Associative Behavior and Affinity for Anthropogenic Habitats in Two Relocated Timber Rattlesnakes

Mindy L. Walker[1], Eric D. Kadlec[1], Ryan D. Miloshewski[1], and George R. Pisani[2]

[1]Department of Biology, Rockhurst University, Kansas City, Missouri 64110, USA (Mindy.Walker@Rockhurst.edu)
[2]Kansas Biological Survey and Ecological Reserves (KSB/KSR), Lawrence, Kansas 66044, USA

The Timber Rattlesnake (*Crotalus horridus*) is considered to be a Species In Need of Conservation (SINC) in Kansas (Brown 1993), which affords the animals and their habitat minimal protection where they occur. Populations of this species often exist near human population centers and have perhaps the most interaction with humans among species of *Crotalus* (Walker et al. 2009). In eastern Kansas, which represents the western extent of the species' geographic range (Clark et al. 2007), human populations frequently encroach on aggregation sites (hibernacula and rookeries) of these animals and often overlap with their foraging and breeding routes during the snakes' active season (Fitch 1999, Pisani and Fitch 2006, Fitch and Pisani 2006, Edwards and Spiering 2005). In some western suburbs of Kansas City, populations of *C. horridus* utilize recently developed areas as both transient habitat (*sensu* Brown 1993) and summer range (Walker et al. 2009).

Walker et al. (2009) described movements over a 2-year period of telemetered Timber Rattlesnakes studied as part of a den-relocation effort. In February 2007, the approximately 25-year-old den on the outskirts of Lenexa (Kansas), composed of road rubble capped with ~1 m of dirt fill, was threatened with imminent destruction to permit the development of a large retail center. That study had two major goals: (1) Save this population of snakes, and (2) test a new model of conservation by relocation. Previous studies on smaller numbers of snakes under different relocation protocols had indicated that relocation generally was not a viable conservation method.

A change in the development plan spared the original den site, which remains part of a Lenexa city park. Not all Timber Rattlesnakes utilizing that den had been captured during the original relocation effort, and periodically some snakes caused public alarm by utilizing habitat around homes. On 22

Fig. 1. Male and female Timber Rattlesnakes (*Crotalus horridus*) entangled in landscaping fabric, July 2009 at a private residence in Lenexa, Kansas. These snakes (transmitter frequencies 105, 515, respectively) were subsequently relocated and their movements tracked by radiotelemetry. This photograph was taken by the homeowner.

Table 1. Four Timber Rattlesnakes (*Crotalus horridus*) relocated and discussed in this paper.

Frequency	Sex	Initial Mass (g)	SVL (cm)	Tail Length (cm)	Release Date	Mortality
373	♀ (gravid)	435	82.2	5.5	4 May 2009	Yes*
482	♀ (gravid)	543	85.3	5.5	4 May 2009	No
515	♀ (gravid)	825	99.0	7.0	16 July 2009	No
105	♂	960	97.0	8.7	16 July 2009	No

* Cause unknown.

April 2009, two female Timber Rattlesnakes were captured separately after emergence from the den, equipped with surgically implanted transmitters (radio frequencies 373 and 482) (Reinert and Cundall 1982, Reinert 1992, Hardy and Greene 2000), relocated to the same site as the snakes relocated by Walker et al. (2009), and subsequently tracked. On 6 July, two additional *C. horridus* (a male and a female) were captured together in a homeowner's yard, ~1.2 km from the Lenexa den site, tangled together in landscaping fabric. They were disentangled, implanted with transmitters (radio frequencies 105 and 515, respectively; Fig. 1; Table 1), relocated to the release site of Walker et al. 2009, and tracked. All three females contained enlarged follicles, with four, seven, and eight follicles, respectively. Like other snakes monitored by Walker et al (2009), the two 22-April snakes dispersed in a pattern that reflected initial dispersal and habitat use of snakes released during the main study (Walker et al. 2009; Fig. 2).

The two 6-July snakes, however, exhibited behavior that we perceive as peculiar for the species (Fig. 2). Rather than dispersing from their release site and each other, both stayed within ~300 m of the release site (the relocation-hibernaculum) for the remainder of the season (2½ months), with the exception of a short foray by the male to a site ~825 m straight line distance away for 2½ weeks (29 August through mid-September; Fig. 3). He subsequently returned to the pair's release site near the den and was found next to the female on 19 September. During their time in the prairie near the den, the two often were located together or near one another.

The mating system of *C. horridus* has been described as prolonged mate-search polygyny (Brown 1995), a system in which males out-compete one another in their efforts to find, court, and copulate with spatially dispersed females during a prolonged, late-summer mating season (Duvall et al.

Fig. 2. Aerial view of the release site (¶) and associated habitats (3,648 ft = 1,112 m). Each snake's periodic location (per telemetry) and habitat use (2009 season) is indicated by a different color.

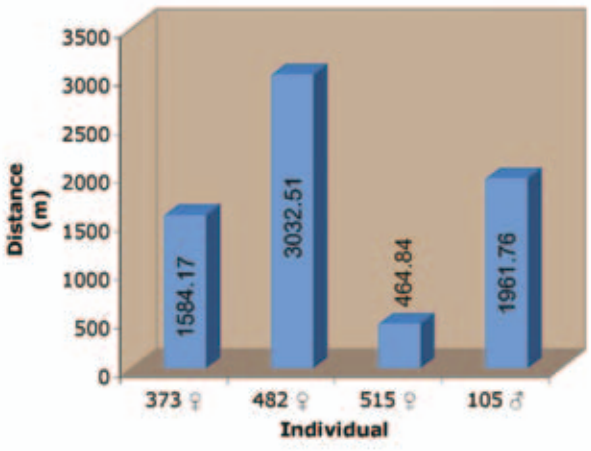

Fig. 3. Maximum dispersal distance (m) traveled by each telemetered individual during the 2009 active season.

1992). The courtship period itself may go on for weeks, and males have been observed accompanying females for up to 15 consecutive days (McGowan and Madison 2008). However, males typically end this courtship period once they have copulated, are displaced by another male, or lose interest in the female (McGowan and Madison 2008). The male in this study was paired with the female upon capture (6 July) and through the active season until both ingressed on 27 September, for a total of six weeks of pairing.

In 2010, following successful hibernation and egress from the relocation-site hibernaculum, the pair diverged. Once separated, both snakes independently exhibited an affinity for anthropogenic structures. The female remained in the yard of a nearby homeowner, and was found beneath the porch of the home multiple times throughout the season; we moved the animal ~100 m in response to homeowner requests, but the snake soon returned. She eventually had to be re-relocated to another population 40 km west in order to placate the homeowner and assure the safety of the snake. The male spent the majority of the season on the grounds of a nearby public facility, then in a different homeowner's yard, and finally in the vicinity of maintenance sheds on private property. He ultimately ingressed at an extensive anthropogenic rock-rubble pile just behind one of the maintenance buildings rather than returning to the relocation-hibernaculum. No other rattlesnakes have been observed or reported from this rubble pile.

This male and female were found ~1.2 km from the individuals collected at the original den site. They might have been part of a different original-den population; not all dens in the Lenexa outskirts have been mapped, and several potential locations exist. This could explain much of their associative behavior, as den mates belong to the same social system, are likely to be more closely related and "familiar" to one another than they are to individuals from another den, and are thought to exhibit kin recognition behavior (Clark 2004). Moreover, the area of the relocation site in which these two jointly spent the first study season (2009) contained abundant rodent trails (Walker, unpubl. data), so prey was likely abundant, making extensive foraging unnecessary. Similarly, prey was plentiful near the manmade structures where each of the two snakes spent the 2010 season (Walker, pers. obs). Specifically, the porch under which the female settled was within a few meters of a bird feeder, and feather rachises were found in snake scat beneath the porch. During one outing we observed a large Copperhead (*Agkistrodon contortrix*) in the same flowerbed within a meter of the female *C. horridus*.

In September 2007, GRP accompanied W.S. Brown to an island in Lake George, New York, on which a *C. horridus* den was located. Two people resident on the island often observed rattlesnakes in their yard, and when GRP asked where, they unhesitatingly replied "under the bird feeders." They had observed that seed dislodged from the several feeders by birds attracted abundant resident chipmunks, and these — perhaps with an occasional bird

— were a rich food resource for the rattlesnakes. Sajdak and Bartz (2004) reported predation by *C. horridus* on a Yellow-bellied Sapsucker (*Sphyrapicus varius*) in a residential yard. Brown (1993) cited observations that additionally indicate the adaptability of *C. horridus* to human presence and activity, although this can frequently result in mortality for the snakes.

Kapfer et al. (2010) indicated the importance of the ratio of suitable to unsuitable habitat in assessing the home-range size of a large snake species. An individual's home range is determined by the area the animal must traverse to successfully meet its energetic needs and encounter suitable potential mates. Presumably, if any individual *C. horridus* — a species that employs a "sit and wait" foraging strategy — could meet its foraging needs within a very small tract, it would have incentive to remain there, especially if it was a female and not driven by mate-seeking behavior. Beaupre (2008) observed behavioral differences of *C. horridus* in prey-rich and prey-poor natural conditions. Additionally, *C. horridus* is potentially long-lived (W.S. Brown, pers. comm.; Fitch and Pisani 2002) and might be capable of rapid associative learning when stimuli have high survival value (see discussion in Abramson and Place 2008).

Taken together and applied to the foraging behavior of female-515 and male-105, these observations suggest that adult *C. horridus* might be behaviorally as well as phenotypically plastic (e.g., Jenkins et al. 2009), and that some individuals might be very tolerant of (or even show affinity for) nearby human activity (Fig. 4) and disturbance if abundant prey are associated with anthropogenic habitats (gardens, buildings, etc.). Unfortunately, this tolerance is seldom extended in reverse. Although a strong affinity for buildings is atypical of Timber Rattlesnakes generally, given their widespread geographic overlap with humans (Brown 1993, Walker et al. 2009), their cryptic and generally secretive nature (Brown 1993, Furman 2007), and the copious numbers of potential prey attracted to various anthropogenic structures, that more snakes from the relocation-hibernaculum did not emulate these two animals and forage similarly near anthropogenic structures is perhaps surprising.

DYLAN LEHRBAUM

Fig. 4. Some Timber Rattlesnakes (*Crotalus horridus*) demonstrate an apparent affinity for anthropogenic habitats. This male was found beneath a construction sign.

Acknowledgements

Jennifer Dorr and Lenexa Animal Control officers initially captured the snakes; Linda Lehrbaum, Cody Van Dyke, and Caitlyn McCall helped with tracking; and two anonymous reviewers made helpful comments that improved this report.

Literature Cited

Abramson, C.I. and A.J. Place. 2008. Learning in rattlesnakes: Issues and analysis, pp. 123–142. In: W.K. Hayes, K.R. Beaman, M.D. Cardwell, and S.P. Bush (eds.), *The Biology of Rattlesnakes*. Loma Linda University Press, Loma Linda, California.

Brown, W.S. 1993. Biology, status, and management of the Timber Rattlesnake (*Crotalus horridus*): A guide for conservation. Society for the Study of Amphibians and Reptiles, *Herpetological Circular* (22):1–78.

Beaupre, S.J. 2008. Annual variation in time-energy allocation by Timber Rattlesnakes (*Crotalus horridus*) in relation to food acquisition, pp. 111–121. In: W.K. Hayes, K.R. Beaman, M.D. Cardwell, and S.P. Bush (eds.), *The Biology of Rattlesnakes*. Loma Linda University Press, Loma Linda, California.

Clark, R.W. 2004. Kin recognition in rattlesnakes. *Proceedings of the Royal Society of London B* (supplement) 271:S243–S245.

Clark, R.W., W.S. Brown, R. Stechert, and K.R. Zamudio. 2007. Integrating individual behavior and landscape genetics: The population structure of Timber Rattlesnake hibernacula. *Molecular Ecology* 16:1–12.

Edwards, J. and D. Spiering. 2005. Timber Rattlesnake work with private landowners in Minnesota, pp. 9–10. In: *Timber Rattlesnake* (Crotalus horridus) *Biology and Conservation in the Upper Mississippi River Valley*. Conference Report, St. Mary's University of Minnesota, Winona.

Fitch, H.S. 1999. *A Kansas Snake Community: Composition and Changes over 50 Years*. Krieger Publishing, Malabar, Florida.

Fitch, H.S. and G.R. Pisani. 2002. Longtime recapture of a Timber Rattlesnake (*Crotalus horridus*) in Kansas. *Journal of Kansas Herpetology* (3):15–16.

Fitch, H.S. and G.R. Pisani. 2006. The Timber Rattlesnake in northeastern Kansas. *Journal of Kansas Herpetology* (19):11–15.

Furman, J. 2007. *Timber Rattlesnakes in Vermont and New York: Biology, History and Fate of an Endangered Species*. University Press of New England, Lebanon, New Hampshire.

Hardy, D.L. and H.W. Greene. 2000. Inhalation anesthesia of rattlesnakes in the field for implantation of transmitters. *Sonoran Herpetology* 13:109–113.

Jenkins, C.L., C.R. Peterson, S.C. Doering, and V.A. Cobb. 2009. Microgeographic variation in reproductive characteristics among Western Rattlesnake (*Crotalus oreganus*) populations. *Copeia* 2009:774–780.

Kapfer, J.M., C.W. Pekar, D.M. Reineke, J.R. Coggins, and R. Hay. 2010. Modeling the relationship between habitat preferences and home-range sizes: A case study on a large mobile colubrid snake from North America. *Journal of Zoology* 282:13–20.

McGowan, E.M. and D.M. Madison. 2008. Timber Rattlesnake (*Crotalus horridus*) mating behavior in southeastern New York: Female defense in a search-based mating system, pp. 419–430. In: W.K. Hayes, K.R. Beaman, M.D. Cardwell, and S.P. Bush (eds.), *The Biology of Rattlesnakes*. Loma Linda University Press, Loma Linda, California.

Pisani, G.R. and H.S. Fitch. 2006. Rapid early growth of Timber Rattlesnakes in northeastern Kansas. *Journal of Kansas Herpetology* (20):19–20.

Reinert, H.K. 1992. Radiotelemetric field studies of pit vipers: Data acquisition and analysis, pp. 185–197. In: J.A. Campbell and E.D. Brodie, Jr., (eds.), *Biology of the Pit Vipers*. Selva Press, Tyler, Texas.

Reinert, H.K. and D. Cundall. 1982. An improved surgical implantation method for radio-tracking snakes. *Copeia* 1982:702–705.

Sajdak, R.A. and A.W. Bartz. 2004. *Crotalus horridus* (Timber Rattlesnake). Arboreality, diet. *Herpetological Review* 35:60–61.

Walker, M.L., J.A. Dorr, R.J. Benjamin, and G.R. Pisani. 2009. Successful relocation of a threatened suburban population of Timber Rattlesnakes (*Crotalus horridus*): Combining snake ecology, politics, and education. *Reptiles and Amphibians* 16:210–222.

This feisty Green Anole is no easy lunch; he struggles to dissuade a predatory Cuban Treefrog with a tenacious bite.