North American Pikas: Population Status, Thermal Environments, & Periglacial Processes

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Photo: A. Shcherbina
American Pika
*(Ochotona princeps)*

Collared Pika
*(O. collaris)*

Rabbit Relatives
- Alpine & Arctic
- Talus Dwelling
- Non-Hibernating
- Generalist Herbivore
- Metapopulation Spp
- Thermally Sensitive
Climatic Relations: Impacts of Warming

Historic Extirpations

• Prehistoric pika sites
○ Extant pika sites
⊕ Extirpated 20th century

Modeled Future Extirpation

Are Low and Warm Populations at Risk?
Will Pika Migrate off Mountain Tops?

Petitioned for ESA protection, CA & Federal levels

Grayson 2005, Beever et al. 2003

Loarie et al. in review
Surveys in Sierra Nevada & W Great Basin Show Wide Elevation Range: 1827 - 4344m

Early 20th Century Range: 2500m was considered low – 19% of current sites are lower

519 Sites
12 Mountain Ranges

Millar & Westfall in press, AAAR
Even locally, pika have very wide elevation ranges

Low-High Elevation Pairs for 6 Canyons, Sierra Nevada

* = pika sites

...occupying available habitat from low to high

Mono Basin pika range: 2191m - 3981m
=1790m (5872ft) elevation span
Might Pika be Coping with Warming Climate?

1. Time-series analyses are essential to interpret trends in a metapop species.

**Total Patch Occupancy**

20 Censuses: 1972-2009, 76 patches

- **Average** = 39.6% occupancy
- **Range** = 23.7 - 58.7%

**Northern Patches**

- **Average** = 70.2% occupancy
- **Range** = 48.6 - 88.2%

**2009: 83.8% occupied**

**Bodie, CA: Low Elevation Site**

Smith, Nichols, Nagy, in prep
2. Pika Mitigate Their Thermal Environment

Local microclimatic processes and behaviors buffer pika against regional warming

- Topographic Position
- Cold-Air Pooling (CAP)
- Within-Talus Processes
- Adaptive Behavior

Narrow steep canyons, cirques, Northern aspects

Thanks to Forsyth & Lundquist, based on Lundquist et al 2008
Taluses Provide Unique Thermal Refugia

Periglacial Origins: Common in Arid, Arctic Environments

85% of 519 Pika Sites Were Block Field Taluses

Different from Rockfall or Till

Self-organizing freeze-thaw & sorting processes, form in situ, Kessel & Werner 2003

→ optimal clast size
→ deep internal matrices for dispersal & predator escape
→ fine sediments removed

Millar & Westfall 2008 & in press
Periglacial Processes Studied at High Latitudes

Internal temps are in disequilibrium with external air temps
- Cooler than ambient air flows down & out base in summer
- Warmer than ambient air flows up & out top in winter

Balch & Chimney-Flue Circulation

Delaloye & Lambiel 2005

Juliussen & Humlum 2008

Local perma-frost elevations depressed by as much as 1000m
RIFs Provide Optimal Pika Habitat: **Forage**

Unlike many non-RIF streams, RIF outlet streams remain wet & seep water throughout the dry season

...supporting diverse forefield plant communities
Talus Thermal Regimes in the Sierra Nevada

Sierra Nevada, CA

Temp Study (iButtons)
4 Taluses
2 Elevs: High ~3260m, Low ~2360m
2 Substrates: Granitic, Metamorphic

Millar & Westfall, ongoing study
Taluses Mitigate Warm Temperatures

**SUMMER**

1. Talus Matrix is Cooler than Talus Surface

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<th>Surface</th>
<th>SD</th>
<th>Matrix</th>
<th>SD</th>
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<td>5.3</td>
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<td>14.9</td>
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<td>12.7</td>
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</tbody>
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° C

2. Daily Temp Fluctuations at Talus Matrix Are Less than Surface
3. Temperatures are Coolest Low in Taluses (surface & matrix) and on Adjacent Forefields
Positive Lapse Rates especially relative to talus base

Talus Surface
Rate High:Low

Compare cool & overcast periods

Talus Matrix
Rate Mid:Low

Pika spend much of their time near talus base & in forefield

haypile
Pika Escape Heat Adaptively by Changing Time of Activity  

Pika retreat to matrix during mid-day on warm summer days, especially at low elevation.

**Behaviour**

Warm Days = Crepuscular  
Cool Days = Diurnal

**Daily Activity**

Bodie, CA (low elev)  
Tioga Crest (high elev)  
Smith 1974
Winter: Talus Surface Warmer than Matrix

Pika avoid severe cold in winter by staying at hay-piles, which they locate near talus surfaces.
Key Findings

Metapopulation Behavior: Time-series monitoring is essential to interpret decadal population trends.

Elevation Range: Pika can (& do) persist over a broad elevation range in the SN & W Great Basin.

Thermal Processes of Talus: Mitigate ambient air temperatures.

Pika Behavior: Pika use talus adaptively to avoid extreme heat & severe cold.
Talus Characteristics  Summer

– Matrix cooler than surface
– Lower daily temp fluctuations in matrix than at surface
– Strong positive lapse rates (coolest at talus base), esp on warm, dry days
– Forefields adjacent to talus also cool, but have high daily temperature fluctuation
Talus Characteristics  Winter

Talus surface is warmer than matrix when snow-covered, (~0°C vs <0°C); Pika locate haypiles near talus surfaces

Semi-arid locations, such as SN & GB, where snowpack is light or blows off, or regions where snowpacks are diminishing, may be vulnerable for pika