Lassen Volcanic National Park
Small Vertebrate Inventory Project:

Preliminary Results
2000 – 2004

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SUMMARY

Biologists at Lassen Volcanic National Park in northern California conducted an inventory of non-flying small mammals, amphibians and reptiles from 2000 through 2004. The four primary habitat types in the park (brush, forest, riparian and subalpine) were each sampled at one high elevation and one mid-elevation site in the park. Each of the eight sites was sampled for four six-day periods between June and September each year using a combination of pitfall, Sherman and Tomahawk traps, coverboards and unbaited automatic camera stations. This effort yielded 12,150 captures and 776 photo detections. A total of 649 voucher specimens, representing 19 mammal, one amphibian and two reptile species, was collected and accessioned to the Museum of Vertebrate Zoology at the University of California, Berkeley.

The inventory detected a total of 36 mammal species, consisting of seven insectivores, 17 rodents, three lagomorphs, eight carnivores and one ungulate. Three new park records were obtained: *Sorex preblei* and *S. tenellus* were confirmed with voucher specimens and *Reithrodontomys megalotis* was reported but not confirmed with a voucher specimen. Mammal richness ranged from 13 to 18 species per site and was highest at the riparian sites and lowest at the subalpine sites. Small mammal diversity was highest at the riparian sites (Simpson's D = 4.11) and lowest at the brush sites (D = 2.49).

The inventory also detected two salamander species, two frog species, two lizard genera and one snake genus. Amphibian richness ranged from one to three species per site and was highest at the forest sites and lowest at the subalpine sites. Reptile richness ranged from one to three genera per site and was highest at the riparian sites and lowest at the subalpine sites. For sites with ≥10 captures, amphibian diversity was highest at the forest sites and reptile diversity was highest at the riparian sites.

By marking individuals, the inventory documented the variation in relative abundance among habitat types and among years. Relative abundance of several small mammal species declined sharply in 2003, perhaps due to weather conditions. Comparison with historical records indicates that the ranges of several species may have expanded to higher elevations in recent decades. This inventory represents the most comprehensive and intensive mammal, amphibian and reptile survey conducted to date in the park, even though it did not meet its goal of detecting 90% of the species believed to occur in the park. The data collected by this inventory will be critical for the development of a long-term monitoring program for these species in the park. The current sampling design may require modification to make it appropriate and practical for long-term monitoring.

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INTRODUCTION

Lands administered by the National Park Service (NPS) provide important habitat for many native vertebrate species. In keeping with its goal to preserve, protect and manage biological resources, the NPS recently embarked on a program to inventory and monitor the vertebrate diversity on its lands. (For more information on the Biological Inventories Program, see http://www.nature.nps.gov/biology/biologicalinventories/index.cfm.)

The primary goal of the Small Vertebrate Inventory Project at Lassen Volcanic National Park (LVNP) was to conduct a scientifically-based inventory to document approximately 90% of the terrestrial vertebrate species (mammals, reptiles and amphibians) within the park. Secondary goals were to quantify the distribution, diversity and natural annual variation of these species at several key habitat types within the park. This report summarizes the methodology used and the basic data collected, compares the results with prior vertebrate inventories in and near the park, assesses how well the program met its goals and provides some recommendations for future work. The results of this inventory will be used to develop a long-term inventory and monitoring program so that changes in the local populations of mammals, reptiles and amphibians can be correlated with natural and human-caused environmental changes. Small vertebrates can be important indicators of ecosystem function and health, and changes in local populations can indicate ecosystem degradation (Carey 1998).

Study site:

Lassen Volcanic National Park is a 430 km² reserve containing portions of Lassen, Plumas, Shasta, and Tehama Counties in northern California. The park is dominated by Lassen Peak, a dormant volcano that is the southernmost peak of the Cascade Range. Elevations in the park range from 1600 to 3200 m. The rugged topography is dominated by several types of conifer communities, including mountain hemlock (*Tsuga mertensiana*) and whitebark pine (*Pinus albicaulis*) above 2400 m, red fir (*Abies magnifica*) and lodgepole pine (*P. contorta*) from 2400 to 2000 m, and white fir (*A. concolor*) and Jeffrey pine (*P. jeffreyi*) below 2000 m. Shrub (predominantly *Arctostaphylos nevadensis*) and wet alpine meadow communities are also common, as are barren areas and talus slopes at higher elevations (Taylor 1990, Parker 1991, White et al. 1995). Approximately 75% of the park is federally-designated wilderness, and most of the remainder is managed as such (LVNP 2001). The park is surrounded on all sides by the

Lassen National Forest, much of which is actively managed for timber production. The area has a Mediterranean climate with warm dry summers and cold wet winters. Mean monthly temperature in Mineral (1478 m), 11 km southwest of the park, ranges from -0.8°C in January to 17.2°C in July (Beaty and Taylor 2001). Most of the annual precipitation occurs as snow from November through April (Parker 1991, Beaty and Taylor 2001). In winter, this area usually receives among the highest snowfalls in the state, typically averaging >50 cm per month (Krohn et al. 1997). At high elevations, snow may accumulate to >5 m deep and it often persists well into the summer months.

SURVEY METHODOLOGY

Small vertebrate sampling arrays were established in four major habitat types: brush, forest, riparian and subalpine. These cover types comprise approximately 80% of the park (LVNP 2001). One high-elevation and one mid-elevation site was sampled for each habitat type, for a total of eight sites (Table 1). All sites were located in the western half of the park (Figure 1). Sites were located along the Highway 89 corridor for ease of access, but all arrays were >50 m from the road. Each site was sampled by four Y-shaped sampling arrays, each containing seven pitfall traps linked with drift fence. At the end of each arm of each array were a pair of Sherman live traps and a pair of cover boards, each a 0.6 m x 1.2 m x 1.3 cm (2 ft x 4 ft x 0.5 in) sheet of exterior-grade plywood. (See Figures 2 and 3.) Each pitfall trap consisted of a five-gallon plastic paint bucket buried to the rim. Each bucket contained a 15 cm length of PVC drain pipe insulated with a 5 cm length of 0.6 cm thickness foam core to provide cover for captured animals, a damp sponge to provide moisture for captured amphibians, a mealworm to sustain captured shrews, and a pinch of dry old-fashioned oats (not quick oats) to sustain other captured mammals. Pitfall traps were 5 m apart, making each arm of the array 10 m long. In addition, Tomahawk live traps were set at some sites where flying squirrels and other arboreal rodents were expected. Although the schematic shows the four arrays in a square approximately 100 m per side, at most sites (especially the riparian sites) the arrays had to be in a more linear arrangement. (See Appendix A for maps of the sampling arrays at each site.) To detect larger vertebrates, one unbaited TrailMaster camera station was set up at each site, typically near game trails, and was operated continuously

Table 1: Vegetation communities represented by small vertebrate sampling sites. Descriptions adapted from LVNP 2005. See Appendix A for photographs of each site.

Brush 1 (B1): Subalpine Low Shrub 2190 m (7180 ft)
A low shrub habitat dominated by pinemat manzanita (*Arctostaphylos nevadensis*) within very open woodlands. Trees occur as scattered individuals or as small groups composed primarily of red fir (*Abies magnifica*) and western white pine (*Pinus monticola*). Tree cover varies widely but is generally <15%. Associated shrubs (<10% cover) include bush chinquapin (*Castanopsis sempervirens*) and huckleberry oak (*Quercus vaccinifolia*). This shrub community is most commonly associated with high elevation red fir forests and is widespread throughout the park and the Caribou Wilderness.

Brush 2 (B2): Lowland Seral Shrub 1800 m (5900 ft)
This plot is located within an old, decadent seral shrub field that was created by a series of high-intensity fires around 1900. Greenleaf manzanita (*Arctostaphylos patula*) is the dominant species, with scattered patches of tobacco brush (*Ceanothus velutinus*) and bitter cherry (*Prunus emarginata*). This assemblage is common at lower elevations in the northern part of the park, particularly near Manzanita Lake and along the northeastern border. White fir (*Abies concolor*) establishment is occurring in most of these areas. More than half of the seral shrub fields in this area have been successionally replaced by *A. concolor* over the past 50 years.

Forest 1 (F1): Montane Mixed Conifer 1980 m (6500 ft)
This area is characterized by an overstory of red fir (*Abies magnifica*), white fir (*A. concolor*), western white pine (*Pinus monticola*) and lodgepole pine (*P. contorta*). Pole-sized fir thickets are common. Canopy closure ranges from 50-90%. Herbaceous ground cover and understory shrubs are sparse. Herbaceous species include white-flowered hawkweed (*Hieracium albiflorum*), little prince's-pine (*Chimaphila menziesii*) and dwarf lousewort (*Pedicularis semibartbata*). Wax currant (*Ribes cereum*) is one of the few shrub species present. A thick layer of litter, duff and down wood contribute to the ground cover. Standing snags are abundant.

Forest 2 (F2): Climax Jeffrey Pine 1765 m (5780 ft)
This is an old-growth climax forest composed of Jeffrey pine (*Pinus jeffreyi*) and Ponderosa pine (*P. ponderosa*), with occasional sugar pine (*P. lambertiana*) in the overstory. This is a xeric site with coarse soils and lacks a sufficient component of white fir (*Abies concolor*) to successionally progress to a fir climax. The understory consists primarily of bunch grasses (*Festuca* spp.), squirrel tail (*Elymus* spp.), various forbs, litter and down wood. This type occurs primarily in the northern part of the park below 1920 m (6300 ft) and covers about 13% of the park.

Riparian 1 (R1): Subalpine Alder Riparian 1960 m (6430 ft)
The arrays are located within a high elevation riparian stringer adjacent to a series of small spring-fed streams. Streamside vegetation is dominated by mountain alder (*Alnus incana*), with corn lily (*Veratrum californicum*) and sedges in the associated wet meadows. These glades typically occur in the subalpine forest belts along steep mountain slopes. Small stringers of red fir (*Abies magnifica*) and western white pine (*Pinus monticola*) occur within the matrix of mountain alder and wet meadows.

Table 1, continued.

Riparian 2 (R2): Lowland Riparian 1940 m (6350 ft)
This riparian habitat along upper Lost Creek is characterized by a complex mosaic of shrubs, grasses and deciduous trees. It is primarily willow dominated, with both Lemmon's willow (*Salix lemmonii*) and yellow willow (*S. lucida*) abundant. Sedge meadows and small quaking aspen (*Populus tremuloides*) groves are interspersed between the willows. Mixed conifer forests of Jeffrey pine (*Pinus jeffreyi*), white fir (*Abies concolor*) and lodgepole pine (*P. contorta*) surround the riparian area, with increasingly barren vegetation upstream at the edge of the Devastated Area.

Subalpine 1 (S1): Subalpine Parkland 2200 m (7200 ft)
This site is an open red fir (*Abies magnifica*) woodland within a matrix of dense slope meadows. Trees occur as scattered individuals or small clumps within the dry meadow matrix. Occasional western white pine (*Pinus monticola*) and mountain hemlock (*Tsuga mertensiana*) are present. The dry herbaceous meadows are dominated by mules ears (*Wyethia mollis*), grasses, lupines (*Lupinus* spp.), balsamroot (*Balsamorhiza sagittata*), stickseed (*Hackelia* spp.) and other forbs.

Subalpine 2 (S2): Subalpine Woodland 2560 m (8390 ft)
An open, patchy subalpine woodland of whitebark pine (*Pinus albicaulis*) and mountain hemlock (*Tsuga mertensiana*) just below timberline. This site is characterized by persistent snowfields that usually remain well into July. Trees occur around exposed rocky outcroppings where snow melts earlier in the spring. The understory is sparse, consisting primarily of bunch grasses (*Festuca* spp.) and scattered forbs. Much bare soil and rock is present. Snags and down wood are slow to decay and persist for many years.

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for the entire summer. The array design and sampling protocols were adapted from those used by Fellers and Pratt (2002) at Point Reyes National Seashore.

The arrays were installed in the summer of 1999 and data collection began in 2000 and continued through 2004. Each year, sampling generally began in June and continued through September. At any given time one pair of sites (totaling eight arrays) was active, with sampling occurring for six nights. This approach allowed all eight sites to be sampled each month, resulting in four sampling periods per site each year. Sampling was contingent on the environmental conditions at the site. For example, the S2 arrays could not be activated during the first session in 2000, 2003 and 2004 due to remaining snow cover, and the F2 site opened three days late in 2004 due to a nearby prescribed burn. (See Table A1 for site-specific sampling dates.)

Based on this design, there were 168 pitfall, 144 Sherman and 144 coverboard trap-nights per site per six-day session. With four sampling sessions per year, each site totaled 672 pitfall,

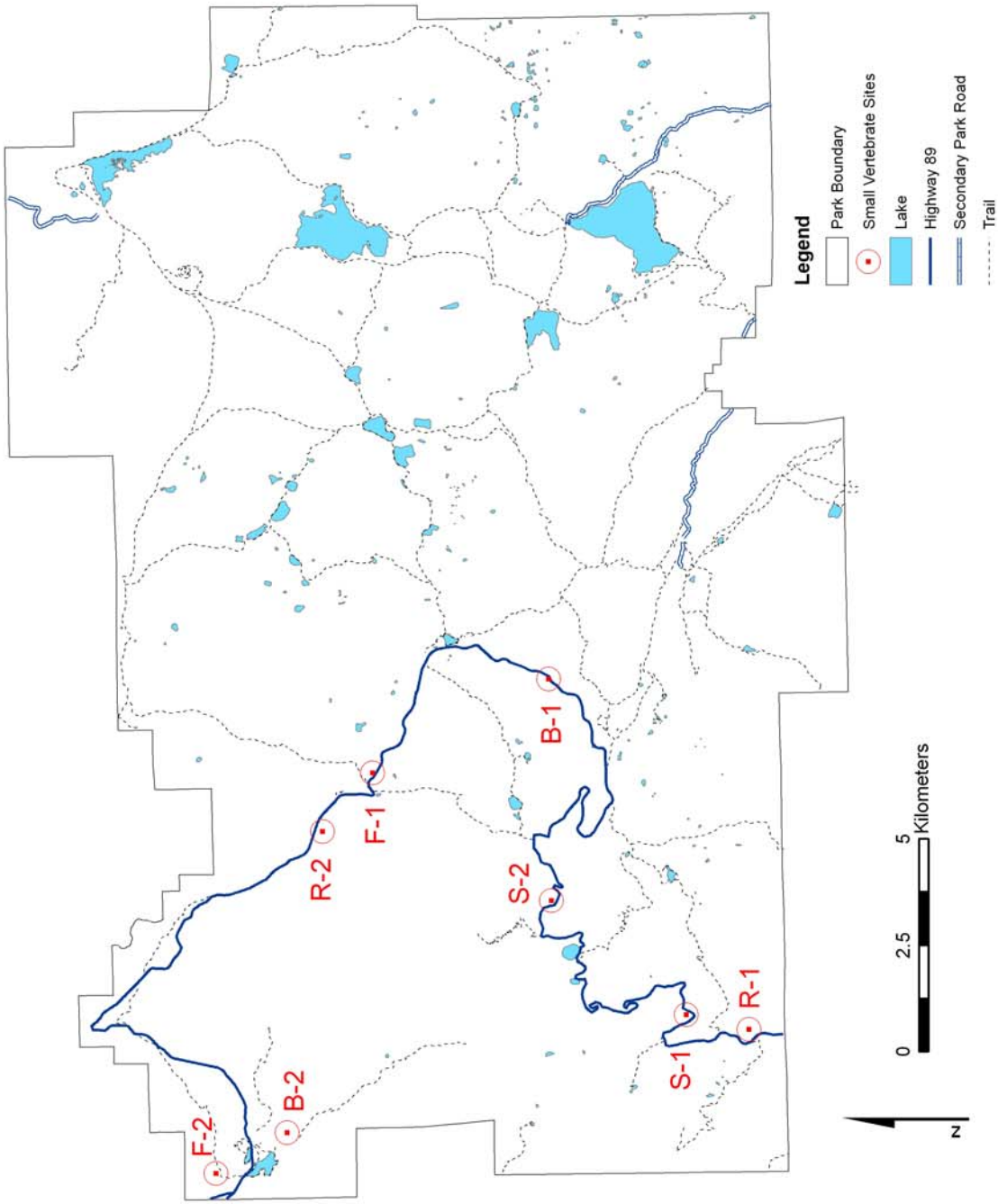

Figure 1: Location of small vertebrate sampling sites in Lassen Volcanic National Park. See Appendix A for maps of individual arrays and vegetation photographs at each site.

Figure 2: Layout of small vertebrate traps in a sampling array. The four arrays at a site were often not in a perfect square as shown here; see Appendix A for actual layouts.

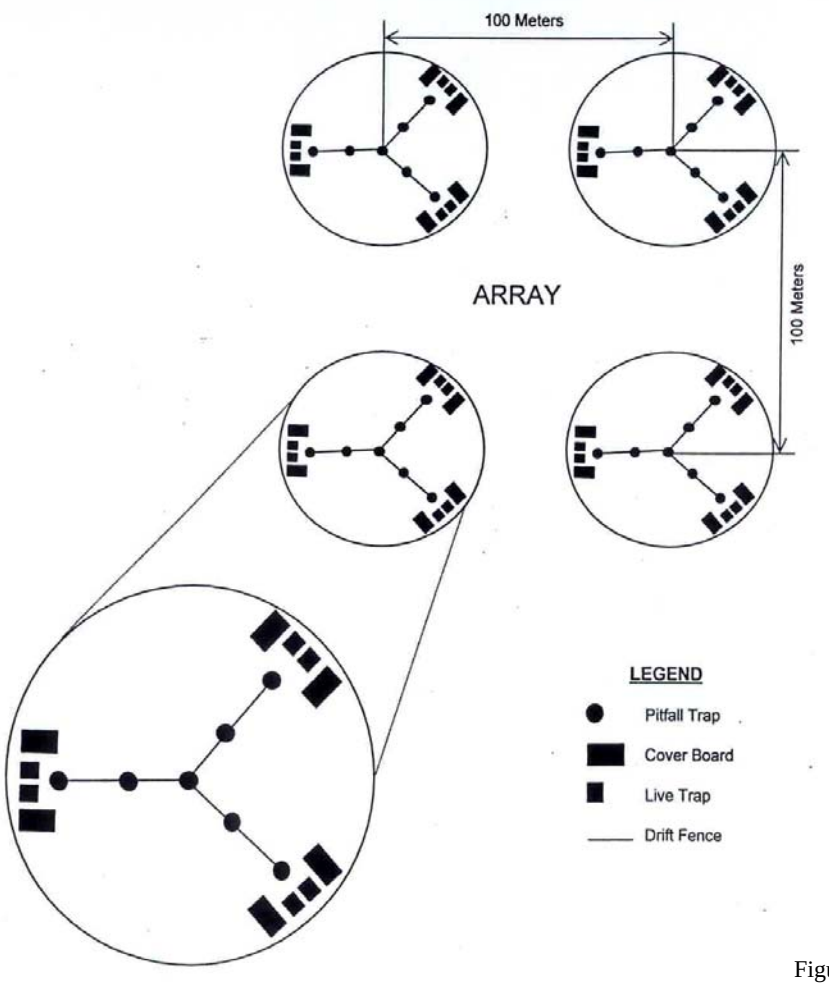

Figure from LVNP 2005.

576 Sherman and 576 coverboard trapnights annually. The annual trap effort across eight sites totaled 5376 pitfall, 4608 Sherman and 4608 coverboard trapnights. Total trap effort during the five-year survey was 26,880 pitfall, 23,040 Sherman and 23,040 coverboard trapnights. This total does not include the Tomahawk traps, camera stations or trapnights lost due to bad weather, bear damage and other factors. Active arrays were checked every morning and again in late afternoon (R1 and F1 were checked only in the mornings because chipmunks were rare at these sites). At each visit to an active site, the current weather conditions, current temperature, and 24-hour maximum and minimum temperatures were recorded. (See Appendix B for weather patterns during the survey period.) Captured animals were identified, marked, measured and then released. Rodents were marked with metal ear tags; gophers were tagged in the cheek

pouch. On the rare occasions when tags were not available, captured animals were marked with dye on their throats which at least allowed recaptures to be noted. Shrews were released immediately without marking to reduce trap mortality. Reptiles and amphibians were marked by toe-clipping. Standard measurements included weight, body length (snout-vent length for reptiles and amphibians), tail length, ear length, hind foot length, anus-genital length, age class, and sex. Animals that had been previously marked were considered "recaptures" and were usually reweighed but not measured again. Special safety procedures were employed when handling *Peromyscus* sp. to reduce the risk of hantavirus exposure (Mills et al. 1995). Trap-dead animals were retained as voucher specimens and were sent to the Museum of Vertebrate Zoology (MVZ) at UC Berkeley for confirmation of the species identification and for archival storage. Identification at the MVZ was based upon species-specific external characters (such as color patterns) and skeletal morphology (especially of the skull or baculum, when applicable). For *Sorex* and *Tamias*, taxa where species identification can be difficult, mitochondrial DNA

Figure 3: Photograph of the sampling array at the S2 site showing drift fence (black canvas) and pitfall traps (white buckets). A cover board (a sheet of plywood) is visible just beyond the end of the drift fence of the upper arm of the array.

sequences (especially the cytochrome *b* gene) were used to confirm the species identity (Shohfi et al, *in press*).

Terminology:

The following terms are used throughout this report to differentiate types of captures:

Capture event: a capture of an animal in a trap, regardless of whether that individual animal had been captured previously. This also includes a few sightings at array sites, such as snakes or mice that were seen under coverboards but immediately escaped.

Unique capture: the first capture of an individual, either per year or throughout the study. Known recaptures are excluded within the specified time frame. The total number of unique captures per year is higher than the number of *tagged individuals* (see below) because some animals were marked with dye instead of numbered tags. The dye markings allowed recaptures to be noted within that season but individuals could not be distinguished. All captures of untagged or unmarked individuals were considered to be "unique captures" because there was no evidence that they were recaptures.

Tagged individuals: an animal assigned a unique tag number. The field team used a variety of numbering systems for the various taxa, but these were revised prior to the data analysis so that each animal had a unique identifying number. Accounting was also made for individuals which received more than one tag in their lifetimes, such as when the original tag was poorly fastened or became infected. However, an unknown number of individuals may have lost their original tag and then been counted as a new individual upon a subsequent capture. A small number of captured animals did not receive tags, especially if the animal appeared injured or in distress.

Estimating relative abundance:

The number of *unique captures* of a species at a site in a year was considered an index of the relative abundance of that species. Since the capture effort was approximately equal at all

sites in all years, variation in the number of unique captures likely indicates population fluctuations by year and site. However, such comparisons should be made only within a specific taxon, where the assumption of constant detection probability is likely to be met. Estimates of the relative abundance among taxa at a given site are confounded by unequal taxon-specific probabilities of detection. In other words, if the number of mice captures was twice the number of chipmunk captures at a site, this would not be evidence that mice were twice as abundant as chipmunks – they might just be twice as likely to be captured. Species-specific capture probabilities could be estimated based on the data collected, but such analyses are beyond the scope of this report.

OVERALL RESULTS

Trapping arrays:

From 2000 through 2004, the eight sites yielded a total of 12,150 captures of mammals, amphibians and reptiles (Table 2). Incidental captures of birds were rare and were not included in the following analyses. The small vertebrate traps captured 16 genera of mammals, four genera of amphibians and three genera of reptiles. Mammal captures far exceeded amphibian and reptile captures (97.3% vs 2.7%; Figure 4). *P. maniculatus* and *Tamias* sp. comprised 84.8% of the 11,819 mammal captures, with no other taxon accounting for >5% of captures. Among reptiles and amphibians, *Elgaria* sp., *Sceloporus* sp. and *Ambystoma macrodactylum* accounted for 90.7% of the 331 captures. Several species, including *Aplodontia rufa, Ensatina eschscholtzii, Neurotrichus gibbsii* and *Reithrodontomys megalotis*, were captured only once or twice during the five-year survey. Only nine genera of mammals, two genera of amphibians and two genera of reptiles were captured >10 times. Of these, only seven mammal, one amphibian and two reptile genera had >50 captures.

The number of mammal captures per site ranged from 662 (5.6% of total captures) at F1 to 1,982 (16.8% of total captures) at B2. Mammal captures were more evenly distributed among sites than were amphibian and reptile captures (Figure 5). The number of amphibian captures was highest at F2 (38.4% of captures), followed by F1 and B2 (22.1% of captures each); the remaining five sites each had <5 amphibian captures. Reptile captures were highest at R2, B2,

R1 and S1 (38.8%, 25.3%, 18.7% and 11.8%, respectively), and the remaining four sites had <10 captures (Table 2).

Sherman traps accounted for the vast majority of mammal captures (86.2% of total captures), with pitfalls accounting for most of the remainder (13.4%). In contrast, most amphibian and reptile captures were via pitfalls (70.4%) or coverboards (26.0%). The distribution of captures by trap type varied among sites and years (see Appendix C for details).

The number of total captures includes recaptures of previously marked individuals. When animals were tagged, it was possible to differentiate recaptured individuals from those that had not previously been captured, and to calculate what proportion of total captures were actually recaptures (Table 3). However, not all taxa were tagged. As mentioned above, shrews were released untagged to minimize trap mortality. Therefore, identification of recaptured shrews was impossible. In contrast, most *Peromyscus* and *Tamias* were tagged prior to release, and >80% of the capture events for these taxa were recaptures of previously-tagged individuals. Therefore, it would be possible to conduct mark-recapture analyses for these taxa to calculate habitat-specific population densities, survival rates or capture probabilities. Such analyses are beyond the scope of this report.

Trap mortality:

A total of 640 mammal, eight reptile and one amphibian voucher specimens were collected and sent to the Museum of Vertebrate Zoology for identification and archival storage (see Appendix D for totals by site and year). This total includes eight vouchers collected in October 1999 when the arrays were tested. All of these animals were trap-dead; none was intentionally sacrificed. The total trap mortality was slightly higher than the number of voucher specimens collected, as some trap-dead individuals were discarded because they had been partially eaten by other animals. Total trap-associated mortality (Table 4) from 2000 through 2004 was 715 mammals (6.0% of total captures), two amphibians (2.3% of total captures) and 11 reptiles (4.5% of total captures). Among taxa with >5 captures, the mortality rate was highest for shrews (45.8% of captures), voles (14.0%) and pocket gophers (9.0%). As the project progressed, efforts were made to reduce trap mortality. For example, pitfall traps were stocked with additional nesting and insulating cover for rodents and mealworms for shrews, and Sherman traps were re-checked in the evenings where diurnal rodents (especially chipmunks) were

common. However, it was not possible to completely eliminate trap mortality. Direct causes of mortality included low overnight temperatures, drowning in rainwater, consumption by other animals in the same trap, killed when bears mangled the trap, and injuries caused by the trap-door mechanism of the Sherman and Tomahawk traps. Mammal mortality was highest at R1 (11.2% of captures) and F1 (8.6% of captures), and amphibian and reptile mortality was highest at R1 and S1 (each 6.1% of captures). Site-specific trap mortality was a function of local environmental conditions as well as the local fauna; sites with an abundance of shrews and voles, for example, would be expected to have higher mortality rates, as would sites where the temperature was quite hot during the day or quite cold at night.

Camera stations:

One unbaited TrailMaster camera station per site was operated throughout the summer from 2001 through 2004; cameras were not used in the 2000 field season. In 2002, researchers at UC Berkeley and the University of York added a baited camera station to each site for one month and compared the number of species detected (Balzer 2003). The data from these baited cameras are not included in this report but are on file at the Resources Management office at LVNP and are being prepared for publication in a scientific journal. During this study the cameras were monitored weekly but in other years they were monitored less frequently. This may account for the slightly larger number of photographs and species detections in 2002 compared to other years.

The camera stations detected a total of 17 identifiable mammal taxa: eight carnivores, six rodents, two lagomorphs and one ungulate (Table 5). With the exception of squirrels, the species detected by the cameras had little overlap with the species detected by the trapping arrays. This illustrates the importance of using multiple detection methods at a site. Several species of birds were also detected, but they are not included in the following analyses.

The cameras primarily detected deer and squirrels: Of 776 mammal photographs, 58.1% were *Odocoileus hemionus*, 13.3% were *Spermophilus lateralis*, 10.7% were *Tamiasciurus douglasii*, 7.7% were *Tamias* sp., and 2.7% were other squirrel species. Carnivores, lagomorphs and other rodents were rarely detected in comparison. *O. hemionus* was the most widely detected species, photographed at all eight sites. *Ursus americanus* was the most widely detected carnivore, photographed at five sites, and *Canis latrans* and *Martes americana* were

each detected at three sites. The B1, B2, R2 and S1 sites detected the most carnivore species (three species each), and the F1, R1 and S2 sites detected the fewest (one species each). Lagomorphs were detected only at the B2 and F2 sites, with only one species detected per site. *Erethizon dorsatum* was detected at F1, F2 and R2, and *Sciurus griseus* was detected only at F2.

There was some annual variability in the species detected at each site (Table 6), but there were also some consistent patterns. For example, *S. griseus* was detected only at the F2 site in 2001, 2002 and 2003, and *Lepus americanus* was detected only at the B2 site in 2002, 2003 and 2004, suggesting that both species may have restricted distributions within the park. For other species, however, the camera data should be interpreted with caution, and direct comparison with the results from the trapping arrays is unwise. These unbaited camera stations have an unquantified probability of detection. If a species was not photographed a site, it is difficult to determine whether the species was not present at the site or whether it was present and not detected. Similarly, the number of photographs of a species per site per year should not be interpreted as an index of relative abundance, because multiple photographs could be obtained in a single evening or could represent multiple detections of a single individual.

Species richness per site:

Species richness was calculated as the number of species detected per site. For most species, the field identity was assumed to be correct (but see Appendix E for an evaluation of this assumption). However, there was consistent uncertainty in species identifications of *Microtus*, *Sorex* and *Tamias* among mammals, and of all three reptile genera (*Elgaria*, *Sceloporus* and *Thamnophis*). Therefore, the individual species of these six genera were not included in the species richness of a site unless a voucher specimen had been collected at that site. Otherwise, only one taxon of each genus was assumed to be present at each site. For example, at B1, vouchers of *Tamias amoenus* and *T. speciosus* were collected, but *T. senex* was also reported captured; the chipmunk richness was therefore considered to be two species. At R1, all three species were reported captured but no vouchers were collected, so the chipmunk richness was conservatively estimated at one species: *Tamias* sp.

Mammalian species richness ranged from 13 to 18 species per site (Table 7a). The Riparian habitat had the highest average richness, with 17.5 mammal species. The Brush habitat

averaged 16 mammal species, and the Forest and Subalpine habitats each averaged 15.5 mammal species. Amphibian richness and reptile richness both ranged from one to three species per site (Table 7b). Average amphibian richness was highest at the Forest sites, whereas average reptile richness was highest at the Riparian sites. The Subalpine sites had the lowest average richness for both amphibians (1.5 species) and reptiles (1 species). Total richness (the sum of mammal, amphibian and reptile richness) ranged from 16 species (at F1) to 24 species (at F2). For most of the habitat types, the total richness was quite similar between the high- and mid-elevation sites. The Forest sites were an exception, and the large difference between the sites suggests that elevation may play a stronger role in the composition of the faunal community in forests than for other habitat types. Average total richness was highest at the Riparian sites (22 species) and was lowest at the Subalpine sites (18 species).

By definition, the species richness value does not account for the relative abundance of different species. A species with only one capture in five years is counted the same as a species with hundreds of captures. (For an abundance-weighted index, see Species Diversity below.) Species that were rarely detected, even by the trapping arrays, may not necessarily be rare in the park. Rather, these species just might not be easily detected by the trapping methods used in this study. For example, it is doubtful that *Glaucomys sabrinus* and *Mustela* sp. occurred only at the F1 and R1 sites. Both species are probably more widespread but happened to be detected only at these two sites. Such incidental captures contributed to the higher species richness at the Riparian sites. The Riparian sites also had voucher specimens of both *Microtus* species and ≥3 *Sorex* species. But even if the field identifications for all the problematic taxa were assumed to be correct, average species richness would still be highest in the Riparian habitat and lowest in the Subalpine habitat.

Species diversity per site:

Unlike the richness index, the species diversity index accounts for the number of times a species was detected at a site. Species diversity was calculated for each site using Simpson's Index (D) = $1 / \Sigma\, p_i^2$, where p_i represents the proportion of unique captures of species i at that site. This analysis excluded recaptures of the same individual and employed a more conservative taxonomy due to the difficulty in field-identifying several species (e.g., *Sorex tenellus,* identified

only by voucher specimens, so the total number of field captures of this species is therefore unknown). Use of the conservative taxonomy automatically decreased the diversity at sites with multiple species of same genera. But this approach was necessary since the diversity index is based on the number of captures of each taxon, and this simply could not be calculated for species that could not be reliably identified in the field. Camera and audio-visual data were not included in this analysis because individuals could not be reliably differentiated by these methods.

R1 had the most unique mammal captures (n = 1,018) and F1 had the least (n = 254) (Table 8). Mammal diversity was highest in the Riparian habitat (unweighted average D = 4.11), followed by Forest, Subalpine and Brush habitats (unweighted average D = 3.26, 2.86 and 2.49, respectively). Mammalian diversity was quite similar between sites of the same habitat type, but this was less true for amphibian and reptile diversity. The number of unique amphibian captures was highest at the Forest sites and lowest at the Riparian sites. Reptiles had the opposite pattern, with the number of unique captures being highest at the Riparian sites and lowest at the Forest sites. For both amphibians and reptiles, the highest diversity occurred at sites with <10 unique captures. Discounting these sites, amphibian diversity was highest at the Forest sites (unweighted average D = 1.38) and reptile diversity was highest at the Riparian sites (unweighted average D = 1.57).

EVALUATION OF RESULTS AND METHODOLOGY

This project represented the most comprehensive and labor-intensive vertebrate inventory in the history of Lassen Volcanic National Park. It represented a significant investment of time and resources, with total project costs exceeding $100,000 (Table 9). Nevertheless, the inventory did not meet its goal of detecting 90% of the target species in the park. Of the 44 non-bat mammal species that have previously been confirmed to occur in the park, this inventory detected 32, or 72.7% (Table 10a; this includes *Ochotona princeps* which was detected only by the audio-visual protocol which was begun in 2002). If the three new mammal species (*Sorex preblei, S. tenellus* and *Reithrodontomys megalotis*) are included, along with the confirmation of a *Sylvilagus* sp., the proportion would be slightly higher (75%) but still short of the 90% goal. Insectivores were the best represented mammal group, with all five known species captured and

two new species verified by voucher specimens. Both lagomorph species previously confirmed in the park were detected, and a third species may have been photographed. Carnivores were the most poorly represented, with eight of the 14 confirmed species detected (57.1%). The only confirmed ungulate, *Odocoileus hemionus*, was detected, but the only marsupial species in the park, *Didelphis virginiana*, was not. Rodent detections were intermediate, with 16 of 21 species detected (76.2%). Many of the mammals not detected are strongly associated with habitats that were not targeted, such as ponds and streams (e.g., *Castor canadensis, Ondatra zibethicus, Lutra canadensis* and *Mustela vison*) or rock outcrops and talus slopes (e.g., *Marmota flaviventris*). These species are also more easily detected using methods other than trapping arrays and camera stations, as illustrated by the audio-visual detection of *Ochotona princeps*.

The inventory detected four of six amphibian species, or 66.7% (Table 10b). However, this may be all that could reasonably have been expected given the sampling methods employed. Both *Taricha granulosa* and *Rana cascadae* have small and highly restricted populations within the park (Stead et al. 2005). *R. cascadae* was previously common in the park but its populations have declined dramatically in recent decades (Fellers and Drost 1993, Stead et al. 2005); it is now a California Species of Special Concern. For reptiles, the uncertainty in the species identifications and the lack of voucher specimens made it difficult to assess the proportion of species detected. But since at least three of the nine potential species (counting *Sceloporus occidentalis*) were not detected, the detection rate did not exceed 66.7% (Table 10b). As with the mammals that were not detected, targeted surveys of the appropriate habitats for these amphibian and reptile species (e.g., Stead et al. 2005) may have better success than the broad-spectrum approach used in this inventory.

These results underscore the importance of collecting voucher specimens, especially when the field crew is composed largely of seasonal student workers with minimal previous taxonomic training and a high year-to-year turnover rate. To some, it may seen counter-intuitive or distasteful to intentionally sacrifice animals as part of a conservation program in a national park. But uncertain species identifications compromise the basic goal of such a program: to scientifically and authoritatively document the presence, distribution and population dynamics of species within the park. The regular collection of voucher specimens would greatly strengthen the quality of these data and would have no practical impact upon the populations of these

species. In some cases, such as with *Sorex preblei* and *S. tenellus*, the death of a few individuals may provide the only conclusive proof of their presence.

Although the inventory did not detect 90% of its target species, it successfully documented most of the amphibian, reptile and non-bat mammal species, including several new records for the park. It also provided an important five-year record of the annual variability of many of these species across multiple habitat types in the park. Many of these data, such as the habitat-specific annual variation in the relative density of *P. maniculatus*, warrant deeper analysis than is possible in this summary report. Clearly, this project has made a major contribution toward a comprehensive faunal inventory of the park.

It is less clear whether these inventory methods are appropriate for ongoing or periodic monitoring for species declines in the park. Resource managers must evaluate whether this methodology has the statistical power to reliably detect significant population changes. Such an evaluation should include consideration of the species detected by these methods, the number and distribution of sampling sites, the number of detections of each species at each site, the annual variation in these detections, and the time and resources necessary to conduct such sampling. It may be the case that a comparable index of abundance could be obtained with a single sampling period per site rather than the four periods in the current design. Furthermore, some species that were readily detected by the current methods may be of lower conservation priority than some species that were poorly detected. These latter species may warrant additional, targeted surveys and monitoring of their own. Given the limited resources available, it may be worthwhile to consider alternate monitoring designs, such as sampling more sites with a wider spectrum of methods but with less time spent per site. A similar program is currently being evaluated by the US Forest Service in the Sierra Nevada (Manley et al. 2004, 2005). Given that Lassen Volcanic National Park is completely surrounded by Forest Service lands, park managers may want to evaluate adopting a similar approach or collaborating with the Lassen National Forest on a regional monitoring effort.

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photographs were taken by Alan Wilhelm and members of his field crew. Calvin Farris, Arnie Petersen and Nancy Nordensten made the maps.

Figure 4: Distribution of total captures by taxon.

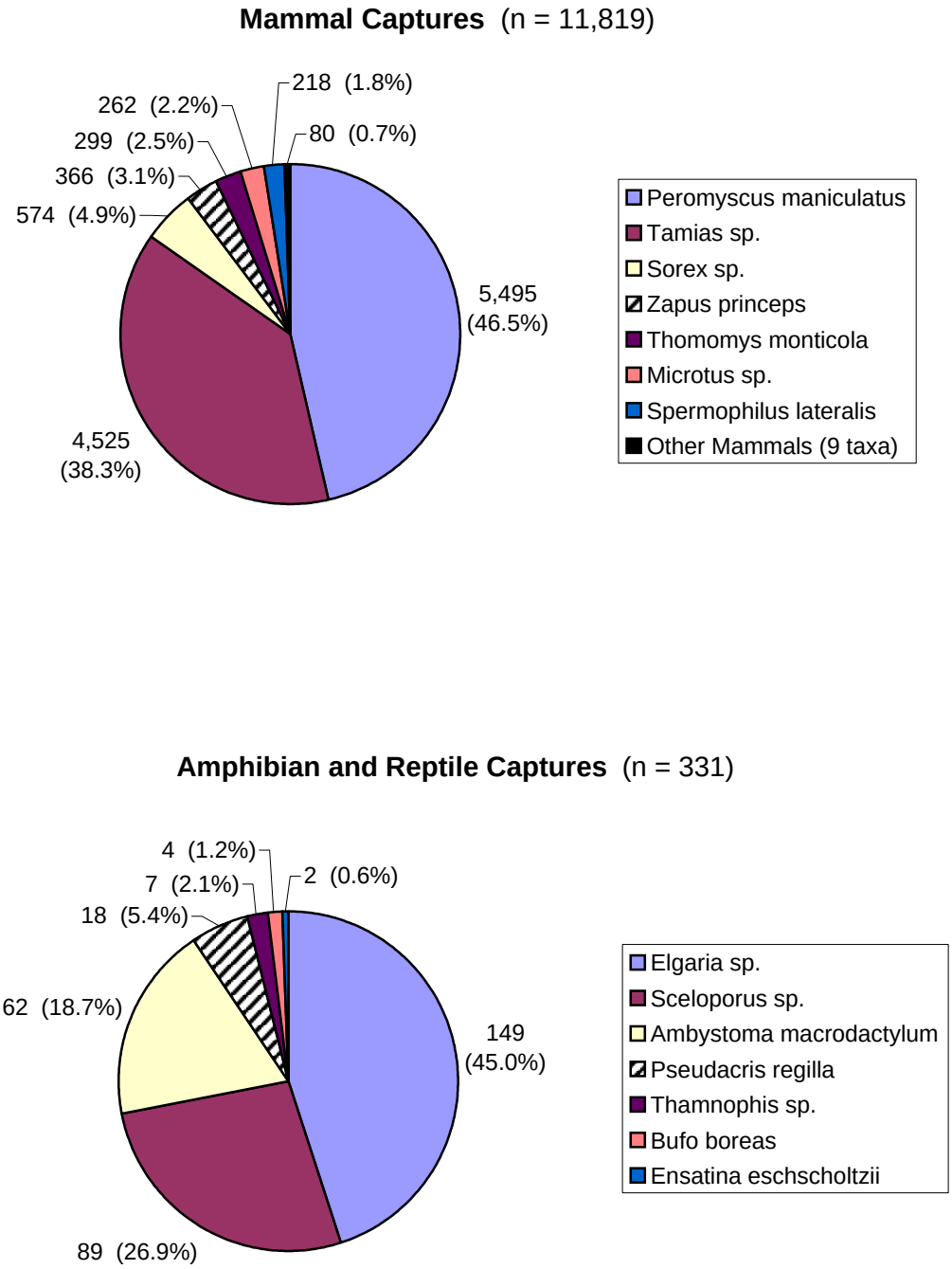
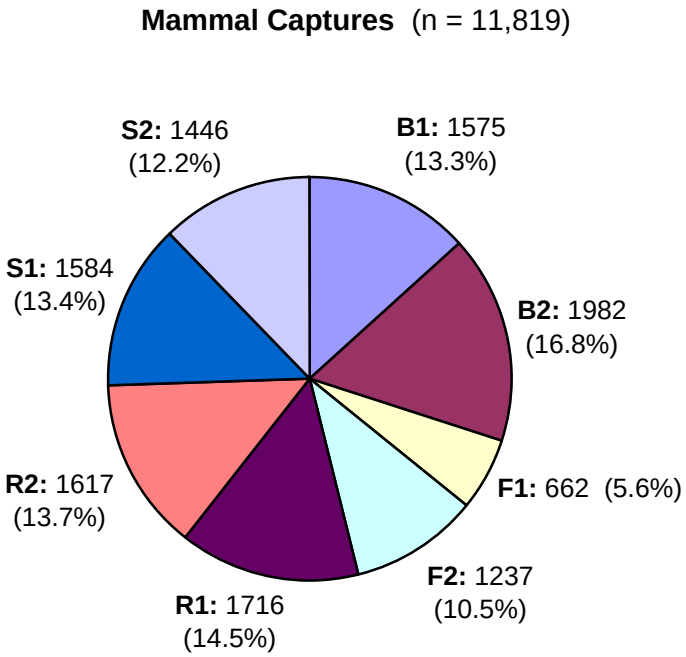


Figure 5: Distribution of total captures by site.



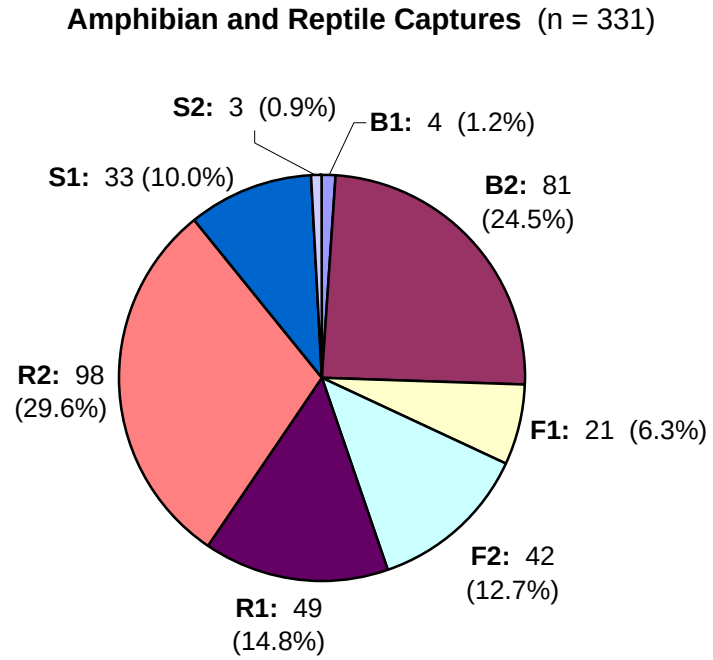


Table 2: Total captures per site in small vertebrate arrays. See Appendix C for site-specific details by year and trap type.

Species	B1	B2	F1	F2	R1	R2	S1	S2	Total
Aplodontia rufa	-	-	-	-	2	-	-	-	2
Clethrionomys californicus	1	1	7	-	19	16	1	1	46
Glaucomys sabrinus	-	-	4	-		-	-	-	4
Microtus sp.	8	-	14	3	155	71	6	5	262
Mustela sp.	-	-	-	-	1	-	-	-	1
Neurotrichus gibbsii	-	-	-	-	-	1	-	-	1
Peromyscus maniculatus	625	908	454	378	946	816	676	692	5,495
Reithrodontomys megalotis	-	-	-	1	-	-	-	-	1
Scapanus latimanus	-	-	-	1	2		2	-	5
Sorex sp.	64	35	59	39	196	103	51	27	574
Spermophilus beecheyi	-	7	-	1	-	-	-	-	8
Spermophilus lateralis	21	16	-	141	-	3	5	32	218
Tamias sp.	837	1,014	98	665	13	471	787	640	4,525
Tamiasciurus douglasii	2	-	4	4	1	1	-	-	12
Thomomys monticola	17	1	22	4	105	48	53	49	299
Zapus princeps	-	-	-	-	276	87	3	-	366
subtotal:	1,575	1,982	662	1,237	1,716	1,617	1,584	1,446	11,819
Ambystoma macrodactylum	2	19	17	24	-	-	-	-	62
Bufo boreas	1	-	-	-	1	1	-	1	4
Ensatina eschscholtzii	-	-	-	2	-	-	-	-	2
Pseudacris regilla	-	-	2	7	2	2	4	1	18
subtotal:	3	19	19	33	3	3	4	2	86
Elgaria sp.	1	37	-	4	45	33	29	-	149
Sceloporus sp.	-	25	-	4	1	58	-	1	89
Thamnophis sp.	-	-	2	1	-	4	-	-	7
subtotal:	1	62	2	9	46	95	29	1	245

Note: "Total captures" includes recaptures of tagged individuals. These totals are not compatible with the charts in the species accounts, in which known recaptures have been removed ("unique captures").

Table 3: Distribution of capture events by tag status.

Species	Total captures	Tagged? *		
		No	Yes, 1 capture	Yes, >1 capture
Aplodontia rufa	2	100.0%	0.0%	0.0%
Clethrionomys californicus	46	15.2%	26.1%	58.7%
Glaucomys sabrinus	4	75.0%	25.0%	0.0%
Microtus sp.	262	22.1%	35.1%	42.7%
Mustela sp.	1	100.0%	0.0%	0.0%
Neurotrichus gibbsii	1	100.0%	0.0%	0.0%
Peromyscus maniculatus	5495	6.6%	10.6%	82.8%
Reithrodontomys megalotis	1	0.0%	100.0%	0.0%
Scapanus latimanus	5	100.0%	0.0%	0.0%
Sorex sp.	574	100.0%	0.0%	0.0%
Spermophilus beecheyi	8	25.0%	37.5%	37.5%
Spermophilus lateralis	218	11.0%	26.1%	62.8%
Tamias sp.	4525	6.6%	12.5%	80.9%
Tamiasciurus douglasii	12	91.7%	8.3%	0.0%
Thomomys monticola	299	17.4%	52.8%	29.8%
Zapus princeps	366	15.6%	48.4%	36.1%
Ambystoma macrodactylum	62	14.5%	79.0%	6.5%
Bufo boreas	4	50.0%	50.0%	0.0%
Ensatina eschscholtzii	2	0.0%	0.0%	100.0%
Pseudacris regilla	18	44.4%	33.3%	22.2%
Elgaria sp.	149	24.2%	51.7%	24.2%
Sceloporus sp.	89	29.2%	48.3%	22.5%
Thamnophis sp.	7	100.0%	0.0%	0.0%

* "No" = animal was not tagged or assiged a unique individual number.
"Yes, 1 capture" = animal was tagged and numbered, but never recaptured.
"Yes, >1 capture" = animal was tagged and then recaptured at least once.

Table 4: Mortality rates at small vertebrate traps.

Taxon		Total Captures	Trap-Dead n	Trap-Dead %
Aplodontia rufa		2	1	50.0%
Clethrionomys californicus		46	9	19.6%
Glaucomys sabrinus		4	1	25.0%
Microtus sp.		262	34	13.0%
Mustela sp.		1	0	0.0%
Neurotrichus gibbsii		1	1	100.0%
Peromyscus maniculatus		5,495	285	5.2%
Reithrodontomys megalotis		1	0	0.0%
Scapanus latimanus		5	2	40.0%
Sorex sp.		574	263	45.8%
Spermophilus beecheyi		8	0	0.0%
Spermophilus lateralis		218	3	1.4%
Tamias sp.		4,525	75	1.7%
Tamiasciurus douglasii		12	0	0.0%
Thomomys monticola		299	27	9.0%
Zapus princeps		366	14	3.8%
	subtotal:	11,819	715	6.0%
Ambystoma macrodactylum		62	2	3.2%
Bufo boreas		4	0	0.0%
Ensatina eschscholtzii		2	0	0.0%
Pseudacris regilla		18	0	0.0%
	subtotal:	86	2	2.3%
Elgaria sp.		149	8	5.4%
Sceloporus sp.		89	3	3.4%
Thamnophis sp.		7	0	0.0%
	subtotal:	245	11	4.5%
	Total:	12,150	728	6.0%

Table 5: Species detections by unbaited camera stations. Cell entries are the number of photographs obtained of each species.

Group	Species	B1	B2	F1	F2	R1	R2	S1	S2	Total
Ungulates	*Odocoileus hemionus*	10	103	27	51	31	102	64	63	451
Carnivores	*Canis latrans*	-	1	-	-	1	-	1	-	3
	Lynx rufus	-	-	-	2	-	3	-	-	5
	Martes americana	4	-	-	-	-	-	1	1	6
	Mustela sp.	-	-	-	-	-	-	1	-	1
	Taxidea taxus	-	1	-	-	-	-	-	-	1
	Urocyon cinereoargenteus	-	-	-	-	-	8	-	-	8
	Ursus americanus	1	4	5	1	-	1	-	-	12
	Vulpes vulpes	2	-	-	-	-	-	-	-	2
Lagomorphs	*Lepus americanus*	-	10	-	-	-	-	-	-	10
	Sylvilagus sp.	-	-	-	3	-	-	-	-	3
Rodents	*Erethizon dorsatum*	-	-	2	1	-	1	-	-	4
	Peromyscus sp.	-	-	-	-	-	-	-	3	3
	Sciurus griseus	-	-	-	11	-	-	-	-	11
	Spermophilus beecheyi	-	3	-	-	-	-	-	-	3
	Spermophilus lateralis	19	68	-	12	-	-	1	3	103
	Tamias sp.	5	9	-	16	1	1	17	11	60
	Tamiasciurus douglasii	-	17	10	22	4	2	-	28	83
	Unidentified squirrel	-	3	1	1	-	-	-	2	7
Non-Target	Blue Grouse	-	-	-	-	1	-	1	4	6
	Clark's Nutcracker	-	-	-	-	-	-	-	6	6
	Dark-Eyed Junco	-	-	-	-	-	-	-	1	1
	Mountain Quail	-	-	-	3	-	1	-	-	4
	Northern Flicker	-	-	1	-	-	-	-	3	4
	Robin	2	-	-	-	-	-	6	5	13
	Steller's Jay	1	2	-	-	-	-	6	-	9
	Unidentified hawk	-	-	-	-	-	-	1	-	1
	Unidentified bird	-	-	-	-	-	-	1	-	1

Table 6: Camera station photographs of mammals by site by year.

Year	Species	B1	B2	F1	F2	R1	R2	S1	S2	Total
2001	*Canis latrans*	-	-	-	-	-	-	1	-	1
	Erethizon dorsatum	-	-	-	1	-	-	-	-	1
	Lynx rufus	-	-	-	1	-	-	-	-	1
	Odocoileus hemionus	-	15	5	19	6	30	29	7	111
	Sciurus griseus	-	-	-	1	-	-	-	-	1
	Sylvilagus sp.	-	-	-	2	-	-	-	-	2
	Tamiasciurus douglasii	-	-	-	2	-	-	-	-	2
2002	*Canis latrans*	-	-	-	-	1	-	-	-	1
	Erethizon dorsatum	-	-	1	-	-	-	-	-	1
	Lepus americanus	-	3	-	-	-	-	-	-	3
	Lynx rufus	-	-	-	1	-	-	-	-	1
	Martes americana	3	-	-	-	-	-	-	-	3
	Odocoileus hemionus	3	28	4	13	19	23	20	12	122
	Peromyscus sp.	-	-	-	-	-	-	-	3	3
	Sciurus griseus	-	-	-	1	-	-	-	-	1
	Spermophilus beecheyi	-	3	-	-	-	-	-	-	3
	Spermophilus lateralis	7	38	-	11	-	-	1	3	60
	Tamias sp.	3	7	-	16	1	1	17	11	56
	Tamiasciurus douglasii	-	14	5	18	3	2	-	28	70
	Taxidea taxus	-	1	-	-	-	-	-	-	1
	Ursus americanus	1	3	1	1	-	-	-	-	6
	Unidentified squirrel	-	-	-	1	-	-	-	2	3
2003	*Canis latrans*	-	1	-	-	-	-	-	-	1
	Erethizon dorsatum	-	-	-	-	-	1	-	-	1
	Lepus americanus	-	3	-	-	-	-	-	-	3
	Martes americana	1	-	-	-	-	-	-	1	2
	Odocoileus hemionus	6	17	16	8	4	19	10	9	89
	Sciurus griseus	-	-	-	9	-	-	-	-	9
	Spermophilus lateralis	-	10	-	1	-	-	-	-	11
	Sylvilagus sp.	-	-	-	1	-	-	-	-	1
	Tamias sp.	2	-	-	-	-	-	-	-	2
	Tamiasciurus douglasii	-	1	-	2	-	-	-	-	3
	Ursus americanus	-	1	3	-	-	-	-	-	4
	Vulpes vulpes	2	-	-	-	-	-	-	-	2
2004	*Erethizon dorsatum*	-	-	1	-	-	-	-	-	1
	Lepus americanus	-	4	-	-	-	-	-	-	4
	Lynx rufus	-	-	-	-	-	3	-	-	3
	Martes americana	-	-	-	-	-	-	1	-	1
	Mustela sp.	-	-	-	-	-	-	1	-	1
	Odocoileus hemionus	1	43	2	11	2	30	5	35	129
	Spermophilus lateralis	12	20	-	-	-	-	-	-	32
	Tamias sp.	-	2	-	-	-	-	-	-	2
	Tamiasciurus douglasii	-	2	5	-	1	-	-	-	8
	Urocyon cinereoargenteus	-	-	-	-	-	8	-	-	8
	Ursus americanus	-	-	1	-	-	1	-	-	2
	Unidentified squirrel	-	3	1	-	-	-	-	-	4

Table 7a: Mammal species richness by site. "Y" indicates detection; "**Y**" indicates a voucher or photograph. Voucher specimens were necessary to include >1 species of *Sorex, Microtus,* or *Tamias* in a site's richness score; see text for details.

Order	Species	B1	B2	F1	F2	R1	R2	S1	S2
Insectivores	*Neurotrichus gibbsii*	-	-	-	-	-	**Y**	-	-
	Scapanus latimanus	-	-	-	Y	**Y**	-	**Y**	-
	Sorex palustris	-	-	**Y**	-	**Y**	**Y**	-	Y
	Sorex preblei	**Y**	-	-	-	-	-	-	**Y**
	Sorex tenellus	**Y**	-	-	-	**Y**	-	-	**Y**
	Sorex trowbridgii	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
	Sorex vagrans	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	-	**Y**
	subtotal:	4	2	3	3	5	4	2	4
Rodents	*Aplodontia rufa*	-	-	-	-	**Y**	-	-	-
	Clethrionomys californicus	**Y**	Y	**Y**	-	Y	Y	**Y**	Y
	Erethizon dorsatum	-	-	**Y**	**Y**	-	**Y**	-	-
	Glaucomys sabrinus	-	-	**Y**	-	-	-	-	-
	Microtus longicaudus	Y	-	Y	-	**Y**	**Y**	**Y**	-
	Microtus montanus	Y	-	**Y**	Y	**Y**	**Y**	Y	**Y**
	Peromyscus maniculatus	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
	Reithrodontomys megalotis	-	-	-	Y	-	-	-	-
	Sciurus griseus	-	-	-	**Y**	-	-	-	-
	Spermophilus beecheyi	-	**Y**	-	Y	-	-	-	-
	Spermophilus lateralis	**Y**	**Y**	-	**Y**	-	Y	**Y**	**Y**
	Tamias amoenus	**Y**	**Y**	-	Y	Y	**Y**	**Y**	**Y**
	Tamias senex	Y	**Y**	**Y**	**Y**	Y	Y	**Y**	Y
	Tamias speciosus	**Y**	**Y**	Y	**Y**	Y	Y	**Y**	**Y**
	Tamiasciurus douglasii	Y	**Y**	**Y**	**Y**	**Y**	**Y**	Y*	**Y**
	Thomomys monticola	Y	Y	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
	Zapus princeps	-	-	-	-	**Y**	Y	Y	-
	subtotal:	8	9	8	11	9	10	10	8
Lagomorphs	*Lepus americanus*	-	**Y**	-	-	-	-	-	-
	Ochotona princeps	-	-	-	-	-	-	Y*	-
	Sylvilagus sp.	-	-	-	**Y**	-	-	-	-
	subtotal:	0	1	0	1	0	0	1	0

Table 7a, continued.

Order	Species	B1	B2	F1	F2	R1	R2	S1	S2
Carnivores	*Canis latrans*	-	**Y**	-	-	**Y**	-	**Y**	-
	Lynx rufus	-	-	-	**Y**	-	**Y**	-	-
	Martes americana	**Y**	-	-	-	-	-	**Y**	**Y**
	Mustela sp.	-	-	-	-	Y	-	**Y**	-
	Taxidea taxus	-	**Y**	-	-	-	-	-	-
	Urocyon cinereoargenteus	-	-	-	-	-	**Y**	-	-
	Ursus americanus	**Y**	**Y**	**Y**	**Y**	-	**Y**	-	-
	Vulpes vulpes	**Y**	-	-	-	-	-	-	-
	subtotal:	3	3	1	2	2	3	3	1
Ungulates	*Odocoileus hemionus*	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
	subtotal:	1	1	1	1	1	1	1	1
	Mammal Richness:	**16**	**16**	**13**	**18**	**17**	**18**	**17**	**14**

* *T. douglasii* and *O. princeps* were detected at S1 only by the audio-visual protocol; see the species accounts for details.

Table 7b: Amphibian and reptile species richness by site. "Y" indicates detection; "**Y**" indicates a voucher. Voucher specimens were necessary to include >1 species of *Elgaria*, *Sceloporus*, or *Thamnophis* in a site's richness score; see text for details.

Group	Species	B1	B2	F1	F2	R1	R2	S1	S2
Amphibians	*Ambystoma macrodactylum*	Y	Y	**Y**	Y	-	-	-	-
	Bufo boreas	Y	-	-	-	Y	Y	-	Y
	Ensatina eschscholtzii	-	-	-	Y	-	-	-	-
	Pseudacris regilla	-	-	Y	Y	Y	Y	Y	Y
	Amphibian Richness:	**2**	**1**	**2**	**3**	**2**	**2**	**1**	**2**
Reptiles	*Elgaria coerulea*	Y	**Y**	-	Y	**Y**	Y	**Y**	-
	Elgaria multicarinata	-	Y	-	-	Y	Y	Y	-
	Sceloporus graciosus	-	**Y**	-	Y	Y	**Y**	-	-
	Sceloporus occidentalis	-	-	-	Y	-	Y	-	Y
	Thamnophis elegans	-	-	-	-	-	Y	-	-
	Thamnophis sirtalis	-	-	-	-	-	Y	-	-
	Thamnophis sp.	-	-	Y	Y	-	Y	-	-
	Reptile Richness:	**1**	**2**	**1**	**3**	**2**	**3**	**1**	**1**
Mammal + Amphibian + Reptile Richness:		**19**	**19**	**16**	**24**	**21**	**23**	**19**	**17**

Table 8: Number of individuals captured and Simpson's diversity index (*D*) per site. Individuals could only be identified via the trapping arrays, so the camera data are not included. *D* should be interpreted with caution when the sample size is low.

Taxon	B1	B2	F1	F2	R1	R2	S1	S2
Aplodontia rufa	-	-	-	-	2	-	-	-
Clethrionomys californicus	1	1	7		6	5	1	1
Glaucomys sabrinus	-	-	4	-	-	-	-	-
Microtus sp.	7	-	9	1	109	51	6	3
Mustela sp.	-	-	-	-	1	-	-	-
Neurotrichus gibbsii	-	-	-	-	-	1	-	-
Peromyscus maniculatus	185	340	119	154	391	250	251	221
Reithrodontomys megalotis	-	-	-	1	-	-	-	-
Scapanus latimanus	-	-	-	1	2	-	2	-
Sorex sp.	64	35	59	39	195	103	51	27
Spermophilus beecheyi	-	4	-	1	-	-	-	-
Spermophilus lateralis	16	7	-	79	-	2	4	15
Tamias sp.	277	430	35	211	9	129	279	164
Tamiasciurus douglasii	2	-	4	4	1	1	-	-
Thomomys monticola	12	1	17	1	80	41	49	46
Zapus princeps	-	-	-	-	222	57	1	-
subtotal:	564	818	254	492	1,018	640	644	477
D:	2.75	2.22	3.34	3.18	4.01	4.21	2.84	2.89
Ambystoma macrodactylum	2	17	17	24	-	-	-	-
Bufo boreas	1	-	-	-	1	1	-	1
Ensatina eschscholtzii	-	-	-	1	-	-	-	-
Pseudacris regilla	-	-	1	7	2	1	4	1
subtotal:	3	17	18	32	3	2	4	2
D:	1.80	1.00	1.12	1.64	1.80	2.00	1.00	2.00
Elgaria sp.	1	34	-	4	35	28	26	-
Sceloporus sp.	-	21	-	4	1	47	-	1
Thamnophis sp.	-	-	2	1	-	4	-	-
subtotal:	1	55	2	9	36	79	26	1
D:	1.00	1.89	1.00	2.45	1.06	2.07	1.00	1.00

Table 9: Estimated annual expenses for LVNP small vertebrate inventory project.

Expense	1999	2000	2001	2002	2003	2004	2005
Planning							
Biologist [1]	$3,700	$1,000	$1,000	$1,000	--	--	--
Biological Technician [2]	--	--	--	--	$700	$800	--
Field Work							
Personnel							
Project Leader (volunteer) [3]	$0	$0	$0	$0	$0	$0	--
Field Technician	--	$5,400	$5,600	$5,800	$7,000	$7,000	--
SCA 1	--	$2,000	$2,100	$2,000	$2,200	$2,200	--
SCA 2	--	$2,200	Vacant	$2,300	Vacant	Granted	--
SCA (install arrays)	$200	--	--	--	--	--	--
Housing for Field Staff	$800	$1,600	$1,600	$1,700	$1,300	$1,600	--
Vehicles for Field Staff	$1,900	$1,900	$2,000	$2,000	$1,700	$1,900	--
Equipment [4]	$4,200	$500	$1,100	$800	$100	$500	--
Supplies [5]	--	$300	$600	$1,400	$1,100	$1,600	--
Administration							
Data Management							
Field Technician	--	$300	$300	$300	$400	$400	--
SCA 1	--	$200	$200	$200	$200	$200	--
Biological Technician (QA/QC)	--	$600	$600	$700	$700	$800	$1,500
Analysis and Reporting							
Biologist	--	$1,000	$1,000	$1,000	$1,100	$1,100	$1,200
Preparation of Summary Report	--	--	--	--	--	--	$6,800
subtotal:	$10,800	$17,000	$16,100	$19,200	$16,500	$18,100	$9,500
Total:							**$107,200**

Expenses rounded to the nearest $100.

[1] In 1999: Develop RMP project statement, consult with PORE research biologist on project design, conduct project compliance. In 2000-2002: Fundraise, recruit and hire staff, order supplies. In 2005: Develop and administer CESU Task Agreement with University of California.

[2] Fundraise, recruit and hire staff.

[3] In 1999 approximately 680 hours were required to select sites, fabricate and install the 32 sampling arrays. The Project Leader spent approximately 480 hours doing this work and was assisted by volunteers/staff (approx 150 hours) and SCAs (approx 50 hours).

[4] Trailmaster cameras, Sherman traps, Tomahawk traps, processing kit, exterior plywood used for cover boards, plastic buckets and lids, reptile cloth, rebar used for contructing pitfall traps and drift fences, PVC pipe and insulation used for hidey-holes in pitfalls, sponges for amphibian rehydration, etc.

[5] Film, film developing, batteries, bait, ziplock bags, bleach, lysol, cotton bales, mealworms, cables ties, eartags, HEPA filters and masks, gloves, cleaning supplies, etc.

Table 10a: Mammal species list for LVNP and whether each species was detected by the small vertebrate inventory, 2000 - 2004. Detection codes: C = coverboard, P = pitfall, S = Sherman, T = Tomahawk, U = unbaited camera station, X = other; "?" indicates uncertainty. New species detections are in bold.

Scientific name	Common name	Detected?	Comment
Marsupials			
Didelphis virginiana	Virginia opossum	not detected	
Insectivores			
Neurotrichus gibbsii	Shrew-mole	P	
Scapanus latimanus	Broad-footed mole	P	
Sorex palustris	Northern water shrew	P	
Sorex preblei	**Preble's shrew**	P	
Sorex tenellus	**Inyo shrew**	P, S	
Sorex trowbridgii	Trowbridge's shrew	P, S	
Sorex vagrans	Vagrant shrew	P, S	
Rodents			
Aplodontia rufa	Mountain beaver	T	
Castor canadensis	Beaver	not detected	
Clethrionomys californicus	Western red-backed vole	P, S	
Erethizon dorsatum	Porcupine	U	
Glaucomys sabrinus	Northern flying squirrel	S, T	
Marmota flaviventris	Yellow-bellied marmot	not detected	
Microtus longicaudus	Long-tailed vole	P, S	
Microtus montanus	Montane vole	P, S	
Neotoma cinerea	Bushy-tailed woodrat	not detected	
Ondatra zibethicus	Muskrat	not detected	
Peromyscus maniculatus	Deer mouse	C, P, S, U	
Reithrodontomys megalotis	**Western Harvest Mouse**	P	No vouchers collected; cannot confirm identification.
Sciurus griseus	Western gray squirrel	U	
Spermophilus beecheyi	California ground squirrel	P, S, U	
Spermophilus beldingi	Belding's ground squirrel	not detected	
Spermophilus lateralis	Golden-mantled ground squirrel	P, S, T, U	
Tamias amoenus	Yellow-pine chipmunk	S, P? U?	Photos could not be identified to species.
Tamias senex	Allen's chipmunk	P, S, T? U?	Photos could not be identified to species.
Tamias speciosus	Lodgepole chipmunk	P, S, U?	Photos could not be identified to species.
Tamiasciurus douglasii	Douglas' squirrel	S, T, U, X	
Thomomys monticola	Mountain pocket gopher	P, S	
Zapus princeps	Western jumping mouse	P, S, X	

Table 10a, continued.

Scientific name	Common name	Detected?	Comment
Lagomorphs			
Lepus americanus	Snowshoe hare	U	
Lepus californicus **	Black-tailed jack rabbit	not detected	
Ochotona princeps	Pika	X	Detected only by audio-visual protocol.
Sylvilagus nuttallii *	Nuttall's cottontail	U?	Possible, but could not be identified to species.
Carnivores			
Bassariscus astutus *	Ringtail	not detected	
Canis latrans	Coyote	U	
Felis concolor	Mountain lion	not detected	
Felis rufus	Bobcat	U	
Lutra canadensis	River otter	not detected	
Martes americana	Marten	U	
Mephitis mephitis	Striped skunk	not detected	
Mustela erminea	Ermine	S? U?	Probable, but could not be identified to species.
Mustela frenata	Long-tailed weasel	S? U?	Possible, but could not be identified to species.
Mustela vison	Mink	not detected	
Procyon lotor	Raccoon	not detected	
Spilogale putorius *	Spotted skunk	not detected	
Taxidea taxus	Badger	U	
Urocyon cinereoargenteus	Gray fox	U	
Ursus americanus	Black bear	U	
Vulpes vulpes	Red fox	U	
Artiodactyls			
Antilocapra americana *	Pronghorn	not detected	
Cervus elaphus *	Wapiti	not detected	
Odocoileus hemionus	Mule deer	U	

* species not previously confirmed to occur in LVNP but currently included in park species list.
** *L. californicus* has been documented only in the park headquarters area in Mineral.

Note: The following taxa are not included in the mammal species list: Bats (not detectable by the survey methods used), *Bos taurus* (domestic cattle; occasional trespass from outside the park), *Canis lupus* (gray wolf; extirpated), *Martes pennanti* (fisher; extirpated).

Table 10b: Amphibian and reptile species lists for LVNP and whether each species was detected by the small vertebrate inventory, 2000 - 2004. Detection codes are the same as in Table 10a. New species detections are in bold.

Scientific name	Common name	Detected?	Comment
Salamanders			
Ambystoma macrodactylum	Long-toed Salamander	P, S	
Ensatina eschscholtzii	Ensatina	P	
Taricha granulosa	Rough-skinned Newt	not detected	
Frogs			
Bufo boreas	Western Toad	P	
Pseudacris regilla	Pacific Treefrog	C, P	
Rana cascadae	Cascades Frog	not detected	
Snakes			
Charina bottae	Rubber boa	not detected	
Thamnophis elegans	Western terrestrial garter snake	C? P? X?	No vouchers collected; cannot confirm species ID.
Thamnophis sirtalis	Common garter snake	C? P? X?	No vouchers collected; cannot confirm species ID.
Masticophus taeniatus	Striped whipsnake	not detected	
Lizards			
Elgaria coerulea	Northern alligator lizard	C, P	
Elgaria multicarinata	Southern alligator lizard	C? P? X?	No vouchers collected; cannot confirm species ID.
Sceloporus graciosus	Sagebrush lizard	P	
Sceloporus occidentalis	**Western fence lizard**	C? P?	No vouchers collected; cannot confirm species ID.
Turtles			
Clemmys marmorata	Western pond turtle	not detected	

SPECIES ACCOUNTS

The following species-specific analyses were based upon the taxonomic identification, gender and measurements collected at each individual's first capture per year. This approach provides a "common currency" between those individuals that were captured multiple times and those that were not. The caveats in Appendix E should be kept in mind when considering these results. Results are compared with several previous vertebrate surveys of the region. The most extensive of these was conducted by Grinnell et al. (1930), who surveyed throughout a transect from Red Bluff to the Nevada state line. Only their sites in and adjacent to Lassen Volcanic National Park are discussed here. More recently, Stead et al. (2005) conducted targeted searches for amphibians and lentic fish in the park in summer 2004 and in the Thousand Lakes and Caribou Wilderness areas in summer 2002. Most of their sites in LVNP were in the eastern half, but a few were near the F1, F2 and B2 small vertebrate sites. See Figure 2 in Grinnell et al. (1930) and Figure 2 in Stead et al. (2005) for maps and descriptions of their respective survey sites. In addition to these studies, Koo et al. (2004) conducted an extensive survey of reptiles and amphibians on the Lassen National Forest. Although they did not sample in the park, several of their sites were near the park boundary and illustrate the regional distribution of some species.

MAMMALS

1. Insectivores:

Neurotrichus gibbsii (Shrew-Mole)

The only capture of *Neurotrichus gibbsii* occurred in a pitfall trap at the R2 site on 14 June 2002. The animal was trap-dead and became the only voucher of this species collected during this study. It is unclear whether *N. gibbsii* is more abundant or widely distributed in the park. The MVZ has a few specimens collected near Mineral, Lyonsville and Lake Almanor but none from within the park. Grinnell et al (1930) trapped this species at sites just south of Brokeoff Mountain and just east of Mineral but not within the park itself.

Scapanus latimanus (Broad-Footed Mole)

Scapanus latimanus was captured only five times in the five-year survey: once at F2, twice at R1 and twice at S1. All five captures were in pitfalls. Their average (± SD) mass was 62.1 ± 6.0 g (n = 4). One voucher apiece was collected from R1 and S1, and both were correctly identified in the field. It is unclear whether *S. latimanus* is rare in the park or just rarely detected by the trap types used in this inventory. Grinnell et al. (1930) trapped *S. latimanus* at Battle Creek Meadows, Mineral, Lake Helen and Drakesbad.

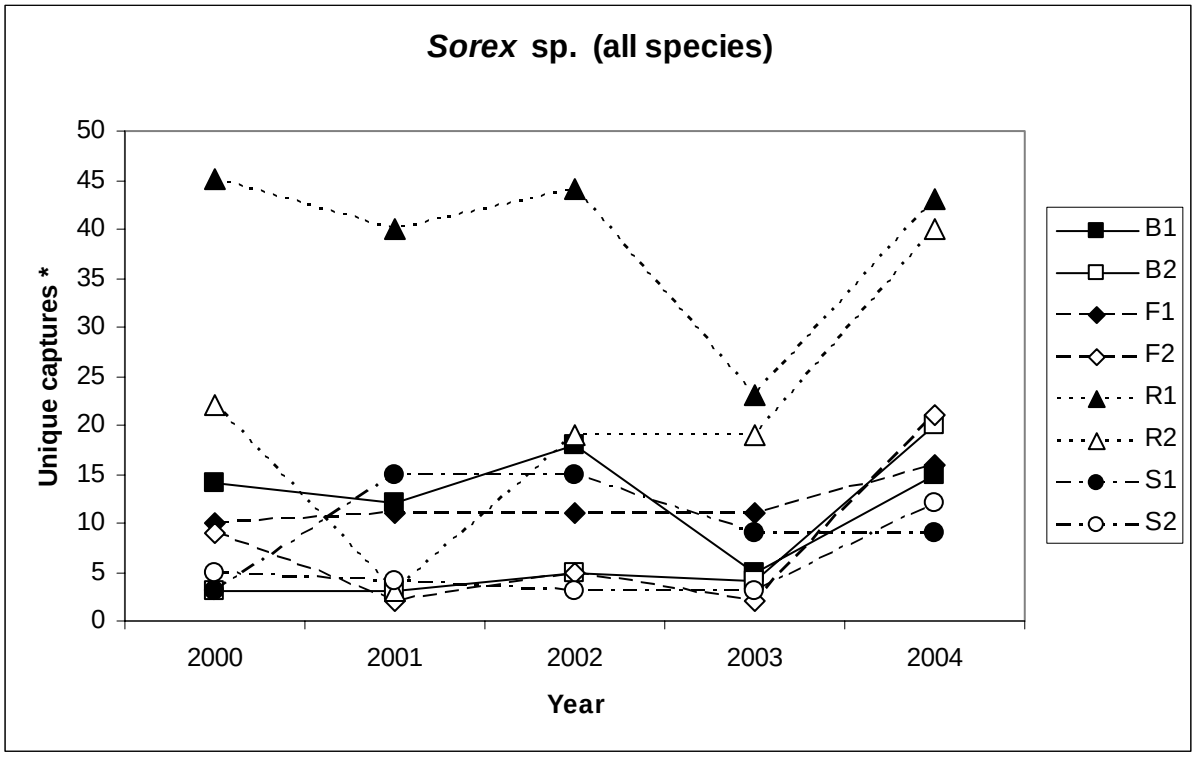
Sorex sp. (Shrews)

Shrews (*Sorex* sp.) were the third most frequently captured mammal taxon in the Park, accounting for 4.9% (n = 574) of total mammal captures. Most of these captures occurred in pitfall (86.0%) or Sherman (13.5%) traps. Despite the number of captures, several factors limit this study's insight into shrew abundance and distribution. The number of unique captures versus recaptures are unclear because shrews were released without tags to minimize handling time and mortality rate. Since the number of "unique captures" of shrews includes an unknown number of recaptures, it should not be compared against other taxa where recaptures could be identified. Secondly, *Sorex* species can be very difficult to differentiate in the field. Voucher specimens indicated that the field identities were frequently incorrect for some species. As a result, the field team stopped attempting to identify shrews to species after the 2001 field season. All of the species-specific analyses below are based solely upon the 243 voucher specimens whose identities were confirmed by the MVZ.

Due to their high metabolism, shrews are particularly prone to trap mortality, and this study was no exception. Among taxa with >5 captures, shrews had the highest rate of trap mortality (45.8%). The field team took steps to minimize shrew mortality, including handling them as quickly as possible, releasing them without ear tags, and even providing mealworms in the pitfall traps as supplemental overnight food. Due to the difficulty in differentiating species of *Sorex* in the field, the trap-dead voucher specimens provide the only insight on the distribution and characteristics of individual species. It is ironic, therefore, that efforts to reduce shrew trap mortality also caused a reduction in species-specific insight by reducing the number of voucher specimens that could be positively identified by the MVZ.

According to the voucher specimens, shrew species richness was highest at the B1, R1 and S2 sites, each of which had four species. The S1 site had the lowest shrew richness, with only *S. trowbridgii*. The total number of captures was poorly correlated with species richness. For example, the R1 site had the most shrew captures every year but the S2 site generally had among the fewest. The S1 site had more captures than the S2 site in every season except 2000 despite having a much lower species richness.

Figure 6: *Sorex* sp. unique captures (n = 573). Species could not be reliably differentiated in the field.



* Unique captures = total captures because individuals were not tagged or marked.

***Sorex monticolus* (Montane Shrew)**

Although several captures of *Sorex monticolus* were reported, this species does not occur in the park (Alexander 1996). Voucher specimens indicate that all of the field identities of *S. monticolus* were incorrect. The 13 voucher specimens that were field-identified as "*S. monticolus*" in 2000 and 2001 were actually *S. trowbridgii* (n = 11) or *S. vagrans* (n = 2). No captures were field-identified as *S. monticolus* after 2001 and none of the other voucher

specimens were identified as such by MVZ. There are no previous records of *S. monticolus* from LVNP.

***Sorex palustris* (Water Shrew)**

Four voucher specimens of *Sorex palustris* were collected at the F1, R1, and R2 sites. Three of these were correctly identified in the field and the fourth was field-identified as "*Sorex* sp." The voucher specimens had an average mass of 9 ± 1.7 g. *S. palustris* was also reported from the S2 site (two captures in 2001) but no voucher was acquired to verify this. Grinnell et al. (1930) trapped *S. palustris* near Mineral, just south of Brokeoff Mountain, Lake Helen, Manzanita Lake, at the head of King's Creek on the southern slopes of Lassen Peak and at Drakesbad.

***Sorex preblei* (Preble's Shrew)**

No captures were field-identified as *Sorex preblei*, but 13 voucher specimens turned out to be of this species. These specimens had been incorrectly identified in the field as "*S. vagrans*" (n = 2) or "*S.* sp." (n = 11). These voucher specimens were collected at the B1 and S2 sites. Their average mass was 2.8 ± 0.7 g. This is the first documentation of *S. preblei* in the park and only the second locality for this species in California (Shohfi et al. *in press*). These records represent an important range extension for the species in California, which previously had been documented only in the Warner Mountains, Modoc County (Williams 1984).

***Sorex tenellus* (Inyo Shrew)**

No captures were field-identified as *Sorex tenellus*, but five vouchers collected at the B1, R1, and S2 sites turned out to be this species. These specimens had been incorrectly identified in the field as "*S. trowbridgii*" (n = 1), "*S. vagrans*" (n = 1), or "*S.* sp." (n = 3). Their average mass was 3.5 ± 1.9 g. This is the first documentation of *S. tenellus* in the park, which is 300 km northwest of its previously recorded locations in the Sweetwater Mountains, Mono County (Shohfi et al. *in press*, Williams 1984).

***Sorex trowbridgii* (Trowbridge's Shrew)**

Sorex trowbridgii appears to be the most abundant and widely distributed shrew in the park. A total of 143 voucher specimens were collected across all eight sites. The most voucher specimens were collected at the F1 and F2 sites (27 specimens each) and the least were at the S2 and B2 sites (seven and nine specimens, respectively). Note, however, that the number of voucher specimens may not be an accurate indicator of relative abundance among sites. The vouchers specimens had an average mass of 4.2 ± 0.8 g. Grinnell et al. (1930) collected *S. trowbridgii* near Mineral, just south of Brokeoff Mountain and near King's Creek Falls; all of these sites were below 2135 m (7000 ft) elevation.

***Sorex vagrans* (Vagrant Shrew)**

This appears to be the second-most abundant and widely-distributed shrew in the park. Vouchers of *S. vagrans* were collected at every site except S1. Most of the 78 voucher specimens were collected at the R1 (56.4%) or R2 (21.8%) sites, and the fewest vouchers were collected at the F1 and F2 sites (one specimen apiece). The voucher specimens had an average mass of 4.3 ± 1.4 g. Grinnell et al. (1930) collected *S. vagrans* at Battle Creek Meadows, Mineral, Lake Helen, the head of King's Creek on the southern slopes of Lassen Peak, near King's Creek Falls and at Drakesbad. These sites ranged up to 2500 m (8200 ft) in elevation.

2. Rodents:

***Aplodontia rufa* (Mountain Beaver)**

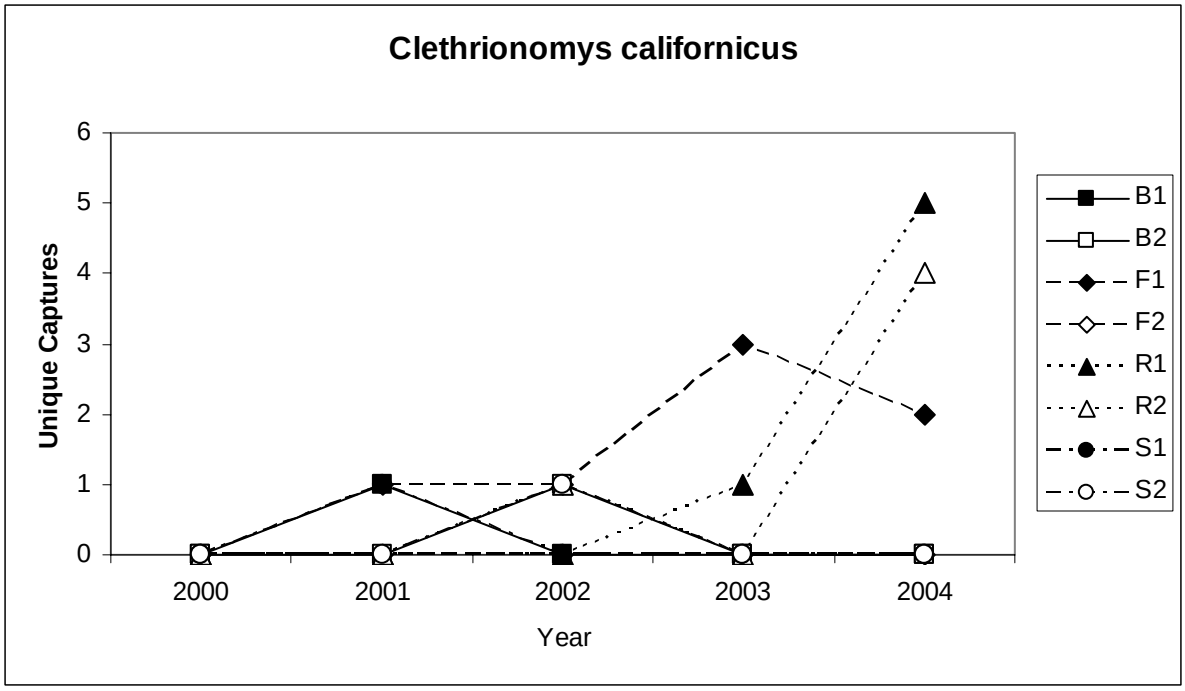
There were only two *Aplodontia rufa* captures during the five-year survey period, both of which occurred in Tomahawk traps near array 2 of the R1 site. The first animal, captured on 1 August 2001, was released without processing. The second capture occurred on 2 September 2003 at a Tomahawk trap set slightly to the north of the array near a network of burrows. This animal, a female, was trap-dead and became the only voucher specimen of this species collected during this project. *A. rufa* is probably more common and more widely distributed in the park than suggested by this inventory, although it is most strongly associated with riparian areas. The

pitfall and Sherman traps used for most of the survey effort are unlikely to capture *A. rufa*, which can weigh up to 1 kg. Grinnell et al. (1930) failed to capture any *A. rufa* during their surveys, which they attributed to drought conditions in the years they conducted their fieldwork. However, they mention that previous collectors had reported *A. rufa* from several locations on the eastern slopes of Lassen Peak. The subspecies in the Lassen region, *A. rufa californica*, is a California Species of Special Concern.

***Clethrionomys californicus* (California Red-Backed Vole)**

C. californicus is the only species of *Clethrionomys* in California (Jameson and Peeters 2004). Therefore, field identities of "*Clethrionomys* sp." were considered to be *C. californicus* for all analyses. Note, however, that there was occasional confusion among *Clethrionomys* and *Microtus* taxa in the field (Tables E1 and E2). *C. californicus* appears to occur widely in the park but at low densities. Voucher specimens were collected at the B1, F1 and S1 sites, with additional captures reported from every other site except F2. However, these totaled only 46

Figure 7: *Clethrionomys californicus* unique captures (n = 22).



capture events in the five-year survey, and consisted of only 22 unique capture events (Figure 7). These data are not sufficient to identify population-level trends. Male:female sex ratio was 0.8. The average mass was 26.5 ± 5.0 g for males and 23.4 ± 7.4 g for females. Most of the captures (73.9%) occurred in Sherman traps. Grinnell et al. (1930) captured 3 male *C. californicus* (then called *Evotomys mazama*) in riparian habitat just south of Brokeoff Mountain.

***Erethizon dorsatum* (Porcupine)**

Camera stations detected *Erethizon dorsatum* at F1 on 4 June 2002 and 12 June 2004, at F2 on 31 August 2001, and at R2 on 16 September 2003. In each case, only a single photograph was acquired. Porcupines occur throughout the conifer forests of California's eastern mountain ranges (Jameson and Peeters 2003). Grinnell et al. (1930) reported this species (then called *E. epixanthum*) as occurring between the western foothills and the eastern sagebrush flats in the Lassen region. Specific sites in and near LVNP were Battle Creek Meadows, Mineral, Summit Creek, just south of Brokeoff Mountain, King's Creek Falls and Butte Lake. They considered the species to be highly associated with red fir, white fir, willow, juniper and sagebrush, but detections also occurred near dry meadows, rocky outcrops and rock slides.

***Glaucomys sabrinus* (Northern Flying Squirrel)**

All four captures of *Glaucomys sabrinus* occurred at the F1 site. On 18 July 2001 a female weighing 121 g was captured in a tree-mounted Tomahawk trap. She was tagged but never recaptured. On 15 June 2004 a specimen was captured in a Sherman trap. The animal was in torpor and later died, becoming the sole voucher specimen collected for this species. The other captures occurred on 16 July and 11 August 2002, both in Tomahawk traps. None of the camera stations detected *G. sabrinus,* possibly because of the downward angle of the camera and the lack of bait. This species occurs throughout open conifer forests (Jameson and Peeters 2003) and is probably more widely distributed in the park than this survey suggests. Baited camera stations have detected *G. sabrinus* near the R1 and S1 sites and near Summit Lake, as well as at numerous sites on the Lassen National Forest south and east of the park (J. Perrine, unpublished

data). Grinnell et al. (1930) detected this species at Kings Creek Falls and in Mineral, and noted that their range likely extended as far west as the 1000 m (3300 ft) contour.

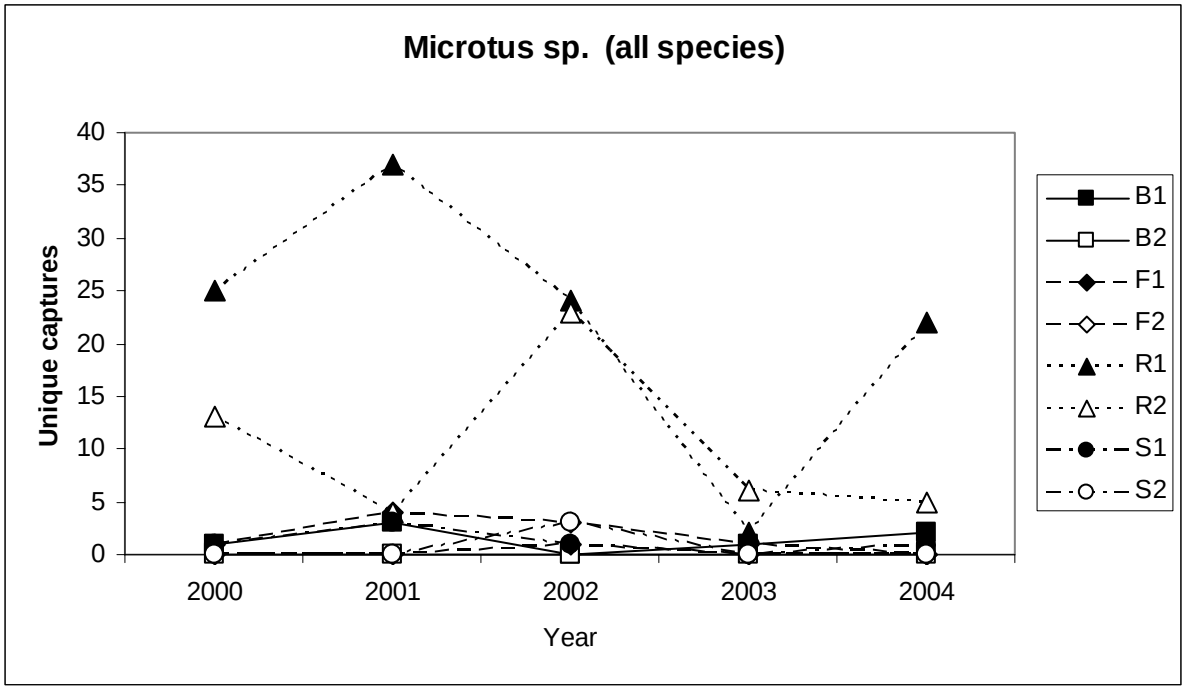
***Marmota flaviventris* (Yellow-bellied Marmot)**

No *Marmota flaviventris* were detected by this survey. They are probably too large to be captured in the trap arrays and unlikely to be photographed at camera stations. Sighting reports suggest that marmots are common in the rocky outcrops throughout the park but no formal inventory of their distribution or abundance has been conducted. Grinnell et al. (1930) collected or observed this species near Mineral, the southwestern slopes of Mount Conard, Hat Creek, Butte Lake, Drakesbad and near Wilson Lake.

***Microtus* sp. (Meadow Voles)**

Captures of *Microtus* occurred at every site except B2. These totaled 262 capture events, approximately 2.2% of the total captures during the five-year survey. The captures were roughly split between pitfall (57.3%) and Sherman (42.7%) traps. Most captured animals were tagged and many were captured multiple times. The Riparian sites had the highest relative abundance of *Microtus* sp., as indexed by the number of unique captures per year (Figure 8). Interestingly, the annual fluctuations at these two sites did not seem to be correlated, except for a sharp decline at both sites in 2003. *Microtus* sp. were uncommon at the other sites, all of which had <5 unique captures per year. Overall trap mortality was 13.0%. A total of 34 voucher specimens were collected from five sites; most (67.6%) were *M. longicaudus* and the remainder were *M. montanus*. The vouchers and the record of recaptures indicated that there was occasional difficulty identifying these animals to species in the field, and occasional confusion with *Clethrionomys* (Tables E1, E2). According to the voucher specimens, *M. longicaudus* and *M. montanus* were sympatric at only the two Riparian sites. However, captures of both species were also reported at the B1, F1, and S1 sites. Clarification of this question would require additional surveys and the collection of additional voucher specimens at these latter sites.

Figure 8: *Microtus* sp. unique captures (n = 187).



***Microtus californicus* (California Meadow Vole)**

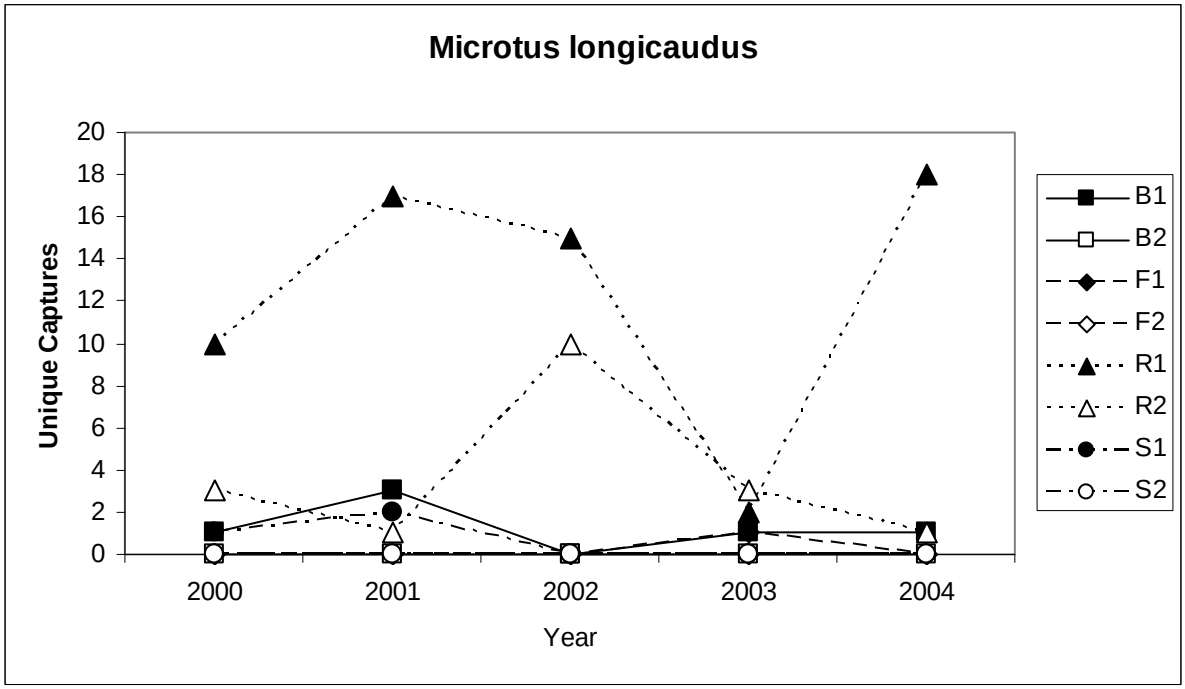
Microtus californicus likely does not occur in the park. No vouchers of this species were collected and only two captures were recorded: one at R1 in 1999 and one at R2 in 2000, with neither animal recaptured. These captures were probably mis-identifications of *M. longicaudus* or *M. montanus*. All capture records of "*M. californicus*" were therefore analyzed as *Microtus* sp. *M. californicus* occurs west of the park at lower elevations than were sampled in this study. The MVZ has 4,280 *M. californicus* specimens from California but none was collected in or adjacent to LVNP. Grinnell et al. (1930) reported *M. californicus* at several locations west of the park ranging from the Sacramento River up to 1075 m (3500 ft).

***Microtus longicaudus* (Long-Tailed Vole)**

This is one of the most abundant voles in the park, reported at five sites and with vouchers collected at three (R1, R2 and S1). A total of 23 vouchers were collected, some of which were mis-identified in the field as "*Microtus* species," "*M. montanus*," or "*Clethrionomys californicus*." *M. longicaudus* was most abundant at the R1 and R2 sites, although there was

considerable annual variation, including a sharp drop in 2003 (Figure 9). Overall, the male:female sex ratio was 1.2. The average mass was 28.4 ± 9.0 g for males and 25.4 ± 10.0 g for females. At the R1 site, the average mass was 29.4 ± 9.5 g for males (n = 28) and 24.4 ± 9.4 g for females (n = 18), whereas at the R2 site the average mass was 23.3 ± 6.1 g for males (n = 6) and 29.5 ± 12.4 g for females (n = 8). There was considerable annual variation in these averages, however (Table 11). Grinnell et al. (1930) reported this species (then called *M. mordax sierrae*) at several locations throughout the Lassen region, most of which were riparian. Specific sites included just south of Brokeoff Mountain, the head of King's Creek canyon on the southern slopes of Lassen Peak, near King's Creek Falls, and at Drakesbad. They also reported *M. mordax mordax* from Butte Lake.

Figure 9: *Microtus longicaudus* unique captures (n = 90).



***Microtus montanus* (Montane Vole)**

Along with *Microtus longicaudus*, *M. montanus* is probably one of the most abundant and widely-distributed voles in the park. Voucher specimens were collected from four sites (F1, R1, R2, and S2) and captures were reported from every other site except B2. A few of the 11 voucher specimens were mis-identified in the field as "*Microtus* species," "*M. longicaudus*" or

Table 11: Annual variation in *Microtus longicaudus* mass. Sample size (unique captures) in parentheses.

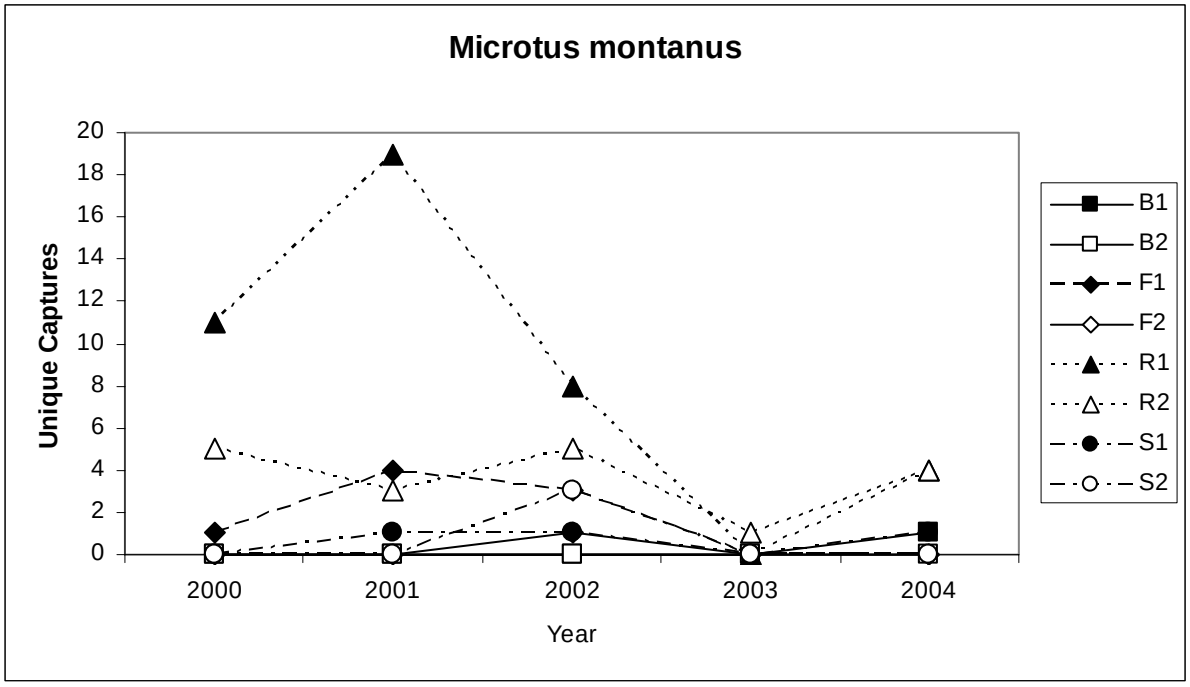
Site	Sex	2000	2001	2002	2003	2004
R1	Male	27.0 ± 11.9 (5)	32.8 ± 8.8 (5)	33.1 ± 7.9 (7)	- (0)	26.5 ± 9.4 (11)
	Female	29.0 ± 1.4 (2)	30.5 ± 7.8 (2)	21.4 ± 9.2 (8)	22.0 (1)	25.4 ± 12.7 (5)
R2	Male	31.0 (1)	21.0 (1)	26.0 ± 7.1 (2)	18.0 ± 1.4 (2)	- (0)
	Female	41.0 (1)	- (0)	29.3 ± 12.9 (6)	19.0 (1)	- (0)

"*Clethrionomys* species." As with *M. longicaudus*, most of the unique captures of *M. montanus* occurred at the R1 site, and there was a sharp decline in 2003 (Figure 10). Overall male:female ratio was 2.1, and the average mass was 25.4 ± 10.5 g for males (n = 38) and 20.6 ± 8.4 g for females (n = 16). At R1 the average mass was 25.5 ± 12.5 g for males (n = 22) and 17.8 ± 9.4 g for females (n = 8). At R2 the average mass was 28.6 ± 4.3 g for males (n = 10) and 26.3 ± 6.0 g for females (n = 3). Even at the riparian sites there were not enough captures to examine the annual variation of these masses. Grinnell et al. (1930) found *M. montanus* at altitudes ranging from 1070 to 1675 m (3500 to 5500 ft) and collected specimens at Drakesbad and at Battle Creek Meadows. Other than these specimens, the MVZ collection does not contain any *M. montanus* from in or adjacent to the park.

Microtus townsendii (Townsend's Vole)

Like *Microtus californicus*, *M. townsendii* does not occur in the park. No vouchers of this species were collected at any sites, and the sole capture event (at R2 in 2000) was probably a mis-identification of *M. longicaudus* or *M. montanus* (three vouchers of each were collected

Figure 10: *Microtus montanus* unique captures (n = 76).



at R2). In California, *M. townsendii* occurs only along the northwestern coasts, across the Sacramento Valley from the park (Hall 1981). The MVZ has only two specimens of *M. townsendii* from California, both of which were collected in Humboldt County.

***Neotoma cinerea* (Bushy-tailed Wood Rat)**

This survey did not detect *Neotoma cinerea*, which is usually associated with rock outcrops in high elevation conifer forests, woodlands and shrublands (Jameson and Peeters, 2004). According to Grinnell et al. (1930), this species occurred widely east of Mineral. Specific sites in and near LVNP were Battle Creek Meadows, just south of Brokeoff Mountain, Lake Helen, the head of King's Creek on the southern slopes of Lassen Peak, near King's Creek Falls, Drakesbad and Willow Lake.

***Peromyscus boylii* (Brush Mouse)**

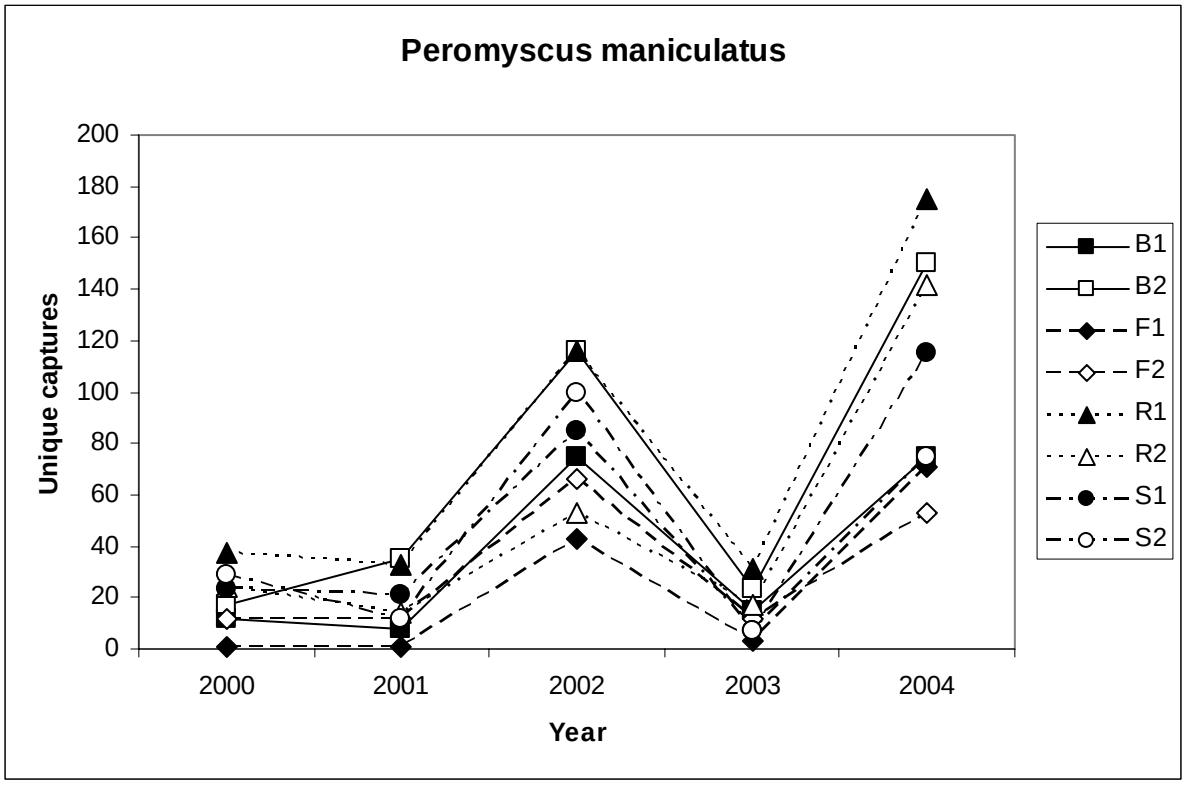
Peromyscus boylii probably does not occur in the park. No voucher specimens were collected at any site during this inventory. All 50 captures identified as "*P. boylii*" in the field

occurred in 2000. A few of these individuals were recaptured in later years, and all were subsequently field-identified as *P. maniculatus*. Vouchers of three of these individuals showed the latter identification to be correct, and it is likely that all of the captures were actually *P. maniculatus*. No prior surveys in LVNP have collected *P. boylii*. Grinnell et al. captured *P. boylii* only at sites west of the park ranging from 90 to 1000 m (300 to 3300 ft), and the MVZ does not have any *P. boylii* specimens collected from within or adjacent to the park.

***Peromyscus maniculatus* (Deer Mouse)**

Peromyscus maniculatus was by far the most frequently captured species in this inventory, accounting for 46.5% of total captures from 2000-2004. The species was detected at almost every site in almost every year. A total of 244 voucher specimens were collected, all of which were correctly identified in the field. However, as mentioned above, a few of these individuals had been incorrectly identified as *P. boylii* at previous capture events in 2000.

Figure 11: *Peromyscus maniculatus* unique captures (n = 1,916).



The 5,495 captures included a total of 1,916 unique captures; the remaining captures were recaptures. The most unique captures occurred at R1 and B2 (392 and 341, respectively), and the fewest occurred at F1 and F2 (119 and 155 unique captures, respectively). Although the relative abundance of *P. maniculatus* varied among sites, all sites showed a strikingly similar pattern of annual variation. In both 2002 and 2004, the number of unique captures rose sharply at all sites (Figure 11). At sites with few captures, such as F1, these spike years represented up to a 30-fold increase in abundance compared to previous years. Even at the riparian sites where captures were common, the spike years represented a 3- to 5-fold increase. In these spike years, it was not uncommon for two *P. maniculatus* to be caught in the same Sherman trap. Females birthing pups in the traps were also frequently encountered, and these animals were released immediately without processing. Due to the high amount of annual variation, it would be difficult to differentiate natural fluctuations from a sudden decline of this species in the park.

The large number of *P. maniculatus* captures permits a detailed look at their sex-specific characteristics. The male:female sex ratio ranged from 1.00 at R2 to 1.31 at B2 (Table 12). Overall, the average mass for males was 14.1 ± 4.1 g (n = 939) and for females was 14.7 ± 5.2 g (n = 789). Male masses were normally distributed, but females had an upper tail due to the presence of pregnant individuals. Most females >25 g were visibly pregnant. Due to the number of captures, *P. maniculatus* is the only species for which sex-specific mass can be assessed by year and site (Table 13).

Table 12: *Peromyscus maniculatus* sex ratio by site.

Site	Males	Females	M:F
B1	88	77	1.14
B2	172	131	1.31
F1	59	54	1.09
F2	79	63	1.25
R1	199	158	1.26
R2	117	117	1.00
S1	131	110	1.19
S2	107	96	1.11

P. maniculatus were occasionally eaten by moles or gophers caught in the same pitfall trap, although it is unclear whether these larger mammals killed the mice or merely scavenged

Table 13: *Peromyscus maniculatus* mass (mean ± SD, in g) by sex, site and year. Sample size in parentheses.

Year	Sex	B1	B2	F1	F2	R1	R2	S1	S2
2000	Male	15.2 ± 1.8 (6)	17.2 ± 4.8 (5)	20 (1)	14.7 ± 4.5 (5)	15.9 ± 4.1 (25)	16.2 ± 3.3 (10)	15.3 ± 2.4 (11)	15.3 ± 3.6 (9)
	Female	13.0 ± 4.1 (4)	14.9 ± 3.4 (7)	- (0)	20.3 ± 4.9 (5)	17.0 ± 5.7 (25)	14.3 ± 3.3 (10)	14.9 ± 3.6 (11)	17.0 ± 8.4 (14)
2001	Male	18.8 ± 2.8 (5)	14.0 ± 3.9 (17)	17 (1)	15.3 ± 1.7 (6)	14.2 ± 5.4 (14)	17.6 ± 2.5 (8)	18.3 ± 4.1 (11)	15.4 ± 1.8 (5)
	Female	13.0 ± 1.4 (2)	14.7 ± 5.9 (16)	- (0)	16.5 ± 4.4 (4)	14.1 ± 7.2 (16)	16.8 ± 4.6 (5)	18.8 ± 5.8 (9)	17.1 ± 3.1 (4)
2002	Male	16.5 ± 3.8 (33)	13.1 ± 3.8 (61)	13.2 ± 3.8 (24)	12.8 ± 3.3 (37)	14.1 ± 4.4 (64)	14.4 ± 3.4 (25)	16.3 ± 3.6 (46)	14.3 ± 4.4 (57)
	Female	15.8 ± 5.4 (33)	13.8 ± 5.0 (40)	13.2 ± 3.9 (17)	12.2 ± 3.7 (23)	15.3 ± 4.8 (37)	14.3 ± 2.8 (20)	16.2 ± 2.7 (31)	14.5 ± 3.2 (33)
2003	Male	12.4 ± 6.3 (7)	14.9 ± 3.3 (11)	7.5 (1)	17.8 ± 1.5 (5)	16.9 ± 6.0 (16)	16.0 ± 2.9 (9)	17.5 ± 2.1 (2)	18 (1)
	Female	16.3 ± 6.6 (6)	17.2 ± 5.3 (11)	8.5 ± 0.0 (2)	18.0 ± 6.5 (5)	20.6 ± 8.0 (9)	18.5 ± 7.2 (7)	19.0 ± 2.7 (4)	20.6 ± 9.3 (5)
2004	Male	14.4 ± 3.7 (36)	12.3 ± 3.7 (73)	13.0 ± 4.5 (32)	11.7 ± 2.6 (26)	14.3 ± 3.7 (77)	12.8 ± 4.3 (64)	13.1 ± 3.7 (60)	12.7 ± 3.7 (33)
	Female	14.3 ± 4.1 (30)	13.5 ± 5.2 (57)	13.1 ± 3.6 (33)	12.5 ± 3.7 (25)	15.4 ± 4.6 (86)	13.3 ± 5.2 (75)	15.1 ± 5.5 (52)	14.1 ± 6.7 (33)

their carcasses. At the R1 site on 23 July 2002, a Steller's Jay (*Cyanocitta stelleri*) depredated a female *P. maniculatus* that had just been released. Overall trap mortality was relatively low, occurring in 5.2% of capture events.

P. maniculatus is one of the most widely distributed small mammals in California, occurring throughout a wide range of elevations and habitat types (Jameson and Peeters 2004). Grinnell et al. (1930: p. 511) trapped them at "every locality where traps were set to catch mice." Sites in and near the park include Brokeoff Meadows and Summit Creek near Mineral, just south of Brokeoff Mountain, Lake Helen, the head of King's Creek Canyon on the southern slopes of Lassen Peak, near King's Creek Falls, Drakesbad, Manzanita Lake and Butte Lake.

***Peromyscus truei* (Piñon Mouse)**

There were no captures recorded or voucher specimens collected of *Peromyscus truei*. However, one individual, captured at the B1 site 10 times between July and September 2004, might have been a *P. truei*. It was identified in the field as "*P. maniculatus*," but the capture team noted its unusually long tail and "large dumbo ears." *P. truei* in the Sierran and Great Basin regions of California usually have very large ears (longer than their hind foot) and a long tail (about 50% of the animal's total length) compared to *P. maniculatus* (Jameson and Peeters 2004). This individual's ears and tail were never measured but its mass was approximately 17 g, slightly below the usual mass for *P. truei* but consistent with *P. maniculatus*. The data sheet made no mention of the animal's coloration.

No prior surveys have documented *P. truei* within the park and the MVZ has no specimens from the immediate area. Grinnell et al (1930) collected *P. truei truei* only east of the park, at a station five miles north of Fredonyer Peak, and *P. truei gilberti* on the western slopes only below 1000 m (3300 ft). Historically, it appears that *P. truei* occurred only at lower elevations around LVNP. The same was true for Yosemite National Park, but recent surveys (MVZ 2005) have documented an eastward range expansion of *P. truei* into Yosemite National Park at sites from 2985 to 3125 m (9785 to 10250 ft) -- 600 m (2000 ft) higher than historic records (Grinnell et al. 1924). Targeted surveys for *P. truei* in LVNP may yield similar findings.

***Reithrodontomys megalotis* (Western Harvest Mouse)**

Reithrodontomys megalotis has not previously been detected in the park and its presence there remains unclear. No voucher specimens were collected at any sites during this study and only two capture events occurred: a male at F2 in June 2000 and a female at B1 when the arrays were being tested in October 1999. Both individuals were identified as juveniles; the male had a mass of 10 g and the female a mass of 17 g. It is likely that both were actually *P. maniculatus* as opposed to *R. megalotis*. Grinnell et al. (1930) collected several specimens from Battle Creek Meadows near Mineral but not at any locations within the park. However, remains of *R. megalotis* were found in three red fox scats collected in the western half of the park in August 1998, August 2000 and January 2001 (Perrine 2005). The teeth and hair were identified by Neil Duncan of the American Museum of Natural History. The foxes ranged widely, however, and may have taken the *R. megalotis* outside the park. *R. megalotis* occurs throughout much of California, especially in grassy areas and oak woodlands, but usually at low to mid-elevations (Jameson and Peeters 2004). As with *P. truei*, recent surveys in the Sierra Nevada have documented a range expansion of *R. megalotis* since the 1920s, including their expansion into Yosemite National Park (MVZ 2005). A similar expansion may have occurred into LVNP and additional fieldwork, including the collection of voucher specimens, appears warranted.

***Sciurus griseus* (Western Gray Squirrel)**

Sciurus griseus was detected only at the F2 site and only by its camera station. A single photograph was acquired on 24 August 2001, another on 24 June 2002, and a total of nine photographs were acquired between 27 June 2003 and 7 September 2003. All photographs were taken between 8:15 am and 3:20 pm, except for one at 6:08 pm on 27 June 2003. This species is unlikely to be captured in pitfall or Sherman traps, and even Tomahawk traps must be set specifically to target *S. griseus* (Jim Patton, pers. com.). *S. griseus* is strongly associated with oaks, especially Black Oak (*Quercus kelloggi*) at higher elevations in California (Verts and Carraway 1998, Jameson and Peeters 2004). Grinnell et al. (1930) detected this species primarily in the valley and western foothills below 1000 m (3300 ft), such as near Dale's, Payne's Creek and Manton, but they also had a sighting near the bridge at Battle Creek Meadows, and trappers they interviewed reported *S. griseus* occurring as far east as Mineral.

Grinnell et al. expressed some doubt about Townsend's (1887) report of *S. griseus* from the "east base [of] Mt. Lassen," but they conceded that such a disparity in range might be due to seasonal population fluctuations. The MVZ does not have any *S. griseus* specimens from the park; all from the region were collected east of the town of Payne's Creek.

***Spermophilus beecheyi* (Beechey Ground Squirrel)**

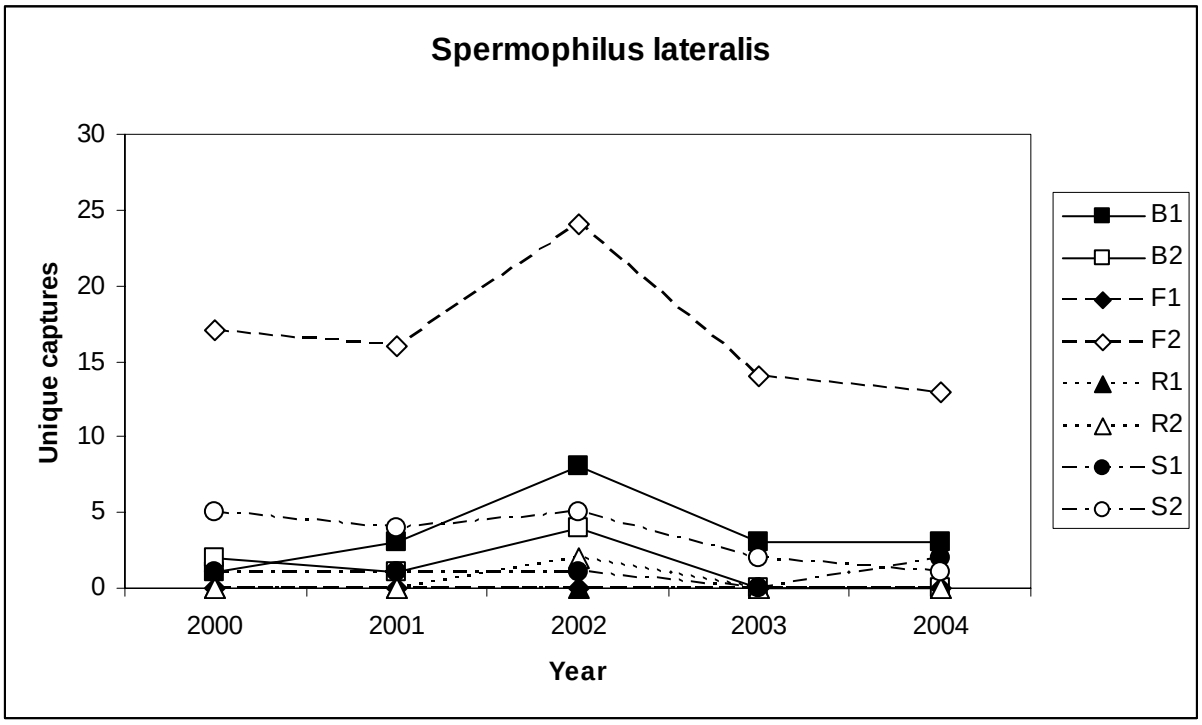
Spermophilus beecheyi was detected only at the B2 (one unique capture in 2001 and three in 2003, and three photographs in 2002) and F2 (one unique capture in 2000) sites. No vouchers were collected. Three individuals were tagged at the B2 site, one of which (a female) was recaptured the following two days. The field crew was uncertain about the species identification for the lone capture at the F2 site, a male weighing 47.5 g and with a tail length of 130 mm and ear length of 24 mm, and which escaped before the measurements could be completed. At the B2 site, one subadult male weighed 249 g and two subadult females weighed 231 g and 237 g. All the captures occurred in Sherman traps, although there was one instance at B2 when a *S. beecheyi* was observed entering and leaving a pitfall trap. *S. beecheyi* is found throughout much of California except the sage brush areas north of the park and in the southeastern deserts, but it is most commonly associated with oak woodlands. It usually occurs at lower elevations than these survey sites. The MVZ has several specimens collected near Lyonsville and Susansville but none from within or immediately adjacent to LVNP. Grinnell et al. (1930) reported this species (then called *Otospermophilus douglasii*) at Battle Creek Meadows and Mineral, but no sites eastward or at higher elevation.

***Spermophilus lateralis* (Golden-Mantled Ground Squirrel)**

The distinctive coloration of *Spermophilus lateralis* makes them easy to identify in the field, even at a distance. A total of 218 captures were obtained, 93.6% of which occurred in Sherman traps. Captures were reported at every site except F1 and R1 and photographs were obtained at every site but F1, R1 and R2. A voucher was collected at each of the B1, B2 and S2 sites, and all three vouchers were correctly identified in the field. Most of the unique captures occurred at the F2 site, which is dominated by climax Jeffrey and Ponderosa pines. No captures

occurred at the other Forest site, which is a younger mixture of red fir, white fir, lodgepole and western white pines. The remaining sites had fewer than 10 unique captures annually (Figure 12). As with several other rodent species, the abundance of *S. lateralis* increased in 2002 and then fell in 2003. Overall, the male:female sex ratio was 1.2; the average mass was 142.4 ± 52.6 g for males (n = 55) and 144.9 ± 42.8 g for females (n = 43). Grinnell et al. (1930) reported this species (then called *Callospermophilus chrysodeirus*) at numerous sites throughout the higher elevations of the region, specifically at Battle Creek Meadows, Mineral, just south of Brokeoff Mountain, Lake Helen, Lassen Peak, the head of King's Creek canyon on the southern slopes of Lassen Peak, near King's Creek Falls, Drakesbad, Prospect Peak and Butte Lake.

Figure 12: *Spermophilus lateralis* unique captures (n = 133).

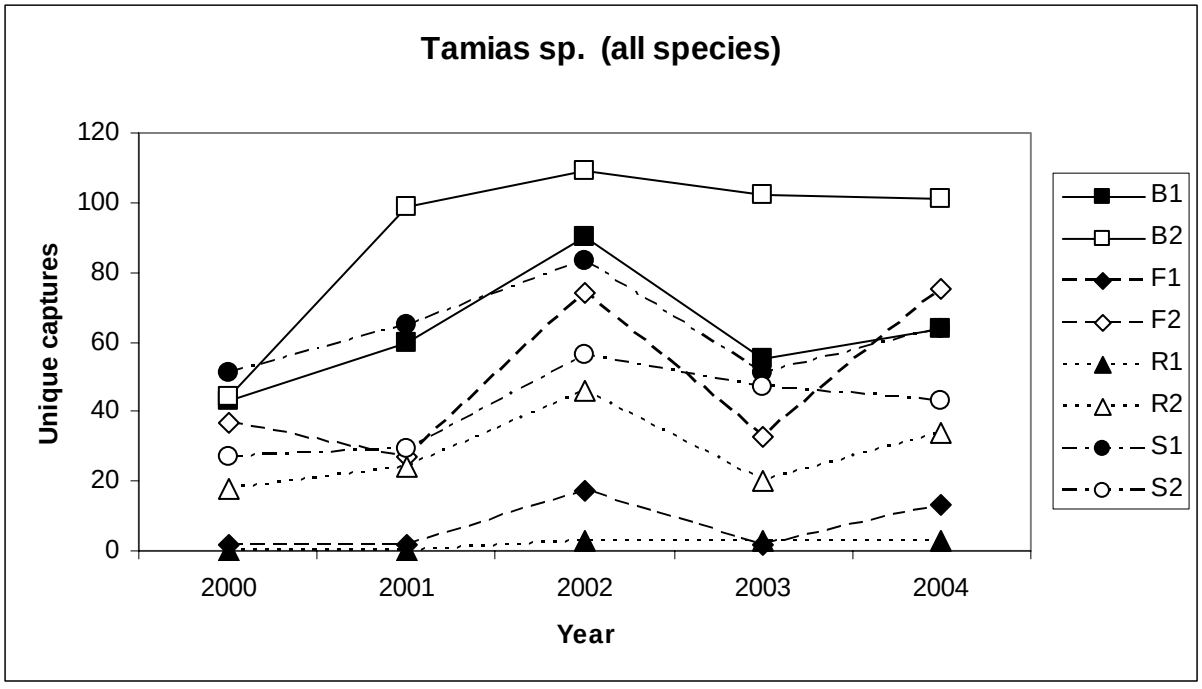


***Tamias* sp. (Chipmunks)**

Chipmunks (*Tamias* sp.) were the second-most frequently captured mammal taxon in this study, accounting for 38.3% of total captures. Of the 4,525 total captures, 3,659 were recaptures of previously captured and marked individuals. Almost all of the captures (99.7%) were in Sherman traps, and the trap mortality rate was low (1.7% of captures). Captures occurred at all eight sites and photographs were obtained at every site except F1.

Differentiating among the three species known to occur at LVNP (*T. amoenus*, *T. senex*, and *T. speciosus*) can be difficult, especially in the field. Differences in proportion and coloration may be subtle even to an expert and these characters may vary seasonally (Sutton 1995). Voucher specimens of all three species were collected during this study and were identified by skeletal examination and mitochondrial cytochrome *b* sequence. There were no vouchers or capture records for *T. quadrimaculatus*, providing additional evidence that this species does not occur in the western portion of the park (Sutton 1995). The voucher specimens suggest that the field identifications were approximately 88% accurate, with *T. senex* having the highest accuracy and *T. amoenus* having the lowest (Table E1). However, individual chipmunks with multiple captures were often identified as several different species (Table E2). For example, Individual 880 was captured 27 times and was field-identified as *T. speciosus* 21 times, as *T. senex* five times and as *T. amoenus* once. To reduce the impact of these errors, the conservative identification of "*Tamias* sp." was used for many of the analyses in this report. Most field identifications were likely correct and the overall trends of abundance and richness are probably accurate, but each individual capture event had a significant probability of identification error. Therefore, trends derived from the voucher specimens may differ slightly from trends derived from the capture records.

Figure 13: *Tamias* sp. unique captures (all species; n = 1,716).



According to the voucher specimens and capture records, chipmunk species richness was highest at the B2 and S1 sites, where vouchers of all three species were collected amid 1,014 and 470 capture events, respectively. These records also suggest that richness was lowest at the R1 site, where no vouchers were collected and there were only 13 capture events. However, all three species were recorded captured at R1 despite the lack of vouchers to verify their presence. In fact, all three species were recorded captured at every site, except for F1 which had only *T. senex* (vouchered) and *T. speciosus* (not vouchered). In most years, the Brush sites had the highest number of unique captures and the Riparian sites had the lowest (Figure 13). Most sites had increases in captures in 2002 and 2004 and a decline in 2003, similar to the pattern seen for *Peromyscus maniculatus* but at lower magnitude.

Table 14: Annual variation in average (± SD) mass of *Tamias* species. Sample size in parentheses.

Species	Sex	2000	2001	2002	2003	2004
T. amoenus	Male	54.1 ± 13.3 (19)	39.8 ± 8.1 (58)	38.6 ± 7.9 (70)	41.2 ± 11.1 (49)	41.3 ± 7.6 (72)
	Female	53.7 ± 14.4 (7)	45.4 ± 12.3 (25)	40.5 ± 12.9 (41)	43.5 ± 12.1 (19)	45.7 ± 9.6 (51)
T. senex	Male	76.3 ± 8.4 (4)	71.9 ± 10.4 (38)	74.0 ± 10.4 (65)	76.0 ± 6.9 (52)	69.2 ± 11.5 (62)
	Female	79.0 ± 21.7 (4)	78.9 ± 10.8 (39)	77.5 ± 13.0 (58)	84.6 ± 11.0 (35)	75.9 ± 17.3 (47)
T. speciosus	Male	59.9 ± 11.7 (19)	50.8 ± 9.9 (69)	52.2 ± 9.5 (87)	53.4 ± 9.8 (91)	51.5 ± 6.9 (53)
	Female	67.1 ± 14.3 (10)	54.6 ± 14.8 (51)	56.2 ± 12.3 (76)	54.8 ± 15.6 (34)	53.8 ± 10.6 (52)

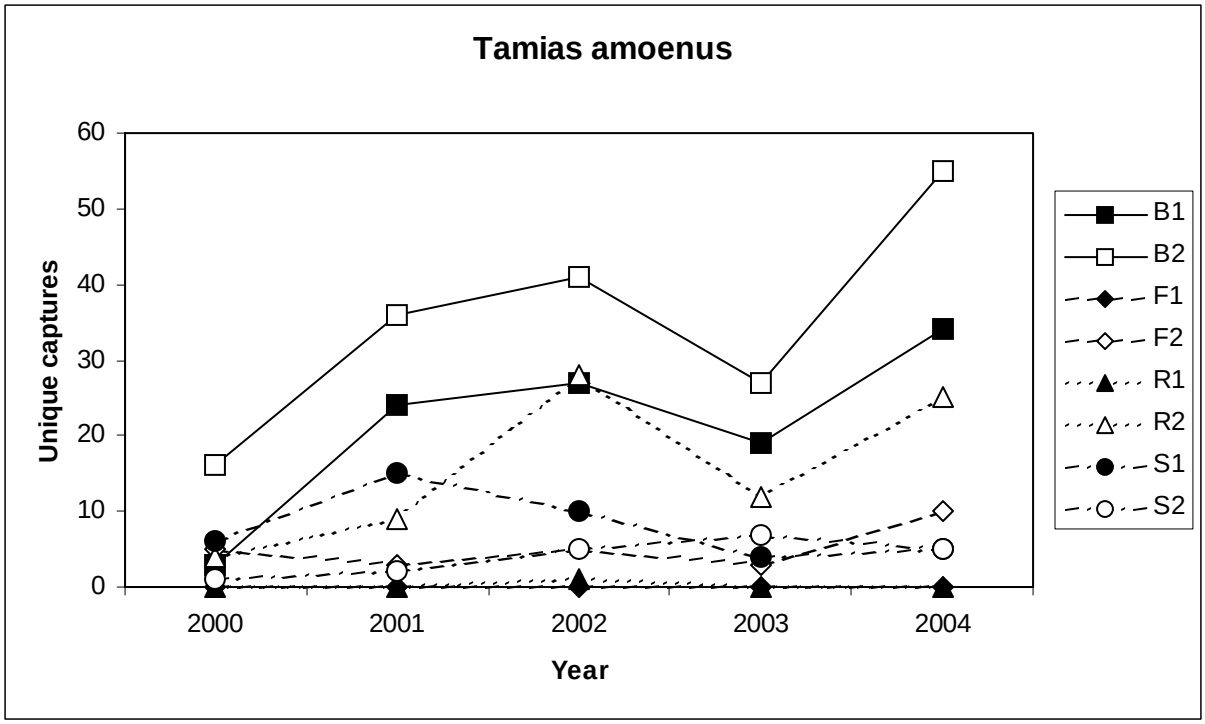
Several *Tamias* individuals were captured quite often. Eleven individuals were captured >20 times apiece, and Individual 870 was captured 39 times. Chipmunks were the only species where the same individual was captured in >2 years. In fact, two individuals were captured in all

five years of the study and nine individuals were captured in four of the five years. Across all *Tamias* species, there was a trend for males to be captured more frequently than females. Females also tended to be slightly heavier than males (Table 14). See the species accounts below for details.

***Tamias amoenus* (Yellow-Pine Chipmunk)**

This species was reported at all sites but F1, but vouchers were collected only at five sites (B1, B2, R2, S1 and S2). Of the 35 voucher specimens field-identified as "*Tamias amoenus*," five were actually *T. speciosus*, yielding an identification accuracy rate of 85.7%. In addition, two vouchers identified as "*T. speciosus*" and four of the vouchers identified as "*Tamias* species" were actually *T. amoenus*. Of the 36 *T. amoenus* vouchers, most (58.3%) were collected at the B2 site. Likewise, most of the unique captures occurred at the B2 and B1 sites (Figure 14). There was only one unique capture at the R1 site, in 2002, and this individual may have been mis-identified. The other six sites where *T. amoenus* was reported had ≥1 unique capture every year. As with many other rodents, the number of captures dropped at many sites in 2003 and

Figure 14: *Tamias amoenus* unique captures (n = 447).

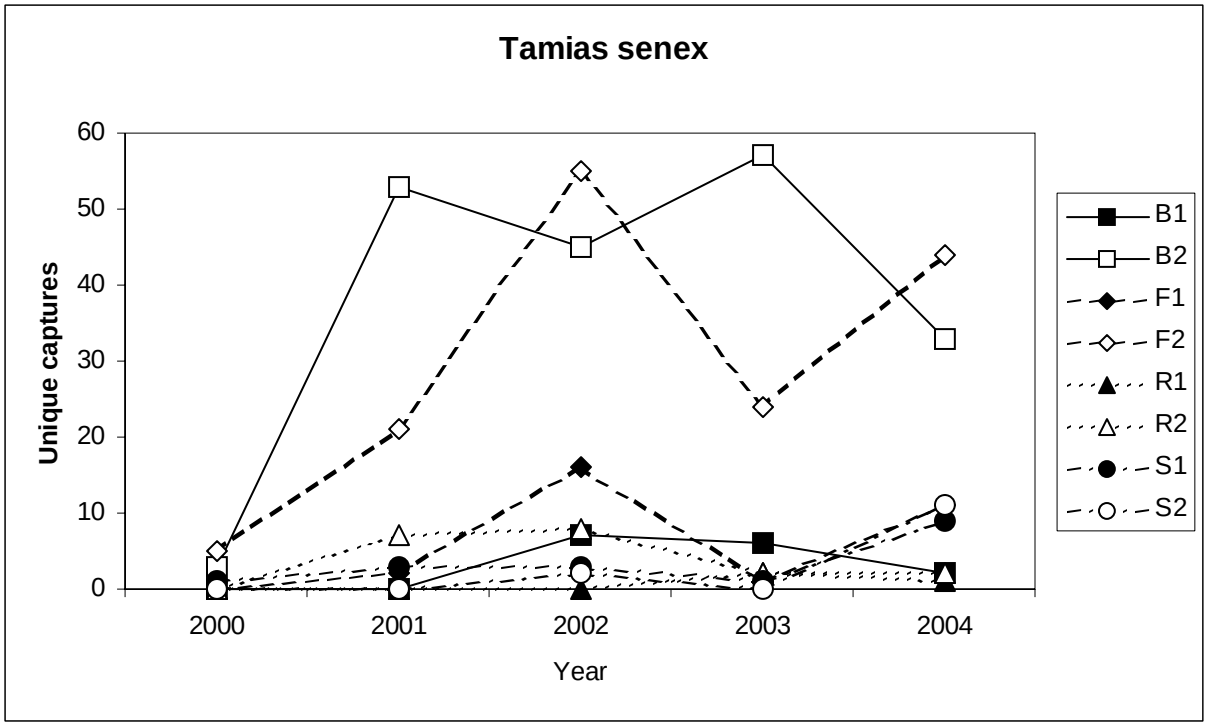


increased in 2004. Overall male:female sex ratio was 1.90, and the average mass was 41.1 ± 9.7 g for males and 44.3 ± 11.9 g for females. Grinnell et al. (1930) collected this species (then called *Eutamias amoenus*) at Battle Creek Meadows, just south of Brokeoff Mountain, Lake Helen, the head of King's Creek canyon on the southern slope of Lassen Peak, near King's Creek Falls, Drakesbad and Butte Lake. As its name implies, this species is most closely associated with Ponderosa pine and Jeffrey pine forests (Jameson and Peeters 2003).

***Tamias senex* (Shadow Chipmunk)**

Tamias senex was reportedly captured at all sites, but vouchers were collected only at four sites (B2, F1, F2 and S1). Overall field identification of this species was quite good, especially after the first year. Of the 16 voucher specimens that were field-identified as "*T. senex*", all but one was correctly identified, for an accuracy rate of 93.7%. The one mis-identification was in 2000, the first year of the study. None of the vouchers field identified as "*Tamias* species", "*T. amoenus*" or "*T. speciosus*" turned out to be *T. senex*. Of the 15 voucher specimens of *T. senex*, most (66.7%) were collected at the B2 site. The B2 site and the F2 site

Figure 15: *Tamias senex* unique captures (n = 437).

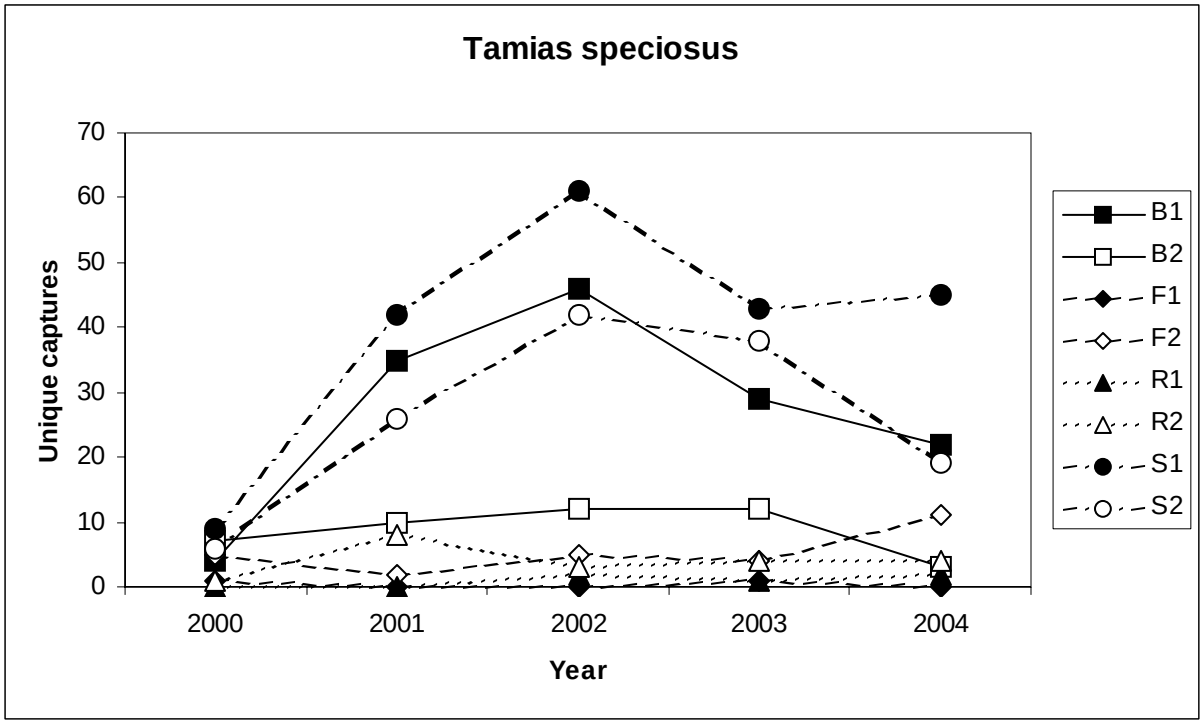


also accounted for most of the unique captures, with the other sites usually recording fewer than 10 unique captures per year (Figure 15). The B2 and F2 sites appeared to fluctuate in opposite directions in most years, with the number of captures decreasing at one site and increasing at the other. Both Forest sites showed a decline in captures in 2003 and an increase in 2004, similar to several other species during this study. Overall male:female sex ratio was 1.20, and average mass was 72.8 ± 10.3 g for males and 78.8 ± 13.9 g for females. Grinnell et al. (1930) collected this species (then called *Eutamias senex*) at Mineral, just south of Brokeoff Mountain, the head of King's Creek canyon on the southern slopes of Lassen Peak, near King's Creek Falls and Drakesbad. This species is found throughout the montane coniferous forests of northern California (Jameson and Peeters 2003).

Tamias speciosus **(Lodgepole Chipmunk)**

This species was reported captured at all sites, but vouchers were collected only at five sites (B1, B2, F2, S1 and S2). All but two of the 15 voucher specimens that were field-identified as "*Tamias speciosus*" were correctly identified, yielding an accuracy rate of 86.7%. Both

Figure 16: *Tamias speciosus* unique captures (n = 565).



incorrectly-identified vouchers were actually *T. amoenus*. Specimens of *T. speciosus* were incorrectly identified in the field as "*T. amoenus*" (five of 35 vouchers) or as "*T. senex*" (one of 16 vouchers). Additionally, three of the seven vouchers field-identified as "*Tamias* sp." turned out to be *T. speciosus*. This resulted in a total of 22 *T. speciosus* voucher specimens, most of which were collected at the B1 (50%) and S1 (27.3%) sites. The S1 site had the highest number of unique captures, followed by B1 and S2 (Figure 16). The remaining sites had <10 unique captures annually. The low number of unique captures at all sites in 2000 may be an artifact of the field team learning to identify *T. speciosus*. Both the S1 and B1 sites had local declines in 2003, similar to several other species in this study. Overall male:female sex ratio was 1.44. Average mass was 52.6 ± 9.6 g for males (n = 319) and 55.6 ± 13.3 g for females (n = 223). Grinnell et al. (1930) collected this species (then called *Eutamias speciosus*) near Mineral, just south of Brokeoff Mountain, Lake Helen, the head of King's Creek canyon on the southern slope of Lassen Peak, near King's Creek Falls, Drakesbad and Manzanita Lake. As its name implies, this species is most closely associated with yellow pine and lodgepole pine forests (Jameson and Peeters 2004).

***Tamiasciurus douglasii* (Douglas Squirrel)**

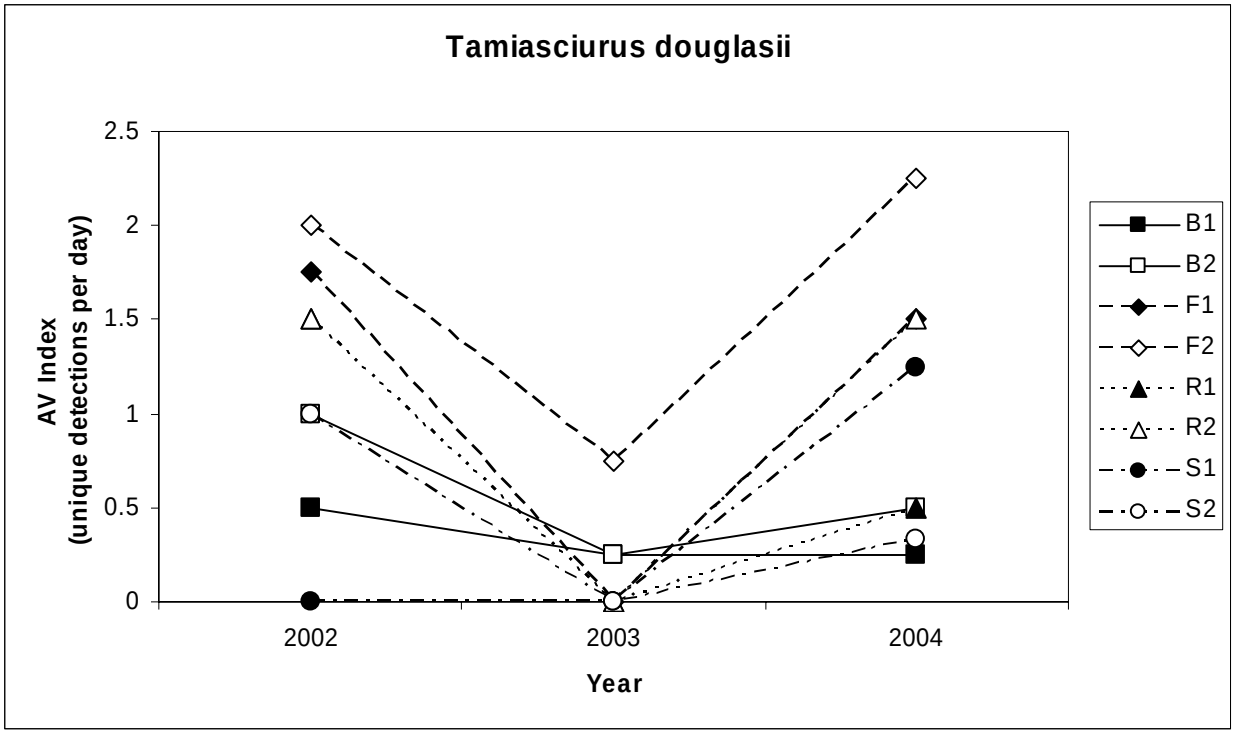
This species was detected at every site, but only by combining the data from several survey methods. Only 10 captures were obtained during the five years of trapping (two at B1, four at F1, two at F2, one at R1 and one at R2). Most of the captures (80%) were in Sherman traps and the remainder were in Tomahawks. One individual was tagged but was never recaptured. Four individuals were sexed; all were females, with an average mass of 187.3 ± 13.9 g. No vouchers were collected but this species is easily identified in the field.

Due to the paucity of captures compared with the relative ease of seeing and hearing this species when it is present, in 2002 the survey team began using an audio-visual detection protocol to record sightings or calls of *Tamiasciurus douglasii* at the arrays. Each site received an index equal to the highest number of daily unique detections within the six-day sampling period at that site. Sites that were visited in mornings and afternoons received a separate score for each visit to prevent them from being "double-weighted" relative to the sites that were visited only in the mornings. For each site, the index was then averaged across the four sampling

periods to give a yearly score (Figure 17). There was a sharp decline in 2003 similar to that documented for many other rodents (compare with Figures 11 and 14). Note that the audio-visual sampling detected *T. douglasii* at every site even though it was never captured at three sites (B2, S1, S2) and was never photographed at two sites (B1 and S1).

Grinnell et al. (1930) found this species (then called *Sciurus douglasii*) at numerous places above 915 m (3000 ft). Localities in and adjacent to the park were near Mineral, just south of Brokeoff Mountain, near King's Creek Falls, Drakesbad, Willow Lake and Butte Lake.

Figure 17: Audio-visual detection index for *Tamiasciurus douglasii*. A site's index score was equal to the annual average of the maximum number of daily unique detections per six-day sampling period at that site.

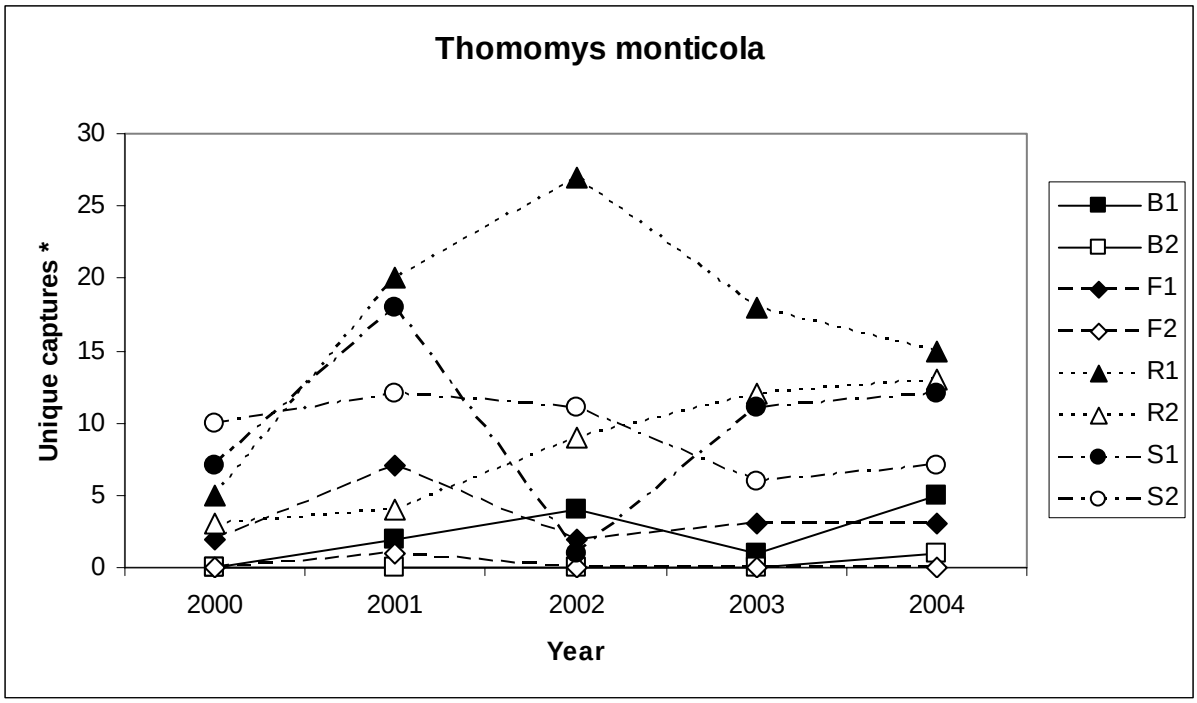


Thomomys monticola (Mountain Pocket Gopher)

Thomomys monticola is the only gopher documented in the park. At least one was captured at every site during this study, although the B2 and F2 sites had only one unique capture apiece. Gophers were captured almost exclusively in pitfall traps (97.3% of the 299 capture events). A total of 22 vouchers were collected from five different sites and all were correctly

identified in the field. Four captures of "*Thomomys* sp." were considered to be *T. monticola* for all analyses. Overall male:female ratio was 0.4. Site-specific sex ratio ranged from 0.9 at S2 (9M:10F) to 0.05 at R2 (1M:19F). Average mass was 74.6 ± 24.6 g for males (n = 35) and 49.1 ± 16.6 g for females (n = 81). Due to their fossorial habits, the pitfall and Sherman traps used in this study are probably not the best way to determine the distribution and relative abundance of *T. monticola*. Many of these captures may have been dispersing juveniles. Targeted surveys of

Figure 18: *Thomomys monticola* unique captures (n = 252).



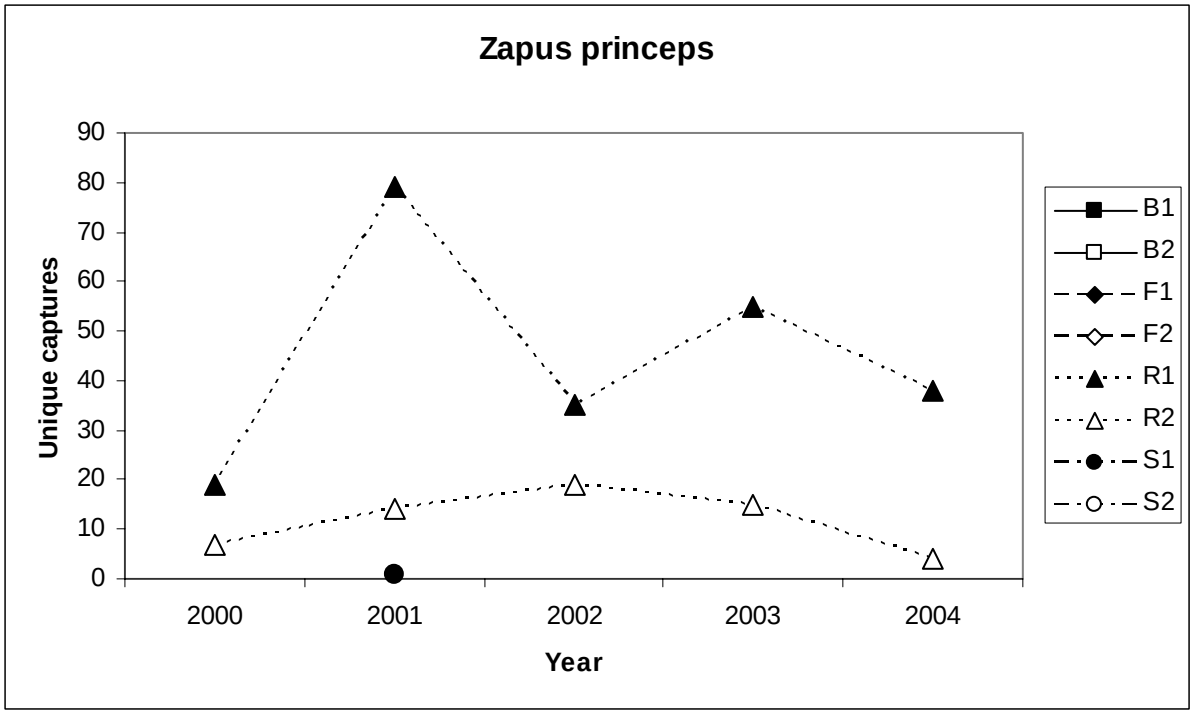
their mounds and castings would likely be a more robust approach. Grinnell et al. (1930) found *T. monticola* at most mountainous sites between Battle Creek Meadows and Eagle Lake. Specific sites in and adjacent to the park were Mineral, Manzanita Lake, just south of Brokeoff Mountain, Lake Helen, the head of King's Creek canyon on the southern slope of Lassen Peak, near King's Creek Falls, Drakesbad and Willow Lake.

Zapus princeps (Western Jumping Mouse)

Of the species with >10 captures, *Zapus princeps* had the most restricted distribution, occurring almost exclusively at the Riparian sites. A single individual was captured at the S1

site on 28 July 2001; it was a male weighing 13 g, and he was recaptured twice in the following two days. No voucher was collected from the S1 site, however. All 10 voucher specimens were collected at the R1 site and all were correctly identified in the field. Most of the capture events (74.0%) were in Sherman traps and the remainder were in pitfalls. Relative abundance was considerably higher at R1 than R2 (Figure 19). At the R1 site the male:female ratio was 1.4 and average mass was 20.6 ± 5.2 g for males (n = 100) and 22.0 ± 6.9 g for females (n = 69). At the R2 site the male:female ratio was 1.9 and the average mass was 21.6 ± 4.1 g for males (n = 30) and 24.1 ± 3.3 g for females (n = 17). At the R1 site *Z. princeps* showed a sharp decline in 2002, an increase in 2003 and a decline in 2004 – the opposite of the pattern shown by *P. maniculatus* and several other species. The R2 site showed little overall pattern, although captures reached a shallow peak in 2002. The MVZ collection contains specimens of *Z. princeps* collected throughout the Sierra Nevada, Cascades and Warner Mountains. Collection localities near the park include Warner Valley, near Mineral, and just west of Lake Almanor. Grinnell et al. (1930) reported this species (then called *Zapus pacificus*) at Battle Creek Meadows, near Mineral, just south of Brokeoff Mountain, Lake Helen, the head of King's Creek canyon on the southern slopes of Lassen Peak, Drakesbad and Willow Lake.

Figure 19: *Zapus princeps* unique captures (n = 286).



3. Lagomorphs:

Lepus americanus (Snowshoe Hare)

Camera stations detected *Lepus americanus* at the B2 site in 2002, 2003 and 2004, but they were not detected at any other site by any other method. The ten photographs were acquired on nine separate nights and most were taken between 10 pm and 2 am. Grinnell et al. (1930) found *L. americanus* in forested areas from 1460 to 2015 m (4800 to 6600 ft), especially in thickets of small firs, alders, willows and snow-brush. They collected or observed this species (then called *L. washingtonii klamathensis*) at Battle Creek Meadows, Mineral, Summit Creek, Willow Lake, near King's Creek Falls and at Kelly's. The hares were locally plentiful but not abundant. A recent analysis of red fox, marten and coyote scats from in and around the western half of the park found virtually no *L. americanus* remains, raising questions about their current abundance in the area (Perrine 2005). It is a California Species of Special Concern. The sampling methods in this inventory were not ideal for detecting *L. americana* and additional surveys targeting this species may shed more light on its current distribution and abundance in the park.

Ochotona princeps (Pika)

The sole detection of *Ochotona princeps* by this inventory was at the S1 site at 6:05 pm on 12 September 2002 via the audio-visual protocol (for methodology, see the *Tamiasciurus douglasii* species account). According to field notes made at the time, a pika sounded its alarm call as a peregrine falcon (*Falco peregrinus*) glided low along the cliff face 200 m north of array 4. It is likely that pika are more abundant and widespread in the park than these survey results suggest. Trapping arrays and automatic cameras are not ideal ways to detect this species. Furthermore, pika occur primarily in talus slopes adjacent to mountain meadows, two habitat types that were not well represented in this survey. The current distribution of pika in the park remains unclear. Grinnell et al. (1930) found this species (then called *Ochotona schisticeps*) to be broadly distributed in the Lassen region above 1460 m (4800 ft) on the western slopes and 1620 m (5300 ft) to the east. They reported "conies" at Battle Creek Meadows, Summit Creek, Martin Creek, just south of Brokeoff Mountain, Lake Helen, Lassen Peak, Prospect Peak, the

head of the Kings Creek drainage on the southern slope of Lassen Peak, near Kings Creek Falls, Butte Lake, Kelly's and several sites near Eagle Lake. This distribution was apparently quite similar to that reported by Townsend (1887). Recent surveys in the Great Basin (Beever et al. 2003) have documented the extirpation of pika from sites that were occupied at the time of Grinnell's Lassen surveys. Targeted surveys using specialized methods should be conducted to determine the current distribution and abundance of *O. princeps* in the park.

***Sylvilagus* sp. (Unidentified Rabbit)**

An unidentified rabbit was photographed at the F2 site on 31 August 2001 and 11 August 2003. Although the species could not be conclusively identified, these photographs may represent confirmation of the presence of *Sylvilagus nuttallii* in the park. On the other hand, a young *Lepus americanus* may have been mis-identified. Grinnell et al. (1930) did not report any *Sylvilagus* from in or adjacent to the park, although they reported *S. nuttallii* east of Eagle Lake, *S. bachmani* at several sites west of the park at 1000 m (3300 ft), and *S. audubonii* near Red Bluff. Likewise, the MVZ does not have any *Sylvilagus* specimens collected in or near the park. In light of the inability to confidently identify the species in the photographs, the presence of *S. nuttallii* should remain unconfirmed. As with *L. americanus* and *O. princeps*, a more targeted survey for *Sylvilagus* sp. in the park may be warranted.

4. Carnivores:

Carnivores were detected only by camera stations, with the exception of one *Mustela* sp. captured in a Sherman trap at the R1 site. (Bears mauled the Sherman traps or pitfalls at several sites but these data were not systematically recorded.) The camera station detections must be interpreted with care even though they are a standard means of inventorying carnivores (e.g., Zielinski et al 1995, Karanth and Nichols 2002). Unbaited stations may not be an effective way to assess the presence and distribution of carnivores, especially if the cameras and the target taxa are not concentrated upon game trails or other areas. Moreover, the failure to detect carnivores at unbaited cameras (or even at baited cameras) is not conclusive evidence of their absence at that site. In general, and with a few important exceptions, carnivores have larger home ranges,

lower population densities and more general habitat requirements than the other taxa in this inventory. Therefore, most of these species are likely more abundant and widely distributed in the park than the camera detections would suggest. A systematic survey of the park using baited cameras may provide better data on the presence and distribution of these species, and an integrated analysis with photosurvey data from the adjacent Lassen National Forest would also be beneficial. Historic data on the distribution of these species in the Lassen region is spotty, as Grinnell et al. (1930) derived much of their information on carnivores from interviews with local trappers; as with the modern data, the lack of documentation of a given species at a given site should not be interpreted as evidence of that species' absence.

***Canis latrans* (Coyote)**

Coyotes were photographed on only three occasions: at B2 on 16 August 2003, at R1 on 26 September 2002 and at S1 on 7 August 2001. All of the photos were between 1 am and 7 am and only one photograph was obtained each time. Grinnell et al. (1930) considered *Canis latrans t*o be widely distributed throughout the region, from the Sacramento River to the Nevada state line. In and near the park, they reported coyotes at Mineral, Summit Creek, Lake Helen, the upper Kings Creek drainage, Wilson Lake, Willow Lake and Kelly's. At the time, the local abundance of coyotes and other carnivores was probably affected by fur trapping and predator-poisoning campaigns – practices that are now illegal. Therefore, coyotes may be more abundant now than during Grinnell's surveys. Recently, baited camera stations have detected coyotes throughout much of the park and the Lassen National Forest (Perrine 2005). However, their local distribution may be even wider, as coyotes have been shown to detect and deliberately avoid camera stations on their territories (Sequin et al. 2003).

***Lynx rufus* (Bobcat)**

Lynx rufus was photographed at only two sites: at the F2 site on 1 September 2001 and 5 September 2002, and at the R2 site on three days in July and August 2004 (the exact dates are unclear). All of the photographs were between 6 pm and 1 am and only one photograph was obtained per night. Grinnell et al. (1930) considered the Lassen region to separate the two local

races of bobcats, with *L. rufus californicus* found to the west and *L. r. pallescens* to the east. Detection sites in and near the park were Battle Creek Meadows and Drakesbad.

***Martes americana* (American Marten)**

Camera stations detected marten at the B1, S1 and S2 sites. At the B1 site, marten were photographed three times in 2002 (on 30 June, 13 July and 4 September) and once in 2003 (in August). At S1 a marten was photographed on 21 July 2004, and at S2 a marten was photographed on 15 August 2003. All of the photographs were taken between 7 pm and 3 am. Compared to other carnivores in the area, marten habitat requirements are fairly narrow. They are found primarily in mature, dense conifer forest with abundant snags and downed logs (Buskirk and Powell 1994). However, much of the park is ideal habitat for marten (Schempf and White 1977). Grinnell et al. (1930) considered them present throughout most of the area between Brokeoff Mountain and Eagle Lake, but noted that fur trapping may have affected their local distribution and abundance. They collected specimens or noted sign at Brokeoff Mountain and near King's Creek Falls. Recently, baited camera stations have detected marten throughout much of the park, including near all the sites where the unbaited cameras did not detect them (Perrine 2005). Marten are a US Forest Service species of special concern.

***Mustela* species (Weasels)**

The lone capture of a weasel occurred on 14 September 2002 in a Sherman trap at the R1 site. It had a mass of 50 g, a body length of 160 mm and a tail length of 62 mm, suggesting it was *Mustela erminea* (short-tailed weasel or ermine). The pelage was brown above and white below, and the tail had a black tip 10 to 12 cm in length. A weasel was also photographed at the S1 site in July 2004, but the date, time and species identity are unclear. Both *M. erminea* and *M. frenata* (long-tailed weasel) have been documented in LVNP. Specimens of both are included in the park's reference collection. Baited camera stations have detected *M. frenata* near the R1, R2 and S1 sites and *M. erminea* between the S1 and S2 sites (Perrine, unpublished data). Grinnell et al. (1930) captured a male *M. erminea* (then called *M. muricus*) weighing 54.5 g just south of Brokeoff Mountain. They also captured three *M. frenata* (then called *M. arizonensis*), weighing approximately 250 g, at Kelly's camp in Warner Valley. Other than these specimens, the MVZ

does not have any other specimens of *M. erminea* or *M. frenata* collected in or adjacent to the park. Both species are unlikely to be captured by the traps and unbaited cameras used in this survey and are probably more abundant and widespread than the two detections suggest.

***Taxidea taxus* (Badger)**

The only detection of *Taxidea taxus* by this inventory was a single photograph at the B2 site at 6:06 am on 8 August 2002. Grinnell et al. (1930) found *T. taxus* throughout their Lassen transect, from Red Bluff to near the Nevada border. They observed badgers or sign at the head of Kings Creek Canyon on the southern slope of Lassen Peak and at the Devastated Area, and they collected a specimen near Kings Creek Falls. This is the only specimen in the MVZ collection from in or adjacent to the park.

***Urocyon cinereoargenteus* (Gray Fox)**

Eight photographs of *Urocyon cinereoargenteus* were obtained at the R2 site between 14 June and 31 August 2004. All of the photographs were taken between 6 pm and 6 am. Grinnell et al. (1930) did not report *U. cinereoargenteus* from any sites in or near the park, although the abundance of this species had likely been reduced by coyote poisoning campaigns. Grinnell et al. considered them to primarily inhabit chaparral in the foothills, and they noted that their range did not overlap with the mountain red fox (*Vulpes vulpes necator*). It is unclear whether these data were incorrect or whether gray fox have expanded their range into the park since the 1920s. The MVZ has no specimens of *U. cinereoargenteus* collected from within the park, but a roadkill was collected on Highway 44 just outside the park in 2002.

***Ursus americanus* (Black Bear)**

Ursus americanus was the most widely detected carnivore, with photographs acquired at five sites (B1, B2, F1, F2, and R2). Each photograph was on a separate date and all were taken between 7 pm and 7 am. The field team also observed bears or bear sign at several sites but these data were not considered part of the formal inventory. Within the park, bears may be more

widely distributed than other carnivores, but they are also more likely to be photographed due to their larger body size and slower gait. Grinnell et al. (1930) did not encounter any bears during their surveys in the park, but trappers they interviewed considered them common and reported them occurring as far east as Eagle Lake. The MVZ has only a few *U. americanus* specimens from in or near the park: one collected near Mineral in 1943, one collected at Silver Lake (just east of the park) in 1950, and a road-killed cub collected near the McGowan Lake Road in 2001.

***Vulpes vulpes* (Red Fox)**

A red fox was photographed at the B1 site twice in September 2003. The first was on 21 September at 11:42 pm, and the second was four days later at 10:34 pm. It is unclear whether both photographs were of the same individual. Historically, the Lassen Peak region was an important population center for the native Sierra Nevada red fox, *Vulpes vulpes necator* (Grinnell et al. 1937, Schempf and White 1977). According to Grinnell et al. (1930), they could be found between Mineral and Eagle Lake, and they observed red fox sign at Mineral, Summit Creek, near Kings Creek Falls, and on Brokeoff Mountain and Lassen Peak. *V. v. necator* was listed as a California Threatened species in 1980 and its current distribution and population trend are unknown (CDFG 2005). Recent surveys throughout much of the Cascade and Sierra Nevada mountains have failed to detect red foxes, suggesting that the Lassen region may contain one of the only remaining populations (Perrine 2005, Zielinski et al. 2005).

5. Ungulates:

***Odocoileus hemionus* (Mule Deer)**

Odocoileus hemionus was the most widely occurring and frequently detected species, photographed at virtually every site every year and accounting for 58.1% of all photographs. They were also the only species (other than birds) for which two or more individuals were regularly detected in the same photograph. This usually consisted of a doe and one fawn, but several photographs contained a pair of fawns or a doe with a pair of fawns. Does with fawns were photographed at every site but F1 and R1, and does with two fawns were photographed at

B1, R2 and S2. Grinnell et al. (1930) reported that *O. hemionus* (then considered two separate species, *O. hemionus* and *O. columbianus*) occurred widely in and around the park. The current survey suggests that this remains true.

AMPHIBIANS

Ambystoma macrodactylum (Long-toed Salamander)

Ambystoma macrodactylum was captured at both Brush and both Forest sites but not at the Riparian or Subalpine sites. The one voucher specimen, collected from the F1 site, was correctly identified in the field. Most captured animals were marked by toe-clipping but few individuals were recaptured; the few recaptures usually occurred at the same array on the following day. Of the 60 unique captures, 39 (65%) occurred in 2000, with no more than eight unique captures in any other year. In fact, over half of the total captures (33 of 62 total captures) occurred between 9 and 11 June 2000, when there were late spring rains and the days were cool and cloudy. Most individuals were not identified to sex. Overall, their average mass was 6.3 ± 2.7 g, with a range of 1.8 to 13.0 g (n = 56), and the average snout-vent length was 64.6 ± 9.9 mm, with a range of 40.0 to 80.0 mm (n = 56).

A. macrodactylum occurs throughout much of northeastern California, from the sagebrush zone to alpine meadows and lakes (Stebbins 2003). Grinnell et al. (1930) found this species at only one site in the park: Emerald Lake on 14 July 1924. They noted that other researchers had found these salamanders near Mineral and Wilson Lake but had not collected voucher specimens. Koo et al. (2004) documented *A. macrodactylum* at several sites close to the park border, including Table Mountain Lake, Brokeoff Meadows, near Rhodes Meadow and in the small lakes just northeast of Butte Lake. They concluded that *A. macrodactylum* was common throughout the Lassen National Forest but required waters without exotic fish and with sufficient cover to protect the egg masses and developing larvae from dessication.

Stead et al. (2005) found *A. macrodactylum* at 19 sites throughout the park and at several additional sites in the Thousand Lakes and Caribou Wilderness. In the park, *A. macrodactylum* were found in lakes, permanent ponds, temporary ponds and wet meadows. The only detection

near a small vertebrate array was at the F2 site, but they were also noted near Summit Lake and Lake Helen. Local populations were usually small, with only seven sites having >10 individuals detected; the largest number of individuals detected at any one site in the park was 85. Stead et al. also noted an unusually high number of dead individuals at a few sites in the park. They failed to detect *A. macrodactylum* at Sifford Lakes, where previous surveys have detected them, and called for a more detailed investigation of the status of this species in and around the park.

***Bufo boreas* (Western Toad)**

A single capture of *Bufo boreas* occurred at the B1, R1, R2 and S2 sites, with each capture occurring in a different year. The R1 toad weighed 94 g and had a snout-vent length of 110 mm. The R2 toad, a female, weighed 60 g and was not measured. A toe was collected and some photographs were taken before the animal was released. The B1 toad was not weighed but had a snout-vent length of 74 mm. The S2 toad was released without processing. All four captures occurred in pitfall traps. No voucher specimens were collected.

This species occurs in a wide variety of habitats in California, ranging from sea level to the high Sierra. The Lassen area is in the contact zone between the Boreal Toad (*B. b. boreas*) and the California Toad (*B. b. halophilus*) (Stebbins 2003). Grinnell et al. (1930) reported *B. boreas* from numerous sites in the Lassen region ranging from 1070 to 2560 m (3500 to 8400 ft). Specific sites in and adjacent to the park were Mineral, Manzanita Lake, the head of King's Creek canyon on the southern slope of Lassen Peak, Butte Lake and Willow Lake. Koo et al. (2004) documented *B. boreas* at several sites near the park's western border, including Table Mountain Lake and Brokeoff Meadows. Stead et al. (2005) found *B. boreas* at 29 sites in the park, seven sites in the Thousand Lakes Wilderness and one site in the Caribou Wilderness. Only one of these detections was near a small vertebrate array (the F2 site). Their surveys near Manzanita Lake and Hat Lake, near the B2 and F1 sites, did not detect *B. boreas*. Stead et al. concluded that sites in the park generally had larger local populations than in the adjacent wilderness areas. Eight of their sites in the park had >1,000 individuals, with the largest population having approximately 34,000 individuals.

***Ensatina eschscholtzii* (Ensatina salamander)**

Ensatina eschscholtzii was detected only at array 2 at the F2 site. A single individual was captured on 9 June 2000 under a coverboard on the first trapping day of the season after 24 hours of spring rain. It weighed 6.4 g and had a snout-vent length of 65 mm. The same individual was recaptured the following morning in a pitfall. Some doubt has been expressed about whether this individual was actually an immature *A. macrodactylum*, which were also captured at this site. Genetic analysis of the toe clip collected from this individual is pending but had not occurred at the time of this report. Grinnell et al. (1930) found this species (then called *Ensatina sierrae*) only near Mineral and at one other site in the foothills at 1070 m (3500 ft). Neither Koo et al. (2004) or Stead et al. (2005) detected *E. eschscholtzii* at any sites in the park or the nearby wilderness areas or on the Lassen National Forest near the park boundary. This species can be difficult to detect during dry months, even with targeted sampling. In California, this species occurs in forested areas of the coastal and interior mountains, but not in the Central Valley or along the eastern border. The Lassen area is in the intergrade zone between the Painted Ensatina (*E. e. picta*) and the Sierra Nevada Ensatina (*E. e. platensis*), and the population in this area warrants additional study (Stebbins 2003).

***Pseudacris regilla* (Pacific Treefrog)**

Pseudacris (= *Hyla*) *regilla* were detected at every site except the two Brush sites. Most of the individuals were captured at F2 (43.8%) or S1 (25%). Most individuals were not sexed. Their average mass was 5.4 ± 7.4 g with a range of 1.0 to 25.0 g (n = 10), and their average snout-vent length was 31.6 ± 5.2 mm with a range of 25.0 to 39.0 mm (n = 5). No voucher specimens were collected.

These small frogs occur throughout all of California except the arid southeast (Stebbins 2003). Grinnell et al. (1930) found this species, then called *Hyla regilla*, at many sites throughout the Lassen region, ranging from Red Bluff (90 m; 300 ft) to Lake Helen (2500 m; 8200 ft). Specific sites in and adjacent to the park were near Mineral, Manzanita Lake, Lake Helen, the head of King's Creek canyon on the southern slope of Lassen Peak, near King's Creek Falls, Drakesbad and Butte Lake. Koo et al. (2004) detected this species at many sites along the park border, including Table Mountain Lake, Brokeoff Meadows, near Twin Meadows, near

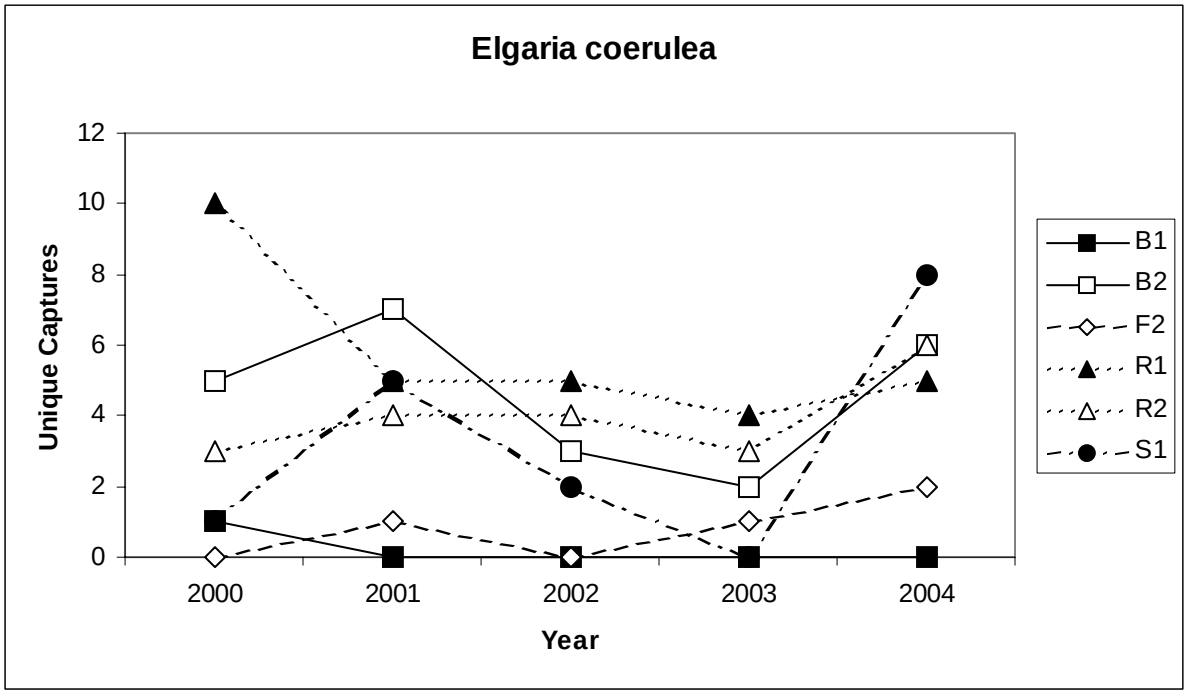
Rhodes Meadows, Willow Lake, Blue Lake near Warner Valley, Butte Creek and the small lakes just northeast of Butte Lake. Likewise, the Pacific treefrog was the most common amphibian species encountered by Stead et al (2005). They were detected at numerous sites throughout the park and the Thousand Lakes and Caribou Wilderness areas, including sites near the F1 and F2 arrays.

REPTILES

Elgaria (Alligator Lizards)

Elgaria lizards were the most frequently captured reptile or amphibian in this study, with 149 total captures across every site except F1 and S2. The number of individuals captured was roughly equal (range: 26-35) across the B2, R1, R2 and S1 sites, but the F2 and B1 sites had far fewer (four individuals and one individual captured, respectively). Most captures were in pitfalls (63.1%) or coverboards (31.5%). The six voucher specimens were all *E. coerulea* (northern

Figure 20: *Elgaria coerulea* unique captures (n = 93). Does not include individuals identified as *E. multicarinata* or "*Elgaria* species." No captures of *E. coerulea* were reported from the F1 and S2 sites.



alligator lizard), five of which were correctly identified in the field and one which was identified as "*Elgaria* sp." The field team had some difficulty differentiating *E. coerula* from *E. multicarinata* (southern alligator lizard), so a number of individuals were identified only as "*Elgaria* species." There were 93 unique captures of *E. coerula* (Figure 20). They had an average mass of 11.9 ± 10.2 g with a range of 0.5 to 36.0 g (n = 75), an average tail length of 86.3 ± 40.4 mm with a range of 12.0 to 170.0 mm (n = 42), and an average snout-vent length of 72.0 ± 26.0 mm with a range of 11.2 to 125.0 mm (n = 76). The distribution of snout-vent length was clearly bimodal, with one peak at 40 to 60 mm and another peak at 80 to 100 mm. Only nine individuals were sexed; two were males and seven were females, for a male:female sex ratio of 0.28. With <10 unique captures per site per year, it was difficult to discern trends in the local populations.

There were nine unique captures of individuals identified as *E. multicarinata*: four at B2, three at S1 and two at R2. There was only one unique capture per site per year, except for two unique captures at S1 in 2003. The accuracy of these field identities cannot be assessed as no vouchers were collected, but no previous surveys have found *E. multicarinata* in the western half of the park (see below). These individuals had an average mass of 14.7 ± 7.0 g with a range of 7 to 27 g (n = 7), an average tail length of 123.9 ± 37.1 mm with a range of 60 to 160 mm (n=9), and an average snout-vent length of 84.1 ± 17.2 mm with a range of 55 to 105 mm (n = 8).

Grinnell et al. (1930) reported *Elgaria coerulea* (then called *Gerrhonotus palmeri*) at several sites west of Lassen Peak, at elevations ranging from 920 to 2075 m (3000 to 6800 ft). Sites in or adjacent to the park were Battle Creek Meadows, Mineral, just south of Brokeoff Mountain and Manzanita Lake. Since Grinnell's surveys, additional specimens of *E. coerulea* have been collected at Manzanita Lake, Reflection Lake, near Summit Lake, and along Battle Creek just west of Mineral. Koo et al. (2004) found *E. coerulea* at several sites along the park border, including Duck Lake (just northeast of Butte Lake), several lakes near Warner Valley, and several sites near Rhodes Meadows and Feather River Meadows.

Grinnell et al. (1930) found *E. multicarinata* (then called *Gerrhonotus scincicauda*) only west of Manton, at elevations below 700 m (2300 ft). The MVZ collection does not contain any *E. multicarinata* from the park; all the specimens are from the foothills to the west. Likewise,

Koo et al. (2004) found *E. multicarinata* only in the foothills of the Lassen National Forest in and around the Ishi Wilderness.

However, Stead et al (2005) reported both *E. coerulea* and *E. multicarinata* while conducting amphibian and fish surveys in the park. One adult *E. coerulea* was found at Manzanita Lake and one subadult was found near Juniper Lake, where one adult *E. multicarinata* was also reported. The also found one adult of "*Elgaria* sp." at Butte Lake (Stead et al, unpublished data). They did not collect any voucher specimens.

Range maps in Stebbins (2003) suggest that both *E. coerulea* and *E. multicarinata* may occur in the Lassen region, although the park may be just beyond the western extent of *E. multicarinata*. *E. multicarinata* usually occurs in more open habitats while *E. coerulea* is more associated with forests and cooler, damper areas (Stebbins 2003). Survey results to date suggest that alligator lizards in the park are probably more likely to be *E. coerulea* than *E. multicarinata*. Targeted surveys and the collection of additional voucher specimens should be conducted to clarify if and where *E. multicarinata* occurs in the park.

***Sceloporus* (Spiny Lizards)**

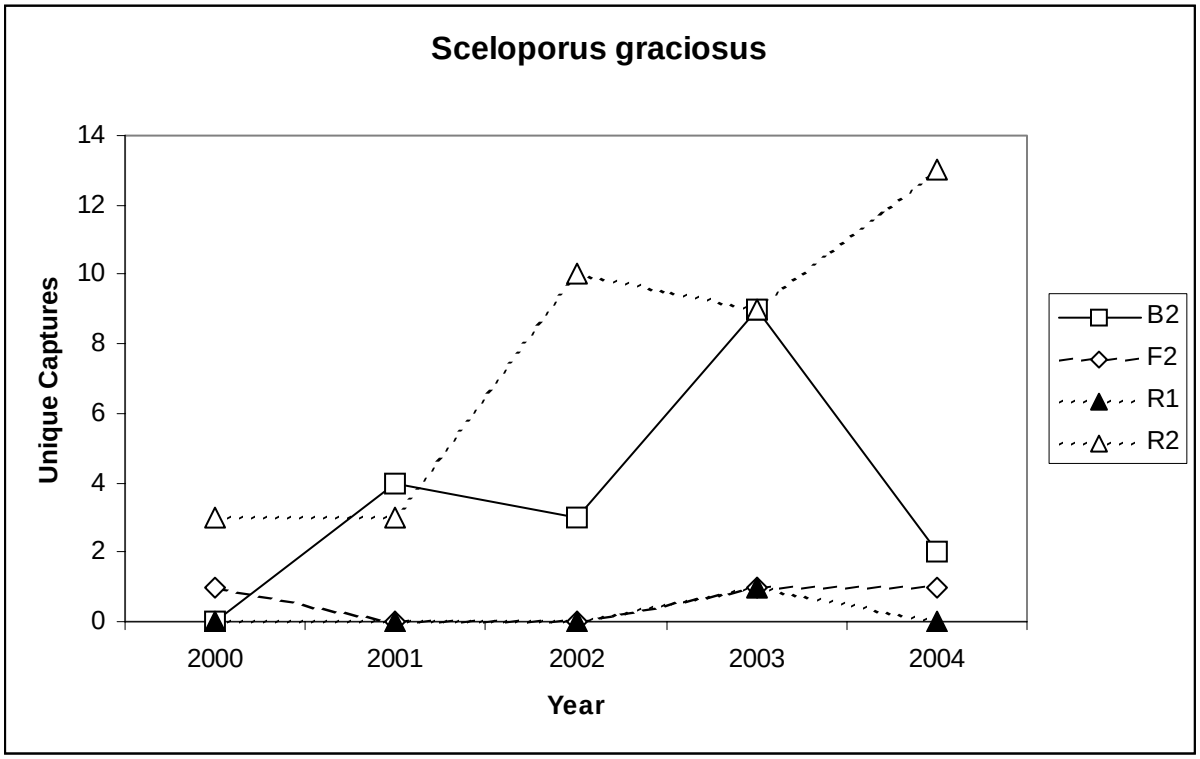
Sceloporus lizards were captured at five sites: B2, F2, R1, R2 and S2. There were 89 total captures, 79 of which were unique captures. Most of the unique captures were at R2 (63.3%) or B2 (29.1%). Eight individuals were recaptured, and none were identified as a different species upon recapture. The low number of captures per site per year makes it difficult to identify local population trends.

Both *S. graciosus* (sagebrush lizard) and *S. occidentalis* (western fence lizard) may occur in the park. These species can be difficult to differentiate, especially as juveniles. Thirteen unique captures were identified as "*Sceloporus* sp." in the field. Eight of these were at R2 and five were at B2. No voucher specimens of "*Sceloporus* sp." were collected, so the true species identity of these individuals is unknown.

Most of the unique captures (60 of 79, or 75.9%) were identified as *S. graciosus*. These occurred predominantly at the R2 and B2 sites, although a few captures were at F2 and R1 (Figure 21). Voucher specimens of *S. graciosus* were collected from B2 and R2, and both specimens were identified correctly in the field. Captures identified as *S. graciosus* had an

average mass of 3.7 ±1.8 g, with a range of 1 to 7.4 g (n = 47), and an average snout-vent length of 42.3 ± 8.9 mm, with a range of 18 to 55 mm (n = 51). These snout-vent lengths are at the lower end of the range for this species (47 to 89 mm; Stebbins 2003), suggesting that many of these individuals were juveniles. Of the 23 unique captures identified to sex, 21 were male, yielding a male:female sex ratio of 10.5. (However, it is unclear how many of the "unknown sex" individuals were female.) The males had an average mass of 3.7 ± 1.8 g with a range of 1 to 7.4 g, and an average snout-vent length of 43.4 ± 7.8 mm with a range of 29 to 54 mm (n =

Figure 21: *Sceloporus graciosus* unique captures (n = 60). This does not include individuals identified as *S. occidentalis* or as "*Sceloporus* species." No captures of *S. graciosus* were reported from the B1, F1, S1 or S2 sites.



20). Both females occurred at the R2 site. One had a mass of 3 g and a snout-vent length of 42 mm, and the other had a mass of 6 g and a snout-vent length of 52 mm.

Six unique captures were identified as *S. occidentalis*. Four of these were at R2 (two in 2000, one in 2001 and one in 2003), one was at F2 (in 2001) and one was at S2 (in 2002). No vouchers were collected, so it is impossible to assess the accuracy of these field identifications. One unique capture was identified as a male; he had a mass of 1 g, a snout-vent length of 31 mm and a tail length of 40 mm. One unique capture was identified as a female; she had a weight of

0.8 g and a snout-vent length of 24 mm. The other four captures were not identified to sex. One had a weight of 6.6 g, and another had a snout-vent length of 26 mm and a total length of 49 mm. All measured individuals were captured at R2. According to Stebbins (2003), the usual snout-vent length for *S. occidentalis* is 57 to 89 cm, suggesting that this inventory was capturing mostly immature individuals.

The distribution of *S. graciosus* and *S. occidentalis* in the park remains unclear. Both species inhabit sagebrush, chaparral and conifer forests in California, and their ranges include the Lassen region (Stebbins 2003). Grinnell et al. (1930) reported *S. graciosus* at many sites ranging from 1000 m (3300 ft) on the western side of Lassen Peak to the Nevada border, but the only sites in or adjacent to the park were near Mineral and at Manzanita Lake. In addition to Grinnell's specimens, the MVZ collection contains 15 *S. graciosus* collected in the Chaos Jumbles in 1945. Grinnell et al. did not find *S. occidentalis* at any sites near or in the park. Likewise, the MVZ collection does not contain any *S. occidentalis* from the park; the nearest collection locality is near Subway Cave several miles to the north. Likewise, Koo et al. (2004) reported *S. graciosus* at numerous sites along the park border, but they found *S. occidentalis* only to the north and near the Ishi Wilderness to the southwest. Stead et al. (2005) reported encountering both *S. graciosus* and *S. occidentalis* while conducting amphibian and fish surveys in the park. They found *S. graciosus* at Manzanita Lake, Crags Lake, near Summit Lake, near Little Bear Lake, at Snag Lake and at Butte Lake. Two adult *S. occidentalis* were reported from Juniper Lake, along with four adults of unidentified species (Stead et al, unpublished data). No voucher specimens were collected.

Surveys to date indicate that *S. graciosus* is probably the most common spiny lizard in the park. The trapping arrays used in this inventory may not be the ideal method to inventory spiny lizards. Additional targeted surveys for these two species, including the collection of voucher specimens, are warranted to clarify their distribution and abundance in the park.

Thamnophis (Garter Snakes)

Garter snakes (*Thamnophis* sp.) were the only snakes detected by this inventory. There were four captures at R2, one capture and one non-capture observation at F1, and one capture at F2. Four captures were in pitfalls and the other two captures were under coverboards. None of

these individuals were dead and no voucher specimens were collected, so their species identities cannot be confirmed. All were small and probably juveniles.

One individual at R2 was identified as *T. elegans*, the western terrestrial garter snake. It weighed 2 g but no other measurements were taken. Two captures at R2 in 2003 were identified as *T. occidentalis*, the common garter snake. These may have been the same individual, as the captures occurred on 12 and 14 September 2003, and the weight was 15 g both times. The snout-vent length measured at the second capture was 355 mm. The remaining captures were identified as "*Thamnophis* species." Their total lengths ranged from 240 to 300 mm (n = 3), their snout-vent lengths ranged from 185 to 255 mm (n = 3) and their masses averaged 3.5 g (n = 2).

Range maps in Stebbins (2003) indicate that both *T. elegans* and *T. sirtalis* may occur in the park. Both occur in a wide variety of habitat types from sea level to high mountains. Grinnell et al. (1930) considered *T. elegans* (then called *T. ordinoides elegans*) to be widely distributed throughout the Lassen region at elevations ranging from 1000 to 2075 m (3300 to 6800 ft). Detection sites in or adjacent to the park were just south of Brokeoff Mountain and Willow Lake. The only specimen of *T. elegans* in the MVZ collection from the park was collected at Drakesbad in 1923 (by a collector not associated with the Lassen Transect survey), although a pair were collected in Old Station in 1947 and four were collected at Wilson Lake in 1938. Grinnell et al. (1930) found *T. sirtalis* at several sites between Red Bluff and LVNP, but the only sites in or near the park were Battle Creek Meadows, Manzanita Lake and Butte Lake. Nine additional *T. sirtalis* specimens were collected near Reflection Lake in 1945.

Koo et al. (2004) detected both species at numerous sites near the park boundary. They found *T. elegans* in Hat Creek, Butte Creek and in the Warner Valley, and they found *T. sirtalis* at Lost Creek, Table Mountain Lake, Bailey Creek, near Rhodes Meadows, Willow Lake, near the Warner Valley, and at the small lakes just northeast of Butte Lake. They collected voucher specimens of both species. They also collected one *T. couchii* (Sierra garter snake) from Butte Creek just north of Butte Lake.

Garter snakes were the most common reptile encountered by Stead et al. (2005) while conducting their amphibian and fish surveys in the park. They observed both *T. elegans* and *T. sirtalis*, but noted that *T. sirtalis* was generally more common than *T. elegans*. They found *T.*

sirtalis widely throughout the park, but found *T. elegans* only at Manzanita Lake, Reflection Lake, Butte Lake, Bathtub Lake and Widow Lake. They did not collect any voucher specimens.

These surveys indicate that both *T. elegans* and *T. sirtalis* likely occur in the park, but the latter is more common and more widely distributed. The distribution of both species in LVNP warrants more detailed investigation using targeted searches that are more likely to detect adult individuals which can be identified with more confidence.

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APPENDIX A:

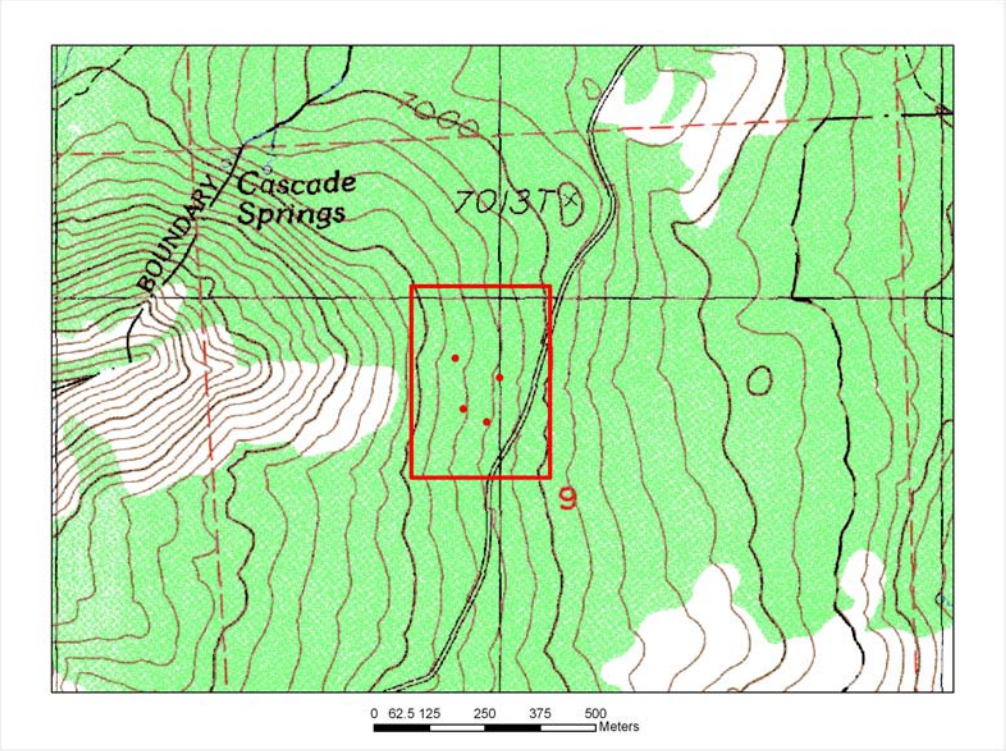
SAMPLING DATES, ARRAY MAPS AND HABITAT PHOTOGRAPHS PER SITE

Table A1: Sampling dates per site.

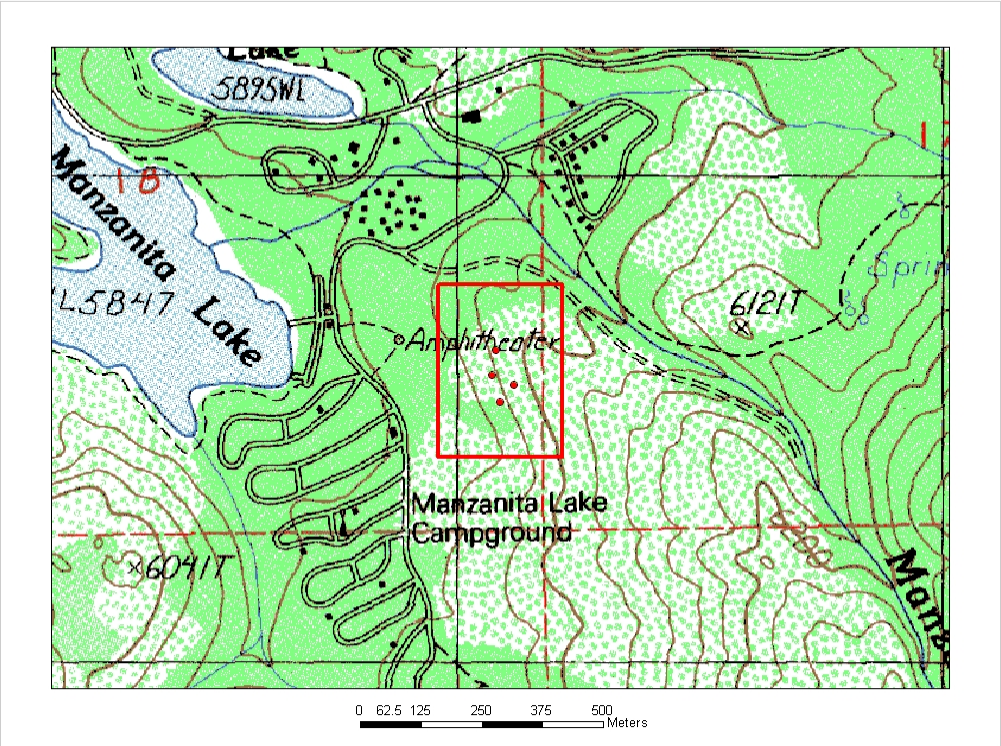
Site	2000	2001	2002	2003	2004
B1	June 22-28	June 21-27	June 27 - July 3	July 3-9	June 24-30
	July 20-26	July 19-25	July 25-31	July 31 - Aug 6	July 22-28
	Aug 17-23	Aug 16-22	Aug 22-28	Aug 28 - Sept 3	Aug 19-25
	Sept 21-27	Sept 13-19	Sept 19-25	Sept 25 - Oct 1	Sept 16-22
B2	June 8-14	June 7-13	June 9-12	June 12-18	June 3-9
	July 6-12	July 5-11	July 4-10	July 10-16	July 1-7
	Aug 3-9	Aug 2-8	Aug 1-7	Aug 7-13	July 29 - Aug 4
	Sept 7-13	Aug 30 - Sept 5	Aug 29 - Sept 4	Sept 4-10	Aug 26 - Sept 1
F1	June 16-21	June 14-20	June 13-19	June 19-25	June 10-16
	July 13-19	July 12-18	July 11-17	July 17-23	July 8-14
	Aug 10-16	Aug 9-15	Aug 8-14	Aug 14-20	Aug 5-11
	Sept 14-20	Sept 6-12	Sept 5-11	Sept 11-17	Sept 2-8
F2	June 8-14	June 7-13	June 9-12	June 12-18	June 6-9
	July 6-12	July 5-11	July 4-10	July 10-16	July 1-7
	Aug 3-9	Aug 2-8	Aug 1-7	Aug 7-13	July 29 - Aug 4
	Sept 7-13	Aug 30 - Sept 5	Aug 29 - Sept 4	Sept 4-10	Aug 26 - Sept 1
R1	June 29 - July 5	June 28 - July 4	June 20-26	June 26 - July 2	June 17-23
	July 27 - Aug 2	July 26 - Aug 1	July 18-24	July 24-30	July 15-21
	Aug 24-30	Aug 23-29	Aug 15-21	Aug 21-27	Aug 12-18
	Sept 28 - Oct 4	Sept 20-25	Sept 12-17	Sept 18-24	Sept 9-15
R2	June 16-21	June 14-20	June 13-19	June 19-25	June 10-16
	July 13-19	July 12-18	July 11-17	July 17-23	July 8-14
	Aug 10-16	Aug 9-15	Aug 8-14	Aug 14-20	Aug 5-11
	Sept 14-20	Sept 6-12	Sept 5-11	Sept 11-17	Sept 2-8
S1	June 22-28	June 28 - July 4	June 20-26	June 26 - July 2	June 17-23
	July 20-26	July 26 - Aug 1	July 18-24	July 24-30	July 15-21
	Aug 17-23	Aug 23-29	Aug 15-21	Aug 21-27	Aug 12-18
	Sept 21-27	Sept 20-25	Sept 12-17	Sept 18-24	Sept 9-15
S2	**	June 21-27	June 27 - July 3	**	**
	July 27 - Aug 2	July 19-25	July 25-31	July 31 - Aug 6	July 22-28
	Aug 24-30	Aug 16-22	Aug 22-28	Aug 28 - Sept 3	Aug 19-25
	Sept 28-Oct 4	Sept 13-19	Sept 20-25	Sept 25 - Oct 1	Sept 16-22

** no sampling conducted. See text for details.

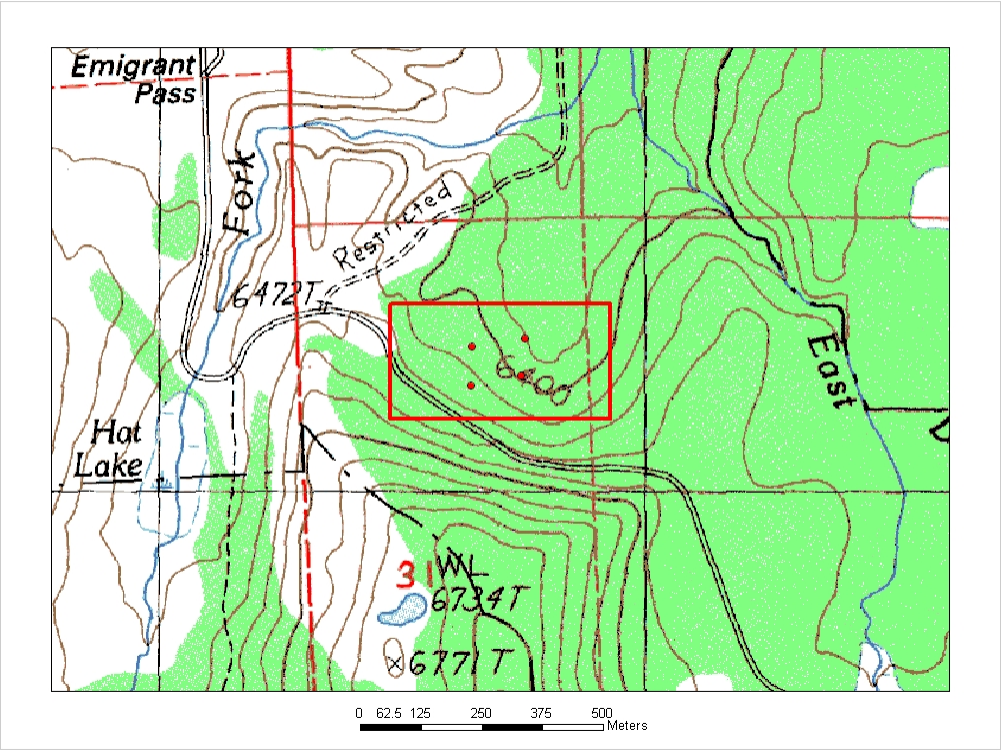
Brush 1 (B1) -- Subalpine low shrub.



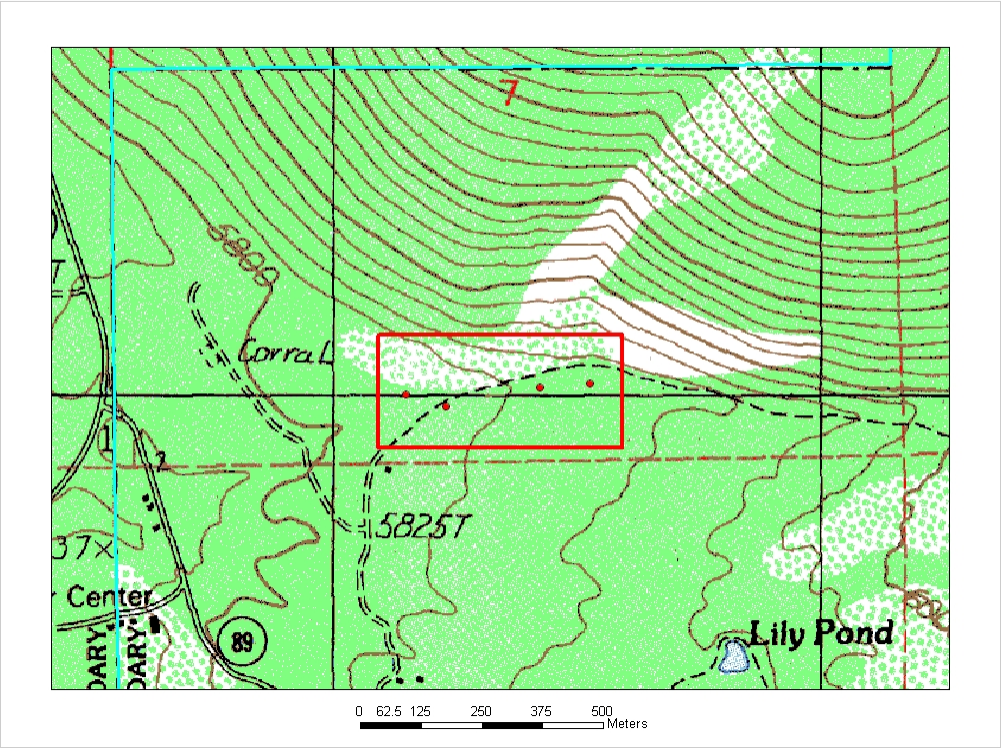
Brush 2 (B2) -- Lowland seral shrub.



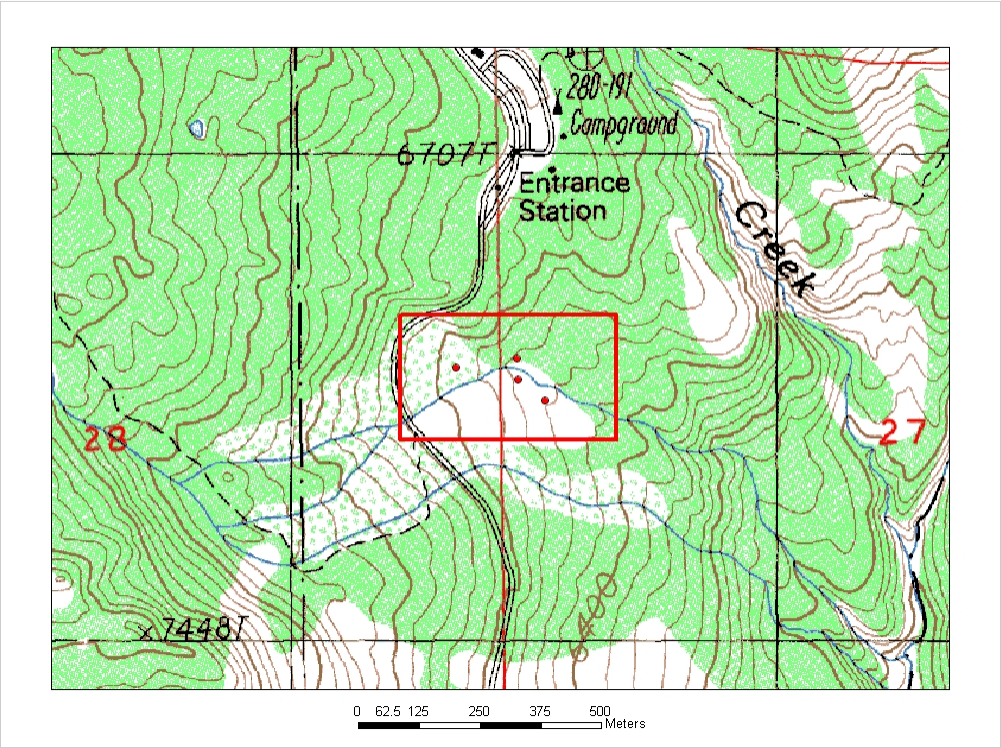
Forest 1 (F1) -- Montane mixed conifer.



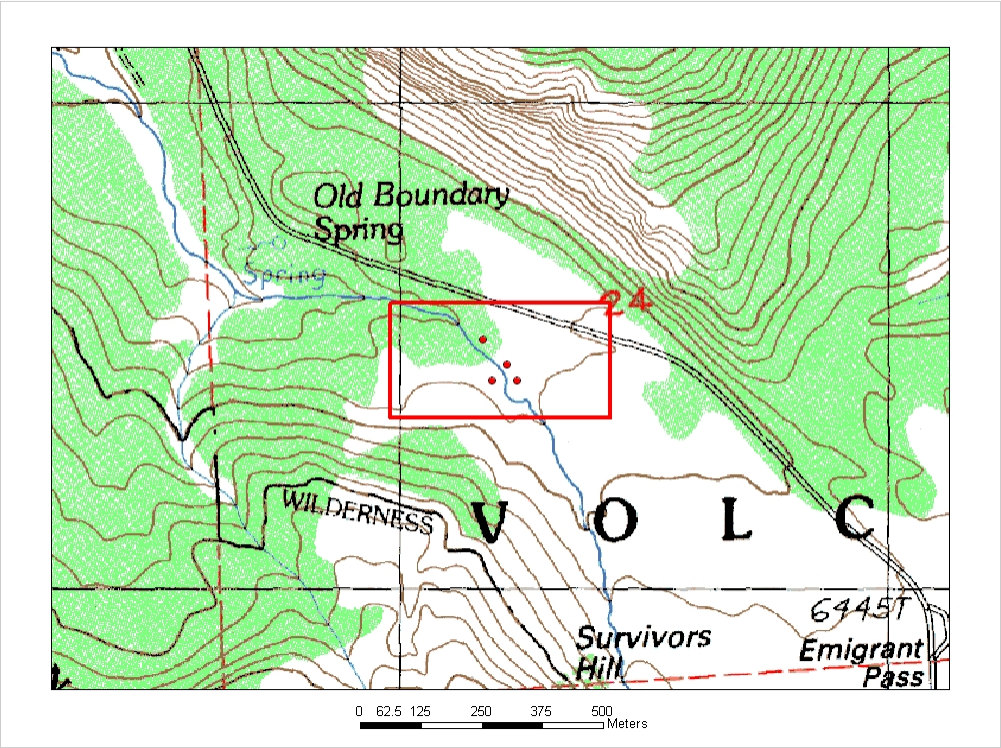
Forest 2 (F2) -- Climax Jeffrey pine.



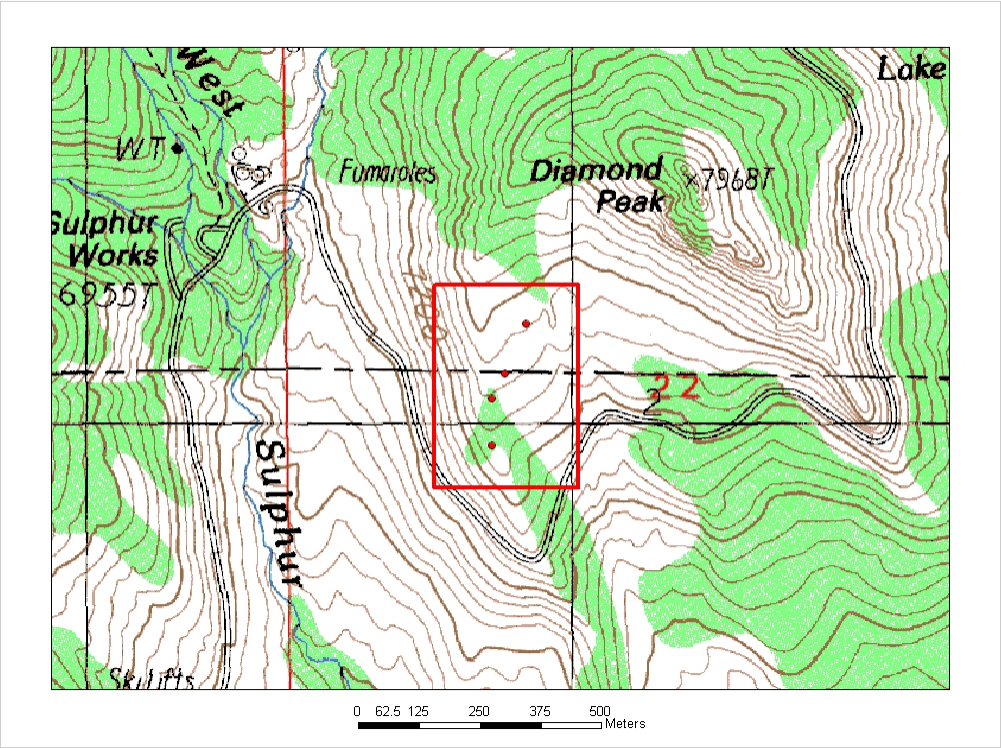
Riparian 1 (R1) -- Subalpine alder riparian.



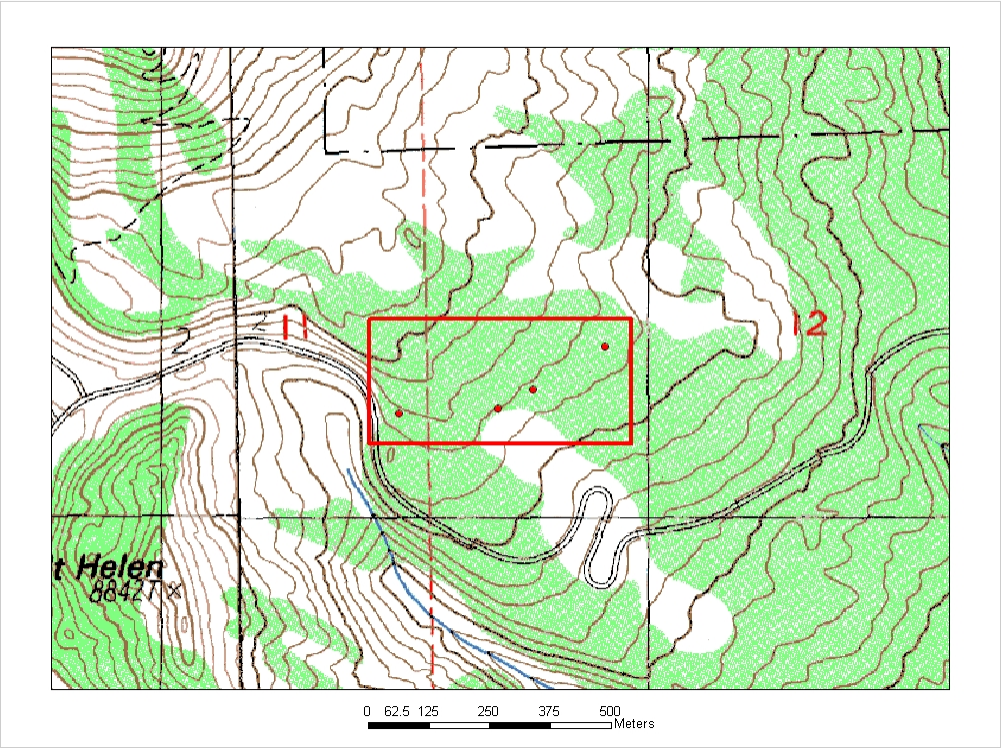
Riparian 2 (R2) -- Lowland riparian.



Subalpine 1 (S1) -- Subalpine parkland.



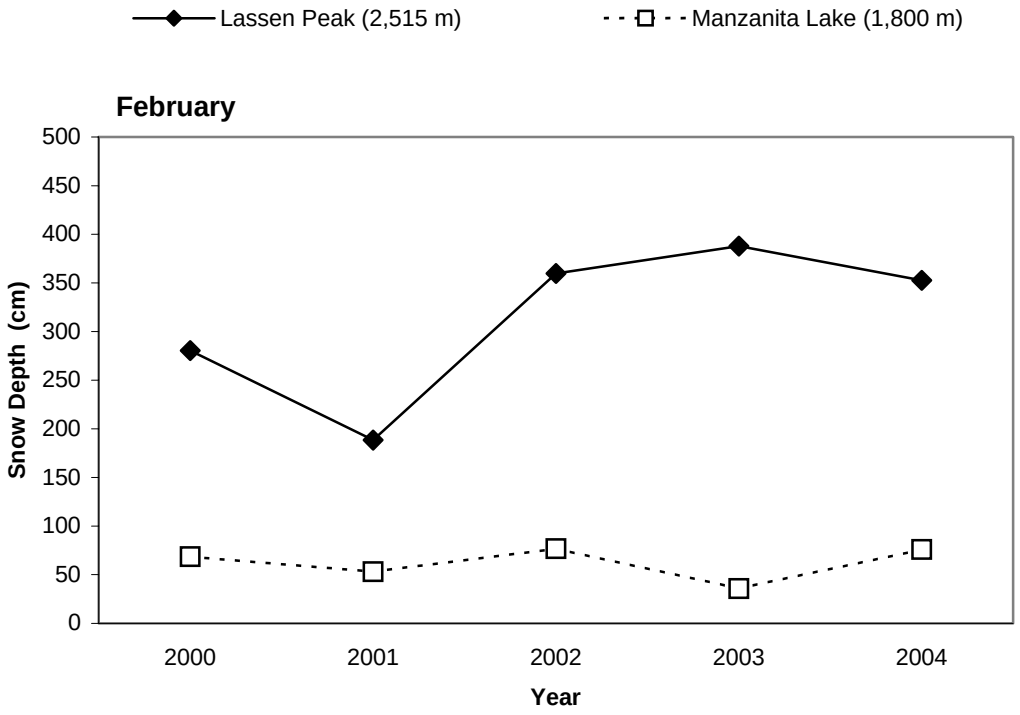
Subalpine 2 (S2) -- Subalpine woodland.



APPENDIX B:

WEATHER

Figure B1: Snow depth in February and April, prior to small vertebrate sampling in summer.



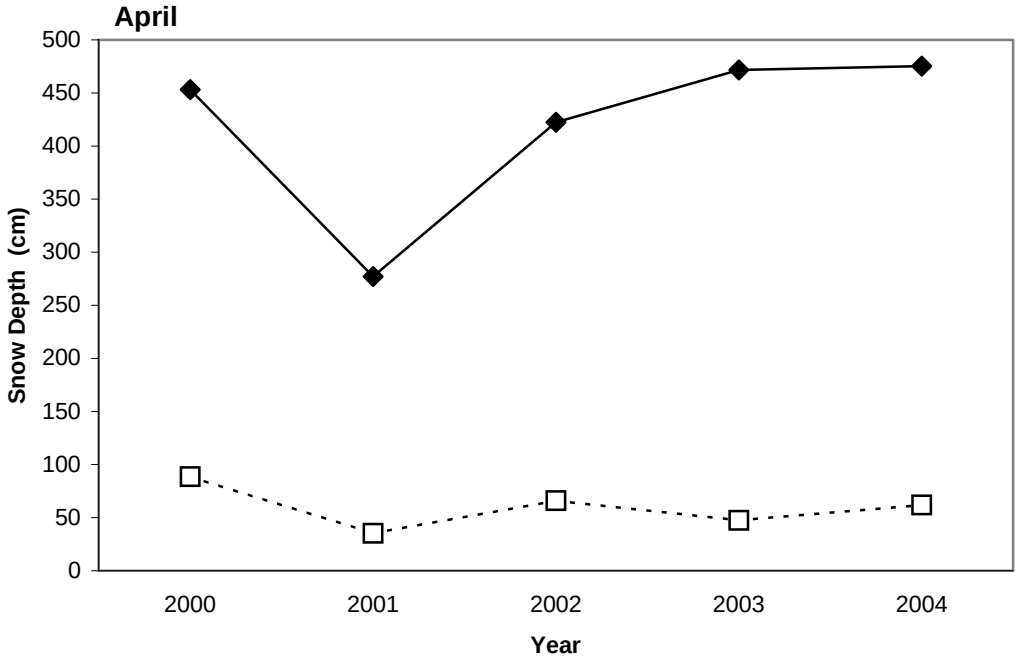
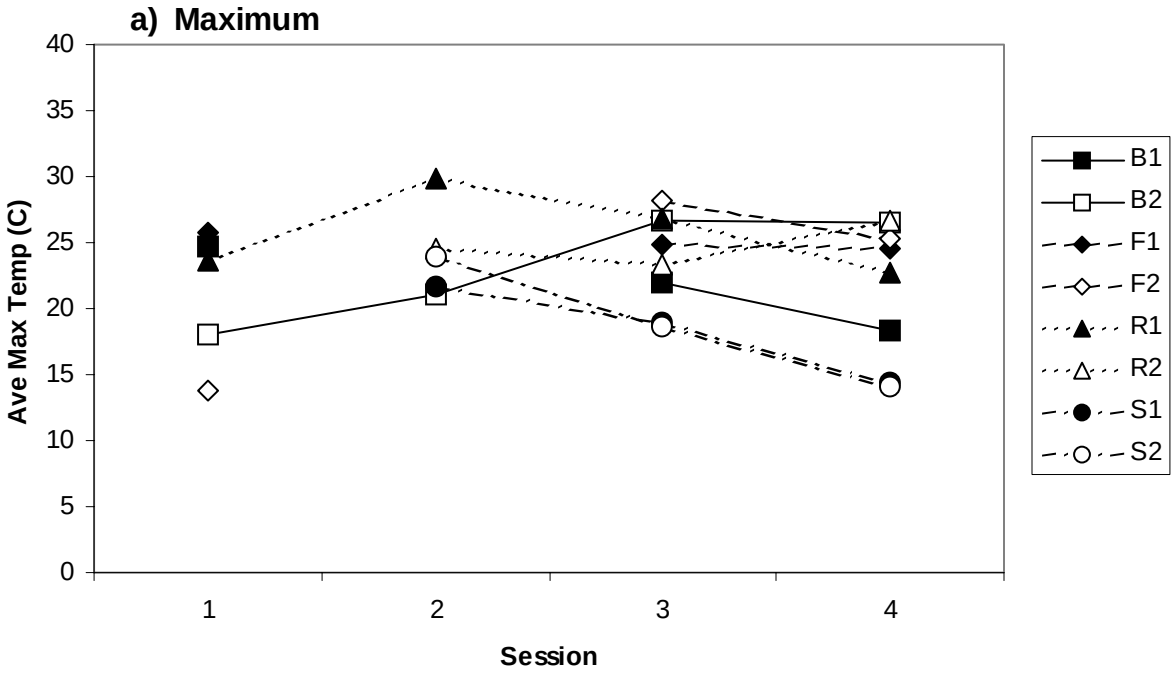


Figure B2: Average daily temperature maximum and minimum per sampling session in 2000. See Table A1 for dates of sampling sessions for each site.



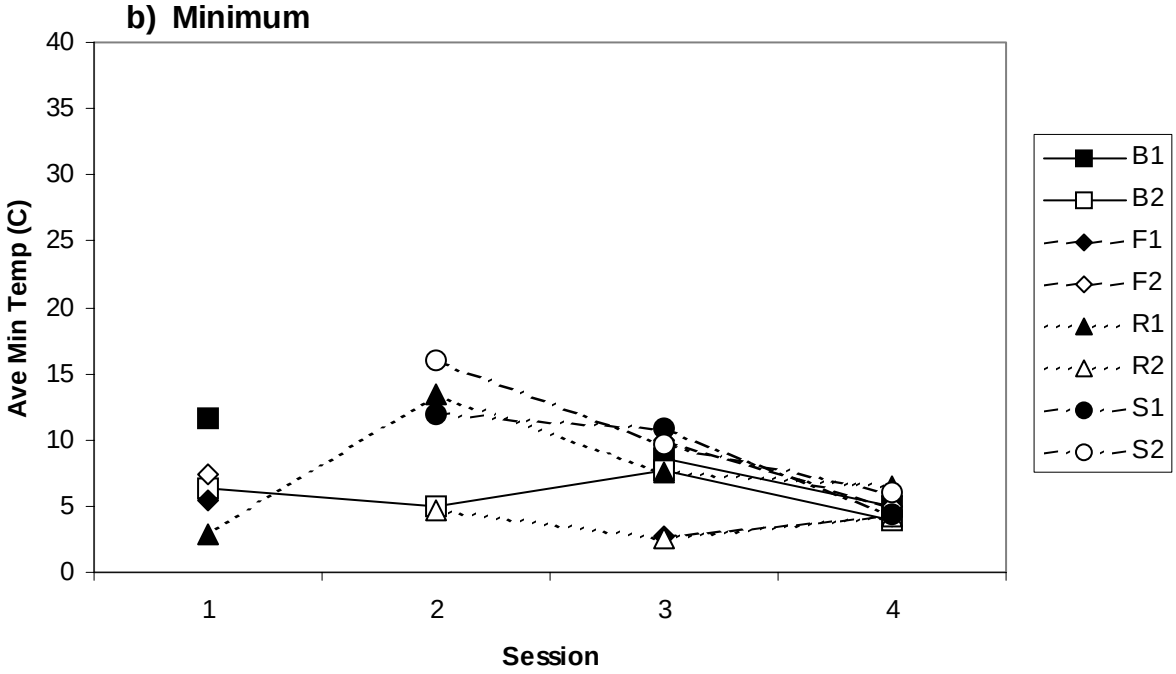
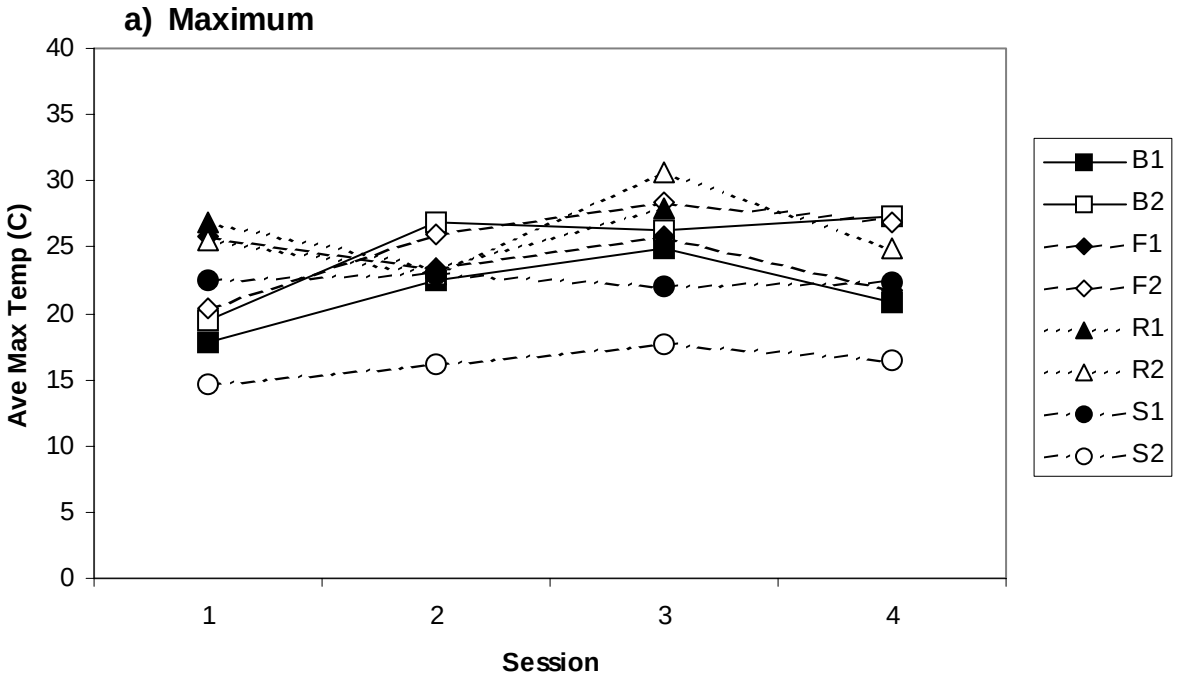


Figure B3: Average daily temperature maximum and minimum per sampling session in 2001.



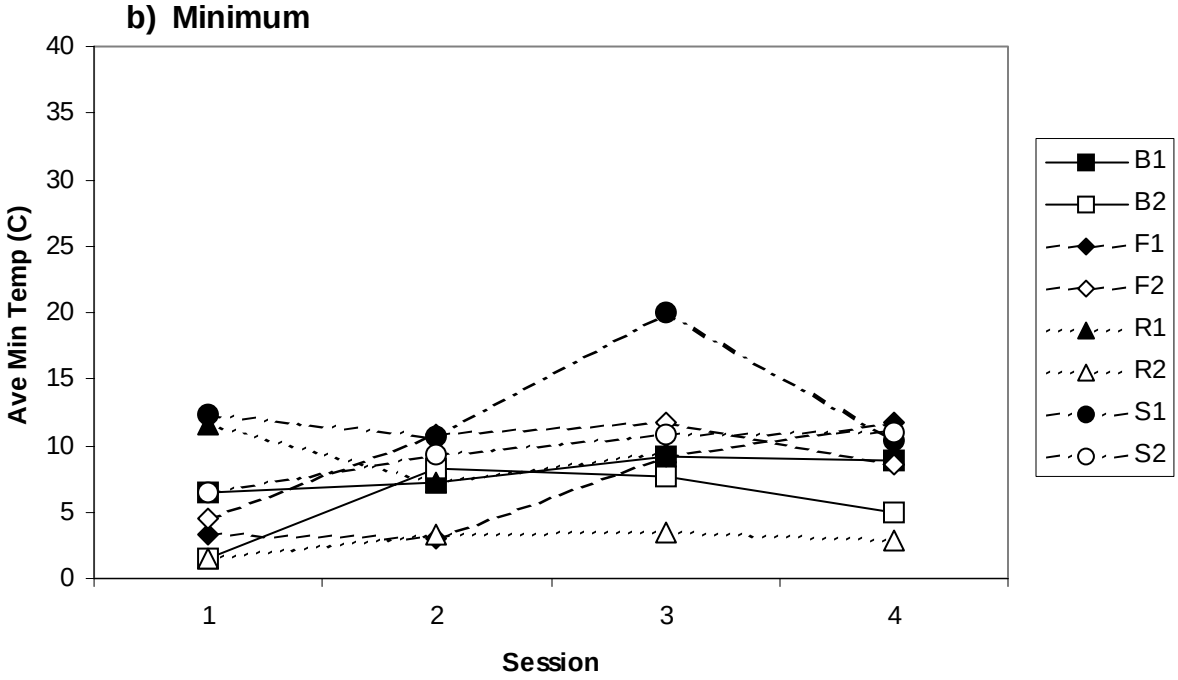
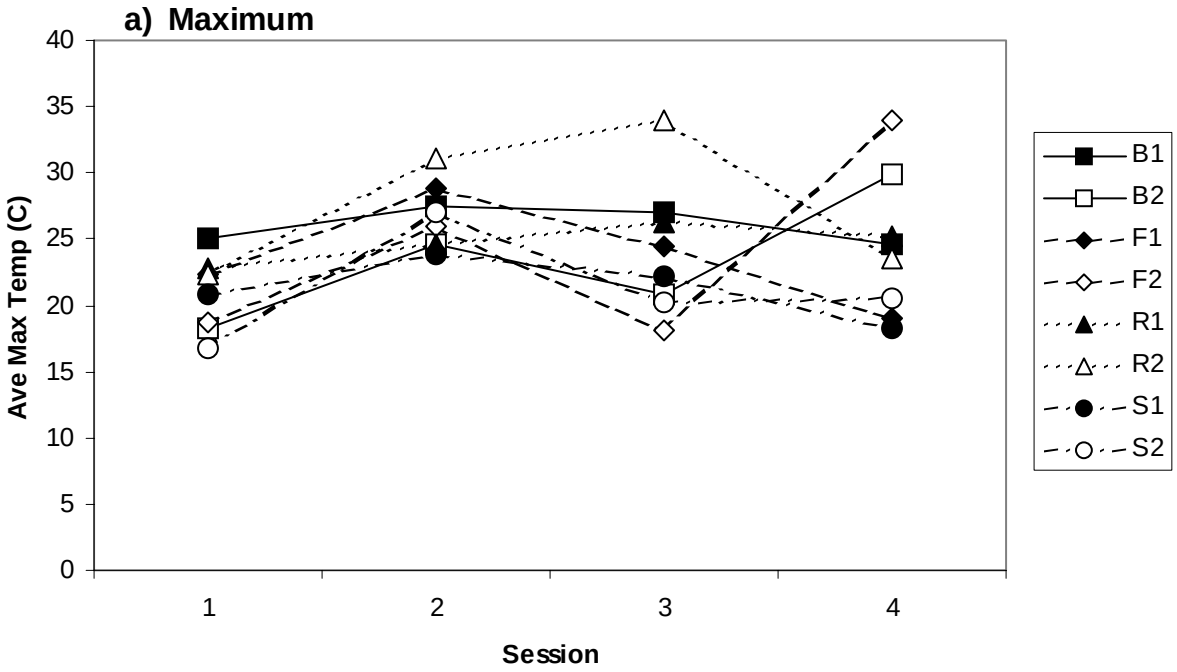


Figure B4: Average daily temperature maximum and minimum per sampling session in 2002.



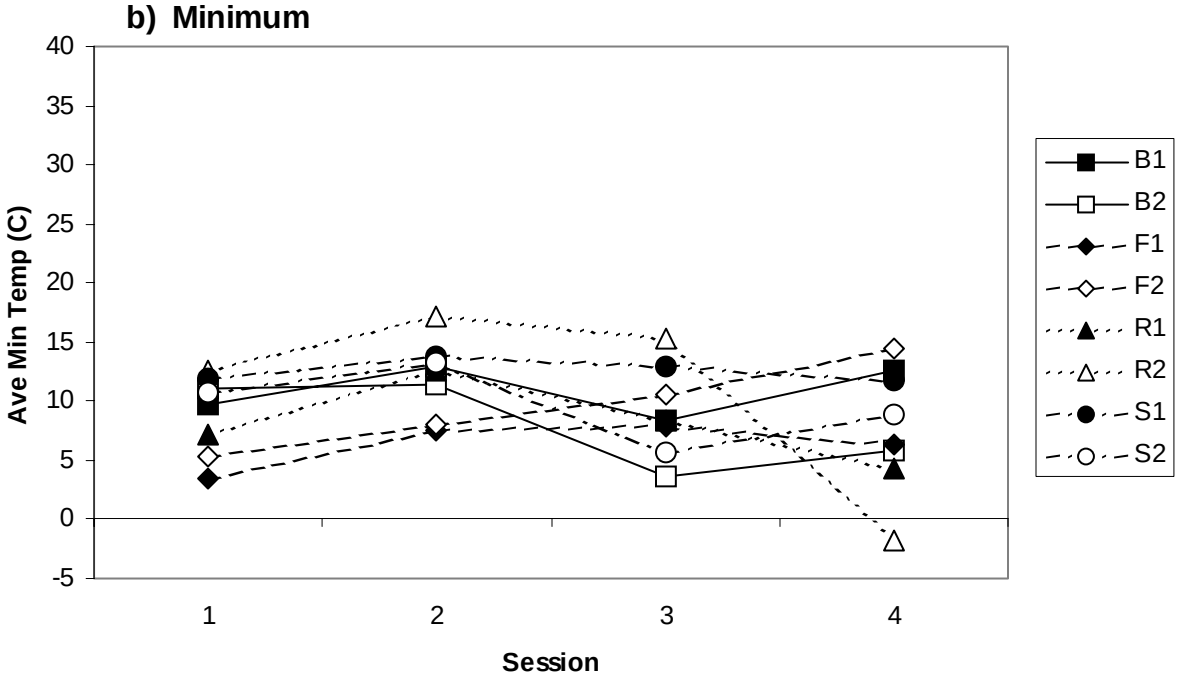


Figure B5: Average daily temperature maximum and minimum per sampling session in 2003.

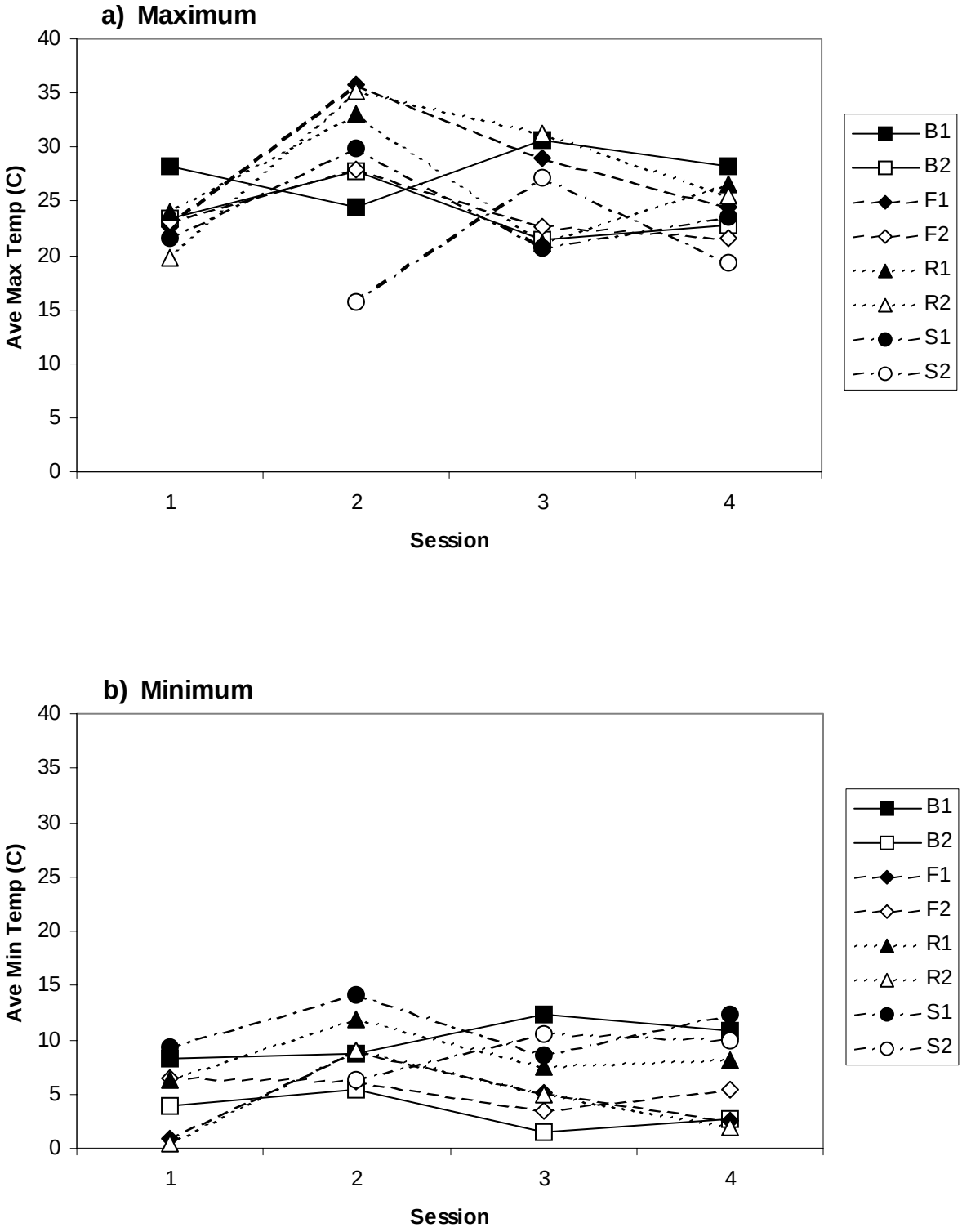
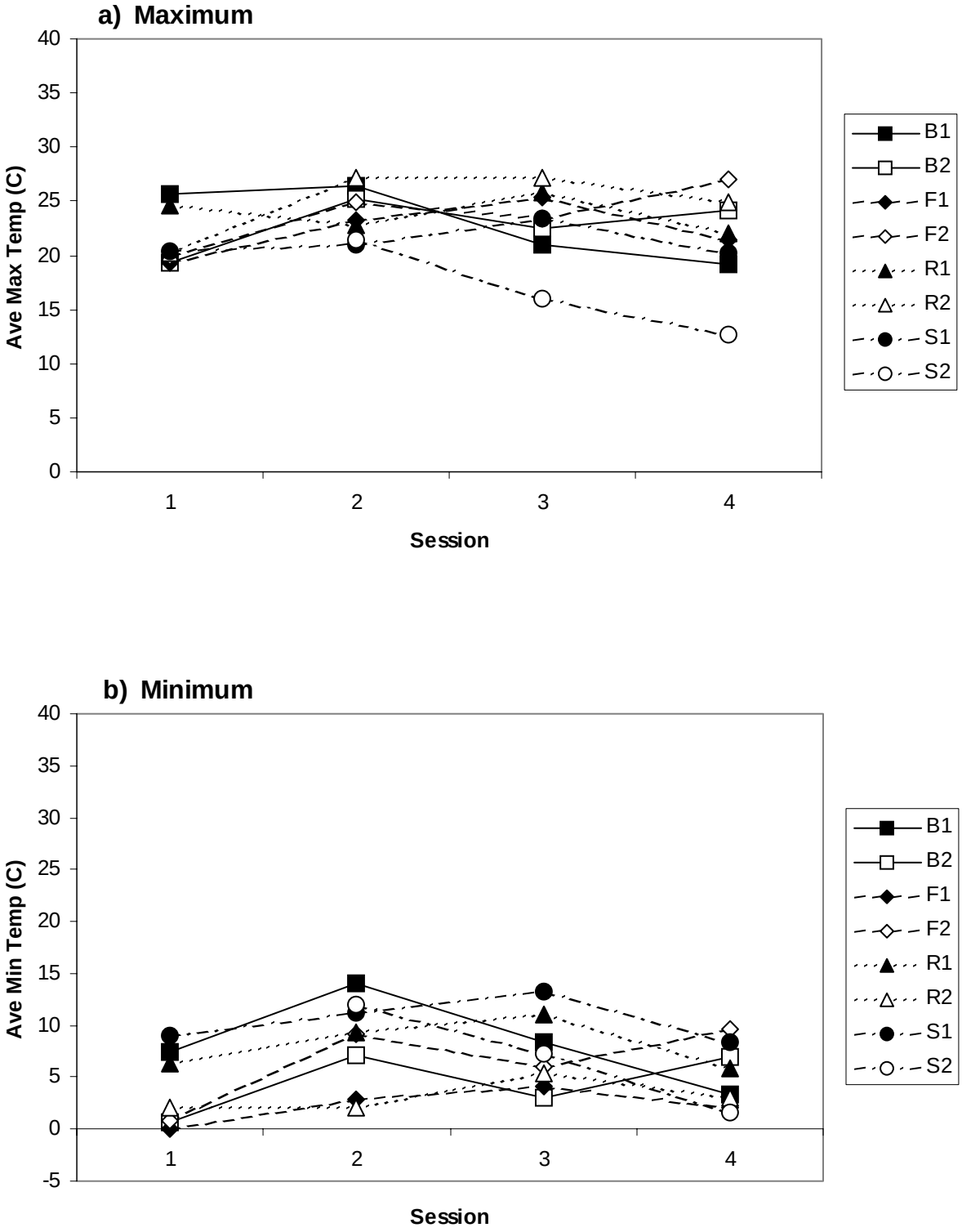


Figure B6: Average daily temperature maximum and minimum per sampling session in 2004.



APPENDIX C:

CAPTURES BY TRAP TYPE

Table C1: Total captures by trap type.

Species	Trap Type C	P	S	T	Other
Aplodontia rufa	-	-	-	2	-
Clethrionomys californicus	-	12	34	-	-
Glaucomys sabrinus	-	-	1	3	-
Microtus sp.	-	150	112	-	-
Mustela sp.	-	-	1	-	-
Neurotrichus gibbsii	-	1	-	-	-
Peromyscus maniculatus	21	520	4,949	-	1
Reithrodontomys megalotis	-	1	-	-	-
Scapanus latimanus	-	5	-	-	-
Sorex sp.	1	492	77	-	2
Spermophilus beecheyi	-	1	7	-	-
Spermophilus lateralis	-	2	204	12	-
Tamias sp.	-	9	4,512	1	2
Tamiasciurus douglasii	-	-	8	2	2
Thomomys monticola	-	291	4	-	4
Zapus princeps	-	94	271	-	1
subtotal:	22	1,578	10,180	20	12
Ambystoma macrodactylum	-	61	1	-	-
Bufo boreas	-	4	-	-	-
Ensatina eschscholtzii	-	2	-	-	-
Pseudacris regilla	5	12	-	-	1
subtotal:	5	79	1	0	1
Elgaria sp.	47	94	3	-	5
Sceloporus sp.	32	56	1	-	-
Thamnophis sp.	2	4	-	-	1
subtotal:	81	154	4	0	6
Total captures	103	1,732	10,184	20	18
Trap success *	0.0047	0.0673	0.4421	na	na

C = coverboard; P = pitfall; S = Sherman; T = Tomahawk

* captures per trap-night, based on five-year totals.

Note: Trap type was not specified for 7 mammal captures.

Table C2: Total captures by trap type by site.

Species	Site: / TrapType:	B1 C	B1 P	B1 S	B1 T	B2 C	B2 P	B2 S	B2 T	F1 C	F1 P	F1 S	F1 T	F2 C	F2 P	F2 S	F2 T
Aplodontia rufa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clethrionomys californicus		-	1	-	-	-	1	-	-	-	3	4	-	-	-	-	-
Glaucomys sabrinus		-	-	-	-	-	-	-	-	-	-	1	3	-	-	-	-
Microtus sp.		-	8	-	-	-	-	-	-	-	9	5	-		1	2	
Mustela sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neurotrichus gibbsii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peromyscus maniculatus		1	37	587	-	8	163	737	-	-	34	419	-	1	18	359	-
Reithrodontomys megalotis		-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Scapanus latimanus		-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Sorex sp.		-	60	4	-	-	35	-	-	-	36	23	-	-	24	15	-
Spermophilus beecheyi		-	-	-	-	-	1	6	-	-	-	-	-	-	-	1	-
Spermophilus lateralis		-	1	15	5	-	-	15	1	-	-	-	-	-	-	135	6
Tamias sp.		-	3	834	-	-	1	1,013	-	-	1	97	-	-	-	665	-
Tamiasciurus douglasii		-	-	2	-	-	-	-	-	-	-	2	2	-	-	2	-
Thomomys monticola		-	16	1	-	-	1	-	-	-	22	-	-	-	4	-	-
Zapus princeps		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	subtotal:	1	126	1,443	5	8	202	1,771	1	0	105	551	5	1	49	1,179	6
Ambystoma macrodactylum		-	2	-	-	-	19	-	-	-	17	-	-	-	23	1	-
Bufo boreas		-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ensatina eschscholtzii		-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Pseudacris regilla		-	-	-	-	-	-	-	-	2	-	-	-	1	5	-	-
	subtotal:	0	3	0	0	0	19	0	0	2	17	0	0	1	30	1	0
Elgaria sp.		-	1	-	-	8	28	1	-	-	-	-	-	-	4	-	-
Sceloporus sp.		-	-	-	-	4	21	-	-	-	-	-	-	-	4	-	-
Thamnophis sp.		-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-
	subtotal:	0	1	0	0	12	49	1	0	0	1	0	0	0	9	0	0
	Total:	1	130	1,443	5	20	270	1,772	1	2	123	551	5	2	88	1,180	6

C = coverboard; P = pitfall; S = Sherman; T = Tomahawk

Note: Captures at "Other" trap types have been omitted.

Table C2, continued.

Species	Site: / TrapType:	R1 C	R1 P	R1 S	R1 T	R2 C	R2 P	R2 S	R2 T	S1 C	S1 P	S1 S	S1 T	S2 C	S2 P	S2 S	S2 T
Aplodontia rufa		-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Clethrionomys californicus		-	3	16	-	-	2	14	-	-	1	-	-	-	1	-	-
Glaucomys sabrinus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microtus sp.		-	89	66	-	-	36	35	-	-	4	2	-	-	3	2	-
Mustela sp.		-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Neurotrichus gibbsii		-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Peromyscus maniculatus		8	146	790	-	3	67	745	-	-	23	652	-	-	32	660	-
Reithrodontomys megalotis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scapanus latimanus		-	2	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Sorex sp.		-	173	20	-	1	91	10	-	-	47	4	-	-	26	1	-
Spermophilus beecheyi		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spermophilus lateralis		-	-	-	-	-	-	3	-	-	-	5	-	-	1	31	-
Tamias sp.		-	-	13	-	-	2	467	1	-	2	784	-	-	-	639	-
Tamiasciurus douglasii		-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-
Thomomys monticola		-	103	2	-	-	45	-	-	-	52	-	-	-	48	1	-
Zapus princeps		-	92	183	-	-	-	87	-	-	2	1	-	-	-	-	-
	subtotal:	8	608	1,092	2	4	244	1,362	1	0	133	1,448	0	0	111	1,334	0
Ambystoma macrodactylum		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bufo boreas		-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-
Ensatina eschscholtzii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudacris regilla		-	2	-	-	2	-	-	-	-	4	-	-	-	1	-	-
	subtotal:	0	3	0	0	2	1	0	0	0	4	0	0	0	2	0	0
Elgaria sp.		20	23	1	-	12	17	-	-	7	21	1	-	-	-	-	-
Sceloporus sp.		-	1	-	-	28	29	1	-	-	-	-	-	-	1	-	-
Thamnophis sp.		-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-
	subtotal:	20	24	1	0	42	48	1	0	7	21	1	0	0	1	0	0
	Total:	28	635	1,093	2	48	293	1,363	1	7	158	1,449	0	0	114	1,334	0

C = coverboard; P = pitfall; S = Sherman; T = Tomahawk

Note: Captures at "Other" trap types have been omitted.

Table C3: Total captures by trap type by site and year. These totals are not comparable to those in the Species Accounts, where recaptures have been removed.

Site: B1

Species	Year:	2000				2001				2002				2003				2004			
	TrapType:	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T
Aplodontia rufa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clethrionomys californicus		-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glaucomys sabrinus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microtus sp.		-	1	-	-	-	4	-	-	-	-	-	-	-	1	-	-	-	2	-	-
Mustela sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neurotrichus gibbsii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peromyscus maniculatus		-	4	32	-	-	-	35	-	1	14	267	-	-	5	13	-	-	14	240	-
Reithrodontomys megalotis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scapanus latimanus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sorex sp.		-	13	1	-	-	11	1	-	-	16	2	-	-	5	-	-	-	15	-	-
Spermophilus beecheyi		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spermophilus lateralis		-	-	1	-	-	-	4	-	-	-	3	5	-	-	5	-	-	1	2	-
Tamias sp.		-	1	124	-	-	-	134	-	-	2	265	-	-	-	127	-	-	-	184	-
Tamiasciurus douglasii		-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thomomys monticola		-	-	-	-	-	1	1	-	-	4	-	-	-	1	-	-	-	10	-	-
Zapus princeps		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ambystoma macrodactylum		-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Bufo boreas		-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ensatina eschscholtzii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudacris regilla		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Elgaria sp.		-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sceloporus sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thamnophis sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C3, continued.

Site: B2

Species	Year:	2000				2001				2002				2003				2004			
	TrapType:	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T
Aplodontia rufa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clethrionomys californicus		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Glaucomys sabrinus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microtus sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mustela sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neurotrichus gibbsii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peromyscus maniculatus		-	1	36	-	2	3	128	-	-	69	201	-	1	7	30	-	5	83	342	-
Reithrodontomys megalotis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scapanus latimanus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sorex sp.		-	3	-	-	-	3	-	-	-	5	-	-	-	4	-	-	-	20	-	-
Spermophilus beecheyi		-	-	-	-	-	1	-	-	-	-	-	-	-	-	6	-	-	-	-	-
Spermophilus lateralis		-	-	9	-	-	-	1	-	-	-	5	1	-	-	-	-	-	-	-	-
Tamias sp.		-	-	105	-	-	-	233	-	-	-	257	-	-	-	162	-	-	1	256	-
Tamiasciurus douglasii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thomomys monticola		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Zapus princeps		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ambystoma macrodactylum		-	13	-	-	-	2	-	-	-	-	-	-	-	2	-	-	-	2	-	-
Bufo boreas		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ensatina eschscholtzii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudacris regilla		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Elgaria sp.		-	8	-	-	1	7	-	-	5	4	-	-	-	3	1	-	2	6	-	-
Sceloporus sp.		-	1	-	-	-	6	-	-	3	2	-	-	1	10	-	-	-	2	-	-
Thamnophis sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C3, continued.

Site: F1

Species	Year:	2000				2001				2002				2003				2004			
	TrapType:	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T
Aplodontia rufa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clethrionomys californicus		-	-	-	-	-	1	-	-	-	-	1	-	-	1	2	-	-	1	1	-
Glaucomys sabrinus		-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	1	-
Microtus sp.		-	1	-	-	-	6	2	-	-	1	3	-	-	1	-	-	-	-	-	-
Mustela sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neurotrichus gibbsii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peromyscus maniculatus		-	-	1	-	-	-	2	-	-	11	197	-	-	3	-	-	-	20	219	-
Reithrodontomys megalotis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scapanus latimanus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sorex sp.		-	5	5	-	-	6	5	-	-	6	5	-	-	10	1	-	-	9	7	-
Spermophilus beecheyi		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spermophilus lateralis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tamias sp.		-	1	4	-	-	-	4	-	-	-	50	-	-	-	4	-	-	-	35	-
Tamiasciurus douglasii		-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	1	-
Thomomys monticola		-	2	-	-	-	9	-	-	-	3	-	-	-	4	-	-	-	4	-	-
Zapus princeps		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ambystoma macrodactylum		-	7	-	-	-	6	-	-	-	2	-	-	-	2	-	-	-	-	-	-
Bufo boreas		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ensatina eschscholtzii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudacris regilla		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Elgaria sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sceloporus sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thamnophis sp.		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-

Table C3, continued.

Site: F2

Species	Year:	2000				2001				2002				2003				2004			
	TrapType:	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T
Aplodontia rufa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clethrionomys californicus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glaucomys sabrinus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microtus sp.		-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-
Mustela sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neurotrichus gibbsii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peromyscus maniculatus		-	2	20	-	-	-	41	-	-	13	156	-	-	2	15	-	1	1	127	-
Reithrodontomys megalotis		-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scapanus latimanus		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Sorex sp.		-	8	1	-	-	2	-	-	-	2	3	-	-	2	-	-	-	10	11	-
Spermophilus beecheyi		-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spermophilus lateralis		-	-	23	-	-	-	22	6	-	-	34	-	-	-	24	-	-	-	32	-
Tamias sp.		-	-	92	-	-	-	66	-	-	-	229	-	-	-	91	-	-	-	187	-
Tamiasciurus douglasii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
Thomomys monticola		-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zapus princeps		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ambystoma macrodactylum		-	19	1	-	-	-	-	-	-	-	-	-	-	3	-	-	-	1	-	-
Bufo boreas		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ensatina eschscholtzii		-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudacris regilla		-	1	-	-	-	-	-	-	-	-	-	-	-	3	-	-	1	1	-	-
Elgaria sp.		-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	2	-	-
Sceloporus sp.		-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1	-	-
Thamnophis sp.		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-

Table C3, continued.

Site: R1

Species	Year:	2000				2001				2002				2003				2004			
	TrapType:	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T
Aplodontia rufa		-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-
Clethrionomys californicus		-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2	16	-
Glaucomys sabrinus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microtus sp.		-	14	14	-	-	44	17	-	-	18	12	-	-	2	-	-	-	11	23	-
Mustela sp.		-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Neurotrichus gibbsii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peromyscus maniculatus		-	3	95	-	-	21	77	-	1	54	255	-	1	7	50	-	6	61	313	-
Reithrodontomys megalotis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scapanus latimanus		-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Sorex sp.		-	46	-	-	-	34	6	-	-	38	4	-	-	21	1	-	-	34	9	-
Spermophilus beecheyi		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spermophilus lateralis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tamias sp.		-	-	-	-	-	-	-	-	-	-	3	-	-	-	7	-	-	-	3	-
Tamiasciurus douglasii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Thomomys monticola		-	5	-	-	-	25	-	-	-	37	-	-	-	18	1	-	-	18	1	-
Zapus princeps		-	1	19	-	-	30	76	-	-	13	26	-	-	18	50	-	-	30	12	-
Ambystoma macrodactylum		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bufo boreas		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Ensatina eschscholtzii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudacris regilla		-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Elgaria sp.		3	11	-	-	5	2	-	-	3	4	-	-	3	5	-	-	6	1	1	-
Sceloporus sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Thamnophis sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C3, continued.

Site: R2

Species	Year:	2000				2001				2002				2003				2004			
	TrapType:	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T
Aplodontia rufa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clethrionomys californicus		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	14	-
Glaucomys sabrinus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microtus sp.		-	7	12	-	-	3	2	-	-	16	19	-	-	4	-	-	-	6	2	-
Mustela sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neurotrichus gibbsii		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Peromyscus maniculatus		-	4	79	-	-	-	56	-	1	3	223	-	-	4	32	-	2	56	355	-
Reithrodontomys megalotis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scapanus latimanus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sorex sp.		-	17	5	-	-	3	-	-	-	19	-	-	-	17	1	-	1	35	4	-
Spermophilus beecheyi		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spermophilus lateralis		-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
Tamias sp.		-	-	55	-	-	-	77	1	-	2	158	-	-	-	49	-	-	-	128	-
Tamiasciurus douglasii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Thomomys monticola		-	3	-	-	-	4	-	-	-	13	-	-	-	9	-	-	-	16	-	-
Zapus princeps		-	-	9	-	-	-	24	-	-	-	30	-	-	-	20	-	-	-	4	-
Ambystoma macrodactylum		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bufo boreas		-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Ensatina eschscholtzii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudacris regilla		-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Elgaria sp.		-	3	-	-	4	5	-	-	4	2	-	-	2	3	-	-	2	4	-	-
Sceloporus sp.		2	5	-	-	2	3	-	-	5	7	-	-	8	5	1	-	11	9	-	-
Thamnophis sp.		-	-	-	-	-	1	-	-	-	1	-	-	2	-	-	-	-	-	-	-

Table C3, continued.

Site: S1

Species	Year:	2000				2001				2002				2003				2004			
	TrapType:	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T
Aplodontia rufa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clethrionomys californicus		-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glaucomys sabrinus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microtus sp.		-	1	-	-	-	1	2	-	-	1	-	-	-	-	-	-	-	1	-	-
Mustela sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neurotrichus gibbsii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peromyscus maniculatus		-	1	43	-	-	2	61	-	-	2	253	-	-	-	15	-	-	18	280	-
Reithrodontomys megalotis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scapanus latimanus		-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-
Sorex sp.		-	2	1	-	-	12	3	-	-	15	-	-	-	9	-	-	-	9	-	-
Spermophilus beecheyi		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spermophilus lateralis		-	-	1	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	2	-
Tamias sp.		-	-	137	-	-	-	169	-	-	1	221	-	-	1	129	-	-	-	128	-
Tamiasciurus douglasii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thomomys monticola		-	8	-	-	-	19	-	-	-	1	-	-	-	12	-	-	-	12	-	-
Zapus princeps		-	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Ambystoma macrodactylum		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bufo boreas		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ensatina eschscholtzii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudacris regilla		-	1	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
Elgaria sp.		-	2	-	-	-	5	-	-	3	5	1	-	1	3	-	-	3	6	-	-
Sceloporus sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thamnophis sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C3, continued.

Site: S2

Species	Year:	2000				2001				2002				2003				2004			
	TrapType:	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T	C	P	S	T
Aplodontia rufa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clethrionomys californicus		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Glaucomys sabrinus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Microtus sp.		-	-	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-	-	-	-
Mustela sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neurotrichus gibbsii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peromyscus maniculatus		-	2	63	-	-	-	49	-	-	16	307	-	-	1	11	-	-	13	230	-
Reithrodontomys megalotis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scapanus latimanus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sorex sp.		-	5	-	-	-	3	1	-	-	3	-	-	-	3	-	-	-	12	-	-
Spermophilus beecheyi		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spermophilus lateralis		-	1	5	-	-	-	8	-	-	-	9	-	-	-	8	-	-	-	1	-
Tamias sp.		-	-	96	-	-	-	154	-	-	-	166	-	-	-	112	-	-	-	111	-
Tamiasciurus douglasii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thomomys monticola		-	11	-	-	-	14	-	-	-	11	-	-	-	6	-	-	-	6	1	-
Zapus princeps		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ambystoma macrodactylum		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bufo boreas		-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ensatina eschscholtzii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudacris regilla		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Elgaria sp.		-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sceloporus sp.		-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Thamnophis sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX D:

VOUCHER SPECIMENS

Table D1: Voucher specimens per site, including captures from 1999.

Species	B1	B2	F1	F2	R1	R2	S1	S2	Total
Aplondontia rufa	-	-	-	-	1	-	-	-	1
Clethrionomys californicus	1	-	4	-	-	-	1	-	6
Glaucomys sabrinus	-	-	1	-	-	-	-	-	1
Microtus longicaudus	-	-	-	-	19	3	1	-	23
Microtus montanus	-	-	1	-	6	3	-	1	11
Neurotrichus gibbsii	-	-	-	-	-	1	-	-	1
Peromyscus maniculatus	12	70	10	7	52	31	24	38	244
Scapanus latimanus	-	-	-	-	1	-	1	-	2
Sorex palustris	-	-	1	-	2	1	-	-	4
Sorex preblei	10	-	-	-	-	-	-	3	13
Sorex tenellus	2	-	-	-	1	-	-	2	5
Sorex trowbridgii	10	9	27	27	21	23	19	7	143
Sorex vagrans	5	7	1	1	44	17	-	3	78
Spermophilus lateralis	1	1	-	-	-	-	-	1	3
Tamias amoenus	6	21	-	-	-	5	3	1	36
Tamias senex	-	10	2	2	-	-	1	-	15
Tamias speciosus	11	1	-	2	-	-	6	2	22
Thomomys monticola	-	-	1	1	10	3	4	3	22
Zapus princeps	-	-	-	-	10	-	-	-	10
Ambystoma macrodactylum	-	-	1	-	-	-	-	-	1
Elgaria coerulea	-	1	-	-	3	-	2	-	6
Sceloporus graciosus	-	1	-	-	-	1	-	-	2

Table D2: Voucher specimens by site by year.

Year	Species	B1	B2	F1	F2	R1	R2	S1	S2	Total
1999	*Peromyscus maniculatus*	-	-	-	-	-	-	1	1	2
	Sorex tenellus	1	-	-	-	-	-	-	2	3
	Sorex trowbridgii	-	-	-	-	1	-	-	-	1
	Tamias amoenus	-	-	-	-	-	-	1	-	1
	Tamias speciosus	1	-	-	-	-	-	-	-	1
2000	*Microtus longicaudus*	-	-	-	-	8	-	1	-	9
	Peromyscus maniculatus	1	1	-	1	6	4	3	5	21
	Scapanus latimanus	-	-	-	-	1	-	-	-	1
	Sorex palustris	-	-	-	-	1	1	-	-	2
	Sorex preblei	2	-	-	-	-	-	-	-	2
	Sorex tenellus	1	-	-	-	-	-	-	-	1
	Sorex trowbridgii	4	1	3	7	6	5	2	1	29
	Sorex vagrans	4	1	-	1	20	8	-	1	35
	Tamias amoenus	1	5	-	-	-	1	-	-	7
	Tamias senex	-	1	1	1	-	-	-	-	3
	Tamias speciosus	-	1	-	2	-	-	-	-	3
	Thomomys monticola	-	-	-	-	1	1	-	1	3
2001	*Clethrionomys californicus*	1	-	1	-	-	-	1	-	3
	Microtus longicaudus	-	-	-	-	7	-	-	-	7
	Peromyscus maniculatus	-	8	1	-	5	2	3	3	22
	Sorex preblei	1	-	-	-	-	-	-	-	1
	Sorex tenellus	-	-	-	-	1	-	-	-	1
	Sorex trowbridgii	1	1	6	1	3	1	2	-	15
	Sorex vagrans	1	-	-	-	3	1	-	-	5
	Tamias amoenus	-	5	-	-	-	-	-	-	5
	Tamias senex	-	1	1	-	-	-	-	-	2
	Tamias speciosus	-	-	-	-	-	-	2	1	3
	Thomomys monticola	-	-	1	1	2	-	1	2	7
	Zapus princeps	-	-	-	-	2	-	-	-	2
	Elgaria coerulea	-	-	-	-	1	-	1	-	2
	Sceloporus graciosus	-	1	-	-	-	1	-	-	2

(continued on next page)

Table D2, continued.

Year	Species	B1	B2	F1	F2	R1	R2	S1	S2	Total
2002	*Microtus montanus*	-	-	1	-	6	3	-	1	11
	Neurotrichus gibbsii	-	-	-	-	-	1	-	-	1
	Peromyscus maniculatus	5	30	2	4	18	7	13	5	84
	Sorex palustris	-	-	-	-	1	-	-	-	1
	Sorex preblei	2	-	-	-	-	-	-	1	3
	Sorex trowbridgii	4	2	5	4	4	4	5	1	29
	Sorex vagrans	-	2	-	-	8	1	-	1	12
	Spermophilus lateralis	1	1	-	-	-	-	-	1	3
	Tamias amoenus	3	7	-	-	-	2	1	-	13
	Tamias senex	-	4	-	1	-	-	1	-	6
	Tamias speciosus	7	-	-	-	-	-	2	-	9
	Thomomys monticola	-	-	-	-	3	-	-	-	3
	Zapus princeps	-	-	-	-	1	-	-	-	1
	Ambystoma macrodactylum	-	-	1	-	-	-	-	-	1
	Elgaria coerulea	-	-	-	-	1	-	-	-	1
2003	*Aplondontia rufa*	-	-	-	-	1	-	-	-	1
	Clethrionomys californicus	-	-	2	-	-	-	-	-	2
	Peromyscus maniculatus	-	5	-	-	3	-	-	-	8
	Scapanus latimanus	-	-	-	-	-	-	1	-	1
	Sorex palustris	-	-	1	-	-	-	-	-	1
	Sorex preblei	1	-	-	-	-	-	-	1	2
	Sorex trowbridgii	-	1	5	1	1	2	6	-	16
	Sorex vagrans	-	1	-	-	8	3	-	1	13
	Tamias amoenus	1	1	-	-	-	1	-	-	3
	Tamias speciosus	2	-	-	-	-	-	-	1	3
	Thomomys monticola	-	-	-	-	3	2	3	-	8
	Zapus princeps pacificus	-	-	-	-	4	-	-	-	4
	Elgaria coerulea	-	1	-	-	1	-	1	-	3
2004	*Clethrionomys californicus*	-	-	1	-	-	-	-	-	1
	Glaucomys sabrinus	-	-	1	-	-	-	-	-	1
	Microtus longicaudus	-	-	-	-	4	3	-	-	7
	Peromyscus maniculatus	6	26	7	2	20	18	4	24	107
	Sorex preblei	4	-	-	-	-	-	-	1	5
	Sorex trowbridgii	1	4	8	14	6	11	4	5	53
	Sorex vagrans	-	3	1	-	5	4	-	-	13
	Tamias amoenus	1	3	-	-	-	1	1	1	7
	Tamias senex	-	4	-	-	-	-	-	-	4
	Tamias speciosus	1	-	-	-	-	-	2	-	3
	Thomomys monticola	-	-	-	-	1	-	-	-	1
	Zapus princeps	-	-	-	-	3	-	-	-	3

APPENDIX E:

ASSESSMENTS OF FIELD DATA ACCURACY

Clearly, the results in this report are contingent upon correct identifications in the field. The voucher specimens, which were independently identified by experts at the MVZ, allow the accuracy of the field identifications to be assessed (Table E1). Problematic taxa are discussed in the body of this report.

Because individual animals were tagged, their capture histories revealed what proportion of these individuals were identified as a different species upon recapture (Table E2). Note that this tally does not indicate the *true* identity of these individuals (accuracy), but it does indicate which taxa were frequently confused in the field (precision). Similarly, these capture histories also revealed the proportion of individuals identified as a different sex upon recapture (Table E3).

These three analyses provide caveats for the data analyses and indicate that a more conservative taxonomy was necessary in some contexts. They also illustrate the difficulty of conducting a multi-year, multi-species study without a resident staff of taxonomic experts. Many studies fail to explicitly disclose these error rates, but they are vital for proper interpretation of the results. They also suggest avenues for improvement should this monitoring program be continued into the future.

Table E1: How accurate were the field identifications of the voucher specimens?

Field ID (when collected) *	**vouchers**	**# wrong**	**% wrong**	**Comment**
Aplodontia rufa	1	0	0.0%	
Clethrionomys californicus	7	1	14.3%	1 was *M. longicaudus* (2004).
Clethrionomys sp. **	1	1	100.0%	1 was *M. montanus* (2002).
Glaucomys sabrinus	1	0	0.0%	
Microtus longicaudus	21	4	19.0%	4 were *M. montanus* (2002).
Microtus montanus	7	3	42.9%	3 were *M. longicaudus* (2000, 2001, 2004).
Microtus sp. **	4	4	100.0%	2 were *M. longicaudus*; 2 were *M. montanus*.
Neurotrichus gibbsii	1	0	0.0%	
Peromyscus maniculatus	244	0	0.0%	3 of these individuals were identified as *P. boylii* at prior capture events (2000).
Scapanus latimanus	2	0	0.0%	
Sorex monticolus	11	11	100.0%	9 were *S. trowbridgii* (2000, 2001); 2 were *S. vagrans* (2001).
Sorex palustris	3	0	0.0%	
Sorex trowbridgii	20	2	10.0%	1 was *S. tenellus* (2001); 1 was *S. vagrans* (2001).
Sorex vagrans	57	20	35.1%	17 were *S. trowbridgii* (2000, 2001); 2 were *S. preblei* (2000); 1 was *S. tenellus* (2000) .
Sorex sp. **	152	152	100.0%	99 were *S. trowbridgii*; 38 were *S. vagrans*; 11 were *S. preblei*; 3 were *S. tenellus*; 1 was *S. palustris*.
Spermophilus lateralis	3	0	0.0%	
Tamias amoenus	35	5	14.3%	5 were *T. speciosus* (2001, 2004).
Tamias senex	16	1	6.3%	1 was *T. speciosus* (2000).
Tamias speciosus	15	2	13.3%	2 were *T. amoenus* (2003, 2004).
Tamias sp. **	7	7	100.0%	4 were *T. amoenus*; 3 were *T. speciosus.*
Thomomys monticola	22	0	0.0%	
Zapus princeps	10	0	0.0%	
Ambystoma macrodactylum	1	0	0.0%	
Elgaria coerulea	5	0	0.0%	
Elgaria sp. **	1	1	100.0%	1 was *E. coerulea.*
Sceloporus graciosus	2	0	0.0%	

* Prior to becoming a voucher, some individuals were captured multiple times, and some received >1 field IDs. (See *P. maniculatus*.)

** Any field ID of "sp." was considered wrong by definition.

Note: Individual species totals are not comparable with the voucher tables in Appendix D, as those contain the *true* IDs, whereas these are *putative* IDs. The total number of voucher specimens, however, is the same. Species with no voucher specimens could not be assessed.

Table E2: What proportion of individuals were identified as a different species upon recapture? See Species Accounts for details.

Species	Tagged Indivs with recaptures	Indivs identified as >1 species	Error rate	Error Types * A	B	C	D
Clethrionomys californicus	5	**3**	60.0%	-	-	3	-
Microtus sp.	39	**2**	5.1%	-	-	2	-
Peromyscus maniculatus	1082	**8**	0.7%	5	3	-	-
Spermophilus beecheyi	1	0	0.0%	-	-	-	-
Spermophilus lateralis	47	0	0.0%	-	-	-	-
Tamias sp.	782	**209**	26.7%	93	91	-	25
Thomomys monticola	37	0	0.0%	-	-	-	-
Zapus princeps	51	0	0.0%	-	-	-	-
Ambystoma macrodactylum	2	0	0.0%	-	-	-	-
Ensatina eschscholtzii	1	0	0.0%	-	-	-	-
Pseudacris regilla	2	0	0.0%	-	-	-	-
Elgaria sp.	15	**5**	33.3%	2	3	-	-
Sceloporus sp.	8	0	0.0%	-	-	-	-

* Error Types:
A = identified as a species and as "sp."
B = identified as >1 species within the genus
C = identified as >1 genera
D = combinations of the above.

Note: These are counts of individuals, not of capture events. All individuals in this table were captured multiple times. The totals in column 1 of this table are not comparable with column 3 in Table 3, which has the sum of capture events, not individuals.

Note: This table does not indicate whether the field ID was *correct* ; only a comparison with voucher ID can indicate that. Rather, this table indicates the *consistency* of the field ID across multiple captures (precision). Inconsistent IDs suggest confusion among taxa.

Table E3: How frequently was the same individual identified as a different sex upon recapture?

Species	Tagged Indivs with recaptures	Indivs identified as both Male and Female	percentage
Clethrionomys californicus	5	1	20.0%
Microtus sp.	39	3	7.7%
Peromyscus maniculatus	1082	89	8.2%
Spermophilus beecheyi	1	0	0.0%
Spermophilus lateralis	47	5	10.6%
Tamias sp.	782	60	7.7%
Thomomys monticola	37	2	5.4%
Zapus princeps	51	4	7.8%
Ambystoma macrodactylum	2	0	0.0%
Ensatina eschscholtzii	1	0	0.0%
Pseudacris regilla	2	0	0.0%
Elgaria sp.	15	1	6.7%
Sceloporus sp.	8	1	12.5%

Note: These are counts of individuals, not of capture events.