Influence of Domestic Livestock Grazing on American Pika (*Ochotona princeps*) Haypiling Behavior in the Eastern Sierra Nevada and Great Basin

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*Running head:* Livestock Grazing and Pika Status
Abstract

In a pilot study, I observed a relationship between domestic livestock grazing and location of American pika (*Ochotona princeps*) haypiles in the eastern Sierra Nevada and several Great Basin mountain ranges. Where vegetation communities adjacent to talus bases (forefields) were grazed, mean distance from talus borders to closest fresh haypiles was 30.1 m (SD = 18.9 m, n = 27), and haypiles were found only high in the talus. In ungrazed forefields, mean distance was 1.8 m (SD = 0.9 m, n = 57), and haypiles were found along the low-elevation talus/vegetation border. Where grazing was active, haypiles consistently comprised vegetation gathered from plants growing within the talus. These appeared to be of lower diversity and species of lower nutritional value than forefield plants, a situation that, if true, would compromise quality of forage for summer browsing and for winter haypile storage. This, combined with potentially less favorable summer and winter thermal conditions of upper talus locations relative to lower talus borders, suggests that grazing might be a factor compromising population conditions and status for pikas. Recent studies have observed higher population extirpation of pikas in Great Basin ranges (primarily NV) than in adjacent regions. Because domestic livestock grazing is widely permitted on public lands throughout pika habitat in the Great Basin, but not permitted (or much less) in pika habitat of the Sierra Nevada, CA, grazing effects might be contributing to observed regional differences in viability of pikas.

**Key Words:** *Ochotona princeps*, American pika, domestic livestock grazing, haypiles, Great Basin, Sierra Nevada

American pikas (*Ochotona princeps*) are small montane mammals related to rabbits (order Lagomorpha) and widely distributed across mountains of western North American (Smith and
They are non-hibernating, favor talus and other rocky habitats, defend solitary territories, and exhibit classic meta-population dynamics (Smith and Gilpin 1997). Poor thermoregulation and low lethal maximum temperatures (Smith and Weston 1990, Kosaka et al. 1999, Yang 1990) have prompted concern for vulnerability of pikas to climate change, and they have been repeatedly petitioned for endangered species listing despite contradictory evidence regarding species status. Resurveys of early 20th-century locations (Beever 2002, Beever et al. 2003, 2008, 2010, in press, Moritz et al. 2008) and surveys of existing populations (Hafner 1994, Simpson 2009, Millar and Westfall 2010, Rodhouse et al. 2010) indicate variability in the current geographic and elevational distribution of pikas relative to their historic range. In ranges with extensive habitat, such as the Sierra Nevada, Cascades Mountains, and Rocky Mountains, pikas persist across wide elevation bands, exploiting diverse talus landforms, and saturating available habitat. Populations in Great Basin mountain ranges, by contrast, appear to have higher extirpation rates, lower abundances, and higher percentages of unoccupied habitat (Beever et al. 2003, 2008, in press, Millar and Westfall 2010).

Attribution of these differences remains uncertain, and several hypotheses have been proposed to explain the status of pikas in the Great Basin. On the one hand, multivariate analyses indicate climatic change, expressed through chronic summer warming and/or acute winter cold stress, are dominantly influencing observed declines in the Great Basin (Beever et al. 2003, 2010, in press; Rodhouse et al. 2010, Wilkening et al. 2010). Alternately, island biogeographic considerations could explain these patterns. Habitat within Great Basin ranges is scattered and disjunct, and mountain ranges are isolated, greatly restricting dispersal within and especially between ranges. This situation, coupled with the metapopulation behavior exhibited by pikas, predicts lower levels of habitat occupancy within ranges, and lower levels of recolonization.
across ranges for regions like the Great Basin relative to extensive cordillera (Smith 1974b, Hafner and Sullivan 1995, Gorrell et al. 2005, Millar and Westfall 2010). Both climatic and island biogeographic hypotheses are supported by paleoecological evidence from the Great Basin, which documents extirpations of pikas from ranges without recolonization during the Holocene and shows that extirpations correlate with low elevations and warm temperatures (Hafner 1993, Grayson 2005).

Given questions about vulnerability of pikas to changing climates, focus on Great Basin populations is important. I offer preliminary observations to suggest another factor that might influence the status of pikas in Great Basin ranges: Grazing by domestic livestock on vegetation communities adjacent to pika talus bases (forefields) can remove preferred forage, driving pikas to poor-quality habitat high in talus fields, and thereby impacting their population health. A difference in range-management policies exists between the primary public agency units that administer pika habitat in this region, and thus a grazing effect, if present, could be pervasive through much of the Great Basin mountain regions. In Nevada and a small portion of California, a significant extent of pika habitat is administered by the USDA Forest Service (USFS, Humboldt Toiyabe National Forest, HTNF) or the Bureau of Land Management; these units maintain active domestic livestock allotments throughout many mountainous regions they administer, including vegetation communities at elevations up to and including alpine. By contrast, most public agencies administering land in the Sierra Nevada (except a piece managed by the HTNF) currently exclude grazing from most mid- to high elevation regions that support pikas (Michele Slaton, Inyo National Forest, pers. comm.).

Under typical conditions, pika territories average less than 50 m diameter and pikas preferentially locate haypiles along lower talus borders adjacent to meadows, grass-, and
shrublands that support choice forage (Smith and Ivins 1984, Smith and Weston 1990). Although pikas are generalized herbivores they nonetheless select high-value forage species depending on season and availability (Huntly et al. 1986). During warm seasons, pikas forage daily in talus forefields within a few meters of the talus border. By mid- to late summer, they begin to collect vegetation for winter consumption, often a different species mix than forage consumed directly, but from the same forefields. Pikas stockpile this vegetation in large hoards (“haypiles”) under boulders within the talus-field, usually one to several per territory (Millar and Zwickel 1972). Haypile vegetation is eaten during winter when fresh forage is unavailable. Haypile plants are selected on the basis of high nutritional- and caloric content as well as capacity to preserve many months in cold, wet conditions (Dearing 1997). Haypiles are often located close (less than 6 m, Millar and Zwickel 1972) to the talus/vegetation interface, reducing time and risk for pikas while traveling from haypile to forefield. Pikas augment their haypiles, especially in late winter or early spring, by running over snow to collect foliage from conifer trees whose branches drape onto the snowpack, or through snow tunnels to vegetation along the talus borders. Location of haypiles near the borders of talus-fields thus appears critical for year-round access to abundant and high-quality forage.

In addition to proximity to forage, lower locations within a talus field appear to have more favorable thermal regimes for pikas than higher intra-talus locations, irrespective of the elevation of the talus field. Studies of periglacial blockfields generally, and preliminary studies of pika-talus in particular, indicate that the coolest warm-season temperatures are within the talus matrix (below surface rocks) at the talus base (Harris and Pederson 1998, Delaloye and Lambiel 2005, Juliussen and Humlum, 2008, Millar and Westfall 2008, 2010, unpublished data). This appears to be related not only to external cold-air drainage but also to intra-talus ventilation processes that
are partially decoupled from external atmospheric conditions. These locations also maintain
greater snowcover in winter than locations higher in talus fields (Harris and Pederson 1998),
thereby insulating haypiles and animals that are near the talus base, and reducing exposure to
cold winter external air temperatures.

In mid-September 2010 I first observed unusual pika behavior in the canyons of Pine Creek,
Toquima Range, NV. Pika calls, activity, and haypiles were not adjacent to talus borders as
typical, rather they were consistently located high in the talus. Haypiles were found in proximity
to patches of *Rubus idaeus* ssp. *strigosus* (red raspberry) a small, thin-leaved shrub that grows
sparsely in scattered clumps, mostly midway up to high in talus fields. Haypiles comprised
almost exclusively this species. Red raspberry foliage and stems have poor energy content, low
nutritional value, and are densely covered with thorns, which contribute to the species being
rated as poor forage for wildlife and livestock (FIES 2010). Compounding this, nutritional
quality of red raspberry leaves and stems declines as the growing season progresses (FIES 2010),
further reducing their value at the time when pikas collect vegetation for haypiles. Whether they
improve or further decline in nutritive value over the winter in haypiles is unknown.

Compared to talus vegetation, forefield plant communities in the Toquima Range were, as is
widely the case elsewhere, highly productive, densely vegetated, mostly mesic meadow types,
containing a variety of species with high nutritional- and energetic forage content for wildlife
and livestock. While these would typically be the locations for pika foraging, during the time I
visited, forefield vegetation that pikas would use was severely impacted. Cattle were abundant in
all drainages where I observed haypiles and pika activity, and forefield plant communities were
heavily browsed with sign indicating that intensive grazing occurred in the past as well as current
years. Plant canopy heights in the forefields were cropped to less than ~5 cm when I visited in mid-Sept 2010.

These observations prompted the hypothesis that livestock grazing in talus forefields removes biomass needed by pikas for daily forage and winter haypile collections. Without this vegetation in forefields, pikas would be forced to seek forage elsewhere. Because pikas prefer talus habitat, and are at greater risk of predation off-talus, the most likely alternative would be for them to seek vegetation that grows within the talus field rather than moving farther off-talus in search of forage (Holmes 1991). By nature of the rocky environments, vegetation within talus fields is generally much lower in abundance, species diversity, and distribution than off-talus (Sawyer et al. 2009). Thus, pikas would likely encounter less vegetation and possibly (as in the case of red raspberry) of poorer quality than on ungrazed forefields, in which case their summer and winter forage and health conditions might be compromised. Further, by being forced higher in talus fields, pikas would be active in summer in locations that appear to have warmer intra-talus thermal regime, and in winter, haypiles would be in talus locations more exposed to cold surface air (less insulating snowpack).

On the basis of this hypothesis I began a pilot study to observe pika behavior during September and October 2010 in locations where 1) grazing was present and forefield vegetation was grazed, and 2) grazing was not present in the forefield, regardless of whether livestock were present in the region (some talus locations are inaccessible to livestock). I visited six Great Basin mountain ranges plus the eastern Sierra Nevada (Great Basin but distinguished because of extensive habitat) where pikas were active (Table 1), and measured the distance (paced and rounded to nearest 0.5 m) from talus/vegetation border to the nearest fresh haypile in 35 disjunct sampling areas (defined as separated by a minimum of 3 km, the estimated maximum dispersal
distance of individual pikas). These mountain ranges span a wide range of parent substrate material and vegetation communities; aside from impacts of cattle, there were no systematic differences in ecologic, geographic, climatic, or physical/environmental conditions between grazed versus ungrazed sampling areas. I recorded haypiles only when they were separated by at least 50 m. Further, in each talus, I recorded only the nearest visible haypile to the low-elevation talus border (adjacent to the toe of the talus field), despite that others might occur above this. The reason for this protocol was because, under normal conditions, locations along the talus border are where pika haypiles are most often located (Smith and Weston 1990). I recorded large mammal grazing activity in forefield plant communities and noted whether haypiles comprised species growing in talus or those occurring predominantly or exclusively on forefields.

Of 84 haypiles I observed, mean distance of haypiles to talus borders for grazed forefields was 30.1 m (SD 18.9 m) and significantly and consistently greater than the mean for ungrazed situations 1.8 m (SD 0.9 m) \((t = 7.8; df = 26; p < 0.0001; \text{Table } 1)\). This relationship occurred across mountain ranges and also within ranges where grazing was permitted and where comparisons were made between both grazed forefields and those where environmental conditions precluded livestock from forefields. In almost all cases where haypiles were distant from talus borders, the dominant vegetation in haypiles derived from species that grew within the talus fields, whereas haypiles near talus borders comprised forefield and within-talus vegetation.

Observations from this pilot study are preliminary but they suggest a possible factor impacting the status of pikas in Great Basin locations where forefields are heavily grazed. Lack of abundant, diverse, and nutritional forage for direct and stored consumption might lower overall fitness of pikas. Similarly, lack of adequate forefield vegetation appears to force pikas high in talus to find alternative food, exposing them to potentially less favorable thermal
conditions in summer as well as winter. Other researchers have suggested a possible role of livestock grazing and pika forage (Huntly et al. 1986). Beever et al. (2003) tested the effect of grazing on pika extirpation in the Great Basin but their results were inconclusive, possibly because grazing was recorded at the mountain-range level, rather than by individual talus.

Because policy differences exist among the public agencies that administer land in this region, grazing might be an important, if little studied, factor affecting persistence of pikas in the Great Basin relative to other regions. That grazing impacts might exacerbate other factors affecting pika viability in Great Basin ranges (climate change, biogeographic challenges) suggests that this hypothesis warrants additional research, a direction we are now pursuing.

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Table 1. Distance from talus border to 84 pika haypiles and source of haypile plants in grazed and ungrazed regions of the Great Basin and Sierra Nevada Ranges, CA and NV. All but one grazed locations (noted) were cattle allotments.

<table>
<thead>
<tr>
<th>Mountain Range</th>
<th>State</th>
<th>N</th>
<th>Elev (m)</th>
<th>N</th>
<th>Mean (SD) Haypile distance to talus edge</th>
<th>Haypile source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazed</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sierra Nevada</td>
<td>CA, NV</td>
<td>4</td>
<td>2835-2940</td>
<td>6</td>
<td>11.7 (3.0)</td>
<td>FF</td>
</tr>
<tr>
<td>Sweetwater</td>
<td>CA</td>
<td>3</td>
<td>3080-3510</td>
<td>5</td>
<td>51.8 (23.1)</td>
<td>T</td>
</tr>
<tr>
<td>Toiyabe</td>
<td>NV</td>
<td>1</td>
<td>2985-3000</td>
<td>3</td>
<td>28.0 (4.4)</td>
<td>T</td>
</tr>
<tr>
<td>Toquima</td>
<td>NV</td>
<td>4</td>
<td>3140-3430</td>
<td>10</td>
<td>32.5 (15.1)</td>
<td>T</td>
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<tr>
<td>White Mtns</td>
<td>CA, NV</td>
<td>2</td>
<td>2490-3020</td>
<td>3</td>
<td>23.0 (13.7)</td>
<td>T</td>
</tr>
<tr>
<td>Total Grazed</td>
<td></td>
<td>14</td>
<td>27</td>
<td></td>
<td>30.1 (18.9)</td>
<td></td>
</tr>
<tr>
<td>Mountain Range</td>
<td>State</td>
<td>N</td>
<td>Elev</td>
<td>N</td>
<td>Mean (&amp; SD)</td>
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<td>(m)</td>
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<tr>
<td><strong>Sampling</strong></td>
<td></td>
<td></td>
<td><strong>Range</strong></td>
<td><strong>Haypiles</strong></td>
<td><strong>distance</strong></td>
<td><strong>source</strong></td>
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<td><strong>(m)</strong></td>
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<td><strong>haypile to</strong></td>
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<td><strong>talus edge</strong></td>
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<tr>
<td><strong>Ungrazed</strong></td>
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<tr>
<td>Bodie Hills</td>
<td>CA</td>
<td>2</td>
<td>2520-2680</td>
<td>9</td>
<td>1.8 (0.7)</td>
<td>FF</td>
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<tr>
<td>Sierra Nevada</td>
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<td>7</td>
<td>2800-3290</td>
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<td>2.4 (0.5)</td>
<td>FF</td>
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<td>3</td>
<td>3100-3290</td>
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<td>3.1 (1.1)</td>
<td>FF</td>
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<td>Wassuk</td>
<td>NV</td>
<td>5</td>
<td>3000-3390</td>
<td>12</td>
<td>1.5 (1.1)</td>
<td>FF</td>
</tr>
<tr>
<td>White Mtns</td>
<td>CA, NV</td>
<td>5</td>
<td>3025-3525</td>
<td>12</td>
<td>1.4 (0.9)</td>
<td>FF</td>
</tr>
<tr>
<td><strong>Total Ungrazed</strong></td>
<td></td>
<td>21</td>
<td>57</td>
<td></td>
<td>1.8 (0.9)</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>35</td>
<td>84</td>
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</tr>
</tbody>
</table>

1 Locations included, SN: Burt Cyn, Molybdenite Cyn, Green Cr Cyn, Virginia Cyn; Sweetwater: Belfort, Frying Pan Cyn, Mt Wheeler, Mt
Patterson, Lobdell Lake; Toiyabe: N and S Fks Twin River Cyn; Toquima: S and Mid Fks Pine Cr, Mt Jefferson Plateau; White Mtns: Crooked Cyn, Wyman Cyn, Mt Barcroft, Cottonwood Cyn, Trail Cyn; Bodie Hills: Bodie State Historic Park, Masonic; Wassuk: Cottonwood Cyns, Dutch Cr Cyn, Rose Cr Cyn, Big Indian Mtn.

2 T, talus plant species only; FF, forefield and talus species.

3 1 region contained a sheep allotment.