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2-12-2020

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Cool, Macy K. and Geluso, Keith, "Range extension for DeKay's Brownsnake (*Storeria dekayi*) in south-central Nebraska" (2020). *Transactions of the Nebraska Academy of Sciences and Affiliated Societies*. 522.

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SHORT COMMUNICATION

Range extension for DeKay's Brownsnake (*Storeria dekayi*) in south-central Nebraska

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Abstract: In Nebraska, DeKay's Brownsnake (*Storeria dekayi*) generally occurs in southeastern parts of the state, where the species was known from 16 counties. Herein, we update the distribution of *S. dekayi* in the state and briefly comment on habitat and abundance from observations in September and October 2018. We documented 7 new county records that extend its distribution in south-central Nebraska. We observed that *S. dekayi* does not only reside in mesic wooded habitats in Nebraska but also occupies open environments, including areas with upland grasslands and row-crop agriculture. DeKay's Brownsnake currently is listed as a species of concern in Nebraska. Our limited data do not support that *S. dekayi* needs protection in Nebraska, as the species occurs over a much larger area of the state than previously known and was the most common species observed along roadways in autumn 2018.

Keywords: abundance, DeKay's Brownsnake, distribution, habitat, Nebraska, *Storeria dekayi*.

DOI: 10.32873/unl.dc.tnas.40.1

DeKay's Brownsnake (*Storeria dekayi*) occurs throughout the eastern half of the United States, extreme southeastern Canada, and eastern parts of Mexico (Christman 1982, Ernst and Ernst 2003). Along the western edge of its distribution in the United States, records are known from extreme northeastern South Dakota, extreme eastern Nebraska, eastern half of Kansas, most of Oklahoma, and eastern half of Texas (Christman 1982, Ernst and Ernst 2003). *Storeria dekayi* inhabits nearly all terrestrial and marshland habitats across its distribution and is especially common along woodland edges (Ernst and Ernst 2003). Throughout its distribution in the United States, *S. dekayi*'s conservation status is considered secure, but in Nebraska its conservation status is considered vulnerable, which indicates a moderate risk of extirpation in the state (Schneider *et al.* 2018). The only other threatened population occurs in the lower Florida Keys (Ernst and Ernst 2003).

In Nebraska, *S. dekayi* generally occurs in extreme southeastern parts of the state, with a few disjunct observations in south-central (Webster County) and north-eastern (Thurston County) parts of the state (Ballinger *et al.* 2010, Fogell 2010). Recently, records also have been reported in Adams and Saline counties in southern parts of the state (Geluso 2012, Schultz and Geluso 2017). Habitats for *S. dekayi* in Nebraska generally include moist woodlands, and often individuals are observed beneath cover

objects such as logs (Ballinger *et al.* 2010, Fogell 2010). Published records show that this species is known from only 16 of Nebraska's 93 counties (Ballinger *et al.* 2010, Fogell 2010, Geluso 2012, Schultz and Geluso 2017). Herein, we report on 7 new county records that extend its distribution in the state and briefly comment on habitat associations and observed abundance in the region based on our new observations.

Most of our records were gathered opportunistically while driving paved and gravel roadways in the late afternoon and early evenings on warm days in September and October 2018. At this time of the year, this species and others commonly are observed moving to hibernacula (Ernst and Ernst 2003, Geluso 2012). In fact, Fogell (2010) states DeKay's Brownsnakes bask in abundance on roadways on warm days in October. At least one individual was retained as a voucher specimen for each county without a prior record. Voucher specimens were deposited in the Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas, and Curtis J. Schmidt verified specimens. For those individuals not too damaged from being salvaged along roadways, we collected tissue samples and deposited them at the Sternberg Museum of Natural History.

We documented new county records in Clay, Fillmore, Kearney, Nuckolls, Seward, Thayer, and York counties

(Appendix, Fig. 1). These observations fill in a large distributional gap between former records in south-central parts of the state as well as extend the distribution for this species slightly westward and northward in the region (Fig. 1). The individual from Kearney County now represents the westernmost record in Nebraska.

Examination of habitats adjacent to localities of occurrences within a 0.25 km radius demonstrates individuals were in areas with a combination habitats, with scattered trees at 82% of sites, upland grasslands at 73% of sites, and center-pivot agriculture at 64% of sites. Our observations do not support that *S. dekayi* only resides in mesic wooded habitats in Nebraska. Instead, our data demonstrate this species also occupies open environments. In other parts of its distribution, DeKay's Brownsnake also occurs in open habitats (Ernst and Ernst 2003).

With regard to observed abundance on roadways in south-central Nebraska, *S. dekayi* was the most abundant species observed on 2 late season trips in 2018. On 18 October 2018, we drove about 70 km in Adams and Kearney counties searching for snakes on roadways. During that search, we observed 4 snakes in Adams County (2 Common Gartersnakes [*Thamnophis sirtalis*], 1 Lined Snake [*Tropidoclonion lineatum*], and 1 *S. dekayi*) and 3 snakes in Kearney County (2 Ring-necked Snakes [*Diadophis punctatus*] and 1 *S. dekayi*). On 19 and 20 October 2018, we drove many roadways in southern Nebraska looking for county records of herpetofauna. In Clay County, we observed 16 *S. dekayi*, 12 *D. punctatus*, 3 *T. sirtalis*, 2 Woodhouse's Toads (*Anaxyrus woodhousii*), and 1 Gophersnake (*Pituophis catenifer*). In Fillmore County, we observed 6 *S. dekayi*, 5 Plains Gartersnakes (*Thamnophis radix*), 5 *A. woodhousii*, and 1 *D. punctatus*. In Furnas County, we observed 1 *T. sirtalis*, 1 North American Racer (*Coluber constrictor*), and 1 Ornate Box Turtle (*Terrapene ornata*). In Harlan County, we observed 2 *P. catenifer* and many small snakes that we did not stop to identify. In Saline County, we observed 5 *S. dekayi* and 1 *T. sirtalis*. In Thayer County, we observed 2 *S. dekayi*, 1 *T. radix*, and 1 Boreal Chorus Frog (*Pseudacris maculata*). In York County, we observed 1 *S. dekayi*. In total for snakes, we observed 32 *S. dekayi*, 15 *D. punctatus*, 7 *T. sirtalis*, 6 *T. radix*, 3 *P. catenifer*, 1 *T. lineatum*, and 1 *C. constrictor* on these 2 trips.

Our new records indicate that *S. dekayi* is present in a larger area of the state than what was known previously (Fig. 1), increasing the total number of counties with observations from 16 to 23. This increase in distribution might reflect an actual change of the species' range or simply represent overlooked populations. Frey (2009)

discussed a method for differentiating between actual increases in distribution (termed "range expansion") and previously undocumented populations (termed "range extension"). She promoted that researchers need to examine records of other species (i.e., background species) that also should be present in the same areas and habitats to indicate historical presence or absence of the species of interest (Frey 2009). If comparable background species have been thoroughly documented and the taxon of interest was not encountered, a range expansion is inferred (Frey 2009). The term "range expansion" is restricted to actual dispersal events and establishments of new populations (Frey 2009). Conversely, if historical sampling efforts were inadequate to document background species, then a "range extension" is inferred (Frey 2009).

Using those methods, absence of records for *S. dekayi* in south-central Nebraska likely is due to lack of prior sampling rather than an actual absence of the species. For example, the Common Gartersnake is an abundant species across the state and was absent from Clay and Fillmore counties (Ballinger *et al.* 2010, Fogell 2010). Other common species of herpetofauna (*D. punctatus* and *T. lineatum*) also are lacking in many of these counties (Ballinger *et al.* 2010, Fogell 2010). Indications of inadequate sampling in the region suggest that *S. dekayi* likely was present in those areas without being detected. Moreover, *S. dekayi* has been described as secretive by Ballinger *et al.* (2010), as they can be difficult to detect. It appears that *S. dekayi* are highly visible in Nebraska when moving to hibernacula during late season warm periods (Fogell 2010, this study) but are harder to detect on the landscape other times of the year. Western distributional limits for *S. dekayi*'s in Kansas, including northern parts of the state, are significantly farther west than the distribution in southern Nebraska. In fact, DeKay's Brownsnakes are absent only from the westernmost fourth of Kansas (Collins *et al.* 2010). Considering those factors, the lack of records for some common species in the region and the seasonal, secretive habits of *S. dekayi* provides the strongest argument for preexisting, undocumented populations in the region. Thus, we infer that our new observations represent a range extension rather than a range expansion.

We cannot exclude, however, the possibility that our data represent an actual distributional shift (i.e., range expansion) for *S. dekayi* in south-central Nebraska. Other groups of vertebrates in Nebraska have expanded distributional ranges in the state (e.g., Benedict *et al.* 2000, Forrester *et al.* 2019). For example, a number of mammals are moving northward, including Eastern Woodrats (*Neotoma*

floridana), Hispid Cotton Rats (*Sigmodon hispidus*), and Nine-banded Armadillos (*Dasypus novemcinctus*), which likely are associated with long-term climatic warming or increases in woodlands (Benedict *et al.* 2000). A number of mammalian species also are expanding westward, mainly species associated with increasing woodlands along rivers and establishment of shelterbelts, hedgerows, and trees associated with towns and homesteads (Benedict *et al.* 2000, Roehrs and Genoways 2004, Serbousek and Geluso 2009, Forrester *et al.* 2019). With *S. dekayi* associated with mesic woodlands in the state (Fogell 2010), afforestation of waterways and other sites in Nebraska might promote expansion or increased abundance for the species. Although a range expansion is possible, we do not have evidence at this time for such a hypothesis.

Recently, *S. dekayi* was listed as a species of concern in Nebraska (Schneider *et al.* 2018), although in the past the species did not have such a designation in the state (Schneider *et al.* 2011). Our limited data suggest this species is more widespread in south-central Nebraska and commonly encountered on warm autumn days. Individuals appear to reside in areas with row-crop agriculture, albeit scattered trees and grassland also generally were present. At this time, we do not find support that *S. dekayi* should afford protection in the state. Further surveys are needed to better delineate the current distribution and to provide baseline data to examine whether *S. dekayi* might be expanding its distribution in the state.

Acknowledgments – We thank T. Labeledz for compiling herpetological records housed at the University of Nebraska State Museum (UNSM), as the museum’s collections are not online at this time. We thank the anonymous reviewers for helpful suggestions on an earlier version of our manuscript. Specimens were collected under a Nebraska Game and Parks Commission, Scientific and Educational Permit No. 617 issued to Keith Geluso. This project was completed as part of the undergraduate Honors Program requirements for M. Cool enrolled in the Herpetology Class at the University of Nebraska at Kearney (UNK) in the fall of 2019. Funding for this research was from the Program of Excellence (POE) to promote Undergraduate Experiential Learning through the UNK Department of Biology.

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Appendix

Localities of occurrence for DeKay's Brownsnake (*Storeria dekayi*) in Nebraska. Previously published records were compiled through queries from the University of Nebraska State Museum (UNSM), the online database VertNet (VertNet.org), and published literature. Understanding the distribution of the two species of *Storeria* in Nebraska (Geluso 2012, Tye *et al.* 2017), we suspect that the five individuals of "*S. dekayi*" from Lincoln County listed on VertNet at the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, most likely represent another species of snake, the Red-bellied Snake (*Storeria occipitomaculata*). Localities of occurrence for our new records of *S. dekayi* documented with voucher specimens and housed at the Sternberg Museum of Natural History (FHSM), Fort Hays State University, Hays, Kansas, also are given below. North American Datum 1983 (NAD 83) was the map datum used for latitude and longitudes for our new records, unless otherwise noted.

Previously Published Records: **Adams Co.:** 6.3 km S, 2.0 km W Holstein (40.4082°N, 98.6747°W; FHSM 16162; Geluso 2012). **Cass Co.:** 4 mi N, 3 mi E Union (UNSM ZM-3239); 0.75 mi N, 1 mi W Union (UNSM ZM-8956). **Douglas Co.:** Dodge Park, Omaha (UNSM ZM-8781); Two Rivers State Park (UNSM ZM-15407). **Gage Co.:** 1 mi N Filley (UNSM ZM-8782). **Jefferson Co.:** 2 mi S Powell (UNSM ZM-15433); 2.5 mi ENE Harbine (UNSM ZM-3388). **Johnson Co.:** 2 mi S, 1 mi E Tecumseh (UNSM ZM-9378). **Lancaster Co.:** 2 mi SW Sprague (UNSM ZM-2381); Hickman (UNSM ZM-8850); Lincoln (UNSM ZM-2382, 2383); Wilderness Park (UNSM ZM-3276, 3277, 3278, 5393, 5394).

Otoe Co.: 0.5 mi S Nebraska City Power Plant (UNSM ZM-15074); Talmage (UNSM ZM-8952). **Pawnee Co.:** 1.5 mi E junction 8 and 99 (UNSM ZM-7273); 1.5 mi N, 3 mi E Burchard (UNSM ZM-3574); 5 mi S, 2.25 mi E Burchard (UNSM ZM-9965); T1N, R12E, Sec. 21 (UNSM ZM-15440). **Richardson Co.:** Indian Cave State Park, 5 mi E Barada (UNSM ZM-6156). **Saline Co.:** 0.5 km N, 2.8 km W Tobias, Road T/74 Road (40.42302°N, 97.36195°W; FHSM 17469; Schultz and Geluso 2017). **Sarpy Co.:** 3 mi N, 1.5 mi W Hwy 6 at Cass Co. line (UNSM ZM-3387); Child's Point (UNSM ZM-2380). **Saunders Co.:** 0.5 mi N, 2 mi E Yutan (UNSM ZM-9836). **Thurston Co.:** 2.2 mi ESE Macy (UNSM ZM-9944). **Washington Co.:** did not locate museum specimen or find locality, originally published in Fogell 2010). **Webster Co.:** 5.5 mi S, 6 mi E Red Cloud (UNSM ZM-15014).

New Records and Observations (This Study): **Adams Co.:** 3.2 km N, 3.0 km E Ayr Post Office (P.O.) (40.46639°N, 98.40348°W; FHSM 17670; represents 2nd record for county). **Clay Co.:** 1.1 km N, 9.7 km W Deweese P.O. (40.36484°N, 98.25279°W; FHSM 17672); 4.0 km N, 7.1 km W Deweese P.O. (40.39116°N, 98.22263°W; FHSM 17673); 2.7 km N, 8.7 km W Deweese P.O. (40.38048°N, 98.24172°W; no voucher retained, observation only). **Fillmore Co.:** 3.0 km S, 6.9 km W Shickley (40.38971°N, 97.80505°W; FHSM 17674); 2.4 km S, 6.9 km W Shickley (40.39392°N, 97.80499°W; FHSM 17675). **Kearney Co.:** 6.3 km S, 0.6 km W Norman (40.42297°N, 98.80017°W; FHSM 17671). **Nuckolls Co.:** 11.0 km N Nelson P.O., Hwy 14 (40.29967°N, 98.06730°W; FHSM 17530). **Seward Co.:** Twin Lakes State Wildlife Area, 3.6 km N, 0.8 km W Pleasant Dale P.O. (40.82462°N, 96.94425°W, WGS84; FHSM 17669). **Thayer Co.:** 2.6 km N, 2.3 km E Davenport P.O. (40.33661°N, 97.78559°W; FHSM 17676). **York Co.:** 2.2 km N, 4.6 km E McCool Junction P.O. (40.76284°N, 97.53946°W; FHSM 17677).

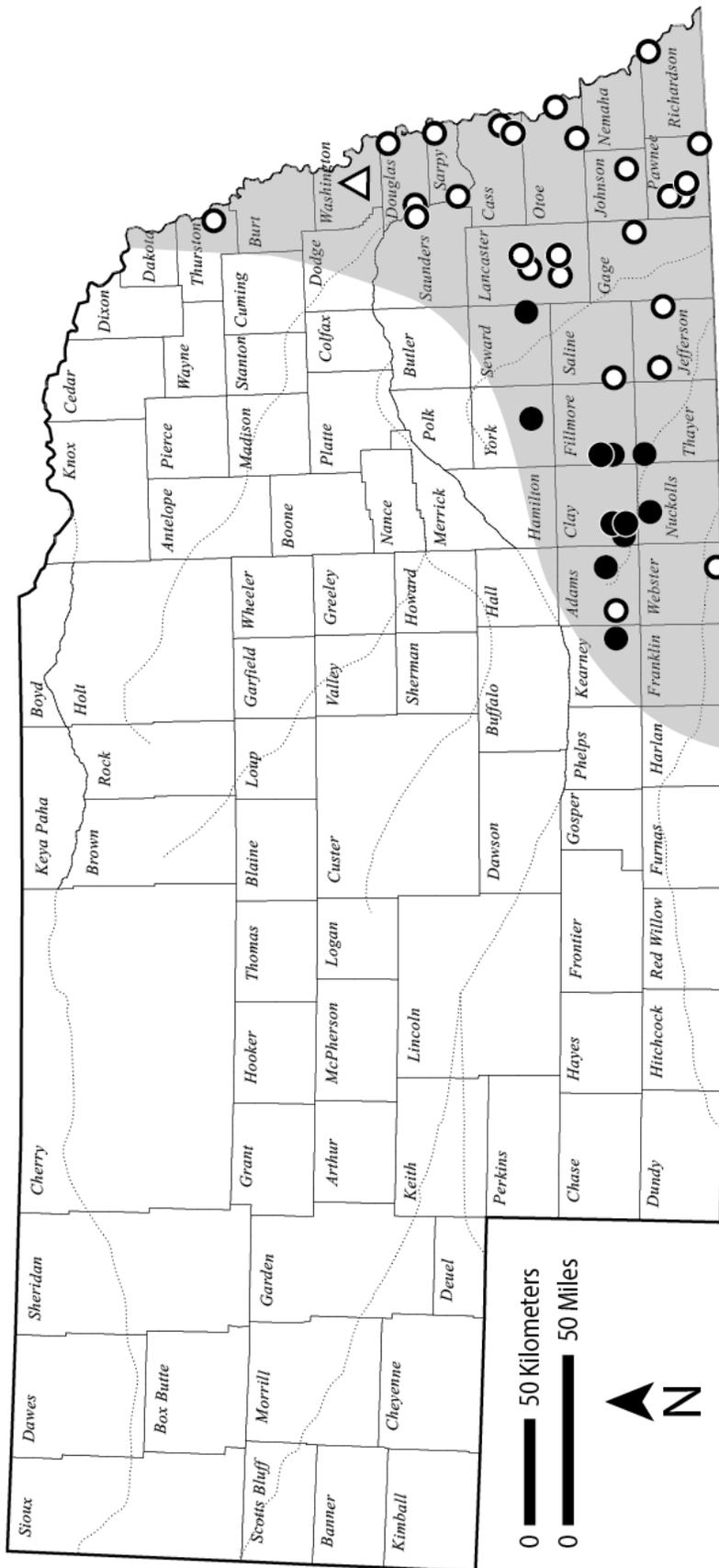


Fig. 1. Distribution of DeKay's Brownsnake (*Storeria dekayi*) in Nebraska. The shaded area represents the suspected distribution based on observations delineated by various symbols shown on this map. Closed circles represent new localities of occurrence reported in this study. Open symbols represent previously published observations obtained from published literature, with circles representing those with known specific localities (see Appendix) and the triangle represents a record without a known specific locality or museum record that we could locate. The record associated with the open triangle originally was published in Fogell (2010). Any new observations of this species documented in counties without records, even in shaded areas, should be formerly documented or published in some manner to continue to learn more about this species.