MARK HAZEL

Most *Lampropeltis pyromelana* activity occurred under cloud cover or topographic shade. For such a strikingly colored animal, *L. pyromelana* can be surprisingly cryptic.

The Sonoran Mountain Kingsnake (*Lampropeltis pyromelana*) in the Great Basin

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Photographs by the authors unless otherwise indicated.

The Great Basin is North America's largest desert, spanning an area of 190,000 square miles. Located in the rain shadow of the Sierra Nevada, the region is arid, mountainous, and cold, with most precipitation falling as snow. Climate varies dramatically, and higher elevations are cooler and wetter than lower elevations. Such climactic variability produces vegetative complexity. Plant communities from valley floor to mountain peak include salt desert, sagebrush, piñon and juniper, mountain mahogany, mixed conifer, riparian, and alpine vegetation. As the most remote region of the contiguous United States, only three cities in the Great Basin have populations over 100,000. These cities, Salt Lake, Reno, and Provo are located on the region's eastern and western fringes. Due to the vast area, vegetative and topographic complexity, and extreme remoteness, Great Basin reptilian communities have historically received little attention (but see Linsdale 1940, Tanner 1941, Hirth et al. 1969, Parker and Brown 1974a, 1974b, Brown and Parker 1982, Setser et al. 2002).

Voucher specimens are sparsely distributed throughout the Great Basin and entire mountain ranges and valleys lack collection data. As a consequence, reptilian distributions, natural history and ecology are poorly understood. This is especially true of secretive species such as the Sonoran Mountain Kingsnake (*Lampropeltis pyromelana*).

Reptilian distributions, natural history, and ecology are poorly understood for many species in the Great Basin. This is especially true of secretive species such as the Sonoran Mountain Kingsnake (*Lampropeltis pyromelana*).

First documented from the central Great Basin in eastern Nevada in 1932 (Linsdale 1940), *L. pyromelana* has since been considered rare due to the low frequency of observations, isolated populations, and the location of Nevada on the extreme northwestern limit of the species' distribution (see Stebbins 2003 and Hubbs 2004 for distribution information). Fewer than ten museum specimens are known from Nevada, and relatively little ecological information on its status has accrued since its first documentation in the state.

Great Basin populations are isolated on mesic mountain ranges separated by xeric valleys. These montane habitats are relicts of cooler and wetter Pleistocene climates, which allowed the expansion of woodlands and forests across Great Basin valleys. Populations expanded under these favorable conditions. As climates became warmer and drier during the Holocene, suitable habitat contracted, isolating *L. pyromelana* to its present mountain chain distribution (Grayson 1993; Tanner and Cox 1981).

Research needs for *L. pyromelana* in Nevada include basic natural history information such as distribution, abundance, and habitat requirements. The Nevada Department of Wildlife and Great Basin National Park surveyed cooperatively to address these data gaps. The primary objectives of these surveys were to document the natural history and ecology of Great Basin reptilian communities, with a particular focus on *L. pyromelana.*

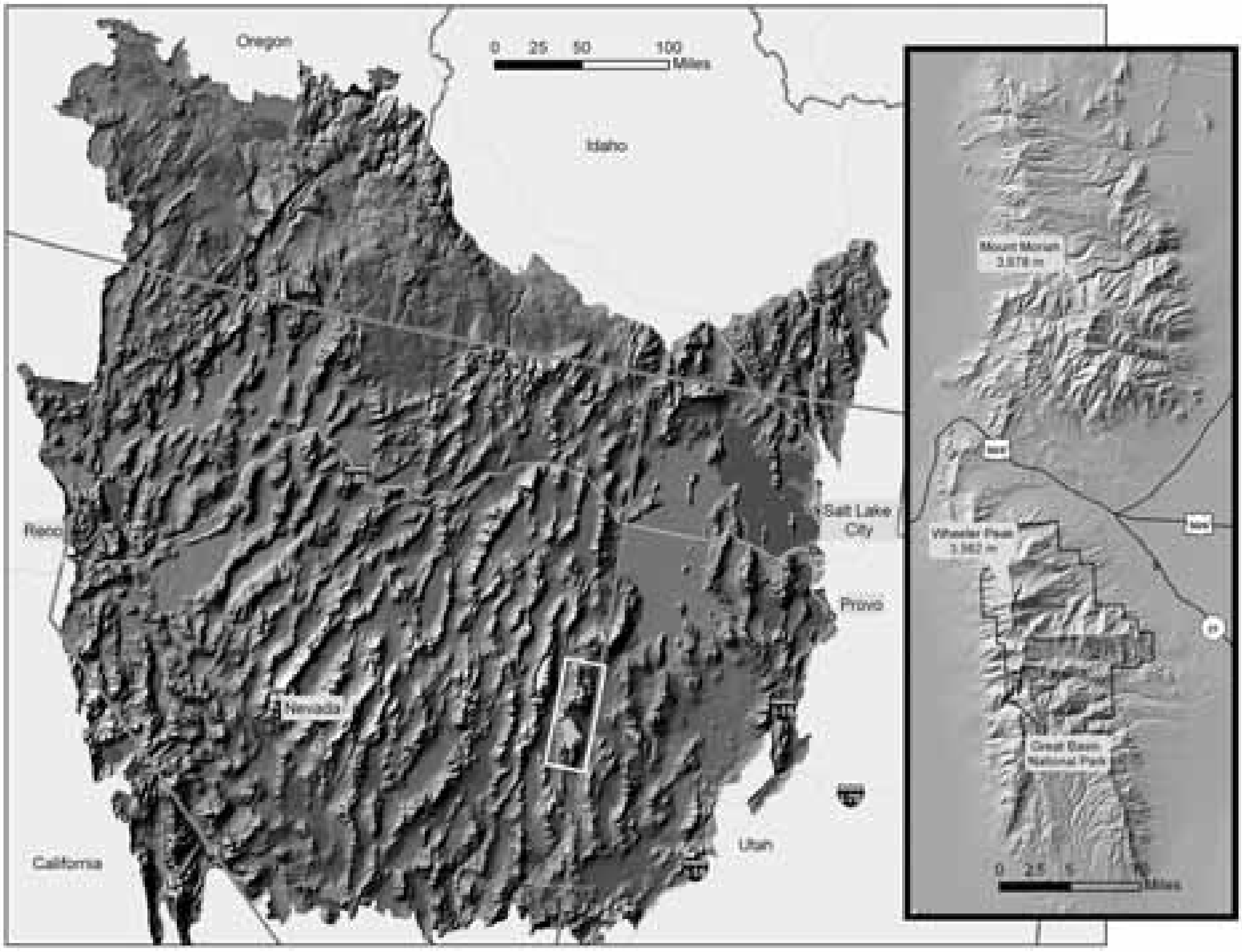
Methods

Study Site

The Snake Range is the largest mountain range in the central Great Basin. Located in eastern Nevada, the southern portion of the range is encompassed by Great Basin National Park (GRBA). Elevations range from 1,585 m in Snake Valley to 3,982 m at the summit of Wheeler Peak. The park is mountainous and dissected by multiple deep canyons. Snowmelt-fed perennial streams support a diverse assemblage of plant and animal communities, resulting in ideal habitat for *L. pyromelana.*

Surveys

Surveys occurred in May of 2006 and 2007. Surveyors included a diverse mix of professional biologists and volunteers, includ-



The Great Basin, Snake Range, and Great Basin National Park. The study site encompassed the entire Snake Range and included Great Basin National Park. The boundary of the Great Basin is defined biologically by contiguous sagebrush plant communities (Grayson 1993).

ing personnel from the National Park Service, Nevada Department of Wildlife, Southern Nevada Water Authority, Brigham Young University, Utah State University, Utah Herpetological Society, and U.S. Geological Survey.

To maximize reptilian encounters and increase the probability of encountering *L. pyromelana,* we used nonrandom, targeted surveys, which are superior to randomized methods in documenting secretive or rare species and maximizing species richness (Campbell and Christman 1982, Persons and Nowak 2007). Survey protocols followed the Visual Encounter Surveys of Scott (1994), and survey sites were exhaustively searched on the surface and under cover objects. To further maximize the likelihood of *L. pyromelana* encounters, survey locations were chosen based on historic localities, anecdotal reports, and sight records. Habitats surveyed included canyons, riparian areas, rocky uplands, and talus.

Reptilian Diversity

Search effort, weather conditions, survey location, and reptilian observations were documented. To permanently document reptilian diversity, a single physical voucher specimen of each reptilian species per location was collected and preserved according to Simmons (2002). For *L. pyromelana*, photographs and tissues rather than physical specimens were collected.

Lampropeltis pyromelana

Activity

To document the seasonal activity pattern of *L. pyromelana* in the Great Basin, we compiled vouchers, observations, and anecdotal reports from the range of the subspecies *L. p. infralabialis* (Tanner 1953), an area that includes Nevada, Utah, and northern Arizona. Data were taken from museum searches, anecdotal reports, and sight records from the period of 1932–2007 and included observations from these surveys.

Natural History

Each *Lampropeltis pyromelana* was photographed, measured, weighed, sexed via probing, and uniquely marked by ventral scale clipping (Brown and Parker 1976). Location, ambient temperature, and substrate temperature were recorded and a tissue sample collected. Habitat characteristics such as geomorphology, surface water, vegetation, elevation, and substrate were recorded at capture sites. All *L. pyromelana* were subsequently released at their exact capture site.

Results

Reptilian Diversity

We surveyed six localities during May of 2006 and 2007. Search effort over both years totaled 424 person hours. A total of 366 individuals of 12 species were observed in the course of the surveys and 59 voucher specimens were collected.

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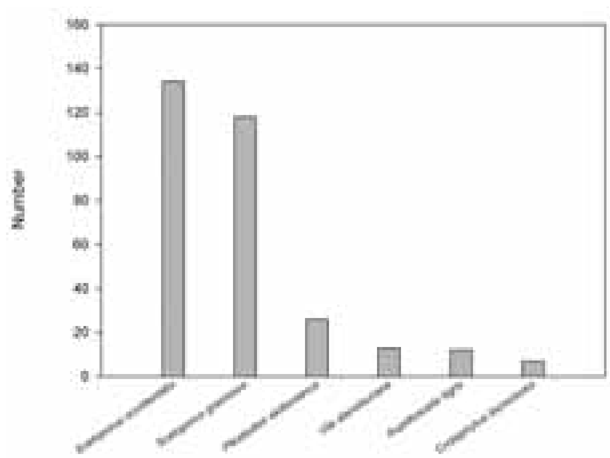
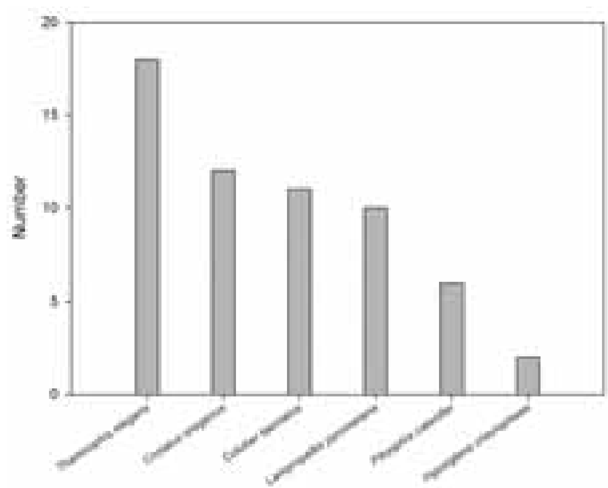
Most *Lampropeltis pyromelana* surface activity occurred at relatively low ambient temperatures, high humidity, and under cloud cover.



Lizard diversity for Visual Encounter Surveys in the Snake Range during 2006 and 2007.



Snake diversity for Visual Encounter Surveys in the Snake Range during 2006 and 2007.

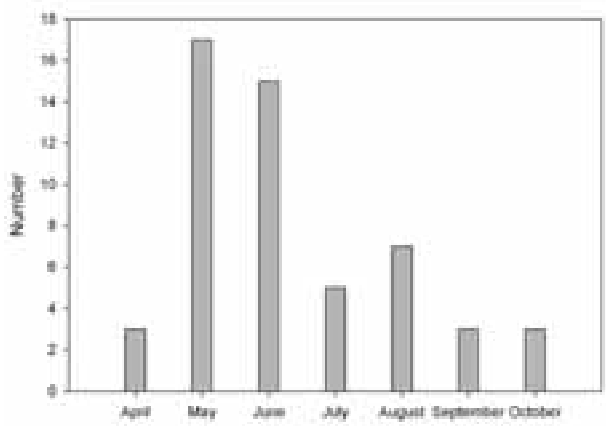
Lizard diversity exhibited a typical right-skewed pattern with two abundant species (*Sceloporus occidentalis* and *S. graciosus*), an intermediately abundant species (*Plestiodon skiltonianus*), and three rare species (*Uta stansburiana*, *Aspidoscelis tigris*, *Crotaphytus bicinctores*).

Snake diversity was more uniform. One species (*Thamnophis elegans*) was abundant, four (*Crotalus oreganus*, *Coluber taeniatus*, *Lampropeltis pyromelana*, *Pituophis catenifer*) were of intermediate abundance, and one (*Hypsiglena chlorophaea*) was rare.

Lampropeltis pyromelana

Activity

Fifty-three *L. pyromelana* voucher specimens and observations were tallied, which included 10 from this project. Activity occurred from April through October, peaked during May and June, and rose again slightly in August. These results suggest that the optimal survey window for *L. pyromelana* surface activity in the Great Basin is during May and June, a typical activity pattern for reptiles in the Great Basin (Fautin 1946, Shelford 1963), and a pattern partially explained by regional climate. In the Great Basin, most precipitation falls during the winter as snow (Trimble 1989). Spring snowmelt increases available soil moisture and plant production peaks in the spring, concurrent with weather conditions favorable for reptilian surface activity. As available soil moisture is depleted in the early summer, plant production ceases and little precipitation is available to replenish soil moisture. During the summer, diurnal weather conditions are also generally too hot and dry for reptilian surface activity until the arrival of monsoonal moisture, which brings cooler temperatures in August. We suggest the August activity spike is due to the influence of a summer monsoon rain regime.



Monthly observations of *Lampropeltis pyromelana infralabialis.* Data are from voucher specimens and sight records from Nevada, Utah, and Northern Arizona from 1932 to 2007 and include data from the present surveys.

Natural History

Ten *L. pyromelana* were documented during our surveys, nine males and one female, which suggested a male-biased sex ratio; (χ^2 = 3.8, d.f. = 1, p = 0.051). Male-biased sex ratios are commonly observed in snake populations due to sampling bias, detectability differences, differential sex ratios at birth, and differential survival (Burger and Zappalorti 1988, Iverson 1990, Madsen and Shine 1992, Shine and Bull 1977). Male *L. pyromelana* may be more detectable than females due to more frequent movements and surface activity while searching for mates or due to earlier emergence from hibernation than females. Alternatively, survival of *L. pyromelana* may be higher in males than females due to higher costs associated with reproduction in females.

Mean SVL was 64.8 cm and mean mass was 96.6 grams (N = 10), sizes within the range reported by Stebbins (2003) and Hubbs (2004).

Our surveys confirmed a relationship between *L. pyromelana* surface activity and weather (Hubbs 2004). Activity was observed at relatively low ambient temperatures (mean = 22.4 °C, N = 10), high humidity (mean = 19.4%), and high cloud cover (mean = 39%). Cloud cover seemed to be a key variable associated with surface activity. Cloud cover filters direct sunlight, lowers substrate temperatures, and is associated with higher humidity. Although four *L. pyromelana* were observed under conditions of zero cloud cover, all snakes were shielded from direct sunlight by topographic shade. Searching for *L. pyromelana* in shaded canyons in the morning or evening is a search strategy often employed successfully in Arizona (R. Legere, pers. comm.). Topographic shade mimics cloud cover by lowering substrate temperature and providing favorable thermal conditions for surface activity.

Lampropeltis pyromelana habitat in the Snake Range varied from open sagebrush shrubland to piñon/juniper woodland. Habitats were generally close to perennial riparian vegetation and had high cover in the form of rocks or vegetation.

Lampropeltis pyromelana was observed at intermediate elevations (mean = 6,354 ft), in the lower reaches of canyons, and utilized three major habitat types: piñon/juniper woodland, riparian, and mixed sagebrush shrubland. No specific plant species or combination of species was noted that would serve as an indicator of suitable *L. pyromelana* habitat.

Although not measured, the availability of cover, either in the form of vegetation, litter, or rocks appeared to be an important habitat component. *Lampropeltis pyromelana* is only occasionally active on the surface due to its elongate body shape, high surface-to-volume ratio, and thin, porous skin. High cover and abundant refugia facilitate the semi-fossorial habits of *L. pyromelana* and provide suitable subsurface environmental conditions.

Lampropeltis pyromelana was generally found close to perennial water (mean distance =186 m) in association with riparian vegetation. One locality lacked surface water and riparian vegetation, but was characterized by more mesic upland vegetation such as Skunkbrush (*Rhus trilobata)* and Squaw Apple *(Peraphyllum ramosissimum)*. Surface water often is considered an important component of the *L. pyromelana* habitat template (Ernst and Ernst 2003). However, many ectotherms are capable of completing their life cycle with minimal access to surface water provided that enough cover is present to provide access to suitable subsurface environmental conditions and food is relatively high in water content (Congdon et al. 1982, Gans 1979, Greene 1997, Karasov and Martinez del Rio 2007, Meyer 1966, Pianka and Vitt 2003, Pough 1980, Rubio 1998, Schmidt-Nielsen 1991). Our observations of two *L. pyromelana* at a location lacking surface water suggest that, while surface water is not a requirement for Nevada *L. pyromelana*, it is an important component of their habitat, as the other eight individuals were observed in close proximity to streams. We suggest that riparian vegetation provides the link between *L. pyromelana* and water. *Lampropeltis pyromelana* was generally found in close proximity to riparian vegetation. Riparian vegetation provides cover, moderates microclimate, and is more productive than uplands in providing a greater prey base (lizards and small mammals). Although the exact details of the relationship between *L. pyromelana* and riparian areas remain unclear, a combination or interaction between factors such as surface water, prey base, cover, and microclimate are almost certainly responsible.

Conclusion

Prior to these surveys, fewer than ten *L. pyromelana* were documented from Nevada. These surveys doubled that number, documented natural history and ecology of the species, and further documented reptilian diversity through collection of voucher specimens. Partnerships facilitated these results. The partnership between Nevada Department of Wildlife and Great Basin National Park was critical in this effort, as were the efforts of the academic, professional, and amateur herpetologists who provided the bulk of the observations and data.

Although this is the largest dataset on Nevada *L. pyromelana*, it is quite limited (10 observations over a two-year period). *Lampropeltis pyromelana* is a sensitive species in Great Basin National Park, a species of conservation priority in Nevada's Wildlife Actions Plan, and is protected from collection in

Cooperative surveys by Great Basin National Park and NDOW brought together a diverse mix of surveyors from volunteers to academic and agency biologists. These cooperative efforts doubled the available information on *Lampropeltis pyromelana* in Nevada.

Nevada. Further surveys will be conducted. With continued data and voucher collection, the resolution of our understanding of reptilian communities in the Great Basin continues to improve. For more information on surveying, please contact the authors.

Acknowledgements

Surveyors who provided much of the data for this work: Aaron Ambose, Gretchen Baker, JoAnn Blalack, Rosaleen Conrad, Neal Darby, Alan De Quieroz, Brian Eagar, Jenny Hamilton, Mandy Harmon, Stephanie Harris, Mark Hazel, Meg Horner, John Hurst, RayJean Layland, Neil Marchington, Nichole Marchington, Dan Mulcahy, Erika Nowak, Ryan O'Donnell, Ben Roberts, Travis Smith, Harry Sweet, Dave Syzdek, Shawn Thomas, Ryan Thomas, Fran Thompson, Jen Ward, Becky Williams, and Jason Williams.

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