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Small mammal activity in south-central Idaho during the 2017 solar eclipse

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Abstract.—We collected quantitative data on small mammal activity during the 2017 solar eclipse at a locality in south-central Idaho, at the center of the path of totality where the eclipse reached totality near midday. The day before the eclipse, temperature and light intensity approached daily maximum values during the 3-h period that would encompass the solar eclipse, and only diurnal squirrels were active during this interval. During the eclipse, changes in temperature and light were similar to those that normally occur before dusk and following dawn. Results suggest that diurnal species may have curtailed their activity during the eclipse, and species with facultative activity responded as they would with the approach of dusk. Despite their numerical dominance, nocturnal species were not detected during the eclipse, perhaps due to the brevity of the event or the stronger influence of endogenous activity cycles.

Resumen.—Recopilamos datos cuantitativos sobre la actividad de pequeños mamíferos durante el eclipse solar de 2017 en una localidad en el centro-sur de Idaho, en el centro del camino de totalidad donde el eclipse alcanzó totalidad cerca del mediodía. El día anterior al eclipse, la temperatura y la intensidad de la luz se acercaron a los valores máximos diarios durante el período de tres horas que abarcaría el eclipse solar, y solo las ardillas diurnas estuvieron activas durante este intervalo. Durante el eclipse, los cambios en la temperatura y la luz fueron similares a los que ocurren normalmente antes del atardecer y después del amanecer. Resultados sugieren que las especies diurnas pueden haber reducido su actividad durante el eclipse, y las especies con actividad facultativa respondieron como lo harían con el enfoque del atardecer. A pesar de su dominio numérico, las especies nocturnas no se detectaron durante el eclipse, quizás debido a la brevedad del evento o la mayor influencia de los ciclos de actividad endógena.

A total solar eclipse is a profound astronomical event that elicits considerable interest among scientists and the public. There are numerous reports on the behavior of animals during solar eclipses. Often, reports are inconclusive, but in many instances, animals respond to solar eclipses as they normally would at the oncoming of dusk, with diminishing activity for species that are diurnal and increasing activity for species that are crepuscular or nocturnal (Wheeler et al. 1935, Dubrovsky and Tytar 2015, Brinley Buckley et al. 2018). Among mammals, there are reports on behavioral observations of captive animals or free-ranging large mammals (Wheeler et al. 1935, Murdin 2001). There are also reports of bats flying during the period of totality and of reduced activity in diurnal squirrels (Wheeler et al. 1935, Sánchez et al. 1999). Beyond these, we have found no published information on behavioral responses of small free-living mammals to a total solar eclipse.

The brevity of totality presents inherent difficulties in measuring the potential behavioral effects of the most profound changes in ambient light and temperature that occur during an eclipse. The season, time of day, weather conditions, and other local factors further influence these changes. During the North American solar eclipse of 21 August 2017, the maximum period of totality along the eclipse path was relatively brief, ranging from approximately 1 min 58 s to 2 min 41 s (Wright 2016). However, the eclipse occurred near midday in late summer, when air temperature and solar illuminance normally are near daily and seasonal maxima. This time period provided favorable conditions for major changes in local air

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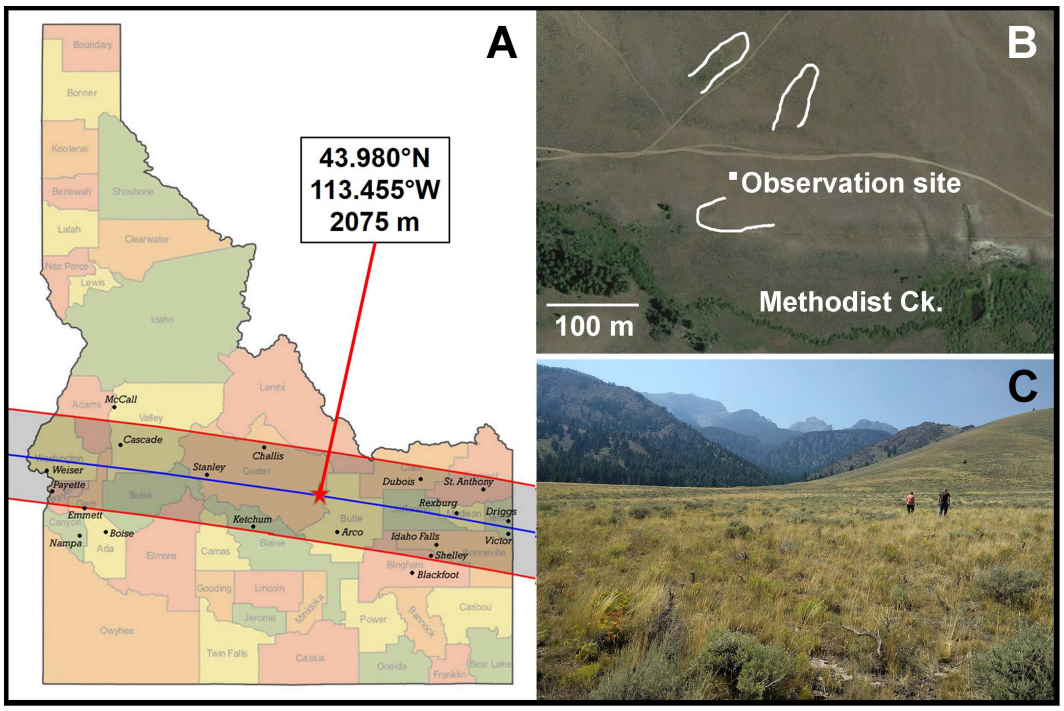

Fig. 1. *A*, Map of Idaho showing the path of totality for the solar eclipse of 21 August 2017, with coordinates of the eclipse observation site in eastern Custer Co., Idaho. *B*, Satellite image of the eclipse observation site north of Methodist Creek with location of adjacent small mammal trap lines. *C*, Habitat near the observation site, dominated by sagebrush, native bunch grasses, and forbs; view WSW toward the upper Methodist Creek drainage, from a position NE of the observation site (photographed 19 August 2017).

temperature and solar illuminance within the zone of totality. Herein, we use standard terminology for the major eclipse events: first contact (start of the first partial phase), second contact (start of the total phase), third contact (end of the total phase), and fourth contact (end of the second partial phase).

In this study, our objective was to gather quantitative data on the activity of regional small mammals before and during the 2017 eclipse, while simultaneously recording changes in light intensity and air temperature. For our study area, we chose the Pass Creek drainage of the Lost River Range in south-central Idaho (Fig. 1A). This site was at the center of the path of totality, where the duration of the eclipse was 2 h 41 min 18 s and the period of totality was 2 min 16 s (Wright 2016; Table 1). This area supported a wide range of microhabitats, including streamside riparian vegetation, aspen (*Populus tremuloides*) woodland, mixed coniferous forest, and open expanses dominated by big sagebrush (*Artemisia tridentata*). Our eclipse observation site was an open area with an unobstructed view of the sky immediately north of Methodist Creek, a tributary to Pass Creek (Fig. 1B). Vegetation surrounding the site included sagebrush, basin wildrye (*Leymus cinereus*), other bunchgrasses, and mixed forbs (Fig. 1C).

We measured solar illuminance (lux) with an AMS TMD4903 color (RGB) sensor with a resolution of 1 lux (ams AG, Premstaetten, Austria), and we measured air temperature (°C) with a Wescor TH-65 digital thermometer (Wescor, Inc., Logan, UT). On the day preceding the eclipse, we gathered control data (lux and air temperature) at hourly intervals from 10:00 to 13:00 MDT to record normal changes in solar illuminance and temperature during the midday period that would encompass the eclipse. On the day of the eclipse, we measured lux and air temperature at 15-min intervals over the same 3-h period, with an additional measurement at 11:32 to span the brief interval of totality (Table 1).

Table 1. Illuminance (lux) and air temperature (°C) measurements, and timing of eclipse events, Pass Creek drainage, Custer County, Idaho.

Date/time (MDT)	lux	°C	Comment
20 Aug 2017			
10:00:00	161723	22.4	
11:00:00	164727	24.8	pre-eclipse
12:00:00	219428	29.5	control
13:00:00	369077	31.0	
21 Aug 2017			
10:00:00	186477	23.8	pre-contact
10:13:51			1st contact
10:15:00	187674	23.3	
10:30:00	175461	24.1	
10:45:00	134417	22.6	partial
11:00:00	93154	21.1	eclipse
11:15:00	40383	17.9	
11:30:00	4	15.3	
11:30:34			2nd contact
11:32:00	<1	14.7	total eclipse
11:32:50			3rd contact
11:45:00	67370	17.2	
12:00:00	126690	*	
12:15:00	*	*	partial
12:30:00	179360	24.2	eclipse
12:45:00	194877	25.4	
12:55:09			4th contact
13:00:00	219173	25.6	post-eclipse

*Not recorded

Before the eclipse (18–19 August), we did general trapping to determine the species composition of the regional small mammal community. We trapped in riparian and forest understory habitat in the Bear Creek drainage, approximately 1 km north of the eclipse observation site, using a mixture of Sherman live traps (H.B. Sherman Traps, Tallahassee, FL) and Museum Special snap traps (Woodstream Corporation, Lititz, PA) for a total of 144 trap-nights. Traps were set in the late afternoon and remained set until midmorning the following day.

On 20 August, we did control trapping in the sagebrush-dominated habitat surrounding our observation site to assess typical small mammal activity during the 3-h midday period. We set 120 Sherman traps in 3 separate traplines of 40 traps, each tended by 1 person (Fig. 1B). Traps were set just before 10:00 and checked at 11:00, 12:00, and 13:00, for a total of 360 trap-hours. We repeated this trapping protocol the following day over the same 3-h interval covering the entirety of the eclipse (Table 1). On 20 August, we released captured animals after the final trap check. We retained animals captured during the eclipse and most of those taken in the Bear Creek drainage as voucher specimens. Vouchers were deposited in the mammal collection of the Natural History Museum of Utah.

Weather conditions were consistently favorable during our study. On both 20 and 21 August, midday skies were cloud-free, but there was substantial atmospheric haze due to smoke from regional wildfires. On 20 August, temperature and solar illuminance increased across the 3-h measurement period (Table 1). On 21 August, starting values for both variables were slightly higher. Maximum illuminance, measured at 10:15 just after the start of the eclipse, was 187674 lux; maximum air temperature (24.1 °C) occurred 15 min later. At totality, solar illuminance was <1 lux, and air temperature reached a minimum of 14.7 °C, a drop of 9.4 °C and approximately 12 °C lower than at the same time of day on 20 August.

We documented 9 species of small mammals (rodents and shrews) across different habitat types in the study region (Table 2). Trapping in riparian and forest-floor habitats yielded 6 species, one of which (*Peromyscus maniculatus*) was numerically dominant (59 out of 77 individuals, 77%).

At the eclipse observation site, control trapping on 20 August yielded 2 *Tamias minimus*, captured between 11:00 and 12:00, and between 12:00 and 13:00. On 21 August we caught 1 *T. minimus* (UMNH:Mamm:42244) and 1 *Lemmiscus curtatus* (UMNH:Mamm:42245) between 10:00 and 11:00. This period included an interval (<15 min) before first contact (start of the eclipse) and a portion of the initial partial phase of the eclipse (>45 min), during which solar illuminance dropped nearly 50% from the maximum at first contact and ambient temperature fell by 2 °C (Table 1). We captured a second *L. curtatus* (UMNH:Mamm:42246) and 1 *Microtus montanus* (UMNH:Mamm:42247) between 11:00 and 12:00 as solar illuminance and temperature continued to drop to minimal values at totality and then commenced to rise during the second partial phase (Table 1). There were no captures during the third hour of trapping that included the final partial phase of the eclipse.

Changes in ambient light and temperature that we recorded during the eclipse were comparable to those documented elsewhere along the path of totality (Vernier 2017). They were qualitatively similar to changes in solar

TABLE 2. Numbers of small mammals trapped at localities in the Pass Creek drainage, Custer Co., Idaho. Species are categorized by their primary period of diel activity: D (diurnal), N (nocturnal), G (generalist, day or night), and SF (seasonally facultative). Habitats at the trapping sites include R (riparian), F (forest understory), and S (open sagebrush).

Species	Activity	Habitat(s)	Regional 18–19 Aug	Control 20 Aug	Eclipse 21 Aug
Sorex monticolus	G	R	1		
Sorex palustris	G	R	4		
Tamias amoenus	D	F, R	6		
Tamias minimus	D	S		2	1
Peromyscus maniculatus	N	F, R	59		
Lemmiscus curtatus	SF	S			2
Microtus longicaudus	SF	F, R	6		
Microtus montanus	SF	S			1
Zapus princeps	SF	R	1		
Effort (trap-nights)			144		
Effort (trap-hours)				360	360
Total captures			77	2	4

illuminance and temperature that normally occur before dusk and following dawn. Comparative trapping over the 3-h midday period the day before the eclipse and the day of the eclipse yielded few captures. However, the midday capture of *M. montanus* and *L. curatatus* during the eclipse is noteworthy. Diel activity of these voles is facultative; both species may be active at any time of day, depending upon the season and weather conditions (Carroll and Genoways 1980, Sera and Early 2003). In *M. montanus*, activity is predominantly nocturnal/crepuscular during summer and diurnal during winter; this seasonal shift is cued by changes in photoperiod and is an adaptation to avoid the most stressful environmental conditions of both seasonal extremes (Rowsemitt et al. 1982, Claypool 1984). During a cloudless summer day, we would expect the 2 vole species to avoid midday conditions and to have strictly nocturnal/crepuscular activity. As such, activity during the eclipse resembled normal crepuscular activity.

Although we did not conduct overnight trapping at the eclipse site, deer mice are generally among the most abundant small mammal species found in sagebrush-dominated habitat (Nichols et al. 1975, Handley 1999, Holmes and Robinson 2016), and given their overwhelming abundance in nearby habitat they were undoubtedly present at the site. Unlike voles, deer mice are strictly nocturnal/crepuscular (Marten 1973, Handley 1999), with activity principally governed by endogenous rhythms rather than immediate environmental cues (Falls 1968). While the changes in ambient light and temperature during totality were profound, we surmise that they were too brief to have elicited a behavioral response in deer mice.

In future attempts to study the effects of a solar eclipse on small mammal behavior, we suggest using methods to facilitate data collection and increase sample size; for example, these studies could use crowdsourced data collected by using a standardized protocol at multiple points along the eclipse path, and could employ remote sensing technology to monitor the behavior of multiple individuals of many species with temporal precision (see Brinley Buckley et al. 2018).

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