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

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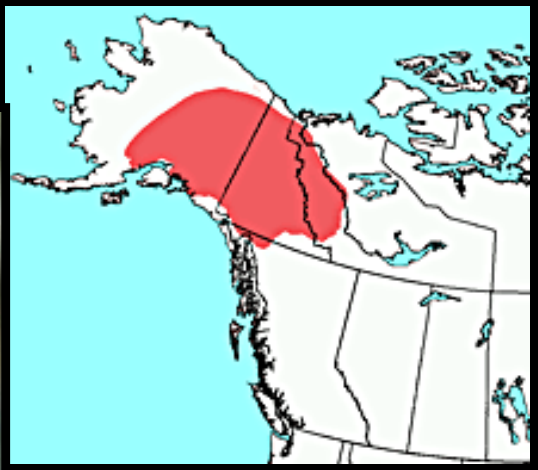
Photo: A. Shcherbina

American Pika

(*Ochotona princeps*)

Collared Pika

(*O. collaris*)



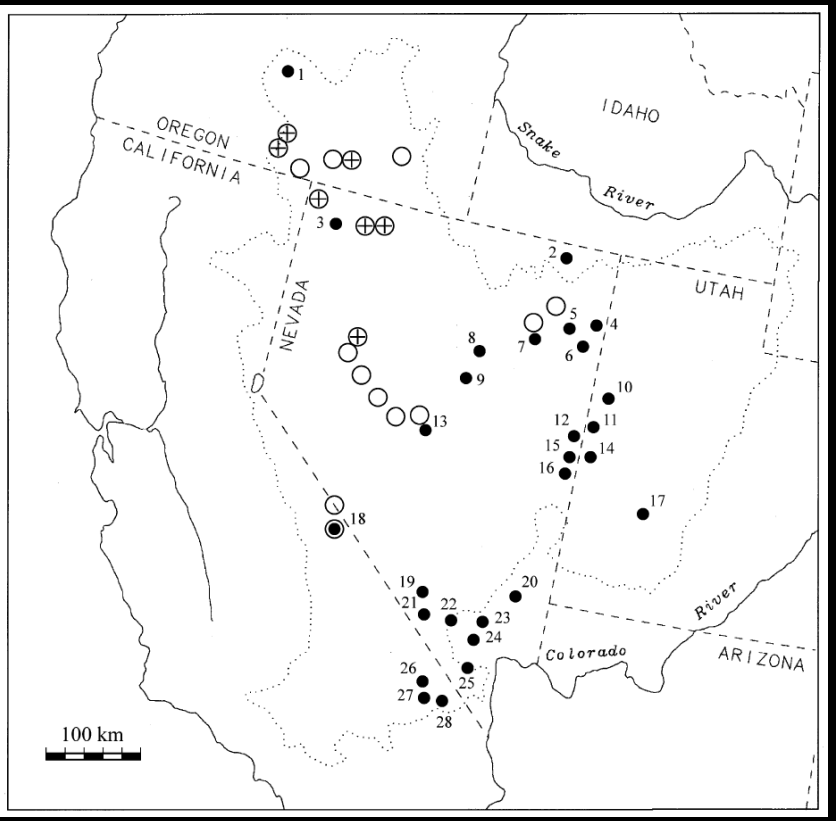
Rabbit Relatives

- Alpine & Arctic
- Talus Dwelling
- Non-Hibernating
- Generalist Herbivore
- Metapopulation Spp
- Thermally Sensitive

Climatic Relations: Impacts of Warming

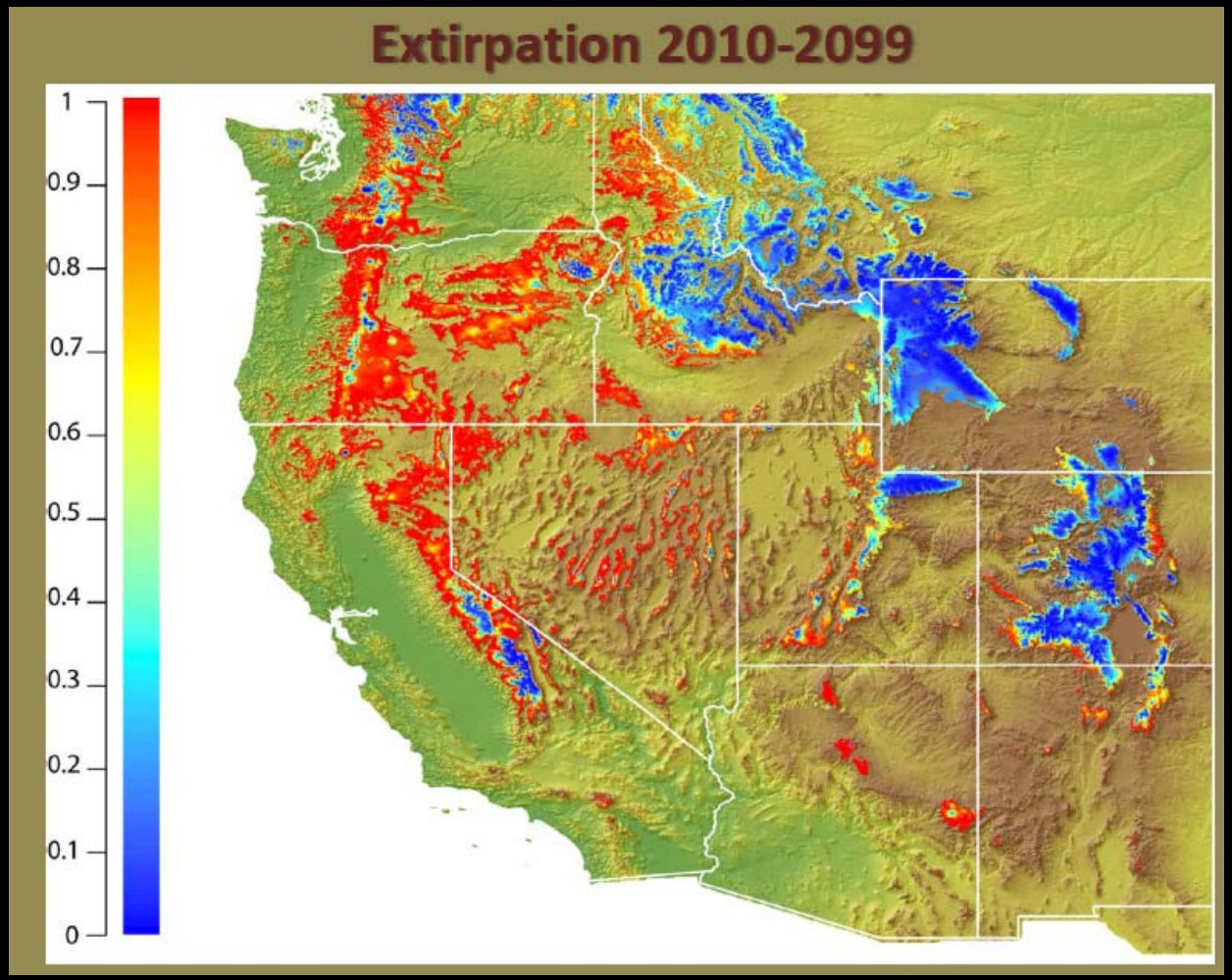
Historic Extirpations

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



Grayson 2005, Beever et al. 2003

Modeled Future Extirpation



Loarie et al. in review

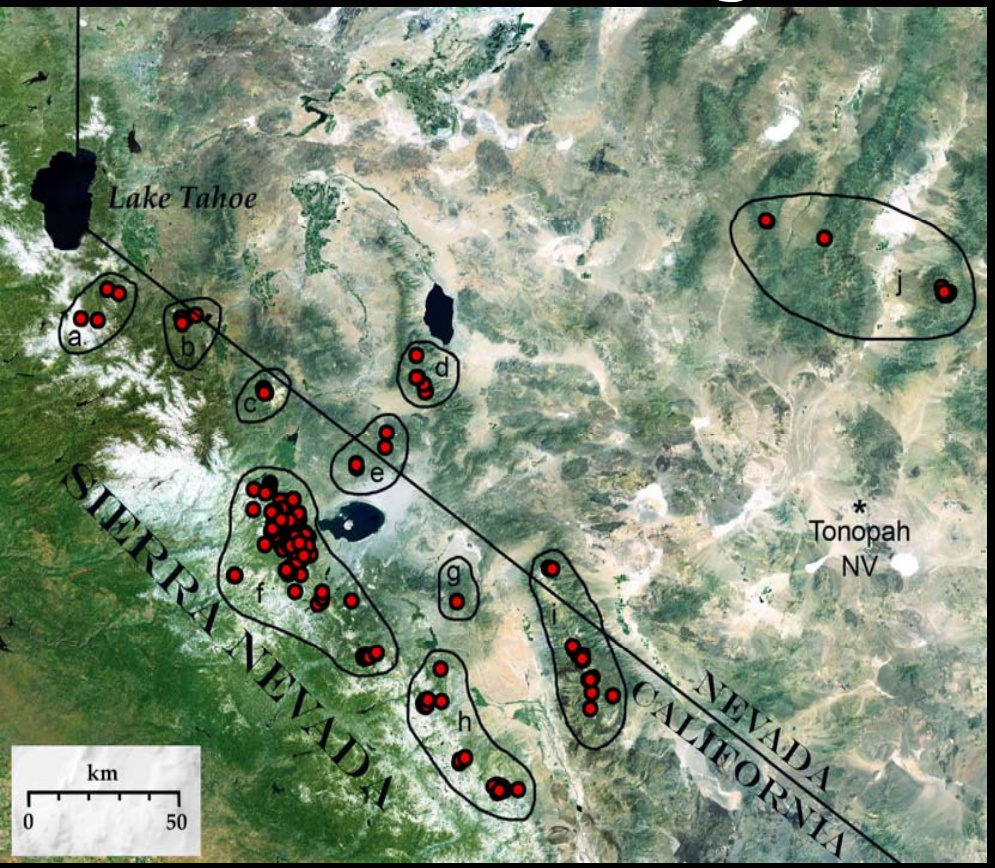
Are Low and Warm Populations at Risk?
Will Pika Migrate off Mountain Tops?

Petitioned for ESA protection, CA & Federal levels

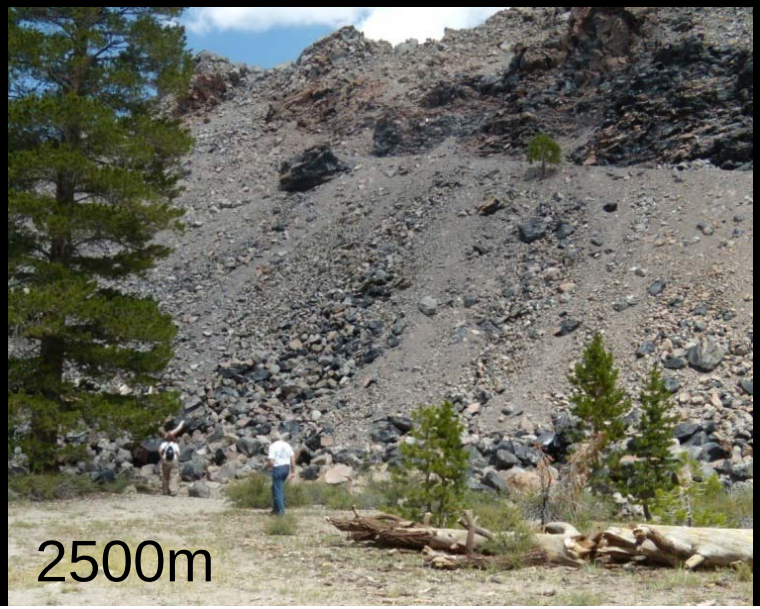
Surveys in Sierra Nevada & W Great Basin Show Wide Elevation Range: 1827 - 4344m

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

519 Sites
12 Mountain Ranges



Millar & Westfall in press, AAAR



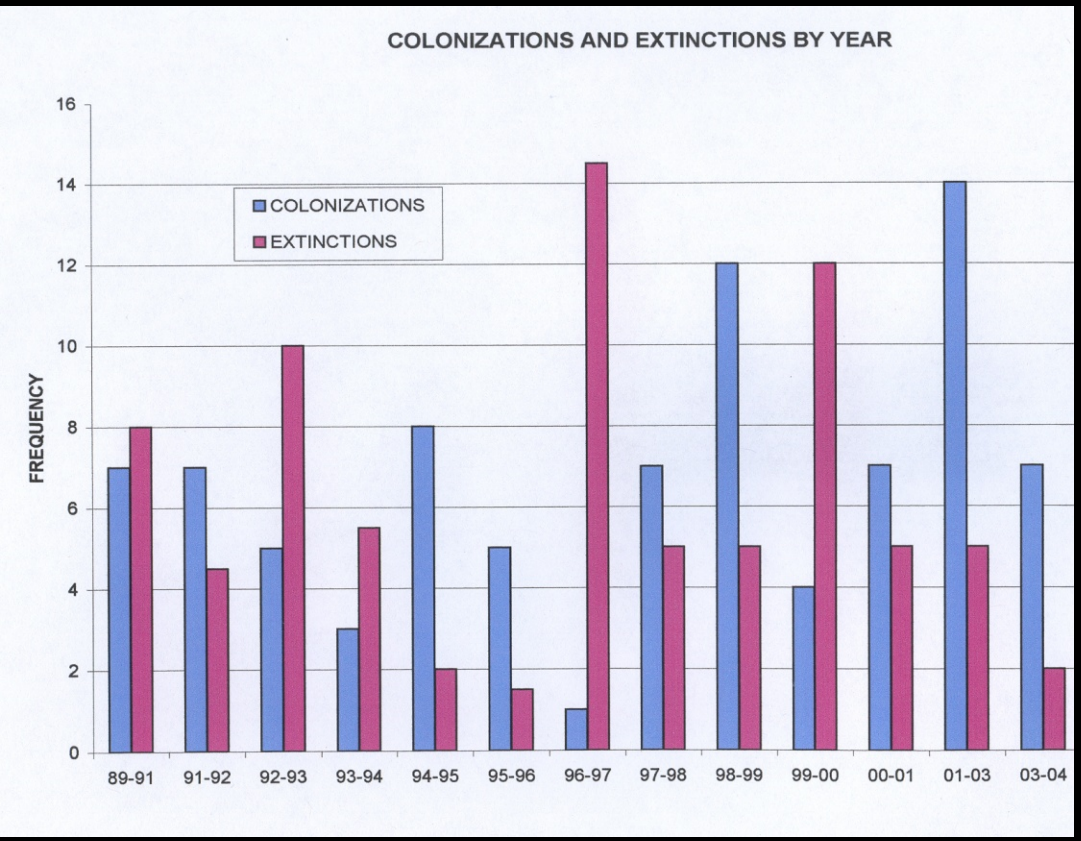
Even locally, pika have very wide elevation ranges

...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*



Bodie, CA: Low Elevation Site

Smith, Nichols, Nagy, in prep

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

2. Pika Mitigate Their Thermal Environment

Local microclimatic processes and behaviors

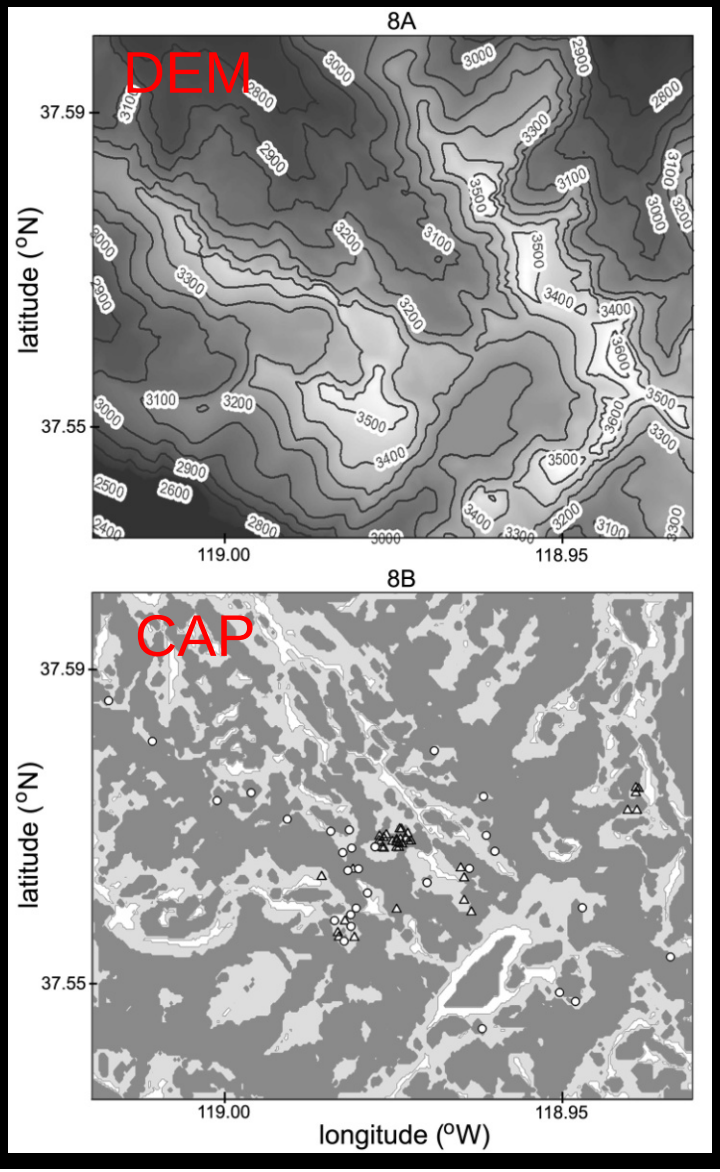
buffer pika against regional warming

–Topographic Position

– Cold-Air Pooling (CAP)

– Within-Talus Processes

– Adaptive Behavior



Thanks to Forsyth & Lundquist,
based on Lundquist et al 2008

Taluses Provide Unique Thermal Refugia

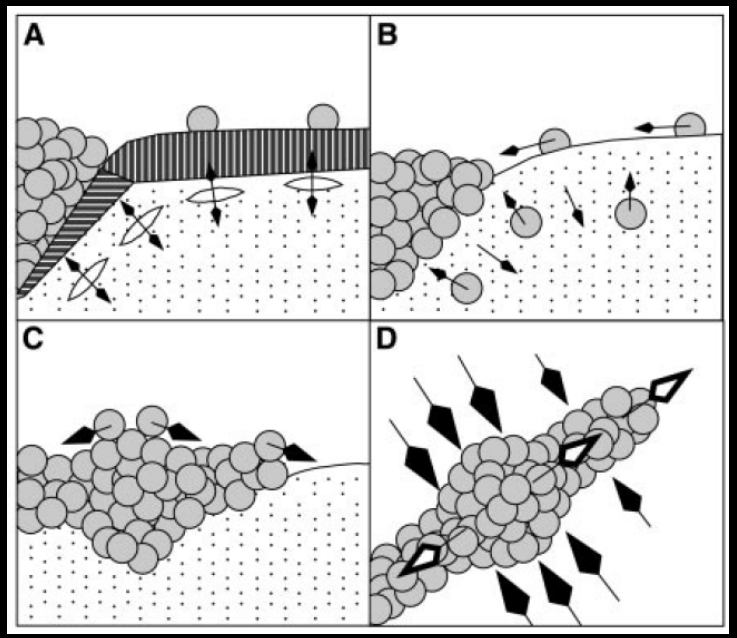
Periglacial Origins: Common in Arid, Arctic Environments

85% of 519 Pika Sites Were Block Field Taluses

Millar & Westfall 2008 & in press

Different from Rockfall or Till

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



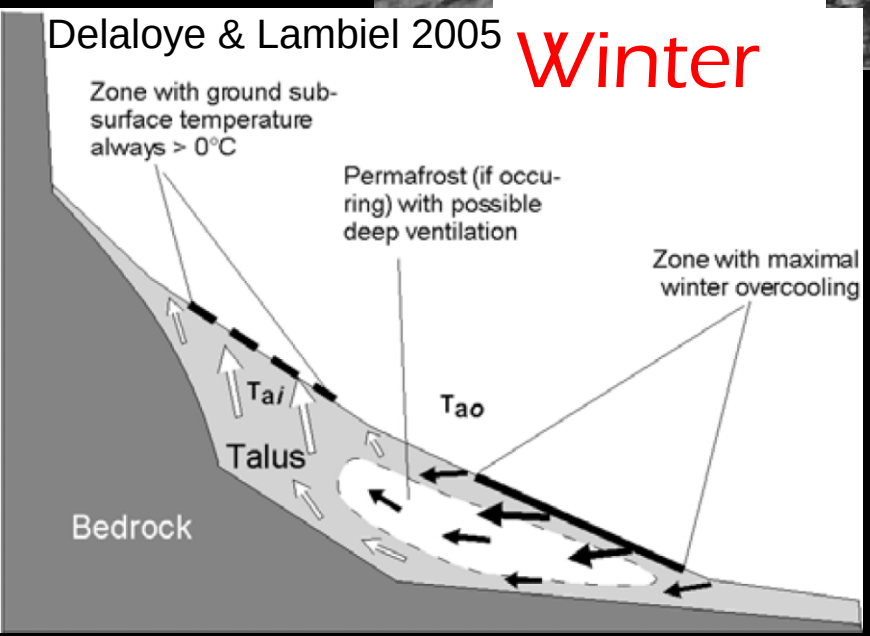
→ optimal clast size
→ deep internal matrices for dispersal & predator escape
→ fine sediments removed

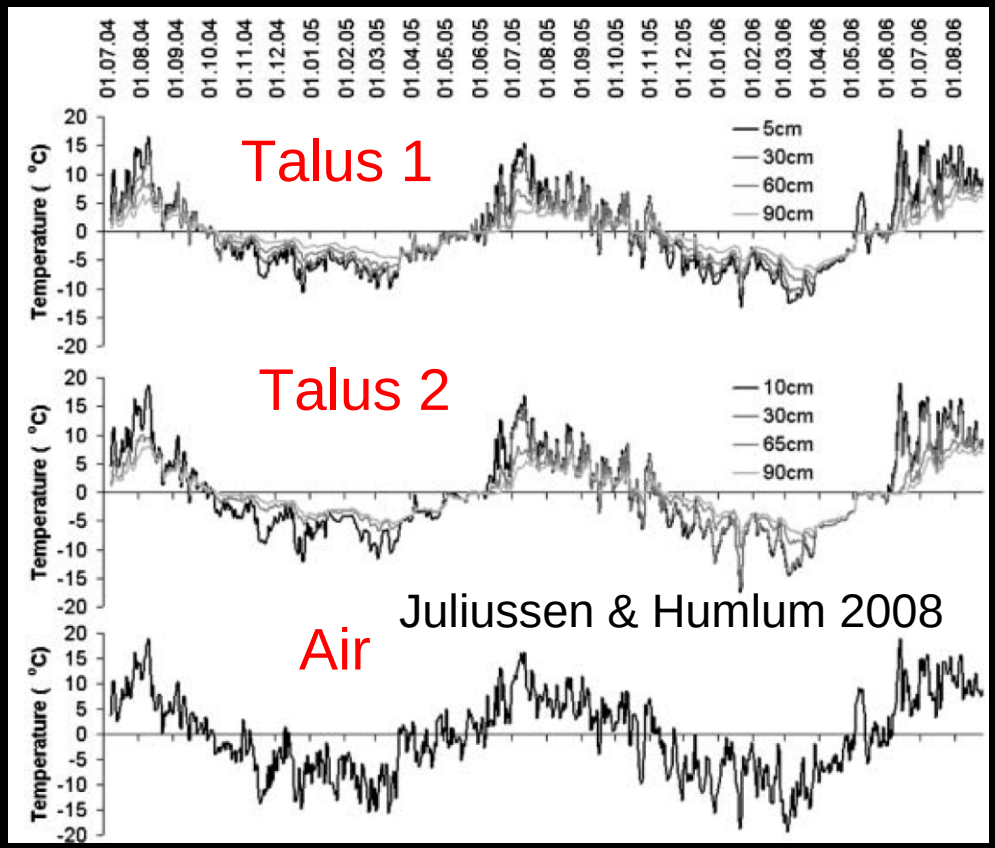
Periglacial Processes Studied at High Latitudes

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





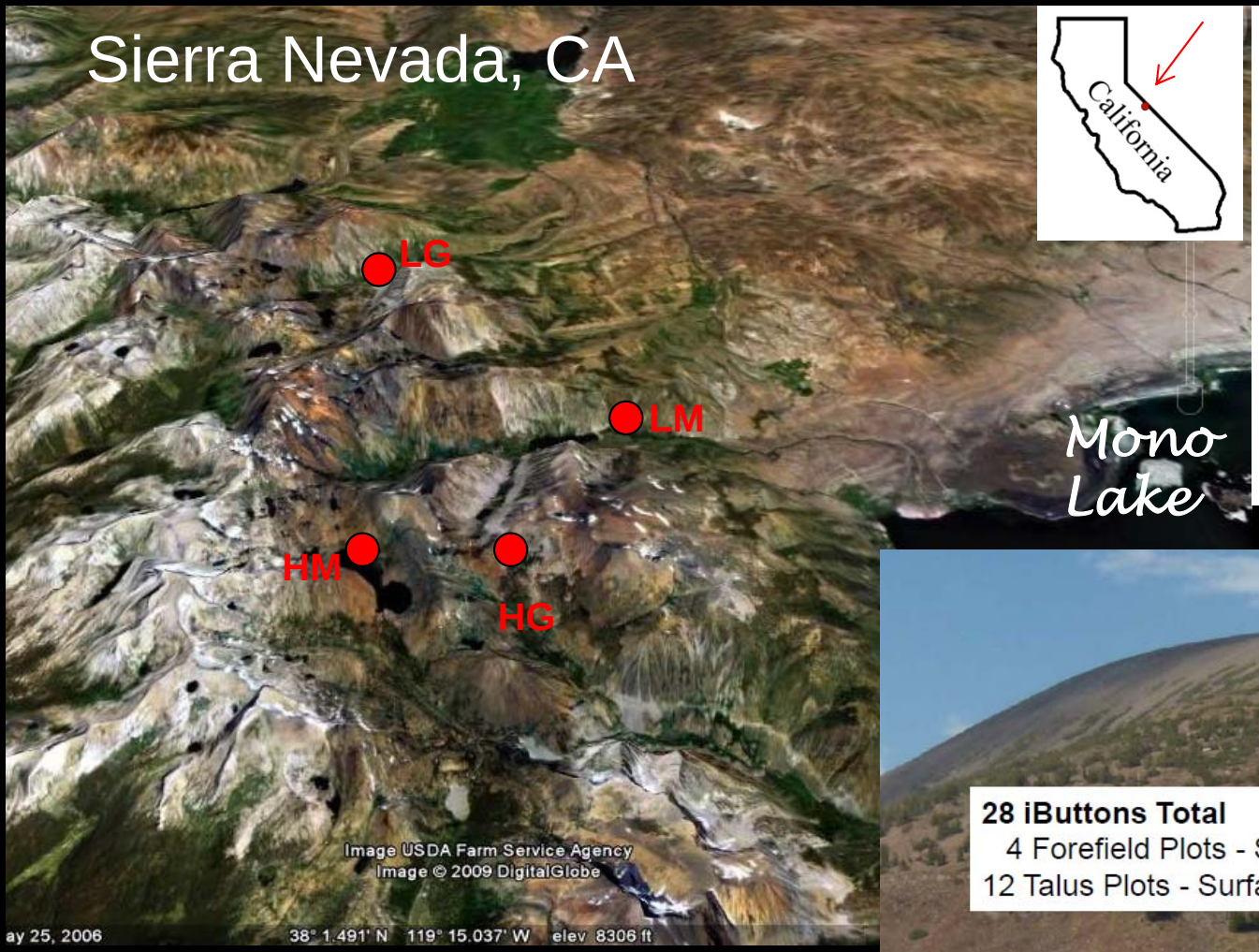
Local perma-frost elevations depressed by as much as 1000m

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

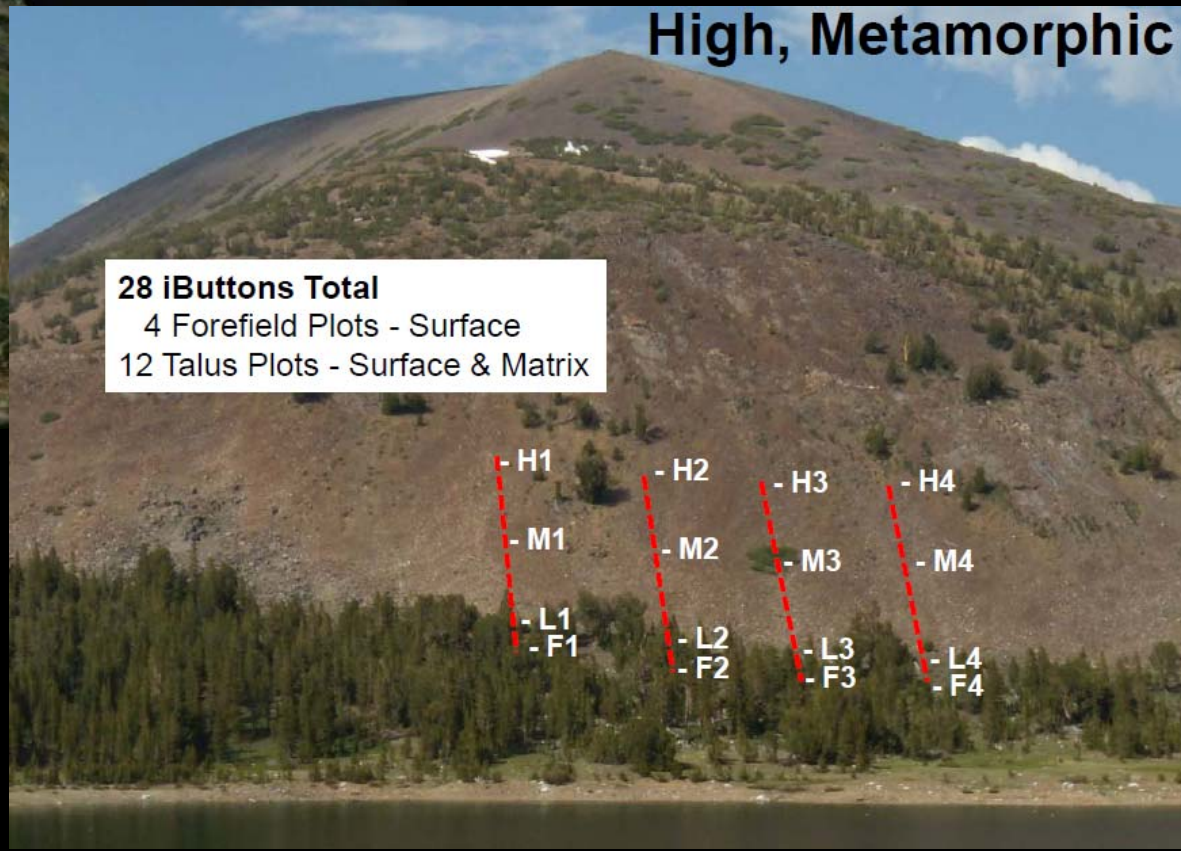


Temp Study (iButtons)

4 Taluses

2 Elevs: High ~3260m, Low ~2360m

2 Substrates: Granitic, Metamorphic



Millar & Westfall, ongoing study

Taluses Mitigate Warm Temperatures

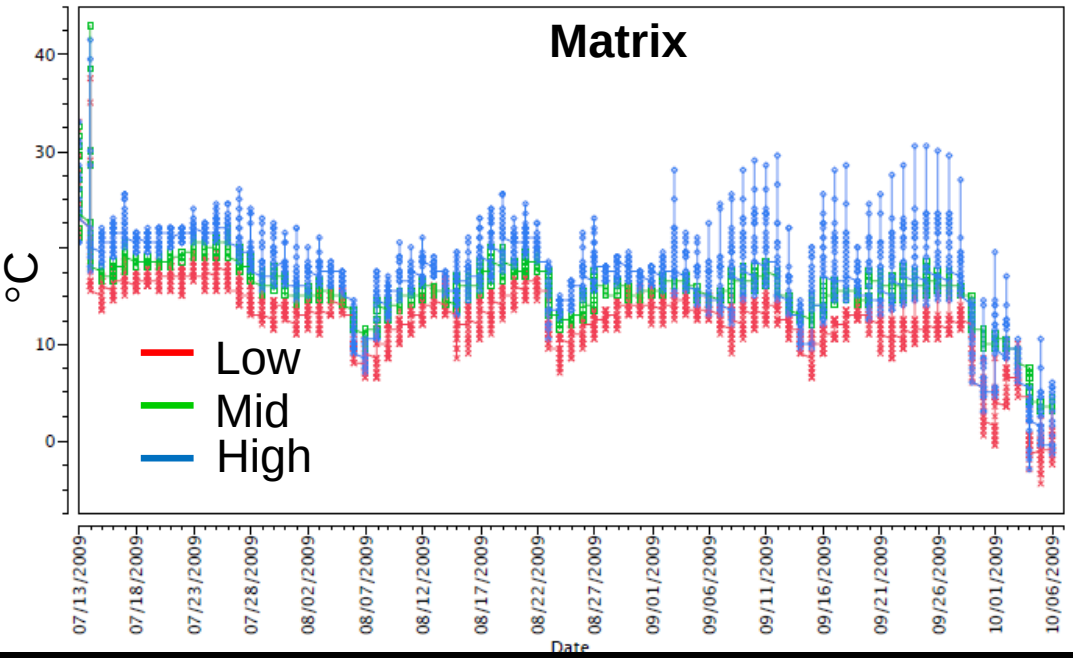
SUMMER

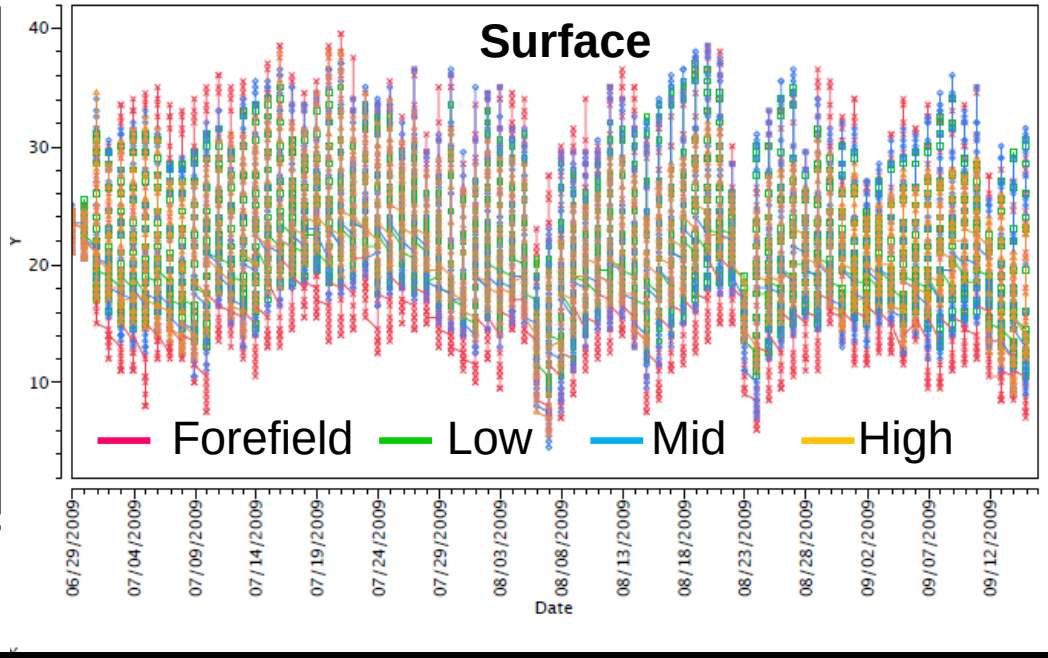
1. Talus Matrix is Cooler than Talus Surface

	Surface	SD	Matrix	SD
Low Meta	**22.4**	5.3	**20.5**	2.5
Low Granitic	**18.2**	3.4	**15.2**	1.2
High Meta	**16.1**	4.2	**13.9**	2.2
High Granitic	**14.9**	4.0	**12.7**	1.4

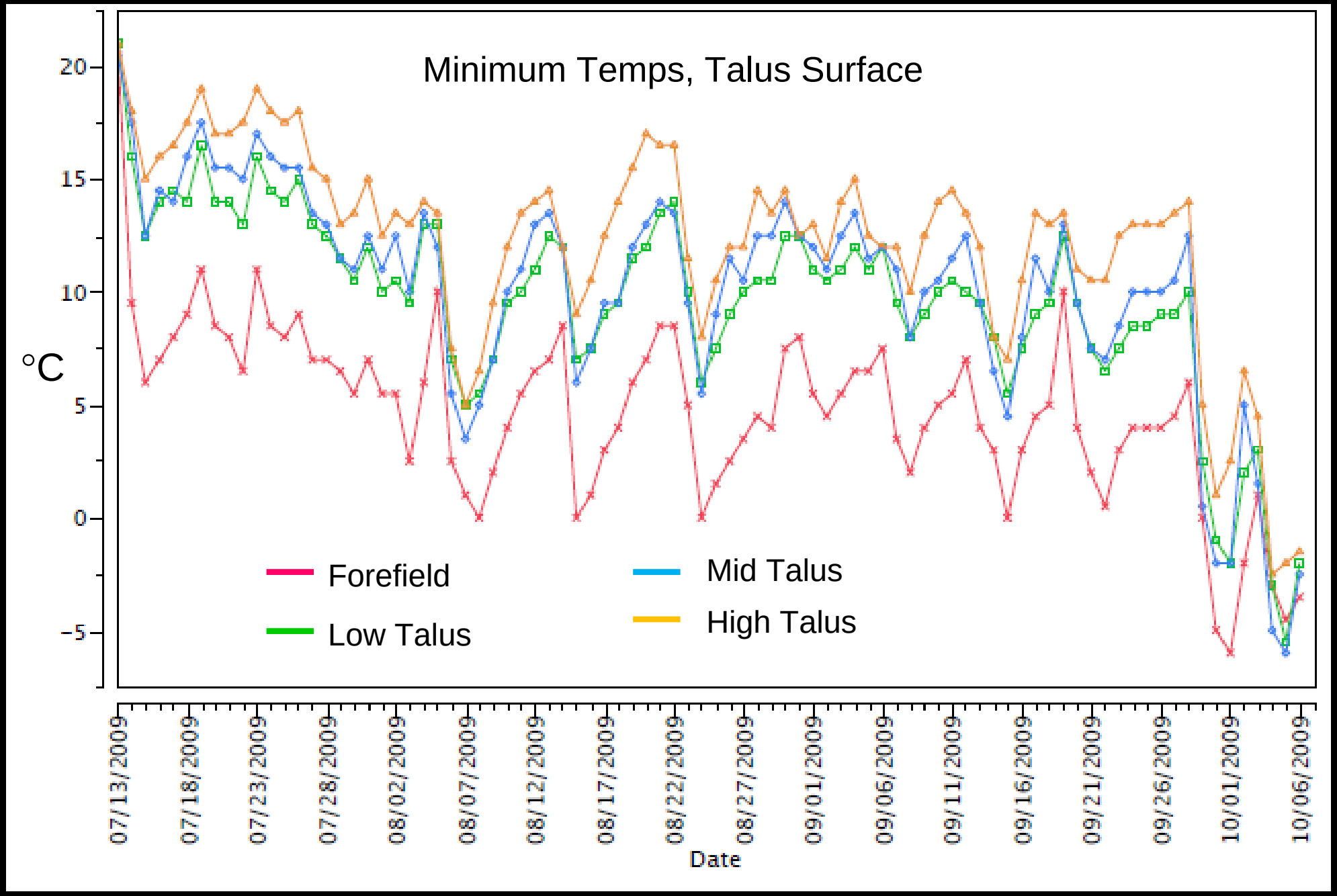
°C

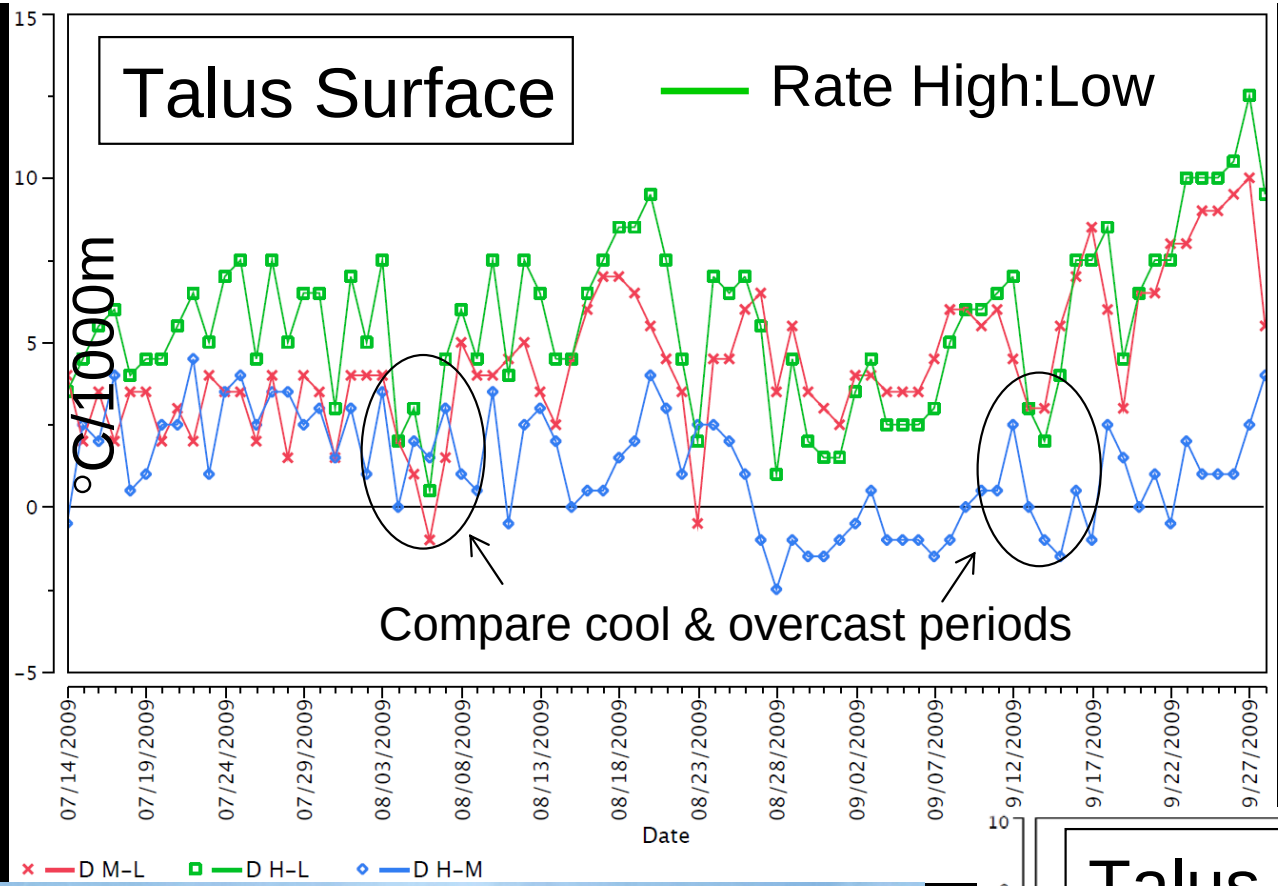
2. Daily Temp Fluctuations at Talus Matrix Are Less than Surface





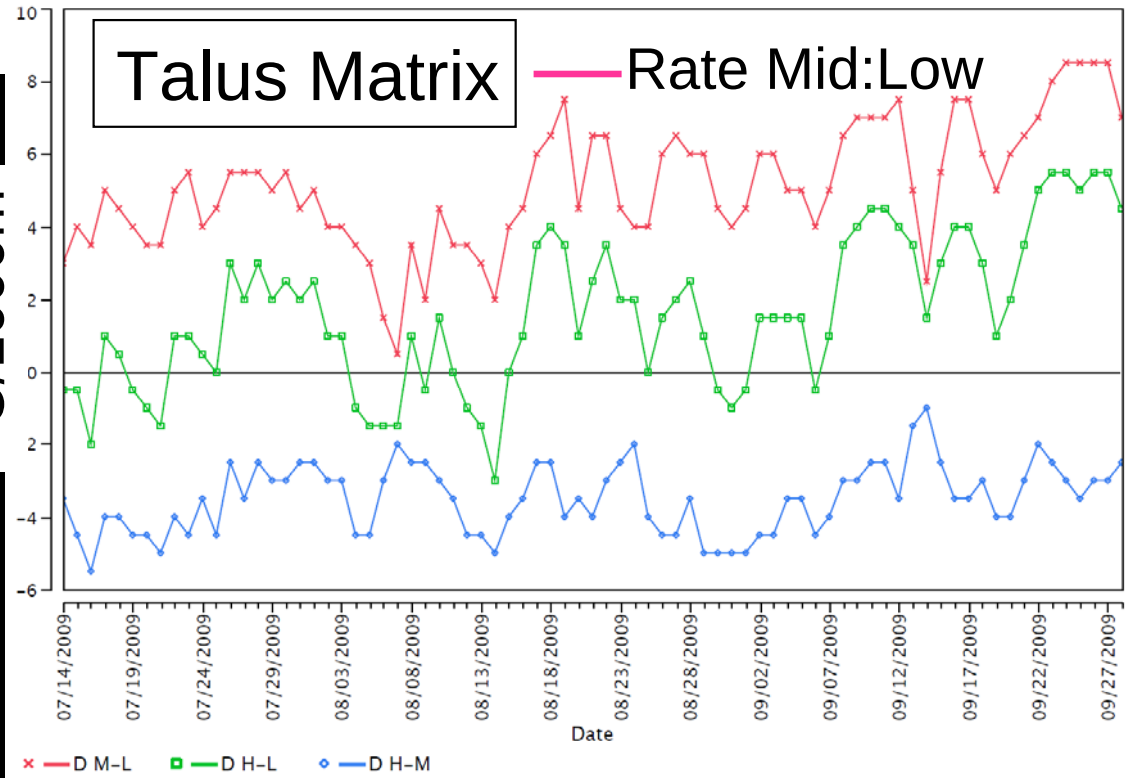
3. Temperatures are Coolest *Low* in Taluses (surface & matrix) and on Adjacent Forefields





Positive Lapse Rates

especially relative to talus base



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

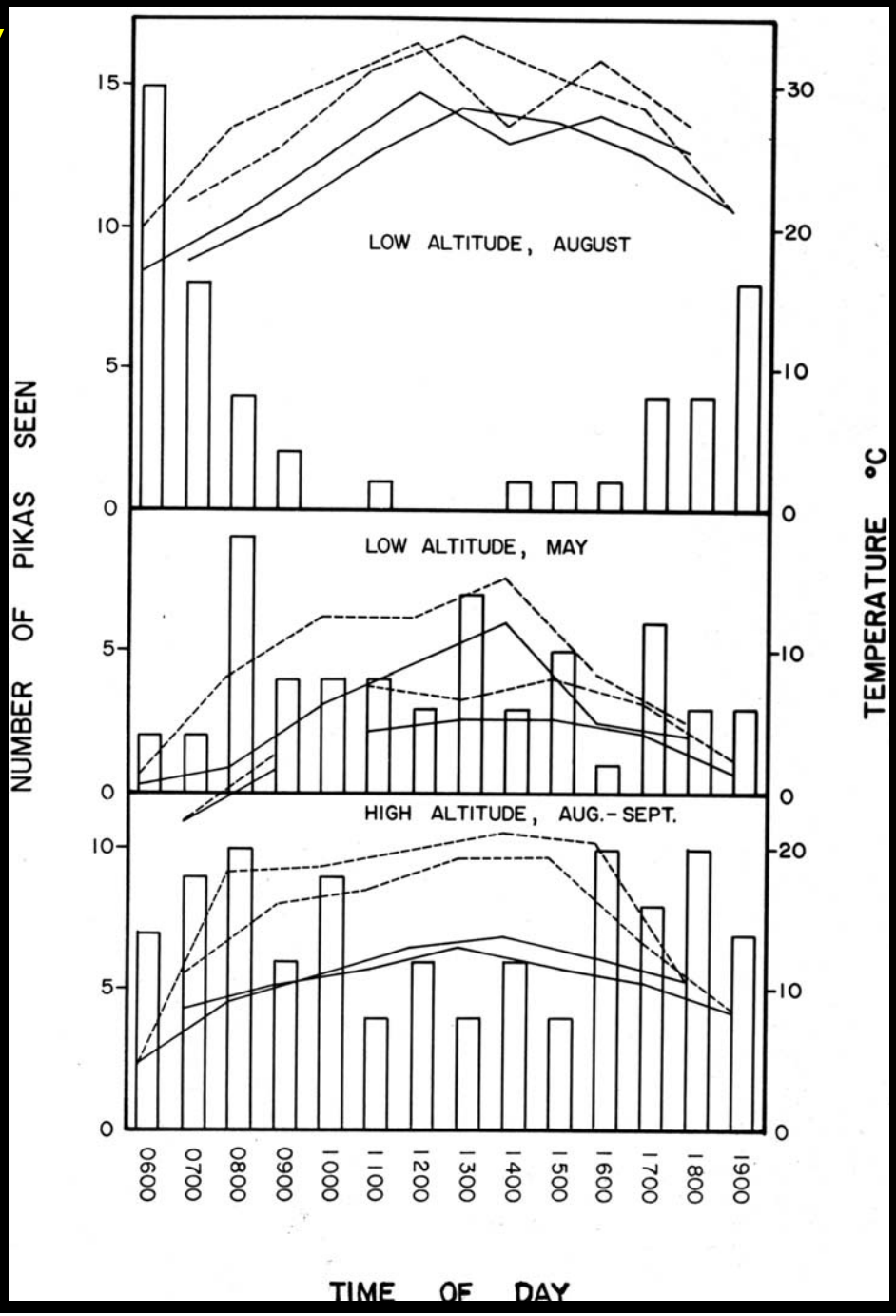
Cool Days = Diurnal

Daily Activity

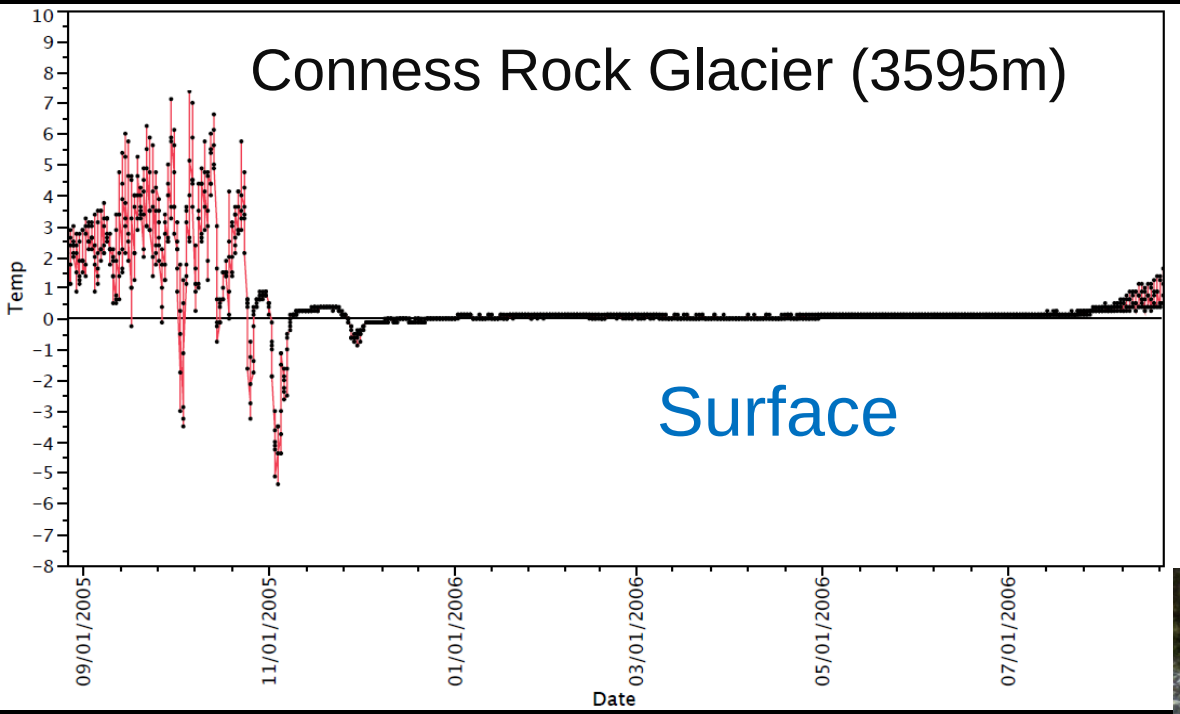
Bodie, CA (low elev)

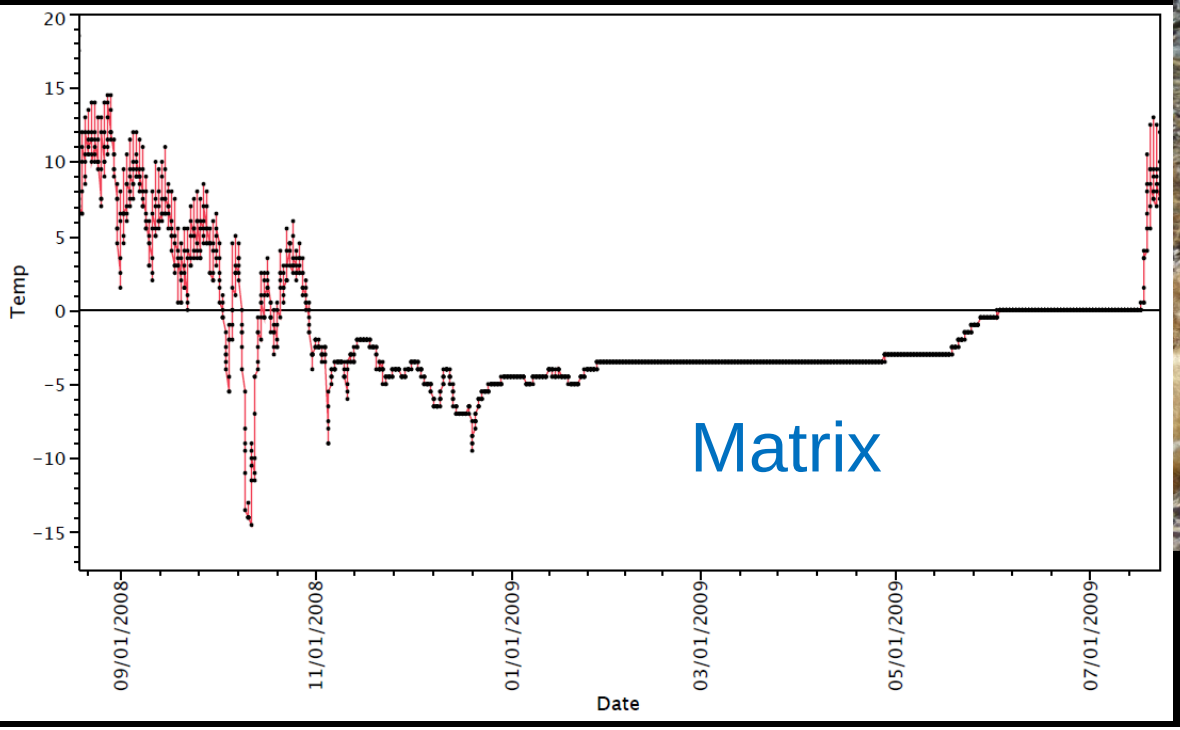
Tioga Crest (high elev)

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