NORTHWESTERN NATURALIST 96:156–160 AUTUMN 2015

USE OF COMMUNAL SHEDDING SITES BY THE NORTHERN PACIFIC RATTLESNAKE (*CROTALUS OREGANUS OREGANUS*) IN CENTRAL WASHINGTON STATE

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Key words: *Crotalus oreganus oreganus*, Grant County, Northern Pacific Rattlesnake, shedding aggregations, Washington State

Ecdysis (shedding of skin) is an important event for a snake. For rattlesnakes, most adults shed only once per year, although some adult males may shed more than once per year (Klauber 1972; Diller and Wallace 1984, 2002; Macartney and others 1990). During this time, feeding and mating opportunities are compromised, snakes are more vulnerable to predators, and they show a narrowed range of tolerance to temperature and humidity (Klauber 1972; Peterson and others 1993). Females may be particularly receptive to mating immediately after shedding, as sex hormones may be released from the skin (Graves and Duvall 1987; Aldridge and Brown 1995) and males may respond to the female shedding cycle by searching for mates (Schuett 1992). Given these ecological, behavioral, and physiological consequences, the decision of where to shed becomes particularly important for a rattlesnake.

Like many northern latitude squamate reptiles, rattlesnakes gather (sometimes in large numbers) and overwinter communally in subsurface rock shelters (hibernacula) to escape potentially lethal winter temperatures (St. John 2002). Northern Pacific Rattlesnakes (*Crotalus oreganus oreganus*) are able to locate hibernacula by recognizing structural qualities that afford thermal protection (Gienger and Beck 2011). Such qualities allow for use by several different age and size classes of *C. o. oreganus* (Gregory 1984). In the spring, adult males may be the first to emerge before perhaps making long-distance movements to foraging and breeding areas (Graves and Duvall 1990). Adult females with developing follicles openly bask, and at this time copulations may take place (Fitch 1970). Young snakes bask side-by-side with each other and adults before leaving to forage. Similarly, during fall ingress, hibernacula afford all individuals protected basking opportunities to fully digest their last meals (Greene 1997). Here we describe both direct and indirect observations of multiple shedding aggregations near a communal hibernaculum of *Crotalus o. oreganus* from a location in central Washington State. We present evidence that, in addition to overwintering hibernacula, shed rocks may comprise an important feature of the social structure of this population of rattlesnakes.

Our study site is in Grant County, approximately 8 km south of George, Washington (elevation: 370 m), and located in the shrub-steppe of the Columbia Basin eco-region. This is a habitat characterized by open, sandy flats with Big Sagebrush (*Artemesia tridentata*), Stiff Sagebrush (*A. rigida*), buckwheat (*Erigonium* spp.), rabbitbrush (*Chrysothamnus* spp.), and Bluebunch Wheatgrass (*Pseudoroegneria spicata*), with small to large basalt rock outcrops scattered throughout the landscape. At the southeastern edge of the site is a large, wetland dominated by Russian Olive (*Elaeagnus angustifolia*), willow (*Salix* spp.), cattail (*Typha* spp.), and a mix of non-native invasive species. We haphazardly searched for snakes and potential shed rocks on an irregular schedule throughout the active season (late March through early October) in 2012 and 2013.

In August and September 2012, we observed multiple *C. o. oreganus* skins at 3 separate basalt outcrops (Table 1). The 1st outcrop was found on 14 August 2012, and was approximately 0.7 km east from the only 2 overwintering dens in this area (Shed Rock 1; Fig. 1A). This outcrop had 5 adult-sized skins along the edges of the rocks or below the largest rock (approximately 1.0 x 0.6 x 0.3 m) in that outcrop. Less than 1 m away from the large rock, 2 adult *C. o. oreganus* (1 male, 1 female) were observed coiled together under a smaller rock. This outcrop was <3 m away from the edge of the wetland area, receiving partial shade from overhanging willow and Russian Olive. At a second, smaller

TABLE 1. Dates, microhabitat types, and behavioral observations for 7 different shed rocks for Northern Pacific Rattlesnakes (*Crotalus oreganus oreganus*) in Grant County, central Washington State.

Shed Rock No.	Date observed	No. new skins	Microhabitat	Observations
1	14 Aug 2012	5	Basalt outcrop in shrub-steppe on edge of wetland	Adult female and male observed under rock together
	29 July 2013	3		
2	14Aug 2012	2	Basalt outcrop in shrub-steppe	
3	2 Sept 2012	4	Basalt outcrop in shrub-steppe	1 gravid, 1 post-partum female, 1 adult male observed
	29 July 2013	3		
	24 Aug 2013	—		2 gravid females (1 telemetered and observed in ecdysis)
4	1 Aug 2013	2	Basalt outcrop in shrub-steppe	
5	1 Aug 2013	4	Basalt outcrop in shrub-steppe	Male and female observed copulating
	10 Aug 2013	—		Gravid female observed
	2 Sept 2013	—		Telemetered adult male observed in ecdysis
6	10 Aug 2013	5	Basalt outcrop in shrub-steppe	
7	2 Sept 2013	5	Basalt outcrop in shrub-steppe on edge of wetland	

outcrop (Shed Rock 2), approximately 60 m north of Shed Rock 1, but away from the wetland edge, we found 2 adult *C. o. oreganus* skins. No snakes were found in the immediate vicinity. The 3rd group of shed skins was found on 2 September 2012 at a large outcrop approximately 0.5 km east of the main den (Shed Rock 3), well away from the wetland area. This outcrop had 4 adult *C. o. oreganus* skins scattered along the east-facing side. Three adult snakes were encountered at this site; 1 adult male, 1 post-partum female, and 1 gravid female. All 3 adults were under rocks separate from each other; no neonates were encountered.

All shed skins were removed from their respective shed rocks in 2012, and we returned in 2013 to see if there was repeated use of these sites (Table 1). On 29 July 2013, we found 4 more shed skins from adult snakes at Shed Rock 1, and 3 adult shed skins among the rocks at Shed Rock 3. Additionally, 2 gravid females (1 telemetered) were found at Shed Rock 3.The telemetered female was observed shedding on 24 August. These females were both found in one of the rock cracks where the gravid female from 2012 (above) had been observed.

We observed 3 more groups of *C. o. oreganus* skins in August, within 40 m of each other and all at basalt outcrops (Table 1). Two aggregations were found on 1 August 2013; Shed Rock 4 had 2 adult snake skins at the entrance of a crack, with no snakes observed, and Shed Rock 5 had 4 adult snake skins bunched up at the entrance of a main rock crack (Fig 1B). Inside the rock crack was a pair of copulating adult *C. o. oreganus* (Fig. 1C). On 10 August 2013, a gravid *C. o. oreganus* (separate individual from 1 August) was found in Shed Rock 5. We also discovered another aggregation (Shed Rock 6) that had 5 adult *C. o. oreganus* skins at the entrance of the rock crack (Fig. 1D). Finally on 2 September 2013, we tracked a telemetered adult male undergoing ecdysis to Shed Rock 5, and we also found another group of 5 shed skins near the edge of the wetland (Shed Rock 7) approximately 40 m southeast of Shed Rock 6.

Communal shedding sites may help rattlesnakes identify the location of secure sites for shedding. All shed rocks were relatively conspicuous basalt outcrops that contained a diversity of thermoregulatory opportunities and places to hide. Microhabitat features of shed

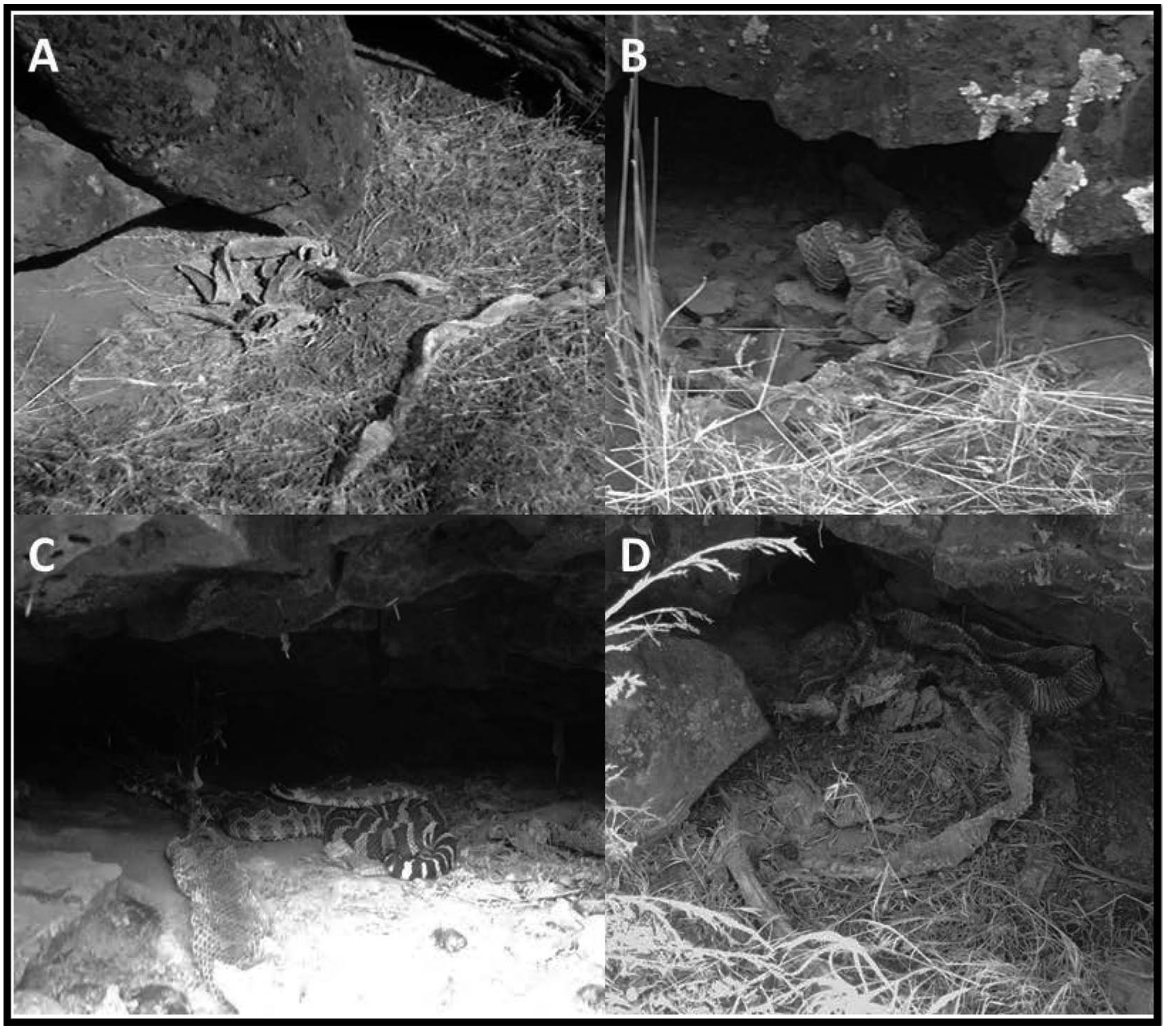

FIGURE 1. Top left (A): a communal shedding area of *Crotalus oreganus oreganus* with 4 adult snake skins in 2012 (Shed Rock 1). Top right (B): a communal shedding area with 4 adult snake skins in 2013 (Shed Rock 5). Bottom left (C): 2 adults copulating at a communal shedding area in 2013 (Shed Rock 5). Bottom right (D): a communal shedding area with 5 adult snake skins in 2013 (Shed Rock 6).

rocks that appeal to individual snakes could be the variety of openings, providing both open basking sites, as well as deeper, more secluded fissures as refugia. These qualities contrast with the surrounding open sagebrush flats, or the dense stands of Russian Olive, willows, and cattails nearby. All shed rocks were within 0.5 to 0.7 km of a communal denning location, and would thus be known by the inhabitants of the den as they traveled in proximity during annual egress and ingress.

Shedding aggregations likely occur not only because there are a limited number of good places to shed, but also may serve an important role in the social structure of the population (Gregory 1984). Shed skins of both males and females were found at the shed rocks, males and females were observed pairing and copulating at the shed rocks, and both gravid and post-partum females were observed (Table 1). Our observations suggest that shed rocks may comprise an important habitat feature of the social structure of this rattlesnake population, in the same way that communal hibernacula play a similar role in the fall and spring. In some cases, individual rattlesnakes may be attracted to previously used shed rocks, perhaps due to a sense of safety (Gregory 1984). Shedding aggregations may also occur in part because females are receptive following shedding, but males also were found to shed at group shed rocks in our study.

Bisexual aggregations of *C. o. oreganus* in the Okanagan Valley of southern British Columbia overlap the period of ecdysis in late summer; males often court and mate within 48 h following ecdysis (Macartney and Gregory 1988). Macartney and others (1990) discuss the timing of ecdysis for males, gravid and non-gravid females, and juveniles. Macartney and Gregory (1988) observed shedding aggregations in *C.* [*oreganus*] *viridis*, but provided few details of the circumstances. In Wyoming, *C. o. concolor* (previously recognized as *C. viridis concolor*) has been observed in communal shedding aggregations (Ashton 1999; Parker and Anderson 2007).

Because of the inherent structural and thermal heterogeneity in a landscape, snakes must be able to recognize environmental cues that indicate where an ideal shedding site may be. These can be abiotic (physical qualities of the landscape) or biotic cues (chemical cues left by conspecifics). Presumably, the latter should be especially important in navigation and decision making, because an individual could benefit by honing in on signals left by conspecifics that are under the same pressures (Valone and Templeton 2002; Clark 2007). Our observations add to additional evidence that rattlesnakes are social creatures (Greene 1994; Clark and others 2012), and that in addition to overwintering in aggregations they may also shed their skins at group shed rocks.

Acknowledgments.—We appreciate the assistance of B Andrews, T Butterfield, and E LaPlatney in the field. Funding assistance was provided by the Central Washington University Office of Graduate Studies. Our research was conducted under IACUC protocol #A091201.

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