

Final report on mammalian diversity in Devils Postpile National Monument

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Executive Summary

We surveyed mammalian diversity in Devils Postpile National Monument on three occasions: late summer 2015, late spring-early summer 2016, and fall 2016. Our focus was on the small, terrestrial mammal fauna, which is easily assayed by a standardized trapping program. While we also included observational records of larger-bodied species, we made no effort to examine bat diversity. Our study builds on that by Harold Werner, wildlife ecologist for SEKI, in 2004.

Werner's 2004 report concluded with a list of 18 mammal species confirmed as present in the Monument and an additional list of 19 species that might be present and thus for which surveys should be conducted. Of these latter 19 species, our work confirmed the presence of 6 species (broad-footed mole, *Scapanus latimanus*; gray fox, *Urocyon cinereoargenteus*; northern flying squirrel, *Glaucomys sabrinus*; montane vole, *Microtus montanus*; bushy-tailed woodrat, *Neotoma cinerea*; and western jumping mouse, *Zapus princeps*). In addition, we added two species whose presence was heretofore unsuspected (California ground squirrel, *Otospermophilus beecheyi*; heather vole, *Phenacomys intermedius*). The mammal fauna of Devils Postpile National Monument thus contains a minimum of 26 species, again exclusive of bats, with another 13 species that remain for future studies to confirm.

Introduction

At the request of Superintendent Deanna Dulen and Resource Specialist Monica Buhler, this project was initiated with four goals in mind: (1) build on the species list compiled in 2004 by Harold Werner, now retired wildlife ecologist in Sequoia-Kings Canyon National Parks, through increased effort and habitat coverage; (2) assess the species diversity of certain taxa, especially shrews of the genus *Sorex*; (3) accumulate

data to assess the biogeographic placement of the Monument's mammal fauna relative to west-slope versus east-slope elements in the central Sierra Nevada; and (4) provide an assessment of the suitability of Soda Springs Meadow as a potential cold air refugium, especially with reference to Belding's ground squirrel (*Urocitellus beldingi*).

Protocol

We followed a standard protocol, using Sherman live traps to assess presence and abundance of small mammals supplementing trap results with direct (sightings) or indirect (tracks, scat) observations of species' presence. Trap lines were established in five areas, each a distinct habitat: (1) the willow riparian community bordering Soda Springs Meadow adjacent to Middle Fork San Joaquin River; (2) dense lodgepole pine along the western margin of Soda Springs Meadow; (3) on the upper slope west of the Middle Fork of the San Joaquin River at the junction of the Pacific Crest / John Muir trails with the King Creek / Fern Lake trails, an area of mixed conifer forest but primarily within red fir-white fir alliance, based on the vegetation map of the Monument; (4) Jeffrey pine and montane/alpine riparian scrub; and (5) whitethorn chaparral in the 1992 Red's Fire burn area at Rainbow Falls. Details of each trapline are provided in digital field notes compiled by Patton and distributed to DEPO staff. These details include georeference points at the beginning, middle, and end of each trapline; general habitat descriptions; formal vegetation profile using the NPS vegetation mapping program data sheets; and photographs of the habitat at cardinal directions at points along each trap line. Below I present a synopsis of trapping areas, mammal species encountered at each, and comments on significance of findings.

Trap Areas

Each trapline, or set of companion traplines, were accorded the following specific localities. General trap results, including both trap success, species diversity, and dominant species in each area follow:

- 1. Soda Springs Meadow, Devils Postpile National Monument, Sierra Nevada, Madera Co., California 7557 ft 37.62931°N, 119.08551°W [WGS84 datum]**

Traplines were established in the willow riparian community on the left (=east) bank of the Middle Fork of the San Joaquin River where it bisects Soda Springs Meadow in August of 2015; the meadows on both banks were trapped in June 2016; and the right (=west) bank meadow was trapped in September 2016. These areas are indicated in Figure 1.

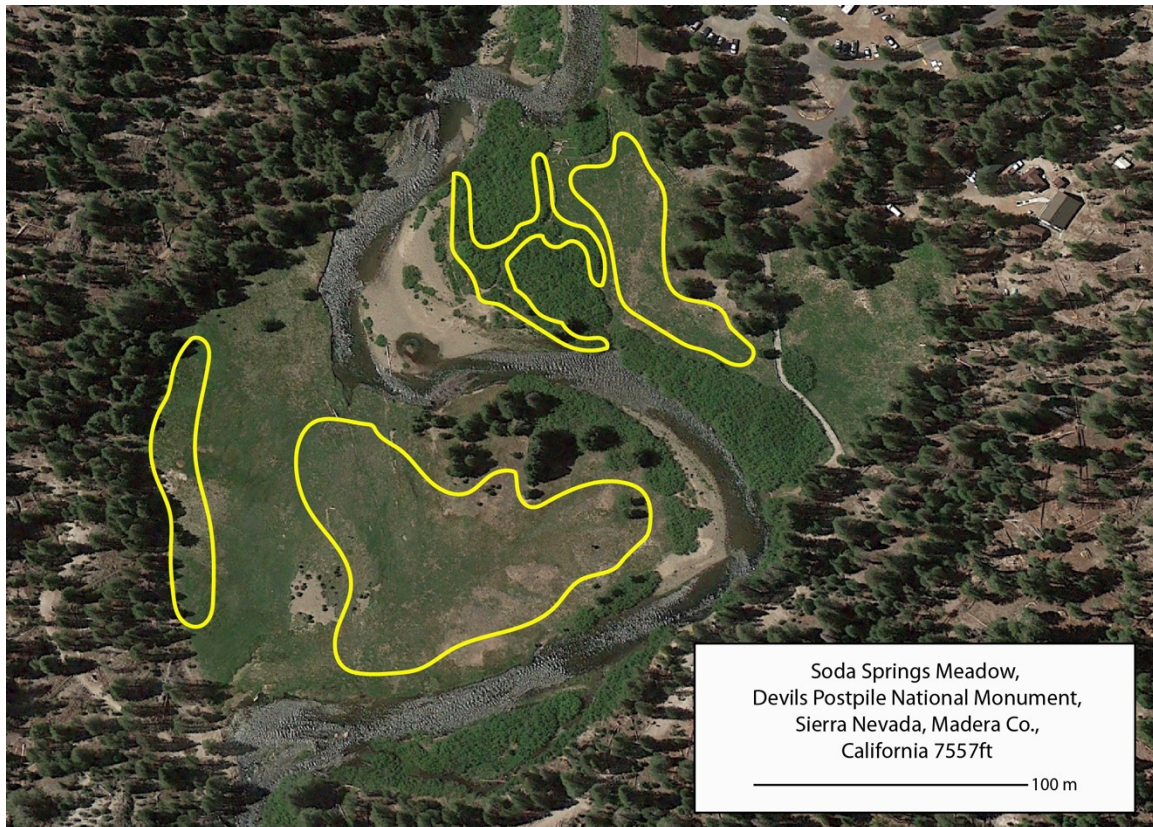


Figure 1. Sampling locations at Soda Springs Meadow, Devils Postpile National Monument, Sierra Nevada, Madera Co., California.

Species trapped or recorded by observation included:

Lipotyphla:	Soricidae:	<i>Sorex monticolus</i> [trapped]
	Talpidae:	<i>Scapanus latimanus</i> [burrows and runways]
Carnivora:	Canidae:	<i>Urocyon cinereoargenteus</i> [skeletal remains]
Rodentia:	Sciuridae:	<i>Urocitellus beldingi</i> [trapped, observed]
	Geomyidae:	<i>Thomomys monticola</i> [trapped]
	Cricetidae:	<i>Microtus longicaudus</i> [trapped]
	Cricetidae:	<i>Microtus montanus</i> [trapped]
	Dipodidae:	<i>Zapus princeps</i> [trapped]

Comments: Fresh pocket gopher (*Thomomys monticola*) mounds and old winter earthen snow cores were abundant throughout the meadow, especially in the larger, right (=west) bank part of the complex. Fresh sign was largely restricted to the edge of the meadow system in the better drained soils, especially in June, when the water table was high; winter snow cores were more abundant throughout the middle of the meadow where little gopher sign was evident during the summer months. Active broad-footed mole (*Scapanus latimanus*) runways were abundant in the wetter, but less densely vegetated part of the meadow, especially during our June visit. Montane voles (*Microtus montanus*) were captured both along the edge of the willow thicket on the left bank, as were montane shrews (*Sorex monticola*) the long-tailed vole (*Microtus longicaudus*) and

jumping mouse (*Zapus princeps*), and abundant runways were evidenced in the thicker, wetter grass on the right bank. Montane voles are restricted to wet meadows, and regular determination of their presence and density could offer a biotic window into meadow “health” in a drying climate over the coming decades.

2. jct Minaret Falls and Kings Creek/Fern Lake trails, Devils Postpile National Monument, Sierra Nevada, Madera Co., California 7582 ft 37.62745°N 119.08634°W [WGS84 datum]

Traplines were established in the dense, predominantly lodgepole pine on the western margin of Soda Springs Meadow at the trail junction. This area was trapped only in September 2016.

Species trapped or observed:

Rodentia:	Sciuridae:	<i>Callospermophilus lateralis</i> [trapped]
		<i>Glaucomys sabrinus</i> [trapped]
		<i>Tamias speciosus</i> [trapped; observed]
		<i>Tamiasciurus douglasi</i> [observed; heard]
	Cricetidae:	<i>Peromyscus maniculatus</i> [trapped]

Comment: Our capture of a flying squirrel (*Glaucomys sabrinus*) here, while perhaps unexpected, is still noteworthy. A survey of museum holdings for site localities of this species found only two records on the eastern slope of the Sierra Nevada, both from the immediate vicinity of Mammoth (both specimens in the collection at the Santa Barbara Museum of Natural History). MVZ has no specimens from the east side south of the Lake Tahoe basin, and the nearest specimen records to this one from DEPO are from Jeffrey pine / lodgepole pine forest at Merced Lake in Yosemite National Park (Mariposa Co.), about 20 miles NW of DEPO, and Huntington Lake (Fresno Co.), nearly 30 miles to the SSW. Conversations with people living today in or immediately around Mammoth suggest that this species can be relatively common, and readily seen, at bird feeders at night in predominantly Jeffrey pine forest. Nevertheless, our record confirms this species as a member of the mammal fauna of the Monument.

3. jct PCT/JMT and King Creek/Fern Lake trails, Devils Postpile National Monument, Sierra Nevada, Madera Co., California 7815 ft 37.62377°N, 119.08753°W [WGS84 datum]

Separate traplines were established along the King Creek/Fern Lake and PCT/JMP trails, as depicted in Figure 2. These lines were run during each of the three visits to the Monument. Vegetation here is open mixed conifer dominated by red fir with white fir, western white pine, and Jeffrey pine of secondary importance. Patches of manzanita, chinquapin, huckleberry oak, and Sierra gooseberry are also present

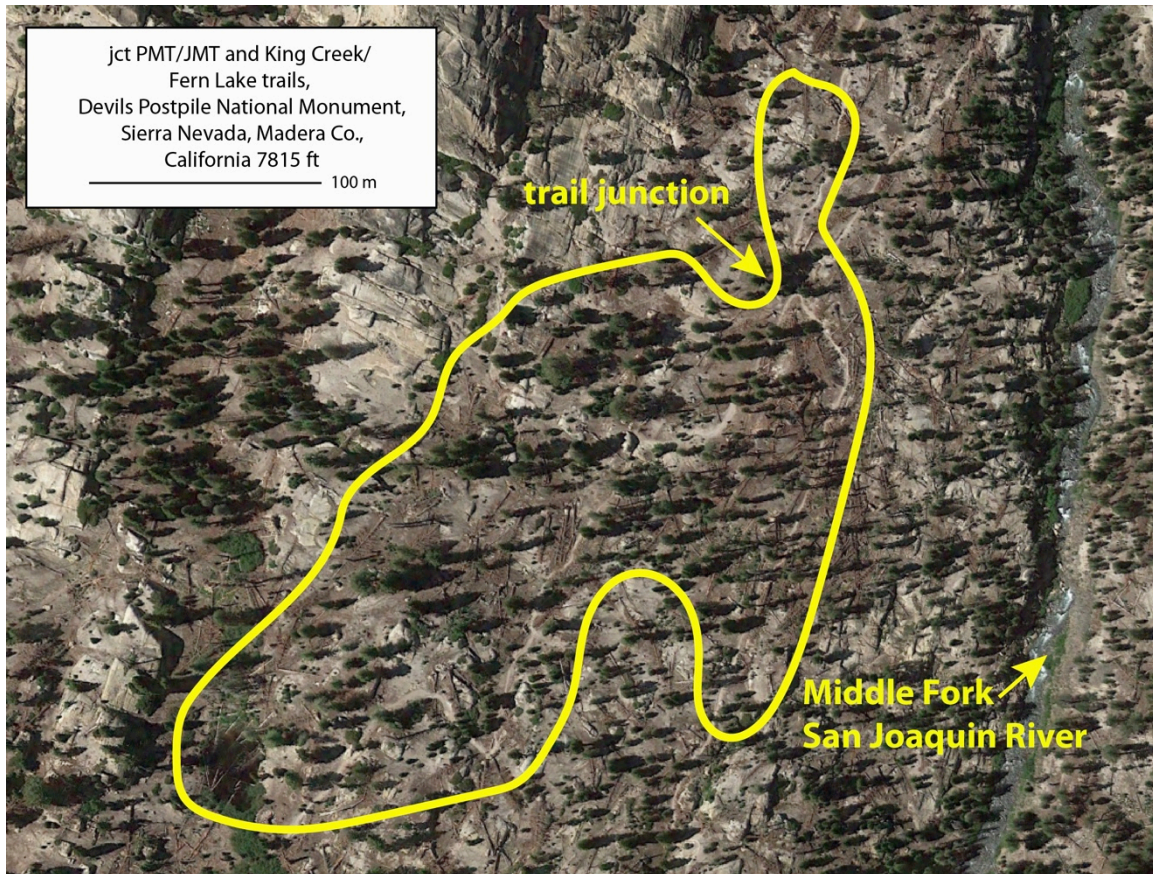


Figure 2. Sampling locations at jct PCT/JMT and King Creek/Fern Lake trails, Devils Postpile National Monument, Sierra Nevada, Madera Co., California.

Species trapped or observed:

Lipotyphla:	Soricidae:	<i>Sorex monticolus</i> [trapped]
Rodentia:	Sciuridae:	<i>Tamias speciosus</i> [trapped]
		<i>Callospermophilus lateralis</i> [trapped]
		<i>Tamiasciurus douglasi</i> [observed; heard]
Rodentia:	Cricetidae:	<i>Microtus longicaudus</i> [trapped]
		<i>Peromyscus maniculatus</i> [trapped]

Comments: We monitored this area during all three trap periods as chipmunk density, in particular, was extremely high in August of 2015 and we wished to obtain some information on over-winter survival and subsequent annual reproduction. Average trap success during the initial sampling period (animals per 24-hr period) was 40.4%. In contrast, average trap success was 10.3% for the following June 2016 sampling period, suggesting an over-winter mortality rate of nearly 66%. All individuals trapped in June were either 1st or 2nd year (or older) adults and in reproductive condition. By fall 2016, while average trap success increased only slightly, to 12.2%, the majority of captures (51%) were young-of-the-year, indicating that reproductive success this past year was quite good.

4. 0.6 mi N Rainbow Falls, right bank Middle Fork San Joaquin River, Devils Postpile National Monument, Sierra Nevada, Madera Co., California 7427 ft 37.61099°N 119.08560°W [WGS84 datum]

This area is on the right bank of the Middle Fork of the San Joaquin River a little over a half mile almost due north of Rainbow Falls and just south near where the PMT/JMP trail crosses the footbridge over the river. This area is an interesting series of narrow, parallel rounded ridges topped with granite outcrops and with intervening narrow, elongated wetland areas in otherwise mostly open Jeffrey pine. It was along one of these ridges where Harold Werner's crew caught two *Peromyscus boylii*, a species we would not expect in this habitat, but we confirmed the identification by DNA sequences derived from ear clips Werner's crew archived in the MVZ. The area we trapped is depicted in Figure 3.

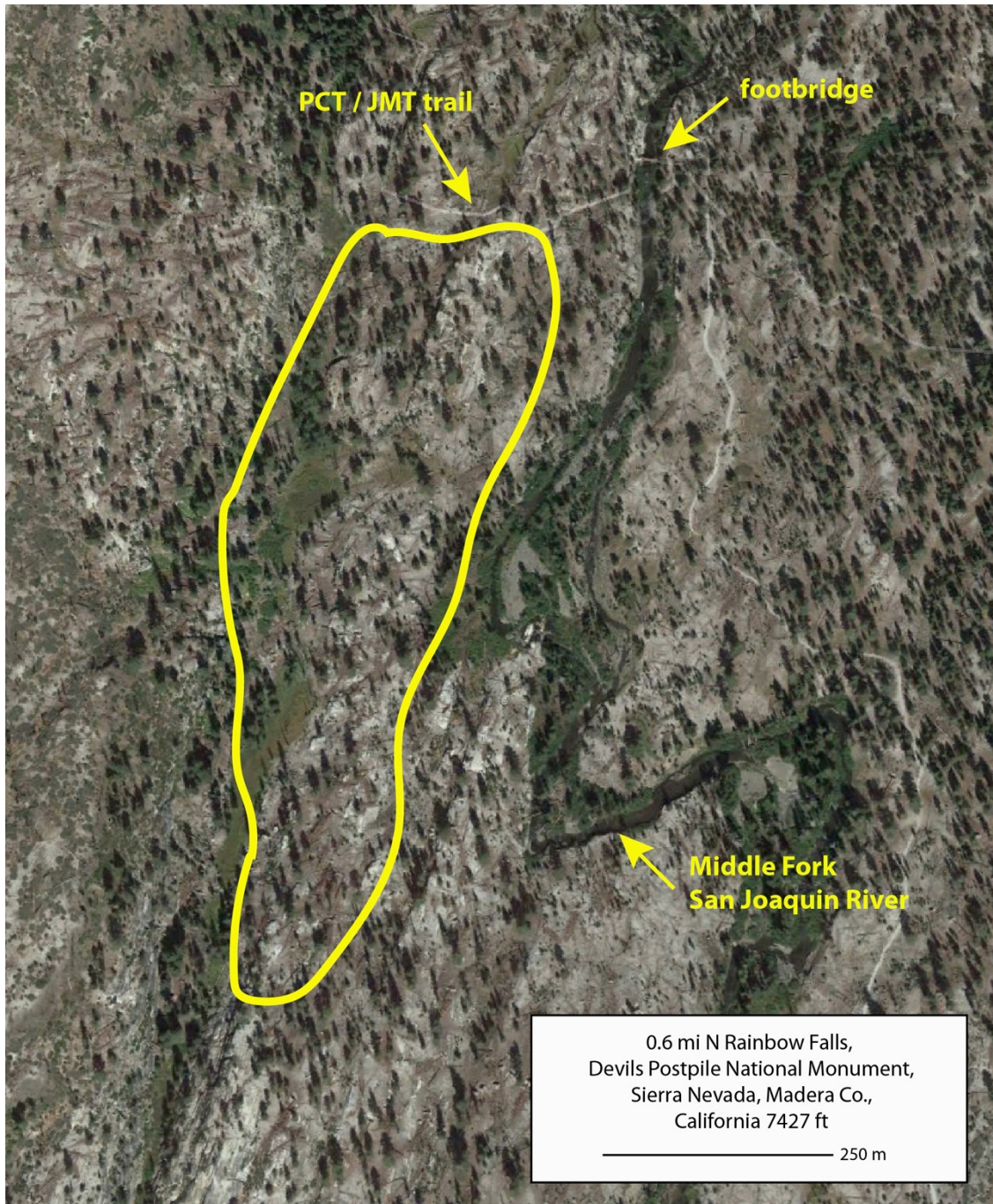


Figure 3. Sampling location 0.6 mi N Rainbow Falls, right bank Middle Fork San Joaquin River, Devils Postpile National Monument, Sierra Nevada, Madera Co., California.

Species trapped or observed:

Rodentia:	Sciuridae:	<i>Callospermophilus lateralis</i> [trapped]
		<i>Tamias speciosus</i> [trapped]
		<i>Tamiasciurus douglasi</i> [heard; seen]
	Cricetidae:	<i>Peromyscus maniculatus</i> [trapped]
		<i>Phenacomys intermedius</i> [trapped]

Comments: While we failed to trap any brush mice (*Peromyscus boylii*), we did obtain a single heather vole (*Phenacomys intermedius*), an unexpected record for this elevation and habitat. With a single exception (Glen Aulin, Yosemite National Park, where individuals were captured at two sites, one at 7800 and the other at 8175 feet elevation) historic and modern records of this species in the central Sierra Nevada are all between 9400 to 11,360 feet in elevation, mostly among moist patches of *Phyllodoce* or within clusters of western hemlock. The spot where this animal was trapped was on a dry, south-facing gentle slope at the base of a large exposure of granite, with the trap placed along a large (~30" diameter) Jeffrey pine log amid mostly open Jeffrey pine with a few lodgepole pine and red fir, and small clumps of Sierra gooseberry (*Ribes roezlii*) and whitethorn (*Ceanothus cordulatus*); the relatively fine-grained (<5 mm particles) pale-gray to nearly white pumice soil is covered by a layer of woody and pine duff debris.

5. **Rainbow Falls, Devils Postpile National Monument, Sierra Nevada, Madera Co., California 7417 ft 37.60008°N, 119.08324°W** [WGS84 datum]

Traplines were set in the extensive area that burned in the 1992 Red Fire (Figure 4) and had been converted from conifer forest to an extremely dense chaparral dominated by whitethorn ceanothus (*Ceanothus cordulatus*), manzanita (*Arctostaphylos patula*), Sierra gooseberry (*Ribes roezlii*), and wax current (*Ribes cereum*). The burned area is large, extending from well west of the monument's boundary to the top of the ridge that forms the eastern boundary of the river valley. Narrow washes with clumps of willows are present coursing down-slope to the river. Sparsely scattered lodgepole pine with many more standing dead trees and downed logs, remain emergent above the thick shrub layer. Young Jeffrey pine, from seedling size to mid-height (~3 m), are also scattered throughout. Dense grasses (3-4 species of bunch grass), small shrubs (such as rabbitbrush, *Ericameria nauseosa*, now in full flower), and numerous wildflowers (such as lupines, mint [*Monardella* sp.], and a carpet of red-stemmed *Gnaphalium canescens*) cover the ground between the wide expanses of whitethorn and other shrubs.

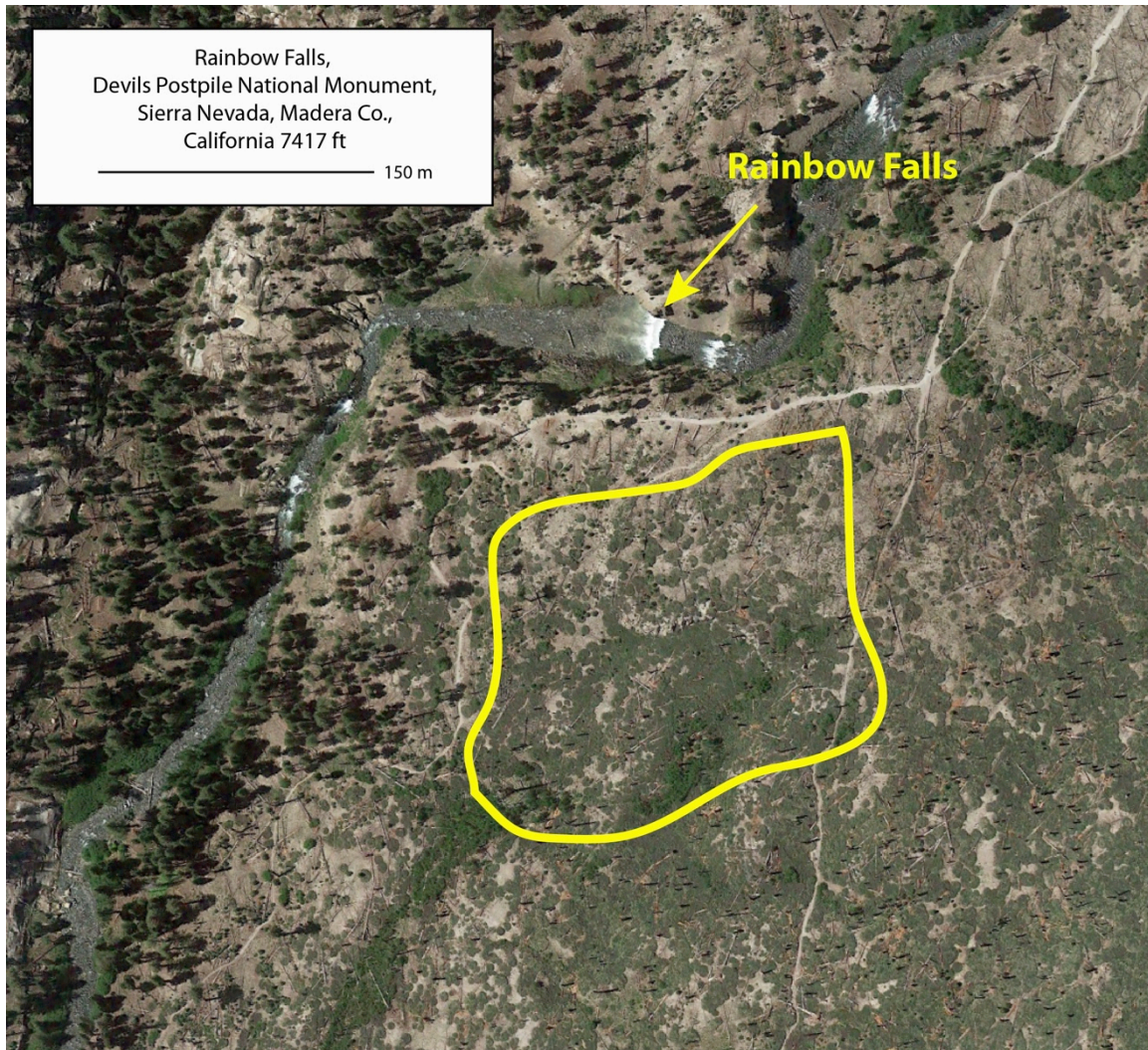


Figure 4. Sampling location at Rainbow Falls, Devils Postpile National Monument, Sierra Nevada, Madera Co., California.

Species trapped or observed:

Rodentia:	Sciuridae:	<i>Callospermophilus lateralis</i> (trapped)
		<i>Otospermophilus beecheyi</i> (tail tip, confirmed by DNA)
		<i>Tamias speciosus</i> (trapped)
Rodentia:	Geomyidae:	<i>Thomomys monticola</i> (trapped)
Rodentia:	Cricetidae:	<i>Neotoma cinerea</i> (trapped)
		<i>Peromyscus maniculatus</i> (trapped)
Carnivora:	Mustelidae:	<i>Mustela erminea</i> (trapped)

Comments: In this area we confirmed the presence of bushy-tailed woodrats (*Neotoma cinerea*) and ermine (*Mustela erminea*) as part of the Monument's mammalian fauna, and added the California ground squirrel (*Otospermophilus beecheyi*) to the list as

well. The latter was unexpected, and one wonders if it has moved upriver or come across the Sierran crest into the upper San Joaquin drainage (see below).

Satisfying our four original goals:

(1) build on the species list compiled in 2004 by Harold Werner, now retired wildlife ecologist in Sequoia-Kings Canyon National Parks, through increased effort and habitat coverage

Table 1 below summarizes the past and current list of non-volant (exclusive of bats) mammal species list within the boundary of Devils Postpile National Monument (DEPO). Data in the first three columns summarize those given by Werner in his 2004 report; data in the fourth column summarize results of our 2015-2016 surveys; and the final column presents the combined species list confirmed by trapping results and direct (visual sighting or vocalization heard) or indirect (skeletal parts recovered, burrow and/or runway constructions, scat, etc.) observations. Asterisks marking and 'X' in the fourth column highlight those species we either confirmed or added to the DEPO list; the two new species added to the list are highlighted in red.

Table 1. Comparison of species occurrence results from Werner (2004) and this study with an updated list of species present in Devils Postpile National Monument.					
Taxon	2003 trap results ¹	DEPO list ²	Suspected presence ³	2015-2016 trap results ⁴	DEPO list [confirmed]
Lipotyphla: Soricidae					
<i>Sorex monticolus</i>	X	X	.	X	X
<i>Sorex palustris</i>	.	X	.	.	.
<i>Sorex trowbridgii</i>	.	.	X	.	.
Talpidae					
<i>Scapanus latimanus</i>		.	X	X*	X
Rodentia: Aplodontiidae					
<i>Aplodontia rufa</i>	.	.	X	.	.
Sciuridae					
<i>Callospermophilus lateralis</i>	X	X	.	X	X
<i>Glaucomys sabrinus</i>	.	.	X	X*	
<i>Tamias speciosus</i>	X	X	.	X	X
<i>Marmota flaviventris</i>	.	X	.	.	.
<i>Otospermophilus beecheyi</i>				X*	X
<i>Tamiasciurus douglasi</i>	.	X	.	X	X
<i>Urocitellus beldingi</i>	X	X	.	X	X
Geomyidae					
<i>Thomomys monticola</i>	.	X	.	X	X
Dipodidae					
<i>Zapus princeps</i>	.	.	X	X*	X
Cricetidae					

<i>Microtus longicaudus</i>	X	X	.	X	X
<i>Microtus montanus</i>	.	.	X	X*	X
<i>Phenacomys intermedius</i>	.	.	.	X*	X
<i>Neotoma cinerea</i>	.	.	X	X*	X
<i>Peromyscus boylii</i>	X	X	.	.	X
<i>Peromyscus maniculatus</i>	X	X	.	X	X
<i>Peromyscus truei</i>	.	.	X	.	.
<i>Reithrodontomys megalotis</i>	.	.	X	.	.
Carnivora: Canidae					
<i>Canis latrans</i>	.	X	.	X	X
<i>Urocyon cinereoargenteus</i>	.	.	X	X*	X
Ursidae					
<i>Ursus americanus</i>	.	X	.	X	X
Procyonidae					
<i>Bassariscus astutus</i>					
<i>Procyon lotor</i>					
Mustelidae					
<i>Martes americana</i>	X	X	.	.	X
<i>Mustela erminea</i>	.	X	.	X	X
<i>Mustela frenata</i>	.	X	.	.	X
<i>Pekania pennanti</i>	.	.	.	.	.
<i>Taxidea taxus</i>	.	.	X	.	.
Felidae					
<i>Lynx felis</i>		.	X	.	.
<i>Puma concolor</i>		.	X	.	.

1 = Table 1 in Werner report; 2 = Table A-IV; and based additional museum records from nearby localities;
3 = Table A-V; 4 = species identified by * are either new additions to the Monument's mammalian fauna or
are confirmations of those suspected to be present, based on vouchered records from nearby localities.

(2) assess the species diversity of certain taxa, especially shrews of the genus *Sorex*

Our work failed to expand the list of shrews potentially present within DEPO, as we trapped only the common montane shrew (*Sorex montanus*). More extensive effort in the narrow riparian corridors along several of the narrow streams entering the Middle Fork of San Joaquin River are needed, especially those using pitfall cups. Two additional species may be recovered by this method, including the Inyo shrew (*Sorex tenellus*) and Lyell shrew (*Sorex lyelli*); both turn out to be relatively widespread in Yosemite at similar elevations.

(3) accumulate data to assess the biogeographic placement of the Monument's mammal fauna relative to west-slope versus east-slope elements in the central Sierra Nevada

Thorough phylogeographic analyses using sophisticated genomic tools, of collected specimens from multiple localities on both sides of the Sierran divide, including

those from the upper San Joaquin River from DEPO, will likely be required to achieve this objective. Such a study is beyond the scope of our limited project, although the few specimens preserved and archived (as standard museum preparations of study skin with skull and skeleton as well as with tissue samples preserved in liquid nitrogen) in the Museum of Vertebrate Zoology will prove central should such work be undertaken. As it is, we attempted to ascertain whether the single specimen of California ground squirrel (*Otospermophilus beecheyi*) could be attributed to an east slope or west slope origin by examining the sequence of this specimen's mitochondrial DNA cytochrome b gene and comparing that sequence to others that delineate strongly supported mitochondrial clades. Unfortunately, as is apparent in Figure 5, the results are equivocal, as the sequence of this animal belongs to a “southern Sierra clade”, one that is broadly distributed on both sides of the southern Sierra Nevada.

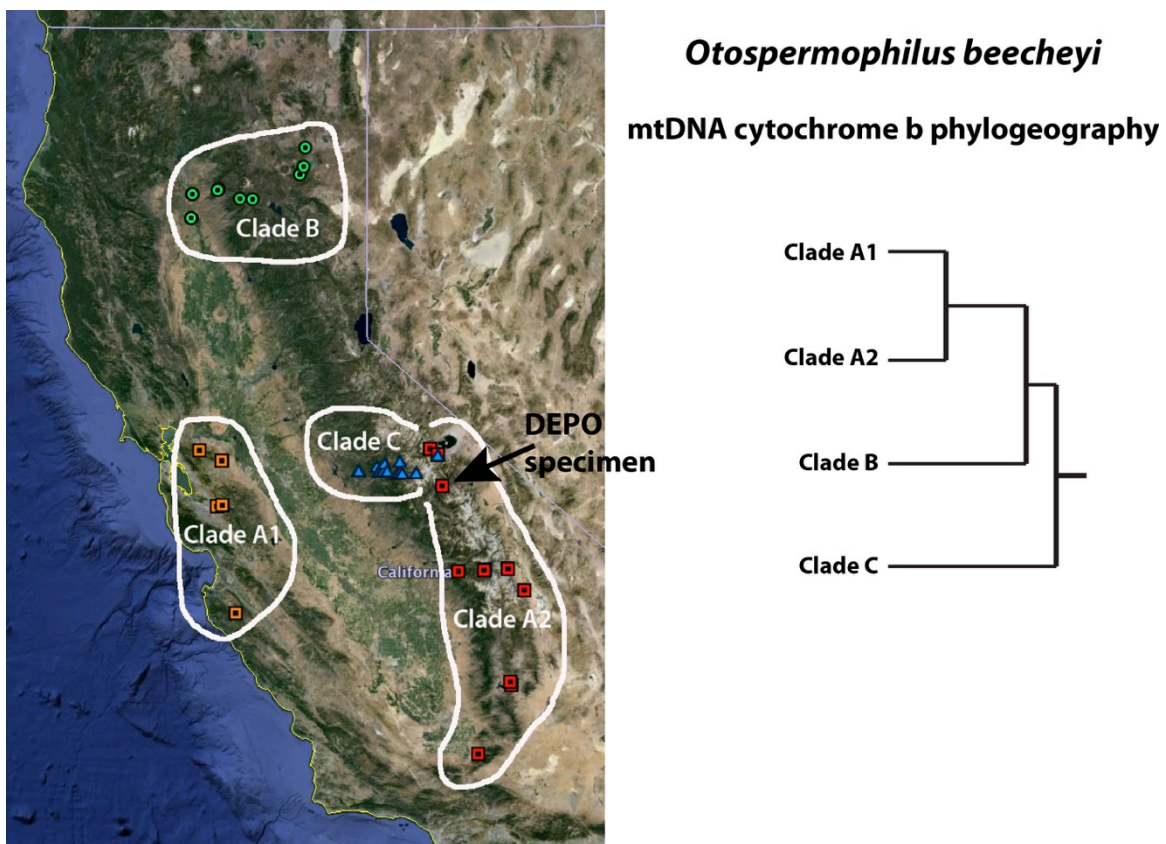


Figure 5. Map and cladogram showing distribution of *Otospermophilus beecheyi* clades in the Sierra Nevada, California.

(4) provide an assessment of the suitability of Soda Springs Meadow as a potential cold air refugium, especially with reference to Belding's ground squirrel (*Urocitellus beldingi*)

Toni Lyn Morelli, research ecologist at the USGS North Climate Science Center, joined us in June 2016 to broaden her sampling of Belding ground squirrel (*Urocitellus beldingi*) genetic samples. She is a leading scholar on historical range contraction of Belding ground squirrels (see Morelli et al. 2012. Anthropogenic refugia ameliorate the

severe climate-correlated decline of a montane mammal along its trailing edge. Proc. Royal Soc. B 279:4279-4286) and climate change refugia (see Morelli et al. 2016. Managing climate change refugia for climate adaptation. PLOS One, 11[8], p.e0159909). She took ear clips for genetic analysis from 9 individuals from Soda Springs Meadow, and we took one additional sample in September 2016; these are now archived in the frozen tissue collection of the MVZ. To date no genetic work has been done on these.

Populations of both Belding ground squirrels and montane voles resident in Soda Springs Meadow, which is in a cold air pool, would be worthy of periodic (yearly?) monitoring, to judge the utility of the meadow to serve as a climate refuge as temperatures continue to rise. It would be a simple process to develop protocols for monitoring both species (involving scan sampling methods on a defined schedule for the ground squirrel and line-transect counts of active and inactive runways for the vole) that could be easily accomplished by seasonal interns provided with rudimentary training. We encourage such a monitoring program to be developed and implemented, and would be more than willing to help in establishing either protocol.

Specimens Collected

Patton prepared museum voucher specimens from 65 individuals collected over the three trapping periods; many of these were trap mortalities but a few were taken as vouchers to document the actual presence of a particular species in the Monument (e.g., singleton specimens of *Glaucomys sabrinus*, *Microtus montanus*, *Neotoma cinerea*, *Phenacomys intermedius*, and *Zapus princeps*). The single specimen of *Otospermophilus beecheyi* is represented by only the terminal 3 inches of its tail, which was caught in a trap too small to hold the entire animal. These specimens have been accessioned into the mammal collections of the Museum of Vertebrate Zoology, UC-Berkeley, accession numbers MVZ:Mamm:15142 (MVZ:Mamm:catalog numbers 232119-232162), MVZ:Mamm:15237 (MVZ:Mamm:catalog numbers 232872-232882), and MVZ:Mamm:15246 (MVZ:Mamm:catalog numbers 232971-232980). The Belding ground squirrel ear clips collected by Toni Lyn Morelli are cataloged as accession MVZ:Mamm:15238 (MVZ:Mamm:catalog numbers 232883-232891). All accessions can be accessed via the MVZ database (<http://arctos.database.museum/SpecimenResults.cfm>) where all data (identification, locality, date of collection, sex, external measurements, preparation parts, etc. can be downloaded as a spreadsheet). NPS catalog numbers can be assigned to each specimen and, when returned to us, will be added to the specimens and database.