**Appendix S1.** Supplementary Methods

The historical portion and contemporary supplement of the Colorado mammal specimen database was constructed mostly from museum specimen records, and includes records for all mammals in the state from all dates and localities. We received these records by contacting museum personnel or through online data repositories (i.e., GBIF [www.gbif.org], Arctos [https://arctos.database.museum]). The museums from which we received specimen data included: Academy of Natural Sciences of Philadelphia, American Museum of Natural History, Angelo State Natural History Collection, Brigham Young University Monte L. Bean Life Science Museum, California Academy of Science, Carnegie Museum of Natural History, Cornell University Museum of Vertebrates, Denver Museum of Nature and Science, Eastern New Mexico University Natural History Museum, Field Museum, Florida Museum of Natural History, Illinois Natural History Survey, James R. Slater Museum of Puget Sound University, Los Angeles County Museum of Natural History, Louisiana State University Museum of Natural Science, Museum of Comparative Zoology Harvard University, Michigan State University Museum, Museum of Southwestern Biology University of New Mexico, Museum of Texas Tech University, New Mexico Museum of Natural History and Science, North Carolina State Museum of Natural Sciences, Oklahoma State University Collection of Vertebrates, Oregon State University Department of Fisheries and Wildlife Mammal Collection, Royal Ontario Museum, San Diego Natural History Museum, Santa Barbara Museum of Natural History, State Museum of Pennsylvania, Sternberg Museum of Natural History Fort Hays State University, Texas A&M University Texas Cooperative Wildlife Collection, United States National Museum of Natural History, Universidad Nacional Autónoma de México, University of Alaska Museum of the North, University of Arizona Collection of Mammals, University of California Berkeley Museum of Vertebrate Zoology, University of Colorado Museum of Natural History, University of Georgia Museum of Natural History, University of Kansas Museum of Natural History, University of Michigan Museum of Zoology, University of Minnesota James F. Bell Museum of Natural History, University of Nebraska State Museum, University of Oklahoma Sam Noble Oklahoma Museum of Natural History, University of Washington Burke Museum, University of Wisconsin Zoological Museum, Utah Museum of Natural History, Western New Mexico University Museum, and Yale University Peabody Museum. This work would not have been possible without the countless number of people contributing, preserving, and supporting natural history collections; we thank each and every one past, present, and future.

The sites of contemporary sampling by the authors included 32 sites from 2010–2012 (Figure S1.1: white circles) with the lowest three sites in the northern Front Range transect resampled in 2017; pilot study sampling in the San Juans in 2007 (blue circles); additional sampling in Mesa Verde National Park in 2018 (live trapping and pitfall sites: black stars, pitfall sites: black dots). For a detailed discussion of the mammal sampling design and results, see (McCain *et al.*, 2018). Overall, the authors' sampling effort for this comparative study included ~77,030 trap-nights in the Front Range and ~81,550 trap-nights in the San Juans plus all the visual surveys and other sighted mammals. These contemporary data were augmented with all other specimen data from these mountain regions collected or documented by other researchers in the Colorado mammal database in 2006 or later.

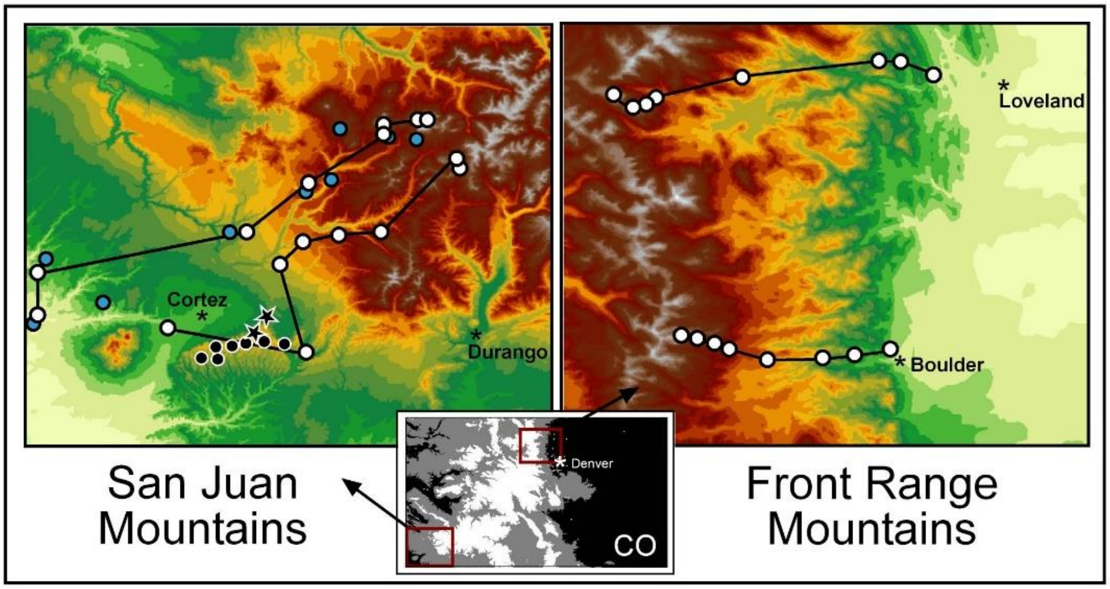


**Figure S1.1.** The contemporary mammal survey sites in the Colorado Rocky Mountains. The four elevational transects sampled in 2010-2012 in the northeast (Front Range Mountains) and two in the southwest (San Juan Mountains) are shown in white circles connected with black lines. The lower three in the northern Front Range transect were resampled in 2017. The nine sites sampled in the San Juans in 2007 are shown in blue circles, and the sites sampled in Mesa Verde National Park are shown in stars (all survey methods) and black dots (pitfalls & visual surveys).

The Bayesian models:

To estimate elevations in which each species had a high probability of occurrence beyond the observed range, we developed a Bayesian model. Occupancy models typically rely on repeated surveys and local environmental data to predict a species' probability of presence when undetected in a particular locality (Kéry & Royle, 2008, MacKenzie *et al.*, 2002, Szewczyk & McCain, 2019). Such data are unavailable in many cases, including for typical compiled historical datasets. Consequently, we employed a modified conceptual framework for occupancy to evaluate the probability of sampling error rather than directly considering species' environmental preferences. Within each time period, mountain range, and elevational bin, we constructed models using the overall community sampling distribution (Fig. S1.2), the species' abundance distribution, the probability of detecting a given individual of the species, a function of the elevational distance to the nearest detection, and the patchiness within the species' interpolated range (i.e., the proportion of elevational bins without detections within the interpolated range). See the article text for model details and *R* code below).

We included a second set of Bayesian models for the larger small mammal species (e.g., tree squirrels, marmots). These species historically were live trapped, but also hunted with rifles for collection. Contemporarily, they are still caught in live traps but usually just immature individuals in the smaller traps with larger traps needed specifically for adults, and are now more likely just to be sighted in visual surveys. Thus, these species have a lower sampling effort and their sampling may be less associated with the complete sampling effort of other small mammals, particularly contemporarily. Thus, we used the specimen-localities for just the larger species as an estimate of the sampling effort over each gradient per time period to reassess just the larger species Bayesian range limits. The range limits were slightly larger than using the complete sampling effort (Appendix S2). For example, for the four species used in the analyses the differences between the all-sample Bayesian sampling models and the large-only Bayesian sampling models was on average only 32 m per species. Some of these enlarged ranges appeared implausible given our knowledge of the species on each mountain, and since they are based on few samples, are less well-supported. Thus, we used the all-sampling effort Bayesian models for the range shift analyses in the text, but the potential range extensions are shown in Figure 2 as dashed lines.

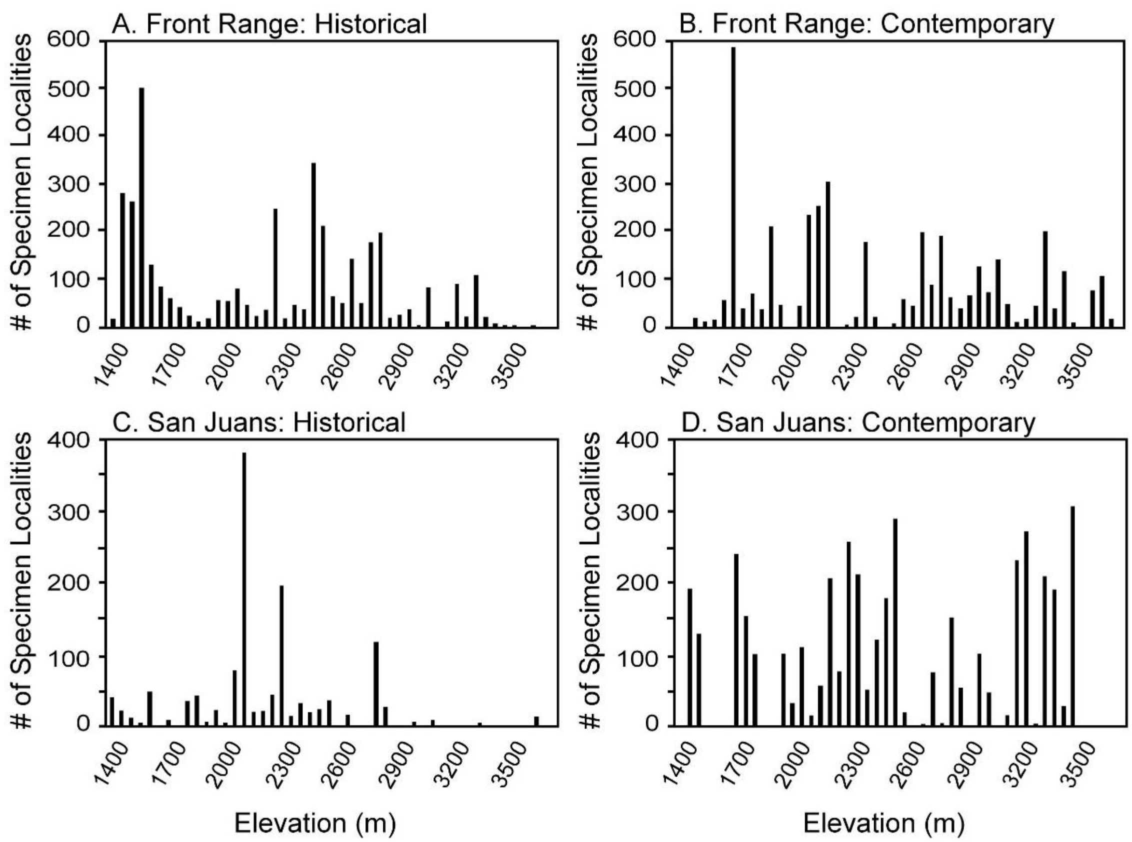


**Figure S1.2.** The historical and contemporary distribution of mammal specimen-localities along the Front Range (A, B) and San Juan (C, D) elevational gradients. These sums were used in the Bayesian undersampling models and give a minimum indication of the sampling effort on both mountains. This underestimates the sampling effort, since trap-nights per band were not recorded, thus unpreserved captures, specimens on non-target species, and efforts with few or no captures or specimens are not included.

For testing the phylogenetic signal in the lower and upper range shifts, we used the mammal supertree (Bininda-Emonds et al., 2007) pruned to the taxa included in each mountain dataset. Phylogenetic signal was calculated with *phylosignal* (Keck *et al.*, 2016) in R (Team,

2019) using all five significance tests (*Cmean*, *I*, *K*, *K.star*, and *Lambda*). Table S1.1 includes all of the *phylosignal* test values and significances; all of which are non-significant.

**Table S1.1.** Statistics from phylogenetic signal tests in the upper and lower range shifts (*p* = *p*-value).

| Range Limit | *Cmean* | *p* | *I* | *p* | *K* | *p* | *K.star* | *p* | *Lambda* | *p* |
|---|---|---|---|---|---|---|---|---|---|---|
| **FR Lower** | 0.119 | 0.073 | 0.047 | 0.085 | 0.279 | 0.113 | 0.289 | 0.147 | 0.242 | 0.203 |
| **FR Upper** | -0.135 | 0.754 | -0.062 | 0.571 | 0.178 | 0.534 | 0.185 | 0.534 | <0.001 | 1.000 |
| **SJ Lower** | -0.107 | 0.685 | -0.087 | 0.705 | 0.120 | 0.936 | 0.139 | 0.950 | <0.001 | 1.000 |
| **SJ Upper** | -0.046 | 0.416 | -0.036 | 0.368 | 0.224 | 0.383 | 0.229 | 0.478 | <0.001 | 1.000 |

## *R* code for Bayesian undersampling model:

```
#-----------------------------------------------
# Model for each mountain range per time period
#-----------------------------------------------
#
# written for JAGS
#
# DATA -----------------------------------------
#  n.el = number of elevational bins
#  J = number of species
#  y[n.el, ] = number of detections of each species
#  Y[n.el] = total number of detections at each elevation
#  delta[J] = pr(detect an individual if present)
#  LAMBDA[J] = total number of detections of each species
#  distAway[n.el,J] = number of meters from bin i to last detection
#     NOTE: 0 if inside interpolated range, positive if outside interpolated range
#  interpPatchy[J] = proportion of bins without detections in interpolated range
#
# NOTE: distAway and interpPatchy were z-transformed to a standard normal
# distribution (mean=0, sd=1) for improved MCMC convergence
#
# PARAMETERS -----------------------------------
# lambda[n.el,J] = true relative abundance of each species (unobserved)
# beta[3] = slopes (all species together)
# a[J] = intercepts (species-specific)
# alpha = average intercept across all species
# sigma = standard deviation in intercept across all species
# Z[n.el,J] = true presence (1) or absence (0) of species
# psi[n.el,J] = pr(Z=1) based on sampling uncertainty

model{
  # Likelihood
  for(i in 1:n.el) {

    # species pool probabilities
    p[i,1:J] <- lambda[i,1:J]*delta[1:J]*Z[i,1:J]

    # detections from a multinomial distribution
    # with probabilities p (divide by sum(p) to enforce [0,1] & sum = 1)
    y[i,] ~ dmulti(p[i,1:J]/sum(p[i,1:J]), Y[i])

    # occupancy and sampling effects
```

```
    for(j in 1:J) {
        Z[i,j] ~ dbern(psi[i,j])
        logit(psi[i,j]) <- a[j] +
          beta[1]*distAway[i,j] +
          beta[2]*interpPatchy[j] +
          beta[3]*distAway[i,j]*interpPatchy[j]
    }
  }

  # Prior distributions
  alpha ~ dnorm(0, 0.01)
  tau <- 1/(sigma*sigma)  # JAGS uses precision = 1/variance
  sigma ~ dnorm(0, 0.01) T(0, )
  beta[1] ~ dnorm(0, 0.01)
  beta[2] ~ dnorm(0, 0.01)
  beta[3] ~ dnorm(0, 0.01)
  for(j in 1:J) {
    a[j] ~ dnorm(alpha, tau)
    # lambda prior for each bin = Normal(mean=total abundance, sd=100)[0,]
    for(i in 1:n.el) {
      lambda[i,j] ~ dnorm(LAMBDA[j], 0.0001) T(0, )
    }
  }
}
```

Supplementary Methods Literature Cited


Keck F, Rimet F, Bouchez A, Franc A (2016) phylosignal: an R package to measure, test, and explore the phylogenetic signal. Ecology and Evolution, **6**, 2774-2780.

Kéry M, Royle JA (2008) Hierarchical Bayes estimation of species richness and occupancy in spatially replicated surveys. Journal of Applied Ecology, **45**, 589-598.

Mackenzie DI, Nichols JD, Lachman GB, Droege S, Andrew Royle J, Langtimm CA (2002) Estimating site occupancy rates when detection probabilities are less than one. Ecology, **83**, 2248-2255.

Mccain CM, King SRB, Szewczyk T, Beck J (2018) Small mammal species richness is directly linked to regional productivity, but decoupled from food resources, abundance, or habitat complexity. Journal of Biogeography, **45**, 2533–2545.

Szewczyk TM, Mccain CM (2019) Disentangling elevational richness: a multi-scale hierarchical Bayesian occupancy model of Colorado ant communities. Ecography, **42**, 977-988.

Team RDC (2019) R: A language and environment for statistical computing.  pp Page, Vienna, Austria, R Foundation for Statistical Computing.

**Appendix S2**. The dataset of small mammal species tested for elevational range changes in the Front Range and San Juan Mountains of Colorado. USA. The taxonomic order, family of rodents, and species name are list for each mountain range. The probability of detection is how likely a single individual of a species is to be detected based on contemporary mark and recapture statistics. Telev. Rng = the location of the species on the mountain: montane, low elevation, or cosmopolitan (across most elevations). Max. Lat. Is the highest latitude in the geographic range of the species in North America. Rng Edge = the location of the study area in relationship to the species geographic edge, if it is not on an edge in the cardinal directions then it is the middle. The empricial number of specimens, lower elevational limit and upper elevational limit are shown for the hstorical and contemporary time periods as are the Bayseian 95% lower and upper limits in both time periods. The Baeysian models using all the specimen data include "All" in the header whereas those specifically for larger rodents include "Large" in the header. Finally, the elevation change in the lower, upper, and overall combined limits are shown and the type of shift (upward, downward, none, or local extirpation). All elevational values are in meters.

| | | | Probability | | Max. | Rng | Empirical: Historical | | | Bayesian: All, Hist. | | Bayes.: Large, Hist | | Empirical: Contemporary | | | Bayesian: All, Cont. | | Bayes.: Large, Cont. | | Lower | Upper | Overall | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxon | Species | Mountain | Detection | Elev. Rng | Lat. | Edge | Data # | Lower | Upper | Lower | Upper | Lower | Upper | Data # | Lower | Upper | Lower | Upper | Lower | Upper | Change | Change | Change | SHIFT |
| Rodentia, Sciuridae | Callospermophilus lateralis | Front Range | 0.170 | Montane | 56.4 | East | 135 | 1760 | 3388 | 1700 | 3549 | | | 100 | 1939 | 3356 | 1750 | 3799 | | | 50 | 250 | 300 | UP |
| Rodentia, Heteromyidae | Dipodomys ordii | Front Range | 0.220 | Low | -- | -- | 29 | 1524 | 1890 | 1438 | 2049 | | | 0 | -- | -- | -- | -- | | | -- | -- | -- | EXTIR. |
| Rodentia, Sciuridae | Ictidomys tridecemlineatus | Front Range | 0.241 | Low | 54.9 | West | 48 | 1492 | 1876 | 1438 | 2199 | | | 2 | 1545 | 1550 | 1438 | 1799 | | | 0 | -400 | -400 | DOWN |
| Rodentia, Sciuridae | Marmota flaviventris | Front Range | 0.241 | Montane | 51.1 | East | 34 | 1628 | 3688 | 1600 | 3799 | 1550 | 3799 | 34 | 1863 | 3737 | 1750 | 3799 | 1650 | 3799 | 150 | 0 | 150 | UP |
| Rodentia, Cricetidae | Microtus longicaudus | Front Range | 0.184 | All | 68.1 | East | 97 | 1506 | 3353 | 1438 | 3549 | | | 66 | 1704 | 3607 | 1438 | 3799 | | | 0 | 250 | 250 | UP |
| Rodentia, Cricetidae | Microtus montanus | Front Range | 0.122 | All | 52.9 | East | 129 | 1506 | 3528 | 1438 | 3649 | | | 62 | 1513 | 3725 | 1438 | 3799 | | | 0 | 150 | 150 | UP |
| Rodentia, Cricetidae | Microtus ochrogaster | Front Range | 0.228 | Low | 56.0 | West | 143 | 1484 | 2218 | 1438 | 2299 | | | 31 | 1532 | 2242 | 1438 | 2549 | | | 0 | 250 | 250 | UP |
| Rodentia, Cricetidae | Microtus pennsylvanicus | Front Range | 0.189 | Low | 70.3 | West | 269 | 1494 | 1984 | 1438 | 2049 | | | 9 | 1519 | 1942 | 1438 | 2099 | | | 0 | 50 | 50 | NONE |
| Rodentia, Cricetidae | Myodes gapperi | Front Range | 0.210 | Montane | 62.4 | East | 102 | 2515 | 3353 | 2350 | 3549 | | | 59 | 2611 | 3310 | 2450 | 3549 | | | 100 | 0 | 100 | UP |
| Rodentia, Cricetidae | Neotoma mexicana | Front Range | 0.289 | Low | 41.0 | North | 125 | 1489 | 2537 | 1438 | 2649 | | | 158 | 1538 | 2187 | 1438 | 2399 | | | 0 | -250 | -250 | DOWN |
| Rodentia, Sciuridae | Otospermophilus variegatus | Front Range | 0.241 | Low | 41.9 | North | 41 | 1517 | 2134 | 1438 | 2299 | 1438 | 2299 | 1 | 1717 | 1717 | 1550 | 1899 | 1438 | 2049 | 112 | -400 | -288 | DOWN |
| Rodentia, Heteromyidae | Perognathus fasciatus | Front Range | 0.220 | Low | -- | -- | 10 | 1524 | 1524 | 1438 | 1599 | | | 0 | -- | -- | -- | -- | | | -- | -- | -- | EXTIR. |
| Rodentia, Heteromyidae | Perognathus flavus | Front Range | 0.220 | Low | -- | -- | 11 | 1524 | 1524 | 1438 | 1599 | | | 0 | -- | -- | -- | -- | | | -- | -- | -- | EXTIR. |
| Rodentia, Cricetidae | Peromyscus maniculatus | Front Range | 0.429 | All | 65.6 | Middle | 931 | 1489 | 3588 | 1438 | 3599 | | | 1948 | 1518 | 3731 | 1438 | 3799 | | | 0 | 200 | 200 | UP |
| Rodentia, Cricetidae | Peromyscus nastutus | Front Range | 0.197 | Low | 41.2 | North | 167 | 1494 | 2560 | 1438 | 2699 | | | 81 | 1660 | 2155 | 1438 | 2399 | | | 0 | -300 | -300 | DOWN |
| Rodentia, Cricetidae | Phenacomys intermedius | Front Range | 0.175 | Montane | 58.7 | East | 19 | 2742 | 3673 | 2600 | 3799 | | | 37 | 2700 | 3700 | 2450 | 3799 | | | -150 | 0 | -150 | DOWN |
| Rodentia, Cricetidae | Reithrodontomy megalotis | Front Range | 0.234 | Low | 50.6 | Middle | 53 | 1531 | 2084 | 1438 | 2249 | | | 169 | 1682 | 2239 | 1438 | 2399 | | | 0 | 150 | 150 | UP |
| Rodentia, Sciuridae | Sciurus aberti | Front Range | 0.241 | Low | 41.3 | North | 38 | 1641 | 2638 | 1550 | 2699 | 1450 | 2749 | 12 | 1724 | 2673 | 1500 | 2799 | 1450 | 2799 | -50 | 100 | 50 | NONE |
| Soricidae | Sorex cinereus | Front Range | 0.200 | All | 70.3 | East | 77 | 1492 | 3353 | 1438 | 3499 | | | 63 | 2798 | 3452 | 2550 | 3649 | | | 1112 | 150 | 1262 | UP |
| Soricidae | Sorex hoyi | Front Range | 0.112 | Montane | 67.4 | South | 22 | 2638 | 2936 | 2550 | 3049 | | | 16 | 2806 | 3447 | 2500 | 3749 | | | -50 | 700 | 650 | UP |
| Soricidae | Sorex monticolus | Front Range | 0.112 | All | 69.4 | East | 103 | 1628 | 3505 | 1450 | 3699 | | | 95 | 1726 | 3493 | 1438 | 3799 | | | -12 | 100 | 88 | UP |
| Soricidae | Sorex palustris | Front Range | 0.200 | All | 65.1 | East | 61 | 1591 | 3307 | 1450 | 3449 | | | 3 | 2786 | 2859 | 2550 | 3049 | | | 1100 | -400 | 700 | UP |
| Rodentia, Sciuridae | Tamias minimus | Front Range | 0.240 | All | 66.4 | East | 302 | 1796 | 3600 | 1750 | 3749 | | | 445 | 1546 | 3492 | 1438 | 3599 | | | -312 | -150 | -462 | DOWN |
| Rodentia, Sciuridae | Tamias quadrivittatus | Front Range | 0.238 | Low | 41.0 | North | 49 | 1585 | 2795 | 1438 | 2849 | | | 60 | 1721 | 2659 | 1500 | 2799 | | | 62 | -50 | 12 | NONE |
| Rodentia, Sciuridae | Tamias umbrinus | Front Range | 0.325 | Montane | 45.4 | East | 77 | 2134 | 3414 | 1950 | 3599 | | | 59 | 2343 | 3385 | 2250 | 3599 | | | 300 | 0 | 300 | UP |
| Rodentia, Sciuridae | Tamiasciurus hudsonicus | Front Range | 0.241 | All | 67.8 | East | 143 | 1766 | 3475 | 1700 | 3649 | 1650 | 3649 | 126 | 1882 | 3356 | 1750 | 3599 | 1550 | 3599 | 50 | -50 | 0 | NONE |
| Rodentia, Dipodidae | Zapus hudsonicus preblei | Front Range | 0.293 | Low | 65.0 | South | 32 | 1553 | 1634 | 1450 | 1699 | | | 6 | 1726 | 2130 | 1500 | 2349 | | | 50 | 650 | 700 | UP |
| Rodentia, Dipodidae | Zapus princeps | Front Range | 0.293 | Montane | 62.3 | East | 109 | 2006 | 3259 | 1900 | 3349 | | | 89 | 2402 | 3140 | 2250 | 3299 | | | 350 | -50 | 300 | UP |
| Rodentia, Sciuridae | Ammospermophilus leucurus | San Juans | 0.241 | Low | 44.1 | East | 13 | 1418 | 2134 | 1414 | 2299 | | | 6 | 1506 | 1735 | 1414 | 1949 | | | 0 | -350 | -350 | DOWN |
| Rodentia, Sciuridae | Callospermophilus lateralis | San Juans | 0.170 | Montane | 56.4 | South | 33 | 1981 | 3109 | 1650 | 3399 | | | 70 | 2227 | 3524 | 1900 | 3799 | | | 250 | 400 | 650 | UP |
| Rodentia, Cricetidae | Microtus longicaudus | San Juans | 0.184 | Montane | 68.1 | South | 59 | 2050 | 2827 | 1900 | 3049 | | | 17 | 2079 | 3411 | 1900 | 3599 | | | 0 | 550 | 550 | UP |
| Rodentia, Cricetidae | Microtus mogollonensis | San Juans | 0.220 | Low | 31.3 | North | 26 | 2133 | 2407 | 1950 | 2649 | | | 21 | 1494 | 2384 | 1414 | 2499 | | | -536 | -150 | -686 | DOWN |
| Rodentia, Cricetidae | Microtus montanus | San Juans | 0.122 | All | 52.9 | South | 57 | 1895 | 3407 | 1550 | 3799 | | | 81 | 1812 | 3519 | 1600 | 3749 | | | 50 | -50 | 0 | NONE |
| Rodentia, Cricetidae | Myodes gapperi | San Juans | 0.210 | Montane | 62.4 | South | 10 | 2827 | 2840 | 2600 | 3049 | | | 83 | 2570 | 3530 | 2400 | 3749 | | | -200 | 700 | 500 | UP |
| Rodentia, Cricetidae | Neotoma albigula | San Juans | 0.257 | Low | 39.0 | North | 17 | 1483 | 2085 | 1414 | 2249 | | | 20 | 1512 | 2020 | 1414 | 2199 | | | 0 | -50 | -50 | NONE |
| Rodentia, Cricetidae | Neotoma mexicana | San Juans | 0.289 | Low | 41.0 | North | 46 | 1610 | 2285 | 1450 | 2449 | | | 66 | 1715 | 2570 | 1550 | 2649 | | | 100 | 200 | 300 | UP |
| Rodentia, Sciuridae | Otospermophilus variegatus | San Juans | 0.241 | Low | 41.9 | North | 20 | 1610 | 2202 | 1450 | 2399 | 1414 | 2649 | 25 | 1482 | 2530 | 1414 | 2799 | 1414 | 2849 | -36 | 400 | 364 | UP |
| Rodentia, Cricetidae | Peromyscus boylii | San Juans | 0.434 | Low | 46.3 | Middle | 44 | 1418 | 2444 | 1414 | 2649 | | | 96 | 1482 | 2510 | 1414 | 2699 | | | 0 | 50 | 50 | NONE |
| Rodentia, Cricetidae | Peromyscus crinitus | San Juans | 0.372 | Low | -- | -- | 31 | 1418 | 2307 | 1414 | 2449 | | | 0 | -- | -- | -- | -- | | | -- | -- | -- | EXTIR. |
| Rodentia, Cricetidae | Peromyscus maniculatus | San Juans | 0.429 | All | 65.6 | Middle | 535 | 1418 | 3691 | 1414 | 3799 | | | 1481 | 1486 | 3538 | 1414 | 3749 | | | 0 | -50 | -50 | NONE |
| Rodentia, Cricetidae | Peromyscus truei | San Juans | 0.428 | Low | 46.7 | Middle | 76 | 1418 | 2354 | 1414 | 2549 | | | 394 | 1481 | 2513 | 1414 | 2699 | | | 0 | 150 | 150 | UP |
| Rodentia, Cricetidae | Reithrodontomy megalotis | San Juans | 0.234 | Low | 50.6 | Middle | 30 | 1610 | 2597 | 1414 | 2799 | | | 60 | 1486 | 2426 | 1414 | 2499 | | | 0 | -300 | -300 | DOWN |
| Soricidae | Sorex monticolus | San Juans | 0.112 | Montane | 69.4 | South | 21 | 2115 | 2827 | 1800 | 3099 | | | 143 | 2507 | 3530 | 1850 | 3799 | | | 50 | 700 | 750 | UP |
| Rodentia, Sciuridae | Tamias minimus | San Juans | 0.240 | All | 66.4 | South | 130 | 1981 | 3407 | 1700 | 3649 | | | 1057 | 1503 | 3559 | 1414 | 3749 | | | -286 | 100 | -186 | DOWN |
| Rodentia, Sciuridae | Tamias quadrivittatus | San Juans | 0.238 | All | 41.0 | Middle | 29 | 1840 | 3386 | 1650 | 3599 | | | 13 | 2410 | 2570 | 2350 | 2749 | | | 700 | -850 | -150 | UP |
| Rodentia, Sciuridae | Tamias rufus | San Juans | 0.231 | Low | 40.8 | South | 22 | 1418 | 2264 | 1414 | 2499 | | | 50 | 1503 | 2348 | 1414 | 2449 | | | 0 | -50 | -50 | NONE |
| Rodentia, Dipodidae | Zapus princeps | San Juans | 0.293 | Montane | 62.3 | South | 25 | 2050 | 3407 | 1900 | 3649 | | | 30 | 2079 | 3433 | 1900 | 3599 | | | 0 | -50 | -50 | NONE |

Appendix S3. Supplementary Results

The dataset of small mammals used in the elevation shift analyses, and their historical and contemporary range limits both for the empirical data and the Bayesian 95% models are in Appendix S2. Six species in the Front Range Mountains (FR) and 13 species in the San Juan Mountains (SJ) were not sampled sufficiently historically (i.e., fewer than 10 specimens) for robust elevational range comparisons. These are presented here for those who may be interested in specific species (Figure S3.1). Four species were detected historically, albeit rarely, that were undetected contemporarily: *Reithrodontomys montanus* (FR), *Xerospermophilus spilosoma* (both), *Perognathus flavescens* (FR), and *Sorex merriami* (SJ). Four species were caught at lower elevations contemporarily: *Peromyscus boylii* (FR), *Notiosorex crawfordi* (SJ), *Sciurus aberti* (SJ), and *Marmota flaviventris* (SJ). Seven species were caught at higher elevations contemporarily: *Chaetodipus hispidus* (FR), *Sorex merriami* (FR), *Perognathus flavus* (SJ), *Dipodomys ordii* (SJ), *Sorex nanus* (SJ), *Tamiasciurus hudsonicus* (SJ), and *Sorex palustris* (SJ). Lastly, a few species of small mammals that are likely under-sampled contemporarily due to differences in sampling methods (e.g., lack of shooting as a collecting method) and/or their patchy and specialized locations (e.g., particular types of montane streams, rocky outcrops), included *Neotoma cinerea* on both transects, and *Urocitellus elegans* and *Sorex palustris* in the Front Range.

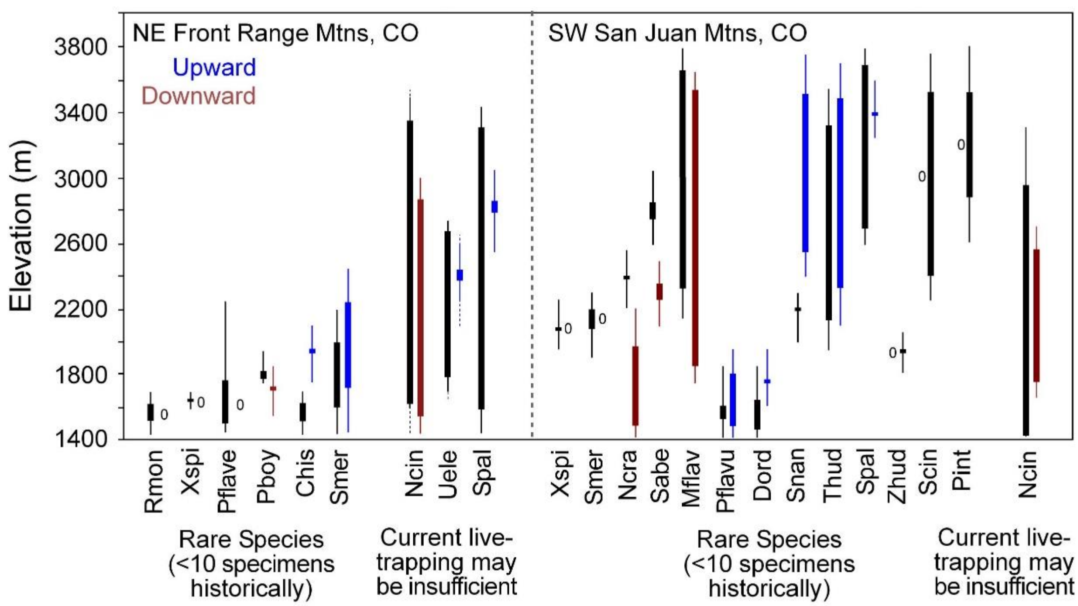


**Figure S3.1.** Elevational ranges historically and contemporarily for those small mammals that were too rare (<10 specimens historically) to include in the main analyses or potentially too under-sampled contemporarily due to methodological changes.

To assess whether range losses and range gains at the range edges were associated with particular areas on the mountains across the included species, we calculated the number of species loosing or gaining range at each 50m band up each mountain. Because the number of species per elevational band differs (unimodal with highest richness of included species between

1900–2000m), counts of range losses and range gains summed across all species for each 50m elevation on each mountain gradient is biased towards elevations with more species (Figure S3.2). Thus, we examined the percentage of range losses and range gains for each 50m elevation on each mountain gradient by dividing the species counts by the historical number of species present at each band (Figure 4).

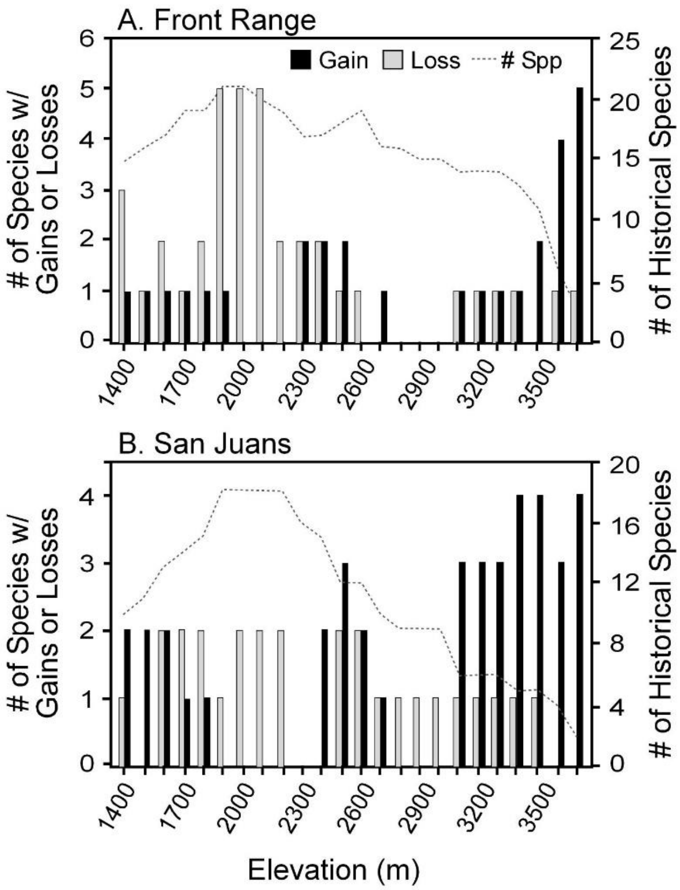


**Figure S3.2.** Elevational distribution of the range gains (black bars) and losses (grey bars) for species' range edges summed at each 50m elevational band across the studied species. The summed numbers of gains and losses per band (bars) are shown with the number of species in each band (dotted grey curves) for the Front Range (A) and the San Juans (C). Percentage gains and losses, corrected for species richness, as well as a geographical heat map are shown in Figure 4.