**Supplementary Information**

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**Supplementary Methods**

*Survey Regions and 20th Century Climate Change*

The three regions of montane California differed considerably in climate and physiognomy. The northern region (Lassen) was the coolest and wettest, and had the smallest elevation range and the least topographic complexity. The southern region (Sequoia) was the driest, and had the largest elevation range and greatest topographic complexity. Climate change over the past century differed among the three regions (Fig. 1b). The central region (Yosemite) experienced the greatest and the northern region the least increase in mean annual temperature, whereas precipitation increased in both but not in the southern region. Across all three regions, maximum temperature of the warmest month was constant, whereas minimum temperature of the coldest month increased (Supplementary Figure S1).

*Survey and Resurvey Data*

We used historical maps, written descriptions in field notes, and modern ground-truthing with historical photographs and hand-held GPS units to georeference historical localities. Modern trapline coordinates were obtained from handheld GPS units, with coordinates recorded at the beginning, middle, and end of each trapline. We determined the elevation of each historical and modern trapline using a digital elevation model (DEM) derived from the Shuttle Radar Topography Mission (v4) with a resolution of 1 arc sec and verified these values by manual comparison to elevations determined on the ground or on topographic maps (Supplementary Table S1).

Of the 134 historical localities, 34 were in the Northern, 47 were in the Central, and 32 were in the Southern region of montane California (Fig. 1a). Each site was surveyed for 1-16 nights (median = 5) for a total of 681 survey-nights. For most sites, surveys were conducted over consecutive nights. Historical trapping efforts used snap traps, Macabee gopher traps, mole traps, and steel traps that were set in suitable locations in various habitats around a central camp. For each historical site, the average number of traps per night ranged from 6 - 335 (median = 96). Shooting and observations resulted in additional opportunistic records of diurnal mammals, primarily squirrels and pikas. Of the 15,277 historical mammal records used in this study, 8,688 are backed by voucher specimens in the MVZ1-3.

Modern mammal resurveys were conducted between 2003 and 2010 as part of the Grinnell Resurvey Project4,5; Fig. 1a). We surveyed a total of 166sites, including 85 of the 134 historical sites; 38 were in the Northern, 81 were in the Central, and 47 were in the Southern region of montane California. Additional modern sites were selected to maximize elevation coverage and to serve as proxies for historical sites that were otherwise inaccessible. We surveyed each site for 1-11 nights (median = 6) for a total of 916 survey-nights. As with historical surveys, most modern surveys at a site were conducted over consecutive nights. Using historical locality maps and habitat descriptions recorded in field notebooks, we set traplines to sample historical sites as closely as possible. We used a combination of Sherman traps and Tomahawk traps, with standard traplines containing 40 Sherman traps and 10 Tomahawk traps run for 4 consecutive nights in suitable spots. Pitfall traps, consisting of 32-oz plastic cups placed in the ground, were used to collect shrews and were set at the same time as the Sherman lines. Pocket gophers were trapped using Macabee gopher traps where gopher mounds were observed. For each modern site, the average number of traps per night ranged from 3-339 (median=65). Additional observational records were recorded daily. Of the 14,316 modern mammal records obtained from these surveys, 6,144 are backed by voucher specimens in the MVZ6-8.

*Species Set*

Our data set included records for 67 species of small mammals in the modern and/or historical eras (Supplementary Table S2). Our resurvey protocols were not designed to detect carnivores, ungulates, or bats, so these were not included. Following Moritz et al.4, we adjusted the slope cut-off for *Peromyscus truei* to reflect known boundaries between Sierra Nevada and Great Basin subspecies9. We also considered only those west slope species that are characteristic of the Sierra Nevada and Cascade Range. For example, we did not include Mojave Desert species such as *Neotoma lepida* or *Perognathus longimembris*.

*Modelling Changes in Elevational Ranges*

To simultaneously estimate the probability of detection (*p*) and the probability of occupancy (*Ψ*) of each species at each locality, we used the single-season occupancy modelling framework implemented in the program MARK v6.010,11). Our single-season model implemented an “unpaired-site” framework12, which tests for temporal changes in occupancy by fitting time period (‘era’) as a covariate effect. To fit these models we included the 28 species and 228 sites for which quantitative trapping data were available. We used the package ‘RMark’ v2.0.1 in the R v2.12.2 framework to build design matrices, combine models, and to compare AIC weights among models13.

To develop detection-adjusted elevation range profiles for each species in each era and region, we parameterized 25 occupancy models (*Ψ*) building on the model set of Moritz et al.4 and Tingley et al.5. The 25 models included all 2- and 3-way interactions among the following variables: era (categorical: historical or modern), elevation (linear), elevation (quadratic) and region (categorical: Northern, Central, or Southern), as well as a constant model (.). The full model set is listed in Supplementary Table S5. Following Moritz et al.4 we estimated the probability of detection per survey night (*p*) based on 34 competing models with the following variables: era (historical or modern), trend (linear change in detections over sequential nights due to the collection of trapped individuals, trap habituation or to trap-shyness), trap effort (number of traps/100 and the log10 of the number of traps), the interaction between era and trend, and the interactions between era and trap effort variables. We built detection models with all additive combinations of these independent variables, as well as a constant model (.). The full candidate model set is listed in Supplementary Table S5. We ran this full candidate *p* model set with two parameterizations of *Ψ*: a constant model and a fully parameterized model. From these analyses, we selected the set of *p* models that incorporated the best (lowest AIC) model and all models with ΔAIC < 2 for each species (Supplementary Table S3). This subset of *p* models (*n* = 16) were then combined with the full set of 25 *Ψ* models for a total of 400 competing models that were run for each species and compared using AIC4.

Following Moritz et al.4, we estimated temporal shifts in the lower and upper range limits for each species on each of the three regions. For elevation distributions, we used all detection data including quantitatively trapped specimens, incidentally collected (shot or salvaged) specimens, and observational records (Supplementary Figure S2). We plotted all localities in each transect for each era against elevation, and coded each species at a locality as present or undetected. We then calculated the change in elevation of each range limit from the historical to the modern era. To test the significance of these shifts, we estimated site-specific detection probabilities (*p\**) by model averaging model-specific *p* estimated using AIC weights from our 400 occupancy models14,4 (Supplementary Figure S3).

*Testing Predictions of Range Shifts*

We used generalized linear mixed models (GLMM) to examine how patterns of range shifts were related to regional variation and the elevational distributions of species. All GLMM models used a logit link and were run in R with the ‘lme4’ package15. Species identity was included as a random effect and model performance was assessed by AIC. We first used GLMMs to evaluate what factors were associated with occurrence of a range shift (as a binary variable). Species widespread across elevations (*P. maniculatus* and *O. beecheyi*) were excluded from this analysis. We defined 12 models comprised of a null model (intercept only) and all additive combinations and one-way interactions between 3 categorical explanatory variables: (1) limit (upper or lower elevation range limit), (2) region, and (3) zone (low or high elevation species). Second, to resolve interaction effects associated with zone, we then analysed low elevation and high elevation species separately, retaining limit and region variables.

We used one-sided binomial tests to evaluate whether upslope shifts were the most common across regions (Prediction 1), whether range contractions were more likely in high elevation species and range expansions were more common in low elevation species (Prediction 2), and to evaluate whether the patterns of range shifts were consistent across regions (Prediction 3). For each of these analyses, we included only those species that exhibited significant shifts determined from the *Pfa* analysis above.

*Climatic Nearest Neighbour*

We examined spatial heterogeneity in climate change (Prediction 4) by identifying the nearest climatic neighbours of historical localities under modern climate conditions, following the approach described in Tingley et al.5. Using four standard BIOCLIM variables (mean annual temperature, B1; maximum temperature of the warmest month, B5; minimum temperature of the coldest month, B6; and mean annual precipitation, B12) from the Parameter-elevation Regressions on Independent Slope Model (PRISM16 at a resolution of 30 arc-second (1 km2), we calculated 20-year averages for the historical (1910-1930) and modern (1989-2009) survey periods. Climatic distances for each of the BIOCLIM variables were calculated between each historical locality and modern era PRISM grid cells within the same region, which was defined by a 20-kilometer buffer around the minimum convex polygon that encompassed all survey sites. For each historical site, we identified the 5% of modern cells that were nearest climatically and the 5% of historical cells that were nearest climatically. This was calculated separately for each climatic variable using the Euclidian distance. We subtracted the elevation of the historical site from the average elevation of the modern nearest climate neighbour cells; positive values indicated upslope movement in climate space. We recorded these values (positive or negative) for the two historical localities defining the upper and lower limits of each species on each transect. These values provided a climate-based prediction for movement of species at their range limits for each region (i.e., upslope or downslope). We compared these climate-data derived models to an “overall warming model” that assumes an increased temperature at all grid cells over the same time period, which always predicted upslope movements. For each climatic variable at each site, we also identified rare or disappearing climates using climatic thresholds of 1 °C temperature or 10 cm precipitation. We defined rare climates as those that occurred within climatic thresholds at < 2.5% of historical cells. We defined disappearing climates as those that occurred within climatic thresholds at ≥ 5% of historical cells and < 2.5% of modern cells. We excluded this subset of site-specific climate change from nearest neighbour comparisons because they violate an assumption of the method that climatically similar sites are available. We used a one-sided binomial to test if the upslope movement predicted from the overall warming model and predictions from each of the BIOCLIM variables were consistent with the direction of observed shifts (Prediction 4).

**Supplementary Methods References**

1. <http://arctos.database.museum/project/historic-grinnell-survey-lassen-transect>
2. <http://arctos.database.museum/project/historic-grinnell-survey-yosemite-transect>
3. <http://arctos.database.museum/project/historic-grinnell-survey-southern-sierra-nevada-transect>
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# Supplementary Figure Legends

Supplementary Figure S1. Violin plot of BIOCLIM variables included in this study. Each plot represents all cells within 20-kilometer buffer around the minimum convex polygon that encompassed all survey sites for (a) B1 (mean annual temperature), (b) B5 (maximum temperature of the warmest month), (c) B6 (minimum temperature of the coldest month), and (d) B12 (mean annual precipitation) for each region in the historical and modern eras. Median and the upper and lower quartiles are represented by the white circle and black bar, respectively.

Supplementary Figure S2. Distribution by elevation and region of all 67 species of small mammal detected within the study regions over both eras. Green diamonds and crosses represent species presences recorded through quantitative (e.g., Sherman live trap) or non-quantitative (e.g., Shotgun) trapping effort, respectively. Blue crosses represent species presences recorded through observation alone. For species subject to detectability analysis, the size of the open circle represents site-specific detectability. Grey circles represent elevation of surveyed sites for those species not subject to detectability analysis.

Supplementary Figure S3. Occupancy curves in the historical and modern eras by region for the 28 occupancy-modelled small mammal species. Curves represent the probability of occupancy in the historical (dark blue) and modern (green) eras across elevations with the elevation of sites surveyed in each era given by triangles (historical) and circles (modern).

# Supplementary Tables

Supplementary Table S1. Historical and modern locality data for sites included in this study.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Aggregate name | Latitude | Longitude | Era | Slope | Region | Elevation (m) |
| Red Bluff 4 | 40.1903286 | -122.2252066 | H | W | N | 83 |
| Red Bluff 5 | 40.2121782 | -122.2297661 | H | W | N | 89 |
| Red Bluff 3 | 40.1707 | -122.1254 | H | W | N | 90 |
| Red Bluff 1 | 40.1339 | -122.2061 | H | W | N | 92 |
| Battle Creek | 40.37479 | -122.18016 | H | W | N | 103 |
| Red Bluff 2 | 40.24038 | -122.110955 | H | W | N | 167 |
| Red Bluff 6 | 40.3221638 | -122.2855723 | H | W | N | 177 |
| Dales, Payne Creek | 40.3146 | -122.0695 | H | W | N | 208 |
| Manton | 40.425439 | -121.889271 | H | W | N | 535 |
| Lymans | 40.3096 | -121.7678 | H | W | N | 1051 |
| Turners | 40.30825 | -121.738116 | H | W | N | 1335 |
| Petes Valley | 40.52927 | -120.46209 | H | E | N | 1382 |
| Mineral 3 | 40.3377636 | -121.5961291 | H | W | N | 1478 |
| Eagle Lake 3 | 40.5729252 | -120.838016 | H | W | N | 1561 |
| Eagle Lake 2 | 40.6709426 | -120.7895831 | H | W | N | 1564 |
| Mineral, Summit Creek 2 | 40.3628 | -121.5663 | H | W | N | 1583 |
| Eagle Lake 1 | 40.73439 | -120.719636 | H | W | N | 1586 |
| Grasshopper Valley | 40.850087 | -120.756895 | H | E | N | 1616 |
| Termo | 40.8915 | -120.4564 | H | E | N | 1622 |
| West Red Rock PO | 40.8995 | -120.25399 | H | E | N | 1626 |
| Mineral, Summit Creek 1 | 40.3489 | -121.5878 | H | W | N | 1627 |
| North Observation Peak 1 | 40.86135 | -120.17049 | H | E | N | 1628 |
| East Ravendale | 40.79823 | -120.23207 | H | E | N | 1668 |
| Willow Lake | 40.4052369 | -121.3657268 | H | W | N | 1672 |
| Kellys 2 | 40.4326779 | -121.3520687 | H | W | N | 1675 |
| North Fredonyer Peak | 40.801001 | -120.61175 | H | E | N | 1711 |
| South West Ravendale | 40.6969 | -120.409 | H | E | N | 1717 |
| Hot Spring Valley | 40.44423 | -121.3938 | H | W | N | 1784 |
| Manzanita Lake | 40.5314 | -121.5648 | H | W | N | 1790 |
| Butte Lake | 40.5642 | -121.3023907 | H | W | N | 1845 |
| Black Butte | 40.4147 | -121.5319 | H | W | N | 1971 |
| Warner Creek 1 | 40.4596926 | -121.4418428 | H | W | N | 2061 |
| Warner Creek 2 | 40.4635115 | -121.4719669 | H | W | N | 2462 |
| Lake Helen | 40.469128 | -121.518495 | H | W | N | 2514 |
| Sacramento River, Blue Tent Creek | 40.2026 | -122.21628 | M | W | N | 80 |
| Coyote Creek | 40.09325 | -122.22687 | M | W | N | 92 |
| Sacramento River, Perry Riffle | 40.29721 | -122.17534 | M | W | N | 97 |
| Jellys Ferry | 40.319965 | -122.18149 | M | W | N | 103 |
| Reading Island | 40.38927333 | -122.1922033 | M | W | N | 111 |
| Paynes Creek | 40.30254 | -122.10614 | M | W | N | 168 |
| Dales Lake | 40.330645 | -122.072605 | M | W | N | 207 |
| Hog Lake | 40.28261 | -122.12289 | M | W | N | 270 |
| Vasquez Ranch | 40.436528 | -121.875444 | M | W | N | 608 |
| Lyman Springs | 40.31124 | -121.764275 | M | W | N | 1044 |
| Petes Valley | 40.52613667 | -120.4655133 | M | E | N | 1383 |
| Battle Creek | 40.34945 | -121.631705 | M | W | N | 1459 |
| Battle Creek Meadows | 40.33948 | -121.609185 | M | W | N | 1468 |
| Eagle Lake, Merrill Creek | 40.552305 | -120.814665 | M | W | N | 1559 |
| Eagle Lake Pine Creek | 40.66796 | -120.78612 | M | W | N | 1566 |
| Eagle Lake, Brockman | 40.59293 | -120.844295 | M | W | N | 1584 |
| Summit Creek | 40.35804 | -121.55757 | M | W | N | 1616 |
| Wilson Lake | 40.344115 | -121.439425 | M | W | N | 1620 |
| Coyote Flat | 40.88974 | -120.26846 | M | E | N | 1621 |
| Eagle Lake, Papoose Meadow | 40.525815 | -120.76727 | M | W | N | 1628 |
| Observation Peak 1 | 40.86155 | -120.1599 | M | E | N | 1631 |
| Observation Peak 2 | 40.84532 | -120.17653 | M | E | N | 1632 |
| Dodge Ranch | 40.89014 | -120.17355 | M | E | N | 1632 |
| Horne Ranch | 40.82822 | -120.13889 | M | E | N | 1647 |
| Slate Creek | 40.842596 | -120.769944 | M | E | N | 1663 |
| Willow Lake | 40.40586 | -121.362885 | M | W | N | 1680 |
| Tuledad Road | 40.92563 | -120.13857 | M | E | N | 1696 |
| Bailey Creek | 40.805722 | -120.610026 | M | E | N | 1702 |
| Summit Creek North | 40.3689 | -121.53831 | M | W | N | 1723 |
| Dodge Reservoir | 40.96926 | -120.135055 | M | E | N | 1759 |
| Pole Spring | 40.5872 | -121.2870167 | M | W | N | 1783 |
| Drakesbad | 40.444655 | -121.4085 | M | W | N | 1785 |
| Manzanita Lake | 40.53759 | -121.57018 | M | W | N | 1791 |
| Butte Lake | 40.562405 | -121.29966 | M | W | N | 1850 |
| Bluff Falls | 40.4122025 | -121.531905 | M | W | N | 1990 |
| Kings Creek Falls | 40.45971 | -121.44478 | M | W | N | 2100 |
| Upper Kings Creek Meadow | 40.46521 | -121.4764 | M | W | N | 2276 |
| Helen, Emerald Lakes | 40.4697275 | -121.5139775 | M | W | N | 2491 |
| Minkler | 36.7166 | -119.4641 | H | W | S | 118 |
| Bakersfield | 35.4198391 | -119.0087676 | H | W | S | 180 |
| Dunlap | 36.717103 | -119.132257 | H | W | S | 636 |
| Bodfish | 35.600131 | -118.496674 | H | W | S | 721 |
| Mill Creek | 35.5305856 | -118.6221592 | H | W | S | 787 |
| Weldon, South | 35.666083 | -118.28948 | H | W | S | 809 |
| Onyx | 35.685739 | -118.21827 | H | E | S | 865 |
| Weldon, Fay Creek North | 35.7412 | -118.31 | H | W | S | 1261 |
| Walker Pass 06 | 35.6692 | -118.0371 | H | E | S | 1416 |
| Walker Pass 05 | 35.6877503 | -118.0493023 | H | E | S | 1424 |
| Walker Pass 07, Freeman Canyon | 35.6501 | -118.0109 | H | E | S | 1481 |
| Kings River Canyon | 36.7938 | -118.581 | H | W | S | 1529 |
| Hume Lake | 36.787727 | -118.913013 | H | W | S | 1592 |
| Carroll Creek | 36.5051 | -118.10244 | H | E | S | 1699 |
| Smith Meadow, Trout Creek | 35.96474 | -118.22947 | H | W | S | 1860 |
| Kiavah Mountain, Scodie Mountains | 35.682227 | -118.085094 | H | E | S | 1959 |
| Jordan Hot Springs | 36.229654 | -118.30169 | H | W | S | 1984 |
| Hockett Trail 1 | 36.49339 | -118.13676 | H | E | S | 2000 |
| Hockett Trail 4 | 36.49577 | -118.1123 | H | E | S | 2142 |
| Taylor Meadow | 35.830658 | -118.29175 | H | W | S | 2147 |
| Cannell Meadow | 35.825082 | -118.36717 | H | W | S | 2268 |
| Hockett Trail 3 | 36.477695 | -118.137275 | H | E | S | 2281 |
| Hockett Trail 5 | 36.49732 | -118.11483 | H | E | S | 2313 |
| Horse Corral Meadow | 36.74744 | -118.75404 | H | W | S | 2314 |
| Jackass Meadow | 36.092861 | -118.2262 | H | W | S | 2364 |
| Broder/Monache Meadow | 36.16332 | -118.18188 | H | W | S | 2424 |
| Dry Meadows | 36.214523 | -118.25257 | H | W | S | 2624 |
| Redrocks Meadow | 36.270108 | -118.271385 | H | W | S | 2657 |
| Onion Valley | 36.77438267 | -118.3310457 | H | W | S | 2732 |
| Sirretta Meadows | 35.942 | -118.328 | H | W | S | 2755 |
| Little Pete Meadow | 37.101522 | -118.5958 | H | W | S | 2761 |
| Aster Lake | 36.6001448 | -118.6748248 | H | W | S | 2796 |
| McClure/Colby Meadows | 37.1713 | -118.7024 | H | W | S | 2952 |
| Rock Creek | 36.496066 | -118.326482 | H | W | S | 2954 |
| Whitney Meadow | 36.434131 | -118.2671 | H | W | S | 2969 |
| Little Cottonwood Creek | 36.47914 | -118.128635 | H | W | S | 2997 |
| Little Brush Meadow, Olancha Peak | 36.2541 | -118.13 | H | W | S | 3005 |
| Hockett Trail 2 | 36.49415 | -118.09586 | H | E | S | 3036 |
| Bubbs Creek | 36.763891 | -118.406272 | H | W | S | 3040 |
| Mitchell Peak | 36.732308 | -118.713693 | H | W | S | 3128 |
| Crabtree Meadow, Whitney Creek | 36.551234 | -118.35854 | H | W | S | 3147 |
| Flower/Heart Lake | 36.7695434 | -118.3561116 | H | W | S | 3177 |
| Moose Lake | 36.600674 | -118.637441 | H | W | S | 3214 |
| Bullfrog Lake | 36.772973 | -118.403983 | H | W | S | 3249 |
| Olancha Peak, West Slope | 36.259758 | -118.123273 | H | W | S | 3287 |
| Evolution Lake | 37.1686 | -118.6933 | H | W | S | 3313 |
| Cottonwood Lakes | 36.498147 | -118.220007 | H | W | S | 3384 |
| Dusy Lake | 37.102299 | -118.555 | H | W | S | 3392 |
| Humphreys Basin | 37.2653 | -118.7056 | H | W | S | 3460 |
| Piute Pass, off trapline | 37.231039 | -118.68916 | H | W | S | 3474 |
| Cirque Peak | 36.461735 | -118.238346 | H | W | S | 3503 |
| Kearsarge Pass | 36.7725 | -118.3761 | H | E | S | 3575 |
| Mt. Gould | 36.78039 | -118.37854 | H | W | S | 3940 |
| Minkler 04, Jesse Morrow Mountain | 36.712887 | -119.416629 | M | W | S | 135 |
| Minkler 01, 02, 03 | 36.7504894 | -119.4403854 | M | W | S | 138 |
| Bakersfield | 35.5138617 | -118.8709479 | M | W | S | 231 |
| Bakersfield, Jackrabbit Flat | 35.49501 | -119.0572608 | M | W | S | 250 |
| Dunlap, Mill Creek | 36.7301617 | -119.1186399 | M | W | S | 583 |
| Bodfish 04, Sandy Flat Campground | 35.587765 | -118.440047 | M | W | S | 705 |
| Bodfish 01, 02 | 35.599554 | -118.4967251 | M | W | S | 732 |
| Mill Creek | 35.5353281 | -118.6173197 | M | W | S | 741 |
| Weldon 02, 03, 06, 08, South | 35.6785335 | -118.2953012 | M | W | S | 810 |
| Kelso Creek Road | 35.63622 | -118.24572 | M | W | S | 861 |
| Onyx 01, 03, Canebrake Ecological Reserve | 35.7284779 | -118.1716634 | M | E | S | 866 |
| Onyx 02, 04, Scodie Canyon | 35.6794096 | -118.2144064 | M | E | S | 906 |
| Bodfish 03, Erskine Creek | 35.587765 | -118.440047 | M | W | S | 932 |
| Weldon 01, 05, 07, 09, Fay Ranch Road, Fay Creek North | 35.7163161 | -118.3052221 | M | W | S | 999 |
| Olancha Creek | 36.27383 | -118.02917 | M | E | S | 1221 |
| Walker Pass 04 | 35.725013 | -118.075586 | M | E | S | 1226 |
| Kings River Canyon | 36.791109 | -118.600285 | M | W | S | 1507 |
| Walker Pass 01, Freeman Canyon | 35.6556102 | -118.0138127 | M | E | S | 1514 |
| Smith Meadow, Trout Creek | 35.965359 | -118.2266916 | M | W | S | 1542 |
| Hume Lake | 36.7919836 | -118.9040388 | M | W | S | 1614 |
| Walker Pass 02 | 35.663848 | -118.026011 | M | E | S | 1625 |
| Carroll Creek | 36.510223 | -118.1029541 | M | E | S | 1672 |
| Walker Pass 03 | 35.6663777 | -118.040982 | M | E | S | 2071 |
| Taylor Meadow | 35.8300014 | -118.2957237 | M | W | S | 2167 |
| Horse Corral Meadow | 36.746714 | -118.7664448 | M | W | S | 2262 |
| Cannell Meadow | 35.8334444 | -118.3707494 | M | W | S | 2282 |
| Jackass Meadow | 36.0929196 | -118.2269272 | M | W | S | 2373 |
| Broder/Monache Meadow | 36.1660483 | -118.1919061 | M | W | S | 2413 |
| Evolution Valley 5 | 37.0991 | -118.597 | M | W | S | 2710 |
| Sirretta Meadows | 35.9447078 | -118.3274356 | M | W | S | 2760 |
| Onion Valley | 36.77509 | -118.334185 | M | W | S | 2772 |
| Aster Lake | 36.60162 | -118.6779 | M | W | S | 2785 |
| Little Cottonwood Creek 01, 02 | 36.4753532 | -118.120386 | M | W | S | 2905 |
| Little Brush Meadow, Olancha Peak | 36.2532438 | -118.1341831 | M | W | S | 2940 |
| Whitney Meadow | 36.4314867 | -118.2748239 | M | W | S | 2990 |
| Little Cottonwood Creek 03 | 36.47915687 | -118.1286138 | M | W | S | 2997 |
| Evolution Valley 2 | 37.1717 | -118.716 | M | W | S | 3012 |
| Little Cottonwood Creek, camp | 36.45175 | -118.17046 | M | W | S | 3072 |
| Crabtree Meadow, Whitney Creek | 36.552653 | -118.3576782 | M | W | S | 3166 |
| Bullfrog Lake | 36.7701135 | -118.4040739 | M | W | S | 3240 |
| Moose Lake | 36.603901 | -118.641 | M | W | S | 3269 |
| Rocky Basin Lakes | 36.4444875 | -118.3181318 | M | W | S | 3298 |
| Evolution Valley 4 | 37.1623 | -118.691 | M | W | S | 3316 |
| Cottonwood Lakes | 36.49873 | -118.20772 | M | W | S | 3398 |
| Evolution Valley 3 | 37.188599 | -118.702 | M | W | S | 3441 |
| Evolution Valley 6 | 37.1027 | -118.556 | M | W | S | 3454 |
| Evolution Valley 1 | 37.2099 | -118.689 | M | W | S | 3640 |
| La Grange 1 | 37.6661 | -120.469857 | H | W | C | 52 |
| Snelling 1 | 37.52686909 | -120.4374364 | H | W | C | 80 |
| Pleasant Valley 1 | 37.65638 | -120.29042 | H | W | C | 251 |
| Pleasant Valley 2 | 37.64441 | -120.30118 | H | W | C | 335 |
| Coulterville 1 | 37.710817 | -120.214514 | H | W | C | 493 |
| El Portal 2 | 37.673726 | -119.7935365 | H | W | C | 583 |
| Mt. Bullion 1 | 37.50822 | -120.043898 | H | W | C | 661 |
| El Portal 1 | 37.67989 | -119.783175 | H | W | C | 752 |
| Coulterville 3 | 37.753536 | -120.1058 | H | W | C | 904 |
| Coulterville 2 | 37.73845 | -120.14187 | H | W | C | 975 |
| Sweetwater 1 | 37.588966 | -119.881282 | H | W | C | 1068 |
| Cascade 1 | 37.725765 | -119.710935 | H | W | C | 1101 |
| El Portal 3 | 37.688188 | -119.764217 | H | W | C | 1202 |
| Yosemite Valley 2 | 37.73731867 | -119.6024683 | H | W | C | 1211 |
| Yosemite Valley 3 | 37.739314 | -119.572044 | H | W | C | 1213 |
| Happy Isles 1 | 37.7316 | -119.561 | H | W | C | 1231 |
| Yosemite Valley 1 | 37.74984527 | -119.5905486 | H | W | C | 1251 |
| Yosemite Valley 4 | 37.7458 | -119.6054 | H | W | C | 1420 |
| Merced Grove 1 | 37.74872617 | -119.83866 | H | W | C | 1647 |
| Cascade Creek 1 | 37.73869815 | -119.7029034 | H | W | C | 1803 |
| Aspen Valley 1 | 37.827725 | -119.771211 | H | W | C | 1878 |
| Chinquapin 1 | 37.65236433 | -119.702601 | H | W | C | 1884 |
| Crane Flat 1 | 37.75558867 | -119.7980497 | H | W | C | 1896 |
| Mono PO 1 | 37.990578 | -119.141074 | H | E | C | 1953 |
| Glen Aulin 2 | 37.928858 | -119.461163 | H | W | C | 1971 |
| Salmon Ranch 1 | 37.96326 | -118.9236 | H | E | C | 2001 |
| Dry Creek 1 | 37.9346515 | -118.935186 | H | E | C | 2076 |
| Williams Butte 1 | 37.90891 | -119.1053 | H | E | C | 2090 |
| Mono Craters 2 | 37.90167 | -118.9914 | H | E | C | 2167 |
| Mono Meadow 1 | 37.663396 | -119.592267 | H | W | C | 2176 |
| Indian Canyon 1 | 37.77432 | -119.56902 | H | W | C | 2195 |
| Silver Lake 1 | 37.79923 | -119.1213 | H | E | C | 2216 |
| Merced Lake 1 | 37.728064 | -119.391793 | H | W | C | 2228 |
| Mono Mills 1 | 37.887635 | -118.959868 | H | E | C | 2241 |
| Glen Aulin 1 | 37.91206 | -119.42135 | H | W | C | 2386 |
| Walker Lake 1 | 37.87338 | -119.171 | H | W | C | 2438 |
| Porcupine Flat 1 | 37.80526 | -119.55632 | H | W | C | 2464 |
| Tuolumne Meadows 2 | 37.8785 | -119.3665 | H | W | C | 2622 |
| Tuolumne Meadows 1 | 37.87941 | -119.39498 | H | W | C | 2632 |
| Warren Fork 1 | 37.95505 | -119.2283 | H | W | C | 2773 |
| Gem Lake 1 | 37.75857 | -119.1594 | H | W | C | 2773 |
| Ten Lakes 1 | 37.9038915 | -119.5255205 | H | W | C | 2784 |
| Mt. Hoffman 1 | 37.84461 | -119.50018 | H | W | C | 3026 |
| Lyell Canyon 1 | 37.773896 | -119.260877 | H | W | C | 3026 |
| Young Lakes 1 | 37.9378 | -119.340629 | H | W | C | 3047 |
| Vogelsang 1 | 37.790895 | -119.34256 | H | W | C | 3161 |
| Lyell Canyon 2 | 37.76408752 | -119.2520804 | H | W | C | 3281 |
| LG2 | 37.621805 | -120.525885 | M | W | C | 50 |
| LG3 | 37.66747286 | -120.4679471 | M | W | C | 57 |
| LG1 | 37.6248 | -120.56688 | M | W | C | 76 |
| S2 | 37.53619 | -120.48598 | M | W | C | 89 |
| S1 | 37.51121 | -120.38391 | M | W | C | 90 |
| S3 | 37.529065 | -120.35093 | M | W | C | 115 |
| S4 | 37.54692 | -120.35495 | M | W | C | 118 |
| CPV6 | 37.70881 | -120.22121 | M | W | C | 420 |
| CPV2 | 37.65594 | -120.22132 | M | W | C | 545 |
| CPV4 | 37.72381333 | -120.2637533 | M | W | C | 557 |
| CPV8 | 37.71951 | -120.17941 | M | W | C | 569 |
| CPV5 | 37.73883 | -120.24826 | M | W | C | 646 |
| CPV1 | 37.64055333 | -120.21173 | M | W | C | 728 |
| CPV3 | 37.614215 | -120.18232 | M | W | C | 832 |
| MD2 | 37.74401 | -120.03202 | M | W | C | 853 |
| CPV9 | 37.73636 | -120.166455 | M | W | C | 873 |
| MD1 | 37.75542 | -120.08468 | M | W | C | 887 |
| CPV7 | 37.68405 | -120.12141 | M | W | C | 899 |
| Ca1 | 37.72315 | -119.7120025 | M | W | C | 1045 |
| FM3 | 37.54498 | -119.83822 | M | W | C | 1122 |
| FM2 | 37.5790375 | -119.88213 | M | W | C | 1129 |
| YV1 | 37.71515 | -119.665 | M | W | C | 1191 |
| YV2 | 37.72193 | -119.63632 | M | W | C | 1205 |
| YV5 | 37.74053 | -119.57217 | M | W | C | 1209 |
| YV4 | 37.74276333 | -119.58765 | M | W | C | 1209 |
| YV3 | 37.73242333 | -119.6077033 | M | W | C | 1219 |
| YV6 | 37.73267 | -119.55807 | M | W | C | 1227 |
| YV7 | 37.753365 | -119.54557 | M | W | C | 1256 |
| FM1 | 37.56624 | -119.86851 | M | W | C | 1268 |
| YV8 | 37.75236 | -119.58723 | M | W | C | 1321 |
| F1 | 37.70369 | -119.740075 | M | W | C | 1354 |
| HM1 | 37.79611 | -119.86781 | M | W | C | 1424 |
| MG1 | 37.748264 | -119.839376 | M | W | C | 1646 |
| HG1 | 37.76525 | -119.86233 | M | W | C | 1701 |
| MG2 | 37.76208 | -119.84264 | M | W | C | 1811 |
| AV1 | 37.82534 | -119.77221 | M | W | C | 1872 |
| CF2 | 37.75287813 | -119.7976925 | M | W | C | 1881 |
| Ch1 | 37.68598667 | -119.7243933 | M | W | C | 1951 |
| CF1 | 37.75331 | -119.8089 | M | W | C | 1956 |
| TF1 | 37.75456 | -119.74298 | M | W | C | 2018 |
| CF3 | 37.75775 | -119.7699 | M | W | C | 2098 |
| MMe3 | 37.667798 | -119.623188 | M | W | C | 2126 |
| TC1 | 37.81096 | -119.71286 | M | W | C | 2143 |
| MoMe1 | 37.66637333 | -119.6721133 | M | W | C | 2153 |
| MMe2 | 37.66671667 | -119.5944433 | M | W | C | 2166 |
| WB1 | 37.90766 | -119.12214 | M | E | C | 2180 |
| BC1 | 37.90028 | -119.12977 | M | E | C | 2199 |
| ML2 | 37.73970714 | -119.40517 | M | W | C | 2222 |
| WC1 | 37.89667 | -119.13013 | M | E | C | 2231 |
| IC1 | 37.77716 | -119.566745 | M | W | C | 2232 |
| SM1 | 37.673565 | -119.654315 | M | W | C | 2237 |
| ML1 | 37.729643 | -119.392858 | M | W | C | 2238 |
| MMi1 | 37.88811 | -118.96021 | M | E | C | 2239 |
| YC1 | 37.85038333 | -119.5763733 | M | W | C | 2283 |
| MMe1 | 37.69924 | -119.58647 | M | W | C | 2372 |
| WW3 | 37.83879 | -119.59254 | M | W | C | 2383 |
| WW1 | 37.85844 | -119.651202 | M | W | C | 2426 |
| GA1 | 37.9117 | -119.42495 | M | W | C | 2433 |
| WW2 | 37.849072 | -119.622823 | M | W | C | 2455 |
| WL1 | 37.8730675 | -119.1629695 | M | W | C | 2474 |
| PF1 | 37.80894333 | -119.5686267 | M | W | C | 2495 |
| FD1 | 37.87649 | -119.41609 | M | W | C | 2554 |
| SN1 | 37.822 | -119.504705 | M | W | C | 2610 |
| JR1 | 37.88358 | -119.3634 | M | W | C | 2685 |
| GM1 | 38.16254 | -119.60461 | M | W | C | 2745 |
| WF1 | 37.954035 | -119.22714 | M | W | C | 2784 |
| LM1 | 37.8827 | -119.34655 | M | W | C | 2815 |
| DeM1 | 37.89922 | -119.3477 | M | W | C | 2866 |
| DL1 | 38.1729675 | -119.5947525 | M | W | C | 2874 |
| TL1 | 37.90404 | -119.533565 | M | W | C | 2883 |
| KM1 | 38.12200714 | -119.48195 | M | W | C | 2884 |
| LC1 | 37.779085 | -119.26102 | M | W | C | 2936 |
| MF1 | 37.84097 | -119.49964 | M | W | C | 2938 |
| DD1 | 37.90828 | -119.3475 | M | W | C | 2961 |
| RC1 | 38.06129 | -119.33899 | M | W | C | 3014 |
| WF2 | 37.95899 | -119.26701 | M | W | C | 3052 |
| V1 | 37.792494 | -119.348524 | M | W | C | 3074 |
| LC2 | 37.76912667 | -119.2568567 | M | W | C | 3097 |
| V2 | 37.79766 | -119.335133 | M | W | C | 3131 |
| TP1 | 37.90811 | -119.26396 | M | W | C | 3148 |
| LC3 | 37.76164333 | -119.25687 | M | W | C | 3255 |

H = Historical, M = Modern; E = East Slope, W = West Slope; N = Northern, C = Central, S = Southern

**Supplementary Table S2. List of small mammal species examined in this study.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | Northern‡ | | |  | Central | | |  | Southern | | |
| Species |  | Detection method§ | Occupancy analysis† |  | Slope | H | M |  | Slope | H | M |  | Slope | H | M |
| *Ammospermophilus leucurus* |  | St | - |  | E | 0 | 1 |  | --- | | |  | E + W | 1 | 1 |
| *Ammospermophilus nelsoni* |  | St | - |  | --- | | |  | --- | | |  | W | 1 | 0 |
| *Aplodontia rufa* |  | Sp | - |  | W | 0 | 1 |  | E + W | 1 | 1 |  | --- | | |
| *Brachylagus idahoensis* |  | Obs | - |  | E | 1 | 0 |  | --- | | |  | --- | | |
| *Callospermophilus lateralis* |  | St | Y |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Chaetodipus californicus* |  | St | Y |  | --- | | |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Clethrionomys californicus* |  | St | - |  | W | 1 | 1 |  | --- | | |  | --- | | |
| *Dipodomys agilis* |  | St | Y |  | --- | | |  | --- | | |  | E + W | 1 | 1 |
| *Dipodomys californicus* |  | St | - |  | E + W | 1 | 1 |  | --- | | |  | --- | | |
| *Dipodomys heermanni* |  | St | Y |  | --- | | |  | E + W | 1 | 1 |  | E + W | 1 | 0 |
| *Dipodomys merriami* |  | St | - |  | --- | | |  | --- | | |  | E + W | 1 | 1 |
| *Dipodomys nitratoides* |  | St | - |  | --- | | |  | --- | | |  | W | 1 | 0 |
| *Dipodomys ordii* |  | St | - |  | E | 1 | 1 |  | --- | | |  | --- | | |
| *Dipodomys panamintinus* |  | St | - |  | --- | | |  | E | 1 | 1 |  | E + W | 1 | 1 |
| *Glaucomys sabrinus* |  | St | - |  | W | 1 | 1 |  | W | 1 | 1 |  | --- | | |
| *Lemmiscus curtatus* |  | St | - |  | E | 1 | 1 |  | E | 1 | 1 |  | --- | | |
| *Marmota flaviventris* |  | Obs | N |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | W | 1 | 1 |
| *Microdipodops megacephalus* |  | St | - |  | E | 1 | 1 |  | E | 1 | 0 |  | --- | | |
| *Microtus californicus* |  | St | Y |  | W | 1 | 1 |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Microtus longicaudus* |  | St | Y |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Microtus montanus* |  | St | Y |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Neotoma bryanti* |  | St | - |  | --- | | |  | --- | | |  | E + W | 1 | 1 |
| *Neotoma cinerea* |  | St | Y |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Neotoma fuscipes* |  | St | Y |  | E + W | 1 | 1 |  | --- | | |  | --- | | |
| *Neotoma lepida* |  | St | - |  | E | 1 | 1 |  | --- | | |  | E + W | 1 | 1 |
| *Neotoma macrotis* |  | St | Y |  | --- | | |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Ochotona princeps* |  | Obs | N |  | E + W | 1 | 1 |  | W | 1 | 1 |  | W | 1 | 1 |
| *Onychomys leucogaster* |  | St | - |  | E | 1 | 1 |  | E | 1 | 1 |  | --- | | |
| *Onychomys torridus* |  | St | - |  | --- | | |  | --- | | |  | E + W | 1 | 1 |
| *Otospermophilus beecheyi* |  | St | Y |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Perognathus inornatus* |  | St | - |  | --- | | |  | W | 1 | 1 |  | W | 1 | 1 |
| *Perognathus longimembris* |  | St | - |  | --- | | |  | --- | | |  | E + W | 1 | 1 |
| *Perognathus parvus* |  | St | - |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | E | 1 | 0 |
| *Peromyscus boylii* |  | St | Y |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Peromyscus californicus* |  | St | - |  | --- | | |  | W | 1 | 1 |  | W | 1 | 1 |
| *Peromyscus crinitus* |  | St | - |  | E | 1 | 1 |  | --- | | |  | E + W | 1 | 1 |
| *Peromyscus maniculatus* |  | St | Y |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Peromyscus truei* |  | St | Y |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Phenacomys intermedius* |  | St | - |  | --- | | |  | W | 1 | 1 |  | W | 1 | 1 |
| *Reithrodontomys megalotis* |  | St | Y |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Scapanus latimanus* |  | Sp | - |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | W | 1 | 0 |
| *Sciurus griseus* |  | Obs | N |  | W | 1 | 1 |  | W | 1 | 1 |  | W | 1 | 1 |
| *Sorex merriami* |  | St | - |  | E | 1 | 0 |  | --- | | |  | --- | | |
| *Sorex monticolus* |  | St | Y |  | --- | | |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Sorex ornatus* |  | St | Y |  | --- | | |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Sorex palustris* |  | St | Y |  | W | 1 | 1 |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Sorex tenellus* |  | St | - |  | --- | | |  | W\* | 0 | 1 |  | W | 0 | 1 |
| *Sorex trowbridgii* |  | St | Y |  | E + W | 1 | 1 |  | W | 1 | 1 |  | W\* | 0 | 1 |
| *Sorex vagrans* |  | St | Y |  | E + W | 1 | 1 |  | --- | | |  | --- | | |
| *Sylvilagus audubonii* |  | Obs | - |  | W | 1 | 0 |  | W | 1 | 1 |  | E + W | 1 | 1 |
| *Sylvilagus bachmani* |  | Obs | - |  | W | 1 | 0 |  | W | 1 | 1 |  | W | 1 | 0 |
| *Sylvilagus nuttallii* |  | Obs | - |  | E + W | 1 | 1 |  | E | 1 | 1 |  | W | 0 | 1 |
| *Tamias alpinus* |  | St | Y |  | --- | | |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Tamias amoenus* |  | St | Y |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | --- | | |
| *Tamias merriami* |  | St | Y |  | --- | | |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Tamias minimus* |  | St | - |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | W | 1 | 1 |
| *Tamias panamintinus* |  | St | - |  | --- | | |  | --- | | |  | E + W | 1 | 1 |
| *Tamias quadrimaculatus* |  | St | Y |  | --- | | |  | E + W | 1 | 1 |  | --- | | |
| *Tamias senex* |  | St | Y |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | --- | | |
| *Tamias speciosus* |  | St | Y |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Tamias umbrinus* |  | St | - |  | --- | | |  | --- | | |  | E + W | 1 | 0 |
| *Tamiasciurus douglasii* |  | Obs | N |  | E + W | 1 | 1 |  | W | 1 | 1 |  | W | 1 | 1 |
| *Thomomys bottae* |  | Sp | N |  | W | 1 | 1 |  | W | 1 | 1 |  | W | 1 | 1 |
| *Thomomys monticola* |  | Sp | N |  | W | 1 | 1 |  | W | 1 | 1 |  | --- | | |
| *Thomomys talpoides* |  | Sp | - |  | E | 1 | 0 |  | E + W | 1 | 1 |  | --- | | |
| *Urocitellus beldingi* |  | St | Y |  | E + W | 1 | 1 |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
| *Zapus princeps* |  | St | Y |  | W | 1 | 1 |  | E + W | 1 | 1 |  | E + W | 1 | 1 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Total 67** |  | **54** | **34** |  |  | **45** | **45** |  |  | **48** | **48** |  |  | **50** | **50** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**§Detection methods were standardized trapping (St), specialized trapping (Sp), or observation (Obs).**

**†Species included in the analysis of range shifts were both species with (Y) and without (N) sufficient data for occupancy analysis. Of the 67 species we examined, 54 were detected using standardized trapping, 28 were included in the occupancy analyses and an additional 6 species were included in the analysis of range shifts.**

**‡Species were detected on the east (E) and/or west (W) slopes within each region and detections within each region are listed as detected (0) or not detected (1) in the historical (H) or the modern (M) eras.**

**\* New species records detected during our surveys.**

**Supplementary Table S3. Generalized linear mixed models examining patterns of range limit shifts of 32 montane small mammals of California.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Elevation Range Metric | Model | Parameters\* | AIC | ΔAIC | AIC Weight |
| All Species | Basic | Zone:Limit | 170.80 | 0.00 | 1.00 |
| Any Shift | - | Null | 189.90 | 19.10 | 0.00 |
|  | - | Zone | 190.50 | 19.70 | 0.00 |
|  | - | Limit | 191.90 | 21.10 | 0.00 |
|  | - | Limit+Zone | 192.50 | 21.70 | 0.00 |
|  | - | Region | 193.60 | 22.80 | 0.00 |
|  | - | Region+Zone | 194.10 | 23.30 | 0.00 |
|  | - | Limit+Region | 195.60 | 24.80 | 0.00 |
|  | - | Limit+Zone+Region | 196.10 | 25.30 | 0.00 |
|  | - | Region:Zone | 196.60 | 25.80 | 0.00 |
|  | - | Region:Limit | 197.60 | 26.80 | 0.00 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| High Elevation Species | Basic | Limit | 109.50 | 0.00 | 0.63 |
| Any Shift | - | Region:Limit | 111.90 | 2.40 | 0.19 |
|  | - | Region+Limit | 112.20 | 2.70 | 0.16 |
|  | - | Null | 117.70 | 8.20 | 0.01 |
|  | - | Region | 120.80 | 11.30 | 0.00 |
|  |  |  |  |  |  |
| Low Elevation Species | Basic | Limit | 63.19 | 0.00 | 0.73 |
| Any Shift | - | Region+Limit | 65.66 | 2.47 | 0.21 |
|  | - | Region:Limit | 68.53 | 5.34 | 0.05 |
|  | - | Null | 74.46 | 11.27 | 0.00 |
|  | - | Region | 77.44 | 14.25 | 0.00 |
|  |  |  |  |  |  |
| High Elevation Species | Basic | Region+Limit | 35.80 | 0.00 | 0.82 |
| Shift up vs down | - | Limit | 39.98 | 4.18 | 0.10 |
|  | - | Region:Limit | 42.56 | 6.76 | 0.03 |
|  | - | Region | 42.58 | 6.78 | 0.03 |
|  | - | Null | 43.34 | 7.54 | 0.02 |
|  |  |  |  |  |  |
| Low Elevation Species | Basic | Null | 32.84 | 0.00 | 0.52 |
| Shift up vs down | - | Limit | 34.04 | 1.20 | 0.29 |
|  | - | Region | 36.02 | 3.18 | 0.11 |
|  | - | Region+Limit | 37.11 | 4.27 | 0.06 |
|  | - | Region:Limit | 39.09 | 6.25 | 0.02 |

\* Model parameters included: Region (Northern, Central, Southern), Limit (upper elevation limit, lower elevation limit), and Zone (high or low elevation species).

**Supplementary Table S4. Range limits and shifts of the 34 modelled species examined in this study.**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Species | Region | *p* (H) § | *p* (M) | Historical Elevation Range (m) | Lower Limit Shift | Upper Limit Shift | Pattern | Best Occupancy Model† | AICc Weight | Historical Life Zone¶ |
| 1 | ***Sorex ornatus*** |  |  |  |  |  |  |  | era + elev + elev2 + region | 0.2246 | Upper Sonoran (L) |
|  |  | Northern | NA | NA | NA | NA | NA | NA |
|  |  | Central | 0.55 | 0.32 | 549-914 | -492 | No Change | Expand -L |
|  |  | Southern | 0.31 | 0.49 | 118-180 | No Change | +1362 | Expand +U |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | ***Dipodomys heermanni*** |  |  |  |  |  |  |  | era + elev + region + era\*elev | 0.2148 | Lower-Upper Sonoran (L) |
|  |  | Northern | NA | NA | NA | NA | NA | NA |
|  |  | Central | 0.35 | 0.61 | 52-975 | No Change | -247 | Contract -U |
|  |  | Southern | 0.95 | Undetected | 118-636 | Undetected Current | Undetected Current | NA |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | ***Microtus californicus*** |  |  |  |  |  |  |  | era + elev + region + elev\*region | 0.0669 | Lower-Upper Sonoran (L) |
|  |  | Northern | 0.83 | 0.89 | 79-1335 | No Change | No Change | No Change |
|  |  | Central | 0.76 | 0.60 | 52-1647 | No Change | No Change | No Change |
|  |  | Southern | 0.96 | 0.90 | 118-1261 | +465 | No Change | Contract +L |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 4 | ***Reithrodontomys megalotis*** |  |  |  |  |  |  |  | elev | 0.1738 | Lower–Upper Sonoran (L) |
|  |  | Northern | 0.82 | 0.86 | 79-1478 | No Change | -434 | Contract -U |
|  |  | Central | 0.90 | 0.64 | 52-1158 | No Change | +110 | Expand +U |
|  |  | Southern | 0.96 | 0.90 | 118-1860 | No Change | -861 | Contract -U |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | ***Chaetodipus californicus*** |  |  |  |  |  |  |  | era + elev + elev2 + region | 0.2355 | Lower-Upper Sonoran (L) |
|  |  | Northern | NA | NA | NA | NA | NA | NA |
|  |  | Central | 0.37 | 0.75 | 183-914 | No Change | +787 | Expand +U |
|  |  | Southern | 0.83 | 0.91 | 118-2147 | +113‡ | +226 | Shift +LU |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | ***Neotoma fuscipes/macrotis*** |  |  |  |  |  |  |  |  |  |  |
|  | ***Neotoma fuscipes*** | Northern | 0.69 | 0.98 | 79-1051 | +32‡ | +515 | Expand +U | elev + elev2 + region | 0.2508 | Lower Sonoran–Transition (L) |
|  | ***Neotoma macrotis*** | Central | 0.57 | 0.78 | 183-1647 | No Change | No Change | No Change | elev + elev2 + region + elev\*region + elev2\*region | 0.1464 | Lower Sonoran–Transition (L) |
|  | ***Neotoma macrotis*** | Southern | 0.59 | 0.91 | 118-2147 | +113‡ | +226 | Shift +LU |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | ***Peromyscus truei*** |  |  |  |  |  |  |  | era + elev + elev2 + region + era\*elev + era\*elev2 + era\*region + elev\*region + elev2\*region + era\*elev\*region + era\*elev2\*region | 0.4677 | Upper Sonoran (L) |
|  |  | Northern | 0.67 | 0.60 | 79-1051 | +529 | +408 | Shift +LU |
|  |  | Central | 0.85 | 0.74 | 183-975 | +374 | +836 | Shift +LU |
|  |  | Southern | 0.82 | 0.74 | 636-3147 | -53‡ | -207 | Contract -U |
|  |  |  |  |  |  |  |  |  |  |  |  |
| \*8 | ***Sciurus griseus*** |  |  |  |  |  |  |  | \*Not subject to occupancy analyses | | Lower–Upper Sonoran (L) |
|  |  | Northern |  |  | 103-1051 | No Change | +671 | Expand +U |
|  |  | Central |  |  | 183-1951 | No Change | -262 | Contact -U |
|  |  | Southern |  |  | 787-2364 | +720 | -750 | Contract +L, -U |
|  |  |  |  |  |  |  |  |  |  |  |  |
| \*9 | ***Dipodomys agilis*** |  |  |  |  |  |  |  | era + elev + elev2 + region | 0.2470 | Lower-Upper Sonoran (L) |
|  |  | Northern | NA | NA | NA | NA | NA | NA |
|  |  | Central | NA | NA | NA | NA | NA | NA |
|  |  | Southern | 0.49 | 0.49 | 721-1860 | +89‡ | +307 | Expand +U |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 10 | ***Tamias merriami*** |  |  |  |  |  |  |  | elev + region | 0.1284 | Lower–Upper Sonoran (L) |
|  |  | Northern | NA | NA | NA | NA | NA | NA |
|  |  | Central | 0.25 | 0.21 | 488-1524 | No Change | No Change | No Change |
|  |  | Southern | 0.43 | 0.59 | 636-2732 | No Change | No Change | No Change |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 11 | ***Peromyscus boylii*** |  |  |  |  |  |  |  | era + elev + elev2 + region + elev\*region + elev2\*region | 0.5811 | Upper Sonoran–Transition (L) |
|  |  | Northern | 0.85 | 0.99 | 79-1051 | +89‡ | No Change | Contract +L |
|  |  | Central | 0.88 | 0.88 | 183-2464 | -126‡ | No Change | Expand -L |
|  |  | Southern | 0.97 | 0.99 | 118-3147 | +20‡ | -865 | Contract -U |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 12 | ***Thomomys bottae*** |  |  |  |  |  |  |  | \*Not subject to occupancy analyses | | Lower Sonoran-Transition (L) |
|  |  | Northern |  |  | 75-1335 | No Change | No Change | No Change |
|  |  | Central |  |  | 57-1676 | No Change | No Change | No Change |
|  |  | Southern |  |  | 118-3384 | No Change | No Change | No Change |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 13 | ***Otospermophilus beecheyi*** |  |  |  |  |  |  |  | era + elev + elev2 + era\*elev + era\*elev2 | 0.1069 | Lower Sonoran–Canadian (W) |
|  |  | Northern | 0.05 | 0.67 | 79-1051 | No Change | +734 | Expand +U |
|  |  | Central | 0.28 | 0.42 | 61-2632 | No Change | No Change | No Change |
|  |  | Southern | 0.07 | 0.82 | 118-2997 | No Change | -57‡ | No Change |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 14 | ***Peromyscus maniculatus*** |  |  |  |  |  |  |  | era + elev + elev2 + region + era\*elev + era\*elev2 + era\*region + elev\*region + elev2\*region + era\*elev\*region + era\*elev2\*region | 0.4195 | Lower Sonoran–Arctic-Alpine (W) |
|  |  | Northern | 0.94 | 0.99 | 79-2514 | No Change | No Change | No Change |
|  |  | Central | 0.95 | 0.93 | 52-3281 | No Change | No Change | No Change |
|  |  | Southern | 0.99 | 0.99 | 118-3384 | No Change | No Change | No Change |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 15 | ***Sorex trowbridgii*** |  |  |  |  |  |  |  | elev + elev2 + region | 0.0988 | Transition–Canadian (H) |
|  |  | Northern | 0.49 | 0.68 | 1051-2061 | No Change | No Change | No Change |
|  |  | Central | 0.65 | 0.68 | 1068-2286 | No Change | -54‡ | No Change |
|  |  | Southern | 0.76 | 0.69 | 1507-2373 (Modern) | Undetected Historical | Undetected Historical | New record Modern |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 16 | ***Tamias quadrimaculatus*** |  |  |  |  |  |  |  | elev + elev2 + region | 0.1681 | Transition–Canadian (H) |
|  |  | Northern | NA | NA | NA | NA | NA | NA |
|  |  | Central | 0.54 | 0.49 | 1494-2210 | No Change | No Change | No Change |
|  |  | Southern | NA | NA | NA | NA | NA | NA |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 17 | ***Sorex vagrans*** |  |  |  |  |  |  |  | elev + region | 0.0963 | Transition–Canadian (H) |
|  |  | Northern | 0.62 | 0.96 | 1335-2514 | No Change | No Change | No Change |
|  |  | Central | NA | NA | NA | NA | NA | NA |
|  |  | Southern | NA | NA | NA | NA | NA | NA |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 18 | ***Tamias senex*** |  |  |  |  |  |  |  | elev + elev2 + region | 0.2866 | Canadian (H) |
|  |  | Northern | 0.55 | 0.99 | 1478-2462 | No Change | No Change | No Change |
|  |  | Central | 0.87 | 0.49 | 1402-2743 | +981 | -360 | Contract +L-U |
|  |  | Southern | NA | NA | NA | NA | NA | NA |
|  |  |  |  |  |  |  |  |  |  |  |  |
| \*19 | ***Tamiasciurus douglasi*** |  |  |  |  |  |  |  | \*Not subject to occupancy analyses | | Transition-Hudsonian (H) |
|  |  | Northern |  |  | 886-2061 | No Change | +430 | Expand +U |
|  |  | Central |  |  | 1229-3185 | No Change | No Change | No Change |
|  |  | Southern |  |  | 1592-3384 | No Change | No Change | No Change |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 20 | ***Zapus princeps*** |  |  |  |  |  |  |  | elev + elev2 + region |  | Transition–Hudsonian (H) |
|  |  | Northern | 0.78 | 0.87 | 1478-2462 | +138 | No Change | Contract +L | 0.1800 |
|  |  | Central | 0.92 | 0.86 | 1211-3281 | +213 | No Change | Contract +L |
|  |  | Southern | 0.92 | 0.85 | 1592-2657 | +821 | +583 | Shift +LU |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 21 | ***Microtus montanus*** |  |  |  |  |  |  |  | elev + elev2 + region + elev\*region + elev2\*region | 0.6766 | Transition-Hudsonian (H) |
|  |  | Northern | 0.77 | 0.92 | 1335-1784 | +133 | +66‡ | Shift +L |
|  |  | Central | 0.65 | 0.90 | 1211-3161 | No Change | No Change | No Change |
|  |  | Southern | 0.95 | 0.89 | 1984-3384 | No Change | No Change | No Change |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 22 | ***Microtus longicaudus*** |  |  |  |  |  |  |  | elev + elev2 | 0.2043 | Transition-Hudsonian (H) |
|  |  | Northern | 0.95 | 0.84 | 1672-2462 | -204 | No Change | Expansion |
|  |  | Central | 0.94 | 0.81 | 583-3281 | +644 | No Change | Contract +L |
|  |  | Southern | 0.99 | 0.88 | 1529-3474 | +638 | No Change | Contract +L |
|  |  |  |  |  |  |  |  |  |  |  |  |
| \*23 | ***Thomomys monticola*** |  |  |  |  |  |  |  | \*Not subject to occupancy analyses | | Canadian–Hudsonian (H) |
|  |  | Northern |  |  | 1561-2514 | No Change | No Change | No Change |
|  |  | Central |  |  | 1905-3155 | No Change | No Change | No Change |
|  |  | Southern |  |  | NA | NA | NA | NA |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 24 | ***Neotoma cinerea*** |  |  |  |  |  |  |  | era + elev + elev2 + region + era\*elev + era\*elev2 + era\*region + elev\*region + elev2\*region + era\*elev\*region + era\*elev2\*region | 0.1123 | Canadian–Arctic-Alpine (H) |
|  |  | Northern | 0.66 | 0.67 | 1478-2514 | +202 | -729 | Contract +L-U |
|  |  | Central | 0.79 | 0.51 | 1803-3281 | +580 | -807 | Contract +L-U |
|  |  | Southern | 0.67 | 0.87 | 1529-3384 | No Change | No Change | No Change |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 25 | ***Tamias speciosus*** |  |  |  |  |  |  |  | era + elev + elev2 + era\*elev + era\*elev2 | 0.4140 | Canadian–Hudsonian (H) |
|  |  | Northern | 0.78 | 0.98 | 1561-2514 | +222 | No Change | Contract +L |
|  |  | Central | 0.76 | 0.82 | 1768-3281 | +113‡ | No Change | No Change |
|  |  | Southern | 0.96 | 0.97 | 1529-3384 | +638 | No Change | Contract +L |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 26 | ***Tamias amoenus*** |  |  |  |  |  |  |  | elev + elev2 + region | 0.0765 | Transition–Hudsonian (H) |
|  |  | Northern | 0.79 | 0.96 | 1561-2514 | No Change | No Change | No Change |
|  |  | Central | 0.96 | 0.96 | 2438-2865 | +36‡ | -81‡ | No Change |
|  |  | Southern | NA | NA | NA | NA | NA | NA |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 27 | ***Sorex palustris*** |  |  |  |  |  |  |  | era + elev + region + era\*elev + era\*region + elev\*region + era\*elev\*region | 0.2046 | Canadian–Hudsonian (H) |
|  |  | Northern | 0.53 | 0.24 | 1583-2514 | -975 | -1906 | Contract -L,-U |
|  |  | Central | 0.46 | 0.15 | 1647-3161 | +506 | No Change | Contract +L |
|  |  | Southern | 0.77 | 0.40 | 2314-3384 | +676 | No Change | Contract +L |
|  |  |  |  |  |  |  |  |  |  |  |  |
| \*28 | ***Marmota flaviventris*** |  |  |  |  |  |  |  | \*Not subject to occupancy analyses | | Canadian–Arctic-Alpine (H) |
|  |  | Northern |  |  | 1561-1971 | No Change | +520 | Expand +U |
|  |  | Central |  |  | 2469-3353 | No Change | No Change | No Change |
|  |  | Southern |  |  | 2268-3503 | No Change | No Change | No Change |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 29 | ***Urocitellus beldingi*** |  |  |  |  |  |  |  | elev + elev2 + region + elev\*region + elev2\*region | 0.1967 | Canadian–Arctic-Alpine (H) |
|  |  | Northern | 0.71 | 0.88 | 1485-1845 | No Change | -217 | Contract -U |
|  |  | Central | 0.74 | 0.66 | 2286-3281 | +399 | No Change | Contract +L |
|  |  | Southern | 0.86 | 0.92 | 2761-3474 | +555 | No Change | Contract +L |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 30 | ***Callospermophilus lateralis*** |  |  |  |  |  |  |  | era + elev + elev2 + region | 0.1752 | Transition-Hudsonian (H) |
|  |  | Northern | 0.60 | 0.89 | 1561-3124 | No Change | No Change | No Change |
|  |  | Central | 0.61 | 0.69 | 1646-3200 | +305 | No Change | Contract +L |
|  |  | Southern | 0.83 | 0.91 | 2147-3474 | +115‡ | No Change | Contract +L |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 31 | ***Sorex monticolus*** |  |  |  |  |  |  |  | era + elev + elev2 + region | 0.1349 | Canadian–Hudsonian (H) |
|  |  | Northern | 0.59 | 0.67 | NA | NA | NA | NA |
|  |  | Central | 0.74 | 0.68 | 2176-3281 | -971 | No Change | Expand -L |
|  |  | Southern | 0.84 | 0.80 | 1529-3474 | No Change | No Change | No Change |
|  |  |  |  |  |  |  |  |  |  |  |  |
| \*32 | ***Ochotona princeps*** |  |  |  |  |  |  |  | \*Not subject to occupancy analyses | | Canadian–Arctic-Alpine (H) |
|  |  | Northern |  |  | 1478-2514 | No Change | No Change | No Change |
|  |  | Central |  |  | 2377-3871 | No Change | No Change | No Change |
|  |  | Southern |  |  | 2732-3384 | No Change | No Change | No Change |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 33 | ***Tamias alpinus*** |  |  |  |  |  |  |  | era + elev + region | 0.0603 | Hudsonian–Arctic-Alpine (H) |
|  |  | Northern | NA | NA | NA | NA | NA | NA |
|  |  | Central | 0.86 | 0.81 | 2386-3353 | +497 | No Change | Contract +L |
|  |  | Southern | 0.92 | 0.86 | 2314-3503 | +471 | No Change | Contract +L |
|  |  |  |  |  |  |  |  |  |  |  |  |

§Detectability (*p*) for the historical (H) and modern (M) era is the average detectability of a given species over all sites within that region.

†The best performing occupancy model is given with the corresponding AICc weight.

¶Historical life zone was used to determine whether a species was classified as a low elevation species (L), high elevation species (H) or widespread species (W) following Moritz et al.4.

Species not subject to occupancy modelling are designated with an asterisk (\*) and those with a statistically significant, but biologically trivial limit shift (i.e., <10% of the species’ historical elevation range and <100 meters in elevation; see Methods) are represented by a double dagger (‡).

**Supplementary Table S5. Model parameterizations of detectability (*p*) and occupancy (*ψ*) run for each species with quantifiable trapping effort data (see Supplementary Table S2 for list of modelled species).**

|  |
| --- |
| **Detectability models (*p*)** |
| 1. null |
| 2. Era+LogT+Era\*LogT+T100+Time |
| 3. Era+LogT+Era\*LogT+Time+Era\*Time+T100 |
| 4. Era+LogT+Era\*logT+Time+Era\*Time |
| 5. Era+logT+Era\*logT+Time |
| 6. Era+logT+Time |
| 7. Era+T100+Era\*T100+logT+Era\*logT+Time |
| 8. Era+T100+Era\*T100+logT+Time |
| 9. Era+T100+Era\*T100+Time+Era\*Time |
| 10. Era+T100+Era\*T100 |
| 11. Era+Time+Era\*Time+logT |
| 12. Era+Time+Era\*Time+T100+logT |
| 13. T100+logT+Time |
| 14. T100+Time |
| 15. Time |
| 16. Era+T100+Era\*T100+logT+Era\*logT+Time+Era\*Time |
|  |
| **Occupancy models (*ψ*)** |
| 1. null |
| 2. Era |
| 3. Elev |
| 4. Elev+Elev2 |
| 5. Region |
| 6. Era+Elev |
| 7. Era+Elev+Elev2 |
| 8. Era+Elev+Era\*Elev |
| 9. Era+Elev+Elev2+Era\*Elev+Era\*Elev2 |
| 10. Era+Region |
| 11. Era+Region+Era\*Region |
| 12. Elev+Region |
| 13. Elev+Elev2+Region |
| 14. Elev+Region+Elev\*Region |
| 15. Elev+Elev2+Region+Elev\*Region+Elev2\*Region |
| 16. Era+Elev+Region |
| 17. Era+Elev+Elev2+Region |
| 18. Era+Elev+Region+Era\*Elev |
| 19. Era+Elev+Elev2+Region+Era\*Elev+Era\*Elev2 |
| 20. Era+Elev+Region+Elev\*Region |
| 21. Era+Elev+Elev2+Region+Elev\*Region+Elev2\*Region |
| 22. Era+Elev+Region+Era\*Region |
| 23. Era+Elev+Elev2+Region+Era\*Region |
| 24. Era+Elev+Region+Era\*Elev+Era\*Region+Elev\*Region+Era\*Elev\*Region |
| 25. Era+Elev+Elev2+Region+Era\*Elev+Era\*Elev2+Era\*Region+Elev\*Region+Elev2\*Region+  Era\*Elev\*Region+Era\*Elev2\*Region |