse vegetative growth, perfect habitat for turtle nesting and basking activities. Such habitat is not formed naturally without flooding, and without periodic flushing, succession of plant communities on beaches and sandbars progresses to mature forests with large increases in invasive understory plants (Johnson et al. 2012).

Dixon et al. (2012) found that sandbar habitat had decreased by 96% since the late 1800s along the unchannelized portions of the Missouri River from Nebraska into Montana. Therefore, the lack of flooding along the Missouri River in South Dakota has diminished the amount of suitable nesting and basking habitat available for the smooth softshell.

Natural sandbar and beach formation appears favorable for smooth softshell populations on free flowing tributaries of the Missouri River and other areas where this species ranges. Therefore, the above discussion on beach and sandbar formation may only apply to populations in the Missouri River. However, the lower portions of the Big Sioux and James Rivers (and potentially the Vermillion River) have been highly modified due to the entrenching of the Missouri River, degrading the channels of these rivers to a point that is now 10 – 12 feet lower than historically (Doug Backlund personal communication). This reduces flooding, impairing the formation of turtle nesting beaches. Additionally, radio tracked individual smooth softshells were shown to spend eleven months 20 – 30 miles up the James River, returning to nest on the beaches located on the Missouri River (Aaron Gregor, University of South Dakota, personal communication). This suggests that, at least on the James River, appropriate nesting habitat may be limited.

- Nest depredation: The lack of many suitable nesting beaches results in dense nesting aggregations on the few remaining beaches. Such concentrations can result in higher nest depredation rates, which can damage turtle populations (Dixon 2009).
- Nest disturbance by recreationists: As the number of nesting beaches diminishes for this species, the remaining ones gain a higher concentration of nests (Dixon 2009). Therefore, disturbance to these few critical areas can have a great impact on nesting success. Many such beaches are also popular places for human summer recreation, and, in general, turtle nests can easily and unknowingly be trampled by people (Bolton and Brooks 2007), or destroyed by ATV use (Aaron Gregor, University of South Dakota, personal communication).
- Bank stabilization: Bank stabilization along the Missouri River and its tributaries destroys nesting and basking sites for this species. For example, large aggregations of basking smooth softshells (100+) were seen at numerous sites on the lower James River, but, unfortunately, many of these sites are now stabilized with concrete slab material, making them unsuitable for nesting or basking (Aaron Gregor, University of South Dakota, personal communication).

- Injury by boat propellers: Boat-related injuries are a hazard for this species on the main channel of the Missouri River. This is particularly a problem in early spring and late fall

when animals are active and surfacing, but slow to react to watercraft due to low water temperatures (Aaron Gregor, University of South Dakota, personal communication).

- Fishing hook injuries: Aaron Gregor (University of South Dakota, personal communication) reported having observed numerous smooth softshells with hooks embedded in their throats, and some beheaded, presumably by fishermen.
- Fish trapping: Fish trapping may contribute to mortality in this species, as turtles become entrapped as bycatch and drown. Legal traps utilized to catch fish in South Dakota are hoop nets and slat catfish traps (www.gfp.sd.gov/fishing-boating/docs/setline-hoopnet-regs.pdf). Although we have no information for our state on turtle mortality as bycatch in fish traps, both trap types will catch turtles.
- Pet and food trade: Fortunately, South Dakota's turtles are now legally protected from commercial trade. However, care must be taken to assure that our state's turtles are not being taken illegally, as the black market demand is rather intense. The market for turtle meat is fueled by demand in Asian countries where native turtle populations, including those of several softshell species, have been decimated by years of overharvest. The Turtle Conservation Coalition (2011) states that 75% of Asia's tortoise and freshwater turtle species are threatened as a result of overharvesting. Increasingly, US turtles are being shipped abroad to satisfy the Asian demand. In response to unsustainable turtle harvests, Tennessee, Florida, Georgia, and Alabama recently severely restricted or banned commercial harvest of wild-caught turtles.

  In a recent search of the internet, it was noted that smooth softshells are sold on the pet market, but prices are not extravagant, ranging from $19.95 – $39.95, depending on size (www.turtleshack.com, www.theturtlesource.com). Therefore, pressure to collect this species for the pet trade is probably not intense.

Recommended Conservation and Research Actions:

- Conduct further surveys for this species in the northern and western portions of the state.
- Identify any areas where large concentrations of smooth softshells overwinter. When found, such areas should be protected from disturbance. If below dams, sufficient water releases should be made to prevent winterkill.
- Where nesting beaches for smooth softshells are known to exist along the Missouri River, landowners should be encouraged to maintain open vegetative cover on sandbars and beaches by utilizing land management practices that retain early plant succession stages and restrict later ones. An example of such practices could simply be to walk through habitat and remove certain plants as they sprout. However, this is labor intensive, and thus may not be practical, but mechanical or chemical thinning of vegetation during non-nesting season may be more realistic. Unfortunately, these methods may not be as desirable as removing vegetation by hand due to their negative impacts on other wildlife species.

  More effectively, flooding should be allowed along the Missouri River so sand bars and beaches can form naturally, creating the nesting habitat required by this species. Appropriate water releases from dams would accomplish this. For example,

the unprecedented moisture in the upper Missouri River basin in 2011 triggered record-breaking flow releases from the US Army Corps of Engineers dams (Johnson et al. 2012), with the resulting floods altering much of the bank area. It appears this created considerable areas of new sandbars, at least in the short term (Mark Dixon and Jacob Kerby, University of South Dakota, personal communication). It should be noted that forming and maintaining sandbars in this manner would not only have a positive impact on smooth softshell populations, but also on those of the spiny softshell, the state Threatened false map turtle and eastern hog-nosed snake, the federally and state Endangered least tern, and the federally Threatened and state Endangered piping plover (Dixon 2009).

Man-made sandbars have been created to provide nesting areas for these two bird species, and smooth softshells also utilize them for nesting (Dixon 2009). However, the turtles prefer to nest on sandbars or beaches with steeper inclines than those provided by the man-made islands, thus placing their nests at a slightly higher elevation to protect them from moderate flooding (Dixon 2009). Providing higher man-made sandbars with accessible slopes would be beneficial to turtle populations. Currently, water levels are left low during the majority of the turtle nesting season, so water would not inundate the nests during most of the incubation period. However, water levels can be raised significantly after least terns and piping plovers fledge at the end of July, a full month or more before many turtle eggs may hatch (Dixon 2009). Dixon (2009) recommends that major raises be limited until mid-September, as the majority of eggs should have hatched by that time.

- As recommended by Backlund (2004), monitor reproduction of smooth softshell turtles on the Missouri River between Gavins Point Dam and Elk Point at sites noted in Perkins and Backlund (2000). This will help identify key beaches for further protective measures as outlined in this document.
- In areas where turtle nests are concentrated (due to a lack of many suitable nesting beaches), implement predator control programs for species that consume turtle eggs, such as raccoons and skunks.
- Discourage bank stabilization projects in areas known to contain smooth softshell populations.
- Develop programs and materials to reduce smooth softshell turtle nest disturbance by recreationists. Further, identify a few key nesting beaches, and restrict recreational use during softshell egg incubation season (from June to mid-September). Additionally, post boat speed limits near these nesting beaches and also key basking areas to prevent propeller injuries as these turtles congregate to lay eggs or bask.
- Investigate the extent to which turtles are caught as bycatch in fish traps. Should this prove to be a threat to smooth softshells, trap modifications can be made to ameliorate turtle losses (Bury 2011, Gibbons 1990, Larocque et al. 2012 a and b, Vogt 1980). Additionally, encourage fishermen to remove hooks and release turtles unharmed that they catch by hook-and-line.
- Inform wildlife officers of the potential threat of illegal commercial trade in this species for food and pets.

Policy Recommendations:

- Require those using fish traps to report turtle bycatch.

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Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station; Laura Dixon, Bureau of Land Management, Meeker, Colorado; Aaron Gregor, University of South Dakota.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Bandas, S.J. 2003. Geographical distribution and morphometrics of South Dakota turtles. MS Thesis, South Dakota State University, Brookings, South Dakota.

Bandas, S.J. and K.F. Higgins. 2004. Field guide to South Dakota turtles. SDCES EC 919. South Dakota State University, Brookings.

Bodie, J.R., R.D. Semlitch, and R.B. Renken. 2000. Diversity and structure of turtle assemblages: Associations with wetland characters across floodplain landscape. Ecography 23:444-456.

Bolton, R.M. and R.J. Brooks. 2007. Nest site selection and embryo hatching success in spiny, Blanding's and northern map turtles, and mitigation of mammalian predation and dipteran infestation of turtle nest at [a site in southern Ontario]. Progress report for Wildlife Preservation Canada. 18pp.

Bury, T.B. 2011. Modifications of traps to reduce bycatch of freshwater turtles. Journal of Wildlife Management 75:3-5.

Carr, A. 1952. Handbook of turtles: The turtles of the United States, Canada, and Baja California. Comstock Publishing Associates, a Division of Cornell University Press, Ithica.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

Dixon, L. 2009. False map, spiny softshell and smooth softshell turtle nest and nest-site habitat characteristics along the lower stretch of the Missouri National Recreation River in South Dakota. M.S. Thesis, South Dakota State University, Brookings, South Dakota. (pp. xv, 95 leaves), 112 pp.

Dixon, M.D., W.C. Johnson, M.L. Scott, D.E. Bowen, and L.A. Rabbe. 2012. Dynamics of plains cottonwood (*Populus deltoides*) forests and historical landscape change along unchannelized segments of the Missouri River, USA. Environmental Management 49(5):990-1008.

Ernst, C.H. and J.E. Lovich. 2009. Turtles of the United States and Canada. The Johns Hopkins University Press, Baltimore, MD.

Gibbons, J.W. 1990. Turtle studies at SREL: a research perspective. *In*: Life History and Ecology of the Slider Turtle, Gibbons J.W. (ed.), Smithsonian Institution Press, Washington, DC, pp. 19-44.

Iverson, J.B. 1992. A revised checklist with distribution maps of the turtles of the world. Richmond, Indiana (Privately published).

Iverson, J.B., P.A. Meylan, M.E. Seidel. 2008. Testudines: Turtles. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 67-74. SSAR Herpetological Circular 37:1-84.

Iverson, J.B., P.A. Meylan, M.E. Seidel. 2012. Testudines: Turtles. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, pp. 73-81. SSAR Herpetological Circular 39:1-92.

Jessen, T. 2005. Herpetological survey of eastern South Dakota 2005. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Johnson, W.C., M.D. Dixon, M.L. Scott, L. Rabbe, G. Larson, M.Volke, and B. Werner. 2012. Forty years of vegetation change on the Missouri River floodplain. BioScience 62(2):123-135.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Larocque, S.M., S.J. Cooke, and G. Blouin-Demers. 2012a. Mitigating bycatch of freshwater turtles in passively fished fyke nets through the use of exclusion and escape modifications. Fisheries Research 125-126 (2012):149-155.

Larocque, S.M., S.J. Cooke, and G. Blouin-Demers. 2012b. A breathj of fresh air: avoiding anoxia and mortality of freshwater turtles in fyke nets by the use of floats. Aquatic Conservation: Marine and Freshwater Ecosystems 22:198-205.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Perkins, K. III, and D. Backlund. 2000. Freshwater mussels of the Missouri National Recreational River below Gavins Point Dam, South Dakota and Nebraska. South Dakota Game, Fish and Parks Report 2000-2001.

Plummer, M.V. 1977. Activity, habitat and population structure in the turtle, *Trionyx muticus*. Copeia 1977:431-440.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Timken, R.L. 1975. The distribution and ecology of turtles of South Dakota. Ph.D. dissertation. Department of Zoology, University of South Dakota, Vermillion, South Dakota.

Turtle Conservation Coalition [Rhodin, A.G.J., A.D. Walde, B.D. Horne, P.P. van Dijk, T. Blanck, and R. Hudson (Eds.). 2011. Turtles in trouble: the world's 25+ most endangered tortoises and freshwater turtles – 2011. Lunenburg MA: IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Turtle Conservation Fund, Turtle Survival Alliance, Turtle Conservancy, Chelonian Research Foundation, Conservation International, Wildlife Conservation Society, and San Diego Zoo Global.

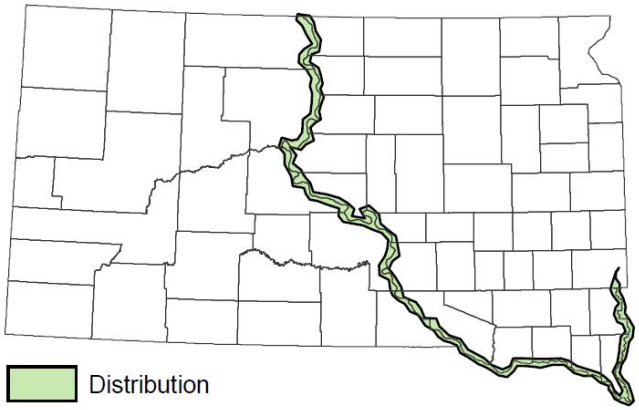
United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

van Dijk, P.P. 2011. *Apalone mutica*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2 www.iucnredlist.org

Vogt, R.C. 1980. New methods for trapping aquatic turtles. Copeia 1980:368-371

Webb, R.G. 1973. *Trionyx muticus*. Catalogue of American amphibians and reptiles 139:1-2.

South Dakota Distribution Map:



Photos:

Smooth Softshell Dan Fogell

Plastron Doug Backlund

Front view of nostrils

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Spiny Softshell

Scientific Name: *Apalone spinifera*

Taxonomic Note: Five North American subspecies of this species are recognized, and the one found in South Dakota is *Apalone spinifera spinifera*, the eastern spiny softshell. Until 2008 the subspecies recognized in South Dakota was *A. spinifera hartwegi* (western spiny softshell), but it was then synonymized with *A. spinifera spinifera* (Iverson et al. 2008, 2012).

Description: This species has a leather-like carapace (top shell) with sandpapery projections, bumps, and spines, especially along the front edge. It also has ridges projecting into its nostrils from the septum (Conant and Collins 1991, Ernst and Lovich 2009). The similar smooth softshell, also found in South Dakota, has a smooth carapace, and does not have nostril ridges.

Population/protection Status

- IUCN: Least Concern
    - Population Trend: Stable
- USFWS: Not listed
- State: This species may be collected under the authority of a state fishing license, and has a bag limit of two daily, with a maximum possession of four. No commercial activity is permitted regarding spiny softshells. This species may not be shot with a firearm.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S2

Distribution

- Global: This species has an extensive range across much of the eastern, central, and portions of the western United States. It is found from western New York, western Pennsylvania, and southern Ontario west to the Dakotas, Montana, Nebraska and Wyoming, and south to North Carolina, South Carolina, Georgia and the Gulf coastal states, then west to Arizona and New Mexico (Conant and Collins 1991, Iverson 1992, Ernst and Lovich 2009).
- South Dakota
    - Historical: Over (1923) did not list this species in the state, but later Carr (1952) showed it ranging across all of South Dakota except a small portion in the northeast.
    - Current: Spiny softshells are found in the Missouri, Big Sioux, Vermillion, James, Choteau, Minnesota, upper Cheyenne and Belle Fourche, White, and the Keya Paha Rivers (Backlund 2004, Ballinger et al. 2000, Bandas 2003, Bandas and Higgins 2004, Jessen 2005, Kiesow 2006, Snethen et al. 2009, Timkin 1975). Interestingly, until recently, spiny softshells had not been reported to be present

in the Cheyenne River from its confluence with the Belle Fourche River to the Missouri River. However, during the summer of 2012 dozens were spotted by the Highway 34 bridge near Bridger (Haakon and Ziebach Counties) (Doug Backlund personal communication).

Population Trend: Overall, populations of this species appear to be stable and fairly widespread in South Dakota. Bandis (2003) reported 5% of the turtles collected in her statewide survey were this species, and Timkin (1975) found that 7% of the turtles he collected in the Missouri River were spiny softshells. There were no historic records in the 1920s, but in the 1950s spiny softshells were reported to range across most of South Dakota. This would indicate an expanding range; however, such a conclusion should be drawn with caution, as early range estimates may have been based on little or no data.

Key Habitat

- Key Habitat Description: This species inhabits almost any type of permanent water body, from fast-flowing large rivers to lakes and reservoirs to small marshy creeks and farm ponds. A soft bottom with some aquatic vegetation appears to be required, as are sand bars or mud banks for basking, and sand banks for egg laying. Accumulations of underwater debris are preferred microhabitat (Bandas and Higgins 2004, Ernst et al. 1994, van Dijk 2011). Backlund (2004) reported that this species is more abundant in smaller streams and rivers rather than the large rivers preferred by the smooth softshell. Ballinger et al. (2000) reported spiny softshells as common in backwater habitats as well as the main channel of the lower Missouri River. Timkin (1975) also found them in the Missouri River, and Bandis (2003) recorded them in rivers, creeks and lakes.
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Mixedgrass Subregion, Tallgrass Subregion, Missouri River Ecoregion, Great Plains Steppe Ecoregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Southern Dark Brown Glaciated Plains (53C), Southern Black Glaciated Plains (55C), Pierre Shale Plains (60A), Northern Rolling Pierre Shale Plains (63A), Southern rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara, Red and Minnesota River.

Threats and Issues in South Dakota:

- Habitat alteration:
    - Lack of nesting and basking sites: Spiny softshell turtles nest and bask on open sandbars and sand beaches close to water (Dixon 2009, Ernst and Lovich 2009, Oldfield and Moriaty 1994). Although such habitat is prevalent in certain parts of

this species' South Dakota range, it has rapidly disappeared along the Missouri River since the construction of four dams in the mid-1900s. The stabilization of the Missouri River by the Missouri River Reservoir System has practically eliminated downstream flooding. Prior to this, frequent floods produced ample sandbars and sand beaches with sparse vegetative growth, perfect habitat for turtle nesting and basking activities. Such habitat is not formed naturally without flooding, and without this force, succession of plant communities on beaches and sandbars progresses to mature forests with large increases in invasive understory plants (Johnson et al. 2012).

Dixon et al. (2012) found that sandbar habitat had decreased by 96% since the late 1800s along the unchannelized portions of the Missouri River from Nebraska into Montana. Therefore, the lack of flooding along the Missouri River in South Dakota has diminished the amount of suitable nesting and basking habitat available for the spiny softshell.

Natural sandbar and beach formation appears favorable for spiny softshell populations on certain portions of free flowing tributaries of the Missouri River and other areas where this species ranges. Therefore, the above discussion on beach and sandbar formation may only apply to populations in the Missouri River.

- Nest depredation: In the Missouri River, the lack of many suitable nesting beaches as described above results in dense nesting aggregations on the few remaining beaches. Such concentrations can result in higher nest depredation rates, which can damage turtle populations (Dixon 2009).
- Nest disturbance by recreationalist and cattle: As the number of nesting beaches diminishes for this species, the remaining ones gain a higher concentration of nests (Dixon 2009). Therefore, disturbance to these few critical areas can have a great impact on nesting success. Many such beaches are also popular places for human summer recreation, and, in general, turtle nests can easily and unknowingly be trampled and deliberately destroyed by people (Bolton and Brooks 2007). Additionally, Werner et al. (2004) noted that in Montana off-road vehicle use and livestock grazing along rivers can destroy nesting areas. These same activities undoubtedly also occur in South Dakota.
- Bank stabilization: Bank stabilization destroys nesting sites for this species (Aaron Gregor, South Dakota State University, personal communication).

- Injury by boat propellers: Boat-related injuries are a hazard for this species on the main channel of the Missouri River. This is particularly a problem in early spring and late fall when animals are active and surfacing, but slow to react to watercraft due to low water temperatures (Aaron Gregor, University of South Dakota, personal communication).
- Fishing hook injuries: Aaron Gregor (University of South Dakota, personal communication) reported observing numerous smooth softshells with hooks embedded in their throats, and some beheaded, presumably by fishermen.
- Fish trapping: Fish trapping may contribute to mortality in this species, as turtles become entrapped as bycatch and drown. Legal traps utilized to catch fish in South Dakota are hoop nets and slat catfish traps (www.gfp.sd.gov/fishing-

boating/docs/setline-hoopnet-regs.pdf). Although we have no information for our state on turtle mortality as bycatch in fish traps, both trap types will catch turtles.

- Environmental Contaminants: Populations of spiny softshells in certain other states have declined as their environment has been polluted (Ernst and Lovich 2009). The release of pesticide, industrial, and household chemicals into waterways has been especially harmful to this species, and softshells have now been found to contain many heavy metal and PCB contaminants (De Solla et al 2003, Fontenot et al. 1996, Setmire et al. 1993).
- Pet and food trade: Werner et al. (2004), in writing about spiny softshells in Montana, noted that eggs and adults of this species are edible to humans, but are rarely eaten. This may also be the case in South Dakota. However, spiny softshell turtles are also sought for export to Asia for food, traditional medicine and farming operations (van Dijk 2011). Fortunately, South Dakota's turtles are now legally protected from commercial trade. However, care must be taken to assure that our state's turtles are not being taken illegally, as the black market demand is rather intense. The market for turtle meat is fueled by demand in Asian countries where native turtle populations, including those of several softshell species, have been decimated by years of overharvest. The Turtle Conservation Coalition (2011) states that 75% of Asia's tortoise and freshwater turtle species are threatened as a result of overharvesting. Increasingly, US turtles are being shipped abroad to satisfy the Asian demand. In response to unsustainable turtle harvests, Tennessee, Florida, Georgia, and Alabama recently severely restricted or banned commercial harvest of wild-caught turtles.

  In a recent search of the internet, it was noted that spiny softshells are sold on the pet market, but prices are not extravagant, ranging from $14.99 – $59.95, depending on size (www.turtleshack.com, www.BackWaterReptiles.com). Therefore, pressure to collect this species for the pet trade is probably not intense.

Recommended Conservation and Research Actions:

- Conduct surveys for this species in the Cheyenne River from its confluence with the Belle Fourche River to the Missouri River.
- Where nesting beaches for spiny softshells are known to exist along the Missouri River, landowners should be encouraged to maintain open vegetative cover on sandbars and beaches by utilizing land management practices that retain early plant succession stages and restrict later ones. An example of such practices could simply be to walk through habitat and remove certain plants as they sprout. However, this is labor intensive, and thus may not be practical, but mechanical or chemical thinning of vegetation during non-nesting season may be more realistic. Unfortunately, these methods may not be as desirable as removing vegetation by hand due to their negative impacts on other wildlife species.

  More effectively, for areas below dams along the Missouri River, flooding should be allowed so sandbars and beaches can form naturally, creating the nesting habitat required by this species. Appropriate water releases from dams would accomplish this. For example, the unprecedented moisture in the upper Missouri River basin in 2011 triggered record-breaking flow releases from the US Army Corps of Engineers dams

(Johnson et al. 2012), with the resulting floods altering much of the bank area. It appears this created considerable areas of new sandbars, at least in the short term (Mark Dixon and Jacob Kerby, University of South Dakota, personal communication). It should be noted that forming and maintaining sandbars in this manner would not only have a positive impact on spiny softshell populations, but also on those of the smooth softshell, the state Threatened false map turtle and eastern hog-nosed snake, the federally and state Endangered least tern, and the federally Threatened and state Endangered piping plover (Dixon 2009).

Man-made sandbars have been created to provide nesting areas for these two bird species, and spiny softshells also utilize them for nesting (Dixon 2009). However, the turtles prefer to nest on sandbars or beaches with steeper inclines than those provided by the man-made islands, thus placing their nests at a slightly higher elevation to protect them from moderate flooding (Dixon 2009). Providing higher man-made sandbars with accessible slopes would be beneficial to turtle populations. Currently, water levels are left low during the majority of the turtle nesting season, so water would not inundate the nests during most of the incubation period. However, water levels can be raised significantly after least terns and piping plovers fledge at the end of July, a full month or more before many turtle eggs may hatch (Dixon 2009). Dixon (2009) recommends that major raises be limited until mid-September, as the majority of eggs should have hatched by that time.

- Backlund (2004) recommended monitoring reproduction of smooth softshell turtles on the Missouri River between Gavins Point Dam and Elk Point at sites noted in Perkins and Backlund (2000). Although spiny softshells are less frequently encountered along this stretch of the river than smooth softshells (Aaron Gregor, personal communication), perhaps such monitoring could simultaneously be accomplished for spiny softshell nests.
- Identify a few key spiny softshell nesting beaches along the Missouri River and elsewhere, and restrict their recreational use during turtle egg incubation season (from June through September). If cattle have access to known nesting beaches, ask landowners to block cattle access to them during this period. Additionally, post boat speed limits near these nesting beaches and also key basking areas to prevent propeller injuries these turtles congregate to lay eggs or bask.
- In areas where turtle nests are concentrated (due to a lack of many suitable nesting beaches), implement predator control programs for species that consume turtle eggs, such as raccoons and skunks.
- Discourage bank stabilization projects in areas known to contain smooth softshell populations.
- Investigate the extent to which turtles are caught as bycatch in fish traps. Should this prove to be a threat to spiny softshells, trap modifications can be made to ameliorate turtle losses (Bury 2011, Gibbons 1990, Larocque et al. 2012 a and b, Vogt 1980). Additionally, encourage fishermen to remove hooks and release turtles unharmed that they catch by hook-and-line.
- Investigate the levels of environmental contaminants in South Dakota spiny softshells.

- Inform wildlife officers of the potential threat of illegal commercial trade in this species for food, traditional medicine, and pets.

Policy Recommendations:

- Require those using fish traps to report turtle bycatch.

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Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station; Laura Dixon, Bureau of Land Management, Meeker Colorado; Aaron Gregor, University of South Dakota.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Bandas, S.J. 2003. Geographical distribution and morphometrics of South Dakota turtles. MS Thesis, South Dakota State University, Brookings, South Dakota.

Bandas, S.J. and K.F. Higgins. 2004. Field guide to South Dakota turtles. SDCES EC 919. South Dakota State University, Brookings.

Bolton, R.M. and R.J. Brooks. 2007. Nest site selection and embryo hatching success in spiny, Blanding's and northern map turtles, and mitigation of mammalian predation and dipteran infestation of turtle nest at a site in southern Ontario. Progress report for Wildlife Preservation Canada. 18pp.

Bury, T.B. 2011. Modifications of traps to reduce bycatch of freshwater turtles. Journal of Wildlife Management 75:3-5.

Carr, A. 1952. Handbook of turtles: The turtles of the United States, Canada, and Baja California. Comstock Publishing Associates, a Division of Cornell University Press, Ithica.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

De Solla, S.R., M.L. Fletcher, and C.A. Bishop. 2003. Relative contributions of organochloride contaminants, parasitism, and predation to reproductive success of eastern spiny softshell turtles (*Apalone spiniferus spiniferus*) from southern Ontario, Canada. Ecotoxicology 123:261-270.

Dixon, L. 2009. False map, spiny softshell and smooth softshell turtle nest and nest-site habitat characteristics along the lower stretch of the Missouri National Recreation River in South Dakota. M.S. Thesis, South Dakota State University, Brookings, South Dakota. (pp. xv, 95 leaves), 112 pp.

Dixon, M.D., W.C. Johnson, M.L. Scott, D.E. Bowen, and L.A. Rabbe. 2012. Dynamics of plains cottonwood (*Populus deltoides*) forests and historical landscape change along unchannelized segments of the Missouri River, USA. Environmental Management 49(5):990-1008.

Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, D.C.

Ernst, C.H. and J.E. Lovich. 2009. Turtles of the United States and Canada. The Johns Hopkins University Press, Baltimore, MD.

Fontenot, L.W., G.P. Noblet, S.G. Platt, and J.M. Akins. 1996. A survey of herpetofauna inhabiting polychlorinated biphenyl contaminated and reference watersheds in Pickens County, South Carolina. J. Elisha Mitchell Sci. Soc. 112:20-30.

Gibbons, J.W. 1990. Turtle studies at SREL: a research perspective. In Life History and Ecology of the Slider Turtle, Gibbons J.W. (ed.), Smithsonian Institution Press, Washington, DC, pp. 19-44.

Iverson, J.B. 1992. A revised checklist with distribution maps of the turtles of the world. Richmond, Indiana (Privately published).

Iverson, J.B., P.A. Meylan, M.E. Seidel. 2008. Testudines: Turtles. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 67-74. SSAR Herpetological Circular 37:1-84.

Iverson, J.B., P.A. Meylan, M.E. Seidel. 2012. Testudines: Turtles. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, pp. 73-81. SSAR Herpetological Circular 39:1-92.

Jessen, T. 2005. Herpetological survey of eastern South Dakota 2005. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Johnson, W.C., M.D. Dixon, M.L. Scott, L. Rabbe, G. Larson, M.Volke, and B. Werner. 2012. Forty years of vegetation change on the Missouri River floodplain. BioScience 62(2):123-135.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Larocque, S.M., S.J. Cooke, and G. Blouin-Demers. 2012a. Mitigating bycatch of freshwater turtles in passively fished fyke nets through the use of exclusion and escape modifications. Fisheries Research 125-126 (2012):149-155.

Larocque, S.M., S.J. Cooke, and G. Blouin-Demers. 2012b. A breathj of fresh air: avoiding anoxia and mortality of freshwater turtles in fyke nets by the use of floats. Aquatic Conservation: Marine and Freshwater Ecosystems 22:198-205.

Oldfield, B. and J.J. Moriarty. 1994. Amphibians and reptiles native to Minnesota. University of Minnesota Press, Minneapolis.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Perkins, K. III, and D. Backlund. 2000. Freshwater mussels of the Missouri National Recreational River below Gavins Point Dam, South Dakota and Nebraska. South Dakota Game, Fish and Parks Report 2000-2001.

Setmire, J.G., R.A. Schroeder, and J.N. Densmore. 1993. Detailed study of water quality, bottom sediment, and biota associated with irrigation drainage in Salton Sea area, California. 1988-90. U.S. Geological Survey Water Research Investigative Report 92-4014:1-102.

Snethen, D. G., K. Hunter, T. Kraft, S. Hunter, and P. Tuttle. 2009. New distribution record for the spiny softshell turtle, *Apalone spinfera hartwegi*, from the White River in Shannon Coounty, South Dakota. Dakota Amphibian and Reptile News 2(2):11-12.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Timken, R.L. 1975. The distribution and ecology of turtles of South Dakota. Ph.D. dissertation. Department of Zoology, University of South Dakota, Vermillion, South Dakota.

Turtle Conservation Coalition [Rhodin, A.G.J., A.D. Walde, B.D. Horne, P.P. van Dijk, T. Blanck, and R. Hudson (Eds.)]. 2011. Turtles in trouble: the world's 25+ most endangered tortoises and freshwater turtles – 2011. Lunenburg MA: IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Turtle Conservation Fund, Turtle Survival Alliance, Turtle Conservancy, Chelonian

Research Foundation, Conservation International, Wildlife Conservation Society, and San Diego Zoo Global.

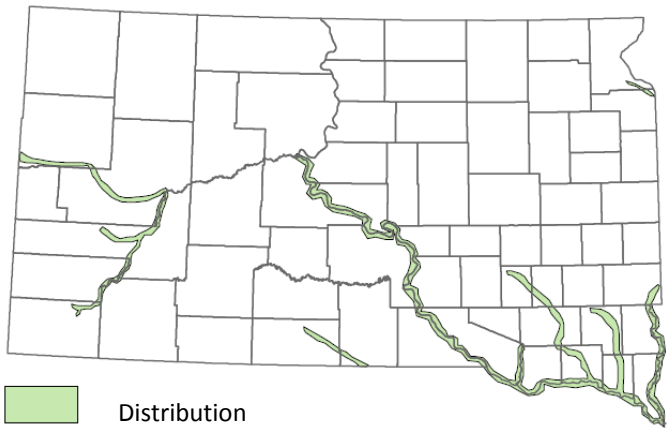
United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

van Dijk, P.P. 2011. *Apalone spinifera*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2 www.iucnredlist.org

Vogt, R.C. 1980. New methods for trapping aquatic turtles. Copeia 1980:368-371.

Werner, J.K., B.A. Maxell, P. Hendricks, and D.L. Flath. 2004. Amphibians and reptiles of Montana. Mountain Press Publishing Company, Missoula, Montana. 262 pp.

South Dakota Distribution Map:



Photos:

Spiny Softshell carapace Al Gage

Plastron Al Gage

Front view of nostrils

-South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Snapping Turtle

Scientific Name: *Chelydra serpentina*

Taxonomic Note: None

Description: This is a turtle with a large head, small plastron (bottom shell), and long tail. The tail is saw-toothed along the upper side (Conant and Collins 1991, Ernst and Lovich 2009).

Population/protection Status:

- IUCN: Least Concern
    - Population trend: Stable
- USFWS: Not listed
- State: This species may be collected under the authority of a state fishing license, and has a bag limit of two daily, with a maximum possession of four. No commercial activity is permitted regarding snapping turtles. This species may not be shot with a firearm, nor can it be exported for any purpose other than personal consumption.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S5

Distribution:

- Global: This species ranges throughout North America east of the Rocky Mountains, occurring northward as far as the Great Lakes region and Nova Scotia, and southward as far as Florida and the Nueces River in Texas (Conant and Collins 1991, Ernst and Lovich 2009, Iverson 1992). Feral turtles have been recorded from California, Japan, the Netherlands, Taiwan, and the United Kingdom (van Dijk 2011).
- South Dakota
    - Historical: Over (1923) reported that this species was common over the state, and Carr (1952) showed it ranging across all of South Dakota.
    - Current: This species ranges statewide in places where permanent water is available (Backlund 2004, Ballinger et al. 2000, Kiesow 2006).

Population Trend: The snapping turtle is common across most of its range, and although some local threats exist, populations are considered secure overall (Ernst and Lovich 2009, Kiesow 2006, NatureServe 2012, van Dijk 2011). Additionally, populations may have expanded in recent years due to an increase in the number of man-made ponds (NatureServe 2012). Illustrating the common occurrence of this species in South Dakota, Hammer (1968, 1969) estimated high densities at Lacreek National Wildlife Refuge, and Bandas (2003) found snapping turtles in all but seven counties in South Dakota (exceptions were Corson, Dewey, Ziebach, McPherson, Marshall, Hyde and Brule Counties). Additionally, of the five habitat types Bandas

sampled (river, creek, lake, road, sandy grassland), she found snapping turtles in all four wetland types, and they were the second most abundant species in each, surpassed only by painted turtles.

Even though snapping turtles are abundant and widespread in the state, actions should still be taken to protect local populations in an effort to keep this common species common, as it is a key component of South Dakota's natural heritage. Additionally, the roles of all species in a given area are very important in the local ecology, and all pieces of the ecological puzzle should be retained.

Key Habitat:

- Key Habitat Description: Snapping turtles inhabit almost any type of water body, from rivers, lakes, and reservoirs to marshes, temporary ponds, and streams (Bandas and Higgins 2004, Ernst and Lovich 2009, Kiesow 2006). It tolerates disturbed habitats and readily colonizes newly created habitats (Ernst and Lovich 2009, Kiesow 2006)
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Mixedgrass Subregion, Tallgrass Subregion, Missouri River Ecoregion, Great Plains Steppe Ecoregion, Black Hills Ecoregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Southern Dark Brown Glaciated Plains (53C), Rolling Soft Shale Plains (54), Central Black Glaciated Plains (55B), Southern Black Glaciated Plains (55C), Red River Valley of the North (56), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Black Hills (62), Northern Rolling Pierre Shale Plains (63A), Southern rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand hills (65), Dakota-Nebraska Eroded Tableland (66), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand Moreau, Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara, Red and Minnesota River, Heart.

Threats and Issues in South Dakota:

- Harvest for food:
    - Local: The flesh and fresh eggs of snapping turtles are eaten throughout much of their range, and local populations can be negatively impacted through excessive harvest (NatureServe 2012). For example, harvests for food have recently severely decimated some populations in Michigan and Illinois (Harding and Holman 1990, Tucker and Lamer 2004). Some populations within the overall range cannot withstand even minimal exploitation without undergoing a decline in numbers (Brooks et al. 1988). Additionally, snapping turtles are hunted because they sometimes prey on young waterfowl (Hammer 1972).
    - Snapping turtles have high rates of egg and juvenile mortality, and long adult life spans (Ernst and Lovich 2009). Species that exhibit these life history traits may be decimated quickly by increased adult mortality (via. harvest), particularly if

the numbers of juvenile recruits and immigrants are low (Congdon et al. 1994). Carefully managed sport harvests of some populations may be sustainable, but commercial harvests will certainly cause substantial population declines (Congdon et al. 1994), and the recovery of overharvested populations is very slow (Ernst and Lovich 2009).

  - Asian markets: Fortunately, South Dakota's turtles are now legally protected from commercial trade. However, care must be taken to assure that our state's turtles are not being taken illegally, as the black market demand is rather intense. Collection of snapping turtles from the wild and captive production in turtle farms for export from the US to East Asia recently increased substantially (from about 10,000 animals in 1999 to over 300,000 annually in recent years) (van Dijk 2011). The market for turtle meat is fueled by demand in Asian countries where native turtle populations have been decimated by years of overharvest. The Turtle Conservation Coalition (2011) states that 75% of Asia's tortoise and freshwater turtle species are threatened as a result of overharvesting. Increasingly, US turtles are being shipped abroad to satisfy the Asian demand. In response to unsustainable turtle harvests, Tennessee, Florida, Georgia, and Alabama recently severely restricted or banned commercial harvest of wild-caught turtles.

- Bycatch in fish traps: Fish trapping may contribute to mortality in this species, as turtles become entrapped as bycatch and drown. Legal traps utilized to catch fish in South Dakota are hoop nets and slat catfish traps (www.gfp.sd.gov/fishing-boating/docs/setline-hoopnet-regs.pdf). Although we have no information for our state on turtle mortality as bycatch in fish traps, both trap types will catch turtles.
- Road mortality: This species is vulnerable to high mortality on roads, especially during the nesting season, which could have negative impacts on the sustainability of local populations (Haxton 2000). Females may migrate up to several kilometers to nesting areas (potentially crossing roads in the process), and some may travel the same distance between summer range and winter hibernation sites.
- Pesticide use and pollution: Snapping turtles have become popular animals to test for pollutants in aquatic environments. Examination of the eggs, fat, and organs have revealed that alarmingly high levels of toxic chemicals are regularly present (i.e., PCBs, dibenzo-p-dioxins, dibenzofurans, hexachlorbenzene, DDE, DDT, mirex, arsenic, cadmium, lead, mercury, and even radioactive isotopes) (Ashpole et al. 2004, Bonnin et al. 1995, De Solla and Fernie 2004, Fontenot et al. 1996, Pagano et al. 1999, Watermolen and Amrhein 1995). In particular, snapping turtle eggs have been shown to be good indicators of the amount of pollution at certain localities. High levels of toxins are especially seen in snapping turtles from waterways flowing through industrial areas and heavily sprayed agricultural regions. Such stored poisons may cause a hazard to people who eat snapping turtles, and eventually reduce the turtle population.
- Climate change: Predictions of climate change in South Dakota point to wetter springs and hotter, drier summers (Cochrane and Moran 2011). It is unknown how snapping turtle populations will respond to such a changing environment. However, this species does exhibit temperature dependent sex determination, which means that the

temperature at which eggs incubate determines sex of the resulting offspring (Bobyn and Brooks 1994, Crews et al. 1989, Dimond 1983, Janzen 1992, Rhen and Lang 1998, Yntema 1976). As a result of climate change, it is predicted that South Dakota temperatures for June, July, and August (the period when snapping turtle eggs are incubating) will increase up to 2° C (3.6 ^{o} F) above current levels (Cochrane and Moran 2011). This increase in environmental temperature could easily result in the production of a skewed sex ratio toward females, or perhaps even all female populations, which would clearly be deleterious to snapping turtles. In support of this, some scientists have recently suggested that climate change has the potential to eliminate the production of male turtle offspring if average global temperatures increase 4°C (7.2 ^{o} F), and that increases of less than 2°C (3.6 ^{o} F) may dramatically skew sex ratios (Janzen 1994).

Recommended Conservation and Research Actions:

- Inform wildlife officers of the potential threat of illegal commercial trade in this species for the Asian and other food markets. Assure that local fishermen are aware of the current bag limit for this species.
- Investigate the extent to which turtles are caught as bycatch in fish traps. Should this prove to be a threat to snapping turtles, trap modifications can be made to ameliorate turtle losses (Bury 2011, Gibbons 1990, Larocque et al. 2012 a and b, Vogt 1980).
- In areas where snapping turtle road mortality is known to be high, provide or modify culverts with drift fences so turtles may safely cross under the roads. Such actions can have a major impact on conserving turtle populations on a local scale, and if other wildlife species utilize turtle passages, their populations will benefit as well (Aresco 2005).
- Examine levels of pollutants and pesticides in snapping turtle populations (eggs are good indicators) in selected areas of the state as an issue of public health (due to human consumption of these turtles), and as a method to examine sources of contamination and habitat quality for this and other species. In areas of high contamination, work with agencies and landowners to reduce toxic chemical levels.

Policy Recommendations:

- Require those using fish traps to report turtle bycatch.

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Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Aresco, M.J. 2005. Mitigation measures to reduce highway mortality of turtles and other herpetofauna at a north Florida lake. Journal of Wildlife Management 69(2):549-560.

Ashpole, S.L., C.A. Bishop, and R.J. Brooks. 2004. Contaminant residues in snapping turtle (*Chelydra s. serpentina*) eggs from the Great Lakes – St. Lawrence River Basin (1999-2000). Archives of Environmental Contamination and Toxicology 47:240-252.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46

Bandas, S. J. 2003. Geographic distribution and morphometrics of South Dakota turtles. M.S. Thesis, South Dakota State University, Brookings, South Dakota.

Bandas, S.J. and K.F. Higgins. 2004. Field guide to South Dakota turtles. SDCES EC 919. Brookings: South Dakota State University.

Bobyn, M.L., and R.J. Brooks. 1994. Interclutch and interpopulation variation in the effects of incubation conditions on sex, survival and growth of hatchling turtles (*Chelydra serpentina*). Journal of Zoology (London) 233:233-257.

Bonnin, J., J.L. DesGranges, C.A. Bishop, J. Rodrigue, A. Gendron, and J.E. Elliot. 1995. Comparative study of contaminants in the mudpuppy (Amphibia) and common snapping turtle (Reptilia), St. Lawrence River, Canada. Archives of Environmental Contamination and Toxicology 28:184-194.

Brooks, M.L., D.A. Galbraith, E.G. Nancekivell, and C.A. Bishop. 1988. Developing management guidelines for snapping turtles. USDA Technical Service General Technical Report Rm-166: 174-179.

Bury, T.B. 2011. Modifications of traps to reduce bycatch of freshwater turtles. Journal of Wildlife Management 75:3-5.

Carr, A. 1952. Handbook of turtles: The turtles of the United States, Canada, and Baja California. Comstock Publishing Associates, a Division of Cornell University Press, Ithaca.

Cochrane, M.A. and C.J. Moran. 2011. Past, present, and future climates for South Dakota: observed climatic variation from 1895-2010 and projected climate change to 2099. Report to South Dakota Department of Game, Fish and Parks.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

Congdon, J.D., A.E. Dunham, and R.C. van Loben Sels. 1994. Demographics of common snapping turtles (*Chelydra serpentina*): Implications for conservation and management of long-lived organisms. American Zoologist 34:397-408.

Crews, D., T. Wibbels, and W.H.N. Gutzke. 1989. Action of sex steroid hormones on temperature-induced sex determination in the snapping turtle (*Chelydra serpentina*). General and Comparative Endocrinology 76:159-166.

De Solla, S.R., and K.J. Fernie. 2004. Characterization of contaminants in snapping turtles (*Chelydra serpentina*) from Canadian Lake Erie areas of concern: St. Clair River, Detroit River, and Wheatley Harbour. International Journal of Environment and Pollution 132:101-112.

Dimond, M.T. 1983. Sex of turtle hatchlings as related to incubation temperature. Proc. 6th Reptile Symposium on Captive Propagation Husbandry Zool. Conserv. (Thurmont, Maryland):88-101.

Ernst, C.H. and J.E. Lovich. 2009. Turtles of the United States and Canada. The Johns Hopkins University Press, Baltimore, MD.

Fontenot, L.W., G.P. Noblet, S.G. Platt, and J.M. Akins. 1996. A survey of herpetofauna inhabiting polychlorinated biphenyl contaminated and reference watersheds in Pickens County, South Carolina. Journal of the Elisha Mitchell Scientific Society 112:20-30.

Gibbons, J.W. 1990. Turtle studies at SREL: a research perspective. *In* Life History and Ecology of the Slider Turtle, Gibbons J.W. (ed.), Smithsonian Institution Press, Washington, DC, pp. 19-44.

Hammer, D. A. 1968. Snapping turtle life history on Lacreek Refuge, South Dakota. M.S. Thesis, South Dakota State University, Brookings, South Dakota.

Hammer, D. A. 1969. Parameters of a marsh snapping turtle population at Lacreek Refuge, South Dakota. Journal of Wildlife Management 33:995-1005.

Hammer, D. A. 1972. Ecological relations of waterfowl and snapping turtle populations. Ph.D. Thesis, Utah State University, Logan, Utah.

Harding, J.H. and J.A. Holman. 1990. Michigan turtles and lizards: A field guide and pocket reference. Michigan State University Cooperative Extension Service, East Lansing.

Haxton, T. 2000. Road mortality of snapping turtles, *Chelydra serpentina*, in central Ontario during their nesting season. Canadian Field-Naturalist 114:106-110.

Iverson, J.B. 1992. A revised checklist with distribution maps of the turtles of the world. Richmond, Indiana (Privately published).

Janzen, F.J. 1992. Heritable variation for sex ratio under environmental sex determination in the common snapping turtle (*Chelydra serpentina*). Genetics 131:155-161.

Janzen, F.J. 1994. Climate change and temperature-dependent sex determination in reptiles. Proceedings of the National Academy of Science USA 91:7487-7490.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Larocque, S.M., S.J. Cooke, and G.Blouin-Demers. 2012a. Mitigating bycatch of freshwater turtles in passively fished fyke nets through the use of exclusion and escape modifications. Fisheries Research 125-126 (2012):149-155.

Larocque, S.M., S.J. Cooke, and G.Blouin-Demers. 2012b. A breath of fresh air: avoiding anoxia and mortality of freshwater turtles in fyke nets by the use of floats. Aquatic Conservation: Marine and Freshwater Ecosystems 22:198-205.

NatureServe. 2012. *Chelydra serpentina*. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. www.natureserve.org/explorer.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Pagano, J.J., P.A. Rosenbaum, R.N. Roberts, G.M. Sumner, and L.V. Williamson. 1999. Assessment of maternal contaminant burden by analysis of snapping turtle eggs. Journal of Great Lakes Research 25:950-961.

Rhen, T., and J.W. Lang. 1998. Among-family variation for environmental sex determination in reptiles. Evolution 52:1514-1520.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Tucker, J.K., and J.T. Lamer. 2004. Another challenge in snapping turtle (*Chelydra serpentina*) conservation. Turtle and Tortoise Newsletter 8:10-12.

Turtle Conservation Coalition [Rhodin, A.G.J., A.D. Walde, B.D. Horne, P.P. van Dijk, T. Blanck, and R. Hudson (Eds.)]. 2011. Turtles in trouble: the world's 25+ most endangered tortoises and

freshwater turtles – 2011. Lunenburg MA: IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Turtle Conservation Fund, Turtle Survival Alliance, Turtle Conservancy, Chelonian Research Foundation, Conservation International, Wildlife Conservation Society, and San Diego Zoo Global.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

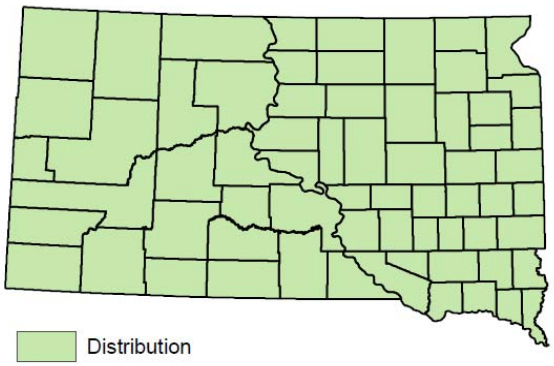
van Dijk, P.P. 2011. *Chelydra serpentina*. *In*: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2 www.iucnredlist.org

Vogt, R.C. 1980. New methods for trapping aquatic turtles. Copeia 1980:368-371.

Watermolen, D.J., and J.F. Amrhein. 1995. Mercury levels in snapping turtles, *Chelydra serpentina*, from Wisconsin. Bulletin of the Chicago Herpetological Society 30:230-233.

Yntema, C.L. 1976. Effects of incubation temperatures on sex differentiation in the turtle, *Chelydra serpentina*. Journal of Morphology 150:453-462.

South Dakota Distribution Map:



Photos:

Snapping Turtle Lauren J. Livo and Steve Wilcox

Carapace Melissa Hough

Plaston Josh Kiesow

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Painted Turtle

Scientific Name: *Chrysemys picta*

Taxonomic Note: Three subspecies of this species are recognized, and the one found in South Dakota is *Chrysemys picta bellii*, the western painted turtle (Iverson et al. 2008, 2012).

Description: Western painted turtles have an olive to brown carapace (upper shell) decorated with a network of dark lines. The plastron (lower shell) is red-orange with black and yellow streaks. The head, legs and neck are also streaked with yellow stripes (Conant and Collins 1991, Ernst and Lovich 2009, Kiesow 2006).

Population/protection Status

- IUCN: Least Concern
    - Population trend: Stable
- USFWS: Not listed
- State: This species may be collected under the authority of a state fishing license, and has a bag limit of two daily, with a maximum possession of four. No commercial activity is permitted regarding painted turtles. This species may not be shot with a firearm.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S5

Distribution

- Global: This species inhabits Canada, the continental United States and northern Chihuahua, Mexico, from British Columbia to Nova Scotia to southern Georgia and the upper Colorado River system of Utah and Arizona (Ernst and Lovich 2009, Iverson 1992). Feral populations have been established in Germany, Indonesia, Philippines, and Spain (van Dijk 2011).
- South Dakota
    - Historical: Over (1923) reported that this species is very common, and may be found in every county, and Carr (1952) showed it occurring statewide.
    - Current: Painted turtles are found statewide in most permanent bodies of water (Backlund 2004, Ballinger et al. 2000, Kiesow 2006)

Population Trend: Painted turtles are one of the most widespread and abundant turtle species in the US and Canada, and although some local threats exist, populations are considered secure overall (Ernst and Lovich 2009, van Dijk 2011). They are the most common turtle in South Dakota, and are found statewide in almost every aquatic habitat (Backlund 2004, Bandas 2003, Bandas and Higgins 2004, Kiesow 2006). In her study of turtles across the state, Bandas (2003) found painted turtles to be by far the most common of the six species captured. Five habitat

types were sampled (river, creek, lake, road, sandy grassland), and this species was found in all four wetland types, and was the most common in each. Even though painted turtles are abundant and widespread in the state, actions should still be taken to protect local populations in an effort to keep this common species common, as it is a key component of South Dakota's natural heritage. Additionally, the roles of all species in a given area are very important in the local ecology, and all pieces of the ecological puzzle should be retained.

Key Habitat

- Key Habitat Description: Painted turtles live in and around ponds, marshes, streams, swamps, lakes, reservoirs, and rivers, but prefer slow-moving or still, shallow waters with soft bottoms, basking sites, and aquatic vegetation (Conant and Collins 1991, Ernst and Lovich 2009, Kiesow 2006, NatureServe 2012). They may even colonize seasonally flooded areas near permanent water.
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Mixedgrass Subregion, Tallgrass Subregion, Missouri River Ecoregion, Great Plains Steppe Ecoregion, Black Hills Ecoregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Southern Dark Brown Glaciated Plains (53C), Rolling Soft Shale Plains (54), Central Black Glaciated Plains (55B), Southern Black Glaciated Plains (55C), Red River Valley of the North (56), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Black Hills (62), Northern Rolling Pierre Shale Plains (63A), Southern rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand hills (65), Dakota-Nebraska Eroded Tableland (66), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand Moreau, Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara, Red and Minnesota River, Heart.

Threats and Issues in South Dakota:

- Road mortality: This is a significant factor in population decline for painted turtles in certain areas. It can occur when turtles move across roads from one wetland to another as they search for food or mates, when they disperse from natal ponds, when females search for appropriate nesting sites, or when they move for a variety of other reasons (Ashley and Robinson 1996, Desroches and Picard 2005, Gibbs and Shriver 2002, Steen and Gibbs 2004a 2004b).
- Habitat alteration: Habitat loss for this species mainly occurs through drainage of wetlands for agricultural or construction purposes. However, any declines in suitable habitat have likely been more than offset by human-augmented increases in such habitat (i.e., pond construction for cattle), which is often readily colonized by painted turtles (NatureServe 2012).
- Human-associated increases in predators (i.e., raccoons): An important cause of painted turtle population decline is raccoon predation on nests and young (Ernst and

Lovich 2009, Quinn personal observation). In South Dakota, raccoons seem to thrive in disturbed areas, including both developed and rural settings (Backlund personal communication).

- Fish trapping: Fish trapping may contribute to mortality in this species, as turtles become entrapped as bycatch and drown. Legal traps utilized to catch fish in South Dakota are hoop nets and slat catfish traps (www.gfp.sd.gov/fishing-boating/docs/setline-hoopnet-regs.pdf). Although we have no information for our state on turtle mortality as bycatch in fish traps, both trap types will catch turtles, potentially causing them to drown.
- Climate change: Predictions of climate change in South Dakota point to wetter springs and hotter, drier summers (Cochrane and Moran 2011). It is unknown how painted turtle populations will respond to such a changing environment. However, this species does exhibit temperature dependent sex determination, which means that the temperature at which eggs incubate determines sex of the resulting offspring (Ewert and Nelson 1991, Ewert et al. 2004, Gutzke and Paukstis 1984, Schwarzkopf and Brooks 1985). As a result of climate change, it is predicted that South Dakota temperatures for June, July, and August (which, coincidentally, is the period when painted turtle eggs are incubating) will increase up to 2° C (3.6^{o} F) above current levels (Cochrane and Moran 2011). This increase in environmental temperature could easily result in the production of a skewed sex ratio toward females, or perhaps even all female populations, which would clearly be deleterious to painted turtles. In support of this, some scientists have recently suggested that climate change has the potential to eliminate the production of male turtle offspring if average global temperatures increase 4°C (7.2^{o} F), and that increases of less than 2°C (3.6^{o} F) may dramatically skew sex ratios (Janzen 1994).
- Pet and food trade: Fortunately, South Dakota's turtles are now legally protected from commercial trade. However, care must be taken to assure that our state's turtles are not being taken illegally, as the black market demand is rather intense. The market for turtle meat is fueled by demand in Asian countries where native turtle populations have been decimated by years of overharvest. The Turtle Conservation Coalition (2011) states that 75% of Asia's tortoise and freshwater turtle species are threatened as a result of overharvesting. Increasingly, US turtles are being shipped abroad to satisfy the Asian demand. In response to unsustainable turtle harvests, Tennessee, Florida, Georgia, and Alabama recently severely restricted or banned commercial harvest of wild-caught turtles.

  In a recent search of the internet, it was noted that painted turtles are sold on the pet market, but prices are not extravagant, ranging from $29.95 - $49.95, depending on size, condition, and source (www.TurtleShack.com, www.TheTurtleSource.com). Thus, pressure to collect them for the pet trade may not be intense.

Recommended Conservation and Research Actions:

- In areas where painted turtle road mortality is known to be high, provide or modify culverts with drift fences so turtles (and other wildlife) may safely cross under the roads. One such area of high painted turtle mortality was noted in South Dakota's Custer State

Park, where a busy highway runs between two lakes containing pained turtle populations. To ameliorate turtle losses, *Turtle Crossing* signs were installed on the highway, a culvert running under the highway between the lakes was slightly modified for easy turtle access, and a graphic about the turtles was installed in a nearby parking area (DARN 2011, Quinn 2009). Such actions can have a major impact on conserving turtle populations on a local scale, and if other wildlife species utilize turtle passages under roads, their populations will benefit as well (Aresco 2005).

- Encourage construction of stock ponds and other wetlands to offset loss of natural wetlands.
- Control raccoon populations in areas where painted turtle nest predation is known to be high.
- Investigate the extent to which turtles are caught as bycatch in fish traps. Should this prove to be a threat to painted turtles in certain areas, trap modifications can be made to ameliorate turtle losses (Bury 2011, Gibbons 1990, Larocque et al. 2012 a and b, Vogt 1980).
- Assure that fishermen are aware of the turtle bag limit in South Dakota.
- Inform wildlife officers of the potential threat of illegal commercial trade in this species for food, traditional medicine, and pets.

Policy Recommendations:

- Require those using fish traps to report turtle bycatch.

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Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Aresco, M.J. 2005. Mitigation measures to reduce highway mortality of turtles and other herpetofauna at a north Florida lake. Journal of Wildlife Management 69(2):549-560.

Ashley, E.P. and J.T. Robinson. 1996. Road mortality of amphibians, reptiles and other wildlife on the Long Point Causeway, Lake Erie, Ontario. Canadian Field-Naturalist 110:403-412.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Bandas, S. J. 2003. Geographic distribution and morphometrics of South Dakota turtles. M.S. Thesis, South Dakota State University, Brookings, South Dakota. (pp. xiv, 106 leaves).

Bandas, S.J. and K.F. Higgins. 2004. Field guide to South Dakota turtles. SDCES EC 919. Brookings: South Dakota State University.

Bury, T.B. 2011. Modifications of traps to reduce bycatch of freshwater turtles. Journal of Wildlife Management 75:3-5.

Carr, A. 1952. Handbook of turtles: The turtles of the United States, Canada, and Baja California. Comstock Publishing Associates, a Division of Cornell University Press, Ithaca.

Cochrane, M.A. and C.J. Moran. 2011. Past, present, and future climates for South Dakota: observed climatic variation from 1895-2010 and projected climate change to 2099. Report to South Dakota Department of Game, Fish and Parks.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

DARN. 2011. Dakota Amphibian and Reptile News 4(1):17.

Desroches, J.F. and I. Picard. 2005. Mortalité des tortues sur les routes de l'Outaouais. Nat. Can. 129:35-41.

Ernst, C.H. and J.E. Lovich. 2009. Turtles of the United States and Canada. The Johns Hopkins University Press, Baltimore, MD.

Ewert, M.A. and C.E. Nelson. 1991. Sex determination in turtles: Diverse patterns and some possible adaptive values. Copeia 1991:50-69.

Ewert, M.A., C.R. Etchberger and C.E. Nelson. 2004. Turtle sex-determining modes and TSD patterns, and some TSD patter correlates. Pp. 21-32. *In*: N. Valenzuela and V.A. Lance (eds.), Temperature-dependent sex determination in vertebrates. Smithsonian Institution Press, Washington, D.C.

Gibbons, J.W. 1990. Turtle studies at SREL: a research perspective. *In*: Life History and Ecology of the Slider Turtle, Gibbons J.W. (ed.), Smithsonian Institution Press, Washington, DC, pp. 19-44.

Gibbs, J.P. and W.G. Shriver. 2002. Estimating the effects of road mortality on turtle populations. Conservation Biology 16:1647-1652.

Gutzke, W.H.N. and G.L. Paukstis. 1984. A low threshold temperature for sexual differentiation in the painted turtle, *Chrysemys picta*. Copeia 1984:546-547.

Iverson, J.B. 1992. A revised checklist with distribution maps of the turtles of the world. Richmond, Indiana (Privately published).

Iverson, J.B., P.A. Meylan, M.E. Seidel. 2008. Testudines: Turtles. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 67-74. SSAR Herpetological Circular 37:1-84.

Iverson, J.B., P.A. Meylan, M.E. Seidel. 2012. Testudines: Turtles. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, pp. 73-81. SSAR Herpetological Circular 39:1-92.

Janzen, F.J. 1994. Climate change and temperature-dependent sex determination in reptiles. Proceedings of the National Academy of Science USA 91:7487-7490.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Larocque, S.M., S.J. Cooke, and G.Blouin-Demers. 2012a. Mitigating bycatch of freshwater turtles in passively fished fyke nets through the use of exclusion and escape modifications. Fisheries Research 125-126 (2012):149-155.

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NatureServe. 2012. *Chrysemys picta*. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. www.natureserve.org/explorer.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Quinn, Holly. 2009. My way or the highway: One DARN member's quest to save local turtles. Dakota Amphibian and Reptile News 2(1):15-16.

Schwarzkopf, L. and R.J. Brooks. 1985. Sex determination in northern painted turtles: Effect of incubation at constant and fluctuating temperatures. Canadian Journal of Zoology 63:2543-2547.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Steen, D.A. and J.P. Gibbs. 2004a. Of roads and turtles: A summary of recent research findings. Turtle and Tortoise Newsletter 8:8-9.

Steen, D.A. and J.P. Gibbs. 2004b. Effects of roads on the structure of freshwater turtle populations. Conservation Biology 18:1143-1148.

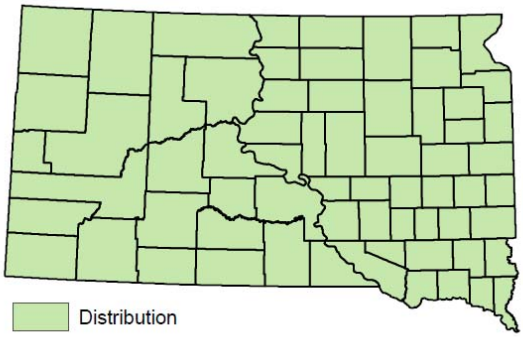
Turtle Conservation Coalition [Rhodin, A.G.J., A.D. Walde, B.D. Horne, P.P. van Dijk, T. Blanck, and R. Hudson (Eds.)]. 2011. Turtles in trouble: the world's 25+ most endangered tortoises and freshwater turtles – 2011. Lunenburg MA: IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Turtle Conservation Fund, Turtle Survival Alliance, Turtle Conservancy, Chelonian Research Foundation, Conservation International, Wildlife Conservation Society, and San Diego Zoo Global.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

van Dijk, P.P. 2011. *Chrysemys picta*. *In*: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2 www.iucnredlist.org

Vogt, R.C. 1980. New methods for trapping aquatic turtles. Copeia 1980:368-371.

South Dakota Distribution Map:



Photos:

Painted Turtles Doug Backlund

Plastron Andrew Kopp

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Blanding's Turtle

Scientific Name: *Emydoidea blandingii*

Taxonomic Note: In the past, Blanding's turtles have been placed in the genera *Cistuda* and *Emys*, but are currently considered in the genus *Emydoidea* (see Iverson et al. 2008, 2012 for discussion).

Description: This species is a medium-sized freshwater turtle with small light spots on the carapace (upper shell), sometimes running together forming bars or streaks. A bright yellow chin and throat are good identification characteristics, and are easily seen with binoculars when turtles are basking. The plastron (bottom shell) is somewhat hinged, so the turtle can nearly close its shell, with head and legs almost all the way inside (Conant and Collins 1991, Ernst and Lovich 2009).

Population/protection Status:

- IUCN: Endangered
    - Population Trend: Decreasing
- USFWS: Not Listed
- State: This species may be collected under the authority of a state fishing license, and has a bag limit of two daily, with a maximum possession of four. No commercial activity is permitted regarding Blanding's turtles. This species may not be shot with a firearm.
- Global Rank (NatureServe): G4
- State Rank (NatureServe): S1

Distribution:

- Global: Blanding's turtles occur from Nova Scotia to Nebraska, with a discontinuous and spotty range east of Ohio and Ontario. There are a few isolated records in southeast South Dakota and northwest Missouri (Conant and Collins 1991, Ernst and Lovich 2009)
- South Dakota
    - Historical: It's difficult to estimate the historical range of this species in South Dakota, as Over (1923) and Carr (1952) didn't list it as occurring in our state, and Iverson (1992) indicated only one locale in the southeastern corner. More recently, Kiesow (2006) and Ernst and Lovich (2009) show it ranging more broadly in that corner of the state. South Dakota's Natural Heritage Database lists only three sightings, all from the southeastern corner of the state, one in 1963, one in the 1970s, and the other from 1996. As discussed below, this can be a difficult species to detect, so it may have historically resided in our state undetected, or it may be a recent, sporadic, invader from populations in western Minnesota and northern Nebraska (also discussed in more detail below).

- Current: It is not known whether populations of this species exist in South Dakota, as only three sightings have been reported in the state, all from the southeastern corner.

Population Trend: In the overall range of this species, some populations appear stable, while others are documented as declining (Brodman et al. 2002, Smith et al. 2006). Summaries of this can be found in Congdon et al. (2008) and Ernst and Lovich (2009). While only a few records of Blanding's turtles exist from South Dakota (South Dakota Natural Heritage Database), several populations have been found within a few miles of our state. These are from Pipestone, Lincoln, and Lac Qui Parle Counties, Minnesota, and Cherry County, Nebraska. In Minnesota's Pipestone County, Blanding's turtle populations have been reported as close as 12 miles from the South Dakota border, in Lincoln County only about six miles , and in Lac Qui Parle County about 13.5 miles (Lisa Gelvin-Innvaer, Minnesota Department of Natural Resources, personal communication; Lang 2006). In Nebraska, Blanding's turtles have been reported about five miles from the South Dakota border (Lang 2004). One of the largest known populations across the entire range of this species is at Valentine National Wildlife Refuge, about 30 miles south of our state (Rhodin and van Dijk 2011). This population is estimated at over 130,000 animals, excluding hatchlings and yearlings (Lang 2004).

Blanding's turtles have been reported sporadically in South Dakota, and are only known from three sightings, all from the southeastern corner of the state (South Dakota Natural Heritage Database). Despite intensive visual surveys from 2001 – 2004, no populations were found (Backlund 2004). Backlund (2004) reported that Dan Fogell (Southeast Community College, Nebraska) focused searches on lakes and streams in south-central South Dakota during 2004, north of locations where the species occurs in Nebraska, and Jessen (2002) focused efforts on Pipestone Creek, since a population exists in Minnesota at the headwaters of that creek. Timken (1975) and Bandas (2003) also reported negative results utilizing baited traps in their searches for Blanding's turtles. Therefore, Backlund (2004) felt that this evidence suggests the species has never existed as a population in South Dakota, and that the few individuals reported may have been dispersing turtles from neighboring states. Additionally, a quick and superficial search by the author in May 2011 in extreme southern Todd County, South Dakota, (just north of Valentine, Nebraska) for appropriate Blanding's turtle habitat revealed none.

Key Habitat:

- Key Habitat Description: Shallow, slow-moving waters, marshes, or ponds, with mud bottoms and abundant aquatic vegetation preferred. Upland, well drained, open areas for nesting are required (Ernst and Lovich 2009, Oldfield and Moriaty 1994, Vogt 1981).
- Linkage to Ecosystem Diversity:
  - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Tallgrass Subregion.
  - Major Land Resource Areas (United States Department of Agriculture 2006): Till Plains (102B), Loess Uplands (102C).
  - Aquatic Drainage Units (Annis et al. 2010): Big Sioux/Vermillion.

Threats and Issues in South Dakota: Since it is not clear that a Blanding's turtle population exists in our state, no threats are identified. Threats elsewhere within this species' range include:

- habitat alteration (degradation, fragmentation and loss),
- road mortality,
- nest depredation: [increased predation of eggs and young by subsidized predators (i.e., unnaturally large populations of predators subsidized by easily available resources near human settlements), such as raccoons (Rhodin and van Dijk 2011]), and
- pet trade

Recommended Conservation and Research Actions:

- Blanding's turtle surveys should continue to determine status, as populations can be small and isolated. Most populations are extremely difficult to detect, and baited hoop net trapping is the preferred method for determining presence or absence (McDiarmid et al. 2012), although visual surveys can also be useful.

  Lang (2006) found that Blanding's turtles in southwestern Minnesota utilize stream habitat for travel and overwintering (in contrast to certain other populations within its range), and ponds, marshes and other wetlands for feeding and other activities. Lang (personal communication) also reported that these populations persist in the few stream and marsh wetland drainages that snake through the otherwise densely agricultural landscape. The few sections not crisscrossed with roads are the best remaining localities. Such habitat should be searched and trapped in South Dakota in areas adjacent to Minnesota populations in Lincoln, Pipestone, and Lac Qui Parle Counties. Visual searches during April and May are typically more productive than other times of the year, as turtles are more likely to be seen basking during these months (personal observation), while trapping is successful from May through July. Surveys should also be conducted in southern Todd County, just north of Valentine, Nebraska. Additionally, the three sites in our state where Blanding's turtles have been previously sighted should be surveyed.
- If a population is found, a management plan should immediately be formulated, identifying a broad range of activities needed to conserve this species, including defining threats and actions needed to ameliorate them. Major threats identified in other areas within this species' range include road mortality; habitat degradation, fragmentation and destruction; pet trade; and increased predation of eggs and young by subsidized predators (i.e., unnaturally large populations of predators subsidized by easily available resources near human settlements), such as raccoons (Rhodin and van Dijk 2011).

Policy Recommendations: None.

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Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station; Jeffery W. Lang, Professor Emeritus, University of North Dakota.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Bandas, S.J. 2003. Geographical distribution and morphometrics of South Dakota turtles. MS Thesis, South Dakota State University, Brookings, South Dakota.

Broadman, R., S. Cortwright, and A. Resetar. 2002. Historical changes of reptiles and amphibians of northwest Indiana Fish and Wildlife properties. American Midland Naturalist 147:135-144.

Carr, A. 1952. Handbook of turtles: the turtles of the United States, Canada, and Baja California. Comstock Publishing Associates a division of Cornell University Press, Ithaca, New York.

Conant, R., and J.T. Collins. 1991. A field guide to reptiles and amphibians: eastern and central North America. Third edition, expanded, Houghton Mifflin, Boston.

Congdon, J.D., T.E. Graham, T.B. Herman, J.W. Lang, M.J. Pappas, and B.J. Brecke. 2008. *Emydoidea blaindingii* (Holbrook 1838) – Blanding's turtle. Chelonian Research Monographs 5:015.1-015.12.

Ernst, C.H. and J.E. Lovich. 2009. Turtles of the United States and Canada. The Johns Hopkins University Press, Baltimore, MD.

Iverson, J.B. 1992. A revised checklist with distribution maps of the turtles of the world. Privately Printed, Richmond, Indiana.

Iverson, J.B., P.A. Meylan, M.E. Seidel. 2008. Testudines: Turtles. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 67-74. SSAR Herpetological Circular 37:1-84.

Iverson, J.B., P.A. Meylan, M.E. Seidel. 2012. Testudines: Turtles. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of

Mexico, With Comments Regarding Confidence In Our Understanding, pp. 73-81. SSAR Herpetological Circular 39:1-92.

Jessen, T. 2002. Blanding's turtle and herpetology survey of northeastern South Dakota. Report to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Lang, J.W. 2004. Blanding's turtles on Valentine NWR, Nebraska: population status, estimation of population size, and road mortality. Final report for 2002 – 2003 Blanding's turtle study on Valentine NWR to Nebraska Department of Roads, Valentine, Nebraska.

Lang, J.W. 2006. Conservation of Blanding's turtles in southwestern Minnesota. Final report to Minnesota Department of Natural Resources Nongame, Minnesota.

McDiarmid, R. W., M. S. Foster, C. Guyer, J. W. Gibbons, and N. Chernoff (editors). 2012. Reptile Diversity. Standard Methods for Inventory and Monitoring. Univ. of California Press, Berkeley.

Oldfield, B. and J.J. Moriaty. 1994. Amphibians and reptiles native to Minnesota. University of Minnesota Press, Minneapolis.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Rhodin, A.G.J. and P.P. van Dijk. 2011. *Emydoidea blandingii.* In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1 www.iucnredlist.org

Smith, G.R., J.B. Iverson, and J.E. Rettig. 2006. Changes in a turtle community from a northern Indiana lake: A long-term study. Journal of Herpetology 40:180-185.

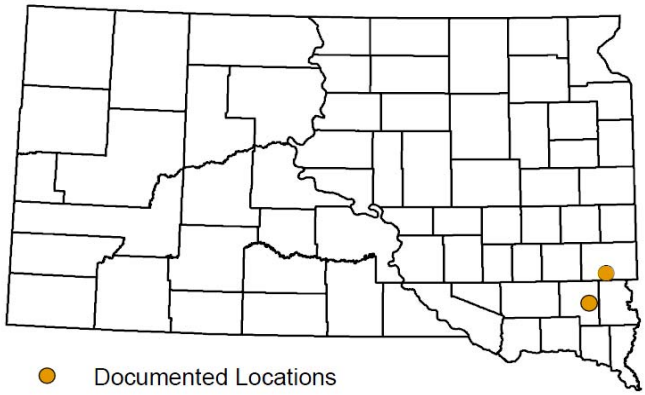
South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Timken, R.L. 1975. The distribution and ecology of turtles on South Dakota. Ph.D. dissertation. Department of Zoology, University of South Dakota, Vermillion, South Dakota.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Vogt, R.C. 1981. Natural history of amphibians and reptiles of Wisconsin. Milwaukee Public Museum, Wisconsin.

South Dakota Distribution Map:



Photos:

Blanding's Turtle carapace Dan Fogell

Plastron Tom Jessen

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: False Map Turtle

Scientific Name: *Graptemys pseudogeographica*

Taxonomic Note: Two subspecies of this species are recognized, and the one found in South Dakota is *Graptemys pseudogeographica pseudogeographica*, the northern false map turtle (Iverson et al. 2008, 2012).

Description: This turtle has a yellow spot or "L" behind each eye, yellow neck stripes, and a carapace (top shell) with spines or knobs down the middle of the back (Conant and Collins 1991, Ernst and Lovich 2009).

Population/protection Status:

- IUCN: Least Concern
    - Population trend: Unknown
- USFWS: Not listed (Note: Listed as Appendix III of CITES)
- State: This is a Threatened species in South Dakota, and a state endangered species permit is required to collect it. False map turtles may not be shot with a firearm.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S3

Distribution:

- Global: This species is found in the Mississippi and Missouri River basins from Louisiana to North Dakota and Ohio (Conant and Collins 1991, Ernst and Lovich 2009).
- South Dakota
    - Historical: The South Dakota range as reported by Over (1923) was the Missouri River, but no specification was made as to where along the length of the river this species was found. Carr (1952) indicated that it entered South Dakota only in the extreme southeastern corner, and Wheeler and Wheeler (1966) did not show it extending into North Dakota.
    - Current: This species is most common in the Missouri River, its backwaters and near the mouths of a few tributaries in southeastern South Dakota, but can also be found locally northward in the river to the North Dakota border (Backlund 2004, Ballinger 2000, Kiesow 2006).

Population Trend: False map turtles have an extensive range in the Missouri and Mississippi River basins, but populations have declined in the Missouri River, especially south of South Dakota to its mouth in Saint Louis, Missouri (van Dijk 2010). This decline is possibly due to several factors, including water pollution, river channelization, reduction of suitable nesting sites, siltation, and unlawful shooting (Ernst and Lovich 2009, Johnson 1987). Vandewalle and

Christiansen (1996) found that river modifications in Iowa, including channel straightening, dredging, impoundments, and other changes to the natural environment, had negative effects on false map turtle populations. Many of the above factors adversely impacting this species elsewhere are also prevalent in our state, so a critical evaluation of the population trend of false map turtles in South Dakota needs to be undertaken. This species has been reported in the Missouri River, its backwaters and near the mouths of a few tributaries in our state, and is common below Gavins Point Dam and Fort Randall Dam (Backlund 2004). Additionally, it has been found on the James River, greater than 45 miles upstream from its confluence with the Missouri River (Aaron Gregor, University of South Dakota, personal communication). Timken (1975) reported it to be the most common turtle in the Missouri River. It is difficult to tell from the literature if populations still thrive above Gavins Point Dam, as most recent reports are from the lower reaches of the river in the state (Backlund 2004, Dixon 2009, South Dakota Natural Heritage Database), but in 2010 Aaron Gregor (University of South Dakota, personal communication) captured this species in traps adjacent to Niobrara State Park. Additionally, populations still persist in the Pierre area, around Farm Island and Laframboise Island, where they are regularly seen and have been observed laying eggs (Doug Backlund personal communication). Therefore, it appears that populations continue to persist along the Missouri River at least as far north as Pierre.

Historic distribution records are confined to the southeastern portion of the state, suggesting that the range has expanded since that time. However, such a conclusion cannot be drawn, as early range estimates were not based on comprehensive surveys.

Key Habitat:

- Key Habitat Description: This species is found in rivers, lakes, ponds, oxbows and occasionally marshlands. Mud bottoms are preferred, as are areas with dense aquatic vegetation and abundant basking sites (logs). Nests are placed on sandy, sparsely vegetated banks (Ernst and Lovich 2009, van Dijk 2010).
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Missouri River Ecoregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Southern Dark Brown Glaciated Plains (53C), Rolling Soft Shale Plains (54), Southern Black Glaciated Plains (55C), Northern Rolling Pierre Shale Plains (63A), Southern rolling Pierre Shale Plains (63B), Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Bad/Choteau, White.

Threats and Issues in South Dakota:

- Habitat alteration:
    - Lack of nesting sites: False map turtles nest on sparsely vegetated beaches and sandbars (Vogt and Bull 1984). Such habitat has rapidly disappeared in the Missouri River in South Dakota since the construction of its four dams in the mid-1900s. The stabilization of the Missouri River by the Missouri River Reservoir System has practically eliminated downstream flooding. Prior to this, frequent

floods produced ample sandbars and sand beaches with sparse vegetative growth, perfect habitat for turtle nesting activities. Such habitat is not formed naturally without flooding, and without this force, succession of plant communities on beaches and sandbars progresses to mature forests with large increases in invasive understory plants (Johnson et al. 2012). Dixon et al. (2012) found that sandbar habitat had decreased by 96% since the late 1800s along the unchannelized portions of the Missouri River from Nebraska into Montana. Therefore, the lack of flooding along the Missouri River in South Dakota has diminished the amount of suitable nesting habitat available for the false map turtle.

  - Nest depredation: Additionally, the lack of many suitable nesting beaches results in dense nesting aggregations on the few remaining appropriate beaches. Such concentrations can result in higher nest depredation rates, which can damage turtle populations (Dixon 2009). Ensuring an abundance of available nesting habitat along the river can help decrease the density of turtle nests, and thus limit the effects of depredation.
  - Overproduction of males: Open or sparsely vegetated nesting beaches are also important in producing a natural sex ratio (see the discussion below on *Climate Change* regarding temperature dependent sex determination in this species). For example, Vogt and Bull (1982, 1984) found that turtle nest temperatures were several degrees cooler in shaded areas than in open areas. Because of variation in the availability of these two general habitat types (shade vs. open), different beaches often produced different hatchling sex ratios. Having only densely vegetated areas available for nesting could result in a preponderance of males being produced, which would be detrimental to false map turtle populations.
  - Nest disturbance by recreationists: As the number of nesting beaches diminishes for this species, the remaining ones gain a higher concentration of nests (Dixon 2009). Therefore, disturbance to these few critical areas can have a great impact on nesting success. Many such beaches are also popular places for human summer recreation, and turtle nests can be unintentionally trampled by people (Bolton and Brooks 2007), or destroyed by ATV use (Aaron Gregor, University of South Dakota, personal communication).
  - Bank stabilization: Bank stabilization destroys nesting sites for this species, and also limits the input of large woody debris, which false map turtles use for cover, basking and foraging (Aaron Gregor, South Dakota State University, personal communication). Large increases in stabilization occurred during the 2011 flood, and as development continues along the Missouri River, bank stabilization will become an increasing threat.

- Injury by boat propellers: Boat-related injuries are a hazard for this species on the main channel of the Missouri River. This is particularly a problem in early spring and late fall when animals are active and surfacing, but slow to react to watercraft due to low water temperatures (Aaron Gregor, University of South Dakota, personal communication).

- Unlawful shooting: While it is illegal to shoot turtles of any species in South Dakota, this practice continues (Aaron Gregor, University of South Dakota, personal communication; South Dakota Department of Game, Fish and Parks 2006). Such an activity has been cited as a major threat for this species throughout its range because of its propensity to Bask for long periods of time on snags and logs that emerge from the water (van Dijk 2010).
- Fishing hook injuries: Aaron Gregor (University of South Dakota, personal communication) reported having caught numerous false map turtles with hooks embedded in their mouths, and in some cases exiting through their throats (with swelling and infection).
- Fish trapping: Fish trapping may contribute significantly to mortality in this species, as turtles become entrapped as bycatch and drown (Ernst and Lovich 2009, Barko et al. 2004). For example, eight percent of the false map turtles captured in nets set in the Mississippi River to assess passive mortality from fishing died (Ernst and Lovich 2009). Legal traps utilized to catch fish in South Dakota are hoop nets and slat catfish traps (www.gfp.sd.gov/fishing-boating/docs/setline-hoopnet-regs.pdf). Although no information currently exists on the level of such turtle mortality in South Dakota, both trap types will catch turtles.
- Climate change: Predictions of climate change in South Dakota point to wetter springs and hotter, drier summers (Cochrane and Moran 2011). It is unknown how false map turtle populations will respond to such a changing environment. However, this species does exhibit temperature dependent sex determination, which means that the temperature at which eggs incubate determines sex of the resulting offspring (Vogt and Bull; 1982, 1984). As a result of climate change, it is predicted that South Dakota temperatures for June, July, and August (the period when false map turtle eggs are incubating) will increase up to 2° C above current levels (Cochrane and Moran 2011). This increase in environmental temperature could result in the production of a skewed sex ratio toward females (Janzen 1994), or perhaps even all female populations, which would clearly be deleterious to false map turtles. Some scientists have suggested that climate change has the potential to eliminate the production of male turtle offspring if average global temperatures increase 4° C, and that increases of less than 2° C may dramatically skew sex ratios (Janzen 1994).
- Commercial trade: There has been a commercial market for this species for a long time (Clark and Southall 1920). Excluding farm-raised turtles, false map turtles were one of the 10 most heavily traded species in the Hong Kong pet trade in 1998 and 1999 (Lau et al. 2000). This turtle trade continues, but fortunately South Dakota's turtles are now legally protected from commercial trade, and the species as a whole recently received additional protection internationally through inclusion in CITES Appendix III (USFWS 2005). However, care must be taken to ensure South Dakota turtles are not being taken illegally, as the black market demand is strong. The market for turtle meat is fueled by demand in Asian countries where native turtle populations have been decimated by years of overharvest. The Turtle Conservation Coalition (2011) states that 75% of Asia's tortoise and freshwater turtle species are threatened as a result of overharvesting. This is relevant because US turtles are increasingly being shipped abroad to satisfy the Asian

demand. In response to unsustainable turtle harvests, Tennessee, Florida, Georgia, and Alabama recently severely restricted or banned commercial harvest of wild-caught turtles.

<u>Recommended Conservation and Research Actions</u>:

- Where nesting beaches for false map turtles are known to exist along the Missouri River, landowners should be encouraged to maintain open vegetative cover on sandbars and beaches by utilizing land management practices that retain early plant succession stages and restrict later ones. An example of such practices could simply be to walk through habitat and remove certain plants as they sprout. However, this is labor intensive, and thus may not be practical. Mechanical or chemical thinning of vegetation during non-nesting season may be more realistic. Unfortunately, these methods may not be as desirable as removing vegetation by hand due to their negative impacts on other animal species.

  More effectively, flooding should be allowed along the Missouri River so sand bars and beaches can form naturally, creating the nesting habitat required by this species. Appropriate water releases from dams would accomplish this. For example, the unprecedented moisture in the upper Missouri River basin in 2011 triggered record-breaking flow releases from the US Army Corps of Engineers dams (Johnson et al. 2012), with the resulting floods altering much of the bank area. It appears this created considerable areas of new sandbars, at least in the short term (Mark Dixon and Jacob Kerby, University of South Dakota, personal communication). It should be noted that forming and maintaining sandbars in this manner would not only have a positive impact on false map turtle populations, but also on those of the smooth and spiny softshells, the state Threatened false map turtle and eastern hog-nosed snake, the federally and state Endangered least tern, and the federally Threatened and state Endangered piping plover (Dixon 2009).

  Man-made sandbars have been created to provide nesting areas for these two bird species, and the false map turtles also utilize them for nesting (Dixon 2009). However, the turtles prefer to nest on sandbars or beaches with steeper inclines than provided by the man-made islands, thus placing their nests at a slightly higher elevation to protect them from moderate flooding (Dixon 2009). Providing higher man-made sandbars with accessible slopes would be beneficial to turtle populations. Currently, water levels are left low during the majority of the turtle nesting season, so water would not inundate the nests during most of the incubation period. However, water levels can be raised significantly after least terns and piping plovers fledge at the end of July, a full month or more before many turtle eggs may hatch (Dixon 2009). Dixon (2009) recommends that major raises be delayed until mid-September, as the majority of eggs should have hatched by that time.
- In areas where turtle nests are concentrated (due to a lack of many suitable nesting beaches), implement predator control programs for species that consume turtle eggs, such as raccoons and skunks.
- Discourage bank stabilization projects in areas known to contain false map turtle populations.

- Inform wildlife officers of the potential threat of commercial trade in this species, as well as the potential persistence of illegal shooting of false map turtles. Educational materials should be developed to reduce illegal shooting.
- Develop programs and materials for defined areas to reduce false map turtle nest disturbance by recreationists. Further, identify a few key nesting beaches, and restrict recreational use during false map turtle egg incubation season (from June to mid-September). Additionally, post boat speed limits near these nesting beaches to prevent propeller injuries to females as they congregate to lay eggs.
- Investigate the extent to which turtles are caught as bycatch in fish traps. Should this prove to be a threat to false map turtles, trap modifications can be made to ameliorate turtle losses (Bury 2011, Gibbons 1990, Larocque et al. 2012 a and b, Vogt 1980). Additionally, encourage fishermen to remove hooks and release turtles unharmed that they catch by hook-and-line.

Policy Recommendations:

- Require those using fish traps to report turtle bycatch.

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Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station; Laura Dixon, Bureau of Land Management, Meeker, Colorado; Aaron Gregor, University of South Dakota.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Barko, V.A., J.T. Briggler, and D.E. Ostendorf. 2004. Passive fishing techniques: A cause of turtle mortality in the Mississippi River. Journal of Wildlife Management 68:1,145-1,150.

Bolton, R.M. and R.J. Brooks. 2007. Nest site selection and embryo hatching success in spiny, Blanding's and northern map turtles, and mitigation of mammalian predation and dipteran infestation of turtle nest at [a site in southern Ontario]. Progress Report for Wildlife Preservation Canada.

Bury, T.B. 2011. Modifications of traps to reduce bycatch of freshwater turtles. Journal of Wildlife Management 75:3-5.

Carr, A. 1952. Handbook of turtles: The turtles of the United States, Canada, and Baja California. Comstock Publishing Associates, a Division of Cornell University Press, Ithica.

Clark, P.J. and J.B. Southall. 1920. Fresh water turtles: A source of meat supply. U.S. Bull. Fish. Doc. 889:3-20.

Cochrane, M.A. and C.J. Moran. 2011. Past, present, and future climates for South Dakota: observed climatic variation from 1895-2010 and projected climate change to 2099. Report to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

Dixon, L. 2009. False map, spiny softshell and smooth softshell turtle nest and nest-site habitat characteristics along the lower stretch of the Missouri National Recreation River in South Dakota. M.S. Thesis, South Dakota State University, Brookings, South Dakota. (pp. xv, 95 leaves).

Dixon, M.D., W.C. Johnson, M.L. Scott, D.E. Bowen, and L.A. Rabbe. 2012. Dynamics of plains cottonwood (*Populus deltoides*) forests and historical landscape change along unchannelized segments of the Missouri River, USA. Environmental Management 49(5):990-1008.

Ernst, C.H. and J.E. Lovich. 2009. Turtles of the United States and Canada. The Johns Hopkins University Press, Baltimore, MD.

Gibbons, J.W. 1990. Turtle studies at SREL: a research perspective. *In*: Life History and Ecology of the Slider Turtle, Gibbons J.W. (ed.), Smithsonian Institution Press, Washington, DC, pp. 19-44.

Iverson, J.B., P.A. Meylan, M.E. Seidel. 2008. Testudines: Turtles. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 67-74. SSAR Herpetological Circular 37:1-84.

Iverson, J.B., P.A. Meylan, M.E. Seidel. 2012. Testudines: Turtles. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, pp. 73-81. SSAR Herpetological Circular 39:1-92.

Janzen, F.J. 1994. Climate change and temperature-dependent sex determination in reptiles. Proceedings of the National Academy of Science USA 91:7487-7490.

Johnson, T.R. 1987. The amphibians and reptiles of Missouri. Missouri Department of Conservation, Jefferson City, Missouri.

Johnson, W.C., M.D. Dixon, M.L. Scott, L. Rabbe, G. Larson, M.Volke, and B. Werner. 2012. Forty years of vegetation change on the Missouri River floodplain. BioScience 62(2):123-135.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Larocque, S.M., S.J. Cooke, and G. Blouin-Demers. 2012a. Mitigating bycatch of freshwater turtles in passively fished fyke nets through the use of exclusion and escape modifications. Fisheries Research 125-126 (2012):149-155.

Larocque, S.M., S.J. Cooke, and G. Blouin-Demers. 2012b. A breathj of fresh air: avoiding anoxia and mortality of freshwater turtles in fyke nets by the use of floats. Aquatic Conservation: Marine and Freshwater Ecosystems 22:198-205.

Lau, M.B., P. Chan, P. Crow, and G. Ades. 2000. Trade and conservation of turtles and tortoises in Hong Kong Special Administrative Region, People's Republic of China. Chelonian Research Monographs 2:39-44.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

South Dakota Department of Game, Fish and Parks. 2006. South Dakota comprehensive wildlife conservation plan. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota. Wildlife Division Report 2006 – 2008.

Timken, R.L. 1975. The distribution and ecology of turtles on South Dakota. Ph.D. dissertation. Department of Zoology, University of South Dakota, Vermillion, South Dakota.

Turtle Conservation Coalition [Rhodin, A.G.J., A.D. Walde, B.D. Horne, P.P. van Dijk, T. Blanck, and R. Hudson. (Eds.)]. 2011. Turtles in trouble: The world's 25+ most endangered tortoises and freshwater turtles – 2011. Lunenburg, Turtle Conservancy, Chelonian research Foundation, Conservation International, Wildlife Conservation Society, and San Diego Zoo Global. 54 pp.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

USFWS. 2005. Inclusion of alligator snapping turtle (*Macroclemys* [=*Macrochelys*] *temminckii*) and all species of map turtle (*Graptemys* spp.) in Appendix III to the Convention on

International Trade in Endangered Species of Wild Fauna and Flora. Federal Register 70:74,700-74,712.

Vandewalle, T.J., and J.L. Christiansen. 1996. A relationship between river modification and species richness of freshwater turtles in Iowa. Iowa Academy of Sciences 103:1-8.

van Dijk, P.P. 2010. *Graptemys pseudogeographica*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1. <www.iucnredlist.org>.

Vogt, R.C. 1980. New methods for trapping aquatic turtles. Copeia 1980:368-371.

Vogt, R.C. and J.J. Bull. 1982. Temperature-controlled sex determination in turtles: Ecological and behavioral aspects. Herpetologica 38:156-164.

Vogt, R. C. and J.J. Bull. 1984. Ecology of hatchling sex ratio in map turtles. Ecology 65:582-587.

Wheeler, G.C. and J. Wheeler. 1966. The amphibians and reptiles of North Dakota. The University of North Dakota, Grand Forks, North Dakota.

South Dakota Distribution Map:

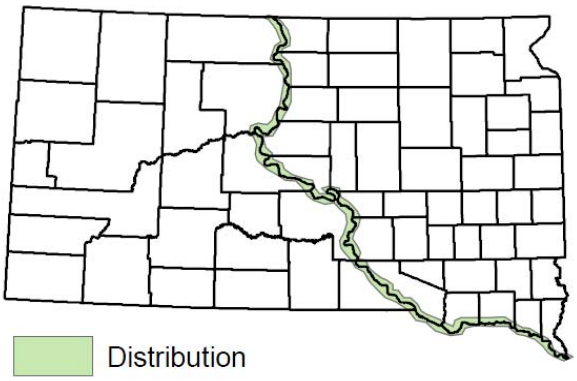

Photo:

False Map Turtles NEBRASKAland Magazine/Nebraska Game and Parks Commission

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Ornate or plains box turtle

Scientific Name: *Terrapene ornata*

Taxonomic Note: Two subspecies of this species are recognized, and the one found in South Dakota is *Terrapene ornata ornata*, the plains box turtle (Iverson et al. 2008, 2012).

Description: This is a 4 – 5 inch terrestrial turtle with a hinged, completely closeable shell. It is well ornamented above and below with yellow radiating lines on the otherwise brownish shell (Conant and Collins 1991, Ernst and Lovich 2009).

Population/protection Status:

- IUCN: Near Threatened
    - Population trend: Decreasing
- USFWS: Not listed (Note: listed on Appendix II of CITES)
- State: This species may be collected under the authority of a state fishing license, and has a bag limit of two daily, with a maximum possession of four. No commercial activity is permitted regarding ornate box turtles. This species may not be shot with a firearm.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S2

Distribution:

- Global: The ornate box turtle ranges from Wisconsin and northern Indiana through the central Great Plains from southern South Dakota to Arizona, northern Mexico and the Gulf Coast in Texas (Dodd 2001, Ernst and Lovich 2009, Redder et al. 2006).
- South Dakota:
    - Historical: Over (1923) reported that this species was found in the Sandhills region in the southwestern corner of the state. He also mentioned that it did not occur in the Black Hills, north of Pennington County, or east of Washabaugh County (a former county, now merged with Jackson County). Later, Carr (1952) showed this species ranging across the entire southern portion of the state from Iowa to Wyoming.
    - Current: Ornate box turtles are found in the Sandhills (sand prairie) region in the southcentral part of the state (Backlund 2004, Ballinger et al. 2000, Kiesow 2006). This species appears to be commonly transported and released, as specimens have been found on LaFramboise Island by Pierre (Doug Backlund; Retired Wildlife Biologist; South Dakota Department of Game, Fish and Parks; personal communication).

Population Trend: Across its range through the Great Plains, this species can be locally common, but populations are predicted to remain relatively stable or decline 30% in the short term, and decline 30 – 50% in the long term (NatureServe 2012). It is further predicted that the species will continue, if not accelerate, its decline, potentially becoming restricted to only large stretches of protected or low-impact land (van Dijk and Hammerson 2011). In South Dakota ornate box turtles are near the northern extent of their range, and are restricted to areas of appropriate habitat (see Key Habitat section below) in the south-central portion of the state. Prior to a recent study on the ecology and distribution of this species, they were known only from 19 specimens (South Dakota Department of Game, Fish, and Parks Natural Heritage Database 2010). Since that study began in 2010, nearly 200 additional specimens have been located, indicating that South Dakota populations are stronger than previously thought, especially in northern Shannon County on Pine Ridge Indian Reservation (Quinn personal observation). Fortunately, much of the rather extensive box turtle habitat found in this area is relatively undeveloped, undoubtedly contributing to the health of these populations. The predicted range of this species in the state is currently being estimated utilizing GIS technology, and once this analysis is complete, surveys of predicted areas of occurrence should be conducted.

The historical range appears more restricted than the current range according to Over (1923), but broader according to Carr (1952), suggesting that the species may have expanded then contracted its distribution in the state. However, the historical distributions were estimated from only a few specimens, and may not have reflected the actual range.

Key Habitat:

- Key Habitat Description: This species is found in Sandhills (sand prairie) habitat with deep sandy soils for burrowing to escape freezing temperatures during hibernation (Ernst and Barbour 1972, Quinn personal observation).
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Great Plains Steppe Ecoregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Southern rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand hills (65), Dakota-Nebraska Eroded Tableland (66).
    - Aquatic Drainage Units (Annis et al. 2010): White, Niobrara.
    - Great Plains Steppe Ecoregion

Threats and Issues in South Dakota:

- Road mortality: Many authors over the years have commented on deaths of large numbers of ornate box turtles on roads (Blair, 1976, Collins 1993, Doroff and Keith 1990, Ernst and Barbour 1972, Legler 1960, Rodeck 1949), indicating that roadkill is a significant cause of mortality. In fact, more adults seem to be killed by automobiles than all predators combined (Ernst and Lovich 2009).

  It is critical to mitigate these losses given the life history traits of ornate box turtles. Such traits include a long, somewhat sedentary life; a low rate of recruitment; high adult survivorship; high egg and hatchling mortality; relatively late maturity; and low

fecundity (Dodd 2001). As a result of these traits, the loss of even one or two reproductive females per year from small populations can result in the eventual extinction of those populations (Doroff and Keith 1990, Congdon et al. 1993, Belzer 2000, Gibbs and Shriver 2002).

- Habitat alteration: Another leading cause of population declines across the geographic range of ornate box turtles is habitat loss due to human activities (Bowen et al. 2004). In South Dakota, conversion of native prairie to agricultural land is probably the leading cause of habitat alteration negatively affecting this species. Additionally, it appears that management practices that result in: 1) succession of grasslands to a more wooded stage, 2) destruction of shrubs essential for thermoregulation, or 3) elimination of rodents whose burrows are used for thermoregulation or hibernation could be harmful to ornate box turtle populations (Converse and Savidge 2003, Curtin 1997 1998, Fitch 2006, Nieuwolt 1996).
- Farm machinery and mowers: Roadside mowing and using farm machinery can be fatal to box turtles (Metcalf and Metcalf 1985, Doroff and Keith 1990, Dodd 2001).
- Commercial pet trade: Substantial numbers of box turtles have been collected in the past for the domestic and international pet trade, with potentially significant population impacts (van Dijk and Hammerson 2011). Instances are known where entire truckloads of ornate box turtles have been collected in a small area in a single day (Redder et al. 2006). To protect box turtles from international trade, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) listed North American box turtles on Appendix II in 1994. This international treaty regulates and monitors trade in species that either are or might become endangered by trade. Box turtles receive an additional measure of protection from the U.S. Food and Drug Administration. Commercial sale of turtles less than four inches in carapace length is prohibited in order to prevent the spread of salmonella (see Levell 1997). However, even with these protective measures from various state and federal agencies, as well as an international treaty, a large black market for commercial trade of box turtles still persists in Japan and Europe, with individual animals being sold for hundreds of dollars (Dodd 2001). A recent check of the internet found ornate box turtles for sale for $219.95 (www.turtlesale.com), $249 (baby), $269 (juvenile), and $219 (adult) (www.turtleshack.com).

  As mentioned in the Road Mortality section above, removal of even small numbers of adult box turtles is detrimental to population sustainability. Populations can take decades to recover (Hall et al. 1999), and simply cannot withstand the pressures of commercial collection.
- Disease (*Ranaviris*): We have not observed any apparent box turtle mass mortality events in South Dakota due to diseases. However, as a cautionary note, such mortality events have occurred as a result of the pathogen *Ranaviris* in eastern and Florida box turtles (*Terrapene carolina carolina* and *T. carolina bauri*) from Florida, Georgia, New York, and Pennsylvania. These mortalities occurred between 2003 – 2005, but were preceded by die-offs in Texas during 1998 (Johnson et al. 2007). More recently (2008 – 2011), an outbreak in Maryland decimated populations there (Farnsworth and Seigel 2012). While these mortalities impacted the closely related box turtles to the east and

south, ornate box turtles can also be affected by this disease (Johnson et al. 2007). This disease has been detected in South Dakota, and can impact not only turtles, but also frogs, salamanders, fishes, and insects (Jacob Kirby, University of South Dakota, personal communication; Farnsworth and Seigel 2012).

- Climate change: Predictions of climate change in South Dakota point to wetter springs and hotter, drier summers (Cochrane and Moran 2011). It is unknown how box turtle populations will respond to such a changing environment; however, Converse et al. (2005) found that survival rates of hibernating ornate box turtles in Nebraska are highest in years with low minimum winter temperatures. This suggests that warmer winters might produce higher metabolic rates during hibernation, resulting in depletion of lipid reserves which would adversely affect subsequent survival and reproduction.

  Another concern about climate change is that box turtles experience temperature dependent sex determination (Packard et al. 1985). This means that the temperature at which eggs incubate determines sex of the resulting offspring. At low incubation temperatures, males are produced, and at high temperatures, females (Vogt and Bull 1982). Intermediate temperatures produce varying ratios of both sexes. As a result of climate change, it is predicted that South Dakota temperatures for June, July, and August (which, coincidentally, is the period when box turtle eggs are incubating) will increase up to 2° C (3.6^{o} F) above current temperatures (Cochrane and Moran 2011). This increase in environmental temperature as a result of climate change could easily result in the production of a skewed sex ratio toward females, or perhaps even all female populations, which would clearly be deleterious to ornate box turtles. In support of this, some scientists have recently suggested that climate change has the potential to eliminate the production of male turtle offspring if average global temperatures increase 4° C (7.2^{o} F), and that increases of less than 2° C (3.6^{o} F) may dramatically skew sex ratios (Janzen 1994).

Recommended Conservation and Research Actions:

- Identify areas of high road mortality, and design methods to ameliorate such losses. A proven method to mitigate turtle losses is to provide drift fences that lead to culverts, so the animals may safely move under roads (Aresco 2005).
- Encourage an appropriate level of cattle grazing where box turtle populations are known to exist. Grazing helps maintain a fairly open environment for box turtle basking, while retaining certain shrubs (sage, yucca) for shelter from heat. While Caldwell and Collins (1981) reported trampling by cattle to be an important cause of death in ornate box turtles, Fitch (2006) found the presence of cattle to be an important factor in maintaining box turtle populations. At his Kansas site, succession from grassland to a more wooded stage occurred after cattle were removed, resulting in a collapse of ornate box turtle and other reptile populations. Controlled burns may also be a method to limit tree growth, but could be disastrous, killing many turtles, unless done during the winter when the turtles are hibernating underground.
- Encourage construction of wetlands where box turtle populations occur. Box turtle densities in sand prairies are highest where there are nearby wetlands (including ephemeral ponds and windmill overflows)(Converse et al. 2002). These microhabitats

are used during times of water stress. Hence, constructing ponds or installing wildlife/cattle watering windmills will increase ornate box turtle populations (assuming that cattle densities aren't too high) (John Iverson, Earlham College, personal communication).

- In areas of known turtle populations, encourage county, federal, and tribal agencies to set roadside mower blades at eight inches, thus avoiding contact of blades with turtles (Redder et al. 2006). To minimize the chances of such mortality, mowing should be done during the heat of the day when turtles will be inactive and under cover, or when it is too cold for turtles to be active on the surface.
- Assure South Dakota wildlife officers are aware that a lucrative, illegal trade in ornate box turtles exists, and that no turtles can be collected in our state for commercial purposes.
- Continue surveys for populations of ornate box turtles in the state, especially on protected land (i.e., Buffalo Gap National Grassland, Badlands National Park, Lacreek National Wildlife Refuge, The Nature Conservancy land and easements), and quantify population densities as well as area of continuous suitable habitat within each protected area. This will identify strong populations on protected land for which conservation management plans can be developed. Doroff and Keith (1990) tentatively suggested that areas of at least 100 ha (247 acres) are required to sustain viable box turtle populations, also noting that these areas should be roadless.
- Encourage enactment of tribal law to provide protection of ornate box turtles on the Pine Ridge and Rosebud Reservations, especially in light of the commercial trade value of this species. The Oglala Sioux Tribe currently has no wildlife protection laws. Additionally, encourage development of conservation management plans on tribal lands where box turtle populations occur.

Policy Recommendations: None

Account Author: Hugh Quinn, Department of Biology, Black Hills State University

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Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Aresco, M.J. 2005. Mitigation measures to reduce highway mortality of turtles and other herpetofauna at a north Florida lake. Journal of Wildlife Management 69(2):549-560.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Belzer, B. 2000. A nine year study of eastern box turtle courtship with implications for reproductive success and conservation in a translocated population. Turtle and Tortoise Newsletter 6:17-26.

Blair, W.F. 1976. Some aspects of the biology of the ornate box turtle, *Terrapene ornata*. Southwestern Naturalist 21:89-104.

Bowen, K.D., P.I. Colbert, and F.J. Janzen. 2004. Survival and recruitment in a human-impacted population of ornate box turtles, *Terrapene ornata*, with recommendations for conservation and management. Journal of Herpetology. 38:562-568.

Caldwell, J.P. and J.T. Collins. 1981. Turtles in Kansas. AMS Publishing, Lawrence, KS.

Carr, A. 1952. Handbook of turtles: The turtles of the United States, Canada, and Baja California. Comstock Publishing Associates, a Division of Cornell University Press, Ithica.

Cochrane, M.A. and C.J. Moran. 2011. Past, present, and future climates for South Dakota: observed climatic variation from 1895-2010 and projected climate change to 2099. Report to South Dakota Department of Game, Fish and Parks.

Collins, J.T. 1993. Amphibians and reptiles in Kansas. Third Edition. University Press of Kansas. Lawrence, KS.

Conant, R., and J.T. Collins. 1991. A field guide to reptiles and amphibians: eastern and central North America. Third edition, expanded, Houghton Mifflin, Boston.

Congdon, J.D., A.E. Dunham, and R.C. van Loben Sels. 1993. Delayed sexual maturity and demographics of Blanding's turtles (*Emydoidea blandingii*): implications for conservation and management of long-lived organisms. Conservation Biology 7:826-833.

Converse, S.J., J.B. Iverson, and J.A. Savidge. 2002. Activity, reproduction and overwintering behavior of ornate box turtles (*Terrapene ornata ornata*) in the Nebraska Sandhills. American Midland Naturalist 148:416-422.

Converse, S.J., J.B. Iverson, and J.A. Savidge. 2005. Demographics of an ornate box turtle population experiencing minimal human-induced disturbances. Ecological Applications 15(6):2171-2179.

Converse, S.J., and J.A. Savidge. 2003. Ambient temperature, activity, and microhabitat use by ornate box turtles (*Terrapene ornata ornata*). Journal of Herpetology 37(4):665-670.

Curtin, C.G. 1997. A biophysical analysis of the cost and consequences of changing land-use on ornate box turtles (*Terrapene ornata*), Wisconsin, USA. Pages 31-36 in J. van Abbema (ed.), Conservation, restoration and management of tortoises and turtles. New York Turtle and Tortoise Society, New York, NY.

Curtin, C.G. 1998. Plasticity in ornate box turtle thermal preference. Journal of Herpetology 32:298-301.

Dodd, C.K., Jr. 2001. North American box turtles. A natural history. University of Oklahoma Press, Norman, OK.

Doroff, A.M. and L.B. Keith. 1990. Demography and ecology of an ornate box turtle (*Terrapene ornata)* population in south-central Wisconsin. Copeia 1990:387-399.

Ernst, C.H. and R.W. Barbour. 1972. Turtles of the United States and Canada. University Presses of Kentucky, Lexington, KY.

Ernst, C.H. and J.E. Lovich. 2009. Turtles of the United States and Canada. The Johns Hopkins University Press, Baltimore, MD.

Farnsworth, S.D., and R.A. Seigel. 2012. Simultaneous effects of a Ranavirus outbreak on box turtles (*Terrapene carolina*) and amphibians. 10th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles (Abstract), Tucson, Arizona.

Fitch, H.S. 2006. Collapse of a fauna: reptiles and turtles of the University of Kansas Natural History Reservation. Journal of Kansas Herpetology 17(March):10-13.

Gibbs, J.P. and W.G. Shriver. 2002. Estimating the effects of road mortality on turtle populations. Conservation Biology 16(6):1647-1652.

Hall, R.J., P.F.P. Henry, and C.M. Bunck. 1999. Fifty-year trends in a box turtle population in Maryland. Biological Conservation 88:165-172.

Iverson, J.B., P.A. Meylan, M.E. Seidel. 2008. Testudines: Turtles. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 67-74. SSAR Herpetological Circular 37:1-84.

Iverson, J.B., P.A. Meylan, M.E. Seidel. 2012. Testudines: Turtles. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of

Mexico, With Comments Regarding Confidence In Our Understanding, pp. 73-81. SSAR Herpetological Circular 39:1-92.

Janzen, F.J. 1994. Climate change and temperature-dependent sex determination in reptiles. Proceedings of the National Academy of Science USA 91:7487-7490.

Johnson, A.J., A.P. Pessier, and E.R. Jacobson. 2007. Experimental transmission and induction of Ranaviral disease in western ornate box turtles (*Terrapene ornata ornata)* and red-eared sliders (*Trachemys scripta elegans*). Veterinary Pathology 44(3):285-297.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Legler, J.M. 1960. Natural history of the ornate box turtle, *Terrapene ornata ornata* Agassiz. University of Kansas Publication of the Museum of Natural history 11(10):527-669.

Levell, J.P. 1997. A field guide to reptiles and the law. 2nd ed. Serpent's Tale books, Lanesboro, Minnesota.

Metcalf, A.L. and E.L. Metcalf. 1985. Longevity in some ornate box turtles *Terrapene ornata ornata*. Journal of Herpetology 19:157-158.

NatureServe. 2012. *Terrapene ornata*. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. www.natureserve.org/explorer.

Nieuwolt, P.M. 1996. Movement, activity, and microhabitat selection in the western box turtle, *Terrapene ornata luteola*, in New Mexico. Herpetologica 52:487-495.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Packard, G.C., M.J. Packard, and W.H.N. Gutzke. 1985. Influence of hydration of the environment on eggs and embryos of the terrestrial turtle *Terrapene ornata*. Physiological Zoology 58:564-575.

Redder, A.J., C. K. Dodd Jr., D. Keinath, D. McDonald, and T. Ise. 2006. Ornate box turtle (*Terrapene ornata ornata*): A technical conservation assessment. USDA Forest Service, Rocky Mountain Region. Online, www.fs.fed.us/r2/projects/scp/assessments/ornateboxturtle.pdf.

Rodeck, H.G. 1949. Notes on box turtles in Colorado. Copeia 1949:32-34.

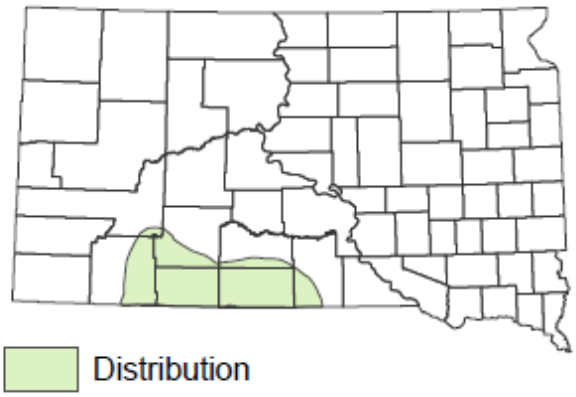
South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

van Dijk. P.P. and G.A. Hammerson. 2011. *Terrapene ornata*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2 www.iucnredlist.org.

Vogt, R.C. and J.J. Bull. 1982. Temperature-controlled sex determination in turtles: Ecological and behavioral aspects. Herpetologica 38:156-164.

South Dakota Distribution Map:



Photos:

Ornate Box Turtle carapace Doug Backlund

Plastron Doug Backlund

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Six-lined racerunner

Scientific Name: *Aspidoscelis sexlineata*

Taxonomic Note: Three subspecies are recognized, and the one found in South Dakota is *Aspidoscelis sexlineata viridis*, the prairie racerunner (de Queiroz and Reeder 2008, 2012).

Description: These lizards have six or (more commonly) seven light stripes extending the length of the body from the head to the base of the tail. Ground color can be brown to bright green. The belly is pale blue on males and creamy white on females and juveniles. The scales on the back of racerunners are small and round, while those on the belly are large, rectangular, and arranged in eight rows. Juveniles have a blue tail (Conant and Collins 1991, Fogell 2010, Kiesow 2006).

Population/protection Status:

- IUCN: Least Concern
    - Population Trend: Stable
- USFWS: Not listed
- State: This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S2

Distribution:

- Global: This species is found from eastern Wyoming, South Dakota, Minnesota, Wisconsin, Indiana, Kentucky, Virginia, and Maryland, south to southern Texas, the Gulf Coast, and southern Florida. It also ranges into extreme northeastern Tamaulipas, Mexico (Trauth and McAllister 1996).
- South Dakota
    - Historical: Over (1923) reported that this lizard lives in the sandhills of Washington County. Washington County was divided in 1943 to comprise all or part of the current Jackson, Pennington, and Shannon Counties. Later, Smith (1946) showed the species ranging across the width of the southern portion of South Dakota.
    - Current: Racerunners are found in southwestern and south-central South Dakota, with a specimen also reported from the extreme southeast corner of the state along the Missouri River from Elk Point Wildlife Production Area (Backlund 2004, Ballinger et al. 2000, Kiesow 2006, South Dakota Natural Heritage Database).

Population Trend: This species has a broad range across a large portion of the eastern and central United States, with no major threats identified (NatureServe 2012). Overall, populations are stable, but a few have declined or disappeared as a result of habitat conversion to human uses, especially agricultural development (Hammerson et al. 2007). In South Dakota, populations appear stable, and recently this species was found to range further north in the state than previously thought (Backlund 2004). However, large scale conversion of prairie to agriculture has caused major declines in other states (Gary Casper personal communication), and such activity may also be negatively impacting populations here, a situation which needs to be further evaluated. Discrepancies in the current and historical ranges described above may not indicate an expanding or contracting distribution of this species in our state, but may simply indicate that we have a better understanding today of its actual distribution based on additional observations.

Key Habitat:

- Key Habitat Description: These lizards are found in arid grasslands with loose, sandy soils and reduced vegetation. They can be abundant along roadsides and in human-disturbed habitats, and also frequent sand-bars along rivers (Ballinger et al. 2000, Ballinger et al. 2010, Fogell 2010)
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Great Plains Steppe and Missouri River Ecoregions.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Pierre Shale Plains (60A), Northern Rolling Pierre Shale Plains (63A), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand hills (65), Dakota-Nebraska Eroded Tableland (66), Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara.

Threats and Issues in South Dakota:

- Habitat alteration: Agricultural development could play a role in diminishing populations of this lizard in our state.

Recommended Conservation and Research Actions:

- Continue searching for new racerunner populations in South Dakota, especially along the Cheyenne River from northeastern Pennington County to its confluence with the Missouri River. Searches up tributaries to the Cheyenne River such as Cherry, Plum, and Rudey Creeks may also prove fruitful. Further searches of appropriate habitat in Gregory, Tripp, Mellette, and Jackson Counties may also help us better understand the distribution of this lizard in our state, as well as along the lower reaches of the Missouri River.
- Evaluate the impact of agricultural development on this species within our state.

Policy Recommendations:

- Because the population trend of racerunners in South Dakota needs to be assessed, a bag limit to protect existing populations should be established. A daily bag limit of two, with a maximum possession of four is recommended at this time. This is the current bag limit for turtles (also reptiles) in our state, and until life table parameters for racerunners can be defined so sustainable harvests can be estimated, it is suggested that the above turtle bag limit may also be suitable for this species.

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Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Ballinger, R.E., J.D. Lynch, and G.R. Smith. 2010. Amphibians and reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Conant, R., and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

de Queiroz, K., and T.W. Reeder. 2008. Squamata: Lizards. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 24-45. SSAR Herpetological Circular 37:1-84.

de Queiroz, K., and T.W. Reeder. 2012. Squamata: Lizards. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in our Understanding pp. 32-51. SSAR Herpetological Circular 39:1-92.

Fogell, D.D. 2010. A field guide to the amphibians and reptiles of Nebraska. University of Nebraska, Lincoln, Nebraska.

Hammerson, G.A., P. Lavin, and F. Mendoza Quijano. 2007. *Aspidoscelis sexlineata*. *In*: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. <www.iucnredlist.org>.

Kiesow, A.M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

NatureServe. 2012. *Aspidoscelis sexlineata*. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. www.natureserve.org/explorer.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Smith, H.M. 1946. Handbook of lizards: Lizards of the United States and of Canada. Comstock Publishing Associates, A Division of Cornell University Press, Ithaca, New York.

Trauth, S.E., and C.T. McAllister. 1996. *Cnemidophorus sexlineatus.* Catalogue of American Amphibians and Reptiles 628:1012.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

South Dakota Distribution Map:

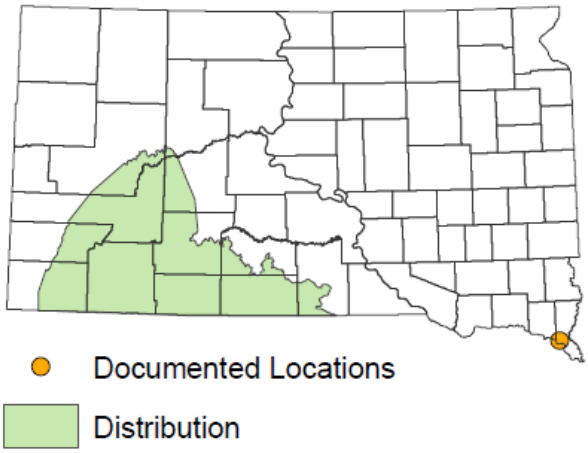


Photo:

Six-lined Racerunner Lauren J. Livo and Steve Wilcox

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Common Earless Lizard

Scientific Name: *Holbrookia maculata*

Taxonomic Note: Five North American subspecies of this species are recognized, and the one found in South Dakota is *Holbrookia maculata maculata*, the Great Plains earless lizard (de Queiroz and Reeder 2008, 2012).

Description: As its name implies, this lizard lacks external ear openings. It has pale longitudinal stripes, one extending from the eye to the base of the tail and another faint one from the armpit to the groin. A single, obscure middorsal stripe is present. Males have a pair of black bars behind the armpits (Conant and Collins 1991, Kiesow 2006). The somewhat similar prairie lizard has ear openings, and lacks the black bars behind the armpits.

Population/protection Status:

- IUCN: Least Concern
    - Population trend: Stable
- USFWS: Not listed
- State: This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S2

Distribution:

- Global: This lizard ranges from South Dakota to central Texas, southwest to southeastern Utah and Arizona, and southward to Jalisco and Guanajuato, Mexico (Conant and Collins 1991, Stebbins 2003).
- South Dakota
    - Historical: Over (1923) did not list this species as occurring in South Dakota, but Smith (1946) showed it occurring in the southern portion of the state from the Missouri River to the southwestern corner of Fall River County.
    - Current: This species ranges in the Sandhills region in the south-central portion of the state (Backlund 2004, Ballinger et al. 2000, Kiesow 2006).

Population Trend: The common earless lizard is locally common across much of its range in the central and southern Great Plains (Hammerson et al. 2007, NatureServe 2012). It reaches the northern most extent of its distribution in south-central South Dakota, and is only known by a few specimens from the Sandhills region across the lower portion of the state in Shannon, Bennett, Tripp and Gregory Counties (Backlund 2004, Ballinger et al. 2000, Marlet 1977). However, based on the existence of appropriate habitat for this species (see Key Habitat section below), it may also occur in certain portions of Fall River, Custer, Pennington, Jackson,

Mellette, and Todd Counties. The historical South Dakota range noted above by Smith (1946) is more extensive than that known today, suggesting a shrinking distribution. However, Smith's map was based on few specimens, so the range may not be shrinking in our state, but may be simply better understood based on additional observations.

Key Habitat:

- Key Habitat Description: This lizard lives in sandy prairies with either no or scant vegetative cover. Specifically, habitats include sandy grasslands, dry sandbars in streambeds, and sand blowouts (Conant and Collins 1991).
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Great Plains Steppe Ecoregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Southern rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand hills (65), Dakota-Nebraska Eroded Tableland (66).
    - Aquatic Drainage Units (Annis et al. 2010): White, Niobrara.

Threats and Issues in South Dakota:

- Habitat alteration:
    - Stabilization of sand dune habitats: Because stabilization of sand dune habitats promotes vegetative growth (and these lizards require either no or scant vegetative cover), this activity is seen as a threat to populations of this species (Ballinger and Jones 1985).
    - Agricultural development: Populations of earless lizards have been reduced or eliminated in some areas within their range as a result of large-scale, intensive cultivation (Hammerson et al. 2007). At the same time, these lizards are attracted to certain disturbances (cattle grazing, fire) that create openings in otherwise thick vegetation (Hammerson 1999). Fortunately for this species, current land use practices within its range in South Dakota are primarily focused on cattle grazing, with less land devoted to agricultural development.

Recommended Conservation and Research Actions:

- Where populations of this lizard are known to occur, discourage sand dune stabilization projects. Creation of open sand should be encouraged, especially on public land, such as Lacreek national Wildlife Refuge. Little active sand dune habitat is left there, as most has been planted in grass as cover for duck nesting (Doug Backlund personal communication).
- Also discourage large-scale agricultural development in areas containing earless lizard populations, and encourage cattle grazing and occasional controlled burns (during winter, when lizards are below ground) to inhibit thick vegetative growth.
- Conduct intensive surveys for this species in areas of sandy soils in Fall River, Shannon, Custer, Pennington, Jackson, Bennett, Mellette, Todd, Tripp, and potentially Gregory Counties. Complicating these surveys will be the strong resemblance of earless lizards

to sympatric prairie lizards, necessitating their capture (and release) to make positive identification (Platt et al. 2004). Because of this resemblance, Platt et al. (2004) felt earless lizards may be more common in the areas they surveyed than was evident by the number they positively identified, as many lizards eluded capture. Therefore, future surveys must take this resemblance into account to accurately identify abundance and distribution of both species involved. It would be most useful to develop detection probability based survey methods to allow for presence/absence determinations (Mazerolle et al. 2007)

- Conduct genetic analyses to determine the distinctiveness of South Dakota populations of this species from those in other parts of its range. While earless lizards are rare in our state, their populations are considered stable across their overall distribution (Hammerson et al. 2007). Populations in South Dakota are at the northern most extent of the species' range, which extends southward, well into Mexico. In general, peripheral populations, such as those of the lesser earless lizard in South Dakota, are more likely to be imperiled than those within the core of the range. This is the case, as they tend to occur in less suitable environments for the species, and are often isolated from more central and continuous populations (Lesica and Allendorf 1995).

  Populations at the edge of a species' range are likely to be genetically different from those in the center due to a number of factors (such as restricted gene flow, small population size, founder effects, and differing selective forces) (Lesica and Allendorf 1995). They are genetically adapted to conditions at the edge of the range, which may vary substantially from those in the core. Conserving peripheral populations helps conserve the wide range of genetic variation within the species as a whole, and thus enhances its ability to adapt to a changing environment. For example, such populations may be well adapted to shifting the species range in response to climate change (Hunter and Hutchinson 1994). Lesica and Allendorf (1995) argue that the more genetically divergent peripheral populations are from their central populations, the higher the priority should be to conserve them (and that these populations may even be important sites of future speciation events). To investigate the distinctiveness of South Dakota earless lizard populations from others within the range of the species, genetic comparisons should be made.

Policy Recommendations:

- Because earless lizards have a very limited distribution in the state, and are only known from a few specimens, a bag limit to protect existing populations should be established. A daily bag limit of two, with a maximum possession of four is recommended at this time. This is the current bag limit for turtles (also reptiles) in our state, and until life table parameters for earless lizards can be defined so sustainable harvests can be estimated, it is suggest that the above turtle bag limit may also be suitable for this species.

Account Author: Hugh Quinn, Department of Biology, Black Hills State University

Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Ballinger, R.E. and S.M. Jones. 1985. Ecological disturbance in a sandhills prairie: Impact and importance to the lizard community on Arapaho Prairie in western Nebraska. Prairie Naturalist 17(2):91-100.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

de Queiroz, K. and T.W. Reeder. 2008. Squamata: Lizards. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 24-45. SSAR Herpetological Circular 37:1-84.

de Queiroz, K. and T.W. Reeder. 2012. Squamata: Lizards. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, pp. 32-51. SSAR Herpetological Circular 39: 1-92.

Hammerson, G.A. 1999 . Amphibians and reptiles in Colorado. Second edition. University Press of Colorado, Boulder, Colorado.

Hammerson, G.A., P. Lavin, J. Vazquez Diaz, G. Quintero Diaz, and H. Gadsden. 2007. *Holbrookia maculata*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2 www.iucnredlist.org.

Hunter, M.L. Jr. and A Hutchinson. 1994. The virtues and shortcomings of parochialism: conserving species that are locally rare, but globally common. Conservation Biology 8(4):1163-1165.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Lesica, P. and F.W. Allendorf. 1995. When are peripheral populations valuable for conservation? Conservation Biology 9(4):753-760.

Marlet, L. 1977. The herpetofauna of Lacreek National Wildlife Refuge. Transactions Kansas Academy of Science 80:145-150.

Mazerolle, M. J., L. L. Bailey, W. L. Kendall, J. A. Royle, S. J. Converse, & J. D. Nichols. 2007. Making great leaps forward: accounting for detectability in herpetological field studies. Journal of Herpetology 41(4):672-689.

NatureServe. 2012. *Holbrookia maculata*. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. www.natureserve.org/explorer.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Platt, S.G., A. Fast Horse, S. Mannel, C. Comes Killing. 2004. A herpetofaunal survey of southwestern South Dakota with an emphasis on species of conservation concern. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

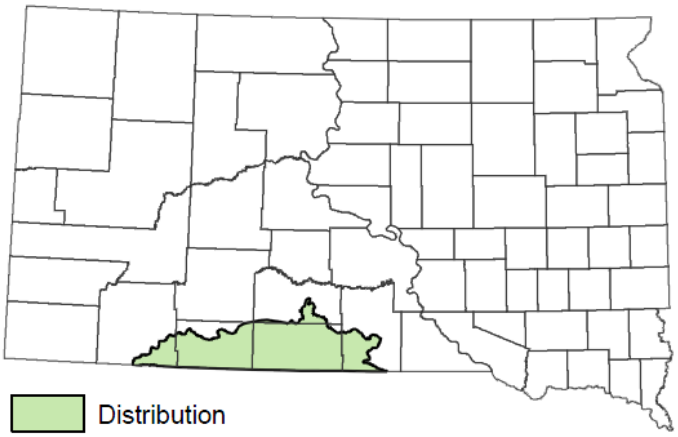
Smith, H.M. 1946. Handbook of lizards: Lizards of the United States and of Canada. Comstock Publishing Associates, a division of Cornell University Press, Ithaca, New York.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Stebbins, R.C. 2003. A field guide to western reptiles and amphibians. Third Edition. Houghton Mifflin Company, Boston, Massachusetts.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

South Dakota Distribution Map:



Photos:

Common Earless Lizard Lauren J. Livo and Steve Wilcox

Common Earless Lizard Colorado Division of Wildlife

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Greater short-horned lizard

Scientific Name: *Phrynosoma hernandesi*

Taxonomic Note: The greater short-horned lizard was once recognized as a subspecies of *Phrynosoma douglasii* (*P. douglasii brevirostre*), but has now been elevated to the species level (see de Queiroz and Reeder 2008, 2012 for further discussion).

Description: This species has horns or spikes (modified scales) on the head and outer parts of the body. It has a flattened and somewhat rounded body shape, and a short tail. Color is variable with a ground color of gray or brown and a light stripe down the middle of the back from neck to tail. A series of large, irregular blotches occurs on either side of this line with numerous smaller blotches scattered on the back (Conant and Collins 1991, Fogell 2010, Kiesow 2006).

Population/protection Status:

- IUCN: Least Concern
    - Population Trend: Stable
- USFWS: Not listed
- State: This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S2

Distribution:

- Global: This species ranges from southern Alberta and southern Saskatchewan south through eastern Montana, the western Dakotas, Wyoming, western Nebraska, Colorado, Utah, eastern Nevada, New Mexico, Arizona, and the mountains of western Texas to southern Durango (Zamudio et al. 1997, Stebbins 2003, Hammerson 2007)
- South Dakota
    - Historical: Over (1923) reported this species from around Crow Buttes in southern Harding County and along Wounded Knee Creek in Shannon and Washington Counties. Washington County was divided in 1943 to comprise all or part of the current Jackson, Pennington, and Shannon Counties. Visher (1914) and Patton (1926) both found short-horned lizards common in Harding County. Later Smith (1946) showed them ranging from the southwestern portion of the state to the northwestern corner.
    - Current: This species is represented by scattered populations, roughly across the western third of the state (Kiesow 2006), but is absent from the once occupied northeast and central portions of this range (Quinn et al. 2009). However, there are potentially credible reports of this species from the northeast portion of its

range along the Cheyenne River breaks north of Hayes (Doug Backlund personal communication).

Population Trend: Populations appear relatively stable over this species' rather vast range; however, local declines have been caused by habitat loss and degradation (urbanization, intensive cultivation, and conversion of native shrubland to dense grass) (Hammerson 2007). In South Dakota, populations have declined significantly, with this species probably no longer persisting in Meade, Pennington, Stanley, and western Jackson Counties, areas that it previously occupied (Quinn et al. 2009).

Key Habitat:

- Key Habitat Description: This species is usually found in open, shrubby or open wooded areas with sparse vegetation at ground level. Soil may vary from rocky to sandy, with soft substrate generally nearby (Degenhardt et al. 1996, Hammerson 1999, Kiesow 2006, Quinn et al. 2009, Stebbins 2003)
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Great Plains Steppe Ecoregion, Black Hills Ecoregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Rolling Soft Shale Plains (54), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Black Hills (62), Mixed Sandy and Silty Tableland and Badlands (64).
    - Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand Moreau, Middle Missouri, Cheyenne, White, Heart.

Threats and Issues in South Dakota:

- Habitat alteration: The constriction of the short-horned lizard range in South Dakota (as noted above in the Population Trend section) is probably a result of conversion of native prairie to cropland or densely planted pasture (Quinn et al. 2009). This impact appears most prevalent in the northeast and central portions of its range within the state, but is also evident elsewhere. Reynolds (1979) concluded that converting sagebrush range to crested wheatgrass in Idaho resulted in the reduction of population densities of pygmy horned lizards (*Phrynosoma douglasii*), a closely-related species. He felt that increased plant density may be a negative factor for lizard survival. It should be noted that Quinn et al. (2009) observed apparently healthy short-horned lizard populations in many South Dakota cattle-grazed areas of natural prairie (areas without supplemental planting), and one site with dense ground cover.
- Insecticide use: The main dietary component of short-horned lizards is ants, with smaller amounts of grasshoppers, beetles and crickets (Hotton 1955, Pianka and Parker 1975, Montanucci 1981, Powell and Russell 1984). If these food sources are eliminated from an area, short-horned lizards residing there will not survive. Therefore, the widespread use of insecticides is of conservation concern for lizard populations. A potential example of this was discussed in Quinn et al. (2009) regarding treatment of a plague-infested prairie dog town with pesticide dust. A record for horned lizards

occurred at the site several years before the treatment, but no lizards and only one active ant mound could be found the year after treatment.

- Road mortality: Short-horned lizards sometimes can be found on or very near sand or dirt roads (Quinn et al. 2009). They may be attracted to such roads due to the lack of ground cover (providing basking opportunities) and soft, disturbed soil (enhancing burrowing). Quinn et al. (2009) reported several lizards being killed on such roads in South Dakota, creating concern regarding vehicle use within areas known to contain short-horned lizard populations.
- Pet trade: The potential for commercial trade of this species is high, as (at first glance) many people feel these unique-looking lizards would make appealing pets. However, horned lizards are notoriously difficult to maintain in captivity, requiring special equipment and specific food resources (Montanucci 1983). Captive animals usually die quickly.

Recommended Conservation and Research Actions:

- Discourage agricultural development, but encourage cattle grazing in areas known to contain horned lizard populations. Quinn et al. (2009) noted that light cattle grazing in natural prairie may positively affect short-horned lizard populations in South Dakota, as cattle, like their bison predecessors, may help prevent dense vegetative growth, which is detrimental to horned lizard populations (Reynolds 1979).
- Encourage use of insecticides in as discriminating a manner as possible, especially in areas where short-horned lizard populations are known to exist. Additionally, the potential negative impact on ants of various insecticides used in cattle that pass through with the dung (to control flies) should be examined.
- Discourage motor vehicle use of sand or dirt roads in areas known to contain strong populations of short-horned lizards.
- Enact a bag limit for this species that would minimize collection for commercial purposes.
- Continue surveys to better understand the distribution of this species in the state. One area of potential occurrence may be along the Cheyenne River breaks north of Hayes (Stanley County) (Doug Backlund personal communication). The use of predictive ecological niche modeling should further help define appropriate areas to search for lizards and provide insight into their potential distribution. If these surveys provide supportive information about the apparent decline of this species in our state (see Population Trend section above), then it may be desirable to offer further protection to this species by listing it as Threatened in South Dakota.
- Collect and analyze molecular genetic population data to examine population differentiation, gene flow, and populations potentially at risk due to low genetic variation. It appears that populations are scattered in patches across a landscape of seemingly appropriate habitat, and they rise and fall in various locations over the course of time. Gaining a better understanding of this process and the gene flow associated with it should provide insight into the landscape needs of conserving this species (Quinn et al. 2009).

- Examine micro- and macro-habitat use to better understand the requirements of this species in our state.

Policy Recommendations:

- Since horned lizards are declining in South Dakota, and the potential for commercial exploitation is high, a bag limit to protect existing populations should be established. A daily bag limit of two, with a maximum possession of four is recommended at this time. This is the current bag limit for turtles (also reptiles) in our state, and until life table parameters for horned lizards can be defined so sustainable harvests can be estimated, It is suggested that the above turtle bag limit may also be suitable for this species.

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Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico.

de Queiroz, K. and T.W. Reeder. 2008. Squamata: Lizards. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 24-45. SSAR Herpetological Circular 37:1-84.

de Queiroz, K. and T.W. Reeder. 2012. Squamata: Lizards. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, pp. 32-51. SSAR Herpetological Circular 39: 1-92.

Fogell, D.D. 2010. A field guide to the amphibians and reptiles of Nebraska. University of Nebraska, Lincoln, Nebraska.

Hammerson, G.A. 1999. Amphibians and reptiles in Colorado. Second edition. University Press of Colorado, Boulder, Colorado.

Hammerson, G.A. 2007. *Phrynosoma hernandesi*. *In*: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. www.iucnredlist.org.

Hotton, N., III. 1955. A survey of adaptive relationships of dentition to diet in North American Iguanidae. American Midland Naturalist 53(1):88-114.

Kiesow, A.M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Montanucci, R.R. 1981. Habitat separation between *Phrynosoma douglassi* and *P. orbiculare* (Lacertilia: Iguanidae) in Mexico. Copeia 1981(1):147-153.

Montanucci, R.R. 1983. Breeding, captive care and longevity of short-horned lizard *Phrynosoma douglassi*. International Zoo Yearbook 23:148-156.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34

Patton, F.A. 1926. Our trip to the eagle's nest. The Oolgist 43:30.

Pianka, E.R., and W.S. Parker. 1975. Ecology of horned lizards: a review with special reference to *Phrynosoma platyrhinos*. Copeia 1975(1):141-142.

Powell, G.L., and A.P. Russell. 1984. The diet of the eastern short-horned lizard (*Phrynosoma douglassi brevirostre*) in Alberta and its relationship to sexual size dimorphism. Canadian Journal of Zoology 62(3):428-440.

Quinn, H.R., B. Smith, H.F. Quinn, and G.H. Writer. 2009. Sort-horned lizard (*Phrynosoma hernandesi*) survey in South Dakota 2008 – 2009. Report to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Reynolds, T.D. 1979. Response of reptile populations to different land management practices on the Idaho National Engineering Laboratory site. Great Basin Naturalist 39(3):255-262.

Smith, H.M. 1946. Handbook of lizards: Lizards of the United States and of Canada. Comstock Publishing Associates, A Division of Cornell University Press, Ithaca, New York.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Stebbins, R.C. 2003. A field guide to western reptiles and amphibians. Third Edition. Houghton Mifflin Company, Boston, Massachusetts.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Visher, S.S. 1914. The biology of Harding County northwestern South Dakota. South Dakota Geological Survey Bulletin 6. State Publishing Company, Pierre, South Dakota.

Zamudio, K.R., K.B. Jones, and R.H. Ward. 1997. Molecular systematics of short-horned lizards: biogeography and taxonomy of a widespread species complex. Systematic Biology 46:284-305.

South Dakota Distribution Map:

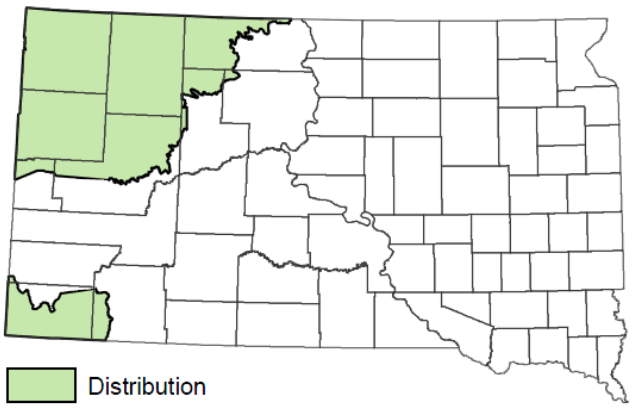

Photo:

Greater Short-horned Lizard Doug Backlund

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Common five-lined skink

Scientific Name: *Plestiodon fasciatus*

Taxonomic Note: Until somewhat recently, this species was placed in the genus *Eumeces*, along with many other skinks worldwide, but is now placed in the genus *Plestiodon* (see de Queiroz and Reeder 2008, 2012 for discussion).

Description: The scales on the back of five-lined skinks are smooth and shiny. Hatchlings have five white or yellowish stripes on a black ground color, and their tails are bright blue. As they grow, their tail turns grey, and their body pattern becomes less conspicuous as the stripes darken and the ground color lightens. Females usually retain some indications of the striped pattern, with the most prominent stripe a broad dark band extending backward from the eye and along the side of the body. Adult males usually show traces of stripes, but they tend to become nearly uniform brown or olive, with orange-red coloration on their jaws during spring breeding season. Prairie skinks and many-lined skinks, also found in South Dakota, are similar to five-lined skinks, but have more than five light-colored stripes (Conant and Collins 1991).

Population/protection Status:

- IUCN: Least Concern
    - Population Trend: Stable
- USFWS: Not Listed
- State: This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): SU

Distribution:

- Global: Five-lined skinks range from New England to northern Florida, and west to Wisconsin and eastern parts of Kansas, Oklahoma, and Texas. There are isolated colonies in northeastern Iowa and adjacent parts of Wisconsin and Minnesota, southwestern Minnesota, northwestern Wisconsin, and southeastern South Dakota (Conant and Collins 1991, Kiesow 2006).
- South Dakota
    - Historical: Over (1923) reported only one specimen taken, which was found four miles west of Vermillion in the wooded floodplain of the Missouri River on 30 May 1922. Smith (1946) shows this species barely entering South Dakota in the southeastern corner, a distribution that was probably based on Over's above record.
    - Current: Only two records of this species exist for South Dakota, the above mentioned specimen observed in 1922, and one collected in Clay County near

Vermillion I September 1979 by A.C. Stewart (Backlund 2004, Kiesow 2006, South Dakota Natural Heritage Database).

Population Trend: This species tends to be common in most of its rather extensive range across much of the eastern United States and southern Ontario (Hammerson 2007). No major threats have been identified, and overall this species is considered secure (NatureServe 2012). However, as noted above, only two specimens have ever been observed in South Dakota, and they were far removed from known populations in other states. The closest of these are in extreme southeastern Nebraska, and southwestern Minnesota (Ballinger et al. 2010, Fogell 2010, Oldfield and Moriarty 1994). Therefore, if a population of five-lined skinks does exist in our state, it is probably quite small and isolated. This is a dangerous combination of factors for long-term persistence of this species in South Dakota; however, the potential genetic uniqueness of the population would make it extremely important from a conservation standpoint.

Key Habitat:

- Key Habitat Description: This species prefers damp, wooded areas. Cutover woodlots with many rotting stumps and logs, abandoned board or sawdust piles, rock piles, and decaying debris in or near woods are good places to look for these lizards (Conant and Collins 1991).
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Tallgrass Subregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): Little Sioux/Niobrara.

Threats and Issues in South Dakota: Until populations are located and assessed, threats to them cannot be evaluated.

Recommended Conservation and Research Actions:

- Conduct intensive surveys in areas of suitable habitat in the southeastern sector of the state, especially in the area where the two specimens were located previously. If a population is discovered, examine its genetic uniqueness, population status, and produce a conservation action plan to assure its continued persistence.

Policy Recommendations:

- Because five-lined skinks have an extremely limited distribution in the state, and are only known from two specimens, a bag limit to protect any existing populations should be established. A daily bag limit of two, with a maximum possession of four is recommended at this time. This is the current bag limit for turtles (also reptiles) in our state, and until life table parameters for five-lined skinks can be defined so sustainable harvests can be estimated, it is suggested that the above turtle bag limit may also be suitable for this species.

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Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Ballinger, R.E., J.D. Lynch, and G.R. Smith. 2010. Amphibians and reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona.

Conant, R., and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

de Queiroz, K., and T.W. Reeder. 2008. Squamata: Lizards. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 24-45. SSAR Herpetological Circular 37:1-84.

de Queiroz, K., and T.W. Reeder. 2012. Squamata: Lizards. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in our Understanding pp. 32-51. SSAR Herpetological Circular 39:1-92.

Fogell, D.D. 2010. A field guide to the amphibians and reptiles of Nebraska. University of Nebraska – Lincoln, Nebraska.

Hammerson, G.A. 2007. *Plestiodon fasciatus*. *In*: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. www.iucnredlist.org.

Kiesow, A.M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

NatureServe. 2012. *Plestiodon fasciatus*. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. www.natureserve.org/explorer.

Oldfield, B., and J.J. Moriarty. 1994. Amphibians and reptiles native to Minnesota. The University of Minnesota Press, Minneapolis, Minnesota.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Smith, H.M. 1946. Handbook of lizards: Lizards of the United States and of Canada. Comstock Publishing Associates, a division of Cornell University Press, Ithaca, New York.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Photos:

Common Five-lined Skink Jeffrey B. LeClere

Common Five-lined Skink (juvenile) Jeffrey B. LeClere

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Many-lined skink

Scientific Name: *Plestiodon multivirgatus*

Taxonomic Note: Until somewhat recently, this species was placed in the genus *Eumeces*, along with many other skinks worldwide, but is now placed in the genus *Plestiodon* (see de Queiroz and Reeder 2008, 2012 for discussion). Two subspecies are recognized, and the one found in South Dakota is *Plestiodon multivirgatus multivirgatus*, the northern many-lined skink (de Queiroz and Reeder 2008, 2012).

Description: This lizard is smooth and shiny in appearance, with small, frail legs. It has numerous, alternating light and dark stripes, some strong and well defined, others weak and appearing merely as rows of dark dots. However, there is a prominent light stripe restricted to the third row of scales (counting from the center of the back), a character which differentiates this species from the similar-looking prairie skink (*Plestiodon septentrionalis*), which has this stripe on its fourth and fifth row of scales. Another similar South Dakota species, the five-lined skink (*Plestiodon fasciatus*), has only five light stripes along its body, while the many-lined skink has more. Juvenile many-lined skinks have blue tails (Ballinger et al. 2000, Conant and Collins 1991, Kiesow 2006).

Population/protection Status:

- IUCN: Least Concern
  - Population trend: Stable
- USFWS: Not listed
- State: This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S1

Distribution:

- Global: This lizard reaches the northernmost extent of its range in south-central South Dakota, and extends southward through central and western Nebraska, Colorado, southeastern Utah, Arizona, New Mexico and western Texas (Conant and Collins, 1991).
- South Dakota
  - Historical: This species is not listed by Over (1923) as occurring in South Dakota, but later, Smith (1946) showed it ranging into the southwestern and south-central portions of the state.
  - Current: Many-lined skinks are found in the south-central portion of the state, and appear to be confined to the Sandhills (sand prairie) region (Kiesow 2006).

Population Trend: This species is locally common across much of its range in the central Great Plains (Hammerson 2007, NatureServe 2012). It reaches the northernmost extent of its distribution in the sandy regions of south-central South Dakota in Bennett, Shannon, and Trip Counties, and appears quite rare in the state, as it is only known from eight specimens (Backlund 2004). However, its secretive nature (spending most of its time beneath objects and underground) makes it difficult to detect, so it may be more common and widespread than currently known. For example, Platt reported a possible many-lined skink in Fall River County near Oral (Backlund 2004), and Holly Quinn (personal communication) reported one in northern Shannon County south of Scenic, but both lizards escaped before positive identification could be made. Platt et al. (2006) reported that considerable search effort was required to find only one specimen in southern Shannon County. The skink was found after overturning several hundred clumps of dried cattle dung. Others have also reported finding many-lined skinks in this manner (Hammerson 1999, Taylor 1935). Hammerson (1999) noted that this species is hard to detect without labor-intensive pitfall trapping. During his study in Colorado, over 300 many-lined skinks were taken using this method, more than all other amphibians and reptiles combined. Doug Backlund (Retired Biologist; South Dakota Department of Game, Fish, and Parks; personal communication) reported capturing several (2 – 3) in pitfall traps in southern Tripp County (South Dakota) while conducting American burying beetle surveys. Therefore, pitfall trapping may be a feasible method to determine the distribution, abundance and population trend of this species in South Dakota. Such surveys should be made in regions of sandy soils in the south-central portions of the state. This habitat can be found in certain portions of Fall River, Shannon, Custer, Pennington, Jackson, Bennett, Mellette, Todd, Tripp, and potentially Gregory Counties.

The historical South Dakota range noted above by Smith (1946) is more extensive than that known today, suggesting a shrinking distribution. However, the map presented by Smith was based on few specimens, not comprehensive surveys, so the range may simply be better understood at this time, and no conclusions on change can be made.

Key Habitat:

- Key Habitat Description: This lizard occurs in open plains and Sandhhills (sand prairie), and is often found in vacant lots and under debris in towns and settlements. It is sometimes found beneath cow dung, where it has taken shelter or is in search of insects to eat (Conant and Collins, 1991).
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Mixedgrass Subregion, Great Plains Steppe Ecoregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Southern rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand hills (65), Dakota-Nebraska Eroded Tableland (66).
    - Aquatic Drainage Units (Annis et al. 2010): White, Niobrara.

Threats and Issues in South Dakota:

- Habitat alteration: As mentioned above, these lizards appear to thrive in both natural and slightly altered environments. However, conversion of habitat for agricultural uses

has caused local declines in other states (Hammerson 2007, NatureServe 2012). Most communities within the skink's South Dakota range are small, and a substantial portion of the natural prairie is utilized for cattle grazing, an activity that does not seem to be detrimental to these lizards. Therefore, it appears the persistence of this species in our state is not threatened as long as current land use practices continue within its range.

Recommended Conservation and Research Actions:

- Develop and conduct intensive surveys for this species in areas of sandy soils in Fall River, Shannon, Custer, Pennington, Jackson, Bennett, Mellette, Todd, Tripp, and potentially Gregory Counties. Survey methods need to be developed that take into account detection probabilities, and determine the minimum effort needed for confidence in avoiding false absences (McDiarmid et al. 2012). Suggested methods that warrant testing include visual searches, cover object surveys, and pitfall traps. Searches beneath cover objects should include digging in the sand under cow dung.
- Discourage large-scale agricultural development in areas containing many-lined skink populations, and encourage cattle grazing.
- Conduct genetic analyses to determine the distinctiveness of South Dakota populations of this species from those in other parts of its range. As mentioned above, populations in South Dakota are at the northernmost extent of the species' range, which extends southward into Texas, New Mexico and Arizona. In general, peripheral populations, such as those of the many-lined skink in South Dakota, are more likely to be imperiled than those within the core of the range, as they tend to occur in less suitable environments for the species, and are often isolated from more central and continuous populations (Lesica and Allendorf 1995).

  Populations at the edge of a species' range are likely to be genetically different from those in the center due to a number of factors, such as restricted gene flow, small population size, founder effects, and differing selective forces (Lesica and Allendorf 1995). They are genetically adapted to conditions at the edge of the range, which may vary substantially from those in the core. Conserving peripheral populations helps conserve the wide range of genetic variation within the species as a whole, and thus enhances its ability to adapt to a changing environment. For example, such populations may be well adapted to shifting the species range in response to climate change (Hunter and Hutchinson 1994). Lesica and Allendorf (1995) argue that the more genetically divergent peripheral populations are from their central populations, the higher the priority should be to conserve them (and that these populations may even be important sites of future speciation events). To investigate the distinctiveness of South Dakota many-lined skink populations from others within the range of the species, genetic comparisons should be made.

Policy Recommendations:

- Because many-lined skinks have a very limited distribution in the state, and are only known from a few specimens, a bag limit to protect existing populations should be established. A daily bag limit of two, with a maximum possession of four is recommended at this time. This is the current bag limit for turtles (also reptiles) in our

state, and until life table parameters for many-lined skinks can be defined so sustainable harvests can be estimated, it is suggest that the above turtle bag limit may also be suitable for this species.

Account Author: Hugh Quinn, Department of Biology, Black Hills State University

Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station; Steven G. Platt, Wildlife Conservation Society (past instructor at Oglala Lakota College, Kyle, South Dakota).

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

de Queiroz, K. and T.W. Reeder. 2008. Squamata: Lizards. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 24-45. SSAR Herpetological Circular 37:1-84.

de Queiroz, K. and T.W. Reeder. 2012. Squamata: Lizards. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, pp. 32-51. SSAR Herpetological Circular 39: 1-92.

Hammerson, G. 1999. Amphibians and reptiles in Colorado. University Press of Colorado, Niwot, Colorado.

Hammerson, G.A. 2007. *Plestiodon multivirgatus*. *In*: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. <www.iucnredlist.org>.

Hunter, M.L. Jr. and A. Hutchinson. 1994. The virtues and shortcomings of parochialism: conserving species that are locally rare, but globally common. Conservation Biology 8(4):1163-1165.

Kiesow, A.M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Lesica, P. and F.W. Allendorf. 1995. When are peripheral populations valuable for conservation? Conservation Biology 9(4):753-760.

McDiarmid, R. W., M. S. Foster, C. Guyer, J. W. Gibbons, and N. Chernoff (editors). 2012. Reptile Diversity. Standard Methods for Inventory and Monitoring. Univ. of California Press, Berkeley.

NatureServe. 2012. *Plestiodon multivirgatus*. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. www.natureserve.org/explorer.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Platt, S.G., Z. Fast Horse, S. Mannel, C. Comes Killing, and F.R. Rainwater. 2006. A herpetofaunal survey of southwestern South Dakota with an emphasis on species of conservation concern. Journal of Kansas Herpetology 20:10-19.

Smith, H.M. 1946. Handbook of lizards: Lizards of the United States and of Canada. Comstock Publishing Associates, a division of Cornell University Press, Ithaca, New York.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Taylor, E.H. 1935. A taxonomic study of the cosmopolitan scincoid lizards of the genus *Eumeces* with an account of the distribution and relationships of its species. University of Kansas Science Bulletin 23:1-643.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

South Dakota Distribution Map:

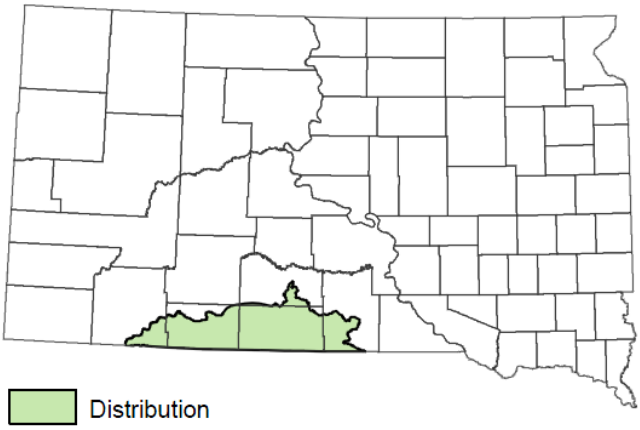

Photo:

Many-lined Skink Doug Backlund

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Prairie skink

Scientific Name: *Plestiodon septentrionalis*

Taxonomic Note: Until somewhat recently, this species was placed in the genus *Eumeces*, along with many other skinks worldwide, but is now placed in the genus *Plestiodon* (see de Queiroz and Reeder 2008, 2012 for discussion). Three prairie skink subspecies are recognized in North America, with *Plestiodon septentrionalis septentrionalis*, the northern prairie skink, found in South Dakota. It should be noted that some authors consider this species as two, one occurring north of central Kansas, and the other south (Collins and Taggart 2009). De Queiroz and Reeder (2008, 2012) maintain that a single species exists, pending further analyses.

Description: The scales on the back of prairie skinks are smooth and shiny. On average, adults are 5 – 9 inches total length, and have numerous light and dark stripes. The sides of the male's lower jaw and head become red during the breeding season. Juveniles have bright blue tails. This species is similar in appearance to the many-lined skink (*P. multivirgatus*), also found in South Dakota. However, the prairie skink has a light stripe that is restricted to the fourth and fifth row of scales (counting from the center of the back), and the many-lined skink has such a stripe restricted to the third row. Another similar species, the five lined skink (*P. fasciatus*), is also found in South Dakota, but only has five light stripes along its body (Conant and Collins 1991, Kiesow 2006).

Population/protection Status:

- IUCN: Least Concern
    - Population Trend: Stable
- USFWS: Not listed
- State: This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S5

Distribution:

- Global: Prairie skinks occur in the central United States in a small band stretching from Minnesota and North Dakota to the Texas coast. An isolated population occurs in southwestern Manitoba (Conant and Collins 1991).
- South Dakota
    - Historical: Over (1923) reported this as the common lizard in the eastern part of South Dakota. Later, Smith (1946) showed it ranging roughly in the eastern half of the state.
    - Current: This skink is found in the eastern fourth of South Dakota (Backlund 2004, Ballinger et al. 2000, Kiesow 2006).

Population Trend: Overall, populations of this somewhat widely ranging species are considered secure (Hammerson 2007). It demonstrates a tolerance to moderate habitat modification, but cannot withstand habitat loss or degradation as a result of large-scale, intensive cultivation (Hammerson 2007, NatureServe 2012). While local threats exist (mainly habitat loss and alteration), no major, widespread threats to remaining populations have been identified. Due to the extensive agricultural development in eastern South Dakota, populations must have declined in historical times, which have created concern over the status of this species in our state (Backlund 2004).

Key Habitat:

- Key Habitat Description: The western edge of this lizard's range closely coincides with the western limits of the tall-grass prairie (Ballinger et al. 2010, Fogell 2010). It is most abundant in open sandy areas, especially where flat rocks and loose soil accommodate its secretive and semi-fossorial habits (Taylor 1935, Breckenridge 1943, Jones et al. 1981). It also occurs on gravelly glacial outwashes with rock outcrops (Oldfield and Moriarty 1994), sandbanks along creeks and rivers (Vogt 1981), at forest edges, and in oak savanna habitat (Backlund 2004).
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Mixedgrass Subregion, Tallgrass Subregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Southern Black Glaciated Plains (55C), Red River Valley of the North (56), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): James, Big Sioux/Vermillion, Little Sioux/Niobrara, Red and Minnesota River.

Threats and Issues in South Dakota:

- Habitat alteration: Habitat loss due to agricultural development.
- Climate Change: Predictions of climate change in South Dakota point to wetter springs and hotter, drier summers (Cochrane and Moran 2011). Summer arid conditions may negatively impact the tall-grass prairie, key habitat for this species. Dan Fogell (Southeast Community College, Nebraska, personal communication) reports that these skinks are absent from the more arid western mixed and short grass prairies in Nebraska, which indicates a preference (need) for the wetter tall-grass region, a scenario that is probably also evident here in South Dakota. So a decrease in moisture due to climate change will likely affect the success of the skink, especially in South Dakota, where it is at the western periphery of its range.

Recommended Conservation and Research Actions:

- Monitor known populations, and continue to search for new ones. New populations will likely be found, as this species can be difficult to detect due to its secretive nature, spending much of its time under objects or underground (Fogell 2010). It would be most useful to develop detection probability based survey methods to allow for

presence/absence determinations (Mazerolle et al. 2007). Due to population declines of this species in South Dakota discussed in Population Trend section above, prairie skinks should probably be tracked in the Natural Heritage Database.

Policy Recommendations:

- Since prairie skinks are declining in South Dakota, a bag limit to protect existing populations should be established. A daily bag limit of two, with a maximum possession of four is recommended at this time. This is the current bag limit for turtles (also reptiles) in our state, and until life table parameters for prairie skinks can be defined so sustainable harvests can be estimated, It is suggested that the above turtle bag limit may also be suitable for this species.

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Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station; Dan Fogell, Southeast Community College, Nebraska.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Ballinger, R.E., J.D. Lynch, and G.R. Smith. 2010. Amphibians and reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Breckenridge, W.J. 1943. The life history of the black-banded skink, *Eumeces septentrionalis* (Barid). American Midland Naturalist 29:591-606.

Cochrane, M.A. and C.J. Moran. 2011. Past, present, and future climates for South Dakota: observed climatic variation from 1895-2010 and projected climate change to 2099. Report to South Dakota Department of Game, Fish and Parks.

Collins, J.T., and T.W. Taggart. 2009. Standard common and current scientific names for North American amphibians, turtles, reptiles, and crocodilians. Sixth edition. The Center for North American Herpetology, Lawrance, Kansas.

Conant, R., and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

de Queiroz, K., and T.W. Reeder. 2008. Squamata: Lizards. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 24-45. SSAR Herpetological Circular 37:1-84.

de Queiroz, K., and T.W. Reeder. 2012. Squamata: Lizards. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in our Understanding pp. 32-51. SSAR Herpetological Circular 39:1-92.

Fogell, D.D. 2010. A field guide to the amphibians and reptiles of Nebraska. University of Nebraska, Lincoln, Nebraska.

Hammerson, G.A. 2007. *Plestiodon septentrionalis*. *In*: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. <www.iucnredlist.org>.

Jones, S.M., R.E. Ballinger, and J.W. Nietfeldt. 1981. Herpetofauna of Mormon Island Preserve, Hall County, Nebraska. Prairie Naturalist 13:33-41.

Kiesow, A.M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Mazerolle, M. J., L. L. Bailey, W. L. Kendall, J. A. Royle, S. J. Converse, & J. D. Nichols. 2007. Making great leaps forward: accounting for detectability in herpetological field studies. Journal of Herpetology 41(4):672-689.

NatureServe. 2012. *Plestiodon septentrionalis*. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. www.natureserve.org/explorer.

Oldfield, B., and J.J. Moriarty. 1994. Amphibians and reptiles native to Minnesota. University of Minnesota Press, Minneapolis, Minnesota.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Smith, H.M. 1946. Handbook of lizards: Lizards of the United States and of Canada. Comstock Publishing Associates, A Division of Cornell University Press, Ithaca, New York.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Taylor, E.H. 1935. A taxonomic study of the cosmopolitan scincoid lizards of the genus *Eumeces* with an account of the distribution and relationships of its species. Kansas University Science Bulletin 23:1-643.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Vogt, R.C. 1981. Natural history of amphibians and reptiles of Wisconsin. Milwaukee Public Museum, Milwaukee, Wisconsin.

South Dakota Distribution Map:

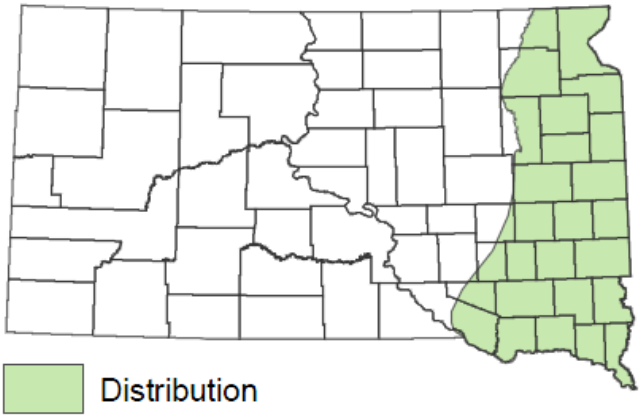


Photo:

Prairie Skink Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Prairie lizard

Scientific Name: *Sceloporus* (*undulatus*) *consobrinus*

Taxonomic Note: Until recently, four species (*Sceloporus consobrinus*, *S. cowlesi*, *S. tristicus*, and *S. undulatus*) were treated as a single species, *S. undulatus*. This taxonomy was revised by Leaché and Reeder (2002), and also noted in de Queiroz and Reeder (2008, 2012). *S. consobrinus*, the prairie lizard, is found in South Dakota.

Description: This is a 4 – 7 inch lizard from head to tail tip. Animals are gray to brown with dark brown sides. A light gray-to-brown stripe runs down the center of the back, which is bordered by two bold and distinct pale stripes and dark spots. These lizards are similar in appearance to the sagebrush lizard (*S. graciosus*), but prairie lizards have overlapping, keeled (rough in texture) scales on the backs of the thighs, whereas these scales are small and granular in sagebrush lizards. Males can have bright blue patches on the sides of their bellies (Keisow 2006, Conant and Collins 1991).

Population/protection Status:

- IUCN: Least Concern (This assessment is for the *Sceloporus undulatus* species complex, which consists of *S. consobrinus*, *S. cowlesi*, *S. tristicus*, and *S. undulatus*. No assessment has been conducted solely for *S. consobrinus*)
    - Population Trend: Stable (This assessment is also for the *S. undulatus* species complex.)
- USFWS: Not listed
- State: This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5 (This assessment is also for the *S. undulatus* species complex.)
- State Rank (NatureServe): S2

Distribution:

- Global: This species ranges in the North American plains between the Mississippi River and the Rocky Mountains, north to South Dakota, and south through central Texas to the Gulf Coast (Leaché 2009, Leaché and Reeder 2002).
- South Dakota
    - Historical: Over (1923) reported that this species lives in the Sandhills of Washington County, and that it is fairly abundant there. Washington County no longer exists, as it was divided and merged into all or part of Jackson, Pennington, and Shannon Counties in 1943. Later, Smith (1946) showed the prairie lizard ranging into the southwestern and south-central portions of the state.

- Current: This lizard is found in the Sandhills (sand prairie) region of south-central South Dakota, including portions of Shannon, Pennington, Jackson, Bennett, Mellette, Todd, and Tripp Counties (Backlund 2004, Ballinger et al. 2000, Kiesow 2006).

Population Trend: Prairie lizard populations appear strong across much of their rather extensive range, and no major threats to the species have been identified, but local declines have been noted as a result of habitat degradation (Hammerson et al. 2007). For example, in the Sandhills of Nebraska, prairie lizards rarely occur in dense grasses, and cattle grazing (much like bison grazing in the past) serves to decrease grass density. When cattle are removed, pastures have thicker grass growth, which reduces habitat and lizard density, sometimes dramatically (Ballinger and Jones 1985, Ballinger and Watts 1995). South-central South Dakota holds vast expanses of Sandhill (sand prairie) habitat for these lizards, especially in Shannon County, and much of this habitat is utilized for cattle grazing, creating ideal prairie lizard habitat. Therefore, as long as cattle grazing continues in these areas, and pastures are not utilized for other purposes (such as agricultural development), prairie lizard populations in our state should remain strong.

In examining the historical and current South Dakota ranges above, it may be tempting to conclude that prairie lizards have experienced expanding and contracting ranges. However, these ranges only depict very few specimen localities, and are not based on comprehensive survey data (South Dakota Natural Heritage Database), so no conclusions can be made on range changes. Additionally, there appear to be no serious threats to this species in our state at this time. Therefore, it seems reasonable to assume that prairie lizard distribution in South Dakota has remained fairly stable, and we are simply gaining a better understanding of it as more specimens are observed.

Key Habitat:

- Key Habitat Description: Habitat utilized by this species across its range varies geographically, but lizards usually occur in sunny, open situations (Hammerson et al. 2007, NatureServe 2012). In South Dakota, this species utilizes sandy, open prairies with scattered cover such as sage or yucca (Kiesow 2006, Quinn personal observation).
- Linkage to Ecosystem Diversity:
  - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Great Plains Steppe Ecoregion.
  - Major Land Resource Areas (United States Department of Agriculture 2006): Southern rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand hills (65), Dakota-Nebraska Eroded Tableland (66).
  - Aquatic Drainage Units (Annis et al. 2010): White, Niobrara.

Threats and Issues in South Dakota:

- Habitat degradation by conversion of native prairie (utilized for cattle grazing) to agricultural land.

Recommended Conservation and Research Actions:

- Encourage cattle grazing within the range of prairie lizards in South Dakota, and discourage development of lizard habitat for agricultural purposes.

Policy Recommendations:

- Because prairie lizards have a somewhat limited distribution in the state, and appear to be restricted to sandy, open prairie habitat within this range, a bag limit should be established to help prevent population declines. A daily bag limit of two, with a maximum possession of four is recommended at this time. This is the current bag limit for turtles (also reptiles) in our state, and until life table parameters for prairie lizards can be defined so sustainable harvests can be estimated, it is suggest that the above turtle bag limit may also be suitable for this species.

Account Author: Hugh Quinn, Department of Biology, Black Hills State University.

Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Ballinger, R.E., and S.M. Jones. 1985. Ecological disturbance in a sandhills prairie: impact and importance to the lizard community on Arapaho Prairie in western Nebraska sandhills prairie. Prairie Naturalist 22:75-86.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Ballinger, R.E., and K.S. Watts. 1995. Path to extinction: impact of vegetational change on lizard populations on Arapaho Prairie in the Nebraska sandhills. American Midland Naturalist 134:413-417.

Conant, R., and J.T. Collins. 1991. A field guide to reptiles and amphibians: eastern and central North America. Third edition, expanded, Houghton Mifflin, Boston.

de Queiroz, K. and T.W. Reeder. 2008. Squamata: Lizards. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 24-45. SSAR Herpetological Circular 37:1-84.

de Queiroz, K. and T.W. Reeder. 2012. Squamata: Lizards. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, pp. 32-51. SSAR Herpetological Circular 39: 1-92.

Hammerson, G.A., P. Lavin, J. Vazquez Diaz, G. Quintero Diaz, and H. Gadsden. 2007. *Scelpoorus undulatus*. *In*: IUCN 2011. IUCN Red List of Threatened Species. Version 2012.1. <www.iucnredlist.org>.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Leaché, A.D. 2009. Species tree discordance traces to phylogeographic clade boundaries in North American fence lizards (*Sceloporus*). Systematic Biology 58(6):547-559.

Leaché, A.D., and T.W. Reeder. 2002. Molecular systematics of the eastern fence lizard (*Sceloporus undulatus*): a comparison of parsimony, likelihood, and Bayesian approaches. Systematic Biology 51:44-68.

NatureServe. 2012. *Sceloporus undulatus*. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. www.natureserve.org/explorer.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Smith, H.M. 1946. Handbook of lizards: Lizards of the United States and of Canada. Comstock Publishing Associates, a division of Cornell University Press, Ithaca, New York.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

South Dakota Distribution Map:

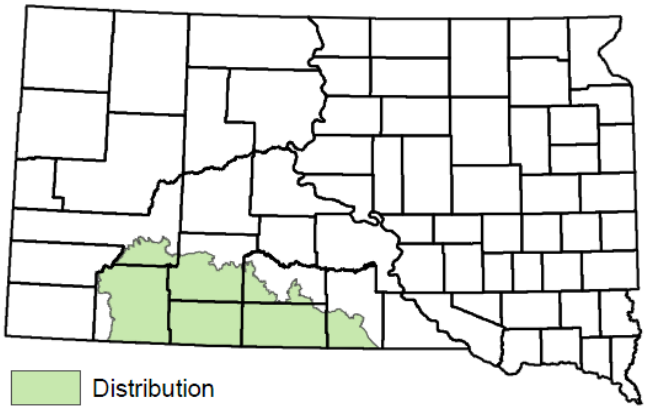


Photo:

Prairie Lizard Doug Backlund

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Sagebrush lizard.

Scientific Name: *Sceloporus graciosus.*

Description: This is a small (4 ½ to 5 ½ inches) nondescript spiny lizard with four rows of dark spots along the dorsum. Sometimes the spots will run together and look like four stripes instead of four rows of spots. There are paired pale dorsolateral stripes running from the eye to the base of the tail. The background color is generally brownish to grayish. In South Dakota, it is found only in the southwestern Black Hills. It closely resembles the prairie lizard, but the prairie lizard is not found in the Black Hills. The short-horned lizard also occurs in the Black Hills but it is a round, slow-moving lizard and cannot be confused with the sagebrush lizard.

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S2.

Distribution

- Global: This is a common wide-ranging western species of lizard found throughout most of Wyoming, southern Idaho, eastern Washington and Oregon, northern and eastern California, all but the southern tip of Nevada, all of Utah, western Colorado, northern Arizona, and northwestern New Mexico (Conant and Collins 1998). It is also found in parts of southern Montana. It occurs spottily in Yellowstone National Park, where it is found around hot springs (Peterson personal communication). South Dakota is the eastern extent of its range.
- South Dakota
    - Historical: Southwestern and western Black Hills (Peterson 1974, Kiesow 2006).
    - Current: No change.

Population trend: Unknown in South Dakota. Throughout the range, they are a common species. Tinkle et al. (1993) reported it to be the most common lizard at their study site in Utah. It is widespread and common throughout the western United States and in Baja California (Nussbaum et al. 1983, Baxter and Stone 1985, Censky 1986, Degenhardt et al. 1996, Hammerson 1999, Stebbins 2003). In Montana, North Dakota, and South Dakota, which are at the northern limit of their range, its occurrence is spotty (Stebbins 2003). Given its northern range limits, it is not surprising to find that this species tolerates cooler temperatures than their congeners (Adolph 1990, Sinervo and Adolph 1994). I am not aware of any reports of declines.

Key Habitat

- Key Habitat Description: Smith et al. (2006) studied the sagebrush lizard in the Black Hills. We found that sagebrush lizards occurred in a few small populations in dry, rocky canyons in the far southwestern Black Hills, frequently on southern or southwestern facing rocky slopes. Our general impressions were that these populations took advantage of the warmest spots they could find within their limited range in the Black Hills, and their existence here depends on very specific local conditions.
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Black Hills Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Black Hills Foot Slopes (61), Black Hills (62).
- Aquatic Drainage Units (Annis et al. 2010): Cheyenne.

Threats and Issues in South Dakota:

- Peripheral populations: The Black Hills populations are peripheral populations of this wide-ranging species. Like any species at the limits of its range, sagebrush lizards are found in small and isolated populations, where they are probably susceptible to even minor habitat disturbance. Smith et al. (2006) studied sagebrush lizards in the Black Hills and included maps to known localities. These populations should be protected from development.

Recommended Conservation and Research Actions:

- Genetic isolation: Genetic studies of isolation by distance from the closest populations in Wyoming and to determine the extent of inbreeding within the small populations in the Black Hills are indicated.
- Population sizes: Studies to determine population sizes in the few scattered populations in the Black Hills should be undertaken. Techniques to do this are well established and straightforward (Tinkle et al. 1993).
- Monitoring: Periodic surveys of the populations found by Smith et al. (2006) should be conducted to assure that these populations are not declining or going locally extinct.

Policy Recommendations:

- Conservation status: This species should be listed as a species of local concern by the United States Forest Service, Black Hills National Forest.
- Monitoring: This species should be monitored by the Department of Game, Fish, and Parks due to its isolation in the Black Hills.
- Threatened/endangered status: Listing as a state threatened or endangered species is probably not warranted given how common it is throughout its extensive range and how there seems to be no indication of declines within its range. Nevertheless, it is a unique member of the South Dakota herpetofauna, and this should be kept in mind in managing the species in the state.

- Bag limits: The sagebrush lizard has a very restricted range in South Dakota and occurs in a few small and isolated populations. To assure that populations are not damaged by over-collection, establish a bag limit of two daily, with a maximum possession of four. This is the current bag limit for turtles in South Dakota, and until life table parameters can be defined (reproduction and recruitment) so sustainable harvests can be estimated, these provisional bag limits may also be suitable for *Sceloporus graciosus*.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station

Account author: Brian E. Smith, Department of Biology, Black Hills State University

Literature Cited

Adolph, S. C. 1990. Influence of behavioral thermoregulation on microhabitat use by two *Sceloporus* lizards. Ecology 71:315-327.

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Baxter, G. T., and M. D. Stone. 1985. Amphibians and Reptiles of Wyoming, 2nd ed. Wyoming Game and Fish Department, Cheyenne, Wyoming.

Censky, E. J. 1986. *Sceloporus graciosus*. Catalog of American Amphibians and Reptiles 386.1-386.4.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Degenhardt, W. G., C. W. Painter, and A. H. Price. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico

Hammerson, G. A. 1999. Amphibians and Reptiles in Colorado, 2nd ed. University Press of Colorado, Boulder, Colorado.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Nussbaum, R. A., E. D. Brodie, Jr., and R. M. Storm. 1983. Amphibians and Reptiles of the Pacific Northwest. University of Idaho Press, Moscow, Idaho.

Peterson, C. R. 1974. A preliminary report on the amphibians and reptiles of the Black Hills of South Dakota and Wyoming. M. S. Thesis, University of Illinois at Urbana-Champaign.

Sinervo, B., and S. C. Adolph. 1994. Growth plasticity and thermal opportunity in *Sceloporus* lizards. Ecology 75:776-790.

Smith, B. E., J. L. Massie, and B. G. Blake. 2006. Distribution of the sagebrush lizard, *Sceloporus graciosus*, in the Black Hills of South Dakota. Unpublished report submitted to the South Dakota Department of Game, Fish, and Parks.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Stebbins, R. C. 2003. A Field Guide to Western Reptiles and Amphibians, 3rd ed. Houghton-Mifflin Company, New York.

Tinkle, D. W., A. E. Dunham, and J. D. Congdon. 1993. Life history and demographic variation in the lizard *Sceloporus graciosus*: A long-term study. Ecology 74:2413-2429.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

South Dakota Distribution Map:

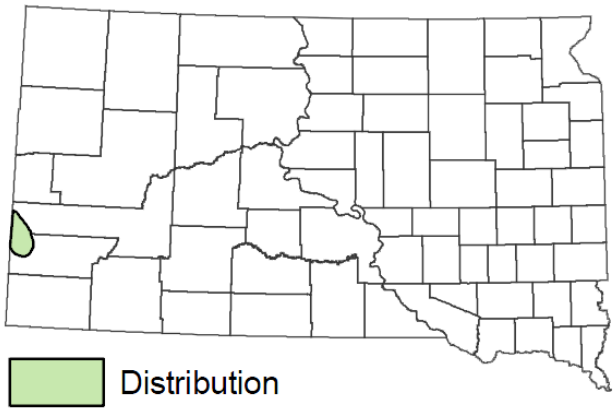


Photo:

Sagebrush Lizard Doug Backlund

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: North American Racer

Scientific Name: *Coluber constrictor*

Taxonomic Note: Eleven subspecies of this species are recognized in North America, and the one found in South Dakota is *Coluber constrictor flaviventris*, the eastern yellow-bellied racer (Crother et al. 2008, 2012).

Description: Adult eastern yellow-bellied racers are plain brown or olive, with a plain yellow or cream-colored belly. Juveniles look totally different, and have chestnut to black spots on their back, sides and belly, and develop the adult coloration in 2 – 3 years at a length of 2 – 2.5 feet (Ernst and Ernst 2003, Kiesow 2006, NatureServe 2012). Smooth green snakes resemble adult yellow-bellied racers, but are brighter green in color and smaller, rarely over 20 inches in length, so racers of comparable size would have the blotched juvenile pattern. Additionally, in green snakes, the nostril is centered in a single scale, but in racers it lies between two scales (Conant and Collins 1991).

Population/protection Status:

- IUCN: Least Concern
    - Population Trend: Stable
- USFWS: Not listed
- State: This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S5

Distribution:

- Global: This species occurs through most of the United States, and ranges into southern Canada and northern and eastern Mexico, discontinuously southwards to Guatemala and Belize (Conant and Collins 1991, Ernst and Ernst 2003, Lee 2000, Stebbins 2003, Wilson 1978)
- South Dakota
    - Historical: Over (1923) reported that this species ranged across all of South Dakota, as did Wright and Wright (1957) and Fishbeck and Underhill (1959).
    - Current: This species occurs in all counties west of the Missouri River, with a few populations intruding short distances east of the river, especially in the extreme southeastern area of the state (Backlund 2004, Ballinger et al. 2000, Kiesow 2006). It invades middle-range elevations in the Black Hills, being observed as high as 5,400 feet elevation (Quinn personal observation).

Population Trend: This snake is common in most of its very large range in the United States, but appears to be rare at the southern extent of its distribution in southern Mexico, Guatemala, and Belize (Hammerson 2007, Lee 2000). Populations in the United States are considered stable, and racers tolerate a broad range of habitats (NatureServe 2012). No major threats have been identified for this species, although historically some populations undoubtedly experienced significant declines, particularly in major agricultural regions of intensive cultivation. Although some local threats exist, remaining populations are extensive and not threatened in most areas (Hammerson 2007).

The historical South Dakota range noted above is more extensive than that known today, indicating a shrinking distribution. However, even though Fishbeck and Underhill (1959) indicated a statewide distribution, their county records demonstrated a distribution similar to that of today. The early range estimates were probably based on few specimens, with certain areas of the state not sampled, leading to inaccurate extrapolation of this species' distribution. Therefore, the racer's range may not be shrinking in our state, but may simply be better understood based on additional observations. In support of this, Backlund (2004) noted that this species appears to have never colonized the glaciated regions of South Dakota, or is very slowly doing so.

Key Habitat:

- Key Habitat Description: In South Dakota, this species can be found in open grassland, prairies and pastures (Ballinger et al. 2000, Kiesow 2006).
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Missouri River Ecoregion, Great Plains Steppe Ecoregion, Black Hills Ecoregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Rolling Soft Shale Plains (54), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Black Hills (62), Northern Rolling Pierre Shale Plains (63A), Southern rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand hills (65), Dakota-Nebraska Eroded Tableland (66), Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand Moreau, Middle Missouri, Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara, Heart.

Threats and Issues in South Dakota:

- Road mortality: Ernst and Ernst (2003, and personal communication) cited road mortality as a substantial cause of death for this species in several parts of the nation. This also seems to be the case in South Dakota, but nonetheless racers remain one of the most common snakes in the western part of our state (Backlund 2004, Ballinger et al. 2000, Quinn personal observation). However, limiting the number of these snakes killed on roads would serve to strengthen populations and help prevent localized declines.

- Habitat alteration: This is primarily a prairie species in our state, and much of that habitat has been lost to intensive agricultural development, a land use practice that is detrimental to this species (Hammerson 2007).
- Pesticide use: Racers may be exposed to pesticides directly during application to fields, or indirectly by consuming pesticide-contaminated food. Direct exposure may also occur when snakes crawl over contaminated soil and plants, or when wind carries pesticides during application on windy days. Ernst and Ernst (2003 and personal communication) cited pesticides as a cause of death in racers, and felt that such contamination was probable through the food chain. While the effects of pesticides specifically on racers are not known, or the extent to which these chemicals are used in areas containing racer populations in South Dakota, it has been shown that certain pesticides can have lethal and sub-lethal effects on other reptiles, impacting their survival and fitness (Pauli et al. 2010).

Recommended Conservation and Research Actions:

- Identify specific areas of high road mortality, and design methods to ameliorate such losses. A proven method to mitigate reptile losses is to provide drift fences that lead to culverts, so the animals may safely move under roads (Aresco 2005).
- In areas where racers are known to occur, discourage conversion of native prairie to cropland. This species seems to do well in areas utilized for cattle grazing (as long as areas are not overgrazed) (Quinn personal observation), so encourage such land use practices.

Policy Recommendations:

- Although populations of this species appear to be strong in South Dakota, a bag limit should be established to help prevent declines. A daily bag limit of two, with a maximum possession of four is recommended at this time. This is the current bag limit for turtles (also reptiles) in our state, and until life table parameters for racers can be defined so sustainable harvests can be estimated, it is suggested that the above turtle bag limit may also be suitable for this species.

Account Author: Hugh Quinn, Department of Biology, Black Hills State University

Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Aresco, M.J. 2005. Mitigation measures to reduce highway mortality of turtles and other herpetofauna at a north Florida lake. Journal of Wildlife Management 69(2):549-560.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

Crother, B.I., J. Boundry, F.T. Burbrink, and J.A. Campbell. 2008. Squamata: Snakes. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 46-65. SSAR Herpetological Circular 37:1-84.

Crother, B.I., J. Boundry, F.T. Burbrink, and J.A. Campbell, R.A. Pyron. 2012. Squamata: Snakes. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 52-71. SSAR Herpetological Circular 39:1-92.

Ernst, C.H. and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington.

Fishbeck, D.W., and J.C. Underhill. 1959. A check list of the amphibians and reptiles of South Dakota. Proceedings of the South Dakota Academy of Science 38:107-113.

Hammerson, G.A. 2007. *Coluber constrictor*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2 www.iucnredlist.org,

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Lee, J.C. 2000. A field guide to the amphibians and reptiles of the Maya World. Cornell University Press, Ithaca, New York.

NatureServe. 2012. *Coluber constrictor*. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. www.natureserve.org/explorer.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Pauli, B.D., S. Money, and D.W. Sparling. 2010. Ecotoxicology of pesticides in reptiles. Pp. 203-224. In: Sparling, D.W., G. Linder, C.A. Bishop, S.K. Krest. Ecotoxicology of amphibians and reptiles, second edition. CRC Press, Taylor & Francis Group, Boca Raton, Florida.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

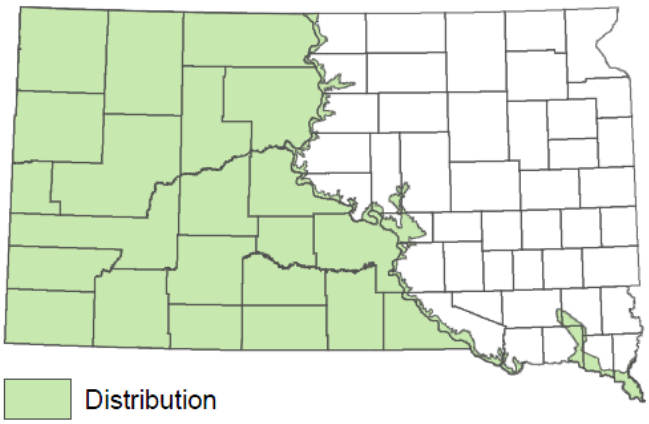
Stebbins, R.C. 2003. A field guide to western reptiles and amphibians. Third Edition. Houghton Mifflin Company, Boston, Massachusetts.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Wilson, L.D. 1978. *Coluber constrictor*. Catalogue of American Amphibians and Reptiles 218:1-4.

Wright, A.H. and A.A. Wright. 1957. Handbook of snakes of the United States and Canada. Comstock Publishing Associates, a division of Cornell University Press, Ithaca, New York.

South Dakota Distribution Map:



Photos:

Adult North American Racer Dan Fogell

Juvenile North American Racer Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Prairie rattlesnake.

Scientific Name: *Crotalus viridis.*

Description: This is the only rattlesnake in South Dakota, and can be distinguished from all other snakes in the state by a series of rattles on the tail tip, vertically elliptical pupil, and a sensory pit between the eye and the nostril. The prairie rattlesnake has dark blotches on a tan background outlined by light coloration, and a pale stripe extending from behind each eye to the corner of the mouth. In South Dakota, the coloration can be quite variable, although retaining the same basic pattern (personal observations). The prairie rattlesnake is a heavy-bodied snake with a triangular head. Specimens are usually 35 – 45 inches long, with a record size of 57 inches (Conant and Collins 1998), but are often smaller than this in South Dakota (unpublished data). The prairie rattlesnake is frequently confused with the bullsnake, *Pituophis catenifer*, which lacks rattles, is not as heavy-bodied, and does not have a triangularly-shaped head. However, the bullsnake mimics the behavior of a rattlesnake, raising the head off the ground in an s-shaped coil and vibrating the tail vigorously, which can create a rattling sound. This is a distinctly different sound from the rattle of a rattlesnake but can nevertheless confuse the layperson. Public reports of rattlesnakes should be treated with skepticism due to the high frequency of misidentification by inexperienced observers.

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S5.

Distribution

- Global: Eastern flanks of the Rocky Mountains across the western half of the Great Plains from extreme southeastern Alberta and extreme southwestern Saskatchewan to extreme northern Mexico immediately south of New Mexico and Texas. This is the rattlesnake of the western Great Plains. Both Conant and Collins (1998) and Ernst and Ernst (2012) err in extending the range along the Missouri River into Iowa (Fogell, personal communication). There is an isolated population in Iowa, but it is disjunct from the South Dakota populations.
- South Dakota
    - Historical: Throughout the state west of the Missouri River (Kiesow 2006), and including areas along the eastern banks of the river, but no further east.
    - Current: Same.

Population trend: Unfortunately, there are no population studies specific to South Dakota from which population trends can be derived, despite widespread consensus that numbers are in decline. However, the prairie rattlesnake is one of the two best-known rattlesnakes in the world. Ernst and Ernst (2012) provide an extensive discussion of the species, and note a consistent drop in numbers throughout the range that they attribute to human persecution. In South Dakota, two correspondents related typical incidents involving human persecution of rattlesnakes to me. In one case, a visitor to Custer State Park stopped his car in the roadway and backed up to run over a rattlesnake on the road, despite a South Dakota Game, Fish, and Parks employee standing near the snake, signaling the driver to stop (Deisch, personal communication, September 2012). In another, a woman reported that "hundreds" of rattlesnakes were killed in a single day at a well-known den site on a ranch in the 1950s. These stories are not at all rare. The difference in numbers between areas in which prairie rattlesnakes are well-protected and those where they are not is striking. On the Buffalo Gap National Grasslands, administered by the United States Forest Service, rattlesnakes are not protected and the bullsnake is the most common snake (Smith et al. 1998a). On the other hand, prairie rattlesnakes were the most abundant snake at Wind Cave National Park, managed by the National Park Service, which protects all wildlife on the park (Smith et al. 1998b). Additionally, the park does not have as many roads and is not hunted, so traffic and disturbance is much less. Ernst and Ernst (2012) cite 11 studies showing either dramatic declines in numbers or small local populations from all parts of the species' range. Seven more references in Ernst and Ernst (2012) note various anecdotal reports of the slaughter of this species, from thousands of snakes collected annually in rattlesnake roundups to collection for sale as curios such as heads encased in Plexiglas. Rattlesnake roundups are especially popular. It is estimated that close to 19,000 rattlesnakes per year are intentionally killed at rattlesnake roundups in the United States (Mushinsky and Savitzky undated). These spectacles can attract tens of thousands of visitors per year to the largest roundup in the nation, in Sweetwater, Texas. Usually, snakes are forced from their dens using gasoline, harming other species that are associated with rattlesnakes. Statistics collected at 25 annual roundups in four states indicate significant mortality across the range. At one large roundup, over three tons of rattlesnakes were collected per year from 1959 – 1991; over 100 tons altogether during this time period. Rattlesnake roundups constitute a significant threat to rattlesnakes, but no roundups exist in South Dakota at this time. However, private individuals are known to raid hibernacula in South Dakota and collect and kill as many rattlesnakes as they can.

Key Habitat

- Key Habitat Description: Found throughout all habitats of western South Dakota, including the forested higher elevations of the Black Hills to at least 5700 feet (1740 meters). They can most readily be collected in rocky areas, although this may be simply because they are easier to observe in rocky areas (personal observations).
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Great Plains Steppe Ecoregion, Black Hills Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Rolling Soft Shale Plains (54), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale

Plains (60A), Black Hills Foot Slopes (61), Black Hills (62), Northern Rolling Pierre Shale Plains (63A), Southern Rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand Hills (65), Dakota-Nebraska Eroded Tableland (66).

- Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand/Moreau, Middle Missouri, Cheyenne, Bad/Choteau, White, Niobrara.

Threats and Issues in South Dakota:

- Den Sites: Den sites are a limiting resource for rattlesnakes. Large numbers may den at ancestral den sites, returning each year to the same den (Travsky and Beauvais 2004). Unfortunately, when dens are found snakes are often persecuted, and there may even be attempts to destroy the dens. In the author's experience, some dens appear to house few rattlesnakes, especially at higher elevations in the Black Hills. Den sites should be located and protected on public land.
- Persecution: There is ample evidence that humans will routinely kill rattlesnakes. Sustainable harvest limits should be put in place, based on sound demographic data. Educational programs can greatly reduce the need and desire to kill snakes on sight or for perceived safety.
- Unsustainable harvest: Organized rattlesnake roundups do not exist in South Dakota, but there is a risk that communities and entrepreneurs may start them. This should be discouraged or prevented by law.

Recommended Conservation and Research Actions:

- Surveys and monitoring: Given the widespread concern over declines and potential for persecution, a rigorous prairie rattlesnake monitoring program is needed, to both estimate existing population status and distribution, and track population trends in a statistically meaningful way. A variety of monitoring methods are available (McDiarmid et al. 2012), but funding for programs is a major obstacle.
- Protection of den sites: Den sites are critical habitat and an effort to locate and preserve them on public lands is recommended. Den sites on private land should also be preserved where possible, with incentives such as conservation easements that provide tax breaks offered.
- Education: Since human persecution is a significant threat to prairie rattlesnakes, effective education programs aimed at dispelling myths, emphasizing the ecological role of snakes (such as rodent control), and teaching safe ways to handle snakes, are an especially important and effective conservation action.

Policy recommendations:

- Bag limits: Rattlesnakes are at risk of further declines, and this has been demonstrated in a number of cases (see Ernst and Ernst 2012 for a summary) and anecdotally in South Dakota. To assure that populations are not damaged by over-collection, establish a bag limit of two daily, with a maximum possession of four. This is the current bag limit for turtles in South Dakota, and until life table parameters can be defined (reproduction and

recruitment) so sustainable harvests can be estimated, these provisional bag limits may also be suitable for *Crotalus viridis*.

Personal communication: Shelly Deisch, South Dakota Department of Game, Fish, and Parks

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station

Account author: Brian E. Smith, Department of Biology, Black Hills State University

Literature Cited

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Ernst, C. H., and E. M. Ernst. 2012. Venomous Reptiles of the United States, Canada, and Northern Mexico. Volume 2: *Crotalus*. The Johns Hopkins University Press, Baltimore, Maryland.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Klauber, L. M. 1972. Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind, 2nd ed. University of California Press, Berkeley, California.

McDiarmid, R. W., M. S. Foster, C. Guyer, J. W. Gibbons, and N. Chernoff (editors). 2012. Reptile Diversity. Standard Methods for Inventory and Monitoring. Univ. of California Press, Berkeley. 412 pp.

Mushinsky, H. R., and A. H. Savitzky. Undated. Position of the American Society of Ichthyologists and Herpetologists Concerning Rattlesnake Conservation and Roundups. http://www.asih.org/files/positionpaper.pdf. Retreived 8 October 2012.

Smith, B. E., D. M. Browning, E. Taylor, R. S. Ferguson, and K. Yturralde. 1998a. Herpetofaunal surveys of the Fall River Ranger District, U.S. Forest Service, southwestern South Dakota and Badlands National Park. Unpublished report submitted to the Northern Prairie Wildlife Research Center, U.S. Geological Survey, Biological Resources Division. Jamestown, North Dakota.

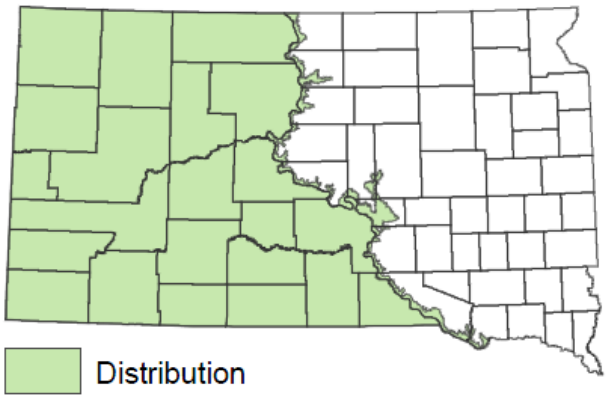
Smith, B. E., J. J. Kolbe, and R. S. Ferguson. 1998b. A herpetological survey of Wind Cave National Park, South Dakota. Unpublished report submitted to the Northern Prairie Wildlife Research Center, U.S. Geological Survey, Biological Resources Division. Jamestown, North Dakota.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Travsky, A., and G. P. Beauvais. 2004. Species assessment for the midget faded rattlesnake (*Crotalus viridis concolor*) in Wyoming. Unpublished report submitted to the United States Department of Interior Bureau of Land Management. http://www.blm.gov/pgdata/etc/medialib/blm/wy/wildlife/animal-assessmnts.Par.93160.File.dat/MidgetFadedRattlesnake.pdf. Accessed 8 October 2012.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

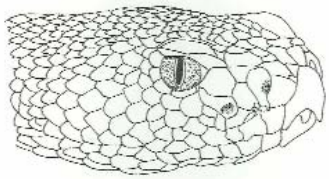
South Dakota Distribution Map:



Photos:

Prairie Rattlesnake Doug Backlund

Rattlesnake den Mike Erickson



Note the elliptical pupil of the Prairie Rattlesnake.

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Ring-necked Snake

Scientific Name: *Diadophis punctatus*

Taxonomic Note: Twelve North American subspecies of this species are recognized, and the one found in South Dakota is *Diadophis punctatus arnyi*, the prairie ring-necked snake (Crother et al. 2008, 2012).

Description: This is a small snake, 10 – 14 inches in length, with a light colored ring around the neck. Belly spots are numerous and highly irregular (Conant and Collins 1991, Ernst and Ernst 2003).

Population/protection Status:

- IUCN: Least Concern
    - Population trend: Stable
- USFWS: Not listed
- State: This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S2

Distribution:

- Global: This species ranges from coast to coast in the U.S. except for large gaps in the arid west, where it is confined to uplands and the vicinity of streams (Conant and Collins 1991, Ernst and Ernst 2003, Stebbins 2003).
- South Dakota
    - Historical: Over (1923) reported this species from only one specimen, which was found in Springfield (Bon Homme County), and Wright and Wright (1957) showed it entering South Dakota in the extreme southeastern corner of the state.
    - Current: This species is found in the Missouri and Big Sioux River valleys in the southeastern portion of the state (Backlund 2004, Ballinger et al. 2000, Kiesow 2006).

Population Trend: This snake has a very large range across much of the US, and also enters Canada and Mexico. In South Dakota it is only found in the southeastern portion of the state in eight counties. In the Missouri River valley it ranges from Union County in the south to Brule County in the north. In the Big Sioux River valley it is found from Union County in the south to Moody County in the north (Backlund 2004, Ballinger et al. 2000, Fogell 2003, Jessen 2003, Jessen 2005, Kiesow 2006). It seems reasonable to assume that it may also occur in the Vermillion and James River valleys, but has not yet been reported from there. Thus, further

surveys in these areas may indicate a broader range in the state than we currently know. The historical range appears more restricted than the current range, suggesting that the species may be expanding its distribution in the state. However, the historical distribution was estimated from only a few specimens, and may not have reflected the actual extent of the range.

Key Habitat:

- Key Habitat Description: This species requires moist habitat, at least seasonally, near woodland edges, prairie uplands, and hilly pastures near wetlands. It is often found near abandoned buildings, in junk piles, and in wooded areas under logs, rocks, and other surface cover (Conant and Collins 1991, Kiesow 2006, Hammerson and Frost 2007, Quinn personal observation).
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Mixedgrass Subregion, Tallgrass Subregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Southern Black Glaciated Plains (55C), Till Plains (102B), Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): James, Big Sioux/Vermillion, Little Sioux/Niobrara, Bad/Choteau.

Threats and Issues in South Dakota:

- Habitat alteration: Urbanization and draining of wetlands for agriculture are key threats to this species.
- Pesticides: It is not known how pesticides affect ring-necked snakes, as exposure to these chemicals has not been tested with this species. However, it has been shown that certain pesticides can have lethal and sub-lethal effects on other reptiles, impacting their survival and fitness through direct and indirect exposure (Pauli et al. 2010). For ring-necked snakes, indirect exposure may come in the form of eating pesticide-contaminated food. Their diet consists of a variety of animals such as insects, slugs, and earthworms (Ernst and Ernst 2003). Direct exposure may come by being sprayed with pesticides during field application, coming in contact with contaminated soil or plants, or being exposed to drifting pesticides on windy days. The portion of South Dakota where ring-necked snakes reside is heavily agricultural, so the possibility of pesticide exposure for this species is probably rather high.

Recommended Conservation and Research Actions:

- Conduct surveys for this species, especially in the lower James and Vermillion River valleys. Ring-necked snakes have only been reported from one protected area in South Dakota, Palisades State Park (Jessen 2005). Jessen (2005) also reported a large population at Arrowhead Park, a municipal park located in East Sioux Falls. Fogell (2003) surveyed several protected areas (i.e., Palisades State Park, Big Sioux State Recreation Area, Beaver Creek Nature Area, Lake Alvin State Recreation Area, Newton Hills State Park, Fairview Game Protection Area, Union Grove State Park, Elk Point Sand Dunes, and Adams Homestead and Nature Area) in the southeastern corner of the state, and found

no ring-necked snakes. It would be advantageous to search these areas further, and also to survey additional protected areas in Union, Clay, Yankton, Bon Homme, Charles Mix, Brule, Lincoln, Minnehaha and Moody Counties to determine if populations are found there. A special effort should be made to determine the status and size of the population at Palisades State Park. Local populations can be quite dense. For example, in three northeastern Kansas counties, ring-necked snakes made up nearly 60% of over 7,000 snakes captured by Fitch (1992). Density estimates would be useful in examining the status of these snakes in our state, even if such estimates are only relative (i.e., a given number observed per unit search time).

- Develop management plans and educational materials for this species within the protected areas where it is known to occur. Such plans and materials should also be developed for Arrowhead Park.
- Discourage drainage of wetlands and removal of cover objects (i.e., rocks, fallen logs) for agricultural and other reasons in areas where this species is known to occur. This is a secretive snake that requires moist habitats, and is often found beneath rocks, logs, stumps, loose bark on fallen trees, cow dung, or human debris (Ernst and Ernst 2003). It has been demonstrated that moist habitats are required to balance evaporative water loss from this snake (Myers 1965, Clark 1967). Drainage of wetlands for agricultural and other purposes creates a drier habitat, and thus is detrimental to this species. Additionally, removal of cover objects is detrimental, and such land management activities should be discouraged in areas where this species is known to occur. Ring-necked snakes seem to do well, even in moderately disturbed areas, as long as appropriate moisture and cover objects are provided.
- In areas where ring-necked snakes are known to occur, encourage land owners not to use pesticides, or to use them in a limited and controlled manner.
- Conduct genetic analyses to determine the distinctiveness of South Dakota populations of this species from those in other parts of its range. While ring-necked snakes may be rare in our state, their populations are considered stable in their overall range (Hammerson and Frost 2007). Populations in South Dakota enter the state in the southeastern portion of the state, but the extensive overall range of this species extends across vast expanses of the eastern, midwestern, and southwestern US. In general, peripheral populations, such as those of the ring-necked snake in South Dakota, are more likely to be imperiled than those within the core of the range. This is the case, as they tend to occur in less suitable environments for the species, and are often isolated from more central and continuous populations (Lesica and Allendorf 1995).

  Populations at the edge of a species' range are likely to be genetically different from those in the center due to a number of factors (such as restricted gene flow, small population size, founder effects, and differing selective forces) (Lesica and Allendorf 1995). They are genetically adapted to conditions at the edge of the range, which may vary substantially from those in the core. Conserving peripheral populations helps conserve the wide range of genetic variation within the species as a whole, and thus enhances its ability to adapt to a changing environment. For example, such populations may be well adapted to shifting the species range in response to climate change (Hunter and Hutchinson 1994). Lesica and Allendorf (1995) argue that the more genetically

divergent peripheral populations are from their central populations, the higher the priority should be to conserve them (and that these populations may even be important sites of future speciation events). To investigate the distinctiveness of South Dakota ring-necked snake populations from others within the range of the species, genetic comparisons should be made.

Policy Recommendations:

- Because the ring-necked snake has a very limited distribution in the state, a bag limit to protect existing populations should be established. A daily bag limit of two, with a maximum possession of four is recommended at this time. This is the current bag limit for turtles (also reptiles) in our state, and until life table parameters for ring-necked snakes can be defined so sustainable harvests can be estimated, it is suggested that the above turtle bag limit may also be suitable for this species.

Account Author: Hugh Quinn, Department of Biology, Black Hills State University

Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Clark, D.R. 1967. Experiments into selection of soil type, soil moisture level, and temperature by five species of small snakes. Transactions of the Kansas Academy of Science 70:490-496.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

Crother, B.I., J. Boundry, F.T. Burbrink, and J.A. Campbell. 2008. Squamata: Snakes. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 46-65. SSAR Herpetological Circular 37:1-84.

Crother, B.I., J. Boundry, F.T. Burbrink, and J.A. Campbell, R.A. Pyron. 2012. Squamata: Snakes. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 52-71. SSAR Herpetological Circular 39:1-92.

Ernst, C.H. and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington.

Fitch, H.S. 1992. Methods of sampling snake populations and their relative success. Herpetological Review 23:17-19.

Fogell, D.D. 2003. Amphibian and reptile surveys of southeast South Dakota with an emphasis on the state-endangered lined snake (*Tropidoclonian lineatum*) May 2002 – June 2003. Final report to the South Dakota Game Fish and Parks Department.

Hammerson, G.A. and D.R. Frost. 2007. *Diadophis punctatus*. *In*: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2 www.iucnredlist.org,

Hunter, M.L. Jr. and A. Hutchinson. 1994. The virtues and shortcomings of parochialism: conserving species that are locally rare, but globally common. Conservation Biology 8(4):1163-1165.

Jessen, T. 2003. A survey of the herpetofauna of the Big Sioux River valley 2003. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Jessen, T. 2005. Herpetological survey of eastern South Dakota 2005. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Lesica, P. and F.W. Allendorf. 1995. When are peripheral populations valuable for conservation? Conservation Biology 9(4):753-760.

Myers, C.W. 1965. Biology of the ringneck snake, *Diadophis punctatus*, in Florida. Bulletin of the Florida State Museum Biological Science 10:43-90.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Pauli, B.D., S. Money, and D.W. Sparling. 2010. Ecotoxicology of pesticides in reptiles. Pp. 203-224. *In*: Sparling, D.W., G. Linder, C.A. Bishop, S.K. Krest. Ecotoxicology of amphibians and reptiles, second edition. CRC Press, Taylor & Francis Group, Boca Raton, Florida.

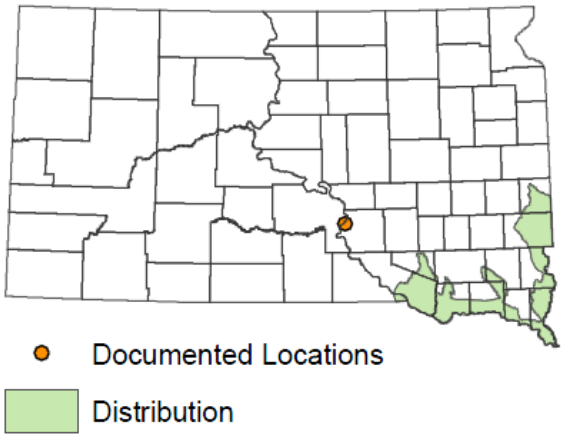
South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Stebbins, R.C. 2003. A field guide to western reptiles and amphibians. Third Edition. Houghton Mifflin Company, Boston, Massachusetts.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Wright, A.H. and A.A. Wright. 1957. Handbook of snakes of the United States and Canada. Comstock Publishing Associates, a division of Cornell University Press, Ithaca, New York.

South Dakota Distribution Map:



Photos:

Ventral surface of Ring-necked Snake Dan Fogell

Dorsal surface of Ring-necked Snake Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Plains hog-nosed snake

Scientific Name: *Heterodon nasicus*

Taxonomic Note: *Heterodon nasicus* once contained three subspecies. At that time, the species was called the "western hog-nosed snake," and the subspecies each had their own common names. When the subspecies were each elevated to the species level, they retained their individual common names. Therefore, the name "western hog-nosed snake" is no longer used (Crother et al. 2008, 2012).

Description: The snout of this species is sharply upturned, and the body is brown with distinct darker brown spots on the midline and sides, forming 4 – 6 rows across the back. The belly is black, with occasional lighter spots of cream or yellow. The plains hog-nosed snake has dark pigment on the underside of the tail, distinguishing it from the similar eastern hog-nosed snake. Both hog-nosed snake species have the habit of hissing, head- and neck-spreading, and playing 'possum when threatened (Ballinger et al. 2000, Kiesow 2006).

Population/protection Status:

- IUCN: Least Concern
    - Population Trend: Stable
- USFWS: Not listed
- State: This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S5

Distribution:

- Global: The plains hog-nosed snake is found through the Great Plains from Minnesota to southeastern Alberta and south to New Mexico and extreme western Texas. Isolated populations occur in Manitoba, central Wyoming, northwestern Colorado, southern Minnesota, western Iowa, and extreme northwestern Missouri (Conant and Collins 1991).
- South Dakota
    - Historical: Over (1923) reported that this species is more often found on the sandy floodplains of the Missouri River, in the sandhills south of the White River, and in the Badlands. Later, Wright and Wright (1957) illustrated its distribution throughout the state.
    - Current: This species ranges statewide, but is most common in the western portion of the state (Backlund 2004, Ballinger et al. 2000, Kiesow 2006).

Population Trend: The plains hog-nosed snake appears to be common across its rather extensive range from Canada to Texas (NatureServe 2012). The current population trend is probably relatively stable overall, with local declines associated with habitat loss or degradation, mostly through conversion of prairie habitat to agricultural use (Hammerson 2007). Such habitat loss in South Dakota has undoubtedly caused population declines over the years, but no data exist to adequately assess trends.

Key Habitat:

- Key Habitat Description: This species is generally found in open prairies with loose, sandy soils or gravel, usually with a water component, either a stream, lake or pond (Backlund 2004, Ballinger et al. 2000, Fogell 2010, Kiesow 2006).
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Mixedgrass Subregion, Tallgrass Subregion, Missouri River Ecoregion, Great Plains Steppe Ecoregion, Black Hills Ecoregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Southern Dark Brown Glaciated Plains (53C), Rolling Soft Shale Plains (54), Central Black Glaciated Plains (55B), Southern Black Glaciated Plains (55C), Red River Valley of the North (56), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Black Hills (62), Northern Rolling Pierre Shale Plains (63A), Southern rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand hills (65), Dakota-Nebraska Eroded Tableland (66), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand Moreau, Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara, Red and Minnesota River, Heart.

Threats and Issues in South Dakota:

- Habitat loss: While Ballinger et al. (2000) reported this species as occurring across the state, Backlund (2004) noted that during a statewide amphibian and reptile survey, plains hog-nosed snakes were only found in the counties west of the Missouri River, and there were only twelve records documented. He further commented that this is a prairie species, and that much of the habitat has been lost. Additionally, sandy or loose soils are preferred by this species, therefore limiting habitat even further in regions where the prairie is still intact.

  Amphibians and lizards are the chief foods of this species (but small mammals and ground-nesting birds are also eaten) (Conant and Collins 1991). Therefore, loss of seasonal/temporary wetlands (no longer protected under the Clean Water Act) are of concern, as they are important breeding places for amphibians (Backlund personal communication).
- Pet Trade: A quick check of the internet revealed that plains hog-nosed snakes are being sold for $89.99 (babies) and $129.99 (juveniles) from www.reptmart.com. They are also being sold from www.generalexotics.com for $99.00 (no age specified).

Therefore, there appears to be a market for this species, and prices are high enough to create incentive for commercial collection.

Recommended Conservation and Research Actions:

- In areas where plains hog-nosed snakes are known to occur, discourage conversion of native prairie to cropland. This species seems to do well in areas utilized for cattle grazing (as long as areas are not overgrazed) (Quinn personal observation), so encourage such land use practices.
- Continue to conduct surveys for this species to examine its continued persistence, especially east of the Missouri River. It would be most useful to develop detection probability based survey methods to allow for presence/absence determinations (Mazerolle et al. 2007).
- Establish a bag limit for this species to discourage large scale commercial collection.

Policy Recommendations:

- Since we do not know what the population trend of this species is in South Dakota (it may be declining due to habitat loss), and since there is a market for this species in the pet trade, a bag limit to protect existing populations should be established. A daily bag limit of two, with a maximum possession of four is recommended at this time. This is the current bag limit for turtles (also reptiles) in our state, and until life table parameters for plains hog-nosed snakes can be defined so sustainable harvests can be estimated, it is suggested that the above turtle bag limit may also be suitable for this species.

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Fogell, D.D. 2010. A field guide to the amphibians and reptiles of Nebraska. University of Nebraska, Lincoln.

Hammerson, G.A. 2007. *Heterodon nasicus*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2 www.iucnredlist.org,

Kiesow, A.M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Mazerolle, M. J., L. L. Bailey, W. L. Kendall, J. A. Royle, S. J. Converse, & J. D. Nichols. 2007. Making great leaps forward: accounting for detectability in herpetological field studies. Journal of Herpetology 41(4):672-689.

NatureServe. 2012. *Heterodon nasicus*. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. www.natureserve.org/explorer.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

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South Dakota Distribution Map:

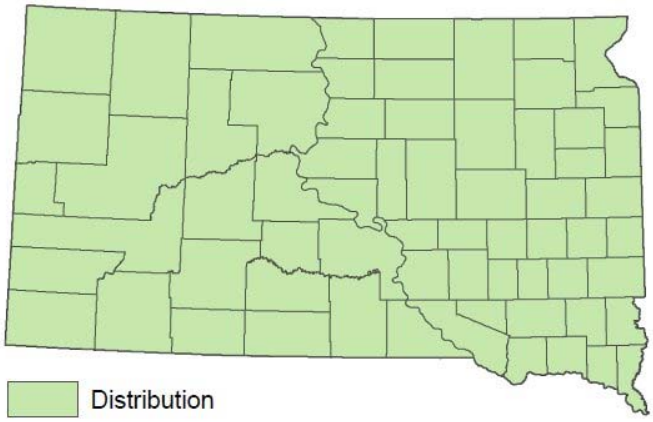
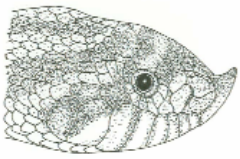


Photo:

Plains Hog-nosed Snake Doug Backlund



The snout is more strongly upturned than that of the Eastern Hog-nosed Snake.

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Eastern Hog-nosed Snake

Scientific Name: *Heterodon platirhinos*

Taxonomic Note: None

Description: This is a medium-sized, harmless snake with a heavy body and an upturned snout. Its habit of hissing, head- and neck-spreading, and playing 'possum when threatened are also good identification characters. Variable colors include tan, yellow, green, orange, and brown with blotches on its back. The underside of its tail is lighter than the rest of its belly, which differentiates this snake from the similar western hog-nosed snake that has dark coloration on the underside of its tail (Ernst and Ernst 2003, Conant and Collins 1991, Kiesow 2006).

Population/protection Status:

- IUCN: Least Concern
    - Population Trend: Stable
- USFWS: Not listed
- State: This is a Threatened species in South Dakota, and a state endangered species permit is required to collect it.
- Global Rank (NatureSere): G5
- State Rank (NatureServe): S2

Distribution:

- Global: This species is found across most of the eastern United States and southwestern Ontario westward to Texas in the south and South Dakota in the north (Conant and Collins 1991, Ernst and Ernst 2003).
- South Dakota
    - Historical: Over (1923) did not provide a description of the range of this species in South Dakota, but did make reference to its coloration being lighter in the western half of the state than in the eastern part, inferring that it is found across much of South Dakota. He further made mention that these snakes were called "copperheads" south of the White River, but did not specify where along the river this occurred. Wright and Wright (1957) showed its range in South Dakota as traversing diagonally across the state from the southeastern to the northwestern corners, but also provided question marks on that portion of the range map, indicating they were not sure of this distribution. Visher (1914) did not report this species from Harding County, located in the extreme northwestern corner of the state. Therefore, the historical distribution of this species in the state seems unclear. Some of this confusion may have come from misidentification of western hog-nosed snakes as eastern hog-nosed snakes,

which are similar in appearance and behavior, and range across most of the state (Kiesow 2006).
    - Current: This species occurs only in the extreme southeastern corner of the state (Kiesow 2006).

Population Trend: While eastern hog-nosed snakes are locally common over much of their somewhat extensive range (Ernst and Ernst 2003), they have a very fragile hold in South Dakota. Their historic range is not clear, but today they only enter the state in the extreme southeast corner in Union, Clay, and Yankton Counties (Backlund 2004, Kiesow 2006). Further, they are restricted to well-drained, loose or sandy soil, with open vegetative cover along the Missouri River (within river segment 10 as defined by the U.S. Army Corps of Engineers) (Kirsch 1983, Platt 1969). In fact, no specimens have ever been recorded in South Dakota except in the river valley, close to the river itself or its backwaters (Backlund 2004, Ballinger et al. 2000, Kirsch 1983). Thus, suitable habitat is not extensive, and is restricted to the narrow stretch of river bottomland along and between the river and adjacent agricultural fields. A 93 km (58 mile) segment of the Missouri River from 10 km (6 miles) south of Elk Point, upstream to Gavins Point Dam near Yankton is one of the few river reaches which remains in a relatively natural state (Kirsch 1983). This area provides the critical habitat required for the survival of this species. However, appropriate habitat and thus snake populations are not continuous (Kirsch 1983), which contributes to the concerns about the ability of this species to persist in the state.

Key Habitat:

- Key Habitat Description: This species is found in well drained, loose or sandy soil, with open vegetative cover, and close proximity to water (Ernst and Ernst 2003, Kirsch 1983).
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Mixedgrass Subregion, Tallgrass Subregion, Missouri River Ecoregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Southern Black Glaciated Plains (55C), Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): James, Big Sioux/Vermillion, Little Sioux/Niobrara.

Threats and Issues in South Dakota:

- Habitat alteration:
    - Habitat succession: The stabilization of the Missouri River by the Missouri River Reservoir System has practically eliminated downstream flooding. The downstream area occupied by the eastern hog-nosed snake was formerly in a true floodplain, with frequent floods, which produced ample sand bars and beaches with sparse vegetative growth, perfect habitat for the snake. Such habitat is not formed naturally without flooding, and soon succumbs to succession of plant communities to mature forests with large increases in invasive understory species (Johnson et al. 2012). Dixon et al. (2012) found that sandbar habitat had decreased by 96% since the late 1800s along the unchannelized portions of the Missouri River from Nebraska into Montana.

Therefore, the lack of flooding along the lower Missouri River in South Dakota has diminished the amount of suitable habitat available for the eastern hog-nosed snake.

  - Agricultural development and recreational use: Not only can appropriate habitat for this species be lost due to plant succession, as described above, but it can also be lost due to development for agricultural and recreational use. For example, net loss of forest and woodland due to agricultural development from the 1950s – 2006 in segment 10 of the Missouri River floodplain was over 47% (Dixon et al. 2012). A rather dramatic graphic representation of habitat loss is provided in Figure 3 of that document, depicting a drastic decline in native grasslands as they were tilled for agricultural use from the late 1800s to the 1950s. Clearly, conversion of land for agricultural use has been a dominant driver of landscape change in this segment of the River. In May 2012 the author visited Kirsch's (1983) Clay County Park eastern hog-nosed snake study site along the Missouri River. No snakes were found, but moderate-to-heavy recreational use was evident. Additionally, little open habitat was available, shoreline beaches had been eroded away, and agricultural fields approached the river (roughly as close as 2 - 3 m at one point). In short, little habitat remained for the snakes. Kirsch also briefly visited this area in June 2012, and found no evidence of hog-nosed snakes. He felt the habitat had degraded from the time of his study, but might still be supporting a population. He noticed that plant coverage was more dense above and back from the river bank, and that there was less open, sandy bank habitat.

- Pesticide use: As mentioned above, within the limited range of eastern hog-nosed snakes in South Dakota, historical native grasslands and forests gave way to current-day agricultural fields. With these fields came the use of pesticides. Eastern hog-nosed snakes eat a variety of prey, but particularly amphibians, and especially toads (Conant and Collins 1991, Ernst and Ernst 2003, Edgren 1955, Platt 1969). Potentially, pesticide use in agricultural areas near hog-nosed snake populations may impact the availability of food (insects) for the toads, which, in turn, will limit the number of toads. Without toads, the snakes will have little to eat, which will negatively impact their survival. Additionally, pesticide use has the potential to negatively impact the snakes by contaminating their prey. The more contaminated toads the snakes eat, the more the pesticides accumulate within their bodies. Also, snakes may be exposed to pesticides directly by being sprayed during application to fields. Direct exposure may also occur when snakes crawl over contaminated soil and plants or be subjected to pesticide drift when spraying takes place on windy days. While the effects of pesticides specifically on eastern hog-nosed snakes are not known, it has been shown that certain pesticides can have lethal and sub-lethal effects on other reptiles, impacting their survival and fitness through direct and indirect exposure (Pauli et al. 2010).

Recommended Conservation and Research Actions:

- Define the location, status and connectivity of remaining populations within the range of this species in the state, and develop a comprehensive critical habitat plan. Kirsch

(personal communication) particularly recommended surveying the Elk Point Sand Dune vicinity, as it contains a broader area of suitable habitat than his Clay County Park study site. Adams Nature Area should also be surveyed, but occurrence of this species there is less optimistic, as the river is entirely riprapped and channelized in this area (Doug Backlund personal communication). Immediate surveys would be desirable to see if the 2011 flooding resulted in a population boom of this species.

- Where populations of eastern hog-nosed snakes are known to exist, private landowners and public agencies should be encouraged to maintain open vegetative cover on sandbars and beaches by utilizing land management practices that retain early plant succession stages and restrict later ones. An example of such practices could simply be to walk through habitat and remove certain plants as they sprout. However, this is labor intensive, and thus may not be practical. Mechanical or chemical thinning of vegetation may be more realistic. Unfortunately, these methods may not be as desirable as removing vegetation by hand due to their negative impacts on other wildlife species. More effectively, flooding should be allowed along the Missouri River so sand bars and beaches can form naturally, creating the habitat required by this species. Appropriate water releases from Gavins Point Dam would accomplish this. For example, the unprecedented moisture in the upper Missouri River basin in 2011 triggered record-breaking flow releases from the US Army Corps of Engineers dams (Johnson et al. 2012), with the resulting floods altering much of the bank area. It appears this created more areas with well-drained sandy soils and open vegetative cover (at least in the short term), which is appropriate habitat for the snake (Mark Dixon and Jacob Kerby, University of South Dakota, personal communication). It should be noted that forming and maintaining sandbars in this manner would not only have a positive impact on the eastern hog-nosed snake, but also on those of the smooth and spiny softshells, the state Threatened false map turtle, the federally and state Endangered least tern, and the federally Threatened and state Endangered piping plover (Dixon 2009).
- Work with agencies and landowners with fields adjacent to known hog-nosed snake populations to make limited or no use of pesticides on their crops. First and foremost, if pesticides and other chemicals must be used, they should be used as directed by manufacturer instructions.
- Establish through acquisition and conservation easement, crop-free, natural buffer zones adjacent to the Missouri River as critical habitat preserves in or adjacent to areas where eastern hog-nosed snakes are known to occur.
- In areas where eastern hog-nosed snakes occur that also experience high public use, such as Kirsch's (1983) Clay County Park study site, provide educational materials about the snakes, and restrict off-road areas to foot traffic only.
- Define patterns of genetic variation and differentiation among South Dakota eastern hog-nosed snake populations, and compare these to populations outside the state. In general, peripheral populations, such as those of the eastern hog-nosed snake in South Dakota, are more likely to be imperiled than those within the core of the range. This is the case, as they tend to occur in less suitable environments for the species, and are often isolated from more central and continuous populations (Lesica and Allendorf 1995).

Populations at the edge of a species' range are likely to be genetically different from those in the center due to a number of factors (such as restricted gene flow, small population size, founder effects, and differing selective forces) (Lesica and Allendorf 1995). They are genetically adapted to conditions at the edge of the range, which may vary substantially from those in the core. Conserving peripheral populations helps conserve the wide range of genetic variation within the species as a whole, and thus enhances its ability to adapt to a changing environment. For example, such populations may be well adapted to shifting the species range in response to climate change (Hunter and Hutchinson 1994). Lesica and Allendorf (1995) argue that the more genetically divergent peripheral populations are from their central populations, the higher the priority should be to conserve them (and that these populations may even be potentially important sites of future speciation events). To investigate the distinctiveness of South Dakota eastern hog-nosed snake populations from others within the range of the species, genetic comparisons should be made.

Policy Recommendations: None

Account Author: Hugh Quinn, Department of Biology, Black Hills State University

Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station; Steve Kirsch, South Middle School, Rapid City, South Dakota.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

Dixon, L. 2009. False map, spiny softshell and smooth softshell turtle nest and nest-site habitat characteristics along the lower stretch of the Missouri National Recreation River in South Dakota. M.S. Thesis, South Dakota State University, Brookings, South Dakota.

Dixon, M.D., W.C. Johnson, M.L. Scott, D.E. Bowen, and L.A. Rabbe. 2012. Dynamics of plains cottonwood (*Populus deltoides*) forests and historical landscape change along unchannelized segments of the Missouri River, USA. Environmental Management 49(5):990-1008.

Edgren, R.A. 1955. The natural history of the hog-nosed snakes, genus *Heterodon*: a review. Herpetologica 11(2):105-117.

Ernst C.H. and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C.

Hunter, M.L. Jr. and A. Hutchinson. 1994. The virtues and shortcomings of parochialism: conserving species that are locally rare, but globally common. Conservation Biology 8(4):1163-1165.

Johnson, W.C., M.D. Dixon, M.L. Scott, L. Rabbe, G. Larson, M. Volke, and B. Werner. 2012. Forty years of vegetation change on the Missouri River floodplain. BioScience 62(2):123-135.

Kiesow, A.M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Kirsch, S.M. 1983. Ecology of the eastern hognose snake (*Heterodon platyrhinos* Latreille) in southeastern South Dakota. MA Thesis, University of South Dakota, Vermillion, South Dakota.

Lesica, P. and F.W. Allendorf. 1995. When are peripheral populations valuable for conservation? Conservation Biology 9(4):753-760.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Pauli, B.D., S. Money, and D.W. Sparling. 2010. Ecotoxicology of pesticides in reptiles. Pp. 203-224. In: Sparling, D.W., G. Linder, C.A. Bishop, S.K. Krest. Ecotoxicology of amphibians and reptiles, second edition. CRC Press, Taylor & Francis Group, Boca Raton, Florida.

Platt, D.R. 1969. Natural history of the hognose snakes *Heterodon platyrhinos* and *Heterodon nasicus*. University of Kansas Publications, Museum of Natural History 18:253-340.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Visher, S.S. 1914. The biology of Harding County Northwestern South Dakota. South Dakota Geological Survey Bulletin Number Six 1914. Report of State Geologist for 1913-1914. State Publishing Co., Pierre, South Dakota.

Wright, A.H. and A.A. Wright. 1957. Handbook of snakes of the United States and Canada. Comstock Publishing Associates, a division of Cornell University Press, Ithaca, New York.

South Dakota Distribution Map:

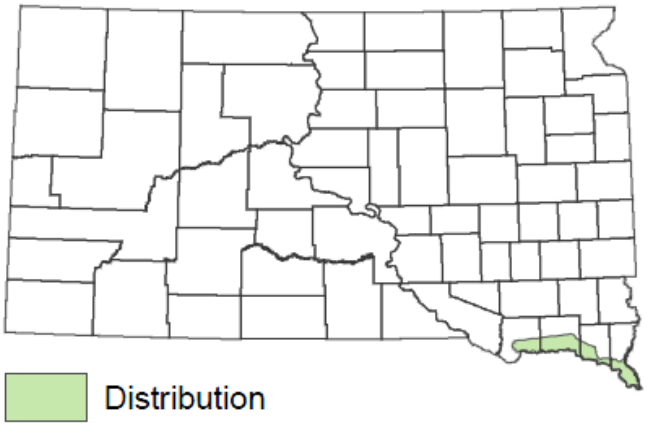


Photo:

Eastern Hog-nosed Snake Dan Fogell

The snout is less obviously upturned than that of the Plains Hog-nosed Snake.

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Milksnake.

Scientific Name: *Lampropeltis triangulum.*

Description: This is one of the most recognizable snakes in South Dakota, and one of the most secretive. It is prominently banded along the length of the body with wide red bands bordered by narrower black bands. Yellow bands alternate with the red bands. The band order is thus: wide yellow band, narrow black band, wide red band, narrow black band, etc. It cannot be confused with any other snake in the state. Its pattern may be reminiscent of a coral snake, but coral snakes are not found in South Dakota. Adults range from 21 – 28 inches in length (Kiesow 2006).

Population/protection Status

- IUCN: Not assessed.
    - IUCN population trend: Not assessed.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S4.

Distribution

- Global: This species has a wide range. It is found across the eastern two-thirds of the United States, reaching its western range limit at the western edge of the Great Plains (Ernst and Ernst 2003). South Dakota, Montana, Iowa, Wisconsin, southern Ontario and Québec are the northern limits of the range (Ernst and Ernst 2003). There are isolated populations in Utah, Arizona and New Mexico (Ernst and Ernst 2003). Its range extends into Mexico, Central America and northwestern South America, with 25 described subspecies (Ernst and Ernst 2003, Smith and Stephens 2003).
- South Dakota
    - Historical: Across South Dakota west of and along the Missouri River. The state Natural Heritage Database contains only five records of this species, with the easternmost records in Vermillion, South Dakota. HerpNet (www.herpnet.org) records nine specimens from seven counties. None of these nine specimens appear to be in the state's database.
    - Current: No change, but the snake is observed infrequently, so data are insufficient.

Population trend: No data are available to assess the population status of this snake in South Dakota.

Key Habitat

- Key Habitat Description: Ernst and Ernst (2003) stated that the milksnake occurs in a wide variety of habitats across its range, but there is so much diversity in the snake (25 subspecies have been described), as well as habitat diversity across its wide range, that this is to be expected. More relevant are Werner et al. (2004), Kiesow (2006) and the author's South Dakota field notes. Werner et al. (2004) described its habitat in Montana as being primarily grasslands, while Kiesow (2006) notes that in South Dakota this snake occurs in grasslands, wooded habitat, forests, and all manner of habitats that exist west of the Missouri River, as well as along the river at least to Vermillion. I have found the snake and have received reports of the snake from grasslands to forests in the Black Hills area, and to elevations of approximately 4500 feet (1370 meters), in Deadwood, South Dakota. Peterson (1974) mentions a museum specimen from Lead, South Dakota, taken at 5400 feet (1650 meters) elevation.
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Eastern Prairie Tall-grass Subregion, Great Plains Steppe Ecoregion, Black Hills Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Rolling Soft Shale Plains (54), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Black Hills (62), Northern Rolling Pierre Shale Plains (63A), Southern Rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand Hills (65), Dakota-Nebraska Eroded Tableland (66), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand/Moreau, Middle Missouri, Big Sioux/Vermillion, Cheyenne, Bad/Choteau, White, Niobrara.

Threats and Issues in South Dakota: Smith and Stephens (2003) discussed conservation of this species. However, they found very little data on milksnakes and their conservation. Fitch (1999) noted that milksnakes appeared to favor intermediate successional stages in wooded habitats. Smith and Stephens (2003) pointed out that so little is known about milksnake natural history that it was difficult to recommend any management strategies that would benefit the species.

Recommended Conservation and Research Actions: While there is no widespread concern over status or declines at this time, very little data upon which to make such a determination exists. Therefore the greatest conservation need for this species is a thorough baseline inventory to determine range limits, followed by population status assessments achieved through mark-recapture studies. Studies should begin with baseline surveys at known population sites to develop survey methods that account for detection probabilities (McDiarmid et al. 2012). When completed, follow up studies may be needed to determine conservation status and needs.

Policy Recommendations:

- Bag limits: Milksnakes (there are several species) are brilliantly-colored snakes that are immensely popular in the pet trade. For example, a web search on the search string

"milk snake care" garnered 1,900,000 hits (performed 11 October 2012). Should a good collecting locality be found in South Dakota, there may be pressure on the site by collectors. Yet this species receives no protection from overzealous collecting in South Dakota. To assure that populations are not damaged by over-collection, establish a bag limit of two daily, with a maximum possession of four. This is the current bag limit for turtles in South Dakota, and until life table parameters can be defined (reproduction and recruitment) so sustainable harvests can be estimated, these provisional bag limits may also be suitable for *Lampropeltis triangulum*.

- Monitoring: Milksnakes need to be monitored in the state and an effort should be made to be certain that wildlife officials in the state are aware of its status. Identification of this species should be a simple matter. Every record of a milksnake in the state is helpful in guiding any decisions that are made regarding study of this species.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station

Account author: Brian E. Smith, Department of Biology, Black Hills State University

Literature Cited

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Ernst, C. H., and E. M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D. C.

Fitch, H. S. 1999. A Kansas Snake Community: Composition and Changes Over 50 Years. Krieger Publishing Company, Malabar, Florida.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

McDiarmid, R. W., M. S. Foster, C. Guyer, J. W. Gibbons, and N. Chernoff (editors). 2012. Reptile Diversity. Standard Methods for Inventory and Monitoring. Univ. of California Press, Berkeley. 412 pp.

Peterson, C. R. 1974. A preliminary report on the amphibians and reptiles of the Black Hills of South Dakota and Wyoming. M. S. thesis, University of Illinois at Urbana-Champaign.

Smith, B. E., and N. T. Stephens. 2003. Conservation assessment of the pale milk snake in the Black Hills National Forest, South Dakota and Wyoming. Unpublished report submitted to the U. S. Department of Agriculture, United States Forest Service.

http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm9_012455.pdf (accessed 11 October 2012).

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Werner, J. K., B. A. Maxell, P. Hendricks, and D. L. Flath. 2004. Amphibians and Reptiles of Montana. Mountain Press Publishing Company, Missoula, Montana.

South Dakota Distribution Map:

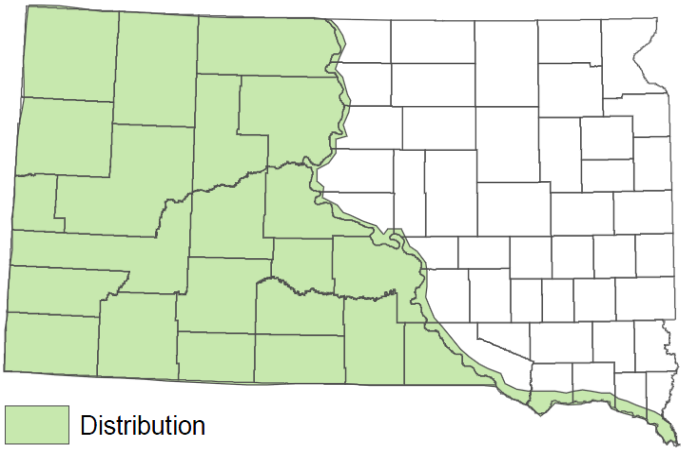


Photo:

Milksnake Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Common watersnake

Scientific Name: *Nerodia sipedon*

Taxonomic Note: There are four subspecies of this species in North America, and the one found in South Dakota is *Nerodia sipedon sipedon*, the northern watersnake (Crother et al. 2008, 2012).

Description: The anterior (front) portion of this snake's body has irregular dark gray to reddish-brown bands that become large blotches further down the back and alternate with small blotches on the sides. The cream-to-yellow belly usually has black-bordered, reddish crescents (Conant and Collins 1991, Ernst and Ernst 2003, Kiesow 2006). The non-venomous watersnakes are often confused with the venomous cottonmouths (also known as water moccasins) (*Agkistrodon piscivorous*). However, cottonmouths do not occur in South Dakota, have a single row of scales under their tails (double in watersnakes), and a deep pit between their eyes and nostrils (absent in watersnakes) (Conant and Collins 1991).

Population/protection Status

- IUCN: Least Concern
    - Population Trend: Stable
- USFWS: Not listed
- State: This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S1

Distribution:

- Global: This species is found across much of the eastern and central United States, extending into a relatively small portion of adjacent southeastern Canada (Conant and Collins 1991. Ernst and Ernst 2003, Gibbons and Dorcas 2004)
- South Dakota
    - Historical: Only four specimens have been recorded from the state, all collected in the 1960s with the exception of one, which was found in 1993 (South Dakota Natural Heritage Database). All were found in the vicinity of Springfield, South Dakota.
    - Current: Found only from Bon Homme County along the Missouri River near Springfield (Backlund 2004, Ballinger, et al. 2000, Kiesow 2006).

Population Trend: Across its relatively extensive range in the US, this species is represented by a very large number of subpopulations, and is abundant in most areas where it occurs (Brown and Weatherhead 1999, Conant 1951, Fitch 1999, Hammerson 2007, King 1986). No major

threats are known, and this snake tolerates a good deal of habitat alteration (Hammerson 2007). As noted by Backlund (2004), the presence of this species in South Dakota was first recorded in 1964, when several specimens were collected at two localities along the Missouri River in Bon Homme County near Springfield. There is a known population in the Niobrara River in Nebraska, and that population may be the source of the sporadic reports in South Dakota (Backlund 2004). However, searches at the confluence of the Niobrara and Missouri Rivers have not located any specimens (Kirsten Wert, University of South Dakota, personal communication). The author conducted a brief (ca. 2 hours) survey along the backwaters of the Missouri River in mid-May 2012 at the Springfield Recreation Area, and did not locate any specimens, but habitat and available food for this species appeared appropriate. The status of northern watersnakes in our state is unknown, but they appear to have always been quite rare or even absent historically, and if present in South Dakota, are at the edge of their overall range.

Key Habitat:

- Key Habitat Description: This is an aquatic snake which can be found in a variety of freshwater habitats within its range as long as there is abundant food and cover. It has been recorded from lakes, ponds, swamps, marshes, bogs, rivers, oxbows, streams, creeks, brooks, canals, and sloughs, with bottoms varying from rock or gravel to sand or mud (Ernst and Ernst 2003).
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Missouri River Ecoregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Southern Black Glaciated Plains (55C).
    - Aquatic Drainage Units (Annis et al. 2010): Little Sioux/Niobrara.

Threats and Issues in South Dakota:

- None known

Recommended Conservation and Research Actions:

- Conduct surveys for this species near the confluence of the Niobrara and Missouri Rivers, especially in the vicinity of Springfield, South Dakota.
- If a population is found, examine the genetic distinctiveness of South Dakota northern watersnakes, comparing them to other populations within the range of this species. In general, such peripheral populations, such as those of the northern watersnake in South Dakota, are more likely to be imperiled than those within the core of the range. This is the case, as they tend to occur in less suitable environments for the species, and are often isolated from more central and continuous populations (Lesica and Allendorf 1995). Populations at the edge of a species' range are likely to be genetically different from those in the center due to a number of factors (such as restricted gene flow, small population size, founder effects, and differing selective forces) (Lesica and Allendorf 1995). They are genetically adapted to conditions at the edge of the range, which may vary substantially from those in the core. Conserving peripheral populations helps

conserve the wide range of genetic variation within the species as a whole, and thus enhances its ability to adapt to a changing environment. For example, such populations may be well adapted to shifting the species' range in response to climate change (Hunter and Hutchinson 1994). Lesica and Allendorf (1995) argue that the more genetically divergent peripheral populations are from their central populations, the higher the priority should be to conserve them, (and that these populations are potentially important sites of future speciation events). To investigate the distinctiveness of South Dakota northern watersnake populations from others within the range of this species, genetic comparisons should be made.

Policy Recommendations:

- Because watersnakes have an extremely limited distribution in the state, and are only known from a few specimens, a bag limit to protect existing populations should be established. A daily bag limit of two, with a maximum possession of four is recommended at this time. This is the current bag limit for turtles (also reptiles) in our state, and until life table parameters for watersnakes can be defined so sustainable harvests can be estimated, it is suggested that the above turtle bag limit may also be suitable for this species.

Account Author: Hugh Quinn, Department of Biology, Black Hills State University

Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Brown, G.P. and P.J. Weatherhead. 1999. Demography and sexual size dimorphism in northern water snakes, *Nerodia sipedon*. Canadian Journal of Zoology78:1358-1366.

Conant, R. 1951. The reptiles of Ohio. 2nd ed. Notre Dame, Indiana: Notre Dame Press.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

Crother, B.I., J. Boundry, F.T. Burbrink, and J.A. Campbell. 2008. Squamata: Snakes. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 46-65. SSAR Herpetological Circular 37:1-84.

Crother, B.I., J. Boundry, F.T. Burbrink, and J.A. Campbell, R.A. Pyron. 2012. Squamata: Snakes. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, pp. 52-71. SSAR Herpetological Circular 39:1-92.

Ernst C.H. and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C.

Fitch, H.S. 1999. A Kansas snake community: Composition and changes over 50 years. Malabar, Florida: Krieger Publishing Co.

Gibbons, J.W. and M.E. Dorcas. 2004. North American watersnakes: A natural history. University of Oklahoma Press, Norman, Oklahoma.

Hammerson, G.A. 2007. *Nerodia sipedon*. In: IUCN 2011. IUNN Red List of Threatened Species. Version 2011.2 www.iucnredlist.org.

Hunter, M.L. Jr. and A. Hutchinson. 1994. The virtues and shortcomings of parochialism: conserving species that are locally rare, but globally common. Conservation Biology 8(4):1163-1165.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

King, R.B. 1986. Population ecology of the Lake Erie water snake, *Nerodia sipedon insularum*. Copeia 1986:757-772.

Lesica, P. and F.W. Allendorf. 1995. When are peripheral populations valuable for conservation? Conservation Biology 9(4):753-760.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

South Dakota Distribution Map:

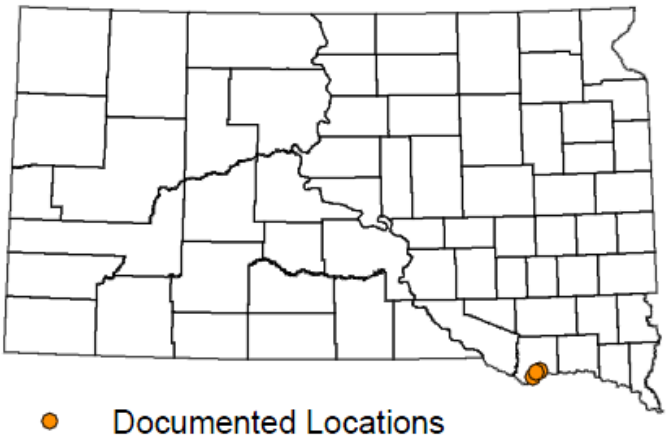


Photo:

Common Watersnake Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Smooth greensnake.

Scientific Name: *Opheodrys vernalis.*

Taxonomic note: Oldham and Smith (1991) erected the genus *Liochlorophis* to refer to the species *Opheodrys vernalis*, retaining its sister species, *O. aestivus*, in the genus *Opheodrys*. However, this taxonomic arrangement creates the monotypic genus *Liochlorophis* (*L. vernalis*) to refer to *Opheodrys vernalis*, while retaining the sister species *O. aestivus* in the monotypic genus *Opheodrys*. Using two monotypic genera to refer to two sister taxa is unnecessary, as Crother (2011) points out. He retains *Opheodrys vernalis* in the genus *Opheodrys*. The arrangement of Oldham and Smith (1991) has been perpetuated throughout a number of works, including Ernst and Ernst (2003), Kiesow (2006), and others, including the South Dakota Natural Heritage Database. Conant and Collins (1998) refer to the smooth greensnake using its correct moniker, *Opheodrys vernalis*. For more information, see Crother (2011). Additionally, subspecies as described by Grobman (1992) are not supported by genetic work (Smith et al. 2007 and ongoing studies in Smith lab).

Description: This is an unmistakable snake, with a bright green body and an ivory belly. Adults range from 12 – 20 inches in length (Conant and Collins 1998).

Population/protection Status

- IUCN: Not assessed.
    - IUCN population trend: Not assessed.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S4.

Distribution

- Global: Grobman (1992), in an analysis of 2174 specimens of smooth green snakes, presented the most extensive range map. Later maps are largely based on his work. Found from Wisconsin and Iowa east to the Atlantic shore of New England. The southernmost extent of their range in the eastern half of the United States is in northern Illinois and throughout Ohio, Pennsylvania, New York, and the states of New England. The northern extent of its range is southern Saskatchewan, Manitoba, Ontario, Québec and Nova Scotia. Scattered populations are found in the northern Great Plains. They are also found in Wyoming. Grobman (1992) presents a dot distribution map of the species, showing scattered localities in Utah, Colorado, and New Mexico. Grobman (1992) also shows specimens taken along the Gulf Coast of Texas and one locality in Mexico.

- South Dakota
    - Historical: Primarily in the Black Hills region. According to the state's Natural Heritage Database, many specimens have been observed in the prairie pothole region in northeastern South Dakota, though no voucher specimens appear to have been collected there.
    - Current: Probably unchanged. It is still commonly found in the Black Hills (unpublished data), and many were observed in Day County in 2011 (Backlund, personal communication). This species has been well documented in the Black Hills area, where it is restricted to forested areas, but it needs to be properly documented with voucher specimens in the prairie pothole region.

Population trend: Anecdotally, it seems stable in the Black Hills. The status of other populations is unknown.

Key Habitat

- Key Habitat Description: Within South Dakota, this species is found in two fairly distinct habitats. It is relatively common in the higher elevations of the Black Hills, including ponderosa pine forests, riparian areas, wet meadows, and other habitats. It may favor more mesic conditions (Smith et al. 2007), but I have collected it on roads some distance from water. It is not found in the plains surrounding the Black Hills (unpublished data). However, it is known from the plains in the prairie pothole region in northeastern South Dakota (Smith et al. 2007), which is a mesic area of plains dotted with numerous prairie pothole lakes and ponds.
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Eastern Prairie Tall-grass Subregion, Black Hills Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Central Black Glaciated Plains (55B), Southern Black Glaciated Plains (55C), Red River Valley of the North (56), Black Hills Foot Slopes (61), Black Hills (62), Rolling Till Prairie (102A), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): James, Big Sioux/Vermillion, Cheyenne, Bad/Choteau, White, Red and Minnesota River.

Threats and Issues in South Dakota: Redder et al. (2006) evaluated the status of this species in the Rocky Mountains for the United States Forest Service, but most of their conclusions are not relevant in South Dakota.

- Habitat destruction: Habitat destruction has led to population declines in other states and the snake is now protected in several states (Ernst and Ernst 2003).
- Pesticides: Minton (1972) found two dead smooth green snakes at a site in northern Indiana that had been heavily sprayed. Because the snake eats various insects, Ernst and Ernst (2003) speculated that Minton's (1972) findings indicate that the species is susceptible to poisoning by insecticides. Others have discussed similar concerns (Werner et al. 2004).

- Protection of hibernacula: This species may have communal hibernacula (Stuart and Painter 1993, Degenhardt et al. 1996), especially in ant mounds (see several references in Ernst and Ernst 2003). Hibernacula should be located and protected where it is possible to do so. Destruction of hibernacula would eliminate entire populations. Evidence exists that hibernacula may be in rock formations as well (Stuart and Painter 1993, Degenhardt et al. 1996), and this accords with some observations I have made in the Black Hills (unpublished data).

Recommended Conservation and Research Actions:

- Basic surveys: Although the snake is well known in the Black Hills and its presence there documented with voucher specimens deposited in major natural history museums, this has not been done in the prairie pothole region. A proper survey of the prairie pothole region should be undertaken to document the species' occurrence there, with voucher specimens collected and placed in natural history museums.
- Genetic studies: Although Smith et al. (2007) worked on genetic variation in the state, their study did not incorporate specimens from the prairie pothole region. Further analyses should be conducted incorporating prairie pothole specimens and specimens from outside the state to further document genetic variation within and among populations in South Dakota. Smith et al. (2007) worked out some of the genetic techniques that would be required. Isolation by distance probably causes substantial intraspecific variation in such a small snake. In particular, the Black Hills populations are disjunct from other populations by hundreds of kilometers (Smith et al. 2007).
- Movements and population sizes: There is some indication that populations may be very localized (personal observations). Population studies at known localities should be completed to determine population sizes, movement patterns, and location of hibernacula.

Policy recommendations:

- Taxonomic issues: This species is properly known as *Opheodrys vernalis* (see "Taxonomic Note"). The Natural Heritage Database erroneously assigns the species to *Liochlorophis vernalis*. This error should be corrected. Unfortunately, NatureServe accepts the validity of *Liochlorophis*, so this mistake needs to be corrected by NatureServe at the national level and not at the state level. Communication with NatureServe should be initiated by state wildlife officials to correct this error. Crother (2011) can be used as the authority in making this change.
- Monitoring: The Black Hills populations seem to be secure, but populations on the plains may be scattered in occurrence. The species outside of the Black Hills should be monitored until the status of these populations is better understood. Game, Fish, and Parks personnel should be aware of the status of this species and should be encouraged to report specimens found outside of the Black Hills. It should be relatively simple for any trained biologist to identify this snake, so misidentifications should be rare. Monitoring is not necessary within the Black Hills.

- Bag limits: Since its status is unknown outside of the Black Hills, and because populations seem localized and small in much of its range, it would be appropriate to institute bag limits for this species. To assure that populations are not damaged by over-collection, establish a bag limit of two daily, with a maximum possession of four. This is the current bag limit for turtles in South Dakota, and until life table parameters can be defined (reproduction and recruitment) so sustainable harvests can be estimated, these provisional bag limits may also be suitable for *Opheodrys vernalis*.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station

Account author: Brian E. Smith, Department of Biology, Black Hills State University

Literature Cited

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Crother,B. I., Committee Chair. 2011. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, Edition 6.1. http://www.ssarherps.org/pages/comm_names/Index.php. Accessed 13 October 2012.

Degenhardt, W. G., C. W. Painter, and A. H. Price. 1996. Amphibians and Reptiles of New Mexico. University of New Mexico Press, Albuquerque, New Mexico.

Ernst, C. H., and E. M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D. C.

Grobman, A. B. 1992. Metamerism in the snake *Opheodrys vernalis*, with a description of a new subspecies. Journal of Herpetology 26:175-186.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Minton, S. A., Jr. 1972. Amphibians and reptiles of Indiana. Indiana Academy of Science, Monograph 3:1-346.

Oldham, J. C., and H. M. Smith. 1991. The generic status of the smooth green snake, *Opheodrys vernalis*.

Redder, A. J., B. E. Smith, and D. A. Keinath. 2006. Smooth green snake (*Opheodrys vernalis*): A technical conservation assessment. Unpublished report submitted to the U. S. Department of Agriculture, U. S. Forest Service. http://www.fs.fed.us/r2/projects/scp/assessments/smoothgreensnake.pdf. Accessed 13 October 2012.

Smith, B. E., C. Anderson, S. Sarver, and L. R. Cottingham. 2007. Genetic variation in the smooth green snake, *Opheodrys vernalis*, in South Dakota. Unpublished report submitted to the South Dakota Department of Game, Fish, and Parks.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Stuart, J. N., and C. W. Painter. 1993. Notes on hibernation of the smooth green snake, *Opheodrys vernalis*, in New Mexico. Bulletin of the Maryland Herpetological Society 29:140-142.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Werner, J. K., B. A. Maxell, P. Hendricks, and D. L. Flath. 2004. Amphibians and Reptiles of Montana. Mountain Press Publishing Company, Missoula, Montana.

South Dakota Distribution Map:

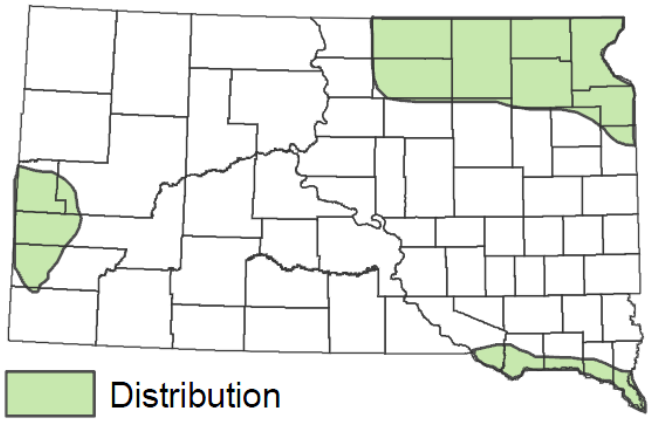


Photo:

Smooth Greensnake Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Western Foxsnake

Scientific Name: *Pantherophis* (*vulpinus*) *ramspotti*

Taxonomic Note: Until somewhat recently, western foxsnakes were placed in the genus *Elaphe* along with many other ratsnakes worldwide, but they are now considered in the genus *Pantherophis*, which embraces all North American ratsnakes (see Crother et al. 2008, 2012 for discussion), with two species of foxsnakes, the eastern and the western. Until recently, the eastern foxsnake was recognized as *P. gloydi*, and the western foxsnake as *P. vulpinus*. A relatively large gap existed between the two species' ranges, spanning much of Indiana, Michigan, and Ohio. Populations to the east of the gap were considered *P. gloydi*, and those to the west *P. vulpinus*. Recently, based on analysis of a single mitochondrial gene, the boundary between the two species was proposed to be the Mississippi River, which lies substantially west of the gap, which results in the eastern species containing two major populations (separated by the gap mentioned above), with the western major population extending westward to the Mississippi River (Crother et al. 2011). Since the type locality for the original description of *P. vulpinus* was just east of the Mississippi River, Crother et al. (2012) consider the appropriate scientific name for all foxsnakes east of the river to be *P. vulpinus*, and populations west of the Mississippi River were re-assigned to *P. ramspotti* (western foxsnake). Clearly, the taxonomy of these species remains in a state of flux, but at this time we call the species we have in South Dakota *P. ramspotti* (western foxsnake).

Description: This snake has a yellowish tan to gray background color with brown to black mid-dorsal blotches and a row of alternating smaller blotches along each side. Blotches are outlined in black. The head is a solid copper or brown color. The belly is pale yellow with brown or black markings. Young foxsnakes typically have a lighter background color, and a dark bar between their eyes, extending to the corner of the mouth on each side. (Conant and Collins 1991, Ernst and Ernst 2003, Kiesow 2006). Foxsnakes are often confused with gophersnakes in South Dakota, but foxsnakes have a divided anal plate (the scale that covers the anus is divided into right and left parts), and gophersnakes do not. Additionally, foxsnakes have weakly keeled scales (scale with a rough ridge down its center) on their backs and scales without keels on their sides, whereas gophersnakes have strongly keeled scales on their backs and sides (Kiesow 2006).

Population/protection Status

- IUCN: Least Concern
    - Population trend: Stable
- USFWS: Not listed
- State: This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5

- State Rank (NatureServe): S2

Distribution

- Global: This species ranges west of the Mississippi River from Minnesota and Iowa westward to eastern South Dakota and Nebraska (Conant and Collins 1991, Ernst and Ernst 2003).
- South Dakota
    - Historical: Over (1923), as well as Wright and Wright (1957), reported that this species was restricted to the southeastern corner of the state.
    - Current: Foxsnakes occur in the southeastern corner of South Dakota in Minnehaha, Lincoln, Union, Clay, Bon Homme, and Charles Mix Counties (Ballinger et al. 2000, Backlund 2004, Kiesow 2006).

Population Trend: This species is considered locally common across its somewhat broad range throughout much of the north-central United States (Hammerson 2007), and seems to thrive in disturbed areas of partial deforestation and where farming is not intensive (NatureServe 2012). Although its distribution in South Dakota is restricted to the southeastern corner of the state, it is quite abundant there (Jessen 2003, 2005), and has been considered such for quite some time (Over 1923). In fact, in a two year survey of this region, Fogell (2003) found that western foxsnakes were one of the most commonly encountered snakes. This area of the state is highly agricultural, with extensive fields and little natural habitat remaining. Since a key component of the diet of these snakes is rodents (Ballinger et al. 2010, Ernst and Ernst 2003, Vogt 1981), and since certain rodents may thrive on the grains produced in the fields, there may be a preponderance of food for the snakes, accounting for their abundance. While native rodents may be rare in agricultural areas of southeastern South Dakota, introduced rats, house mice, and perhaps native deer mice (in road ditches) may be common (Doug Backlund personal communication).

Key Habitat

- Key Habitat Description: This species is found in open grasslands, scrub brush, hedgerows, farmlands, and open woods (Conant and Collins 1991, Ernst and Ernst 2003)
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Tallgrass Subregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Southern Black Glaciated Plains (55C), Southern rolling Pierre Shale Plains (63B), Till Plains (102B), Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): James, Big Sioux/Vermillion, Little Sioux/Niobrara, Bad/Choteau.

Threats and Issues in South Dakota:

- Road mortality: Oldfield and Moriaty (1994) report that the greatest loss of foxsnakes in Minnesota is due to road mortality and habitat destruction. Many are seen dead on

South Dakota roads as well (Fogell 2003, Jessen 2003, 2005, Quinn personal observation).

- Pet trade: Oldfield and Moriaty (1994) report that foxsnakes are collected for the pet trade. A quick check of the internet found no western foxsnakes for sale, but eastern foxsnakes were advertised for $66.99 (www.Reptiles-N-Critters.com). Since this is a relatively small amount, the pet trade market may not play a key role in threatening foxsnake populations, but a watchful eye should be kept on this market.

Recommended Conservation and Research Actions:

- If specific areas of high road mortality for this species are identified (i.e., busy roads adjacent to hibernation sites), then actions to ameliorate snake losses should be undertaken. A proven method to accomplish this is to provide drift fences that lead to culverts, so the snakes (and other wildlife) may safely move under roads (Aresco 2005).
- Establish a bag limit to discourage commercial activity regarding this species.
- Conduct genetic analyses to determine the distinctiveness of South Dakota populations of this species from those in other parts of its range. Western foxsnakes marginally enter South Dakota in the southeastern corner of the state, representing the westernmost extent of their entire range. In general, such peripheral populations are more likely to be imperiled than those within the core of the range. This is the case, as they tend to occur in less suitable environments for the species, and are often isolated from more central and continuous populations (Lesica and Allendorf 1995). Populations at the edge of a species' range are likely to be genetically different from those in the center due to a number of factors (such as restricted gene flow, small population size, founder effects, and differing selective forces) (Lesica and Allendorf 1995). They are genetically adapted to conditions at the edge of the range, which may vary substantially from those in the core. Conserving peripheral populations helps conserve the wide range of genetic variation within the species as a whole, and thus enhances its ability to adapt to a changing environment. For example, such populations may be well adapted to shifting the species range in response to climate change (Hunter and Hutchinson 1994). Lesica and Allendorf (1995) argue that the more genetically divergent peripheral populations are from their central populations, the higher the priority should be to conserve them (and that these populations are potentially important sites of future speciation events). To investigate the distinctiveness of South Dakota populations from other populations within the range of the species, genetic comparisons should be made.

Policy Recommendations:

- Because foxsnakes have a very limited distribution in the state, and because of the potential commercial value of this species, a bag limit to protect existing populations should be established. A daily bag limit of two, with a maximum possession of four is recommended at this time. This is the current bag limit for turtles (also reptiles) in our state, and until life table parameters for foxsnakes can be defined so sustainable harvests can be estimated, it is suggested that the above turtle bag limit may also be suitable for this species.

Author: Hugh Quinn, Department of Biology, Black Hills State University

Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Aresco, M.J. 2005. Mitigation measures to reduce highway mortality of turtles and other herpetofauna at a north Florida lake. Journal of Wildlife Management 69(2):549-560.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Ballinger, R.E., J.D. Lynch, and G.R. Smith. 2010. Amphibians and reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

Crother, B.I., J. Boundry, F.T. Burbrink, and J.A. Campbell. 2008. Squamata: Snakes. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 46-65. SSAR Herpetological Circular 37:1-84.

Crother, B.I., M.E. White, J.M. Savage, M.E. Eckstut, M.R. Graham, and D.W. Gardner. 2011. A reevaluation of the status of the foxsnakes *Pantheropohis gloydi* Conant and *P. vulpinus* Baird and Girard (Lepidosauria). ISRN Zoology 2011 (Article ID 436049, 15 pp.).

Crother, B.I., J. Boundry, F.T. Burbrink, and J.A. Campbell, R.A. Pyron. 2012. Squamata: Snakes. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, pp. 52-71. SSAR Herpetological Circular 39:1-92.

Ernst C.H. and E.M. Ernst 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C.

Fogell, D.D. 2003. Amphibian and reptile surveys of southeast South Dakota with an emphasis on the state-endangered lined snake (*Tropidoclonian lineatum*) May 2002 – June 2003. Final report to the South Dakota Game Fish and Parks Department.

Hammerson, G.A. 2007. *Pantherophis vulpinus*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. www.iucnredlist.org.

Hunter, M.L. Jr., and A. Hutchinson. 1994. The virtues and shortcomings of parochialism: conserving species that are locally rare, but globally common. Conservation Biology 8(4):1163-1165.

Jessen, T. 2003. A survey of the herpetofauna of the Big Sioux River Valley 2003. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Jessen, T. 2005. Herpetological survey of eastern South Dakota 2005. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Lesica, P. and F.W. Allendorf. 1995. When are peripheral populations valuable for conservation? Conservation Biology 9(4):753-760.

NatureServe. 2012. *Pantherophis vulpinus*. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. www.naturserve.org/explorer.

Oldfield, B and J.J. Moriarty. 1994. Amphibians and reptiles native to Minnesota. University of Minnesota Press, Minneapolis.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Vogt, R.C. 1981. Natural history of amphibians and reptiles of Wisconsin. Milwaukee Public Museum, Milwaukee, Wisconsin.

Wright, A.H. and A.A. Wright. 1957. Handbook of snakes of the United States and Canada. Comstock Publishing Associates, a division of Cornell University Press, Ithaca, New York.

South Dakota Distribution Map:

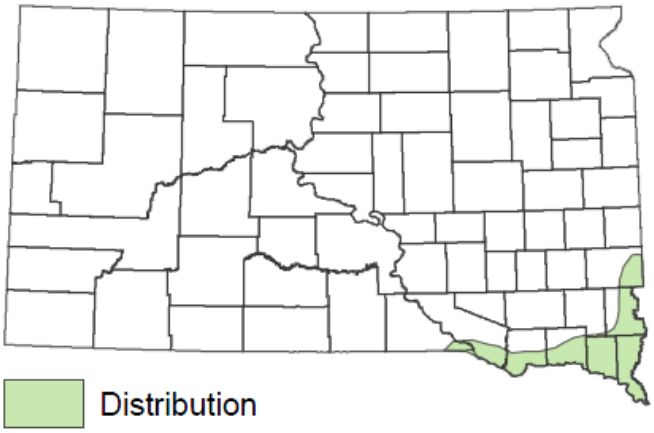


Photo:

Western Foxsnake Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Gophersnake

Scientific Name: *Pituophis catenifer*

Taxonomic Note: Six subspecies of this species are recognized in North America, and the one found in South Dakota is *Pituophis catenifer sayi*, the bullsnake (Crother et al. 2008, 2012).

Description: This is a large snake, with some individuals exceeding five feet in length. Body color is tan to yellowish, with black blotches near the head and tail and brown blotches between. The tail contains bold, dark rings, and the belly is cream to white, with dark spots along its border. This species is somewhat similar in appearance to the western foxsnake, *Pantherophis* (*vulpina*) *ramspotti* (an inhabitant of the southeastern portion of the state), but has strongly keeled scales (rough ridge down the middle of each scale) and an anal scale that is not divided. Foxsnakes have weakly keeled scales, and their anal plate is divided (scale covering the anus is divided into right and left parts) (Ballinger et al. 2000, Kiesow 2006).

Population/protection Status:

- IUCN: Least Concern
    - Population Trend: Stable
- USFWS: Not listed
- State: This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S5

Distribution:

- Global: The range of this species extends from southern British Columbia to Indiana, and south through all of western North America to northern Baja California, Sonora, Sinaloa, and Zacatecas in Mexico (Conant and Collins 1991, Ernst and Ernst 2003, Grismer 2002, Hammerson 2007, Stebbins 2003).
- South Dakota
    - Historical: Over (1923) described the bullsnake as one of the common snakes in the state, but did not discuss its distribution further. Later, Wright and Wright (1957) showed it ranging across the entire state.
    - Current: This species is found commonly west of the Missouri River, but absent in much of eastern South Dakota, found only 30 – 60 miles east of the river throughout much of its length in the state (Backlund 2004, Ballinger et al. 2000, Kiesow 2006).

Population Trend: This species is relatively common in many areas across its broad range, and is reported to have no major threats (NatureServe 2012). However, notable declines have

occurred in areas with intensive agricultural development, greatly reducing bullsnake numbers and distribution in the Midwest (Kapfer et al. 2008). It does appear that these snakes can persist in semi-agricultural landscapes and rural residential areas (Hammerson 2007). This pattern of abundance probably holds true for South Dakota populations as well.

The historical South Dakota range noted above by Wright and Wright (1957) is more extensive than that known today, suggesting a shrinking distribution. However, the map presented by Wright and Wright was based on available specimen data, and not a comprehensive survey, so the South Dakota range may not be shrinking, but may simply be better understood based on additional observations.

Key Habitat:

- Key Habitat Description: This species occurs in a wide variety of habitats, including pastureland, certain farmlands, roadsides, as well as native prairies and woodlands (Ballinger et al. 2000, Quinn personal observation).
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Mixedgrass Subregion, Tallgrass Subregion, Missouri River Ecoregion, Great Plains Steppe Ecoregion, Black Hills Ecoregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Southern Dark Brown Glaciated Plains (53C), Rolling Soft Shale Plains (54), Southern Black Glaciated Plains (55C), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Black Hills (62), Northern Rolling Pierre Shale Plains (63A), Southern rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand hills (65), Dakota-Nebraska Eroded Tableland (66), Till Plains (102B), Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand Moreau, Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara, Heart.

Threats and Issues in South Dakota:

- Road mortality: Ernst and Ernst (2003, and personal communication) cited road mortality as a major cause of death for this species in several parts of the nation. This also seems to be the case in South Dakota, but bullsnakes remain one of the most common snakes in the western part of our state (Backlund 2004, Ballinger et al. 2000, Quinn personal observation). However, limiting the number of these snakes killed on roads would serve to strengthen populations.
- Habitat alteration: This is primarily a prairie species in our state, and much of that habitat has been lost to intensive agricultural development, a land use practice that is detrimental to bullsnakes (Hammerson 2007). Deep tilling in particular can cause direct mortality of snakes in burrows, which is where they spend most of their time (Kapfer et al. 2008).
- Pesticide use: Ernst and Ernst (2003, and personal communication) cited pesticides as a cause of death in bullsnakes in other states, and felt that such contamination was

probable throughout the food chain. Since many parts of South Dakota are heavily agricultural, pesticides are probably a cause of population declines in our state as well.

- Commercial collection: Ernst and Ernst (2003) expressed concern about the impact of the pet trade on bullsnake populations. A quick check of the internet indicated there is a market for these animals in the pet trade, with specimens selling for $79.99 (adults) (www.reptmart.com) and $59.99 (babies) (www.generalexotics.com). While these prices do not create tremendous incentive for commercial collection, such activity could damage populations, especially if collections were intensive at a local level.

Recommended Conservation and Research Actions:

- Identify specific areas of high road mortality, and design methods to ameliorate such losses. A proven method to mitigate reptile losses is to provide drift fences that lead to culverts, so the animals may safely move under roads (Aresco 2005).
- In areas where bullsnakes are known to occur, discourage conversion of native prairie to cropland. This species seems to do well in areas utilized for cattle grazing (as long as areas are not overgrazed) (Quinn personal observation), so encourage such land use practices.
- Encourage use of insecticides in as discriminating a manner as possible, especially in areas where bullsnake populations are known to exist.
- Enact a bag limit for this species that would minimize collection for commercial purposes.

Policy Recommendations:

- Although populations of this species appear to be strong in South Dakota, a bag limit should be established to help prevent declines. A daily bag limit of two, with a maximum possession of four is recommended at this time. This is the current bag limit for turtles (also reptiles) in our state, and until life table parameters for bullsnakes can be defined so sustainable harvests can be estimated, it is suggested that the above turtle bag limit may also be suitable for this species.

Account Author: Hugh Quinn, Department of Biology, Black Hills State University

Reviewers: Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Aresco, M.J. 2005. Mitigation measures to reduce highway mortality of turtles and other herpetofauna at a north Florida lake. Journal of Wildlife Management 69(2):549-560.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks. Pierre, South Dakota.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

Crother, B.I., J. Boundry, F.T. Burbrink, and J.A. Campbell. 2008. Squamata: Snakes. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 46-65. SSAR Herpetological Circular 37:1-84.

Crother, B.I., J. Boundry, F.T. Burbrink, and J.A. Campbell, R.A. Pyron. 2012. Squamata: Snakes. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, pp. 52-71. SSAR Herpetological Circular 39:1-92.

Ernst C.H. and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C.

Grismer, L.L. 2002. Amphibians and reptiles of Baja California, including its Pacific Islands and the islands in the Sea of Cortés. University of California Press, Berkeley and Los Angeles, California.

Hammerson, G.A. 2007. *Pituophis catenifer.* In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. www.iucnredlist.org.

Kapfer, J. M. , J. R. Coggins and R. Hay. 2008. Estimates of population size, measurements of sex ratios, and reported mortality rates for bullsnakes (*Pituophis catenifer sayi*) at a site in the upper Midwestern United States. Journal of Herpetology 42:265-269.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

NatureServe. 2012. *Pituophis catenifer*. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. www.natureserve.org/explorer.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

Stebbins, R.C. 2003. A field guide to western reptiles and amphibians. Third Edition. Houghton Mifflin Company, Boston, Massachusetts.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Wright, A.H. and A.A. Wright. 1957. Handbook of snakes of the United States and Canada. Comstock Publishing Associates, a division of Cornell University Press, Ithaca, New York.

South Dakota Distribution Map:

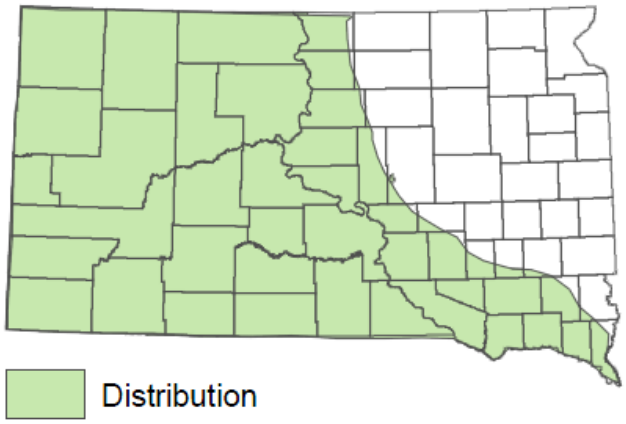


Photo:

Gophersnake Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Dekay's brownsnake

Scientific Name: *Storeria dekayi*

Taxonomic Note: This species is represented by four subspecies in North America, with *Storeria dekayi texana*, the Texas brownsnake, recorded from South Dakota (Crother et al. 2008, 2012).

Description: This is a small snake, with average adult length of 9 – 13 inches. The body color varies from grayish-brown to reddish-brown, usually with a light stripe down the middle of the back. The stripe may be bordered by a row of small, dark spots. A large dark spot is located on each side of the neck, and there may be a smaller spot under each eye. The belly is pale pink or cream-colored. Unlike adults, juveniles have a light yellow or white band around the neck and a dark body color. The closely related red-bellied snake normally has a bright red belly, differentiating it from the brownsnake. Ring-necked snakes are easily confused with immature brownsnakes, but have smooth body scales, compared to the keeled scales (a rough ridge down the middle of each scale) of brownsnakes (Ernst and Ernst 2003, Kiesow 2006, Oldfield and Moriarty 1994).

Population/protection Status:

- IUCN: Least Concern
    - Population Trend: Stable
- USFWS: Not listed
- State: This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S1

Distribution:

- Global: Brownsnakes range from southern Maine, southern Quebec, southern Ontario, Michigan, Minnesota, and northeastern South Dakota south to southern Florida (including the Lower Keys), the US Gulf coast, and through eastern and southern Mexico to Veracruz and Oaxaca, and from Chiapas to Honduras (Christman 1982).
- South Dakota
    - Historical: Over (1923) reported only a single specimen of this species from South Dakota. It was found in 1922 along the west shore of Big Stone Lake, Roberts County, in the extreme northeastern corner of the state. Wright and Wright (1957) also reflected this in their range map.
    - Current: This species is only known from three specimens in our state, one from Roberts County (mentioned above), one from Charles Mix County, and one from

Brookings County (South Dakota Game, Fish and Parks Department Natural Heritage Database).

Population Trend: Brownsnakes are locally abundant in many areas across their range (up to hundreds per hectare) (one hectare is roughly 2.5 acres) (Hammerson et al. 2007), and, as noted above, their range is rather extensive. Overall, populations are considered stable, and no major threats are evident for the species. In fact, this snake tolerates a high level of habitat disturbance, and can even be found in many urban and suburban areas (Hammerson et al. 2007, Quinn personal observation). However, in South Dakota, only three isolated records for this species exist, each representing only one specimen, and each widely scattered from the others. Not only are these records scattered in terms of distance, but also in terms of time. The Roberts County record was in 1922, the Charles Mix County record was in 1984, and the Brookings County record in 2010. These snakes are secretive, hiding beneath cover objects, potentially making their detection somewhat difficult (NatureServe 2012). However, given the paucity and widely scattered nature of records for this species, it seems that populations in our state are probably relict, quite small, and isolated. This is a dangerous combination of factors for long-term persistence of the species in our state.

The South Dakota records are also isolated from brownsnake populations in Minnesota, Iowa, and Nebraska (Ballinger et al. 2010, Fogell 2010, Ernst and Ernst 2003, Oldfield and Moriarty 1994). Thus, if populations still persist in our state, they could be genetically distinct from those in surrounding states. Such uniqueness would make them extremely important from a conservation standpoint.

Key Habitat:

- Key Habitat Description: Brownsnakes usually inhabit moist situations, but are not an aquatic species. They often occur under debris or logs (Hammerson et al. 2007). Oldfield and Moriarty (1994) reported the species prefers deciduous forest edges near clearings, marshes, and ponds in Minnesota. Vogt (1981) reported that in Wisconsin old fields and vacant city lots are suitable habitat.
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Tallgrass Subregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Rolling Till Prairie (102A).
    - Aquatic Drainage Units (Annis et al. 2010): Red and Minnesota River.

Threats and Issues in South Dakota: Until populations are located, threats to them cannot be evaluated.

Recommended Conservation and Research Actions:

- Conduct intensive surveys, especially in the three areas where brownsnakes have previously been observed. If a population is discovered, examine its genetic uniqueness, and produce a conservation action plan to assure its continued persistence.

Policy Recommendations:

- Because brownsnakes have an extremely limited distribution in the state, and are only known from three specimens, a bag limit to protect any existing populations should be established. A daily bag limit of two, with a maximum possession of four is recommended at this time. This is the current bag limit for turtles (also reptiles) in our state, and until life table parameters for brownsnakes can be defined so sustainable harvests can be estimated, it is suggested that the above turtle bag limit may also be suitable for this species.

Account Author: Hugh Quinn, Department of Biology, Black Hills State University

Reviewers*:* Doug Backlund, Retired Wildlife Biologist, South Dakota Department of Game, Fish and Parks; Gary Casper, University of Wisconsin-Milwaukee Field Station.

Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Ballinger, R.E., J.D. Lynch, and G.R. Smith. 2010. Amphibians and reptiles of Nebraska. Rusty Lizard Press, Oro Valley, Arizona.

Christman, S.P. 1982. *Storeria dekayi*. Catalogue of American Amphibians and Reptiles 306:1-4.

Crother, B.I., J. Boundry, F.T. Burbrink, and J.A. Campbell. 2008. Squamata: Snakes. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 46-65. SSAR Herpetological Circular 37:1-84.

Crother, B.I., J. Boundry, F.T. Burbrink, and J.A. Campbell, R.A. Pyron. 2012. Squamata: Snakes. *In:* B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understanding, pp. 52-71. SSAR Herpetological Circular 39:1-92.

Ernst, C.H., and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington.

Fogell, D.D. 2010. A field guide to the amphibians and reptiles of Nebraska. University of Nebraska – Lincoln, Nebraska.

Hammerson, G.A., F. Mendoza-Quijano, and J. Lee. 2007. *Storeria dekayi*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1 www.iucnredlist.org.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

NatureServe. 2012. *Storeria dekayi*. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. www.natureserve.org/explorer.

Oldfield, B., and J.J. Moriarty. 1994. Amphibians and reptiles native to Minnesota. The University of Minnesota Press, Minneapolis, Minnesota.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Vogt, R.C. 1981. Natural history of amphibians and reptiles of Wisconsin. Milwaukee Public Museum, Milwaukee, Wisconsin.

Wright, A.H., and A.A. Wright. 1957. Handbook of snakes of the United States and Canada. Comstock Publishing Associates, a division of Cornell University Press, Ithaca, New York.

Photo:

Dekay's Brownsnake Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Red-bellied snake.

Scientific Name: *Storeria occipitomaculata.*

Description: Dorsally, this is a nondescript small brown snake. But pick the snake up and turn it over and the brilliant red belly becomes apparent. There are paired dark dorsolateral stripes on either side of the vertebral column. Otherwise, the snake is dull brown. A second color morph is found in the Black Hills, with a grayish, rather than brownish, dorsum (personal observations). The red belly and its small size should help to distinguish this snake from any other snake in South Dakota. Its congener, DeKay's brownsnake (*Storeria dekayi*) is similarly sized with a similarly colored dorsum, but has a whitish belly. Additionally, DeKay's brownsnake does not occur in the Black Hills, although the ranges of both species overlap in eastern South Dakota. The red-bellied snake is from 8 – 10 inches in length (record size 16 inches; Conant and Collins 1998).

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S3.
- United States Forest Service: Species of local concern in the Black Hills National Forest.

Distribution

- Global: The red-bellied snake is found across the eastern United States from the eastern edge of the Great Plains to the Atlantic Seaboard (Ernst and Ernst 2003). The southern terminus of its range is in Arkansas, the southern border of Tennessee, and northern Mississippi, Georgia, and South Carolina. It is absent from parts of Iowa, Missouri, Illinois, Indiana, Ohio, and other parts of its range.
- South Dakota
    - Historical: Along the eastern border of the state with a disjunct population in the Black Hills.
    - Current: Same. In the Black Hills, the range is restricted to areas from the lower bounds of ponderosa pine forests to the highest elevations (personal observations). I have never found it in the grasslands surrounding the Black Hills, other than a specimen I collected on the grasslands just outside of ponderosa pine forest at Wind Cave National Park (Smith and Stephens 2003).

Population trend: Unknown. As is often the case, small non-descript snakes are often overlooked, and no studies have been completed on this snake in South Dakota. Studies are ongoing in the Black Hills (B. Smith, unpublished data). This snake is considered a species of local concern within the Black Hills National Forest by the United States Forest Service. Smith and Stephens (2003) completed a conservation assessment of this species.

Key Habitat

- Key Habitat Description: Red-bellied snakes inhabit woodlands and moist grassy areas, usually near water (Kiesow 2006). In the Black Hills, this species is found in mesic areas, often in wet meadows or along streams, and usually under some sort of cover. Cover boards are effective in sampling this species (unpublished data). Kiesow (2006) mentioned that it is also found in aspen groves. I have not found it on the plains outside of the forested elevations of the Black Hills (unpublished data) other than one record on grasslands just outside of the forest at Wind Cave National Park. In my experience, it is seldom found far from water. In the Black Hills, two cases have been found where it appears to hibernate in rocky outcrops where fissile rock creates numerous small crevices into which the snakes can crawl (personal observations). In parts of its range it has been found hibernating in ant mounds (Lang 1969). In the eastern part of its range it is found in moist woodlands under various cover items (Ernst and Ernst 2003). Smith and Stephens (2003) provided an extensive summary of their biology, which includes a lengthy discussion of habitat use and movement patterns.
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Black Hills Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Red River Valley of the North (56), Black Hills Foot Slopes (61), Black Hills (62), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): Big Sioux/Vermillion, Cheyenne, Red and Minnesota River.

Threats and Issues in South Dakota:

- Habitat alteration and destruction in mesic areas and along streams: Streams and wetland areas have been substantially altered by removal of vegetation since the arrival of European settlers in the Black Hills (Parrish et al. 1996). Given what we know about red-bellied snakes in the Black Hills, this could have altered or destroyed prime habitat for these snakes.
- Destruction of hibernacula: Hibernacula are critical resources for these small snakes, and damage to them would destroy whole populations of snakes. Unfortunately we know little about these sites, other than two cases in which they may hibernate on slopes covered in fissile rock such as slate (personal observations).
- Road mortality: There are at least two areas in the Black Hills where snakes migrate from what are presumed to be dens on one side of the road to suitable summer foraging areas on the other side of the road (Smith and colleagues, study in progress).

Both of these sites are high traffic areas. Large numbers of these small snakes are killed on the roads at these sites.

- Pesticides: Exposure to pesticides through major prey items such as slugs and various other invertebrates may put red-bellied snakes at risk as described for the smooth green snake (Minton 1972), a snake with similar dietary habits.

Recommended Conservation and Research Actions:

- Study of the systematics of this species: Smith (1963) described the Black Hills red-bellied snake as an endemic subspecies in the Black Hills, *Storeria occipitomaculata pahasapae*. It should be studied using modern genetic techniques to more precisely determine the relationships to populations that are at least 320 miles distant to the east (Smith 1963).
- Surveys of the Bear Lodge Mountains: Oddly, Baxter and Stone (1985) make no mention of this snake in the Bear Lodge Mountains. Other snakes restricted to the Black Hills in South Dakota (smooth greensnake, terrestrial gartersnake) are also found in the Bear Lodge Mountains. Although the Bear Lodge Mountains are in Wyoming and outside the jurisdiction of South Dakota Game, Fish, and Parks, surveys for the Black Hills red-bellied snake should be undertaken there. Such surveys would be relevant to the Department of Game, Fish, and Parks in the state of South Dakota, because if they are not found in the Bear Lodge Mountains, then the Black Hills red-bellied snake has an unusual distribution indeed, being a true Black Hills endemic.
- Population and movement studies: Habitat use by this snake needs to be better understood in western South Dakota. Riparian areas may be heavily used, and rocky slopes with numerous small crevices might be used as hibernacula.
- Road mortality: Large numbers of these snakes die on roads in proximity to suitable denning areas (Smith and Massie [U.S. Forest Service] unpublished data). Sites where ongoing road mortality is occurring are a pressing conservation need. Road mortality can be greatly reduced by various measures such as installation of ecopassages, road barriers, or selectively timed road closings (Forman et al. 2002).

Policy recommendations:

- Bag limits: This is an enigmatic snake in the state and may be an endemic subspecies in the Black Hills, yet its collection is not regulated. To assure that populations are not damaged by over-collection, establish a bag limit of two daily, with a maximum possession of four. This is the current bag limit for turtles in South Dakota, and until life table parameters can be defined (reproduction and recruitment) so sustainable harvests can be estimated, these provisional bag limits may also be suitable for *Storeria occipitomaculata*.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station

Account author: Brian E. Smith, Department of Biology, Black Hills State University

Literature Cited

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Baxter, G. T., and M. D. Stone. 1985. Amphibians and Reptiles of Wyoming, 2nd ed. Wyoming Game and Fish Department, Casper, Wyoming.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Ernst, C. H., and E. M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D. C.

Forman, R. T. T., et al. 2002. Road Ecology: Science And Solutions. Island Press, Washington, D.C., 504pp.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Lang, J. W. 1969. Hibernation and movements of *Storeria occipitomaculata* in northern Minnesota. Journal of Herpetology 3:196-197.

Minton, S. A., Jr. 1972. Amphibians and reptiles of Indiana. Indiana Academy of Science, Monograph 3:1-346.

Parrish, J. B., D. J. Herman, and D. J. Reyher. 1996. A Century of Change in Black Hills Forest and Riparian Ecosystems. U.S. Forest Service Agricultural Experiment Station, U.S. Department of Agriculture. South Dakota State University. No. B722. 20 pp.

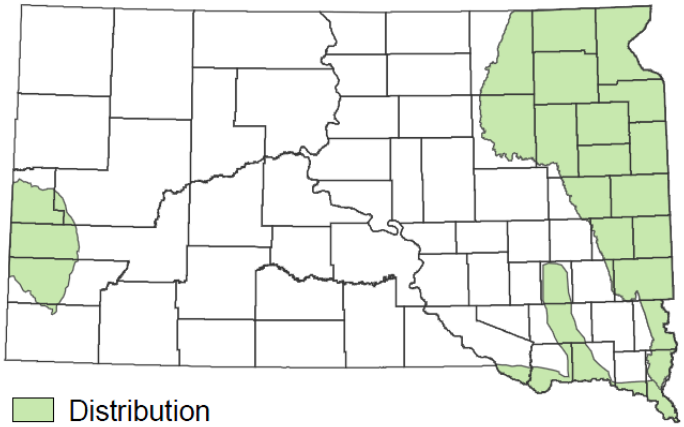
Smith, B. E., and N. T. Stephens. 2003. Conservation assessment for the redbelly snake in the Black Hills National Forest, South Dakota and Wyoming. Unpublished report submitted to the U. S. Department of Agriculture, U. S. Forest Service. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm9_012483.pdf. Accessed 13 October 2012.

Smith, H. M. 1963. The identity of the Black Hills population of *Storeria occipitomaculata*, the red-bellied snake. Herpetologica 19:17-21.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

South Dakota Distribution Map:



Photos:

Red-bellied Snake Scott Weins

Red-bellied Snake Doug Backlund

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Terrestrial gartersnake.

Scientific Name: *Thamnophis elegans.*

Description: The terrestrial gartersnake is unlike the other two species of gartersnakes found in South Dakota. Like those species, it also has paired light-colored lateral stripes and a mid-dorsal stripe on an olive background with dark lateral spots. However, the mid-dorsal stripe is light-colored with no hint of yellow and the body is darker than either of the other two species. There is no reddish skin between the scales and no hint of orange to the mid-dorsal stripe. Compare this description to that of the common and plains gartersnakes found in their species profiles. Also, in my experience the terrestrial gartersnake is never found on the plains. It is restricted to the forested areas of the Black Hills above the plains ecoregion. Snakes on the plains are either common gartersnakes or plains gartersnakes. Some members of the public have described a "black" snake in the Black Hills. There are no black snakes in the Black Hills. While these specimens could be melanistic forms of the common gartersnake (see common gartersnake account), they are most likely darkly colored terrestrial gartersnakes. The terrestrial gartersnake is typically 18 – 30 inches, record size 37 inches (Conant and Collins 1998). The subspecies found in South Dakota is known as the wandering gartersnake (*Thamnophis elegans vagrans*).

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S4.

Distribution

- Global: The terrestrial gartersnake ranges widely across the western United States (Rossman et al. 1996). It is generally a snake of higher elevations, although populations are found along the California and Canadian coastlines. It is found across southwestern Saskatchewan, southern Alberta and British Columbia, parts of Vancouver Island, eastern Washington and Oregon, northern California and the northern Sierra Nevada, northern Nevada, eastern Utah, northern Arizona and New Mexico, western Colorado to the western border of the plains region, and almost all of Idaho. Its range in Wyoming is unclear. Rossman et al. (1996) show it ranges across all but the northeastern quarter of the state, with isolated populations in what appear to be the Black Hills and Bear Lodge Mountains and possibly the Bighorn Mountains (their maps are not to a scale where individual mountain ranges can be discerned). Ernst and Ernst (2003) depict it as absent

in a north-south band through central Wyoming. They depict the Black Hills and Bear Lodge Mountains populations not as isolated populations, but continuous with populations to the south, apparently following the range map of Conant and Collins (1998). Baxter and Stone (1985) show that it occurs throughout Wyoming to elevations of 10,000 feet and that the Bear Lodge Mountains and Black Hills populations are not disjunct populations. See South Dakota range immediately below for further comments.

- South Dakota
    - Historical: Kiesow (2006) noted that the terrestrial gartersnake is found in South Dakota in a disjunct population in the Black Hills above 4500 feet elevation. She also notes recent specimens collected in the North Cave Hills and in Harding County.
    - Current: No change. Recent records from the North Cave Hills and Harding County probably reflect our lack of understanding of this species' range in South Dakota and not recent expansions of the range.
    - Comments: In South Dakota, this snake is found in the higher elevations of the Black Hills and in the North Cave Hills and Harding County. It is found in Wyoming, but Baxter and Stone (1985), Rossman (1996), Conant and Collins (1998), and Ernst and Ernst (2003) are at odds about its Wyoming range. It is not found at Devils Tower, where the common gartersnake was the only gartersnake found by Smith et al. (2008). Clearly, insufficient data exist to accurately delimit its range in South Dakota and northeastern Wyoming.

Population Trend: Ernst and Ernst (2003), citing a number of sources, claim that this snake is generally common across its range. My subjective judgment in the Black Hills is that it is generally less common than the common gartersnake. However, it is the only gartersnake my colleagues and I have collected in the western part of the Limestone Plateau physiographic division of the Black Hills (unpublished data), which is well-drained with few ponds. Insufficient data exist to judge the overall density of the Black Hills populations or population trends in South Dakota. Recent finds in the North Cave Hills and Harding County and disagreement about its range in northeastern Wyoming suggest we need to learn more about the range and population sizes in South Dakota and northeastern Wyoming.

Key Habitat

- Key Habitat Description: Ernst and Ernst (2003) note that this species occurs in a variety of habitats, and the wandering gartersnake (*Thamnophis elegans vagrans*) is likely to occur further from water than the other subspecies of *T. elegans*. In my experience, this is a snake of higher elevations and drier country than the other gartersnakes of South Dakota. I have never found them on the plains. In particular, despite many hours spent searching for herpetofauna on the plains between known populations in the Black Hills and Bear Lodge Mountains, I have never found them in the plains.
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Great Plains Steppe Ecoregion, Black Hills Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Northern Rolling High Plains - Eastern Part (58D), Black Hills Foot Slopes (61), Black Hills (62).

- Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand/Moreau, Cheyenne.

Threats and Issues in South Dakota: None noted, although they have not been studied in the disjunct populations that occur in South Dakota.

Recommended Conservation and Research Actions:

- Establishing the South Dakota range: We need to know more about this species in western South Dakota. These populations are disjunct from other populations, but it is unclear from Baxter and Stone (1985), Rossman et al. (1996), Ernst and Ernst (2003), and Kiesow (2006) just how disjunct the South Dakota populations are. Rossman et al. (1996) show the Black Hills and Bear Lodge Mountains as a single disjunct population, with the nearest populations possibly in the Bighorn Mountains, though this is hard to establish from their range map. From my data, the Black Hills and Bear Lodge Mountains are two separate populations. The range map in Baxter and Stone (1985) implies that the Black Hills and Bear Lodge Mountains populations are not disjunct from populations further west in Wyoming, but they do not discuss populations in South Dakota. This does not accord with my limited observations on Wyoming. Kiesow (2006) does not discuss the disjunct nature of South Dakota populations, but does provide an updated South Dakota range map. Ernst and Ernst (2003) appear to be following the range map of Conant and Collins (1998), and do not represent South Dakota populations as disjunct from other populations to the south and west. My experience in the area implies that South Dakota populations are not only disjunct from each other, but also disjunct from other populations to the west. For instance, they were not found at Devils Tower National Monument (Smith et al. 2008), where the common gartersnake was the only gartersnake encountered. This is another species in which the wildlife agencies of Wyoming and South Dakota have a shared interest. Findings in Wyoming will affect management in South Dakota, as they will determine the isolation, or lack thereof, of South Dakota populations from those in Wyoming. I recommend a two-pronged approach to investigating the range in western South Dakota and northeastern Wyoming.
    - Museum surveys: Museum records and specimens should be requested from any institutions with holdings of terrestrial garter snakes. Northeastern Wyoming and South Dakota specimens need to be examined to verify identity and collecting localities. From these records, an accurate range map can be drawn from current knowledge.
    - Field surveys: Based on museum data, historical localities should be visited to determine whether terrestrial garter snakes still occur there. Additionally, the areas north, south, and west of the Black Hills should be surveyed to determine the boundaries of the range in northeastern Wyoming and western South Dakota.
- Population studies: The terrestrial gartersnake was at one time tracked by the South Dakota Natural Heritage Program, and this indicates some concern about the populations in western South Dakota. If museum and field surveys can establish the range in South Dakota and northeastern Wyoming, populations should be studied in

more detail to determine their status and whether the South Dakota populations should be monitored.

Policy Recommendations:

- Status: The status of terrestrial gartersnakes in South Dakota should be assessed. While the species does not appear to be in danger of declines at this time, we know little about it.
- Monitoring: Until the range is established in South Dakota, this species should be monitored by the South Dakota Department of Game, Fish, and Parks. In particular, new localities for the species should be flagged for further investigation.
- Bag limits: Population numbers and sizes are poorly known within the state. To assure that populations are not damaged by over-collection, establish a bag limit of two daily, with a maximum possession of four. This is the current bag limit for turtles in South Dakota, and until life table parameters can be defined (reproduction and recruitment) so sustainable harvests can be estimated, these provisional bag limits may also be suitable for *Thamnophis elegans*.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station

Account author: Brian E. Smith, Department of Biology, Black Hills State University

Literature Cited

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Baxter, G. T., and M. D. Stone. 1985. Amphibians and Reptiles of Wyoming, 2nd ed. Wyoming Game and Fish Division.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Ernst, C. H., and E. M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D. C.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Rossman, D. A., N. B. Ford, and R. A. Siegel. 1996. The Garter Snakes: Evolution and Ecology. University of Oklahoma Press, Norman, Oklahoma.

Smith, B. E., J. Massie, and B. G. Blake. 2008. A herpetofaunal survey of Devils Tower National Monument, with comments on survey techniques and prairie rattlesnake management. Unpublished report submitted to the National Park Service.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

South Dakota Distribution Map:

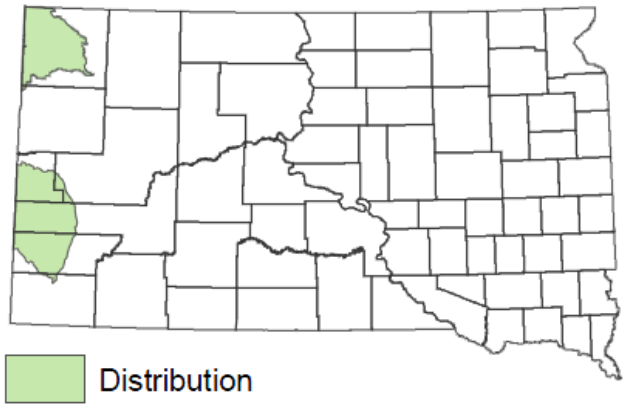


Photo:

Terrestrial Gartersnake Doug Backlund

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Plains gartersnake.

Scientific Name: *Thamnophis radix.*

Description: This gartersnake is a moderately-sized snake, typically from 15 – 28 inches long, record length 43 inches (Conant and Collins 1998). It is similar to the common gartersnake, with dark spots on an olive background, two light colored lateral stripes, and a mid-dorsal stripe. But in the plains gartersnake, the mid-dorsal stripe is orange-yellow. In the common gartersnake, *T. sirtalis*, the mid-dorsal stripe is yellowish, with no hint of orange. Additionally, the common gartersnake has red skin between the scales (hence the common name "red-sided gartersnake"). To see this feature, hold the snake and spread the scales apart to clearly observe the red interscalar skin. In the plains gartersnake no red coloration will be evident. Another discriminating character is the lateral stripe, which runs along dorsal scale rows 3 and 4 in the Plains gartersnake and dorsal scale rows 2 and 3 in the common gartersnake (Conant and Collins 1998). Among the three gartersnakes present in South Dakota, the orange-hued mid-dorsal stripe of the plains gartersnake, lateral stripe on scale rows 3 and 4, and lack of red interscalar skin distinguishes the plains from the common gartersnake. The terrestrial gartersnake is much darker than either of the other two gartersnakes, has no yellow longitudinal stripes, and in the state is only known from the Black Hills and pine forests of Harding County.

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S5.

Distribution

- Global: This is the gartersnake of the Great Plains. It is found throughout the Great Plains from northern Texas and Oklahoma north throughout the states of the Great Plains, including eastern Colorado and all of Kansas, Nebraska, South Dakota, and North Dakota. Its range also extends into the plains region of eastern Montana and southern Alberta, Saskatchewan, and Manitoba, throughout Iowa, northern Indiana, far southern Wisconsin, the western half of Minnesota, and far northeastern New Mexico.
- South Dakota
    - Historical: Statewide (Rossman et al. 1996). Rossman et al.'s (1996) range map shows slight differences from the range maps of Conant and Collins (1998), Ernst

and Ernst (2003), and Kiesow (2006) within the state of South Dakota. Rossman et al. (1996) is considered the authoritative account.

- Current: Statewide.

Population Trend: No population data are available specific to South Dakota, but there are a number of studies that illustrate the potential abundance of plains gartersnakes. At one site in Illinois, 298 of 383 (77.8%) marked snakes were plains gartersnakes (Seibert and Hagen 1947). Estimated population size at this site ranged from 845 – 889 gartersnakes/hectare (Seibert 1950). Over a three-year period Reichenbach and Dalrymple (1986) estimated biomass at their study site from 3.5 – 8.6 kg/hectare, depending on the year. One characteristic of this species in South Dakota is that they can be quick to colonize new habitat. For example, a homeowner in downtown Spearfish, South Dakota, renovated her home and had a metal sleeve inserted between the foundation and surrounding soil. Within a few years, plains gartersnakes were routinely being found in her basement, apparently coming from this artificially created space. In the second case, I built a new home on the outskirts of Spearfish, and for the first couple of years set about landscaping it, observing no gartersnakes in the process. As shrubs and trees were planted and watered, plains gartersnakes appeared. Now (October 2012), nine years later, a small but thriving population lives on the property. In one instance I found 12 under a 1 ft. X 12 ft. board, the largest such gathering I have found under one cover item. They may be using a newly constructed rock retaining wall with southern exposure as a hibernaculum.

Key Habitat

- Key Habitat Description: Within South Dakota this is the gartersnake of the arid plains. It becomes progressively more common as one proceeds from east to west within the state (personal observations). It is the most common snake on the plains surrounding the Black Hills and is not found in the forests of the Black Hills, where the common gartersnake replaces it (personal observations). It is the most common snake at Badlands National Park (Smith et al. 1998) and in many areas around South Dakota west of the Missouri River (personal observations). In some of the wetter areas of western South Dakota, the common gartersnake may predominate (Ernst and Ernst 2003, personal observations).
- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Eastern Prairie Tall-grass Subregion, Missouri River Ecoregion, Great Plains Steppe Ecoregion, Black Hills Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Southern Dark Brown Glaciated Plains (53C), Rolling Soft Shale Plains (54), Central Black Glaciated Plains (55B), Southern Black Glaciated Plains (55C), Red River Valley of the North (56), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Black Hills (62), Northern Rolling Pierre Shale Plains (63A), Southern Rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand Hills (65), Dakota-Nebraska Eroded Tableland (66), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).

- Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand/Moreau, Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara, Red and Minnesota River, Heart.

Threats and Issues in South Dakota: None noted.

Recommended Conservation and Research Actions: None.

Policy Recommendations:

- Bag limits: Rossman et al. (1996) noted no conservation issues facing the plains gartersnake except in Ohio, where a relictual population occurs. Nevertheless, even the common gartersnake, arguably present in larger numbers rangewide, can be over-collected by the pet and scientific trade (Rossman et al. 1996). To assure that populations are not damaged by over-collection, establish a bag limit of two daily, with a maximum possession of four. This is the current bag limit for turtles in South Dakota, and until life table parameters can be defined (reproduction and recruitment) so sustainable harvests can be estimated, these provisional bag limits may also be suitable for *Thamnophis radix*.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station

Account author: Brian E. Smith, Department of Biology, Black Hills State University

Literature Cited

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Ernst, C. H., and E. M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D. C.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

Reichenbach, N. G., and G. H. Dalrymple. 1986. Energy use, life histories, and the evaluation of potential competition in two species of garter snakes. Journal of Herpetology 20:133-153.

Rossman, D. A., N. B. Ford, and R. A. Siegel. 1996. The Garter Snakes: Evolution and Ecology. University of Oklahoma Press, Norman, Oklahoma.

Seibert, H. C. 1950. Population density of snakes in an area near Chicago. Copeia 1950:229-230.

Seibert, H. C., and C. W. Hagen. 1947. Studies on a population of snakes in Illinois. Copeia 1947:6-22.

Smith, B. E., D. M. Browning, E. Taylor, R. S. Ferguson, and K. Yturralde. 1998. Herpetofaunal surveys of the Fall River Ranger District, U.S. Forest Service, southwestern South Dakota and Badlands National Park. Unpublished report submitted to the Northern Prairie Wildlife Research Center, U.S. Geological Survey, Biological Resources Division. Jamestown, North Dakota.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

South Dakota Distribution Map:

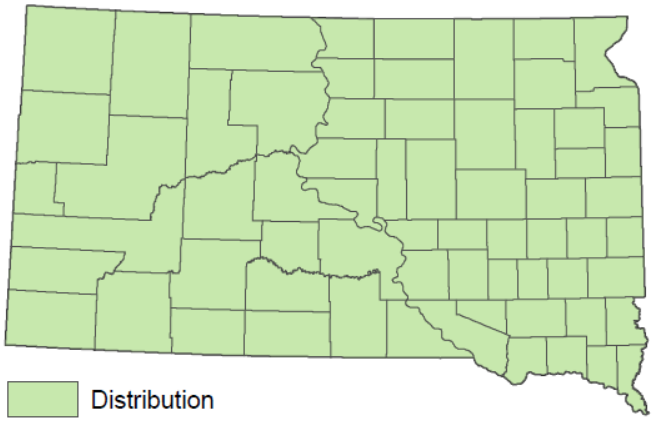


Photo:

Plains Gartersnake Doug Backlund

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Common gartersnake.

Scientific Name: *Thamnophis sirtalis.*

Description: The common gartersnake is from 16 – 26 inches in length, with a record size of almost 49 inches (Conant and Collins 1998). It has three longitudinal stripes; paired lateral stripes and a dorsal stripe, all of which are bright yellow, on a greenish-olive background checkered with dark spots. The three gartersnakes of South Dakota (see species accounts for the terrestrial and Plains gartersnakes) can easily be confused, but with a closer look it is not that hard to tell them apart. The subspecies of *T. sirtalis* found in South Dakota is the red-sided gartersnake, *Thamnophis sirtalis parietalis* (Conant and Collins 1998, Kiesow 2006). The reddish skin found between the scales on the side of the body is characteristic. With the animal in the hand, spread the scales apart, and the distinctive reddish skin between each scale will be readily apparent. Also, the dorsal stripe is yellow. The plains gartersnake's dorsal stripe is orange-yellow, and there is no reddish skin between the scales. With some practice, the difference is quite noticeable. Another feature separating the two species is that the lateral stripe on the common gartersnake runs along dorsal scale rows 2 and 3, and on the plains gartersnake the lateral stripe runs along dorsal scale rows 3 and 4 (Conant and Collins 1998). The terrestrial gartersnake is much darker than either of the other two gartersnakes, has no yellow longitudinal stripes, and in the state is only found in the Black Hills. The common gartersnake is not as likely to venture as far from water as the other two species of gartersnakes that occur in the state. Several observations of a "black" snake in the Black Hills have been made by various members of the public (personal communications). It is unclear what species these snakes are. The terrestrial gartersnake, *Thamnophis elegans*, may be very darkly colored and could appear black to the casual observer (see terrestrial gartersnake account). However, melanistic populations of common gartersnakes are known from the Lake Erie region (King 1988, Bittner et al. 2002).

Population/protection Status

- IUCN: Least concern.
    - IUCN population trend: Stable.
- USFWS: Not listed.
- State: Not listed. This species receives no legal protection in South Dakota.
- Global Rank (NatureServe): G5.
- State Rank (NatureServe): S5.

Distribution

- Global: Rossman et al. (1996), Conant and Collins (1998), Ernst and Ernst (2003), and Kiesow (2006) all provide range maps for the common gartersnake with slight variations. Rossman et al. (1996) is considered the authoritative text on gartersnakes. Ernst and

Ernst (2003) appear to follow Rossman et al. (1996). The common gartersnake is the widest ranging gartersnake in the world and ranges further north than any species of North American snake. It is found across the eastern one-half to two-thirds of the United States, roughly from the Great Plains east to the Atlantic and south to the Gulf Coast. They are also found throughout the southern reaches of the Canadian provinces and range far to the north in British Columbia and Alberta. Additionally, the range encompasses most of Montana and the Pacific Northwest and extends throughout northern California. There are also populations along the Rio Grande River in New Mexico.

- South Dakota
    - Historical: Both Conant and Collins (1998) and Kiesow (2006) indicate the distribution is statewide, but this conflicts with Rossman et al. (1996) and Ernst and Ernst (2003), who show the species to be absent from the far northwestern corner of South Dakota. Backlund and Massie (personal communications) have found the snake is less common west of the Missouri River in South Dakota. I have found the common gartersnake to be spottily distributed on the plains of western South Dakota west of the Missouri River, although it is found throughout the Black Hills. Here it replaces the plains gartersnake, which does not occur in the Black Hills. The western edge of the common gartersnake's range follows the western border of South Dakota, although in northern North Dakota it ranges further west. It is almost completely absent from Wyoming (Baxter and Stone 1985).
    - Current: Its current range is probably similar to its historical range. No literature exists to suggest otherwise.

Population Trend: It is likely that populations are stable in South Dakota but no population studies are available. Common gartersnakes are found in very large numbers across their range. Ernst and Ernst (2003) note a number of studies verifying this, including hibernacula in Canada where from 500 – 10,000 snakes have been found (see Ernst and Ernst 2003 for a summary of den site literature). They cite a number of studies of relative abundance and population densities across the range. Several studies found that from 10% to 20% of all snakes captured at study sites were common gartersnakes (Dalrymple et al. 1991, Fitch 1992, Cavitt 2000). Densities of from 4 – 89 snakes per hectare have been reported. Long-term data in South Dakota do not exist, but gartersnakes are commonly found in all sorts of habitats, including backyards and downtown lots.

Key Habitat

- Key Habitat Description: Wright and Wright (1957) may have most accurately summarized the key habitat of common gartersnakes when they noted that it occurs "everywhere". This is probably true within much of their range, but it is more common around waterways, which is why it is less common in arid areas in western South Dakota. I have found it to be the most common snake in the Black Hills, where the plains gartersnake is absent. But on the plains surrounding the Black Hills the plains gartersnake is more abundant. On the arid plains of western South Dakota, common

gartersnakes seem to be restricted to areas closer to permanent water bodies, like streams, rivers, permanent ponds, and lakes. Even in these habitats, the plains gartersnake may be more common.

- Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Eastern Prairie Mixed-grass Subregion, Eastern Prairie Tall-grass Subregion, Missouri River Ecoregion, Great Plains Steppe Ecoregion, Black Hills Ecoregion.
- Major Land Resource Areas (United States Department of Agriculture 2006): Central Dark Brown Glaciated Plains (53B), Southern Dark Brown Glaciated Plains (53C), Rolling Soft Shale Plains (54), Central Black Glaciated Plains (55B), Southern Black Glaciated Plains (55C), Red River Valley of the North (56), Northern Rolling High Plains - Eastern Part (58D), Pierre Shale Plains (60A), Black Hills Foot Slopes (61), Black Hills (62), Northern Rolling Pierre Shale Plains (63A), Southern Rolling Pierre Shale Plains (63B), Mixed Sandy and Silty Tableland and Badlands (64), Nebraska Sand Hills (65), Dakota-Nebraska Eroded Tableland (66), Rolling Till Prairie (102A), Till Plains (102B), Loess Uplands (102C).
- Aquatic Drainage Units (Annis et al. 2010): Little Missouri, Grand/Moreau, Middle Missouri, James, Big Sioux/Vermillion, Little Sioux/Niobrara, Cheyenne, Bad/Choteau, White, Niobrara, Red and Minnesota River, Heart.

Threats and Issues in South Dakota: None noted.

Recommended Conservation and Research Actions: None.

Policy Recommendations:

- Bag limits: Rossman et al. (1996) pointed out that populations of common gartersnakes were substantially reduced in Manitoba by over-collection for the pet and scientific trade. To assure that populations are not damaged by over-collection, establish a bag limit of two daily, with a maximum possession of four. This is the current bag limit for turtles in South Dakota, and until life table parameters can be defined (reproduction and recruitment) so sustainable harvests can be estimated, these provisional bag limits may also be suitable for *Thamnophis sirtalis*.

Comments: The common gartersnake is one of the two best-studied snakes in the world. Rossman et al. (1996) and Ernst and Ernst (2003) provide extensive discussions of the natural history of common gartersnakes. Massie (unpublished Master's thesis 2010) completed a thesis on post-glacial colonization of South Dakota by the common gartersnake. It is currently under revision for publication.

Reviewers: Douglas Backlund, South Dakota Department of Game, Fish, and Parks (retired); Gary Casper, University of Wisconsin-Milwaukee Field Station

Account author: Brian E. Smith, Department of Biology, Black Hills State University

Literature Cited

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Baxter, G. T., and M. D. Stone. 1985. Amphibians and Reptiles of Wyoming, 2nd ed. Wyoming Game and Fish Department.

Bittner, T. D., R. B. King, J. M. Kerfin, and R. E. Gatten, Jr. 2002. Effects of body size and melanism on the thermal biology of garter snakes (*Thamnophis sirtalis*). Copeia 2002:477-482.

Cavitt, J. F. 2000. Fire and a tallgrass prairie reptile community: Effects of relative abundance and seasonal activity. Journal of Herpetology 34:12-20.

Conant, R., and J. T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 3rd ed. Houghton Mifflin Co., New York.

Dalrymple, G. H., F. S. Bernardino, Jr., T. M. Steiner, and R. J. Nodell. 1991. Patterns of species diversity of snake community assemblages, with data on two Everglades snake assemblages. Copeia 1991:517-521.

Ernst, C. H., and E. M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D. C.

Fitch, H. S. 1992. Methods of sampling snake populations and their relative success. Herpetological Review 23:17-19.

Kiesow, A. M. 2006. Field Guide to Amphibians and Reptiles of South Dakota. South Dakota Department of Game, Fish, and Parks. Pierre, South Dakota.

King, R. B. 1988. Polymorphic populations of the garter snake *Thamnophis sirtalis* near Lake Erie. Herpetologica 44:451-458.

Rossman, D. A., N. B. Ford, and R. A. Siegel. 1996. The Garter Snakes: Evolution and Ecology. University of Oklahoma Press, Norman, Oklahoma.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Wright, A. H., and A. A. Wright. 1957. Handbook of Snakes of the United States and Canada. Comstock Publishing Associates, Ithaca, New York.

South Dakota Distribution Map:

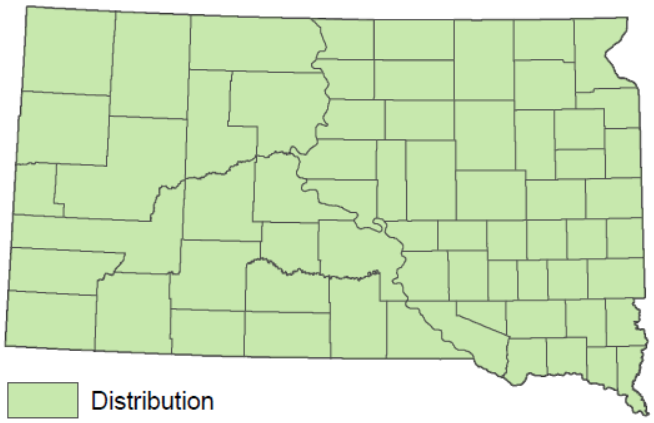


Photo:

Common Gartersnake Dan Fogell

South Dakota Amphibian and Reptile Threats Assessment
Species Profile

Common Name: Lined snake

Scientific Name: *Tropidoclonion lineatum*

Taxonomic Note: None

Description: This small snake has one light mid-dorsal and two lateral stripes on its body, with a double row of bold, black half-moons down the belly (Conant and Collins 1991, Ernst and Ernst 2003, Kiesow 2006).

Population/protection Status:

- IUCN: Least Concern
    - Population trend: Stable
- USFWS: Not listed
- State: This is an Endangered species in South Dakota, and a state endangered species permit is required to collect it.
- Global Rank (NatureServe): G5
- State Rank (NatureServe): S1

Distribution:

- Global: This species has disjunct populations in Illinois, Iowa, Colorado and New Mexico, but somewhat continuous occurrences from South Dakota in the north to south-central Texas in the south (Conant and Collins 1991, Ernst and Ernst 2003).
- South Dakota
    - Historical: Over (1923) and Wright and Wright (1957) reported that this species is restricted to the southeastern corner of South Dakota.
    - Current: Lined snakes are found in the southeastern corner of the state (Kiesow 2006). See map below.

Population Trend: There appears to be no change between the historical and current ranges of lined snakes in South Dakota. However, today much of the landscape within this area is agricultural, and therefore unsuitable habitat for this species. While the overall range of the species within our state may not have changed much with time, agricultural development undoubtedly diminished the size and numbers of populations.

The lined snake reaches the northernmost extent of its entire range in the southeastern corner of South Dakota, and has only been reported from a few locations in Minnehaha, Union, and Lincoln Counties (Backlund 2004, Ballinger et al. 2000, Fogell 2003, Jessen 2003, Jessen 2005). It is secretive and sometimes hard to find, but Tom Jessen (Mankato, Minnesota) did find it abundant at one site northeast of Sioux Falls (Doug Backlund; Retired Wildlife Biologist; South Dakota Department of Game, Fish and Parks; personal communication). Outside South

Dakota it is often common and sometimes locally abundant in suitable habitat (Hammerson 2007). It tolerates and even thrives on moderate habitat alteration, but requires moist situations in which to find earthworms, its principal prey (Ernst and Ernst 2003, Hammerson 2007).

Key Habitat:

- Key Habitat Description: This species occurs in open grasslands and sparsely timbered areas, preferring moist habitat, often living around springs, ponds, marshes, streams, and rivers. It can also be found in disturbed areas such as city lots, parks, cemeteries, and gardens (Conant and Collins 1991, Ernst and Ernst 2003, Dan Fogell, Southeast Community College, Nebraska, personal communication).
- Linkage to Ecosystem Diversity:
    - Ecoregions (South Dakota Department of Game, Fish, and Parks 2006): Tallgrass Subregion.
    - Major Land Resource Areas (United States Department of Agriculture 2006): Till Plains (102B), Loess Uplands (102C).
    - Aquatic Drainage Units (Annis et al. 2010): Big Sioux/Vermillion, Little Sioux/Niobrara.

Threats and Issues in South Dakota:

- Habitat alteration: Because lined snakes thrive in natural as well as moderately altered habitat, principle threats for this species are human activities that severely alter habitat, such as drainage of wetlands and agricultural development.
- Pesticides: It is not known how pesticides affect lined snakes, as exposure to these chemicals has not been tested with this species. However, certain pesticides can have lethal and sub-lethal effects on other reptiles, impacting their survival and fitness through direct and indirect exposure (Pauli et al. 2010). For lined snakes, indirect exposure may come in the form of eating pesticide-contaminated earthworms, its principle food source. Direct exposure may come by being sprayed with pesticides during field application, coming in contact with contaminated soil or plants, or being exposed to drifting pesticides on windy days. The portion of South Dakota where lined snakes reside is heavily agricultural, so the possibility of pesticide exposure for this species is probably rather high.
- Road mortality: Tom Jessen (Mankato, Minnesota) found quite a few roadkill lined snakes near Sioux Falls in late fall (Doug Backlund; Retired Wildlife Biologist; South Dakota Department of Game, Fish and Parks; personal communication)(Jessen 2003). These animals were probably near their suitable hibernation sites, and ventured onto roads. Hibernation may occur singly or in groups, and most hibernate in burrows dug by themselves; however, they may enter animal burrows, rock crevices, compost piles, or rotting logs and stumps (Ernst and Ernst 2003).

Recommended Conservation and Research Actions:

- Continue surveys to identify population locations within the limited range of this species in our state, with emphasis on finding populations and estimating densities in protected areas. This species has been found in a few protected areas, and surveys should focus on others, especially those in Minnehaha, Union, and Lincoln Counties. The best time to survey these snakes is in late September and October on unseasonably warm days. During this time they emerge *en masse* on roads and trails (Dan Fogell, Southeast Community College, Nebraska, personal communication). It would be most useful to develop detection probability based survey methods to allow for presence/absence determinations (Mazerolle et al. 2007).
- Identify specific areas of high road mortality, and design methods to ameliorate such losses. A proven method to mitigate reptile losses is to provide drift fences that lead to culverts, so the animals may safely move under roads (Aresco 2005).
- Maintain buffer zones around agricultural fields where lined snakes are known to occur, especially in roadside ditches. In Nebraska and Kansas such ditches have been shown to be suitable refugia for populations of lined snakes, and while the habitat is more linear in shape rather than large and square like a grassland section, it is still considered significant from a conservation standpoint (Dan Fogell, Southeast Community College, Nebraska, personal communication).
- Offer landowner incentives to maintain grasslands for properties known to contain lined snakes populations. That has worked well for massasauga rattlesnakes in Nebraska (Dan Fogell, Southeast Community College, Nebraska, personal communication).
- As noted above, this species does occur within existing protected areas in South Dakota, so management plans and educational materials regarding lined snakes should be developed for these sites. These include Palisades State Park (Minnehaha County), Beaver Creek Nature Area (Minnehaha County), and Union Grove State Park (Union County) (Fogell 2003, Jessen 2003, Jessen 2005).
- In areas where lined snakes are known to occur, encourage land owners not to use pesticides or to use them in a limited and controlled manner.
- Conduct genetic analyses to determine the distinctiveness of South Dakota populations of this species from those in other parts of its range. As mentioned above, populations in South Dakota are at the northernmost extent of the species' range, which extends southward into southern Texas. In general, peripheral populations, such as those of the lined snake in South Dakota, are more likely to be imperiled than those within the core of the range. This is the case, as they tend to occur in less suitable environments for the species, and are often isolated from more central and continuous populations (Lesica and Allendorf 1995).

  Populations at the edge of a species' range are likely to be genetically different from those in the center due to a number of factors (such as restricted gene flow, small population size, founder effects, and differing selective forces) (Lesica and Allendorf 1995). They are genetically adapted to conditions at the edge of the range, which may vary substantially from those in the core. Conserving peripheral populations helps conserve the wide range of genetic variation within the species as a whole, and thus enhances its ability to adapt to a changing environment. For example, such populations

may be well adapted to shifting the species range in response to climate change (Hunter and Hutchinson 1994). Lesica and Allendorf (1995) argue that the more genetically divergent peripheral populations are from their central populations, the higher the priority should be to conserve them (and that these populations may even be important sites of future speciation events). To investigate the distinctiveness of South Dakota lined snake populations from others within the range of the species, genetic comparisons should be made.

Policy Recommendations: None

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Literature Cited:

Annis, G.M., S.P. Sowa, D.D. Diamond, A. Garringer, and P. Hanberry. 2010. A GAP Analysis for riverine ecosystems of the Missouri River basin. Final report submitted to the USGS National GAP Analysis Program, USGS National GAP Analysis Program.

Aresco, M.J. 2005. Mitigation measures to reduce highway mortality of turtles and other herpetofauna at a north Florida lake. Journal of Wildlife Management 69(2):549-560.

Backlund, D. 2004. South Dakota statewide herpetology survey 2004. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Ballinger, R.E., J.W. Meeker, and M. Thies. 2000. A checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

Conant, R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston.

Ernst, C.H. and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington.

Fogell, D.D. 2003. Amphibian and reptile surveys of southeast South Dakota with an emphasis on the state-endangered lined snake (*Tropidoclonian lineatum*) May 2002 – June 2003. Final Report to the South Dakota Department of Game Fish and Parks, Pierre, South Dakota.

Hammerson, G.A. 2007. *Tropidoclonion lineatum.* In: IUCN 2011. IUCN Red List of Threatened Species. Vesion 2011.2, <www.iucnredlist.org>.

Hunter, M.L. Jr. and A. Hutchinson. 1994. The virtues and shortcomings of parochialism: conserving species that are locally rare, but globally common. Conservation Biology 8(4):1163-1165.

Jessen, T. 2003. A survey of the herpetofauna of the Big Sioux River Valley 2003. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Jessen, T. 2005. Herpetological survey of eastern South Dakota 2005. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Lesica, P. and F.W. Allendorf. 1995. When are peripheral populations valuable for conservation? Conservation Biology 9(4):753-760.

Mazerolle, M. J., L. L. Bailey, W. L. Kendall, J. A. Royle, S. J. Converse, & J. D. Nichols. 2007. Making great leaps forward: accounting for detectability in herpetological field studies. Journal of Herpetology 41(4):672-689.

Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Pauli, B.D., S. Money, and D.W. Sparling. 2010. Ecotoxicology of pesticides in reptiles. Pp. 203-224. In: Sparling, D.W., G. Linder, C.A. Bishop, S.K. Krest. Ecotoxicology of amphibians and reptiles, second edition. CRC Press, Taylor & Francis Group, Boca Raton, Florida.

South Dakota Department of Game, Fish, and Parks. 2006. South Dakota Comprehensive Wildlife Conservation Plan. South Dakota Department of Game, Fish, and Parks, Pierre. Wildlife Division Report 2006-2008.

United States Department of Agriculture. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific basin. United States Department of Agriculture, Natural Resources Conservation Service, United States Department of Agriculture Handbook 296.

Wright, A.H. and A.A. Wright. 1957. Handbook of snakes of the United States and Canada. Comstock Publishing Associates, a division of Cornell University Press, Ithaca, New York.

South Dakota Distribution Map:

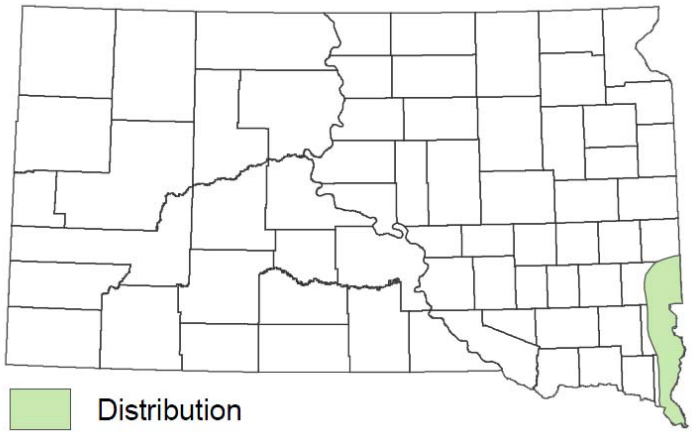

Photo:

Lined Snake Dan Fogell

Brief Overview of State Rules and Regulations Governing the Use of South Dakota Amphibians and Reptiles

Summary

Leopard frogs, tiger salamanders, bullfrogs, and turtles (other than false map turtles) may be collected in South Dakota under the authority of a state fishing license. Daily possession and collection limits apply. With a bait dealers license, commercial activity is permitted with tiger salamanders and leopard frogs, with no limits on take. No commercial activity is permitted with turtles. Of all amphibians and reptiles in South Dakota, false map turtles and eastern hog-nosed snakes are considered state Threatened, and lined snakes Endangered. A state endangered species permit is required to collect animals in these categories (https://gfp.sd.gov/licenses/other-permits/endangered-species-permit.aspx). Therefore, protection or regulation is offered to only 12 of the 46 (26%) species of amphibians and reptiles in the state. There are also regulations governing the health and containment of pet reptiles.

Introduction

Below is a brief overview of state rules and regulations governing the use of South Dakota amphibians and reptiles. Information for the summary was obtained from: 1) various statutes of South Dakota Codified Laws (SDCL) Title 41 (Game, Fish, Parks and Forestry) at http://legis.state.sd.us, 2) the South Dakota 2012 Fishing Handbook (South Dakota Game, Fish & Parks), and 3) State of the Union: Legal Authority Over the Use of Native Amphibians and Reptiles in the United States (Association of Fish & Wildlife Agencies) (http://www.fishwildlife.org/index.php?section=focus-areas,, then click the tab Amphibian and Reptile Conservation, then the tab Amphibian and Reptile Subcommittee Products, then scroll down to the above title and click). The summary is arranged in three sections: 1) Leopard Frogs, Tiger Salamanders, and Bullfrogs, 2) Turtles, and 3) All Other Amphibians and Reptiles. Such an arrangement helped clarify which species are governed by regulations and in what way, and which species are not governed.

Leopard Frogs, Tiger Salamanders, and Bullfrogs

With a fishing license (resident $7 – 34, non-resident $14 – 60, no license required for those under 16 years), an individual can collect all subspecies of leopard frogs and tiger salamanders (scientific names are not provided in the legislation, so leopard frogs could include both *Lithobates pipiens* and *L. blairi*, and tiger salamanders could include both *Ambystoma tigrinum* and *A. mavortium*, thus possibly representing four species). These species are considered legal bait species, and each has a daily collection limit of 24 and a possession limit of 24. Limits do not apply if the animals were purchased from a retail bait dealer. Legal equipment for the noncommercial taking of bait includes seines up to

30 feet long and six feet deep, dip nets up to 30 inches in diameter, lift nets up to four feet square, cast nets up to 24 feet in diameter, and traps no larger than 12 inches in diameter and 36 inches long with rigid entrances no wider than one inch. No equipment for taking bait shall contain mesh larger than 3/8 inch square. South Dakota residents with a valid fishing license may purchase licenses to use hoop nets and traps. There are no reporting requirements for non-commercial use of the above amphibians.

Additionally, bullfrogs may be collected under the authority of a fishing license year-round, with a daily limit of 15 and a possession limit of 30. A person may not take bullfrogs with firearms.

With a bait dealer's license, all subspecies of tiger salamanders and leopard frogs can be sold (exportation of leopard frogs requires approval), either within or out of the state, depending on the type of license obtained. There are no limits on the commercial taking of these species. Bait dealer license types are:

1. Resident Retail Bait Dealer: Allows for *capture*, purchase, selling, and possession. Does not permit sale to wholesale, retail, or export bait dealers. Fee $30.
2. Resident Wholesale Bait Dealer: Allows for the raising, *capturing*, possession, and sale to any retail, wholesale, or export bait dealer within South Dakota or in any adjoining state. Fee $275.
3. Export Bait Dealer: Allows for the purchase and possession within the state and for transport out of the state for resale. Fee $400.
4. Nonresident Retail Bait Dealer: Allows for the purchase, sale, possession, and transport within the state. Does not permit sale of animals to wholesale, retail or export bait dealers. Fee $55.
5. Nonresident Wholesale Bait Dealer: Allows transport and sale of animals within the state to any retail, wholesale or export bait dealers. Fee $550.

Licensed resident wholesale and retail bait dealers are permitted to *capture* bait, and may possess and use regular or bag seines up to 50 feet long and six feet deep and traps larger than 12 inches by 36 inches. No seines, nets, and traps shall contain flexible mesh larger than 3/8 inch square. All traps shall have a rigid entrance no larger than one inch wide and trap throats exposed above the surface of the water shall be blocked by a solid shield or mesh to prevent the entrapment of waterfowl. Special permits for use of larger equipment may be issued by the Department secretary. Restrictions exist on what waters are open to commercially capture bait. Bait dealers must submit a summary of yearly records on forms supplied by the Game, Fish and Parks Department by 31 January of the following calendar year in which their permit was issued.

Turtles

With a fishing license, all seven species of South Dakota turtles except false map turtles may be collected from 1 January to 31 December. There is a daily limit of two turtles of

each species, or a possession limit of four of each species. A person may not buy, sell, barter, or trade any turtles, and snapping turtles may not be exported for any purpose other than personal consumption. False map turtles cannot be collected under the authority of a fishing license, as they are considered a state Threatened species. Turtles may be taken inclusively by line, legal minnow seines, gaff hooks, spears, or by special turtle traps, and may not be shot with a firearm. Turtle traps with mesh less than four inches square shall have an opening at least six inches in diameter leading from it or an entrance opening suspended at or above the water level. Traps shall be clearly marked with their owner's name and address. South Dakota residents with a valid fishing license may purchase licenses to use hoop nets and traps (fee $10).

All Other Amphibians and Reptiles

Most species of South Dakota amphibians and reptiles do not qualify as bait, bullfrogs, or turtles, and have thus been left unprotected and unregulated. The exceptions are those listed as South Dakota Threatened or Endangered. No amphibians are considered in these categories, and only false map turtles and eastern hog-nosed snakes are considered Threatened and lined snakes Endangered. Therefore, protection or regulation is afforded to only 12 of the 46 (26%) species of amphibians and reptiles in the state.

However, within the regulations for commercial bait dealers, it is stated that frogs (species not specified) may not be transported from the state without authorization. Additionally, authorization is required for the importation of nonnative reptiles and amphibians for commerce, culture or introduction in private or public waters. Release of amphibians and reptiles not native to South Dakota into public or private waters within the state is prohibited.

Pet reptiles (SDCL 67:42:03:22), whether kept indoors or outdoors must be in good health, and show no evidence of disease. They must be kept in a covered glass container or tank that is inaccessible to children, and their living quarters must be kept clean. The food supply of pet reptiles must not be accessible to children.

South Dakota does have a scientific collector's permit process. Such licenses may be granted to persons or institutions engaged in scientific research, or to an incorporated society of natural history for scientific or educational purposes. The application process requires information on the species and numbers of animals to be collected, the method of collection, the locations of collection, the collection period, what the purpose or use of the collected specimens will be, the institution for which collections are being made, and final disposition of the specimens collected. The licensee must keep records of specimens collected, dates, locations and dispositions of specimens collected. A report must be completed and submitted to the Game, Fish & Parks Department no later than 31 January following the year in which the scientific collector's license was issued. In addition, work involving state threatened or endangered species must be approved

through a state endangered species permit signed by the Game, Fish and Parks Secretary.

November 2012

Bag Limits for South Dakota Amphibians and Reptiles

The purpose of having bag limits for South Dakota amphibians and reptiles is to assure that populations are not damaged by over-collection for either personal or commercial purposes. Currently, bag limits exist in our state for leopard frogs (24 daily with a maximum possession of 24), tiger salamanders (24 daily with a maximum possession of 24), bullfrogs (15 daily with a maximum possession of 30), and turtles (except false map turtles, which are state Threatened) (2 daily, with a maximum possession of 4).

The frogs and salamanders noted above produce many eggs annually, and their offspring mature relatively quickly, within a year or two. In other words, they have a large intrinsic rate of increase (a high reproductive rate). Species exhibiting such life history traits are said to be r-selected (Elseth and Baumgardner 1981), and can generally withstand (bounce-back from) a reasonable amount of harvest. We can generalize by saying all the amphibians in our state fit into this category. Comparatively, we can generalize by saying South Dakota reptiles do not produce many eggs or offspring annually, and the offspring mature relatively slowly. They have a slow intrinsic rate of increase (a low reproductive rate). Species exhibiting such life history traits are said to be K-selected (Elseth and Baumgardner 1981), and can only withstand a very small amount of harvest (Congden et al. 1993, 1994).

Until life table parameters can be defined so sustainable harvests can be estimated for each of South Dakota's amphibian and reptile species, we suggest the following: Since all our state's amphibians can be generally viewed as r-selected species, we propose that all of the state's amphibians have bag limits of 24 daily with a maximum possession of 24. This applies the existing bag limits for leopard frogs and tiger salamanders to all other amphibians. In a similar vein, since all of our state's reptiles can be generally viewed as K-selected species, we propose that all reptiles have bag limits of two daily, with a maximum possession of four. This applies the existing bag limits for turtles to all other reptiles. State Threatened and Endangered species should not be collected. Exceptions to these rules should be available through the State's scientific collector's permit process.

Literature Cited:

Congdon, J.D., A.E. Dunham, and R.C. van Loben Sels. 1993. Delayed sexual maturity and demographics of Blanding's turtles (*Emydoidea blandingii*): implications for conservation and management of long-lived organisms. Conservation Biology 7:826-833.

Congdon, J.D., A.E. Dunham, and R.C. van Loben Sels. 1994. Demographics of common snapping turtles (*Chelydra serpentina*): Implications for conservation and management of long-lived organisms. American Zoologist 34:397-408.

Elseth, G.D., and K.D. Baumgardner. 1981. Population biology. D. Van Nostrand Company, New York, New York.

November 2012

South Dakota
Herpetological Literature

Compiled by Hugh Quinn and Brian Smith, Department of Biology, Black Hills State University, in partnership with the Dakota Amphibian and Reptile Network (DARN)

Last updated 09 November 2012

Note: Publications included in this list utilized (totally or in part) South Dakota specimens. Additionally included are works which did not utilize specimens, but were focused on South Dakota herpetofauna. Types of documents included are: 1) published research papers appearing in peer-reviewed journals, 2) popular and scientific articles appearing in non peer-reviewed publications, 3) published or unpublished reports to or from governmental agencies, and 4) published or unpublished theses or dissertations. Citations from *Dakota Amphibian and Reptile News* were included if they presented original data or discussed results of herpetological studies in South Dakota. An asterisk (*) indicates an e-copy of the paper has been obtained.

*Anderson, D. L. 1964. A study of the relative growth of the anterior lobe of the pituitary gland in the larvae of *Rana pipiens*. M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (39 leaves).

*Anderson, D. L. 1967. Summer polysaccharide and lipid reserves in *Bufo cognatus*. Thesis, University of South Dakota, Vermillion, South Dakota. (98 leaves).

Anderson, P. 1947. Observations on the denning habits of the prairie rattlesnake, *Crotalus viridis viridis* (Rafinesque). Chicago Academy of Science Natural History Miscellanea No. 9:1-2

Ashton, D. E., and E. M. Dowd. 1991. Fragile legacy: endangered, threatened and rare animals of South Dakota. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Backlund, D. 2000. The lined snake. South Dakota Conservation Digest Oct/Nov. 67(5):22-23.

Backlund, D. 2002. The northern cricket frog. South Dakota Conservation Digest Jan/Feb. 69(1):26-27.

*Backlund, D. 2005. South Dakota statewide herpetology survey 2004. Report to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota 68 pp.

Backlund, D. 2008. Conservation Concerns about South Dakota amphibians and reptiles. Dakota Amphibian and Reptile News 1(1):2.

Bailey and Bailey. 1941. (Title not yet found). Iowa State College Journal of Science 15:172.

Balas, C. J., N. H. Euliss Jr., and D. M. Mushet. 2009. Using occupancy modeling to evaluate the effects conservation programs have on amphibians in the Prairie Pothole Region of the United States. Dakota Amphibian and Reptile News 2(1):5.

*Ballinger, R. E., J. W. Meeker, and M. Thies. 2000. Checklist and distribution maps of the amphibians and reptiles of South Dakota. Transactions of the Nebraska Academy of Sciences 26:29-46.

*Bandas, S. J. 2003. Geographic distribution and morphometrics of South Dakota turtles. M.S. Thesis, South Dakota State University, Brookings, South Dakota. (pp. xiv, 106 leaves), 120 pp.

*Bandas, S. J., and K. F. Higgins. 2004. Field guide to South Dakota turtles. SDCES EC 919. Brookings: South Dakota State University. 36 pp.

*Bandas, S. J. and K. F. Higgins. 2006. Morphometrics of six turtle species from South Dakota. The Prairie Naturalist 38(4):213-222.

*Beauchamp, B. 2007. Herpetofauna survey 2007 Samuel H. Ordway Prairie Preserve McPherson County, South Dakota. Unpublished report to The Nature Conservancy. Minnesota, North Dakota, and South Dakota Chapter, Minneapolis, Minnesota. 5pp.

*Beckwith, M. W. 1930. Mythology of the Oglala Dakota. The Journal of American Folklore 43(170):339-442.

*Bever, G. S. 2005. Variation in the ilium of North American *Bufo* (Lissamphibia: Anura) and its implications for species-level identification of fragmentary anuran fossils. Journal of Vertebrate Paleontology 25(3):548-560.

*Bolek M. G., and J. Janovy Jr. 2007. Evolutionary avenues for, and constraints on, the transmission of frog lung flukes (*Haematoloechus* spp.) in dragonfly second intermediate hosts. The Journal of Parasitology 93(3):593-607.

*Brockman, J., J. Eldridge, J. Shultz, and E. Stewart, 2009. Herpetofauna survey 2009 Samuel H. Ordway Memorial Prairie Preserve McPherson County, SD. Unpublished report to The Nature Conservancy, Minnesota, North Dakota and South Dakota Chapters, Minneapolis, Minnesota. 13 pp.

*Bronikowski, A. M. and S. J. Arnold. 2001. Cytochrome b phylogeny does not match subspecific classification in the western terrestrial garter snake, *Thamnophis elegans*. Copeia 2001(2):508-513.

Brown, J. 2010. Chytrid fungus prevalence and potential impacts on South Dakota amphibians. Dakota Amphibian and Reptile News 3(1):5-6.

*Burdick, S. L. 2008. Blanchard's cricket frog seasonal status and distribution in southeastern South Dakota. M.S. Thesis, University of South Dakota, Vermillion, South Dakota. 35 pp.

*Burdick, S. L. and D. L. Swanson. 2010. Status, distribution and microhabitats of Blanchard's cricket frog *Acris blanchardi* in South Dakota. Herpetological Conservation and Biology 5(1):9-16.

*Burt, C. E., and W. L. Hoyle. 1934. Additional records of the reptiles of the Central Prairie Region of the United States. Transactions of the Kansas Academy of Science 37:193-216.

*Busack, S. D. 1977. Geographic distribution: *Hyla crucifer* (spring peeper). Herpetological Review 8:13.

*Buser, J. B. 1973. Variation in the skink *Eumeces septentrionalis* in eastern South Dakota. Thesis, University of South Dakota, Vermillion, South Dakota. (ii, 35 leaves).

Cabarle, K. C. 2009. DARN open forum. Dakota Amphibian and Reptile News 2(1):4-5.

*Carr, M. T. 2000. Immunocytochemical localization of glutamate receptor subunits in the brain stem and cerebellum of the turtle *Chrysemys picta*. M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 47 leaves).

*Carson, C. N., III. 1996. Diet and olfaction in tiger salamanders, *Ambystoma tigrinum tigrinum* (Green). M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. vi, 76 leaves).

Chace, G. E. 1971. The reptiles of Paha Sapa. Animal Kingdom 8:20-28.

*Chace, G. E. and H. M. Smith. 1968. Two additional examples of Gloyd's linked albinism in the prairie rattlesnake, *Crotalus viridis*. Journal of Herpetology 2(3/4):165-166.

*Chiszar, D., D. Featherman, R. Fuerst, and H. M. Smith. 1994. Observations on the herpetofauna of the Indian Reservations of southwestern South Dakota. Bulletin Chicago Herpetological Society 29:91-94.

Chiszar, D., and H. M. Smith. 1993a. Geographic distribution: *Bufo woodhousii woodhousii*. Herpetological Review 24(4):153.

*Chiszar, D., and H. M. Smith. 1993b. Geographic distribution: *Chrysemys picta bellii*. Herpetological Review 24(4):154.

*Chiszar, D., and H. M. Smith. 1993c. Geographic distribution: *Coluber constrictor flaviventris*. Herpetological Review 24(4):153

*Chiszar, D., and H. M. Smith. 1993d. Geographic distribution: *Pituophis catenifer sayi*. Herpetological Review 24(4):153

*Chrapliwy, P. S., and J. S. Findley. 1956. Records of the central plains spadefoot toad, *Scaphiopus bombifrons* Cope, in South Dakota and Wyoming. Herpetologica 12(2):124.

*Claflin, W. J. 1962. Larval growth and development of *Pseudacris nigrita triseriata* and *Rana pipiens* in semi-permanent ponds in south-eastern South Dakota. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 45 leaves).

*Collins, J. T., D. Backlund, S. L. Collins, and T. W. Taggart. 2005. An herpetofaunal survey of Custer State Park, Custer County, South Dakota. Journal of Kansas Herpetology 15:17-30.

Coues, E. (ed.), M. Lewis, and W. Clark. 1965. The history of the Lewis and Clark expedition. 3 volumes. Dover Publishing Company, Toronto, Ontario. 1364 pp.

*Darrow, T. D. 1961. Food habits of western painted and snapping turtles in southeastern South Dakota and eastern Nebraska. M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 35 leaves).

*Del Fosse, E. S. 1973. Amphibians and reptiles of South Dakota: A manual of identification and species distribution (3rd Revision), Gainesville, Florida. 34 pp.

Dinsmore, S. C. II and D. L. Swanson. 2008. Temporal patterns of tissue glycogen, glucose, and glycogten phosphorylase activity prior to hibernation in freeze-tolerant chorus frogs, *Pseudacris triseriata*. Canadian Journal of Zoology 86:1095-1100.

*Dixon, L. 2009. False map, spiny softshell and smooth softshell turtle nest and nest-site habitat characteristics along the lower stretch of the Missouri National Recreation River in South Dakota. M.S. Thesis, South Dakota State University, Brookings, South Dakota. (pp. xv, 95 leaves), 112 pp.

Dixon, L. A., and C. Dieter. 2008. False map, spiny softshell and smooth softshell turtle nest characteristics along the Missouri National Recreational River, South Dakota. Dakota Amphibian and Reptile News 1(1):6-7.

Dodge, R. I. 1876. The Black Hills. James Miller Publ., New York.

Dowd Stukel, E. 1993. The softshells. South Dakota Conservation Digest 60:20-21.

Dowd Stukel, E. D., and D. C. Backlund. 1997. Animal species monitored by the South Dakota Natural Heritage Program. Prairie Naturalist 29:179-213.

*Doughty, P. 1994. Critical thermal minima of garter snakes (*Thamnophis*) depend on species and body size. Copeia 1994(2):537-540.

*Dunlap, D. G. 1963. The status of the gray treefrog, *Hyla versicolor* in South Dakota. Proceedings of the South Dakota Academy of Science 42:136-139.

*Dunlap, D. G. 1966. Range extensions (*Scaphiophus hammondi*, *Natrix sipedon*, *Emydoidea blandingi*). Copeia 1966(4):894.

Dunlap, D. G. 1967. Selected records of amphibians and reptiles from South Dakota. Proceedings of South Dakota Academy of Science 46:100-106.

Dunlap, D. G. 1968. Critical thermal maximum as a function of temperature of acclimation of two species of hylid frogs. Physiol. Zool. 41:432-439.

*Dunlap, D. G. 1969a. Evidence for a daily rhythm of heat resistance in the cricket frog, *Acris crepitans*. Copeia 1969(4):852-854.

Dunlap, D. G. 1969b. Influence of temperature and duration of acclimation, time of day, sex and body weight on metabolic rates in the hylid frog, *Acris crepitans*. Comparative Biochemistry and Physiology. 31:555-570.

Dunlap, D. G. 1971. Acutely measured metabolic rate-temperature curves in the cricket frog, *Acris crepitans*. Comparative Biochemistry and Physiology. 38A:1-16.

*Dunlap D. G. 1972. Latitudinal effects on metabolic rates in the cricket frog, *Acris crepitans:* acutely measured rates in summer frogs. Biological Bulletin 143(2):332-343.

*Dunlap, D. G. 1973. Latitudinal effects on metabolic rates in the frog, *Acris crepitans*: seasonal comparisons. Biological Bulletin 145(1):103-118.

*Dunlap, D. G. and K. C. Kruse. 1976. Frogs of the *Rana pipiens* complex in the northern and central plains states. Southwestern Naturalist 20(4):559-571.

Dunn, E. R. 1940. The races of *Ambystoma tigrinum*. Copeia 1940(3)154-162.

Dyer, W. G. 1971. Some helminthes of the six-lined lizard, *Cnemidophorus sexlineatus*, in South Dakota. Proc. Helminthol. Soc. Wash., 38:256.

*Edwards, J. 1999. Time course for cryoprotectant synthesis in the freeze-tolerant chorus frog (*Pseudacris triseriata*). M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 25 leaves).

Edwards, J. R., K. L. Koster, and D. L. Swanson. 2000. Time course for cryoprotectant synthesis in the freeze-tolerant chorus frog, *Pseudacris triseriata*. Comparative Biochemistry and Physiology Part A 125:367-375.

*Emerson, D. N. 1967. Preliminary study on seasonal liver lipids and glycogen, and blood sugar levels in the turtle *Graptemys pseudogeographica* (Gray) from South Dakota. Herpetologica 23(1):68-70.

*Ernst, J. A. 2001. Assessment of the *Rana pipiens* complex in southwestern South Dakota. M.S. Thesis, University of Wisconsin, Stevens Point, Wisconsin. (pp. ix, 50 leaves).

Fanslow, D. J. 1960. The relation of oxygen consumption to body weight and starvation in *Rana pipiens* and *Rana catesbeiana*. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 41 leaves).

Fenwick, M. J. 1981. An analysis of spermatogenesis in *Rana pipiens*, *R. blairi*, and their hybrids. M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. ii, 54 leaves).

*Fischer, T. D. 1998. Anura of eastern South Dakota: their distribution and characteristics of their wetland habitats, 1997 – 1998. M.S. Thesis, South Dakota State University, Brookings, South Dakota. 93 pp.

Fischer, T. D., D. C. Backlund, K. F. Higgins, and D. E. Naugle. 1999. Field guide to South Dakota amphibians. SDAES Bulletin 733. South Dakota State University, Brookings, South Dakota. 52 pp.

*Fishbeck, D. W. 1959. The distribution of the amphibians and reptiles of southeastern South Dakota. M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 31 leaves).

Fishbeck, D. W., and J. C. Underhill. 1959. A checklist of the amphibians and reptiles of South Dakota. Proceedings of South Dakota Academy of Science 38:107-113.

*Fishbeck, D. W., and J. C. Underhill. 1960. Amphibians of eastern South Dakota. Herpetologica 16(2):131-136.

*Flowers, M. A. 1994. Feeding ecology and habitat use of juvenile Great Plains toads (*Bufo cognatus*) and Woodhouse's toads (*B. woodhousei*). M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 79 leaves).

*Flowers, M. A., and B.M. Graves. 1995. Prey selectivity and size-specific diet changes in *Bufo cognatus* and *B. woodhousii* during early postmetamorphic ontogeny. Journal of Herpetology 29(4):608-612.

*Fogell, D. D. 2003. Amphibian and reptile surveys of southeastern South Dakota with emphasis on the state-endangered lined snake (*Tropidoclonian lineatum*). Report to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota. 19 pp.

Froiland, S. G. 1990. Natural history of the Black Hills and Badlands. The Center for Western Studies, Augustana College, Sioux Falls, South Dakota. 225 pp.

*Fuerst, G. S., and C. C. Austin. 2004. Population genetic structure of the prairie skink (*Eumeces septentrionalis*): nested clade analysis of post Pleistocene populations. Journal of Herpetology 38(2):257-268.

*Gilliland, L. L. 1986. The effects of oxalic acid on bone development in *Rana pipiens*. M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. iv, 55 leaves).

Gloyd H. K. 1935. Some aberrant color patterns in snakes. Papers Mich. Acad. Sci. Arts Letters 20:661-668.

*Gloyd, H. K. 1946 (1947). Some rattlesnake dens of South Dakota. The Chicago Naturalist 9(4):87-97.

Gloyd, H. K. 1958. Aberrations in the color patterns of some crotalid snakes. Bulletin of the Chicago Academy of Science 10(12):185-195.

Goldberg, S. R., C. R. Bursey, R. G. McKinnell, and I. S. Tan. 2001. Helminths of northern leopard frogs, *Rana pipiens* (Ranidae), from North Dakota and South Dakota. Western North American Naturalist 61:248-251.

Grant, A. B. 2010. Status of northern leopard frog on Fall River Ranger District. Dakota Amphibian and Reptile News 3(1):7.

*Graves, B. M., C. H. Summers, and K. L. Olmstead. 1993. Mediation of aggregation among postmetamorphic *Bufo cognatus*. Journal of Herpetology 27(3):315-319.

Gregor, A. 2009a. Habitat use and movement patterns of smooth shoftshells, *Apelone mutica*, and false map turtles, *Graptemys pseudogeographica*, within the 59-mile segment of the Missouri National Recreational River. Dakota Amphibian and Reptile News 2(1):7.

Gregor, A. 2009b. Habitat use and movement patterns of smooth shoftshells, *Apelone mutica*, and false map turtles, *Graptemys pseudogeographica*, within the 59-mile segment of the Missouri National Recreational River. Dakota Amphibian and Reptile News 2(2):3-4.

Gregor, A., and D. Swanson. 2008. Species composition, age structure, sex rations and abundance of turtles within the 59-mile district of the Missouri National Recreational River. Dakota Amphibian and Reptile News 1(1):9-10.

Gregor, A., and D. Swanson. 2008. Habitat use and movement patterns of smooth softshells, *Apalone mutica*, and false map turtles, *Graptemys psseudogeographica*, within the 59-mile district of the Missouri National Recreational River. Dakota Amphibian and Reptile News 1(2):10-12.

*Grobman, A. B. 1992. Metamerism in the snake *Opheodrys vernalis*, with a description of a new subspecies. Journal of Herpetology 26:175-186.

Grobman, A. G.. 1941. A contribution to the knowledge of variation of *Opheodrys vernalis* (Harlan), with the description of a new subspecies. Miscellaneous Publications of the Museum of Zoology of the University of Michigan 50:1-38.

*Gronke, W. K., S. R. Chipps, S. J. Bandas, and K. F. Higgins. 2006. Reticulate melanism in western painted turtles (*Chrysemys picta bellii*): Exploring linkages with habitat and heating rates. American Midland Naturalist 156(2):289-298.

Hamilton, W. J. Jr. 1950. Food of the prairie rattlesnake (*Crotalus v. viridis* Rafinesque). Herpetologica 6(2):34.

*Hammer, D. A. 1968. Snapping turtle life history on LaCreek Refuge, South Dakota. M.S. Thesis, South Dakota State University, Brookings, South Dakota. (65 pp.).

*Hammer, D. A. 1969. Parameters of a marsh snapping turtle population at Lacreek Refuge, South Dakota. Journal of Wildlife Management 33:995-1005.

*Hammer, D. A. 1972. Ecological relations of waterfowl and snapping turtle populations. Ph.D. Thesis, Utah State University, Logan, Utah. 70 pp.

*Hammer, D. A. (Year not yet found). The durable snapping turtle. (Journal or magazine not yet found) 59-64.

*Hardy, D. G. 1974. Some population dynamics of *Rana pipiens* in an area of southeastern South Dakota. M.A. Thesis, University of South Dakota, Vermillion, South, Dakota. (49 leaves).

*Harris, J. A. 1935. The degree of development of the bull snake embryo at the time of egg laying. M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 11 leaves)

Hayden, F. V. 1862. On the geology and natural history of the upper Missouri. Transactions of the American Philosophical Society 12(1):1-218 (pertinent information regarding milk snake on p. 177)

Hays, T. M., and N. J. Hays. 1999. Inventory of birds, reptiles, and amphibians on The Nature Conservancy preserves and easements in the southern Black Hills. South Dakota Department of Game, Fish and Parks, Wildlife Diversity Report 2003 – 04, Pierre, South Dakota. 16 pp.

*Henrich, T. W. 1965. Morphological evidence of secondary integradation between *Bufo hemiophrys* Cope and *Bufo americanus* Holbrook in eastern South Dakota. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 57 leaves).

*Henrich, T. W. 1968. Morphological evidence of secondary intergradation between *Bufo hemiophrys* Cope and *Bufo americanus* Holbrook in eastern South Dakota. Herpetologica 24(1):1-13.

*Hibma, J. A., and J. C. Hibma. 2001. A preliminary amphibian and reptile survey of Rosebud Sioux Indian Reservation, Todd County, South Dakota. South Dakota Department of Game, Fish and Parks, Wildlife Diversity Report 2003 – 06, Pierre, South Dakota. 6 pp.

*Higgins, S. 2011. Analysis of Urea and Glycerol as Cryoprotectants in the Boreal Chorus Frog (*Pseudacris maculate).* Dakota Amphibian and Reptile Newsletter 4(1):4-5

*Ideker, J. 1968. Secondary intergradation between *Bufo americanus americanus* Holbrook and *Bufo woodhousei woodhousei* Girard in southeastern South Dakota. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 82 leaves).

*Irschick, D. J., and H. B. Shaffer. 1997. The polytypic species revisited: morphological differentiation among tiger salamanders (*Ambystoma tigrinum*) (Amphibia: Caudata). Herpetologica 53(1):30-49.

*James, H. A., and M. J. Ulmer. 1967. New amphibian host records for *Mesocestoides* sp. (Cestoda: Cyclophyllidea). The Journal of Parasitology 53(1):59.

*Jenkins, J. L. 2000. Bioenergetics of freeze-thaw cycles in the chorus frog (*Pseudacris triseriata).* M.S. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. vii, 42 leaves).

Jessen, T. 2002. Blanding's turtle and herpetology survey of northeastern South Dakota. Report to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota. 6 pp.

Jessen, T. 2003. A survey of the herpetogauna of the Big Sioux River Valley 2003. Report to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota 38 pp.

*Jessen, T. 2005. Herpetological Survey of eastern South Dakota 2005 (Species account). Report to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota 44 pp.

*Johnson, V. O. 1935. Anatomy of the digestive and urogenital systems of the horned toad. M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 19 leaves). Note: the author utilized Texas horned lizards collected in Texas.

*Jorgensen, D. K. 1943. The learning of mazes by salamanders. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 58 leaves).

*Kelsey Charles T, III. 1971. Effects of acclimation on the metabolic rates of *Rana pipiens* schreber. M.S. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. iii, 40 leaves).

Kerby, J. 2009. Prevalence of an emerging disease in South Dakota amphibian populations. Dakota Amphibian and Reptile News 2(1):8-9.

*Kerby, J. 2011. The Presence of Chytrid in South Dakota. Dakota Amphibian and Reptile Newsletter 4(1):11-12.

Kiesow, A. M. 2003. The false map turtle. South Dakota Conservation Digest. 70:22-23.

Kiesow, A. M. 2006. Field guide to amphibians and reptiles of South Dakota. South Dakota Deparetment of Game, Fish and Parks, Pierre, South Dakota. 178 pp.

*Kirsch, S. 1983. Ecology of the eastern hognose snake in southeastern South Dakota. M.A. Thesis, Univesity of South Dakota, Vermillion, South Dakota. (pp. ii, 42 leaves)

*Klauber L. M. 1938. Notes from a herpetological diary, I. Copeia 1938:191-197.

*Klauber L. M. 1943. The correlation of variability within and between rattlesnake populations. Copeia 1943(2):115-118.

Klauber, L. M. 1972. Rattlesnakes: their habits, life histories, and influence on mankind. 2nd Ed. 2 Vols. University of California Press 1533 pp.

*Knowles, C. and P. Knowles. 2005. Prairie rattlesnake autumn behavior on black-tailed prairie dog colonies on the Grand River National Grassland. Final report to the South Dakota Department of Game, Fish and Parks, Pierre, SD. 16 pp.

*Kolbe, J. J., B. E. Smith, and D. M. Browning. 2002. A large aggregation of tiger salamanders (*Ambystoma tigrinum melanostictum*) at a black-tailed prairie dog (*Cynomys ludovicianus*) town in southwestern South Dakota. Herpetological Review 33:95-99.

*Kruse, K. C. 1973. Two morphotypes of *Rana pipiens* complex in the central plains states. M.S. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. ii, 34 leaves).

*Kruse, K. C., and D. G. Dunlap. 1976. Albumins and Hybridization in two species of the *Rana pipiens* complex in the north central United States. Copeia 1976(2):394-396.

*Larson, K. L. 1997. Faunal diversity and richness of natural, restored, dam-created and borrow-pit wetlands in the prairie pothole region of eastern South Dakota. M.S. Thesis, South Dakota State University, Brookings, South Dakota. 98 pp.

*Larson, K. L., W. Duffy, E. Johnson, M. F. Donovan, and M. J. Lannoo. 1999. "Paedocannibal" morph barred tiger salamanders (*Ambystoma tigrinum mavortium*) from eastern South Dakota. American Midland Naturalist 141:124-139.

*Loughry, W. J. 1989. Discrimination of snakes by two populations of black-tailed prairie dogs. Journal of Mammalogy 70(3):627-630.

*Lustig, D. G. 1999. Comparison of cortically and subcortically controlled motor systems in the rat and turtle. M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 91 leaves).

*Malaret, L. 1976. The parietal eye: its effect on the behavior of the northern prairie lizard (*Sceloporus undulatus garmani*). Thesis, University of South Dakota, Vermillion, South Dakota. (i, 63 leaves).

*Malaret, L. 1977. The herpetofauna of Lacreek National Wildlife Refuge. Transactions Kansas Academy of Science 80:145-150.

*Malaret, L. 1988. Effect of parietalectomy on the activity of *Sceloporus undulatus garmani* in South Dakota. Transactions of the Kansas Academy of Science 91(3/4):71-82.

*Marr, J. C. 1944. Notes on amphibians and reptiles from the central Untied States. American Midland Naturalist 32(2):478-490.

*Massie, J. L. 2010. Phylogeography of the common garter snake (*Thamnophis sirtalis*) with an emphasis on fine scale genetic and phenotypic variation across South Dakota. M.A. Thesis, Black Hills State University, Spearfish, South Dakota. 44 pp.

Massie, J. B. Blake, and B. Smith. 2008. Garter snakes galore. Dakota Amphibian and Reptile News 1(2):6-7.

Massie, J. L., B. E. Smith, and B. G. Blake. 2009. Reproductive effort of the common garter snake (*Thamnophis sirtalis*) in South Dakota. Dakota Amphibian and Reptile News 2(1):9-10.

Massie, J. L., B. E. Smith, B. G. Blake, and M. Westphal. 2009. Reproductive effort of the common garter snake (*Thamnophis sirtalis*) in South Dakota. Dakota Amphibian and Reptile News 2(2):18.

*Massie, J.L., B. E. Smith, and G. M. Spellman. 2011. Phylogeography of the common garter snake (*Thamnophis sirtalis*) with an emphasis on fine scale genetic variation across South Dakota. Dakota Amphibian and Reptile Newsletter 4(1):4.

*McAllister, J. and B.E. Smith. 2011. Population genetic structure in the tiger salamander (*Ambystoma mavortium*) in the Black Hills of South Dakota. Dakota Amphibian and Reptile Newsletter 4(1):5-6.

McAllister, D. T., and D. B. Conn. 1990. Occurrence of *Mesocestoides* sp. tetrathyridia (Cestodea: Cyclophyllidea) in North American anurans (Amphibia). Journal of Wildlife Diseases 26:540-543.

McCallum, M. L., and S. E. Trauth. 2004. Blanchard's cricket frog in Nebraska and South Dakota. Prairie Naturalist 36:129-135.

*McCurdy C. 1928. Ring-necked pheasant vs. bull snake. The Wilson Bulletin 40(3):202.

*McKinnell, R. G. 1973. The Lucké frog kidney tumor and its herpesvirus. American Zoologist 13(1):97-114.

*Meeks, W. A. 1996. Nongame vertebrate survey of Sand Lake National Wildlife Refuge, Brown County, South Dakota. M.S. Thesis, South Dakota State University, Brookings, South Dakota. 121 pp.

Meeks, W. A., and K. F. Higgins. 1998. Nongame birds, small mammals, herptiles, fishes: Sand Lake National Wildlife Refuge, 1995-1996. SDAES Bulletin 729. Brookings: South Dakota State University. 28 pp.

*Merrell, D. J. 1965. The distribution of the dominant Burnsi gene in the leopard frog, *Rana pipiens*. Evolution 19(1):69-85.

Miller, S. 2008. Amphibian moonwalk. Dakota Amphibian and Reptile News 1(2):7.

*Mjoen, K. L. 1962. Historical study of the skin and parotoid glands in the genus *Bufo*. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 26 leaves).

Mokin, M. V. 2007. Mechanism of synaptic glutamate receptor trafficking during in vitro classical conditioning in turtles. Ph.D. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. xiv, 215 leaves).

*Naugle, D. E., T. D. Fischer, K. F. Higgins, and D. C. Backlund. 2005. Distribution of South Dakota anurans, p. 283-291. In: The status of United States species. M. J. Lannoo (ed.), University of California Press, Berkeley.

*Nelson, D. E. 1965. Histology of the thyroid and neurophypophysis in leopard frog larvae grown under crowded conditions. M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 38 leaves).

*Nickum, J. G. 1961. Intra-specific variation in the chorus frog *Pseudacris nigrita* Le Conte. M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 52 leaves).

*Niebel, D. B. 1979. The effect of workload on taurine synthesis in frog heart. M.A. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. viii, 57 leaves).

Olson, R. D. 2001. Calling survey for the Blanchard's cricket frog (*Acris crepitans blanchardi*) in Tripp County, South Dakota. South Dakota Department of Game, Fish and Parks, Wildlife Diversity Report 2003 – 07, Pierre, South Dakota. 4 pp.

O'Roke, E. C. 1924. The amphibians of South Dakota. Proceedings of the South Dakota Academy of Science 1924. 9:13-15.

*Orton, G. L. 1954. Dimorphism in larval mouthparts in spadefoot toads of the *Scaphiopus hammondi* group. Copeia 1954(2):97-100.

*Over, W. 1923. Amphibians and reptiles of South Dakota. South Dakota Geological and Natural History Survey Series XXIII Bulletin 12:1-34.

Over, W. 1943. Amphibians and reptiles of South Dakota. Natural History Studies No. VI. University of South Dakota. Vermillion, South Dakota. 31 pp.

Patton, F. A. 1926. Our trip to the Eagle's Nest. The Oologist 43:30.

*Penicnak, A. J. 1961. Localization and distribution of motor neurons in the lumbarregion of *Rana pipiens*. M.S. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 33 leaves).

*Peterka, H. E. 1931. A histological comparison of the alimentary canal of the snake and the rat. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 24 leaves).

*Peterson C. R. 1974. A preliminary report on the amphibians and reptiles of the Black Hills of South Dakota and Wyoming. M.S. Thesis, University of Illinois at Urbana-Champaign. 59 pp.

*Platt, S. G. 2004. Herpetological surveys of southwestern South Dakota April – October 2004. Report to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota. 24 pp.

*Platt, S. G., Z. Fast Horse, L. B. J. Williams, S. M. Miller, and T. R. Rainwater. 2005a. Distribution records of amphibians and reptiles in South Dakota. Herpetological Review 36:210-211.

*Platt, S. G., T. R. Rainwater, and S. Miller. 2008a. *Hemidactylus turcicus* (Mediterranean house gecko). Herpetological Review 39(2):238.

*Platt, S. G., J. L. Stover, and E. J. Stover III. 2005b. An additional record of the ornate box turtle from western South Dakota. Prairie Naturalist 37:123-124.

*Platt, S. G., Z. Fast Horse, S. Mannel, C. Comes Killing, and T. R. Rainwater. 2004. A herpetofaunal survey of southwestern South Dakota with emphasis on species of conservation concern. Report to the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota. 40 pp.

*Platt, S. G., Z. Fast Horse, S Mannel, and C. Comes Killing. 2006. A herpetofaunal survey of southwestern South Dakota with an emphasis on species of conservation concern. Journal of Kansas Herpetology 20:10-19.

*Platt. S. G., Z. Fast Horse, W. Cross, S. Mannel, and T. R. Rainwater. 2008b. Winterkill and biomass of the painted turtle in a South Dakota wetland. Prairie Naturalist 40(3/4):65-72.

*Platz J. E. 1989. Speciation within the chorus frog *Pseudacris triseriata*: morphometric and mating call analyses of the boreal and western subspecies. Copeia 1989(3):704-712.

*Platz, J. E., and D. C. Forester. 1988. Geographic variation in mating calls among the four subspecies of the chorus frog: *Pseudacris triseriata* (Wied). Copeia 1988(4):1062-1066.

*Porter, K. R. 1968. Evolutionary status of a relict population of *Bufo hemiophrys* Cope. Evolution 22(3):583-594.

Quinn, H. F. 2008. Looking for something else: how to find short-horned lizards on the prairie. Dakota Amphibian and Reptile News 1(2):3-6.

Quinn, H. F. 2009. My way or the highway: one DARN member's quest to save local turtles. Dakota Amphibian and Reptile News 2(1):15-16.

Quinn, H. F. (ed.). 2009a. 2009 spring sightings: a recap of those welcome signs of spring as reported on the DARN listserv. Dakota Amphibian and Reptile News 2(1):17.

Quinn, H. F. 2009b. Field ecology course at Oglala Lakota College. Dakota Amphibian and Reptile News 2(2):9-10.

Quinn, H. F. 2009c. Drive-through herping at its best: the quick and easy way to find short-horned lizards. Dakota Amphibian and Reptile News 2(2):15-17.

Quinn, H. F. (ed.) 2009d. Dog's best friend isn't a rattlesnake. Dakota Amphibian and Reptile News 2(2):17.

Quinn, H. F. (ed.). 2010. Let's start this issue of DARN the same way we started… with a bullsnake! Dakota Amphibian and Reptile News 3(2):22.

*Quinn, H.F., and A. Higa. 2010. Going the distance: with ornate box turtles, it's farther than you think. Dakota Amphibian and Reptile News 3(2):14-21.

*Quinn, H.R., H.F. Quinn, and A. Higa. 2011. South Dakota ornate box turtle ecology project. Dakota Amphibian and Reptile Newsletter 4(1):12-15.

*Quinn, H.R., and B.E. Smith. 2011. Analyzing South Dakota herpetological literature to identify knowledge gaps. Dakota Amphibian and Reptile Newsletter 4(1):6-7.

Quinn, H. R., B. E. Smith, H. F. Quinn and G. W. Writer. 2009a. Preliminary report on the distribution and status of short-horned lizards (*Phrynosoma hernandesi*) in South Dakota. Dakota Amphibian and Reptile News 2(1):12.

*Quinn, H. R., B. E. Smith, H. F. Quinn, and G. W. Writer. 2009b. Short-horned lizard (*Phrynosoma hernandesi*) survey in south Dakota 2008 – 2009. Report to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota. 28 pp.

Quinn, H. R., B. E. Smith, H. F. Quinn, and G. W. Writer. 2010. Short-horned lizard (*Phrynosoma hernandesi*) survey in South Dakota: 2008-2009. Dakota Amphibian and Reptile News 3(1):11-12.

Reagan, A. B. 1907. Animals, reptiles and amphibians of the Rosebud Indian Reservation, South Dakota. Transactions Kansas Academy of Science 21:163-164.

*Robbins, C. R. 1952. Variation in the greensnake, *Opheodrys vernalis* (Harlan), from the Black Hills, South Dakota. Copeia 1952:191-192.

*Robinson, J. K. 1952, A comparative study of the blood of the bullhead, garter snake and striped gopher. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 36 leaves)

*Rogal, R. F. 1969. Chronic effects of an anestheic on activity in turtles. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. [v] 51 leaves).

*Rogers, J. S. 1973. Protein polymorphism, genic heterozygosity and divergence in the toads *Bufo cognatus* and *B. speciosus*. Copeia 1973(2):322-330.

*Sarver, S. K. , C. M. Anderson, F. Cain and B. Smith. 2007(?). Development of polymorphic microsatellite markers for the smooth green snake *Opheodrys vernalis*. Report to South Dakota Game, Fish and Parks Department, Pierre, South Dakota. 7 pp.

*Schramm, M. A. 1977. Taurine synthesis in dog and frog heart. Ph.D. Dissertation, University of South Dakota, Vermillion, South Dakota. (pp. vii, 90 p.).

*Shaffer, B. H. and M. L. McKnight. 1996. The polytypic species revisited: genetic differentiation and molecular phylogenetics of the tiger salamander *Ambystoma tigrinum* (Amphiaia: Caudata) complex. Evolution 50(1):417-433.

SDNHP (South Dakota Natural Heritage Program). 2006. Rare, threatened, or endangered animals tracked by the Natural Heritage Program homepage. http://www.state.sd.us/gfp/DivisionWildlife/Diversity/RareAnimal.gtm.

Sharps, J. C., and T. A. Benzon. 1984. A compiled list of South Dakota wildlife. South Dakota Department of Game, Fish and Parks. Rapid City, South Dakota. 26 pp.

*Shrode, C. J. 1972. Effect of temperature and dissolved oxygen concentration on the rate of metamorphosis of *Ambystoma tigrinum*. Journal of Herpetology 6(3/4):199-207.

*Skadsen, D. R. 2009. A guide to the plants and animals of Day, Grant, Marshal and Roberts Counties, South Dakota. Report to South Dakota Game, Fish and Parks, Pierre, South Dakota. 117 pp.

*Skinner, A. 1914. *Ambystoma tigrinum* in South Dakota. Copeia 1914(12):3-4.

*Smith, B. E. 2003a. A conservation assessment of the northern leopard frog (*Rana pipiens*) in the Black Hills of South Dakota and Wyoming. Report to the Black Hills National Forest, U. S. Forest Service. 82 pp. http://www.fs.fed.us/r2/blackhills/projects/planning/assessments/leopard_frog.pdf

*Smith, B. E. 2003b. Conservation assessment of the tiger salamander in the Black Hills National Forrest, South Dakota and Wyoming. Report to the Black Hills National Forest, U. S. Forest Service. 67 pp.

Smith, B. E. 2008. Grand River National Grasslands amphibian and reptile survey. Dakota Amphibian and Reptile News 1(2):9.

Smith, B. E., C. Anderson, S. Sarver, F. Cain, and L. Cottingham. 2008. Genetic variation of the smooth green snake in South Dakota. Dakota Amphibian and Reptile News 1(1):3-4.

*Smith, B. E., C. Anderson, S. Sarver, and L. R. Cottingham. 2007. Genetic variation in the smooth green snake, *Opheodrys vernalis*, in South Dakota. Report to South Dakota Department of Game, Fish, and Parks, Pierre, South Dakota. 30 pp.

Smith, B. E., S. K. Ashton, and R. E. Baum. 1998a. Herpetofaunal surveys on the Spearfish-Nemo District, Black Hills National Forest: preliminary report and recommendations, 1998. Report to U.S.D.A. Forest Service, Black Hills National Forest, Spearfish-Nemo District. 27 pp.

Smith, B. E., D. M. Browning, E. Taylor, R. S. Ferguson, and K. Yturralde. 1998b. Herpetofaunal surveys of the Fall River Ranger District, U. S. forest Service, southwestern South Dakota and Badlands National Park. Report to Northern Prairie Wildlife Research Center, U. S. Geological Survey, Biological Resources Division. Jamestown, North Dakota.

*Smith, B. E., L. R. Cottingham, C. R. Peterson, and M. J. Goode. 2005. A herpetofaunal report of the Black Hills, summer 2004. Report to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota. 67 pp.

*Smith, B. E. and C. Dieter. 2006. Ecology of the Black Hills redbelly snake (*Storeria occipitomaculata pahasapae*) with emphasis on food habits. Report to South Dakota Game, Fish and Parks, Pierre, South Dakota. 4 pp.

Smith, B. E., J. J. Kolbe, and R. S. Ferguson. 1998a. A herpetological survey of Wind Cave National Park, South Dakota. Report to Northern Prairie Wildlife Research Center, U. S. Geological Survey, Biological Resources Division. Jamestown, North Dakota.

*Smith B. E., J. L. Massie, and B. G. Blake. 2004. Inventory of reptiles and amphibians at seven National Park Service units in the northern Great Plains from 2002 – 2003. Report to National Park Service, December 31, 2004. 48 pp.

*Smith, B. E., J. L. Massie, and B. G. Blake. 2006. Distribution of the sagebrush lizard, *Sceloporus graciosus*, in the Black Hills of South Dakota. Report submitted to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota. 10 pp.

Smith, B. E., J. L. Massie, and B. G. Blake. 2008. Distribution of the sagebrush lizard, *Sceloporus graciosus*, in the Black Hills of South Dakota. Dakota Amphibian and Reptile News 1(1):7.

Smith, B. E., M. Mazza II, and J. Niles. 2009. Rattlesnake research at Black Hills State University. Dakota Amphibian and Reptile News 2(2):6-8.

Smith, B. E., and H. R. Quinn. 2008. Status of horned lizards (*Phrynosoma hernandesi*) in South Dakota. Dakota Amphibian and Reptile News 1(1):9.

*Smith, B. E., and N. T. Stephens. 2003a. Conservation assessment of the pale milk snake in the Black Hills National Forrest, South Dakota and Wyoming. Report to Black Hills National Forest, U. S. Forest Service. 20 pp.

*Smith, B. E., and N. T. Stephens. 2003b. Conservation assessment for the redbelly snake in the Black Hills National Forrest South Dakota and Wyoming. Report to Black Hills National Forest, National Forrest Service. 21 pp.

Smith, H. M. 1934. American Midland Naturalist 50:434.

*Smith, H. M. 1963a. The identity of the Black Hills population of *Storeria occipitomaculata*, the red-bellied snake. Herpetologica 19:17-21.

*Smith, H. M. 1963b. New distributional records of amphibians and reptiles from South Dakota and Wyoming. Herpetologica 19:147-148.

*Smith, H. M. 1964. The taxonomic status of the Black Hills population of smooth greensnakes. Herpetologica 19:256-261.

Smith, H. M., R. Mixter, and T. Spangler. 1966. The bullfrog and other reptiles and amphibians in western South Dakota. Journal of the Ohio Herpetological Society 5:106-107.

*Smith, P. W., and D. M. Smith. 1952. The relationship of the chorus frogs, *Pseudacris nigrita feriarum* and *Pseudacris n. triseriata*. American Midland Naturalist 48(1):165-180.

Snethen, D. G., K. Hunter, T. Kraft, S. Hunter, and P. Tuttle. 2009. New distribution record for the spiny softshell turtle, *Apalone spinifera hardwegi*, from the White River in Shannon County, South Dakota. Dakota Amphibian and Reptile News 2(2):14.

Snethen, D. G., E. Whirlwind Horse, and A. Whirlwind Horse. 2009. Extension of the known range of the short-horned lizard *Phrynosoma hernandesi* from eastern Shannon County, South Dakota. Dakota Amphibian and Reptile News 2(2):11-12.

*South Dakota Department of Game, Fish and Parks. 2006. South Dakota comprehensive wildlife conservation plan. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota. Wildlife Division Report 2006 – 2008. 213 pp.

*Spong, E. E. 1965. A survey of *Alaria mesocercariae* from amphibians. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 51 leaves).

Stukel, E. D., D. Backlund, D. Ode, C. Schlueter, L. Gigliotti, and C. Mehl. 2006. South Dakota wildlife action plan – the big picture. South Dakota Game, Fish and Parks. 13 April 2009. http://www.sdgfp.info/Wildlife/Diversity/Comp_Plan/planarticle.pdf.

Swanson, D. L. 2008. To freeze or not to freeze: strategies and mechanisms of overwintering in terrestrial anurans in the northern prairie region. Dakota Amphibian and Reptile News 1(1):4-5.

*Swanson, D. L. and S. L. Burdick. 2007. Blanchard's cricket frog seasonal status and distribution in southeastern South Dakota. Report to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota. 14 pp.

*Swanson, D. L., and S. L. Burdick. 2010. Overwintering physiology and hibernacula microclimates of Blanchard's cricket frogs at their northwestern range boundary. Copeia 2010 (2):247-253.

*Swanson, D. L., and B. M. Graves. 1995. Supercooling and freeze intolerance in overwintering juvenile spadefoot toads (*Scaphiopus bombifrons*). Journal of Herpetology 29:280-285.

Swanson, D. L., B. M. Graves, and K. L. Koster. 1996. Freezing tolerance/intolerance and cryoprotectant synthesis in terrestrially overwintering anurans in the Great Plains, USA. Journal of Comparative Physiology B: Biochemical Systemic and Environmental Physiology 166:110-119.

*Tanner, W. W., and R. B. Loomis. 1957. A taxonomic and distributional study of the western sub-species of the milk snake, *Lampropeltis doliata*. Transactions of the Kansas Academy of Science 60(1):12-42.

*Taylor, R. C. 1962, Photoreaction of morphological changes in amphibian skin caused by ultraviolet radiation. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 33, [34] leaves).

Thompson, S. 1976a. Herps from each county. Report to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

Thompson, S. 1976b. Collections of South Dakota amphibians and reptiles. Report to South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

*Thompson, S. 1982. Turtles of South Dakota. South Dakota Conservation Digest 49:12-15.

Thompson, S., and D. Backlund. 1999. South Dakota snakes: A guide to snake identification. South Dakota Department of Game, Fish and Parks, Pierre, South Dakota. 28 pp.

*Timken, R. L. 1963. An ecological survey of vertebrates of two marsh areas in Clay County, South Dakota. M.A. Thesis, University of South Dakota, Vermillion, South Dakota.

*Timken, R. L. 1968a. The distribution and ecology of turtles in South Dakota. Ph.D. Dissertation, University of South Dakota, Vermillion, South Dakota. 144 pp.

*Timken, R. L. 1968b. *Graptemys pseudogeographica* in the Upper Missouri River of the Northcentral United States. Journal of Herpetology 1:76-82.

*Timken, R. L. 1969. Ornate box turtle distribution in South Dakota. Herpetologica 25:70.

*Trapido, H. 1944. The snakes of the genus *Storeria*. American Midland Naturalist 31(1):20.

*Underhill, J. C. 1958. Notes on the toads of eastern South Dakota. Copeia 1958:149-151.

*Underhill, J. C. 1960. Breeding and growth in Woodhouse's toad. Herpetologica 16:237-242.

*Underhill, J. C. 1961. Variation in Woodhouse's toad, *Bufo woodhousei* Girard in South Dakota. Copeia 1961(3):333-336.

*Underhill, J. C. 1962. Intraspecific variation in the Daktoa toad, *Bufo hemiophrys*, from northeastern South Dakota. Herpetologica 17(4): 220-227.

*Van Epps, G. M. 1936. The general histology of the common toad and a description of the gonads of a hermaphroditic specimen. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 20 leaves).

*Van Gorp, D. D. 2001. Changes in the distribution of *Acris crepitans blanchardi* with studies of nesting microhabitat and the possible impact of ultraviolet-B radiation. M.A. Thesis, Drake University. 58 pp.

*Visher, S. S. 1914. The biology of Harding County Northwestern South Dakota. South Dakota Geological Survey Bulletin Number Six 1914. Report of State Geologist for 1913-1914. State Publishing Co., Pierre, South Dakota. 126 pp.

*Wangemann, A. A. 1961. Size relation of *Thamnophis sirtalis sirtalis* in different environmental conditions. Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 34 leaves).

*Wert, K. 2011. Faunal Surveys on the Niobrara Delta. Dakota Amphibian and Reptile Newsletter 4(1):3-4.

Williams, L. B. J., and S. G. Platt. 2004. Geographic distribution: *Opheodrys vernalis blanchardi* (smooth green snake). Herpetological Review 35:192.

Wilmot, R., M. Baker, T. Horton, and K. Meerdink. 2001. Cricket frog survey: Union County, South Dakota. South Dakota Department of Game, Fish and Parks, Wildlife Diversity Report 2003 – 07, Pierre, South Dakota. 42 pp.

Wolff, D. M. 1966. Studies on the nutrition of the frog lung - fluke, *Haematoloechus medioplexus* (Stafford). Thesis, University of South Dakota, Vermillion, South Dakota. (pp. 51 leaves).