Final Report:
A Re-survey of the Historic Grinnell-Storer Vertebrate Transect in Yosemite National Park, California

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Submitted, June 2007, to:

Sierra Nevada Network
Inventory & Monitoring Program
Sequoia & Kings Canyon National Parks
47050 Generals Highway
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In partial fulfillment of:
Cooperative Agreement H8C0730001
and
Task Agreement J8C07040003

Abstract:

From 2003 through 2006 we conducted a resurvey of the terrestrial vertebrate fauna (mammals, birds, reptiles, and amphibians) at 21 sites within Yosemite National Park (YNP) that were originally studied between 1911-1920 by Joseph Grinnell and other staff of the Museum of Vertebrate Zoology, University of California at Berkeley. The early survey provides the vast majority of available knowledge of the vertebrate fauna of the Park, yet that information is now nearly a century out of date. Our resurveys provide updated information on habitat and community changes at each site over the past century while documenting the presence as well as ranges (geographic and habitat) of species of special concern to the Park and to both the lay and scientific community. Substantial changes in the presence and elevational distribution of species have been noted.

Introduction:

Between 1911 and 1920, Joseph Grinnell and his students (primarily Tracey Storer, Joseph Dixon, Walter Taylor, and Charles Camp) from the University of California at Berkeley's Museum of Vertebrate Zoology (MVZ) surveyed the terrestrial vertebrates at 41 general sites along a transect that stretched from the western foothills of the Sierra Nevada, through Yosemite National Park (YNP), to the area around Mono Lake (Fig. 1). These surveys were part of a larger study of the fauna of California that Grinnell and his colleagues conducted for much of the first half of the twentieth century. The main emphasis of these studies was to characterize the fauna of California, as it existed at that time. But Grinnell also had the foresight to realize that these studies could serve as important baselines against which future studies could be compared in order to measure faunal change over time, and he encouraged future scientists to make these comparisons. To that end, he and his colleagues quantified their observations, and left a record that is rare or absent among the works of their contemporaries. Their compiled observations of the Yosemite area were published in 1924 as *Animal Life In The Yosemite* (University of California Press, authored by Grinnell and Storer; now available on-line through the NPS website, http://www.cr.nps.gov/history/online_books/grinnell/). The original records of their observations are in the form of preserved specimens, volumes of field notes, and photographic images archived in the MVZ.

Grinnell and his colleagues transected the central Sierra Nevada, surveying along a "…narrow rectangular area, 89 1/4 miles in length by 17 1/3 miles in width…" (Grinnell and Storer 1924:1), a band that began on the eastern edge of the San Joaquin Valley at 250 feet elevation and proceeded across the high Sierra to the Great Basin near Mono Lake (Fig. 1). The survey area encompassed some 1547 square miles and involved 957 person-days of fieldwork. Within Yosemite National Park, the transect included the entire Yosemite Valley and most of the area along Tioga Road to Tioga Pass, with high elevation sites both north and south of the road. They established base camps in Yosemite Valley, Porcupine Flat, and Tuolumne Meadows within the Park, from which trips of 1-2 weeks to adjacent areas and habitats were made. Data archived by the MVZ and pertaining to these surveys within the Park include some 2000 pages of field notes, 817 photographs, and 2795 specimens. Collections within the Park were most extensive for mammals (N = 1572), followed by birds (722) and herpetofauna (501). Allowing for the extensive additional information captured in field notes, the original data are quite comprehensive for small mammals, birds, and frogs, but less so for less obvious reptiles

(e.g., snakes) and non-aquatic amphibians (especially salamanders). General areas surveyed by the Grinnell team that are represented by the largest collections and highest known diversities of taxa are listed in Table 1.

Figure 1. The Grinnell Yosemite Transect (red rectangle) across the central Sierra Nevada; white circles with black centers indicate each of the 41 original sites surveyed. 21 of these sites are within the boundary of Yosemite National Park.

Table 1. General localities sampled by teams from the Museum of Vertebrate Zoology headed by Joseph Grinnell and Tracy Storer, 1911-1920. The number of non-volant, small mammal (insectivores, rodents, and lagomorphs) species recorded at each locality is provided as an index of the overall species richness across these sites. NPS Priority Species, as well as those of interest to staff of the MVZ, known from each general locality are listed (for mammals, the number of preserved specimens in the MVZ collections is indicated). Habitats are from Grinnell and Storer (1924: 26-35).

General locality	Elevation (range)	Habitat	Number of known non-volant mammal species	NPS Priority Species
Yosemite Valley	4000 ft	Transition Zone: chaparral, meadow, oak woodland, conifer forest, riparian	13	*Hydromantes platycephalus* *Ensatina eschscholtzii* *Carina bottae* *Thamnophis couchii* *Thamnophis sirtalis* *Eumeces gilberti* *Sorex trowbridgii* *Tamias merriami* *Peromyscus boylii* *Microtus longicaudus)* *Microtus montanus* *Zapus princeps*
Merced Big Trees to Crane Flat	5400-6300 ft	Transition to Canadian Zone: oak woodland, conifer forest, meadow, riparian, talus	11	*Ensatina eschscholtzii* *Sceloporus graciosus* *Sorex trowbridgii)* *Sorex vagrans)* *Tamias quadrimaculatus* *Tamias senex)* *Tamias speciosus* *Zapus princeps)*
Big Oak Flat/Gentry's	5800-6300 ft	Transition Zone: chaparral, yellow-pine, oak, talus	8	*Sorex trowbridgii* *Tamias quadrimaculatus* *Tamias speciosus)*
Chinquapin	6200-6300 ft	Canadian Zone: chaparral, conifer forest, riparian	13	*Sorex trowbridgii* *Tamias quadrimaculatus* *Tamias senex* *Tamias speciosus* *Zapus princeps (12)*
Aspen Valley	6400 ft		11	*Tamias quadrimaculatus* *Tamias speciosus*
E Fork Indian Canyon	7200-7300 ft		13	*Sorex monticolus* *Sorex trowbridgii* *Tamias quadrimaculatus* *Tamias senex* *Tamias speciosus* *Peromyscus boylii* *Zapus princeps*

Mono Meadow	7300-7400 ft		13	*Sceloporus graciosus* *Sorex monticolus* *Tamias senex* *Tamias speciosus* *Zapus princeps*
Merced Lake	7500 ft	Canadian Zone: conifer forest, meadow	13	*Charina bottae* *Sceloporus graciosus* *Sceloporus occidentalis* *Sorex monticolus* *Sorex trowbridgii* *Tamias senex* *Tamias speciosus* *Zapus princeps*
Glen Aulin, Tuolumne River	7700 ft		12	*Sceloporus occidentalis* *Sorex monticolus* *Tamias alpinus* *Tamias senex* *Tamias speciosus* *Peromyscus boylii* *Phenacomys intermedius* *Ochotona princeps*
Porcupine Flat	8100 ft	Canadian-Hudsonian Zone boundary: conifer forest, meadow	22	*Thamnophis elegans* *Sceloporus graciosus* *Sorex monticolus* *Tamias senex* *Tamias speciosus* *Peromyscus boylii* *Zapus princeps*
Tuolumne Meadows	8600-9500 ft	Canadian Zone: conifer forest, meadow, riparian	16	*Thamnophis elegans* *Sorex monticolus* *Tamias alpinus* *Tamias speciosus* *Zapus princeps*
Ten Lakes	9500 ft		10	*Tamias alpinus* *Tamias speciosus* *Phenacomys intermedius*
head Lyell Canyon	9700-11000 ft	Hudsonian-Arctic Alpine Zone:	16	*Hydromantes platycephalus* *Sorex lyelli* *Sorex monticolus* *Tamias alpinus* *Tamias speciosus* *Phenacomys intermedius* *Zapus princeps*
Vogelsang Lake	10350 ft	Hudsonian-Arctic Alpine Zone	15	*Sorex lyelli* *Sorex monticolus* *Tamias alpinus* *Tamias speciosus* *Phenacomys intermedius*

With initial funding from the Inventory and Monitoring Program of the National Park Service and Museum of Vertebrate Zoology, supplemented in subsequent years by funding from the Yosemite Fund, field biologists of the Museum completed resurveys of the terrestrial vertebrate fauna at most of the original "Grinnell sites" in the Park in 2003 through 2006. This report represents a synopsis of the findings of these resurveys across the entire original transect, both within and to the east and west of Yosemite National Park.

General Methods:

We identified the original field sites visited by the 1911-1920 Grinnell Survey from a combination of their original fieldnotes and maps that are archived at MVZ. Written descriptions enabled us to precisely relocate and resample many of the same sites. Field teams spent a minimum of 10 days at each site, and sampled each of the major habitats within a radius of approximately 1 kilometer (chaparral, woodland, forest, meadow, riparian, talus, etc.). Most sites were surveyed one time during the 3-year period, but several were revisited two or more times. Descriptions of habitats were made consistent with the level of detail in the field notes from the original surveys, supplemented by photographs taken at the same locations and under the same light conditions as previously. A standard vegetation profile form was used to characterize habitat surrounding many specific trap-lines, with digital photos taken in each cardinal direction from the GPS point along that line (Fig. 2). All fieldnotes, photographs, datasheets, and maps are archived in the Museum of Vertebrate Zoology.

Methods for avian surveys are detailed in that section below. For mammals, given the diversity of habitats at each site, the differences in major habitats across the elevational transect, and the range in food habits of focal taxa, it was not feasible to establish a standardized trapping design for small mammals (e.g., grid or parallel lines of traps set at uniform distance intervals with a common bait). Any such spatially explicit effort will fail to encompass all habitats with respect to the numbers of traps per habitat. Rather, we standardized our program not by a spatial trap design but by using a standard trap effort (number of traps) for each habitat. Each mammal live trap and pitfall trap line at each site was "run" for a minimum of 4 consecutive days/nights. We used primarily Sherman live traps, supplemented with Tomahawk live traps, with a minimum of 40 traps (40 Sherman live traps, sometimes supplemented with 10 Tomahawk live traps) per habitat per night for the four consecutive nights. Traps were placed in "likely" spots within each habitat (i.e., grass tunnels of *Microtus*). Trap "lines" were moved to different microsites within each dominant habitat during the total sampling period of a given site, depending upon success rate, to maximize assessment of species diversity. Pocket gophers were trapped using commercial Macabee™ gopher traps.

north east

south west

Figure 2. Left: generalized vegetation survey form (front page only), adopted from the NPS vegetation-mapping program, used to characterize vegetation at mammal trap lines. Right: digital images of habitat taken in each cardinal direction from GPS center of mammal trap line at Mono Meadow trailhead.

We used pitfall traps for non-aquatic amphibians, reptiles, and small mammals such as shrews. Two meandering lines, each comprising 25 32 oz. plastic cups were placed in the ground at approximately 10 m intervals using a 4" soil auger. These were run during the same interval as trapping, and retrieved as the survey at a given locality terminated with the hole refilled with dirt. The diversity of traps and methods employed ensured that the full range of target taxa was sampled. These systematic methods were supplemented with targeted searches of microhabitat suitable for priority reptiles and amphibians. Animals caught were identified, sexed, and weighed, with reproductive data (e.g., for mammals, testis condition for males, vaginal, pelvic, and nipple condition for females) noted for all individuals released. All trap lines or stations were georeferenced by hand-held GPS units, using the WGS-84 datum; those data are archived in fieldnotes for all individuals encountered, including those released as well as preserved.

Amphibian and reptiles surveys were conducted mostly targeted searches in likely habitat (under downed logs or granite exfoliations for salamanders, stream sides for frogs and tadpoles) or by night driving along paved roads (especially for nocturnal snakes). Timed surveys at given sites were used to determine relative abundances of some taxa, such as fence lizards. Most amphibian and many reptile species were collected by hand, although fence lizards were routinely obtained by a noose tied to a fishing pole.

Voucher specimens of selected small mammals (rodents and shrews), amphibians, and reptiles were taken at each general site, in accordance with permission granted by the National Park Service and Yosemite National Park specifically. For herptiles, all specimens were preserved in formalin and are stored in 70% ethyl alcohol; for mammals, specimens were preserved as standard skin + skull museum specimens, as complete skeletons, or as whole bodies fixed initially in formalin and maintained in 70% ethanol. All specimens are accompanied by precise GPS Georeferenced locality and date information, with standard body measurements (total length, tail length, hind foot length, and ear length plus body mass) recorded for all mammals. Tissue samples (liver or another organ or muscle biopsy) were also taken form each specimen preserved for eventual molecular genetic analysis; these are all stored either at ultra-cold temperatures (-80^{o} C) or in 95% ethanol. All specimens are archived in the collections of the Museum of Vertebrate Zoology, as are those specimens collected during the original Grinnell-era surveys. Complete data (taxon identification, locality, sex, reproductive condition, measurements, date of collection, collector, field and museum catalog numbers, etc.) for all specimens are available via the Museum's website (http://mvz.berkeley.edu), under accession numbers 13817 (2003), 13948 (2004), 14091 (2005), and 14191 (2006).

Methodological caveats: There are at least three caveats that underlie our ability to conduct accurate resurveys of the original Grinnell sample effort along the Yosemite Transect. First, survey methodologies, especially for both birds and mammals, differed substantially between the two survey periods. For example, the Grinnell-era team used shotguns and snap-traps for all mammal surveys while the 2003-2006 survey team used live traps. Since these two sets of methods may result in biases in trapability, we used statistical methods to assess the comparability of survey success for each species across the two time periods. Detectability probabilities (MacKenzie et al., 2002, 2004; Royle et al., 2005) were similar for key species of small mammals, suggesting that the data obtained on species presence at any given site are comparable between the two survey

periods (see section on “Analysis of Elevation Changes). Our analyses of changes in elevational range of mammal species incorporate differences in detectability between eras. Details of avian survey methods, and the significance of differences of methods employed during the Grinnell era and by us, are given below.

A second caveat involves our ability to relocate as specifically as possible the actual sites, transects, and trap lines surveyed by the Grinnell-era investigators. Fortunately, the detailed maps and fieldnotes of those individuals, archived in the MVZ, have made this task relatively simple in most cases. The position of all generalized sites, based on documentation of the actual campsite, has been reasonably well established, and even individual trap lines are often clearly demarcated on hand-drawn maps, but based on USGS topographic maps of that era, can be located with precision. As an example, Fig. 3 provides a hand-drawn map from the fieldnotes of Charles Camp that marks the placement of his traplines in upper Lyell Basin. The combination of this map with his written descriptions of trap sites has allowed us to survey the exact same talus slopes, stream edges, and so forth.

Figure 3. Map of individual trap sites in upper Lyell Canyon from the fieldnotes of Charles Camp, July 1915. Map is drawn from the USGS topographic quadrat in the field.

The third caveat involves the natural year-to-year flux in species' abundances, a level of variation that may affect the detection of particularly rare species and thus the comparisons made between the Grinnell-era and the surveys today. Both surveys were essentially "one point in time" efforts, with a given site typically visited only once during the duration of each survey period. The relatively similar detectability estimates for mammal species across the two time periods (below), coupled with their non-migratory behavior, suggest that comparisons of species richness from both datasets are reasonable even if local abundance measures are not. However, among-year flux can be high in many breeding bird surveys (e.g., see the breeding bird survey data maintained by the USGS at http://www.mbr-pwrc.usgs.gov/bbs/). This issue may be especially important for high elevation localities, where species likely breed or don't breed (and thus are

detectable by song and more likely by sight as well) based on the temperature and snowfall of the previous winter. As noted below, many avian surveys by us were conducted on successive years at the same site, and the data reported sum across both years. This serves to measure (and incorporate) inter-annual flux to some degree, but it is not possible to ascertain the significance of this issue on the original Grinnell data. Hence, caution should be used in assessing the significance of the comparative avian species richness data per site.

Overall Results:

With minor exceptions, including the analysis of changes in elevational range, we report below data only from those original Grinnell-sites, and their resurvey equivalents, found in YNP, and exclude data from sites either to the west or east of the Park boundary. Complete presentations of all data along the entire transect can be found in the cumulative annual reports of our research endeavors to the National Park Service. Complete data for all specimens that were collected and preserved can be accessed from the MVZ collection database at http://mvzarctos.berkeley.edu/SpecimenSearch.cfm; query for the inclusive years 2003 to 2006 and for the locality "Yosemite". All records and data can be downloaded as a tab-delimited file. Fieldnotes from the original Grinnell period surveys are also available on-line at http://bscit.berkeley.edu/mvz/volumes.html?.

We provide a summary of findings for each taxonomic group separately below.

1. **Reptiles and amphibians**

The Grinnell-era survey of frog, salamander, lizard, and snake species was haphazard at best, as species presence was recorded only when observed and no systematic survey methods were employed. As a consequence, there is little basis for comparing species lists for the Park, or for any site within the park, across the two temporal sampling efforts. Lists of all sites within the Park that were surveyed for amphibians and reptiles, including species present and estimates of relative abundance are provided in Appendix 2. Figure 4 maps localities surveyed. Reptile and amphibian resurveys were conducted over the three-year period, 2003-2005.

Figure 4. Map of survey localities for amphibians and reptiles. Numbers correspond to sites listed in Appendix 2.

Notable results from the 2003-2005 herpetological surveys include:

1. Two snake species thought to be absent from the park, the Sharp-Tailed Snake (*Contia tenuis*) and Ringneck Snake (*Diadophis punctatus*) were discovered at Hetch Hetchy.
2. One rare snake species, the Night Snake (*Hypsiglena torquata*), was found in high abundance at Hetch Hetchy.
3. The Mount Lyell Salamander (*Hydromantes platycephalus*) was rediscovered at the type locality at Mount Lyell (~3,200 meters).
4. The scientific literature suggests that the high-elevation subspecies of the Western Fence Lizard, *Sceloporus occidentalis taylori*, may warrant species status due to its unique morphological features (e.g., extensive blue ventral pigmentation, dark dorsal pigmentation, and large size). Our analyses of phenotypes and mtDNA sequence data across paired elevational transects in the Tuolumne and Merced drainages reject this hypothesis. Within the park, *S. occidentalis* from the two drainages are highly distinct genetically, with high elevation populations from each drainage being genetically nested within the adjacent low elevation *S. o. occidentalis*. Further, analyses of phenotypic variation indicate clinal, rather than stepped changes in the characters that were thought to distinguish *S. o. taylori*. These results imply multiple, independent origins of the high-elevation phenotype exhibited by *S. o. "taylori"*.
5. Discovery of a new population of *Hydromantes platycephalus* from Vogelsang Lake (two localities).

6. Breeding populations of *Rana muscosa* and *Bufo canorus* at unnamed lake 0.5 km east of Evelyn Lake
7. Healthy populations of *Rana muscosa* at Dorothy Lake.

2. Birds

Methods

Grinnell and Storer (1924; hereafter GS) carried out several bird censuses within the Yosemite Transect by walking a path and recording the number of individuals of each species encountered. They transferred these observations to their field notebooks, along with the duration of the census, and information about the route, habitat, and weather. Censuses were conducted during all times of the year, although GS mention the advantage of taking bird censuses during the breeding season, when species are fixed to some degree about a defined territory, allowing a more accurate count. GS also noted that more birds are observed at the beginning and at the end of the day when activity is greatest; they thus conducted the majority of their censuses during these time periods.

During 2003 and 2004, we re-surveyed 17 sites across the Yosemite Transect, 13 within Yosemite National Park (Fig. 5, Table 3). Several sites comprised more than one transect. Twelve of our sites are directly comparable seasonally to Grinnell surveys (Table 4). All analyses and comparisons reported below are based on this set of comparable transects. All of our field observations were made by Andrew Rush.

Because the GS surveys were often combined with other activities (e.g., while running mammal trap lines) and were not explicitly replicated by method at each of their sites, it was impossible for us to replicate their surveys exactly. However, while our first aim was to collect data for comparison to those of GS, we also wanted to conduct a systematic inventory of the birds of the original Yosemite transect that could be analyzed more rigorously and used as a point of comparison for future studies. For this reason, we performed 7-minute, variable distance point counts along transects overlapping with the routes used by GS. We established 27 total transects (14 in 2003, 13 in 2004; Fig. 5) made up of a total of 418 points. These transects consisted of points set at least 200 meters apart (avg. 250m); the location of each point was recorded with a GPS receiver. The number of points per transect varied between 11 and 20, with an average of 15. We spent 1 minute at the point before we began counting for seven minutes in order to allow birds to acclimate to our presence. Our censuses began within one hour of sunrise, and ended by 11:00 AM. We sampled most 2003 transect three times but some only twice. We sampled each of the 2004 transects twice using point counts (with the exception of Snelling, which was sampled once with point counts), and once using line transect counts. We also conducted additional point counts at 7 of the 2003 transects in 2004 (for reasons described below).

In many cases, information in the GS field notes was detailed enough to allow precise duplication of the original survey routes. Where the original route was obscure, we sampled near the original campsite, and in similar habitats, but not necessarily along the exact original survey route. Not all transects, however, could be exactly or even approximately duplicated. For example, the Pleasant Valley of the Grinnell era is now

under the impoundment of the Merced River that formed Lake McClure. For circumstances such as this one, we duplicated the transect by sampling similar habitat as geographically close to the original site as possible. Survey dates were chosen to bracket those of the GS surveys at a particular site (i.e., we conducted surveys spanning the GS survey dates [Table 4]).

Table 3. Sites visited and individual line transects per site for avian censuses in 2003 and 2004. Georeferenced coordinates (taken by GPS) of each separate transect (beginning and ending position, plus elevation) are given. Table 1 in Appendix 3 provides a list of birds recorded and numbers of each species on each transect.

		Begin Transect			**End Transect**		
Site	**Individual Transect**	**LON**	**LAT**	**ALT (m)**	**LON**	**LAT**	**ALT (m)**
Chinquapin	Chinquapin	-119.70187740	37.65244523	1861.7	-119.65396820	37.66596557	2278.4
Crane Flat	Crane Flat	-119.80164308	37.75322110	1861.9	-119.81084164	37.77953089	1597.6
Glen Aulin	Cold Canyon	-119.41683452	37.91325585	2436.1	-119.40697380	37.94847024	2677.9
Glen Aulin	McGee Lake	-119.42119210	37.90810056	2415.2	-119.45353166	37.87937704	2551.4
Glen Aulin	Waterwheel Falls	-119.42465022	37.91291270	2372.9	-119.45942657	37.92920645	2063.8
Indian Canyon	Indian Canyon	-119.56282657	37.78304466	2330.1	-119.59293445	37.75648979	2123.9
Merced Grove	Merced Grove	-119.84221753	37.76230993	1809.1	-119.83230409	37.73562120	1576.0
Mono Meadow	Mono Meadow	-119.58439782	37.67246222	2205.4	-119.55970129	37.68240123	2085.0
Mono Meadow	McGurk Meadow	-119.62806384	37.67057721	2139.0	-119.60985064	37.70707545	2226.8
Porcupine Flat	Porcupine Flat	-119.54528576	37.80391678	2469.3	-119.55665162	37.77020996	2464.4
Porcupine Flat	May Lake	-119.50932446	37.81842560	2570.0	-119.49103314	37.84987685	2828.1
Tamarack Flat	Tamarack Flat	-119.77265016	37.76418639	2151.8	-119.72446260	37.74912210	1942.0
Tuolumne Meadows	Tuolumne Meadows	-119.36983249	37.87252265	2613.0	-119.33213094	37.88618993	2822.5
upper Lyell	Donohue Pass	-119.25931869	37.77306023	3006.6	-119.24737658	37.76009946	3366.6
upper Lyell	Lyell Meadows	-119.26330798	37.78084961	2971.8	-119.27734247	37.82501847	2711.0
upper Lyell	Maclure Creek	-119.27623212	37.76536329	3210.7	-119.26494194	37.77313323	3055.2
Vogelsang	Evelyn Lake	-119.34299079	37.79688159	3104.9	-119.30412608	37.81426583	3228.7
Vogelsang	Vogelsang Lake	-119.34503304	37.79416636	3090.7	-119.34367006	37.76860642	2987.6
Yosemite Valley	North Yosemite Valley	-119.61861048	37.72617597	1224.1	-119.66551544	37.72284869	1392.3
Yosemite Valley	Yosemite Valley	-119.66002303	37.71607611	1175.6	-119.62656667	37.72667100	1185.7
Mirror Lake	Mirror Lake	-119.55091194	37.74893451	2102.0	-119.54850164	37.74838952	1240.9
Nevada Falls	Nevada Falls	-119.51415185	37.73465024	1856.4	-119.54843836	37.72456807	1525.7

Figure 5. Transect survey for avian species point-counts in 2003 (upper) and 2004 (lower). The general location of each original “Grinnell sites” are indicated in the upper map by the yellow dots with black centers. Only transects in Yosemite NP were done in 2003; western foothill localities outside of the Park were also surveyed in 2004. The boundary of YNP is indicated on each map. Transects are named or coded by initials corresponding to the list in Table 3.

Transect and site comparisons

We used data from 76 censuses from 11 sites from the Grinnell era (Table 4, Fig. 5). These censuses were of varying duration but all took place in the breeding season either in 1915 or 1919. Census data were extracted from the original field notebooks. We refer to these censuses as the 'GS' censuses and to the data as the 'Grinnell' or the '1915-1919' data. GS rarely replicated censuses along specific routes, and with the exception of Yosemite Valley (visited in three different years) and both Chinquapin and the Coulterville area (visited in two different years), sites were not revisited between years during the breeding season. While GS stressed the importance of recording both the species observed and also numbers of individuals, and of avoiding qualitative terms such as "common" or "rare", which are vague and often have species-specific interpretations. Nevertheless, in some cases their data include a few qualitative terms mixed within otherwise actual counts.

Table 4. Avian transects and dates for the Grinnell period and 2003-2004 surveys. Transects are mapped in Fig. 5 (bottom), by their codes or names.

SITE	Code	Elevation Range (m)	Grinnell survey (1915-1919)	Current Survey (2003-2004)
LaGrange	LG		6, 7, 9(2)-May-1919	3, 13, 21-May-2004
Snelling	SN		26, 27(2), 29-May-1915	4, 19-May-2004
Pleasant Valley	PV		23(2), 24(2), 25(2), 26, 27, 28, 29, 30 May-1915	6, 12, 26-May-2004
Coulterville	CV		31-May, 1, 2, 3, 4, 6-June-1915, 10, 11, 13-May-1919	5, 7, 14, 20, 22, 27-May-2004
YosemiteValley	YV	1176-1392	31-May, 3, 8, 24-June, 22, 23, 24, 25, 30-July-1915, 16(6), 17, 18(4), 21(4), 23, 25(2)-May-1919	4, 13, 14-Juny-2003; 11, 23-May, 4-June-2004
Merced Grove				

To investigate the effect of using the modern (point count) versus the historical (line transect) methods, we conducted 16 line transect counts at each of the 13 transects surveyed in 2004, and at 3 of the routes established in 2003. We compared data from point counts and line transects, using the number of individual birds per hour that were observed at the sites surveyed in 2004. We took point count time as the number of points surveyed multiplied with 7 minutes for each count, rather than the entire time it took to do the census along a route (i.e. not including the time walked between points).

Species richness and turnover

The data from the original and current surveys cannot be directly compared because of differences in observer effort. One way to correct for these differences is to use the time spent during a census. In some cases GS clearly indicated the time spent on a census. Sometimes this was not the case, as the census activities were mixed with other activities. Based on their remarks in their field notebooks, we estimated the time actually spent counting birds for each GS census, and we calculated the number of birds observed per hour for each route. However, the large variation between censuses within a given site in the number of birds observed per unit time by GS as compared to our survey (see Results) indicated that this was not a reliable method for standardizing the data. Consequently, we used two other approaches to correct for differences in effort: bootstrapping and estimation of the true number of species. In our bootstrapping approach for each site, we took random samples of *n* individuals from the larger dataset, where *n* is the size of the smaller dataset. We repeated this 10,000 times, and then used the boostrapped samples to calculate species richness and species turnover between the original and current surveys. With bootstrapping we implicitly assume that there are no significant changes in the overall abundance of birds and the relative abundance distribution of the set of species (but not for each individual species). We checked this assumption by comparing species-abundance curves for both surveys. Another approach to correct for differences in effort is to estimate the "true" species richness, by extrapolation from the species abundance distribution, respective of the sample size (Colwell and Coddington, 1994). We used the EstimateS 7.5 (Colwell, 2005) to calculate both rarefaction and bias corrected Chao1 estimators of species richness and we estimated turnover between the original and recent survey by calculating Chao's abundance-based Jaccard distances (Chao, 1984, 2005; Chao et al., 2005).

Species-level change

To interpret changes in community structure, we examined changes in the abundance of species per site. To be able to classify individual species as having undergone a significant change (as opposed to merely showing a difference due to inter-annual noise), we first compared the results of our surveys for 2003 and 2004 for the 7 transects that had been surveyed in both years. For this comparison, the data were adjusted so that both surveys had the same number of observations (i.e., number of observations for a species in the largest survey of the two was multiplied by the number of observations in smaller sample / number of observations in larger sample). After this adjustment, we used binomial tests to assess the likelihood of a change of a certain level

of statistical significance to occur between two years. For each site and species we calculated a binomial probability (p= 0.5) and a change index. The binomial probability indicates the chance that the two samples were taken from the same population (of the same size in each time period). We calculated the change index as (current – original) / (current + original). This index has values between -1 (species lost) and +1 (species gained). Zero indicates no change.

Cluster Analysis

We characterized the habitat preferences of species based on observations during the current survey, and using a recently completed high resolution vegetation map of YNP. First, the area of vegetation classes within a circle with a radius of 150 meters were assigned to each transect points within YNP. To avoid swamping the effect of rarer vegetation types, the areas by vegetation type were adjusted using their area across all points. Vegetation types were then assigned to species on the basis of their frequency of occurrence per point per visit. We clustered these data using PC-ORD Version 4 (http://www.digisys.net/~mjm/pcordwin.htm), using the Jaccard distance and the UPGMA method. The resulting dendrogram grouped species according to the habitats in which they were most abundant in our surveys within YNP. We used this information to group species into assemblages with similar habitat requirements.

RESULTS

Number of observations and species

From the GS surveys we tallied 133 species and 9872 individual records from 58 censuses. In our surveys we detected 140 species and 18165 individuals (11962 from point counts, 6203 from line transect counts). We did not find 21 of the species that GS found. Some of these were noted as “present”, i.e., detected, but not during a formal census. We found 28 species that Grinnell et al. did not find, some of which GS indicated their presence in their field notes or monograph (Grinnell and Storer 1924). We provide a list of all species and numbers of individuals recorded for both the Grinnell and current surveys in Appendix 3, Table 2. The bootstrapped number of species across all sites for our survey was 133.8 ± 2.4 (i.e., virtually the same as the 133 species detected by the GS survey). The Chao1 estimator, however, was 153 species for our survey and 139 for GS.

In our survey, the number of observations per hour was higher for point counts than for line transects (Fig. 6). The relationship between the two survey methods is strong, and could be used to adjust data from point-counts to match the line-transect data of GS. However, we did not make such adjustments because we detected a large amount of variation in the number of birds detected per hour for the original survey (Fig. 7), making time an unsuitable basis of comparison. In the original survey there was a large difference in terms of birds observed per unit time between J. Grinnell and T. Storer, with Grinnell having much higher scores than Storer for the same area. Grinnell and Storer counts also had a larger variation among their own censuses for a single site than we did during our survey.

Figure 6. Regression of the number of birds encountered per hour along the same transect, as assessed by point-counts (PC, employed by the 2003-2004 survey team) and line transect (LT; employed by the Grinnell-era team) methodologies.

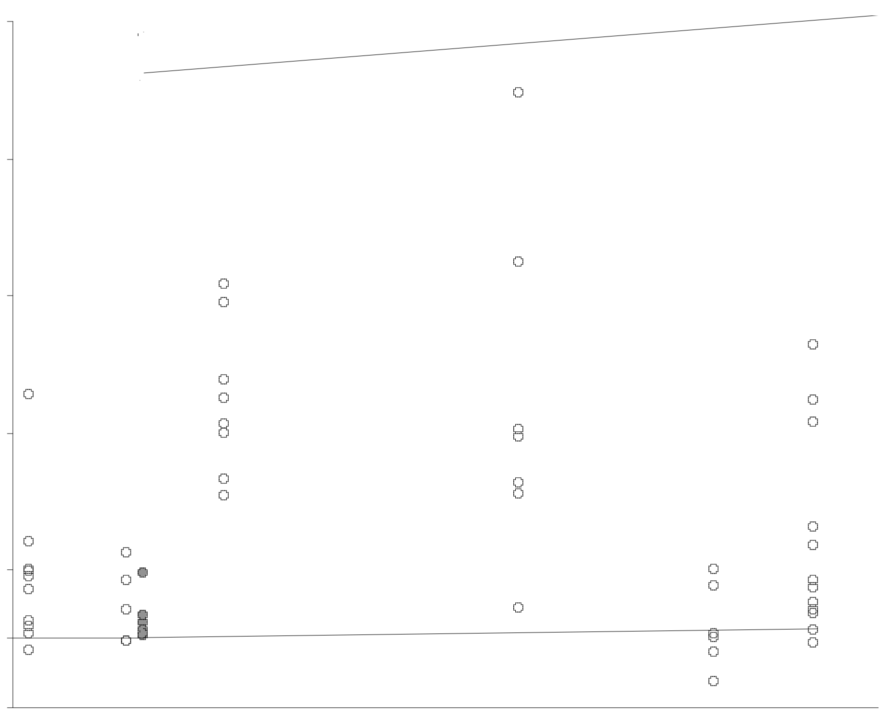

Figure 7. Number of birds observed per hour for the original survey (1915-1919) by Grinnell and Storer, and the current survey (2003-2004) for 12 sites.

The number of birds observed per unit time by GS was likely affected by whether they were strictly engaged in a bird-counting census or engaged in other tasks while surveying birds. GS highest scores tended to be similar to our results, which suggests that those surveys were, like ours, done as focused censuses without interfering activities. This also suggests that the overall abundance of birds has not changed much over the time period considered and supports the use of rarefaction to estimate species richness at each site from the survey data of both time periods. Further support for the use of rarefaction came from the fact that the relative species abundance distributions for the two studies have changed very little over time (Fig 8).

Figure 8. Species abundance distributions for the Grinnell survey period (1915-1919) and the current surveys (2003-2004). Note commonality of distributions.

Species richness and turnover

The 2003-2004 surveys recorded more species at all sites than did the Grinnell-era surveys, but this may be partly due to the higher number of observations we had at all but two of the sites (Table 5). Bootstrap estimates of species numbers, however, also indicate higher species pools at most sites in the comparison of the 2003-2004 surveys relative to the original Grinnell data, significantly so in most cases.

Of our two estimates of total species richness at each site for both time periods, the rarefaction estimate is more consistently comparable across sites to the observed numbers than is the Chao1 estimate (Table 5). This difference is perhaps not surprising, since the Chao1 estimate relies heavily on singleton observations, which may lead to inflated estimates due to the high vagility of birds. Moreover, the original Grinnell censuses did not use a systematic sampling protocol, an underlying assumption of the

Chao1 methodology. Importantly, similarity in species richness between observed numbers and that estimated by rarefaction helps to allay concerns that the two studies are so dissimilar that differences in results may be the result of differences in study design rather than reflecting real changes in the avifauna. By all measures of richness, there appears to be a higher number of avian species per site for the current survey period in comparison to those of the Grinnell era (Fig. 9). On average, across all sites, the original survey found 81% of the number of species according the rarefaction estimate and 91% according to the Chao1 estimator. Both methods indicate that the highest elevation sites (Lyell and Tuolumne Meadows) are where the number of species has increased the most.

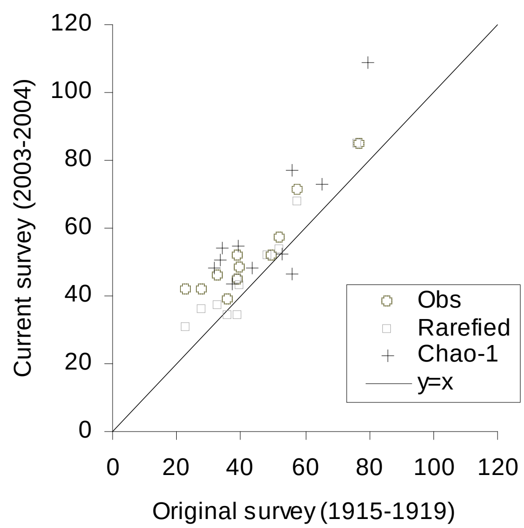

Figure 9. Change in species richness between the two sample periods (the original Grinnell survey of 1915-1919 and our resurvey during 2003-2004) for the raw data (Obs) and rarefied and Chao1 estimates, for each of the 11 comparable sites (Table 5).

Table 5. Number of observations (*n*), number of species (*Sobs*), estimates of number of species by bootstrapping (with 1 standard deviation), estimates of species richness from rarefaction and Chao1 estimates of spe

We found high temporal turnover of species at all sites, despite the overall similarity in species richness (Fig. 10). On average, only 46 % of the species observed per site were present in both surveys. A large proportion of the species that turnover are rare species (5 or less observations), but in every site, there are a few relatively abundant species that are either new to the site, or that were not found in the current surveys (Appendix 3, Table 2). The greatest turnover is at Snelling, the lowest elevation site, but the greatest proportional number of new species in the current survey occurred at the two high elevation sites, Lyell Meadows and Tuolumne Meadows. Several of the 2003-2004 exclusives at TM and LC are riparian or wetland associated species: 4 out of the total 68 (21%) species can be classed as riparian/wetland-associated species; only two of 33 (6%) of the species in common to both surveys are riparian/wetland-associated species; and two of the 17 (12%) Grinnell exclusives, but as many as 12 out of the 36 (33%) 2003-2004 exclusives are riparian/wetland associated. In interpreting apparent changes in community structure, it is crucial to distinguish true species turnover from pseudoturnover, or that resulting from chance (low delectability) or from differences in sampling effort. Drastic changes in abundances are clearly more significant than the presence or absence of rare species for which there are only a few observations. On the other hand, addition or loss of rare species may be more significant if the species in question are related in some way (habitat needs, etc.).

Figure 10. Avian species turnover at each of 11 sites surveyed across the Yosemite transect during the original Grinnell era (1915-1919) and the current surveys (2003-2004).

Species Level Change

We found minor changes in species abundances at each site sampled in both years of our 2003-2004 survey (Appendix 3, Table 3). Differences in abundances between the current survey and the original survey were much larger (Appendix 3, Table 4). Significant increases in the abundance of particular species was typically found for most

low elevation sites (except CV/PV) while all high elevation sites (from CH to LM) displayed more species exhibiting a decrease in abundance than gains. Statistical analyses of change in elevational distributions of the avian species is ongoing.

Habitat Associations and Change

The cluster analysis initially splits species that occurred in more mesic habitats and are more abundant from generalist species found more in coniferous forest habitat (although not necessarily xeric in their habitat preferences). The mesic group includes species that were most abundant in both high-elevation meadows (Tuolumne Meadows and Lyell Fork Meadows) and Yosemite Valley (Appendix 3, Table 4). The first split within the mesic group is between species most abundant in wet herbaceous habitats and those in somewhat drier habitats with a strong broadleaf tree presence (i.e., Yosemite Valley). Additional splits created clusters with the following habitat preferences within the more mesic group: herbaceous /flooded herbaceous; alpine habitat + deciduous shrubs + herbaceous/flooded herbaceous; flooded herbaceous/herbaceous + pine; herbaceous/flooded herbaceous + broadleaf trees + pine; less mesic + strong broadleaf tree presence. Within the generalist/conifer cluster, the initial split creates two clusters, one of species associated with a more closed-canopy conical-form evergreen forest with an understory of shrubs, and one that is associated with a more open mixed conifer/broadleaf forest. Additional splits created clusters with the following habitat preferences within the generalist conifer group: conifer + broadleaf trees; mixed conifers (fewer broadleaf trees) + post-disturbance; conical-form evergreen + drought phenology shrubs; conical-form evergreen.

Examples of species presence and/or shifts in relative abundances associated with the individual clusters include:

Mesic cluster:

Herbaceous /flooded herbaceous subcluster:

- Colonizations (ducks).

Alpine habitat + deciduous shrubs + herbaceous/flooded herbaceous:

- No change with exception of decrease of white-crowned sparrow.

Flooded herbaceous/herbaceous + pine:

- No change with exception of ruby-crowned kinglet, which decreased at lower elevations and did not change at higher elevations; irruptive species (pine siskin and red crossbill) increased in my surveys, but this would be difficult to characterize as real change given their irruptive/nomadic nature.

Herbaceous/flooded herbaceous + broadleaf trees + pine:

- Strong pattern of increase in YV and TM and LM; yellow warbler declined in YV, but colonized TM.
- Less mesic + strong broadleaf tree presence (YV).
- Increase in a few species (Anna’s hummingbird, Bullock’s oriole), but generally no change.

Generalist / Conifer cluster:

Conifer + broadleaf trees subcluster:

- Site-specific increases and decreases, but many of the species which have declined the greatest are included here.

Mixed conifers (fewer broadleaf trees) + post-disturbance subcluster:

- Site-specific patterns of i

Conical-form evergreen + drought phenology shrubs subcluster:

- Tw speci s total (fox sparrow and green-tailed towhee); generall decreased or increased 50 0 0 50 42 0 Tm79 0 Tm (n) Tj 50 00 50 517 0 Tm (a) Tj 50 (has en fi e?).

Conical-form evergreen subcluster:

- Mostly incre sed; the general

Mammals

We present the resurvey results for mammals in five different sections. The first of these identifies those mammalian species that have been added to the faunal list of Yosemite National Park; the second focuses on the current status and range of species specifically identified by Park personnel as of concern because of apparent rarity; the third identifies expanded distributions of some species because of our recent survey efforts in parts of the Park not previously visited by mammalian biologists; the fourth describes a few species that have apparently become increasingly rare in the Park and for which more expanded surveys, now or in the near future, would be useful; and the fifth section documents those species that have experienced substantial range shifts, particularly in their elevational boundaries. Lists of all localities sampled with species caught ij 50 0 0 50 306 0 50 [illegible] 50 0 0 50 1119 0

3. California pocket mouse (*Chaetodipus californicus*). This species also occurs in chaparral and oak woodland west of the Sierra Nevada in central and southern California. It was trapped along with the piñon mouse in white-thorn ceonothus near Hazel Green in 2005.
4. Inyo shrew (*Sorex tenellus*). This rare shrew is known from only a few localities east and north of the Sierra Nevada (e.g., Lassen-Volcanic National Park, Sweetwater Mts., and White Mts.). In 2005 and 2006, specimens of this species were collected in upper Lyell Basin (a "Grinnell site" at 10240 ft) and in 2005 in upper Virginia Canyon along Return Creek (at 9900 ft). The addition of this species brings to 4 the number of sympatric shrews at both localities, providing each with the richest shrew species assemblage in the Sierra Nevada (other co-occurring species include the Montane shrew, *Sorex monticolus*, Lyell shrew, *Sorex lyelli*, and Water shrew, *Sorex palustris*).

<u>Priority species</u>: The Park expressed strong interest in a few species that, based on the few prior records, were either considered rare or of unknown status. Species of special interest, in particular, were the Lyell shrew (*Sorex lyelli*), which was previously known from only 5 specimens from two localities within the Park and only a total of 9 specimens from areas to the east of the Park, and the Heather vole (*Phenacomys intermedius*), which was known only from three localities and four specimens from the Park (and, indeed, the entire central Sierra Nevada).

1. *Sorex lyelli* – our recent surveys for this species have found it at the two original localities were it was recorded in the Grinnell-era (upper Lyell Basin and Vogelsang Lake) and has expanded its known range to the north, and to lower elevations, at Glen Aulin (7900 ft), Kerrick Meadow (9600 ft) and upper Return Creek in Virginia Canyon (9900 ft). This species is uncommon at each locality, especially with respect to sympatric *Sorex monticolus*, and has relatively low detectability.
2. *Phenacomys intermedius* – Known historically from four localities in the Park, we have now expanded the range of this species westward to Snow Flat (south of May Lake) and northward to upper Return Creek and Kerrick Meadow. Again, while not common locally, the species was trapped at nearly all localities surveyed above 8000 feet in elevation.

<u>Expanded ranges</u>: In addition to those species listed immediately above, we have recorded Alpine chipmunks at both upper Return Creek, Virginia Canyon, and in upper Kerrick Meadow, both localities in the northern part of the Park and north of the previously known distributional limits of this high-elevation, and Sierra Nevadan endemic species.

<u>Recently rare species</u>: The resurvey efforts had only very limited success in finding either the Shadow chipmunk (*Tamias senex*) or Bushy-tailed woodrat (*Neotoma cinerea*). Both species were widespread and abundant at nearly all localities encountered during the Grinnell-era survey and are highly detectable. However, we recorded the Shadow

chipmunk only at one locality and the Bushy-tailed woodrat only at three. Site surveys for both species (visual observations of the diurnal Shadow chipmunk and nest or marking sign of the nocturnal woodrat) failed to find much evidence of either across their prior known range in the Park. Other species that might also have declined are porcupines and White-tailed jackrabbits, although the latter is notorious for long-term population cycles and our survey efforts possibly coincided with a "low" in those cycles.

Shifts in elevational range of mammals

Analytical methods: Rigorous comparison of elevation ranges is complicated by differences in methods of trapping and uncertainty in geographic location of historical records (Rowe 2004). Further, when a species is not detected at a given location or series of locations, we need to be able to distinguish between "false absence" (i.e., the species is there but not detected) and "true absence". Fortunately, the Grinnell period field notes provide sufficiently detailed information on trapping effort and captures, enabling us to use formal statistical models to estimate detectability and the incorporate differences in detectability between eras into our evaluations of change in elevational ranges.

To reduce effects of spatial autocorrelation, we first aggregated geographically proximal traplines for both periods (N = 311 Grinnell period, N = 308 in resurvey) – traplines within 2km and ca. 100m elevation and which represented the same vegetation zone were combined into 65 "sites" for the Grinnell period and 133 sites for the re-survey (Fig. 12). The higher level of aggregation in the Grinnell period reflects greater uncertainty in the exact location and elevation of traplines and our generally conservative approach to grouping traplines. Accordingly, there was a larger number of both trap-lines (mean 4.8 vs 2.3) and traps (mean 111 vs 85) per site for the Grinnell period versus the re-survey. However, the mean number of trap-nights per site was similar; 4.1 for Grinnell survey and 3.3 for the re-survey. Most, but not all of the sites were geographically matched between the Grinnell and re-survey periods. Those that were not paired were largely because the historic locality could not be accessed (i.e., some Grinnell sites are now under water due to the construction of Lake McClure [= Exchequer Reservoir]). Accordingly, we focus here on comparing the elevational profiles of species detection and occupancy in order to maximize use of the available data.

To control for differences in trap types and effort per site. we estimated detectability for each species and period from the temporal pattern of presence or "no-presence" records across sites, and incorporated any between-period difference in detectability into our analyses of changes in elevational range limits and profiles of occupancy probability (P(occupancy)). These analyses of detectability and probability of occupancy employed the likelihood framework and AIC model-averaging methods and implemented in Program MARK [http://www.warnercnr.colostate.edu/~gwhite /mark/mark.htm]. To estimate detectability, we constructed competing models with the following independent variables: era (Grinnell or resurvey), trend (detections over sequential nights), trap effort (as number of traps/100 or log10(number of traps), and interaction terms between era and trend or trap effort variables. We selected the model with the highest AIC score and using the parameter values, estimated the overall

Probability of Detection (P*) for each era across sites where the species in question was detected. We evaluated change in elevational range in two ways. First, to estimate the Probability of False Absence (P(false-absence)) across elevational bands where a species was detected in one era but not the other, we calculated 1-P* for each site in question (given specific trap effort and number of nights trapped) and summed the product of these values across the sites in question. Second, to estimate elevational profiles of the Probability of Occupancy (P(occupancy)), we again constructed competing likelihood models incorporating era, elevation (represented as linear (elev) or quadratic (elev*elev) functions) and interactions between era and elevation functions. This resulted in 6 competing models; four with between-era effects (era+elev, era*elev, era+(elev+(elev*elev)), (era*(elev+(elev*elev)), and two without (elev, elev+(elev*elev)). Each of the 6 model types was run with the full range of detectability functions. Models were compared using AIC scores and elevational profiles of P(occupancy) were estimated via model-averaging of parameter values. These models were restricted to west slope records and sites and species for which trapping effort and results could be quantified.

Figure 12. Distribution of aggregated trap sites (mapped as centroids) for historical and modern sampling of small mammal.

Key results: There was sufficient data to estimate detectability and shifts in elevation range shifts for 36 species, with east and west slope comparisons for 14 species, giving 50 comparisons overall (Table 6). Some observed range shifts were statistically significant (by the P(false-absence) test), but were biologically trivial (<5% of range) or of small magnitude (<100m; i.e., within pooling criterion for trap-line aggregation). Such range shifts are regarded as "no change" in the following. In most cases where the

P(false-absence) test indicated a change in elevational range, the occupancy models agreed. However, there were several instances where the occupancy models did not reveal change due either to poor model performance (i.e., insufficient data), or to inclusion of non-standard data (e.g., specimens from historical trap lines for which we could not quantify effort) in the P(false-absence) test, but not the occupancy models. In addition, we elevational rangess for some taxa for which records are derived from methods other than standardized trapping (eg. shooting in Grinnell Period, specialized trapping in either period or visual observations in the resurvey), yet are regarded as highly detectable. Examples include moles, gophers, Douglas and grey squirrels, and marmots. Several other taxa had low detectability or insuffient captures to permit statistical analysis of distributions. Comparisons of elevation ranges for all small mammal taxa are provided as figures in Appendix 5.

Of the

- **17 show range contractions**: 9 due to upward contraction of the lower limit, 3 to downwards shift in upper limit, 4 with bidirectional contractions (*Dipodomys heermanni*, western slope *Neotoma cinerea* and *Zapus princeps*, and *Tamias senex*). *Tamias alpinus* was not detected in modern surveys on the eastern slope, though some historical locations remain to be explored. Four species (*Neotoma cinerea, Ochotona princeps, Spermophilus beldingi, Tamias alpinus*) showed parallel range contractions on both slopes (see Appendix 5).

- **26 species show no evidence of range shift.**

- **Range contractions outnumber expansions, 2.5:1**

Overall, there are a similar number of increases (N = 5) and decreases (N = 6) in the upper limit of elevation ranges, but with larger upwards (mean = 614m; 112-1062m) than downwards (mean = 391m; 224-719m) shifts. **But for lower range limits, upwards contractions (N = 13, mean 522m, 159-1007m) are more common than downwards expansions (N = 3, mean 536m, 122-1003m).**

The impact on individual species of these range fluctuations varies widely (Table 6).

- Of the range expansions, 5 of 8 have increased by >20%, the most dramatic being the >1000m expansion of east slope *Peromyscus truei* (Fig. 11) and the >1000m downwards expansion of *Sorex monticolus* on the west slope (Fig. 13).

- For range contractions, 14 of 17 have contracted by >30%, with 8 species loosing >50% of their elevational range. Of particular note are substantial range contractions for *Dipodomys heermanni* (-37% of transect range; also a California Department of Fish & Game "Species of Special Concern"), *Tamias senex* (-92%), and multiple high elevation taxa, particularly *Neotoma cinerea* (-94% E, -54% W), *Ochotona princeps* (-33% W, c. 100% E), *Spermophilus beldingi* (-35% W, -90% E), and *Tamias alpinus* (-60% W).

- **Overall, range contractions are both more numerous and are of greater magnitude than range expansions**. Range contractions are especially severe for high elevation taxa. Most contractions represent upwards shifts of lower limits, but in some cases, notably *Tamias senex* and *Neotoma cinerea*, there is range collapse (i.e., both increase in L and decrease in U (Fig. 14, *N. cinerea*). Given decreased habitat area with elevation, the upwards shifts in elevation for some of these taxa is expected to result in sharply reduced range area and increase fragmentation. Projection of the occupancy models onto topography illustrates this phenomenon for *Tamias alpinus* (Fig 15).

Figure 14. Elevation profiles for *N. cinerea* in historical (H) and modern (M) sampling periods on W and E slopes of transect (left; Pfa = P(false-absence), grey dots are sampling points, black are presence records) and plot of P(occupancy) for historical (black) and modern (red) periods. This is an example of a range collapse.

Most (7 of 10) range expansions are for formerly low elevation (Lower Sonoran to Transition) species, whereas most range contractions (14 of 20) involve mid to high elevation (Canadian to Arctic) taxa. Notable exceptions are the large downwards expansion of *Sorex monticolus* and the more subtle range contractions of two low elevation taxa, *Dipodomys heermanni* on the west slope and *Perognathus parvus*. This trend makes sense in the light of the overall predominance of upwards shifts in elevational boundaries from the Grinnell Period to the present.

Figure 15. Severe range contracvtion of *Tamias alpinus* from historical to modern sampling (upper left), inferred upward shift in P(occupancy) (upper right), and spatial projection of the occupancy model (right) to illustrate potential decline in area of range and increase in population fragmentation.

historic (above)
modern (below)

<u>Factors contributing the observed changes in elevational ranges</u>**.**

The observed changes in species ranges potentially reflect one of more of three processes; (i) stochastic fluctuation, (ii) fire-related vegetation change, and (iii) regional climate change. The first is certainly possible, yet given our generally conservative approach to identifying shifts and the strong directionality of changes (overall 19 upwards vs 9 downwards) we need to consider other factors. Formal analyses of spatial patterns of change and contributing factors are in progress, but here we can offer some general observations.

Vegetation change within Yosemite National Park from the Grinnell Period to the present has been substantial, and likely reflects both seral dynamics and effects of climate change (Fig. 16; S. Cameron in prep, Millar et al. 2004). Fires have been more frequent at lower elevations of the park, in some cases leading to stand replacement (e.g.,. conifer to shrub). Conversely, fire suppression has lead to successional changes, especially in mid elevations. Finally at high elevations, some expansion of conifer forests is evident, including invasion of meadows and this may be related to increases in temperature (Millar et al. 2004). The magnitude of temperature change across the transect is difficult to establish directly because long-term records are sparse. The Yosemite Valley record (Fig. 16) indicates a substantial increase in monthly minimum temperatures (> 3C over 100 years). This dramatic change, far greater than the average for California, is also evident from tree ring data and analyses of vegetation change (Millar et al. 2004), as well snow melt data (ref) and observed retraction of the Mt Lyell glacier (URL).

Figure 16. Environmental change in Yosemite National Park from the Grinnell Period to the present: Increases in monthly minumum temperatures over 100 years in Yosemite Valley (left), fire history (lower left). and change in vegetation (lower right; S. Cameron, in prep.).

Some of the fluctuations in ranges of small mammals appear directly related to vegetation change. For example, the upwards expansions of *Chaetodipus californicus* and *Peromyscus truei* (on the west slope), both chapparal species, can be attributed to the stand replacing fires in the lower areas of the Park. The large downwards shift in the elevation of *Sorex monticolus* is probably related to its preference for wet meadows and the recovery of wet meadow systems in Yosemite Valley, following cessation of grazing and intense restoration efforts. This species has now largely displaced *Sorex trowbridgii* from this area. Increased prevalence of small mammals of mesic habitats has also been observed for the eastern Rocky Mountains and attributed to recovery from intense grazing (Rowe, 2007). However, the habitat shift accompanying the upwards expansion of east site *Peromyscus truei*, from pinon-juniper to montane conifer forest, serves as a stark reminder that species can and do move independently of vegetation change.

The most likely cause of contractions of the high elevation species and at least some of the upwards expansions of formerly lower elevation taxa, is effect of increased temperatures (Parmesan, 2006). The mean increase in lower and upper limits of 500-600m is roughly as expected given with the observed climate change of +3 C and assuming that species ranges are limited primarily by physiology. For at least one species, *O. princeps,* the changes observed for Yosemite are reflected by range retractions elsewhere in the range (Beever et al., 2003; Grayson, 2000) and have also been attributed to increased temperatures. However, not all species are similarly affected. For example, the high elevation specialist *Sorex lyelli* has persisted and perhaps even expanded its range and, based on observational records (Appendix 4) appears to have maintained its former elevational range. Among the mid-high elevation chipmunks, *Tamias alpinus* and *Tamias senex* are strongly affected, yet *Tamias speciosus* has undergone just a slight contraction in range, if at all. A corollary of variable responses

among related species is that community structure, and perhaps competitive interactions, is highly labile. Whether or not individual species have responded strongly to warming is not obviously related to their ecology or life history. For example, obligate hibernators might be expected to decline should their emergence time become mismatched with phenology of food items (Inouye et al., 2000). While two of high elevation species that have contracted are obligate hibernators (*Spermophilus beldingi*, *Spermophilus lateralis*), others are not (e.g., *Tamias senex* [a facultative hibernator], *Neotoma cinerea, Ochotona princeps* [both non-hibernators]), and other obligate hibernators (e.g., *Marmota flaviventris*) appear to have maintained their elevational range. To further understand the extent and causes of range fluctuations, we have extended our re-surveys of Grinnell sites to other elevational transects in California (e.g., Lassen, White Mountains and southern Sierra.

Recommendations for monitoring & research

The changes of greatest concern relate to the substantial contractions of elevational ranges of the mid-high elevation taxa. While there is little that the Park alone can do to change the course of global warming (other than to communicate these results to the public), a program of monitoring of the strongly affected species and of extending surveys to as yet unexplored habitats will help to further define the extent of the problem. Fortunately, several of the species are readily detected and distinguished by non-specialists, including the diurnally active pika, alpine chipmunk, Belding ground squirrel, and golden-mantled squirrel. Similarly, the nocturnal bushy-tailed woodrat can be monitored via fresh sign, although experience in doing so would be required. A few rather simple continuing surveys, which could easily be implement by Park staff, should be undertaken. For example, all talus between the elevations of 7800 and 9000 feet elevation could be regularly searched (each year or at somewhat longer intervals) for sign of pika (visual sightings, listening for their distinctive calls, searches for active hay piles in the fall, detailed searches for fresh whitewashing on boulders and fecal pellets), especially those historic sites (such as at Glen Aulin) where pika appear to have disappeared. If possible, pika surveys should use the standardized protocol developed by Erik Beever (NPS Great Lakes Netork; erik_beever@nps.gov) so as to contribute quantitative information to the larger picture of the apparent decline of this species throughout its range in the Great Basin. Although our essentially ad hoc observational data for marmots did not reveal any obvious change, standardized abundance monitoring of this species may also be warranted.

The extent to which vegetation change at high elevation is affecting alpine species is not clear, but the Park could extend its program of vegetation monitoring to representative habitats for these species using standardized quadrat protocols.

We do not yet understand why some species are fluctuating more than others, but an obvious place to start is to examine physiological traits in free-ranging populations for signs of temperature-related stress. Physiologically-informed spatial modeling could yield useful predictions of change from the Grinnell period to the present, and then potential responses to future climate change. This could then be used to identify critical

habitats and to inform future vegetation and fire management in the Park. This is obviously not work that Park biologists would, or could undertake, except in conjunction with partners at academic institutions.

Finally, we would recommend that similar, site-specific resurveys of the small mammal fauna of the Park be undertaken at regular intervals (every 20 years?) so that trend lines can be more clearly delineated and future predictions made with the Grinnell and current data can be tested directly. Because each modern trapline has been georeferenced and a standardized trap effort has been employed, both location of specific sites and use of a common protocol will enhance the comparisons of future surveys with those we have undertaken, and describe herein.

Table 6. Estimated detectability per site in Grinnell (P*G) and present (P*P), significant changes in upper (U) and lower (L) elevation limits, % change in elevation range and original lifezone classification (Grinnell & Storer 1924). For elevation changes, * = confirmed by occupancy modeling and N = not analysed.

Species	**P*G**	**P*P**	**Change in elevation**	**% change**	**lifezone (Grinnell)***
RANGE EXPANSIONS					
Chaetodipus californicus	0.28	0.19	+800m U*	109	Upper Sonoran
Microtus californicus	0.81	0.58	+505m U^N	46	Lower and Upper Sonoran
Reithrodontomys megalotis	0.99	0.87	+112m U	10	Lower and Upper Sonoran
Peromyscus truei W*	0.99	0.93	+589m U*, +468m L*	10	Upper Sonoran (west slope)
Peromyscus truei E*	0.99	0.98	+1062m U^N	>500	Transition (east slope)
Sorex monticolus W	0.99	0.97	-1003m L*	93	Canadian and Hudsonian
Sorex ornatus	0.32	0.93	-485m L*	133	Upper Sonoran
RANGE CONTRACTIONS					
Dipodomys heermanni	0.16	0.98	+63m L -293m U*	-37	Lower and Upper Sonoran
Perognathus parvus	0.99	0.99	-224m U^N	-49	Transition (east side)
Neotoma cinerea W	0.90	0.71	+609m L*, -719m U*	-94	Canadian - Arctic-Alpine
Neotoma cinerea E	0.92	0.71	+406m L^N	-54	Canadian - Arctic-Alpine
Microtus longicaudus W	0.99	0.98	+614m L*	-23	Transition - Hudsonian
Ochotona princeps E	na	na	+349m L^N	-163	Canadian - Arctic-Alpine
Ochotona princeps W	na	na	+497m L^N	-33	Canadian - Arctic-Alpine
Sorex palustris W	0.39	0.23	+512m L*	-34	Canadian and Hudsonian
Spermophilus beecheyi W	0.50	0.82	-250m U*	-9	Lower Sonoran - Canadian
Spermophilus beldingi E	na	0.83	+ 939m L^N	-91	Canadian - Arctic-Alpine
Spermophilus beldingi W	0.98	0.98	+ 355m L	-35	Canadian - Arctic-Alpine
Spermophilus lateralis W	0.70	0.89	+ 244m L*	-16	Transition - Hudsonian
Tamias minimus	0.82	0.98	-523m U^N	-66	Transition (east side)
Tamias senex	0.95	0.71	+1007m L^N, -334m U^N	-92	Canadian
Tamias alpinus E	na	na	gone?	gone?	Hudsonian - Arctic-Alpine
Tamias alpinus W	0.92	0.95	+629m L*	-92	Hudsonian - Arctic-Alpine

Zapus princeps W	0.98	0.9	+159m L*, -64m U*	-14	Transition - Hudsonian
NO CHANGE					
Dipodomys panamintinus	0.82	0.99	no change	0.00	Transition (east side)
Glaucomys sabrinus	na	0.10	no change	0.00	Transition - Canadian
Microtus longicaudus E	0.99	0.97	no change	0.00	Transition - Hudsonian
Microtus montanus E	0.67	0.99	no change	0.00	Transition - Hudsonian
Microtus montanus W	0.81	0.98	no change	0.00	Transition - Hudsonian
Neotoma macrotis	0.90	0.91	+ 67m U	0.00	Lower Sonoran - Transition
Peromyscus boylii	0.98	0.97	- 122m L	5.34	Upper Sonoran - Transition
Peromyscus maniculatus E	0.98	0.99	no change	0.00	Lower Sonoran - Arctic-Alpine
Peromyscus maniculatus W	0.99	0.99	no change	0.00	Lower Sonoran - Arctic-Alpine
Phenacomys intermedius	0.29	0.25	+ 185 L	0.00	Hudsonian
Sorex lyelli E	0.41	0.27	no change	0.00	Hudsonian
Sorex monticolus E	0.97	0.84	+85m L	-24.30	Canadian and Hudsonian
Sorex palustris E	0.26	na	no change	0.00	Canadian and Hudsonian
Sorex trowbridgii	0.71	0.88	no change	0.00	Transition - Canadian
Spermophilus beecheyi E	na	0.81	1st record	0.00	Lower Sonoran - Canadian
Spermophilus lateralis E	0.61	0.82	no change	0.00	Transition - Hudsonian
Tamias amoenus	0.98	0.95	no change	0.00	Transition - Canadian
Tamias merriami	0.52	0.07	no change	0.00	Upper Sonoran - Transition
Tamias quadrimaculatus	0.95	0.85	+ 50m U	0.00	Transition - Canadian
Tamias speciosus W	1.00	1.00	+ 128mL, +65m U	-4.54	Canadian - Hudsonian
Tamias speciosus E	1.00	1.00	no change	0.00	Canadian - Hudsonian
Tamiasciurus douglasi E	na	na	no change	0.00	Transition - Hudsonian
Tamiasciurus douglasi W	na	na	no change	0.00	Transition - Hudsonian
Thomomys bottae W	na	na	??	0.00	Lower Sonoran to Transition
Thomomys monticola	0.68	1	??	0.00	Canadian - Hudsonian
Zapus princeps E	0.99	0.91	no change	0.00	Transition - Hudsonian

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APPENDIX 1

“Before” and “After” photographs of four selected Grinnell-era sites in Yosemite National Park illustrating gross, qualitative vegetation changes from the early 1900s to the present. Photographs are in the archives of the Museum of Vertebrate Zoology.

Figure 1. Photograph comparisons of the east end of Stoneman Meadow, Yosemite Valley, looking towards Half Dome. Left: photo taken by Joseph Grinnell in May 1911; Right:. photo taken by Robert Hijmans in May 2003. Note almost complete shift in tree dominance from black oak to conifer (primarily Yellow pine) and encroachment of pine saplings onto meadow floor over the past 98 years.

Figure 2. Photograph comparisons of upper Lyell Fork meadow and Kuna Crest. Left: photo taken by Walter Taylor in July 1915; Right:. photo taken by Robert Hijmans in August 2003. Note increased density of lodgepole pine on slopes and slight encroachment of same into Lyell Fork meadow.

Figure 3. Photograph comparisons of the north end of Vogelsang Lake. Left: photo taken by Walter Taylor in July 1915; Right:. photo taken by Chris Conroy in July 2004. Note expansion and increased growth of white-bark pine, both around original campsite (tent visible on right of 1915 photo) and on granite slabs on far end of lake.

Figure 4. Photograph comparisons of Mt. Gibbs and Mt. Dana, from “Farington’s Ranch, south of Williams Butte, on the east side of the Sierra Nevada. Left: photo taken by Walter Taylor in June 1916; Right:. photo taken by Robert Hijmans in August 2003. Note expansion and increased density of Jeffrey pine (lower slopes) and lodgepole pine (upper slopes).

APPENDIX 2: Herpetological surveys, by year and site:

<u>2003</u>

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1. Hetch Hetchy Area, between Ranger Station and O'Shaughnessy Dam along Hetch Hetchy Road, 1175 – 1704 meters (32 georeferenced localities).

Hetch Hetchy contained the greatest amount of snake diversity of all sampled sites. Driving on roads at night proved to be the most productive method for finding both common and rare species. Three snake species believed to be scarce or even absent from the park were found driving the roads at night. These snakes include *Diadophis punctatus, Contia tenuis,* and *Hypsiglena torquata*. Of these three rare snakes species, *H. torquata* was surprisingly abundant in the Hetch Hetchy area.

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2. Foresta Area, between Hodgon Meadows Campground and Foresta Road along Big Oak Flat Road, 1350 – 1850 meters (16 georeferenced localities).

Two genetic lineages of *Sceloporus occidentalis* are in secondary contact in the Foresta area. It is unclear if these lineages are exchanging genes. Additional sampling throughout the area is needed to refine the species limits of this complex.
One pitfall array was installed at Foresta and monitored for five days. The pitfall array trapped six individual lizards (*S. occidentalis* N=5*, Aspidocelis tigris* N=1*).* These lizards were found in high abundance and were easily collected by noose. Thus, the pitfall array did not result in the discovery of any unsampled reptile or amphibian species at the Foresta site within the timeframe of our survey.

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3. Yosemite Valley, between Arch Rock entrance station and Happy Isles Nature Center, 1292 – 2277 meters (13 georeferenced localities).

Yosemite Valley contained the highest lizard diversity of all the sampled sites. An array of pitfall traps (16 1 gallon paint cans) was installed at Sentinel Beach and monitored for five days. The only species trapped was *Sceloporus graciosus*. This species was abundant in the area and easily captured by noose. The amphibian and snake diversity in Yosemite Valley is also high based on Museum records, although this diversity is not reflected in our 2003 sampling.

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4. Lyell Canyon, between Tuolumne Meadows and Mount Lyell, 2600 – 3200 meters (11 georeferenced localities).

Hydromantes platycephalus were found at their type locality visited by Grinnell and colleagues at the base of Mount Lyell as originally described by Camp in 1916. This nocturnal salamander was only found after dusk following a day of continuous rain. The reptile and amphibian diversity at Lyell Canyon is low due to the high elevation. The

only reptile species found was *Thamnophis elegans*. *Hyla regilla* and *Bufo canorus* tadpoles were found in several small ponds at high elevation, but were absent anywhere trout were present. *Hyla regilla* tadpoles and metamorphs were common in meadows along Lyell Canyon and were usually accompanied by *Thamnophis elegans.*

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5. Glen Aulin, between McGee Lake and California Falls (including Tenaya Lake, Olmsted Point, and Siesta Lake) 2100 – 5600 meters (25 georeferenced localities).

The high elevation subspecies of the Western Fence Lizard, *Sceloporus occidentalis taylori*, is common in Glen Aulin. The scientific literature suggests that this subspecies may warrant species status due to its unique morphological features (e.g., extensive blue ventral pigmentation, dark dorsal pigmentation, and large size). Our preliminary mtDNA sequence data reject this hypothesis. Multiple high elevation populations of this putative species do not form a monophyletic group. This result is intriguing because it implies multiple, independent origins of the unique high-elevation phenotype exhibited by *S. o. taylori*. Populations of *S. occidentalis* at lower elevation have light dorsal coloration, less ventral pigmentation, and are smaller in size. Specimens of *Sceloporus occidentalis* collected along an elevational transect following the Grand Canyon of the Tuolumne from Glen Aulin to Return Creek graded in morphology from the high-elevation "*taylori*" phenotype to the low-elevation phenotype. Additional sampling is required to extend this transect from Return Creek to Hetch Hetchy. A potential genetic contact zone exists along this portion of the Grand Canyon of the Tuolumne transect.

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6. Bridalveil Creek, between Glacier Point and Chinquapin, 1800 – 2300 meters (15 georeferenced localities).

Two pitfall arrays were installed at Bridalveil Creek and monitored for five days. The pitfall traps captured one *Sceloporus graciosus* and a gopher (*Thomomys monticola*). These lizards were scarce in the heavily forested area where the pitfall array was installed. Mountain Yellow-legged frogs (*Rana muscosa*) were found at Summit and Monroe Meadow. Both adult frogs and tadpoles were found. *Sceloporus graciosus* and *S. occidentalis* were common at Glacier Point. All meadows visited contained *Hyla regilla* tadpoles and *Thamnophis elegans.* These species were common in all wet meadows throughout the Park.

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7. Wawona Area, between Mariposa Grove and Rail Creek along Wawona Road, 1200 – 2000 meters (16 georeferenced localities).

After warm winter rains in December, Sierra Nevada salamanders (*Ensatina eschscholtzii platensis*) were common on the forest floor under pine logs in the Wawona area. Slender salamanders (*Batrachoseps gregarius)* were difficult to find and appear to be scarce in the Park. Higher species diversity is expected at Wawona, however our sampling did not begin until late summer when reptiles and amphibians are less abundant.

Table 1. Reptile and amphibian species collected in Yosemite National Park. General collecting localities and numbers of individuals taken are shown. Shaded boxes indicate species considered to be common in Yosemite. Shaded species names indicate common California species

	Hetch Hetchy	Foresta	Yosemite Valley	Lyell Canyon	Glen Aulin	Bridalveil Creek	Wawona
Frogs (3 species)							
Bufo canorus				13			
Hyla regilla	6	1		14	29	26	
Rana muscosa						8	
Salamanders (3 species)							
Batrachoseps gregarius							4
Ensatina eschscholtzii						2	20
Hydromantes platycephalus				5			
Lizards (6 species)							
Aspidoscelis tigris		5					
Elgaria coerulea		2	3		4	1	1
Elgaria multicarinata	1		1				
Eumeces gilberti			3				
Sceloporus graciosus		1	15		21	14	
Sceloporus occidentalis	12	24	15		99*	11	11
Snakes (13 species)							
Charina bottae	1				3		
Coluber constrictor			1				
Contia tenuis	1						
Crotalus viridis	1				1		
Diadophis punctatus	1						
Hypsiglena torquata	13						
Lampropeltis zonata	2						
Masticophis lateralis	1	2					
Pituophis catenifer	5	1					
Thamnophis couchii	2		1				1
Thamnophis elegans				10	29	21	
Total	46	36	39	42	186	83	37

* Combined total of 14 populations including Glen Aulin, Tenaya Lake, Olmsted Point, McGee Lake, and Return Creek. Mean number of specimens collected per population = 7.1.

2004

Amphibian and reptile species recorded during the 2004 field season.

Common Name	Scientific Name
mount lyell salamander	*Hydromantes platycephalus*

yosemite toad	*Bufo canorus*
pacific treefrog	*Hyla regilla*
Bullfrog*	*Rana catesbiana*
mountain yellow-legged frog	*Rana muscosa*
western whiptail lizard	*Aspidoscelis tigris*
gilbert skink	*Eumeces gilberti*
northern alligator lizard	*Elgaria coerulea*
southern alligator lizard	*Elgaria multicarinata*
sagebrush lizard	*Sceloporus graciosus*
western fence lizard	*Sceloporus occidentalis*
rubber boa	*Charina bottae*
gopher snake	*Pituophis catenifer*
night snake	*Hypsiglena torquata*
california whipsnake	*Masticophis lateralis*
western aquatic garter snake	*Thamnophis couchii*
western terrestrial garter snake	*Thamnophis elegans*
western rattlesnake	*Crotalus viridis*

1. vicinity of Porcupine Flat

Locality	Latitude	Longitude	Species
10 Lakes trail near Colby Mt	37.89616	-119.54510	*Elgaria coerulea, Thamnophis elegans*
3.5 mi on Hwy 120 SW of entrance to White Wolf Campground	37.83400	-119.69728	*Sceloporus graciosus*
From May Lake Trailhead to May Lake	37.84105	-119.49166	*Sceloporus occidentalis*
Harden Lake	37.89416	-119.67750	*Hyla regilla, Thamnophis elegans*
Mammal site at turnout ~3.5 mi E White Wolf junction	37.83890	-119.59295	*Sceloporus graciosus*
McSwain Meadow trap line	37.85193	-119.62811	*Hyla regilla, Bufo canorus*
North Dome	37.76022	-119.55880	*Sceloporus graciosus, S. occidentalis*
Porcupine Flat, N of road in creek	37.81188	-119.56390	*Hyla regilla*
Porcupine Flat	37.80701	-119.56500	*Elgaria coerulea*
Pothole Dome	37.87863	-119.41233	*Sceloporus occidentalis*
Return trail from North Dome	37.76936	-119.55708	*Sceloporus graciosus*
Upper White Wolf camp	37.86644	-119.64773	*Hyla regilla*
Yosemite Creek Campground	37.82693	-119.59547	*Sceloporus graciosus, S. occidentalis*
Yosemite Creek on 10 Leuker Trail	37.58540	-119.57218	*Sceloporus graciosus*
Yosemite Creek trail to 10 Lakes	37.86342	-119.57195	*Sceloporus graciosus*

Family	Species	Commonness	# Localities
Hylidae	*Pseudacris regilla*	common	4
Bufonidea	*Bufo canorus*	uncommon	1
Phrynosomatidae	*Sceloporus graciosus*	common	7
Phrynosomatidae	*Sceloporus occidentalis*	common	4
Anguidae	*Elgaria coerulea*	uncommon	2

Colubridae	*Thamnophis elegans*	common	1

2. Vogelsang Lake

Locality	Latitude	Longitude	Species
0.5 km N Tuolumne Pass	37.81046	-119.33971	*Bufo canorus*
E end of Townsley Lake	37.79273	-119.32830	*Bufo canorus*
E side of Vogelsang Lake	37.78827	-119.34250	*Hydromantes platycephalus*
Fletcher Creek, SE of Emeric Lake	37.77634	-119.38064	*Bufo canorus, Hyla regilla*
Pond ~0.25 km W of Boothe Lake	37.79993	-119.35178	*Hyla regilla*
Pond ~0.5 km NE of Evelyn Lake	37.80342	-119.33291	*Bufo canorus, Hyla regilla*
Pond ~0.5 km NE of Townsley Lake	37.79744	-119.32874	*Hyla regilla*
Pond at S end of Vogelsang Lake	37.78476	-119.34244	*Hyla regilla*
Pond NE of Evelyn Lake	37.81044	-119.32504	*Hyla regilla*
Pond NW of Evelyn Lake	37.80799	-119.33141	*Hyla regilla*
Pond on E side of trail, Tuolumne Pass	37.80494	-119.34035	*Hyla regilla, Thamnophis elegans*
SW end of Boothe Lake	37.79834	-119.34946	*Hyla regilla*
SW end of Townsley Lake	37.79275	-119.32952	*Bufo canorus*
unnamed lake, ~1 km E (by trail) Evelyn Lake	37.81059	-119.30991	*Bufo canorus, Hyla regilla, Rana muscosa*

Family	**Species**	**Commonness**	**# Localities**
Bufonidae	*Bufo canorus*	uncommon	6
Hylidae	*Hyla regilla*	common	10
Ranidae	*Rana muscosa*	rare	1
Plethodontidae	*Hydromantes platycephalus*	rare	2
Colubridae	*Thamnophis elegans*	uncommon at high elevation	1

Notable observations:

1. Discovery of a new population of *Hydromantes platycephalus* from Vogelsang Lake (two localities.
2. Breeding populations of *Rana muscosa* and *Bufo canorus* at unnamed lake 0.5 km east of Evelyn Lake

3. Merced Lake

Locality	Latitude	Longitude	Species
~0.2 mi S jct Vogelsang Pass and Merced Lake, ~1.6 mi E Merced Lake	37.74199	-119.39129	*Hyla regilla, Sceloporus occidentalis*
~1 mi NE Merced Lake	37.7412	-119.39444	*Sceloporus graciosus*
~1.2 mi NE of Merced Lake	37.74214	-119.39345	*Sceloporus graciosus*
~100 m E Merced Lake High Sierra Camp	37.73821	-119.40529	*Charina bottae*
~300 m W Little Yosemite Valley Campground	37.72992	-119.52447	*Sceloporus graciosus, S. occidentalis*
0.7 mi N Echo Valley junction, Echo Valley	37.75249	-119.44099	*Elgaria coerulea*
1 km E Merced Lake	37.73946	-119.40217	*Thamnophis elegans*
100 m E Merced High Sierra Camp	37.73811	-119.40462	*Sceloporus graciosus, S.*

			occidentalis
Babcock Lake	37.7569	-119.39650	*Hyla regilla, Thamnophis elegans*
base of Moraine Dome along trail	37.73639	-119.48036	*Hyla regilla, Sceloporus graciosus, S. occidentalis*
Merced River, 0.6 mi W Echo Valley	37.7413	-119.44614	*Hyla regilla*
E side of Bunnell Point along trail	37.73778	-119.45824	*Hyla regilla*
Echo Valley	37.74715	-119.43634	*Sceloporus graciosus, S. occidentalis*
Jct John Muir and Mist trails	37.7252	-119.45930	*Sceloporus graciosus*
Jct Vogelsang Pass and Merced Lake trails	37.74397	-119.38708	*Sceloporus graciosus*
Near Little Yosemite Valley Campground	37.73116	-119.52009	*Sceloporus graciosus, S. occidentalis*
NW end Washburn Lake	37.71835	-119.37406	*Sceloporus occidentalis*
trail between Babcock Lake trail and Merced Ranger Station	37.74231	-119.39352	*Elgaria coerulea, Sceloporus occidentalis*
W side Fletcher Creek, SE Babcock Lake	37.75745	-119.39050	*Hyla regilla, Thamnophis elegans*

Family	Species	Commonness	# Localities
Hylidae	*Hyla regilla*	common	6
Anguidae	*Elgaria coerulea*	uncommon	2
Phrynosomatidae	*Sceloporus graciosus*	common	9
Phrynosomatidae	*Sceloporus occidentalis*	common	8
Colubridae	*Thamnophis elegans*	common	3
Boidae	*Charina bottae*	rare	1

4. Hetch Hetchy

Locality	Latitude	Longitude	Species
~0.5 mi S Ranger Station, Hetch Hetchy	37.88845	-119.85043	*Sceloporus occidentalis*
1.5 mi N of entrance station on E side of road, Hetch Hetchy	37.90305	-119.83464	*Sceloporus occidentalis, Aspidoscelis tigris*
Between Kibbie Ridge and Kibbie Creek, vicinity Lake Eleanor	38.00946	-119.87469	*Sceloporus occidentalis, Crotalus viridis*
Cherry Lake Rd (17), ~5 mi N (by road) Hwy. 120	37.86377	-119.98044	*Pituophis catenifer*
First entrance gate, Hetch Hetchy	37.88374	-119.85378	*Thamnophis elegans*
Hetch Hetchy Road (between Ranger Station and Dam)	37.91219	-119.80981	*Hyla regilla, Hypsiglena torquata, Pituophis catenifer, Crotalus viridis*
Hetch Hetchy Reservoir Dam	37.94723	-119.78532	*Masticophis lateralis*
N side Hetch Hetchy Reservoir	37.95725	-119.78432	*Sceloporus occidentalis, Aspidoscelis tigris*
shower at Ranger Camp, Hetch Hetchy	37.89314	-119.84165	*Hyla regilla*
trail to Lake Eleanor Camp	37.98698	-119.88412	*Sceloporus graciosus*

Family	Species	Commonness	# Localities
Hylidae	*Hyla regilla*	common	2
Teidae	*Aspidoscelis tigris*	common	2
Phrynosomatidae	*Sceloporus graciosus*	uncommon	1
Phrynosomatidae	*Sceloporus occidentalis*	common	4
Colubridae	*Thamnophis elegans*	uncommon	1
Colubridae	*Hypsiglena torquata*	uncommon	1
Colubridae	*Pituophis catenifer*	uncommon	2
Colubridae	*Masticophis lateralis*	uncommon	1
Viperidae	*Crotalus viridis*	uncommon	2

5. Yosemite Valley (8-11 August)

Locality	Latitude	Longitude	Species
~0.5 - 1.5 mi from trailhead of 4-mile trail	37.72983	-119.59753	*Sceloporus occidentalis*
~50 m up Glacier Point Trail, Yellowpine Camp	37.72437	-119.60287	*Sceloporus graciosus, S. occidentalis*
4-mile trail trailhead	37.73151	-119.59934	*Sceloporus graciosus*
Base of Bridalveil Falls in spray zone W pool	37.71617	-119.65128	*Hydromantes platycephalus*
Cascade Creek	37.72374	-119.71124	*Elgaria multicarinata, Sceloporus occidentalis, Thamnophis couchii*

Family	Species	Commonness	# Localities
Plethodontidae	*Hydromantes platycephalus*	rare	1
Anguidae	*Elgaria multicarinata*	uncommon	1
Phrynosomatidae	*Sceloporus graciosus*	common	2
Phrynosomatidae	*Sceloporus occidentalis*	common	3
Colubridae	*Thamnophis couchii*	common	1

6. Foresta Road

Locality	Latitude	Longitude	Species
~1.5 mi by road off Big Oak Flat Road on Foresta Road	37.70284	-119.74478	*Sceloporus occidentalis*
~2.0 mi by road off Big Oak Flat Rd. on Foresta Rd.	37.70265	-119.70567	*Sceloporus occidentalis*
~2.0 mi by road off Big Oak Flat Rd. on Foresta Rd.	37.70265	-119.70567	*Elgaria multicarinata, Sceloporus occidentalis*
1 mi E of Crane Flat, Big Oak Flat Rd.	37.74808	-119.78035	*Masticophis lateralis*
Big Oak Flat Road, 0.4 mi W of Foresta Rd.	37.71557	-119.73821	*Masticophis lateralis*
Foresta Rd.	37.70403	-119.73315	*Aspidoscelis tigris, Eumeces gilberti, Sceloporus occidentalis*
Hodgdon Meadows Campground	37.7976	-119.86618	*Sceloporus graciosus*
Tamarack Creek	37.7505	-119.72898	*Sceloporus graciosus*

Tamarack Flat	37.7512	-119.73296	*Sceloporus graciosus*

Family	Species	Commonness	# Localities
Teidae	*Aspidoscelis tigris*	uncommon	1
Anguidae	*Elgaria multicarinata*	uncommon	1
Phrynosomatidae	*Sceloporus graciosus*	common	3
Phrynosomatidae	*Sceloporus occidentalis*	common	4
Scincidae	*Eumeces gilberti*	uncommon	1
Colubridae	*Masticophis lateralis*	uncommon	2

7. Pate Valley

Locality	Latitude	Longitude	Species
Tuolumne River, between Hetch Hetchy Reservoir and Pate Valley*	37.91699 to 37.91838	-119.66160 to -119.62648	*Hyla regilla, Sceloporus occidentalis, Thamnophis couchii, Crotalus viridis*
Pate Valley**	37.93151 to 37.93106	-119.59417 to -119.55691	*Hyla regilla, Sceloporus occidentalis, Thamnophis couchii, Crotalus viridis*

* represents 21 separate GPS localities
** represents 12 separate GPS localities

Family	Species	Commonness	# Localities
Hylidae	*Hyla regilla*	Common	6
Phrynosomatidae	*Sceloporus occidentalis*	Common	18
Colubridae	*Thamnophis couchii*	Common	3
Viperidae	*Crotalus viridis*	Common	8

2005

Dorothy Lake Area

Locality	Latitude	Longitude	Species
On trail south of Leavitt Meadows, N Roosevelt Lake	38.29783	119.54221	*Thamnophis elegans*
On trail south of Leavitt Meadows, S Lane Lake	38.28542	119.53897	*Elgaria coerulea*
~100m S of Dorothy Lake	38.17303	119.59591	*Thamnophis elegans, Pseudacris regilla*
On east side of ridge ~750m S Bond Pass	38.16594	119.61033	*Pseudacris regilla*
On top of ridge, about 0.5km S Bond Pass	38.16776	119.61063	*Pseudacris regilla*
Grizzly Meadow, about 0.5km SW Emigrant Pass			

			platycephalus
On ridge above Grace Meadow	38.14054	119.61824	*Thamnophis elegans*
Grace Meadow, SE Bigelow Peak	38.14326	119.61478	*Pseudacris regilla*
0.5km NW Dorothy Lake Pass	38.18458	119.58434	*Pseudacris regilla*
Pond at NW end of Grace Meadow	38.1416	119.61604	*Pseudacris regilla*
About 0.5km S Emigrant Pass	38.19545	119.63547	*Bufo canorus*
About 100m E Emigrant Meadow Lake on trail from Grizzly Meadow	38.20243	119.64116	*Bufo canorus*
Outflow dam on west side of Emigrant Meadow Lake	38.20068	119.65139	*Bufo canorus*
About 0.75km NW of outflow dam on west side of Emigrant Meadow Lake	38.20648	119.6553	*Bufo canorus*
About 0.75km SW of Emigrant Pass	38.19543	119.63842	*Bufo canorus*
S end of Grace Meadow	38.13468	119.61919	*Thamnophis elegans*
about 400m N Grace Meadow along PCT	38.14632	119.61263	*Elgaria coerulea*
SE side of Dorothy Lake	38.17303	119.59293	*Rana muscosa*

Family	Species	Commonness	# Localities
Bufonidae	*Bufo canorus*	uncommon	6
Hylidae	*Pseudacris regilla*	common	7
Ranidae	*Rana muscosa*	rare	1
Plethodontidae	*Hydromantes platycephalus*	rare	1
Colubridae	*Thamnophis elegans*	common	4
Anguidae	*Elgaria coerulea*	uncommon	2

Notable observations:

- Discovery of a new population of *Hydromantes platycephalus* from Middle Emigrant Lake
- Healthy adult *Rana muscosa* found at Dorothy Lake

APPENDIX 3: Avian surveys

Table 1. Lists of bird species and numbers of direct observations (recorded by sight or sound) at each site and transect in Yosemite National Park during the 2003 and 2004 surveys.

SITE	Chinquapin	**CH**	CraneFlat	**CF**	GlenAulin			**GA**	IndianCanyon	**IC**	LyellMeadows	**LM**
TRANSECT		**TOTAL**		**TOTAL**	ColdCanyon	McGeeLake	Waterwheel	**TOTAL**		**TOTAL**		**TOTAL**
SPECIES												
acorn woodpecker												
american dipper												
american green-winged teal											2	**2**
american pipit												
american robin	81	**81**	72	**72**	3	11	10	**24**	35	**35**	77	**77**
anna's hummingbird												
band-tailed pigeon	2	**2**				1		**1**				
belted kingfisher							3	**3**			2	**2**
bewick's wren												
black phoebe											1	**1**
black swift												
black-backed woodpecker												
black-headed grosbeak	8	**8**	13	**13**					2	**2**		
black-throated grey warbler			3	**3**								
blue grouse					3			**3**	2	**2**		
blue-grey gnatcatcher												
blue-winged teal											16	**16**
brewer's blackbird	58	**58**	51	**51**							30	**30**
brown creeper	17	**17**	15	**15**	11	13	12	**36**	22	**22**	23	**23**
brown-headed cowbird			1	**1**							1	**1**
bullock's oriole												
bushtit					2		12	**14**				
california gull											1	**1**
calliope hummingbird			1	**1**			1	**1**				
canyon wren					1			**1**				
cassin's finch	23	**23**	1	**1**	17	3	9	**29**	24	**24**	49	**49**
cassin's vireo	24	**24**	32	**32**		1	3	**4**	7	**7**		
chestnut-backed												

[redacted]dee												
[redacted]ng sparrow	24	**24**	33	**33**					3	**3**	1	**1**
[redacted] nutcracker					19	20	30	**69**			54	**54**
[redacted]on merganser												
[redacted]on raven	3	**3**	7	**7**					2	**2**	3	**3**
[redacted]yed junco	183	**183**	125	**125**	54	24	21	**99**	84	**84**	236	**236**
[redacted] woodpecker												
[redacted]flycatcher	88	**88**	43	**43**	4	3	6	**13**				

pine grosbeak					1			**1**				
pine siskin	4	**4**	3	**3**					3	**3**	22	**22**
prairie falcon												
purple finch	8	**8**	3	**3**							7	**7**
pygmy nuthatch									1	**1**		
red crossbill									1	**1**	4	**4**
red-breasted nuthatch	174	**174**	105	**105**	4	12	7	**23**	95	**95**		
red-breasted sapsucker	24	**24**	5	**5**					15	**15**		
red-tailed hawk	1	**1**	1	**1**							1	**1**
red-winged blackbird											88	**88**
rock wren									1	**1**		
ruby-crowned kinglet	1	**1**									8	**8**
rufous hummingbird											2	**2**
song sparrow	5	**5**	7	**7**			6	**6**			24	**24**
spotted sandpiper							4	**4**			4	**4**
spotted towhee	2	**2**	1	**1**					9	**9**		
steller's jay	82	**82**	39	**39**	18	56	22	**96**	88	**88**	8	**8**
townsend's solitaire	18	**18**	5	**5**	9	4	3	**16**	26	**26**	6	**6**
violet-green swallow									4	**4**		
warbling vireo	38	**38**	49	**49**			3	**3**			7	**7**
western bluebird	1	**1**										
western scrub-jay												
western tanager	113	**113**	56	**56**					100	**100**		
western wood-pewee	7	**7**	5	**5**		1	20	**21**	18	**18**	1	**1**
white-breasted nuthatch	2	**2**			5	4	2	**11**	2	**2**	7	**7**
white-crowned sparrow											60	**60**
white-headed woodpecker	53	**53**	23	**23**					23	**23**		
white-throated swift	1	**1**	2	**2**					28	**28**		
williamson's sapsucker					1			**1**	8	**8**	1	**1**
wilson's warbler	13	**13**				1	5	**6**			4	**4**
winter wren	10	**10**	14	**14**					1	**1**		
yellow warbler												
yellow-rumped warbler	263	**263**	176	**176**	81	71	7	**159**	180	**180**	174	**174**
Grand Total	**2199**	**2199**	**1419**	**1419**	**313**	**306**	**270**	**889**	**1238**	**1238**	**1215**	**1215**

SITE	MercedGrove	**MG**	MonoMeadow		**MM**	NevadaFalls	**NF**	Mt. Lyell		**Mly**	MirrorLake	**MLa**
TRANSECT		**TOTAL**	McGurkMeadow	MonoMeadow	**TOTAL**		**TOTAL**	DonohuePass	MaclureCreek	**TOTAL**		**TOTAL**
SPECIES												
acorn woodpecker											42	**42**
american dipper									6	**6**		
american green-winged teal												
american pipit								11	1	**12**		
american robin	55	**55**	41	29	**70**	5	**5**	9	13	**22**	91	**91**
anna's hummingbird						1	**1**				2	**2**
band-tailed pigeon	1	**1**									3	**3**
belted kingfisher												
bewick's wren												
black phoebe												
black swift				1	**1**	4	**4**					
black-backed woodpecker			5	1	**6**							
black-headed grosbeak	9	**9**				3	**3**				86	**86**
black-throated grey warbler						7	**7**				12	**12**
blue grouse				3	**3**							
blue-grey gnatcatcher												
blue-winged teal												
brewer's blackbird				16	**16**			5	8	**13**	56	**56**
brown creeper	40	**40**	16	17	**33**			2	2	**4**	15	**15**
brown-headed cowbird											14	**14**
bullock's oriole											8	**8**
bushtit	10	**10**										
california gull												
calliope hummingbird	3	**3**	1	1	**2**				2	**2**		
canyon wren												
cassin's finch			14	8	**22**	2	**2**	8	17	**25**	1	**1**
cassin's vireo	58	**58**	3	14	**17**	1	**1**				49	**49**
chestnut-backed chickadee	9	**9**										
chipping sparrow	5	**5**	18	2	**20**							
clark's nutcracker								10	12	**22**		
common merganser												

common raven	14	**14**	2	8	**10**						3	**3**
dark-eyed junco	167	**167**	126	57	**183**	5	**5**	39	50	**89**	3	**3**
downy woodpecker											6	**6**
dusky flycatcher	47	**47**	46	22	**68**			11	15	**26**		
evening grosbeak			13	4	**17**							
fox sparrow	67	**67**	7	10	**17**							
golden-crowned kinglet	110	**110**	30	40	**70**	1	**1**				1	**1**
green-tailed towhee	5	**5**										
grey-crowned rosy-finch								31	66	**97**		
hairy woodpecker	18	**18**	10	11	**21**	1	**1**		1	**1**	7	**7**
hammond's flycatcher	33	**33**	15	10	**25**							
hermit thrush	20	**20**	20	32	**52**				1	**1**		
hermit warbler	120	**120**	6	5	**11**	4	**4**					
horned lark												
house wren	2	**2**	2		**2**						3	**3**
hutton's vireo											2	**2**
killdeer												
lazuli bunting												
lesser goldfinch												
lincoln's sparrow			14	32	**46**							
macgillivray's warbler	120	**120**	3	14	**17**						24	**24**
mallard											2	**2**
mountain bluebird								1	7	**8**		
mountain chickadee	91	**91**	60	94	**154**	18	**18**	20	24	**44**	11	**11**
mountain quail	5	**5**	26	25	**51**	17	**17**				2	**2**
mourning dove												
nashville warbler	25	**25**	13	11	**24**	30	**30**				15	**15**
northern flicker	23	**23**	3	2	**5**	3	**3**		2	**2**	37	**37**
northern pygmy-owl	1	**1**										
northern rough-winged swallow												
olive-sided flycatcher	2	**2**	1	2	**3**			1		**1**		
orange-crowned warbler	1	**1**	2		**2**	1	**1**	1		**1**		
pacific-slope flycatcher	65	**65**									45	**45**
pileated woodpecker	12	**12**		6	**6**	2	**2**					
pine grosbeak			3		**3**							
pine siskin			12	1	**13**			2	1	**3**		
prairie falcon									1	**1**		
purple finch	5	**5**										

pygmy nuthatch												
red crossbill												
red-breasted nuthatch	124	**124**	69	48	**117**	5	**5**				5	**5**
red-breasted sapsucker	4	**4**	15	25	**40**	1	**1**					
red-tailed hawk	1	**1**						1	1	**2**		
red-winged blackbird			6		**6**						31	**31**
rock wren								2		**2**		
ruby-crowned kinglet												
rufous hummingbird								2	2	**4**		
song sparrow			7	17	**24**	1	**1**				40	**40**
spotted sandpiper									3	**3**	12	**12**
spotted towhee	65	**65**				6	**6**				7	**7**
steller's jay	82	**82**	58	53	**111**	20	**20**				113	**113**
townsend's solitaire	7	**7**	4	13	**17**				4	**4**		
violet-green swallow												
warbling vireo	56	**56**	14	42	**56**	10	**10**				48	**48**
western bluebird												
western scrub-jay	2	**2**										
western tanager	42	**42**	15	49	**64**	19	**19**				13	**13**
western wood-pewee	2	**2**	12	22	**34**	13	**13**				68	**68**
white-breasted nuthatch	2	**2**		2	**2**	4	**4**					
white-crowned sparrow								16	34	**50**		
white-headed woodpecker	36	**36**	9	12	**21**	2	**2**					
white-throated swift			3	1	**4**	8	**8**				19	**19**
williamson's sapsucker			4	2	**6**							
wilson's warbler			6	10	**16**							
winter wren	35	**35**	3		**3**						12	**12**
yellow warbler											14	**14**
yellow-rumped warbler	106	**106**	99	74	**173**	7	**7**	18	28	**46**	2	**2**
Grand Total	**1707**	**1707**	**836**	**848**	**1684**	**201**	**201**	**190**	**301**	**491**	**924**	**924**

SITE	PorcupineFlat		PF	TamarackFlat	TF	TuolumneMeadows	TM	Vogelsang		V	YosemiteValley		YV
TRANSECT	MayLake	PF	**TOTAL**		**TOTAL**		**TOTAL**	Evelyn	Vogelsang	**TOTAL**	North YV	YV	**TOTAL**
SPECIES													
acorn woodpecker											26	53	**79**
american dipper													
american green-winged teal						1	**1**						
american pipit								3	4	**7**			
american robin	57	6	**63**	16	**16**	84	**84**	14	11	**25**	52	78	**130**
anna's hummingbird											8	8	**16**
band-tailed pigeon											1	2	**3**
belted kingfisher													
bewick's wren											1		**1**
black phoebe								1	1	**2**		2	**2**
black swift													
black-backed woodpecker	1	1	**2**			4	**4**						
black-headed grosbeak				2	**2**						102	66	**168**
black-throated grey warbler											48	15	**63**
blue grouse	1		**1**										
blue-grey gnatcatcher												1	**1**
blue-winged teal													
brewer's blackbird	14		**14**			170	**170**	44	2	**46**	32	92	**124**
brown creeper	15	5	**20**	10	**10**	7	**7**		1	**1**	18	20	**38**
brown-headed cowbird						14	**14**				15	14	**29**
bullock's oriole											1	19	**20**
bushtit													
california gull						2	**2**						
calliope hummingbird									1	**1**			
canyon wren											2	5	**7**
cassin's finch	63	5	**68**	31	**31**	65	**65**	29	23	**52**			
cassin's vireo				14	**14**						49	45	**94**
chestnut-backed chickadee												1	**1**
chipping sparrow	7	3	**10**	32	**32**	28	**28**	1		**1**	11	3	**14**
clark's nutcracker	8		**8**			18	**18**	126	39	**165**			

common merganser								1		**1**		11	**11**
common raven	1		**1**	6	**6**	5	**5**	2		**2**	13	23	**36**
dark-eyed junco	102	10	**112**	79	**79**	146	**146**	57	120	**177**	42	41	**83**
downy woodpecker												1	**1**
dusky flycatcher	12	2	**14**	94	**94**	42	**42**	33	37	**70**	2		**2**
evening grosbeak	3	2	**5**	3	**3**	1	**1**				5	2	**7**
fox sparrow	18	4	**22**	102	**102**				1	**1**		1	**1**
golden-crowned kinglet	17	25	**42**	44	**44**						1	3	**4**
green-tailed towhee				20	**20**								
grey-crowned rosy-finch								4	26	**30**			
hairy woodpecker	14	3	**17**	13	**13**	2	**2**	1	2	**3**	11	9	**20**
hammond's flycatcher				18	**18**								
hermit thrush	24	16	**40**	20	**20**	24	**24**	7	18	**25**			
hermit warbler				53	**53**						1	10	**11**
horned lark								5		**5**			
house wren									3	**3**	1		**1**
hutton's vireo											5	4	**9**
killdeer						12	**12**						
lazuli bunting		1	**1**	2	**2**							1	**1**
lesser goldfinch				1	**1**						1		**1**
lincoln's sparrow				4	**4**	9	**9**						
macgillivray's warbler				46	**46**						1	13	**14**
mallard						7	**7**		7	**7**		15	**15**
mountain bluebird	2		**2**			1	**1**	5		**5**			
mountain chickadee	80	54	**134**	101	**101**	47	**47**	43	20	**63**	27	12	**39**
mountain quail	22	1	**23**	52	**52**						9	1	**10**
mourning dove													
nashville warbler									3	**3**	56	17	**73**
northern flicker	4		**4**	29	**29**	10	**10**				11	29	**40**
northern pygmy-owl													
northern rough-winged swallow												1	**1**
olive-sided flycatcher	3		**3**	27	**27**	1	**1**				3	1	**4**
orange-crowned warbler								2	14	**16**			
pacific-slope flycatcher											2	3	**5**
pileated woodpecker											1		**1**
pine grosbeak	13		**13**										
pine siskin	82	2	**84**	2	**2**	233	**233**	16	9	**25**			
prairie falcon						1	**1**						

purple finch		2	**2**			13	**13**						
pygmy nuthatch													
red crossbill	2	1	**3**			44	**44**						
red-breasted nuthatch	12	20	**32**	118	**118**	8	**8**	2		**2**	3	7	**10**
red-breasted sapsucker		1	**1**	13	**13**								
red-tailed hawk				1	**1**			2		**2**			
red-winged blackbird						21	**21**				15	184	**199**
rock wren								1		**1**			
ruby-crowned kinglet						29	**29**						
rufous hummingbird									4	**4**		1	**1**
song sparrow						19	**19**				13	86	**99**
spotted sandpiper	3		**3**			13	**13**	3	3	**6**	4	38	**42**
spotted towhee											2	2	**4**
steller's jay	26	8	**34**	53	**53**	4	**4**		2	**2**	59	104	**163**
townsend's solitaire	3	3	**6**	13	**13**	1	**1**						
violet-green swallow											9	17	**26**
warbling vireo		1	**1**	29	**29**	15	**15**				31	67	**98**
western bluebird													
western scrub-jay													
western tanager	8	15	**23**	65	**65**	3	**3**				54	57	**111**
western wood-pewee	1	2	**3**	25	**25**	20	**20**				53	93	**146**
white-breasted nuthatch	8		**8**	6	**6**	10	**10**	7		**7**			
white-crowned sparrow	1		**1**			40	**40**	58	66	**124**			
white-headed woodpecker		2	**2**	30	**30**						9	11	**20**
white-throated swift											56	51	**107**
williamson's sapsucker	10	1	**11**	1	**1**	1	**1**						
wilson's warbler									4	**4**	1	1	**2**
winter wren													
yellow warbler						10	**10**				7	53	**60**
yellow-rumped warbler	116	61	**177**	152	**152**	84	**84**	77	55	**132**	7	10	**17**
Grand Total	**753**	**257**	**1010**	**1327**	**1327**	**1269**	**1269**	**544**	**476**	**1020**	**881**	**1404**	**2285**

Table 2. Lists of bird species and numbers of direct observations (recorded by sight or sound) across all comparable transects (Table 4) of the original Grinnell era and by our resurvey efforts. Species that were uniquely found during either survey period are indicated by boxes around their respective number of observations.

Species	Grinnell	2003-2004	Species	Grinnell	2003-2004
Acorn woodpecker	133	273	Lazuli bunting	127	58
American crow	2	48	Lesser goldfinch	105	127
American goldfinch	96	55	Lesser nighthawk	5	
American green-winged teal		3	Lewis' woodpecker	9	
American kestrel	11	10	Lincoln's sparrow	25	95
American robin	322	643	Loggerhead shrike	14	
Anna's hummingbird	8	46	Macgillivray's warbler	47	211
Ash-throated flycatcher	156	261	Mallard		59
Band-tailed pigeon	64	12	Marsh wren		6
Barn Owl	1		Mountain bluebird	33	3
Barn swallow	60	7	Mountain chickadee	249	859
Bell's vireo	38		Mountain quail	65	204
Belted kingfisher	6	16	Mourning dove	314	174
Bewick's wren	70	302	Nashville warbler	82	149
Black phoebe	31	67	Northern flicker	68	196
Black swift		1	Northern harrier	1	
Black-backed woodpecker	3	12	Northern mockingbird	6	1
Black-chinned hummingbird	1		Northern pygmy-owl		1
Black-crowned night-heron	1		Northern rough-winged swallow		19
Black-headed grosbeak	331	471	Nuttall's woodpecker	32	44
Black-throated grey warbler	105	64	Oak titmouse	95	143
Blue grosbeak	10		Olive-sided flycatcher	42	55
Blue grouse	14	6	Orange-crowned warbler	5	37
Blue-grey gnatcatcher	148	16	Osprey	1	3
Blue-winged teal		16	Pacific-slope flycatcher	9	81
Brewer's blackbird	122	457	Phainopepla	22	31
Brewer's sparrow	2		Pied-billed grebe		5
Brown creeper	76	203	Pileated woodpecker	10	32
Brown-headed cowbird	2	168	Pine grosbeak		16
Bullock's oriole	118	103	Pine siskin	121	359
Burrowing owl	2		Prairie falcon		1
Bushtit	79	120	Purple finch	61	40
California gull	1	3	Pygmy nuthatch		1
California quail	178	219	Red crossbill	2	52
California thrasher	59	6	Red-breasted nuthatch	80	565
California towhee	116	154	Red-breasted sapsucker	7	84
Calliope hummingbird	23	5	Red-shouldered hawk	2	28
Canada goose		9	Red-tailed hawk	6	24
Canyon wren	29	14	Red-winged blackbird	188	461
Cassin's finch	94	251	Rock wren	19	29

Cassin's vireo	164	205
Cedar waxwing		5
Chestnut-backed chickadee		10
Chipping sparrow	379	105
Cinnamon teal		2
Clark's nutcracker	40	80
Cliff swallow	288	168
Common merganser		11
Common moorhen		2
Common nighthawk	3	
Common poorwill	2	
Common raven		110
Common yellowthroat	43	4
Cooper's hawk	6	
Dark-eyed junco	497	1197
dDouble-crested cormorant	1	
Downy woodpecker	2	9
Dusky flycatcher	111	399
European starling		224
Evening grosbeak	26	72
Fox sparrow	143	223
Golden eagle	9	
Golden-crowned kinglet	53	500
Golden-crowned Sparrow		1
Great blue heron	4	10
Great egret		2
Greater roadrunner	2	4
Great-horned owl	1	
Green heron	1	7
Green-tailed towhee	27	40
Hairy woodpecker	19	116
Hammond's flycatcher	9	90
Hermit thrush	81	274
Hermit warbler	81	228
House finch	475	113
House Sparrow	24	1
House wren	3	150
Hutton's vireo		28
Killdeer	35	31
Lark sparrow	148	18
Lawrence's goldfinch	4	8
Ruby-crowned kinglet	132	38
Rufous hummingbird		3
Rufous-crowned sparrow	8	53
Sage sparrow	6	28
Sharp-shinned hawk	2	
Song sparrow		208
Spotted sandpiper	15	68
Spotted towhee	82	317
Steller's jay	143	601
Swainson's hawk	1	
Swainson's thrush	21	
Townsend's solitaire	16	81
Townsend's warbler	4	3
Tree swallow	2	145
Tricolored blackbird	50	65
Turkey vulture	70	76
Violet-green swallow	105	88
Virginia rail		1
Warbling vireo	269	286
Western bluebird	100	43
Western kingbird	122	66
Western meadowlark	153	
Western scrub-jay	92	188
Western tanager	196	525
Western wood-pewee	367	263
White-breasted nuthatch	47	94
White-crowned sparrow	96	101
White-headed woodpecker	25	155
White-tailed kite		2
White-throated swift	43	140
Wild turkey		1
Williamson's sapsucker	21	27
Willow flycatcher	39	1
Wilson's warbler	77	135
Winter wren	1	49
Wood duck		3
Wrentit	122	306
Yellow warbler	200	82
Yellow-breasted chat	53	8
Yellow-rumped warbler	147	1174
TOTAL SPECIES	133	140
NUMBER OF UNIQUE SPECIES	21	28
TOTAL OBSERVATIONS	9872	18165

Table 3. Avian species and numbers of individuals encountered at repeated transect surveys during 2003 and 2004 in Yosemite National Park. CH = Chinquapin; CF = Crane Flat; IC = Indian Canyon; LC = upper Lyell Canyon; LM = upper Lyell Meadow; MG = Merced Grove; MM = Mono Meadow; PF = Porcupine Flat; YV = Yosemite Valley.

	CH		CF		IC		LC		LM		MG		MM		PF		YV
species	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003
Acorn woodpecker																	45
American dipper							4	2									
American green-winged teal									1	1							
American pipit							9	3									
American robin	58	23	59	13	13	22	5	17	37	40	29	26	29	41	6	57	54
Anna's hummingbird																	8
Band-tailed pigeon		2									1						2
Belted kingfisher										2							
Black phoebe										1							1
Black swift													1				
Black-backed woodpecker													1	5	1	1	
Black-headed grosbeak	8		8	5		2					9						49
Black-throated grey warbler			1	2													11
Blue grouse					1	1							3			1	
Blue-grey gnatcatcher																	
Blue-winged teal									16								
Brewer's blackbird	37	21	39	12			5	8	23	7			16			14	67
Brown creeper	5	12	11	4	5	17	2	2	5	18	15	25	17	16	5	15	11
Brown-headed cowbird				1					1								7
Bullock's oriole																	8
Bushtit												10					
California gull									1								
Calliope hummingbird			1				2				3		1	1			
Canyon wren																	3
Cassin's finch	12	11		1	14	10	22	3	15	34			8	14	5	63	
Cassin's vireo	3	21	18	14	3	4					22	36	14	3			27

Chestnut-backed chickadee												9					
Chipping sparrow	12	12	22	11	1	2			1			5	2	18	3	7	
Clark's nutcracker							19	3	29	25						8	
Common merganser																	11
Common raven	1	2	5	2	1	1			3		7	7	8	2		1	13
Dark-eyed junco	108	75	87	38	32	52	47	42	97	139	77	90	57	126	10	102	24
Downy woodpecker																	1
Dusky flycatcher	42	46	33	10	11	14	16	10	47	65	23	24	22	46	2	12	
Evening grosbeak	16	7				19							4	13	2	3	2
Fox sparrow	36	32			6	42					34	33	10	7	4	18	1
Golden-crowned kinglet	91	75	70	18	54	54					55	55	40	30	25	17	3
Green-tailed towhee	19	15				1					2	3					
Grey-crowned rosy-finch							35	62									
Hairy woodpecker	11	9	4	9	5	3		1		3	6	12	11	10	3	14	7
Hammond's flycatcher	14	18	44	20							12	21	10	15			
Hermit thrush	44	18	43	15	13	6		1	30	27	12	8	32	20	16	24	
Hermit warbler	31	46	67	37		8					34	86	5	6			9
House wren	4		4						2	5	2			2			
Hutton's vireo																	4
Lazuli bunting	6		10		3										1		1
Lesser goldfinch		3															
Lncoln's sparrow	18	9	23	8	3				4	6			32	14			
Macgillivray's warbler	27	29	25	10	1	2					65	55	14	3			9
Mallard										5							11
Mountain bluebird							7	1								2	
Mountain chickadee	94	57	49	20	80	80	28	16	48	35	49	42	94	60	54	80	5
Mountain quail	35	35	2			5					3	2	25	26	1	22	1
Mourning dove						1											
Nashville warbler	2	4	5	8	2	2				2	4	21	11	13			12
Northern flicker	18	12	9	6	3	6		2	4	3	15	8	2	3		4	25
Northern pygmy-owl												1					
Northern rough-winged swallow																	

Olive-sided flycatcher	11	10			7	9	1					2	2	1		3	
Orange-crowned warbler	3	1	2			5		1	3	2	1			2			
Pacific-slope flycatcher	1	3	6	2							35	30					1
Pileated woodpecker	3	1	11	1	7	2					9	3	6				
Pine grosbeak														3		13	
Pine siskin	4		3		2	1		3	16	6			1	12	2	82	
Prairie falcon							1										
Purple finch	8		3						7		1	4			2		
Pygmy nuthatch						1											
Red crossbill					1				1	3					1	2	
Red-breasted nuthatch	93	81	80	25	40	55					71	53	48	69	20	12	6
Red-breasted sapsucker	7	17	2	3	4	11					2	2	25	15	1		
Red-tailed hawk	1		1				1	1	1		1						
Red-winged blackbird									43	45				6			140
Rock wren						1	2										
Ruby-crowned kinglet	1								2	6							
Rufous hummingbird							1	3		2							1
Song sparrow		5	6	1					16	8			17	7			61
Spotted sandpiper							1	2		4						3	31
Spotted towhee	2		1			9					42	23					2
Steller's jay	43	39	30	9	31	57			1	7	58	24	53	58	8	26	73
Townsend's solitaire	6	12	2	3	18	8	4		1	5	3	4	13	4	3	3	
Violet-green swallow						4											12
Warbling vireo	15	23	30	19					3	4	28	28	42	14	1		46
Western bluebird	1																
Western scrub-jay											2						
Western tanager	65	48	40	16	38	62					17	25	49	15	15	8	38
Western wood-pewee	4	3	2	3	6	12			1		2		22	12	2	1	67
White-breasted nuthatch	2				1	1			2	5	2		2			8	
White-crowned sparrow							33	17	30	30						1	
White-headed woodpecker	32	21	14	9	6	17					24	12	12	9	2		8
White-throated swift	1		2		2	26							1	3			29
Williamson's sapsucker					5	3			1				2	4	1	10	

Wilson's warbler	6	7							1	3				10	6		1
Winter wren	4	6	12	2		1					18	17		3			
Yellow warbler																	37
Yellow-rumped warbler	162	101	133	43	82	98	35	11	73	101	46	60	74	99	61	116	9
Grand Totals	1227	972	1019	400	501	737	280	211	566	649	841	866	848	836	257	753	994

Table 4. Change index [(current – Grinnell) / (current + Grinnell)] and the binomial probability of species abundance for each site surveyed during the Grinnell 1915-1919 era and the current, 2003-2004 period. The change index is measured as: (current – Grinnell) / (current + Grinnell). Values range from -1 (species lost) to +1 (species gain); zero indicates no change (see Avian Methods section, above). Significant changes ($p < 0.05$) based on the binomial probability are in bold.

SPECIES	LG	SN	PV	YV	MG	MM	CH	IC	PF	TM	LM
Acorn woodpecker	0.22	0.65	0.23	0.54							
	0.172	0.055	**0.000**	**0.000**							
American crow	1.00	0.71	1.00								
	0.000	**0.019**	0.125								
American dipper											
American goldfinch	0.00	-0.41	1.00								
	0.430	**0.000**	0.500								
American green-winged teal										1.00	1.00
American kestrel	0.31	-0.39	0.36								
	0.500	0.172	0.344								
American pipit											
American robin	1.00	1.00	-0.33	-0.22	-0.12	0.05	0.08	-0.13	0.34	0.02	0.05
	0.016	**0.002**	**0.001**	**0.001**	0.412	0.437	0.378	0.339	**0.013**	0.500	0.432
Anna's hummingbird	1.00	1.00	0.26	1.00							
	0.002	0.125	0.192	**0.000**							
Ash-throated flycatcher	0.41	0.60	0.12								
	0.001	**0.000**	**0.023**								
Band-tailed pigeon			1.00	-0.94	1.00		1.00				
			0.016	**0.000**			0.500				
Barn owl	-1.00										
	0.500										
Barn swallow	-1.00	-1.00	-0.66								
	0.000	**0.008**	**0.000**								
Bell's vireo	-1.00	-1.00	-1.00								
	0.000	**0.000**	**0.016**								
Belted kingfisher	-0.08	1.00	0.52	-1.00							1.00
	0.344	**0.008**	0.313	0.250							
Bbewick's wren	0.72	0.59	0.61	1.00							
	0.000	**0.000**	**0.000**	0.500							
Black phoebe	0.62	0.35	0.14	0.15	-1.00						1.00
	0.004	0.061	0.243	0.250	0.500						
Black swift						1.00					
Black-backed woodpecker						-0.05			1.00	0.18	
						0.313			0.500	0.250	
Black-chinned hummingbird		-1.00									
		0.500									
Black-crowned night-heron		-1.00									

		0.500									
Black-headed grosbeak	-0.27	-0.76	0.36	-0.07	-0.17	-1.00	-0.29	1.00			
	0.066	**0.000**	**0.000**	0.139	0.500	0.500	0.344	0.500			
Black-throated grey warbler			-0.96	0.12	-1.00			-1.00			
			0.000	0.181	**0.000**			**0.004**			
Blue grosbeak		-1.00									
		0.002									
Blue grouse				-1.00		-0.05		-0.88	-0.61		-1.00
				0.500		0.250		**0.011**	0.250		0.500
Blue-grey gnatcatcher	-1.00		-0.80	1.00							
	0.016		**0.000**	0.500							
Blue-winged teal											1.00
											0.063
Brewer's blackbird	-0.72	-1.00	-0.09	0.56		1.00	1.00		1.00	0.65	1.00
	0.000	**0.002**	0.223	**0.000**		**0.031**	**0.000**		**0.008**	**0.000**	**0.008**
Brewer's sparrow	-1.00										
	0.250										
Brown creeper			1.00	0.40	-0.38	0.42	-0.62	-0.50	0.10	1.00	1.00
			0.125	**0.010**	0.058	0.090	**0.002**	**0.007**	0.407	0.250	**0.031**
Brown-headed cowbird	1.00	0.82	1.00	1.00						1.00	1.00
	0.000	**0.000**	**0.000**	**0.000**						**0.031**	
Bullock's oriole	0.63	-0.55	-0.13	1.00							
	0.033	**0.001**	0.065	**0.000**							
Burrowing owl		-1.00									
		0.250									
Bushtit	0.91	1.00	-0.37		1.00						
	0.000	**0.008**	**0.000**		0.250						
California gull										-0.17	1.00
										0.750	
California quail	0.38	0.12	0.07								
	0.025	0.345	0.108								
California thrasher	-1.00		-0.78								
	0.002		**0.000**								
California towhee	-0.49	-1.00	0.29								
	0.021	**0.000**	**0.000**								
Calliope hummingbird				-1.00	-0.36	-0.86	-1.00	-1.00	-1.00		
				0.016	0.500	**0.020**	0.063	0.250	0.250		
Canada goose	1.00		1.00								
	0.125		0.063								
Canyon wren	1.00		-0.60	-0.25							
	0.500		**0.002**	0.291							
Cassin's finch						-0.25	-0.61	1.00	0.35	-0.16	0.11
						0.240	**0.000**	**0.008**	**0.011**	0.140	0.412
Cassin's vireo	-1.00	-1.00	-0.87	0.04	-0.10	1.00	0.14	-0.33			
	0.016	0.250	**0.000**	0.359	0.412	**0.031**	0.387	0.344			
Cedar waxwing	1.00										
	0.125										
Chestnut-backed chickadee				1.00	1.00						
				0.500	0.500						
Chipping sparrow	-1.00	-1.00	-1.00	-0.88	-0.82	-0.56	0.25	-0.39	-0.70	-0.41	-0.89

	0.250	0.250	**0.000**	**0.000**	**0.020**	**0.003**	0.274	0.500	**0.000**	**0.012**	0.063
Cinnamon teal	1.00										
	0.500										
Clark's nutcracker									-0.12	-0.30	-0.30
									0.500	0.119	**0.045**
Cliff swallow	-0.36	0.49	-1.00								
	0.000	**0.010**	**0.000**								
Common merganser				1.00							
				0.004							
Common moorhen		1.00									
		0.250									
Common nighthawk										-1.00	
										0.125	
Common poorwill		-1.00	-1.00								
		0.500	0.500								
Common raven	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	0.500		**0.000**	**0.000**	0.250	0.125	0.500	0.500		0.250	0.500
Common yellowthroat	-0.47	-1.00									
	0.172	**0.000**									
Cooper's hawk			-1.00	-1.00							
			0.250	0.063							
Dark-eyed junco			-0.63	0.24	-0.15	-0.31	-0.24	-0.28	-0.06	-0.20	0.11
			0.011	**0.014**	0.153	**0.000**	**0.003**	**0.014**	0.290	**0.014**	0.155
Double-crested cormorant	-1.00										
	0.500										
Downy woodpecker	1.00	1.00	1.00	-0.49							
	0.250	0.063	0.500	0.500							
Dusky flycatcher			1.00	-0.63	0.76	-0.21	-0.30	-0.28	0.74	1.00	1.00
			0.500	0.063	**0.035**	0.080	**0.008**	0.132	**0.035**	**0.000**	**0.000**
European starling	1.00	1.00	1.00								
	0.000	**0.000**	**0.000**								
Evening grosbeak				-0.43		0.67	-0.34	1.00	1.00	1.00	
				0.072		0.109	0.084	**0.016**	0.250		
Fox sparrow				1.00	-0.11	-0.58	-0.59	-0.38	0.14		
				0.500	0.271	**0.003**	**0.000**	**0.008**	0.324		
Golden eagle			-1.00							-1.00	-1.00
			0.031							0.250	0.250
Golden-crowned kinglet				1.00	0.89	0.68	0.70	0.20	0.04		
				0.125	**0.000**	**0.000**	**0.000**	0.106	0.437		
Golden-crowned sparrow			1.00								
			0.500								
Great blue heron	0.12	0.40	1.00								
	0.250	0.254	0.250								
Great egret		1.00									
		0.250									
Great grey owl											
Greater roadrunner			0.36								
			0.344								
Great-horned owl	-1.00										

	0.500										
Green heron	0.630										
	0.188										
Green-tailed towhee				-1.00	1.00	-1.00	0.22	-0.92	-1.00		
				0.063	0.500	0.063	0.304	**0.008**	**0.016**		
Grey-crowned rosy-finch											
Hairy woodpecker			0.10	0.39	0.48	0.73	0.29	1.00	0.61	1.00	1.00
			0.500	0.058	0.313	0.063	0.254	0.250	0.055	0.500	0.500
Hammond's flycatcher					0.68	0.58	1.00		-1.00	-1.00	-1.00
					0.109	0.055	**0.002**		**0.016**	**0.016**	**0.004**
Hermit thrush				-1.00	0.02	0.68	0.48	-0.24	-0.04	-0.17	-0.13
				0.001	0.344	**0.002**	**0.017**	0.304	0.437	0.332	0.292
Hermit warbler	-1.00		0.03	-0.72	1.00	-0.36	0.00	-0.13			
	0.250		0.250	**0.000**	**0.000**	0.172	0.439	0.500			
Horned lark											
House finch	-0.53	-0.84	-0.58								
	0.000	**0.000**	**0.000**								
House sparrow	1.00	-1.00	-1.00								
	0.500	**0.000**	**0.002**								
House wren	1.00	1.00	0.86	1.00	1.00	1.00	1.00				0.23
	0.000	**0.000**	**0.000**	0.500		0.500	0.500				0.500
Hutton's vireo	1.00		1.00	1.00							
	0.031		**0.000**	**0.016**							
Killdeer	-0.34	0.27	-0.43							0.03	
	0.084	0.500	**0.039**							0.363	
Lark sparrow	-1.00	-1.00	-0.75								
	0.004	**0.004**	**0.000**								
Lawrence's goldfinch	1.00		0.30								
	0.500		0.274								
Lazuli bunting	1.00	-1.00	-0.28	-0.92	-1.00		1.00	1.00	1.00		
	0.500	**0.000**	**0.001**	**0.000**	0.125		0.250	0.500			
Lesser goldfinch	0.56	0.25	-0.05	-0.82			1.00	-1.00			
	0.001	0.124	0.307	0.035			0.500	0.500			
Lesser nighthawk	-1.00										
	0.031										
Lewis' woodpecker		-1.00	-1.00								
		0.500	**0.004**								
Lincoln's sparrow						-0.04	0.20	1.00	-1.00	1.00	0.07
						0.500	0.387	0.500	0.125	0.125	0.313
Loggerhead shrike	-1.00		-1.00								
	0.000		0.500								
Macgillivray's warbler	1.00		-1.00	-0.28	0.90	0.44	0.32	-0.89			
	0.500		0.063	0.124	**0.000**	0.227	0.105	**0.000**			
Mallard	1.00	1.00	1.00	1.00						1.00	1.00
	0.016	**0.000**	0.063	**0.001**						0.250	0.500
Marsh wren	1.00										
	0.063										
Mountain bluebird									1.00	-0.97	-1.00

									0.500	**0.000**	**0.002**
Mountain chickadee				-0.06	0.17	0.21	0.20	0.14	0.32	-0.46	-0.31
				0.396	0.271	**0.042**	0.060	0.133	**0.001**	**0.000**	**0.015**
Mountain quail			0.48	0.39	-0.77	0.16	0.03	-0.61	0.30		
			0.000	0.172	0.063	0.279	0.500	0.063	0.166		
Mourning dove	-0.81	-0.39	0.02					1.00			
	0.000	**0.000**	0.396								
Nashville warbler			-0.09	0.11	-0.01	1.00	-0.84	1.00			1.00
			0.364	0.171	0.363	**0.008**	**0.000**	0.500			
Northern flicker	-0.22	-0.16	0.55	0.55	-0.16	-0.14	0.35	-0.07	-0.51	0.56	-0.30
	0.500	0.271	**0.000**	**0.001**	0.500	0.313	0.194	0.344	0.145	0.188	0.500
Northern goshawk											
Northern harrier				-1.00							
				0.500							
Northern mockingbird	-1.00	-1.00	0.03								
	0.063	0.500	0.250								
Northern pygmy-owl					1.00						
Northern rough-winged swallow	1.00			1.00							
	0.000			0.500							
Nuttall's woodpecker	0.80	0.58	-0.20								
	0.011	**0.011**	0.111								
Oak titmouse	0.39	1.00	-0.01								
	0.012	0.000	0.468								
Olive-sided flycatcher			-0.06	1.00	-0.88	-0.69	-0.41	-0.27	-0.47	1.00	
			0.500	0.125	**0.031**	0.109	0.058	0.291	0.188		
Orange-crowned warbler	1.00		0.58		1.00	1.00	1.00	1.00			1.00
	0.500		**0.005**			0.500	0.500	0.500			0.500
Osprey		1.00		-1.00							
		0.125		0.500							
Pacific-slope flycatcher	1.00		0.14	0.06	0.67		1.00				
	0.500		0.500	0.344	**0.019**		0.500				
Phainopepla	1.00		0.18								
	0.500		0.131								
Pied-billed grebe	1.00	1.00	1.00								
	0.500	0.250	0.250								
Pileated woodpecker				1.00	-0.23	-0.47	1.00	0.13			
				0.500	0.500	0.227	0.500	0.500			
Pine grosbeak						1.00			1.00		
						0.500			**0.016**		
Pine siskin				-1.00	-1.00	-0.01	0.05	1.00	0.11	0.28	0.00
				0.000	0.500	0.363	0.250	0.500	0.208	**0.001**	0.377
Prairie falcon										1.00	
Purple finch			-0.45	-1.00	-0.12		1.00		1.00	0.07	1.00
			0.048	**0.000**	0.250		0.250		0.500	0.500	0.250
Pygmy nuthatch								1.00			

Red crossbill								1.00	-0.16 0.500	1.00 **0.000**	1.00 0.500
Red-breasted nuthatch			1.00 **0.031**	-0.38 0.067	0.42 **0.026**	0.52 **0.000**	0.50 **0.000**	0.36 **0.019**	-0.04 0.500	1.00 0.125	
Red-breasted sapsucker					-0.52 0.500	0.85 **0.002**	0.38 0.172	1.00 0.063	-0.34 0.500		
Red-shouldered hawk	1.00 0.063	0.83 **0.000**	1.00 0.250								
Red-tailed hawk	0.44 0.313	1.00 0.250	0.68 **0.004**		1.00	-1.00 0.500	1.00		-1.00 0.500		1.00
Red-winged blackbird	-0.08 0.176	-0.80 **0.000**	0.90 **0.000**	0.96 **0.000**		1.00 0.250				1.00 **0.004**	1.00 **0.000**
Rock wren		1.00 **0.000**	0.03 0.500					-0.55 0.500		-1.00 **0.031**	
Ruby-crowned kinglet				-1.00 0.063	-1.00 **0.031**	-1.00 **0.000**	-0.97 **0.000**	-1.00 **0.031**	-1.00 **0.000**	0.02 0.412	0.29 0.500
Rufous hummingbird				1.00 0.500							1.00
Rufous-crowned sparrow	1.00 0.125		0.73 **0.000**								
Sage sparrow			0.66 **0.000**								
Sharp-shinned hawk				-1.00 0.500			-1.00 0.500				
Song sparrow	1.00 **0.004**	1.00 **0.000**	1.00 **0.031**	1.00 **0.000**		1.00 **0.008**	1.00 0.500			1.00 **0.008**	1.00 **0.031**
Spotted sandpiper	0.12 0.500			1.00 **0.000**					1.00 0.500	-0.41 0.105	-0.05 0.250
Spotted towhee	1.00 **0.004**	0.24 0.059	0.84 **0.000**	-0.87 **0.000**	0.44 0.090		1.00 0.500	1.00 0.125			
Steller's jay			0.63 **0.000**	0.38 **0.000**	-0.04 0.500	0.35 **0.011**	0.17 0.168	0.17 0.146	-0.07 0.434	-0.17 0.500	0.29 0.500
Swainson's hawk	-1.00 0.500										
Swainson's thrush		-1.00 0.063	-1.00 **0.016**	-1.00 **0.001**							
Townsend's solitaire					1.00 0.500	0.26 0.363	-0.09 0.500	0.43 0.113	-0.15 0.500	1.00	1.00 0.500
Townsend's warbler	1.00 0.500		-0.58 0.188								
Tree swallow	0.94 **0.000**	1.00 **0.000**									
Tricolored blackbird	-1.00 **0.000**	1.00 **0.000**									
Turkey vulture	0.22 0.172	0.94 **0.000**	-0.43 **0.000**								
Violet-green swallow	-0.27 0.081	1.00 **0.000**	-0.38 **0.000**	-0.04 0.500			-1.00 0.500	1.00 0.500			
Virginia rail			1.00 0.500								

Warbling vireo	0.63	0.40	-0.84	-0.26	-0.32	-0.09	-0.39	-1.00	-0.92	1.00	1.00
	0.188	0.500	**0.000**	**0.000**	0.084	0.371	**0.012**	**0.002**	**0.000**	**0.031**	0.250
Western bluebird	-0.73	0.63	-0.53				1.00				
	0.000	**0.004**	**0.000**								
Western kingbird	-0.45	-0.51	-0.24								
	0.018	**0.021**	**0.004**								
Western meadowlark	-1.00	-1.00	-1.00								
	0.000	**0.000**	**0.000**								
Western scrub-jay	0.43	0.02	0.36		1.00						
	0.039	0.407	0.000								
Western tanager	-0.30	1.00	0.25	0.20	-0.39	-0.07	0.07	0.23	-0.41	0.03	
	0.274	**0.000**	0.024	**0.013**	0.067	0.378	0.347	0.072	**0.007**	0.250	
Western wood-pewee	1.00	-1.00	-0.56	0.01	-0.96	-0.35	-0.77	-0.43	-0.89	-0.64	-0.97
	0.250	**0.000**	**0.000**	0.500	**0.000**	**0.035**	**0.001**	**0.048**	**0.000**	**0.000**	**0.000**
White-breasted nuthatch	0.42	1.00	-0.07		1.00	1.00	-0.29	-0.79	1.00	1.00	1.00
	0.032	**0.016**	0.349			0.500	0.250	0.109	0.063	0.063	0.250
White-crowned sparrow	-1.00					-1.00			-0.61	-0.32	-0.59
	0.000					0.250			0.250	**0.022**	**0.000**
White-headed woodpecker				1.00	-0.03	0.35	0.35	-0.02	-0.01		-1.00
				0.000	0.387	0.254	0.067	0.395	0.250		0.500
White-tailed kite	1.00										
	0.500										
White-throated swift			-1.00	0.44		1.00	1.00	-0.05			
			0.016	**0.000**		0.500		0.500			
Wild turkey			1.00								
			0.500								
Williamson's sapsucker						-0.38		1.00	-0.38	-0.87	1.00
						0.344		0.250	0.072	**0.031**	
Willow flycatcher		-1.00	1.00	-1.00							
		0.000	0.500	**0.000**							
Wilson's warbler	0.52	1.00	0.92	-0.49	-1.00	-0.61	-0.71		-1.00	-1.00	-0.80
	0.007	0.500	**0.000**	0.188	**0.002**	**0.002**	**0.000**		**0.031**	0.500	**0.020**
Winter wren					0.69	1.00	1.00	1.00			
					0.109	0.500	0.125				
Wood duck		1.00									
		0.125									
Wrentit	1.00		0.46	-1.00							
	0.500		**0.000**	0.250							
Yellow warbler	-0.44	-0.88	-0.89	-0.44	-1.00		-1.00			1.00	
	0.048	**0.000**	**0.000**	**0.000**	**0.008**		0.500			0.063	
Yellow-breasted chat	0.23	-0.87	-0.88								
	0.500	**0.000**	**0.000**								
Yellow-rumped warbler				-0.49	0.47	0.44	0.68	0.86	0.45	0.22	0.40
				0.001	**0.017**	**0.000**	**0.000**	**0.000**	**0.000**	0.076	**0.002**
# significant increases	23	22	24	19	7	11	6	4	6	8	6
# significant decreases	19	21	21	15	7	7	10	10	10	9	8

APPENDIX 4:

Record of mammal species trapped or seen at each of the re-survey general sites, as well as additional localities, within Yosemite National Park, by date and general locality. Specific localities for each general size are individual traplines, with coordinates taken by GPS at the approximate mid-point of the line.

2003

1. **Yosemite Valley:**

Specific locality	Latitude	Longitude	Habitat
Leidig Meadow	37.73797	119.60513	meadow
Eagle Creek, base of Rocky Point	37.72982	119.61532	conifer-oak
meadow across from Rocky Point	37.73000	119.61082	meadow
El Capitan Meadow	37.72193	119.63632	meadow
Fern Spring	37.71515	119.66500	conifer-oak
Chapel Meadow	37.74133	119.59365	meadow
meadow south of Chapel	37.74048	119.59162	meadow
Yellow Pine Campground, Sentinel Beach	37.73230	119.60800	meadow, conifer-oak
forest slope south of Sentinel Beach	37.73055	119.60405	conifer-oak
above Mirror Lake	37.75495	119.54604	conifer-oak
Stoneman Meadow	37.74053	119.57217	meadow
Ahwahnee Meadow	37.74618	119.57859	meadow
forest south of Chapel	37.47078	119.59071	conifer-oak
Happy Isles	37.73267	-119.55807	fen meadow
Tenaya Creek	37.75286	-119.54425	riparian
lower Indian Creek Canyon	37.75236	-119.58723	conifer-oak

Mammal species present, by habitat:

Family	Species	Habitat	Commonness	# Localities
Talpidae	*Scapanus latimanus*	meadow	common	7*
Soricidae	*Sorex monticolus*	meadow	very common	6
	Sorex trowbridgii	meadow-forest	rare	1
Sciuridae	*Glaucomys sabrinus*	conifer forest	uncommon	1
	Sciurus griseus	oak-conifer forest	common	2**
	Spermophilus beecheyi	conifer forest	common	3***
Geomyidae	*Thomomys bottae*	meadow	common	3
Cricetidae	*Peromyscus boylii*	oak-conifer forest	very common	9
	Peromyscus maniculatus	oak-conifer forest, fen, riparian	common	8
	Reithrodontomys megalotis	fen, riparian	rare	2
	Neotoma macrotis	oak-conifer forest	rare	2
	Microtus longicaudus	fen, riparian	uncommon	2
	Microtus montanus	meadow	very common	7
Mustelidae	*Spilogale putorius*	oak-conifer forest	common	2

Canidae	*Canis latrans*	meadow, forest	common	****

*mounds or surface tunnels observed in 6 meadows in addition to salvaged specimen found.
observed almost daily along both Southside and Northside drives.
**commonly observed throughout the Valley floor; two road-kill salvaged specimens preserved.
***commonly observed throughout the valley floor, in campgrounds, dwellings, rock outcrops, and forest-meadow edge.
****vocalizing groups were commonly heard at night and very early morning; individuals were seen at multiple sites in the Valley floor.

2. Hodgdon Meadow to Crane Flat

Specific locality	Latitude	Longitude	Habitat
Hodgdon Meadow	37.79395	119.86431	meadow
Hodgdon Meadow	37.79611	119.86781	meadow
Crane Flat	37.75425	119.80368	meadow
Crane Flat	37.75515	119.80015	mixed conifer
Crane Flat	37.75813	119.80161	meadow
Crane Flat	37.75937	119.80127	meadow
Crane Flat	37.75731	119.80131	meadow
Crane Flat	37.75139	119.79149	mixed conifer
Crane Flat Campground	37.74597	119.79930	mixed conifer, meadow
3 mi (by rd) E Crane Flat	37.75775	119.76990	mixed conifer
Merced Grove	37.74826	119.83747	conifer, riparian
Big Meadow	37.70283	119.74784	meadow
0.9 mi E (by rd) Foresta	37.70455	119.73331	chaparral
Tuolumne Creek at Tioga Pass Road	37.61096	119.71286	riparian
North Crane Creek at Old Tioga Pass Road	37.78981	119.83766	riparian
Yosemite Creek at Tioga Pass Road	37.85175	119.57310	riparian
Siesta Lake, 13.4 mi E on Tioga Pass Road	37.85053	119.65900	meadow

Mammal species present, by habitat:

Family	Species	Habitat	Commonness	# Localities
Talpidae	*Scapanus latimanus*	meadow	common	4*
Soricidae	*Sorex monticolus*	meadow	very common	4
	Sorex trowbridgii	meadow-forest	rare	3
Sciuridae	*Glaucomys sabrinus*	conifer forest	uncommon	1
	Tamiasciurus douglasi	conifer forest,	common	4
	Spermophilus beecheyi	conifer forest	common	3**
	Spermophilus lateralis	conifer forest	common	1
	Tamias [redacted]			

	Microtus californicus	riparian	rare	1
	Microtus longicaudus	fen, riparian	uncommon	6
	Microtus montanus	meadow	rare	2
Dipodidae	*Zapus princeps*	meadow, riparian	locally common	4
Mustelidae	*Mustela erminea*	Meadow	rare	1

*fresh mounds and surface runways observed only.
**individual were commonly observed around the campgrounds at both Hodgdon Meadow and Crane Flat.
*** Brush mice (*Peromyscus boylii*) were encountered only in the burned hillsides above Foresta.

3. Chinquapin to Mono Meadow

Specific locality	Latitude	Longitude	Habitat
Mono Meadow trail head	37.67037	119.58527	mixed conifer
0.7 mi W Mono Meadow trail head	37.66792	119.59743	mixed conifer, meadow
south end Pothole Meadows	37.69924	119.58647	mixed conifer
Peregoy Meadow	37.66819	119.62267	meadow
Monroe Meadows	37.66191	119.66409	meadow
Monroe Meadows	37.66285	119.66467	riparian, stream side
0.2 mi W Summit Meadow	37.67152	119.65707	mixed conifer
0.2 mi S Chinquapin	37.64750	119.70387	mixed conifer
Chinquapin	37.25671	119.69941	mixed conifer
Indian Creek, Chinquapin	37.65168	119.70079	riparian
meadow, 600 m NW Monroe Meadows	37.66596	-119.66798	meadow

Mammal species present, by habitat:

Family	Species	Habitat	Commonness	# Localities
Talpidae	*Scapanus latimanus*	meadow	uncommon	1*
Soricidae	*Sorex monticolus*	meadow	common	6
	Sorex trowbridgii	conifer forest	rare	1**
	Sorex palustris	streamside	rare	1
Aplodontidae	***Aplodontia rufa***	riparian, streamside	locally common	2
Sciuridae	*Spermophilus beecheyi*	conifer forest	common	2***
	Spermophilus lateralis	conifer forest	common	
	Tamiasciurus douglasi	conifer forest	uncommon	1****
	Tamias quadrimaculatus	conifer forest	rare	1
	Tamias speciosus	conifer forest	common	5
Geomyidae	*Thomomys monticola*	meadow	common	4*****
Cricetidae	*Peromyscus boylii*	conifer forest	rare	1
	Peromyscus maniculatus	conifer forest, riparian	common	6
	Microtus longicaudus	meadow, riparian	common	8
	Microtus montanus	meadow	common	4
Dipodidae	*Zapus princeps*	meadow, riparian	locally common	4
Mustelidae	***Mustela erminea***	conifer forest	rare	1

*	sign observed only at Chinquapin.
**	recorded only at Chinquapin.
*** individuals seen at Chinquapin and Bridalveil campground; none captured.
****	individuals seen at several places along Glacier Point Road; one road kill specimen was salvaged.
*****	sign of pocket gophers was seen in virtually all meadows we visited; we could find no sign of pocket gophers at Chinquapin, where the species had been previously recorded.

4. upper Lyell Canyon (9800-10,500 ft)

Specific locality	Latitude	Longitude	Habitat
upper Lyell Canyon, 9788 ft	37.77801	119.26115	mixed conifer
upper Lyell Canyon, 9788 ft	37.77719	119.26395	mixed conifer
upper Lyell Canyon, 9788 ft	37.77998	119.26089	mixed conifer
upper Lyell Canyon, 10,010 ft	37.77211	119.25828	talus
upper Lyell Canyon, 10,240 ft	37.76807	119.25506	meadow, forest edge
upper Lyell Canyon, 10,240 ft	37.76220	119.25723	meadow, riparian
upper Lyell Canyon, 10,565 ft	37.76358	119.25996	meadow

Mammal species present, by habitat:

Family	Species	Habitat	Commonness	# Localities
Talpidae	*Scapanus latimanus*	meadow	uncommon	1*
Soricidae	*Sorex monticolus*	meadow	very common	6
Ochotonidae	*Ochotona princeps*	talus	locally common	3
Aplodontidae	*Aplodontia rufa*	stream side	locally common	1*
Sciuridae	*Tamiasciurus douglasi*	conifer forest	common	1*
	Marmota flaviventris	talus	Common	4*
	Spermophilus beldingi	meadow	common	2
	Spermophilus lateralis	conifer forest, talus	common	4
	Tamias alpinus	talus, meadow edge	rare	2*****
	Tamias speciosus	conifer forest, meadow	very common	5
Geomyidae	*Thomomys monticola*	meadow	common	1******
Cricetidae	*Peromyscus maniculatus*	conifer forest, meadow	very common	7
	Peromyscus truei	conifer forest, talus	uncommon	3
	Microtus longicaudus	meadow, riparian	common	7
	Microtus montanus	meadow	rare	1
	Phenacomys intermedius	heather, talus	rare	2
Dipodidae	***Zapus princeps***	riparian, meadow	uncommon	5
Mustelidae	*Martes americana*	conifer forest		1†
Procyonidae	*Procyon lotor*	trail		1††
Cervidae	*Odocoileus hemionus*	meadow		1

*	mole sign was observed along the John Muir Trail above the footbridge, at approximately 9850 feet elevation.
**	mountain beaver sign was observed along both Lyell Fork and Maclure Creek.

*** chickarees were commonly seen among the lodgepole pine from camp to 10,000 feet elevation.
**** yellow-bellied marmots were seen commonly in all rock outcrops and talus slopes from camp at 9788 feet to the highest trapline at 10,565 feet.
***** alpine chipmunks were encountred only at the highest elevations sampled (10,240 and 10,565 ft); only two individuals were observed and one was trapped.
****** pocket gopher sign was seen only in the small meadows near camp at 9788 ft elevation; no sign was seen in the larger meadows above 10,000 feet.
† two pine martens were seen in the immediate vicinity of camp.
†† foot prints of a raccoon were see on the trail between the two meadows at 10,240 and 10,565 feet elevation.

5. Glen Aulin – McGee Lake

Specific locality	Latitude	Longitude	Habitat
Glen Aulin, 7914 ft	37.91355	119.42225	mixed conifer, shrub, granite slab
Glen Aulin, 8175 ft	37.91586	119.41835	mixed conifer, shrub, granite slab
Glen Aulin, 7880 ft	37.91360	119.42421	mixed conifer, shrub, granite slab
Glen Aulin, 2389 m	37.91170	119.42495	meadow, burn
Glen Aulin, 2389 m	37.91245	119.42653	meadow, burn
Glen Aulin, 2400 m	37.91311	119.42397	meadow, burn
Glen Aulin, 7850 ft	37.91042	119.41607	meadow, burn
Glen Aulin	37.91343	119.4286o	meadow, burn
Glen Aulin	37.91543	119.43118	meadow, burn
McGee Lake, 8190 ft	37.90070	119.43209	mixed conifer
McGee Lake, 8171 ft	37.90236	119.42969	riparian (lake edge)
McGee Lake, 2510 m	37.90344	119.43121	open conifer forest, granite outcrops

Mammal species present, by habitat:

Family	Species	Habitat	Commonness	# Localities
Talpidae	*Scapanus latimanus*	meadow	common	1*
Soricidae	*Sorex monticolus*	meadow	common	4
	Sorex lyelli	meadow-forest	uncommon	2
Sciuridae	*Spermophilus lateralis*	forest, slab	common	7
	Tamias speciosus	forest, slab	very common	5
	Tamiasciurus douglasi	open forest	common	**
Geomyidae	*Thomomys monticola*	meadow	rare	1
Cricetidae	*Peromyscus maniculatus*	forest, meadow, slab	very common	8
	Peromyscus truei	forest, scrub, slab	common	4
	Neotoma cinerea	oak-conifer forest	uncommon	3
	Microtus longicaudus	meadow, riparian	common	5
	Microtus montanus	meadow, riparian	rare	2
	Phenacomys intermedius	slab edge	rare	1
Dipodidae	*Zapus princeps*	meadow, riparian	uncommon	2
Mustelidae	*Mustela erminea*	conifer, scrub	rare	1

* mole sign was seen at only one spot in Glen Aulin.

** chickarees were commonly seen on the floor of Glen Aulin around our camp.

2004

1. White Wolf, Porcupine Flat, Yosemite Creek, Lehamite Creek, Mt. Hoffmann

Specific Locality	Latitude	Longitude	Habitat
0.9 mi W Porcupine Flat on Hwy 120	37.81435	119.57728	mixed conifer
3.8 mi E. White Wolf entrance on Hwy 120	37.83979	119.59254	Jeffrey pine, chaparral
Lehamite Creek	37.77441	119.56924	mixed conifer
Lehamite Creek	37.77991	119.56425	mixed conifer
McSwain Meadow	37.85193	119.62811	meadow
Old Tioga Mine Rd.	37.84309	119.62314	meadow
Old Tioga Mine Rd.	37.84469	119.61269	chaparral, mixed conifer
Old Tioga Mine Rd.	37.84631	119.63327	mixed conifer
Porcupine Flat	37.80489	119.56405	mixed conifer
Porcupine Flat	37.80759	119.56455	mixed conifer
SE slope Mt. Hoffmann	37.84097	119.49964	mixed conifer, meadow
Snow Creek at Hwy. 120	37.81763	119.51022	riparian meadow, mixed conifer
Snow Flat	37.82637	119.49919	meadow
White Wolf Campground	37.86644	119.64773	mixed conifer, riparian
White Wolf Campground	37.86806	119.64837	mixed conifer, riparian
White Wolf entrance on Hwy 120	37.85723	119.64744	mixed conifer
Yosemite Creek tributary	37.8497	119.57801	mixed conifer, oak, chaparral

Mammal species present, by habitat:

Family	Species	Habitat	Commonness	# Localities
Soricidae	*Sorex monticolus*	forest, meadow	common	6
	Sorex palustris	riparian	rare	1*
	Sorex trowbridgii	riparian	uncommon	1
Sciuridae	*Spermophilus beecheyi*	roadsides, granite outcrops	uncommon	1
	Spermophilus beldingi	dry meadows	uncommon	1
	Spermophilus lateralis	conifer forest	common	4
	Tamiasciurus douglasii	conifer forest	common	5****
	Marmota flaviventris	conifer forest, meadow	common	1*****
	Glaucomys sabrinus	conifer forest	uncommon	1***
	Tamias senex	conifer forest	uncommon	2**
	Tamias speciosus	conifer forest	common	9
Geomyidae	*Thomomys monticola*	meadows	common	3
Cricetidae	*Peromyscus boylii*	forest, riparian	uncommon	2†
	Peromyscus maniculatus	grassland, forest, riparian	very common	10
	Neotoma cinerea	riparian, forest	uncommon	1††
	Microtus longicaudus	riparian, meadow	common	10
	Microtus montanus	wet meadows	common	5†††
	Phenacomys intermedius	meadow- conifer interface	rare	1††††
Dipodidae	*Zapus princeps*	riparian	common	2

* Grinnnell and colleagues regularly trapped water shrews at most localities, but we found them less common. This may be largely due to our use of live traps, rather than strategically placed snap traps along creeks.
** *T. senex* was an abundant species in 1915, but we found them to be rare, perhaps replaced by *T. speciosus* either actively or passively. Since 1915, the MVZ has acquired only two other specimens of *T. senex* (1966).
*** We caught one specimen on forest floor among Jeffrey Pines. We did not actively trap for this nocturnal species, so it may be quite abundant if searched for specifically.
****While highly abundant, most of our specimens of *T. douglasii* were obtained as roadkill. They are difficult to live trap in tomahawk traps, but on this trip two were caught in tomahawks and one caught in a Sherman live trap.
*****Two juveniles were taken at the base of rocky outcrops along a creek that ran through forest.
† This species is commonly associated with oak woodlands and these captures probably represent the edge of its distribution in this part of the park.
†† This species was much more common in the past.
††† Where highly common, we took ear clips of live animals and released them otherwise unharmed.
†††† This species was collected at Snow Flat, a new locality for the species in the park.

2. Boothe Lake, Fletcher Lake, Townsley Lake, Vogelsang Lake, Merced Lake, Washburn Lake

Specific Locality	Latitude	Longitude	Habitat
0.7 mi NW Washburn Lake	37.72604	119.39541	riparian, mixed conifer
1 km E Merced Lake	37.73946	119.40217	mixed conifer, aspen, meadow
1 km E of Merced Lake on Lewis Creek	37.73775	119.39605	mixed conifer, riparian
1 mi E Merced Lake	37.74036	119.39641	mixed conifer, chaparral
1.5 mi SE Merced Lake	37.73393	119.39339	mixed conifer, meadow
2 mi SE Merced Lake	37.73031	119.39230	granite slab
Merced Lake	37.74051	119.41345	chaparral
Merced Lake	37.74069	119.41023	mixed conifer, aspen, meadow
Merced Lake	37.74090	119.40804	mixed conifer, aspen, meadow
Ranger Station, east end Merced Lake basin	37.73314	119.39529	mixed conifer
Evelyn Lake	37.80485	119.32759	mixed conifer, meadow
east end Townsley lake	37.79125	119.32805	talus, meadow
west end Townsley Lake	37.7965	119.33623	meadow, shrub edge
camp, east end Fletcher Lake	37.79826	119.33917	mixed conifer
east end Fletcher Lake	37.79778	119.33617	willow, meadow
Fletcher Creek	37.78997	119.35275	mixed conifer, meadow
Fletcher Creek	37.79036	119.35120	mixed conifer, meadow
Fletcher Lake	37.79652	119.33929	mixed conifer, meadow
Fletcher Lake	37.79982	119.34177	mixed conifer, meadow
Boothe Lake	37.79834	119.34946	mixed conifer
Outlet Creek, Vogelsang Lake	37.78949	119.34650	riparian, rocky
Vogelsang Lake	37.78769	119.34690	lakeshore, talus
Vogelsang Lake	37.78820	119.34220	lakeshore, talus

Mammal species present, by habitat:

Family	Species	Habitat	Commonness	# Localities
Soricidae	*Sorex monticolus*	forest, meadow	uncommon	11
	Sorex lyelli	meadow, stream edge	uncommon	2
	Sorex palustris	riparian	rare	1

	Sorex trowbridgii	riparian	uncommon	1
Talpidae	*Scapanus latimanus*	conifer forest	common	1****
Sciuridae	*Spermophilus beecheyi*	aspen/conifer forest	common	2*
	Spermophilus beldingi	dry meadows, lake shores	common	4
	Spermophilus lateralis	conifer forest	common	6
	Tamiasciurus douglasii	conifer forest	common	1**
	Marmota flaviventris	conifer forest, meadow	common	1***
	Tamias alpinus	talus, meadow edge	common	6
	Tamias quadrimaculatus	conifer forest	rare	1
	Tamias speciosus	conifer forest	common	5
Geomyidae	*Thomomys monticola*	meadows	common	3
Cricetidae	*Peromyscus boylii*	forest, riparian	uncommon	3
	Peromyscus maniculatus	grassland, forest, riparian	very common	15
	Microtus longicaudus	riparian, meadow	common	10
	Microtus montanus	wet meadows	common	7
Dipodidae	*Zapus princeps*	riparian	common	7
Mustelidae	*Mustela erminea*	meadow	uncommon	1

* *S. beecheyi* was collected at Merced Lake in the past and this represents the upper limit for this species on the Merced drainage.

** *T. douglassi* was only caught in one place, near camp at Merced Lake, but was highly abundant in the forest on the east side of the lake. We also observed this species among lodgepole pine at and around Fletcher Lake where the forest is sparse.

*** Marmots were quite common in the open grassy areas around lakes, but only one was secured; found dead on a trail, possibly dropped by a predator.

****One mole was caught by hand in our camp at Merced Lake. Marmots were seen; sign of coyotes were seen.

3. Tamarack Flat, Aspen Valley, Cascades

Specific Locality	Latitude	Longitude	Habitat
Aspen Valley	37.82534	119.77221	mixed conifer, meadow
Aspen Valley	37.82085	119.77466	mixed conifer, meadow
Cascades	37.724	119.71115	mixed oak/conifer
Merced River at Wildcat Creek	37.7206	119.71456	willows, streambank
Tamarack Flat	37.75456	119.74298	chaparral

Mammal species present, by habitat:

Family	Species	Habitat	Commonness	# Localities
Soricidae	*Sorex monticolus*.	forest, meadow	common	1
Sciuridae	*Spermophilus beecheyi*	aspen/conifer forest	common	2*
	Spermophilus lateralis	conifer forest	common	6
	Sciurus griseus	conifer forest	common	1
	Tamiasciurus douglasii	conifer forest	common	3**
	Tamias quadrimaculatus	conifer forest	uncommon	3***
	Tamias speciosus	conifer forest	common	1****
Geomyidae	*Thomomys monticola*	meadows	common	1[†]
Cricetidae	*Peromyscus boylii*	forest, riparian	common	2[††]
	Peromyscus maniculatus	meadow, forest, riparian	very common	4
	Microtus longicaudus	riparian, meadow	common	1
	Microtus montanus	wet meadows	rare	1[†††]
Mustelidae	*Mustela erminea*	meadow	uncommon	1

Spilogale putorius	forest	common	1††††

* Ground squirrels were observed in a variety of habitats.
** *T. douglasii* were observed in all forested habitats, but only trapped at Tamarack Flat. Other specimens were recovered as roadkill.
*** Two specimens were taken at Aspen Valley and two were taken as roadkill near Crane Flat.
****Only *T. speciosus* was taken at Tamarack Flat in both Sherman and Tomahawk traps.
† *T. monticola* was abundant along the edges of Aspen Valley.
†† *P. boylii* was the most common species captured near Cascades on Hwy. 140 in oak/conifer forest.
††† This is apparently the first record of *M. montanus* at Aspen Valley.
†††† One specimen was obtained as a roadkill.

2005

1. Crane Flat, Merced Grove, Hazel Green – western margins of Yosemite National Park

Specific Locality	Latitude	Longitude	Habitat
Crane Flat	37.75139	-119.79149	mixed conifer (same site as trapped in 2003)
Crane Flat Ranger Station road	37.75331	-119.80890	manzanita scrub, mixed conifer
Crane Flat	37.75817	-119.80033	mixed conifer, oak
Crane Flat	37.75470	-119.80420	mixed conifer, oak
Crane Flat	37.75629	-119.80145	mixed conifer, oak
Crane Flat, along Crane Creek	37.74865	-119.79209	mixed conifer, riparian
0.5 mi SE Hazel Greenft	37.76312	-119.85983	*Ceonothus* chaparral, old burn
Merced Grove Trailhead	37.76208	-119.84264	mixed forest, *Ceonothus* chaparral
Merced Grove	37.74782	-119.84052	mixed forest
Merced Grove	37.74899	-119.83862	mixed forest, riparian

Mammal species present, by habitat:

Family	Species	Habitat	Commonness	# Localities
Soricidae	*Sorex trowbridgii*	wet meadow, *Ceonothus* chaparral	common	5
Sciuridae	*Tamias quadrimaculatus*	mixed conifer	common	6
	Tamias speciosus	mixed conifer	very common	5
	Spermophilus beecheyi	mixed conifer	common	4
Heteromyidae	*Chaetodipus californicus*	*Ceonothus* chaparral	uncommon	1*
Cricetidae	*Neotoma macrotis*	*Ceonothus* chaparral	uncommon	1**
	Peromyscus boylii	oak, mixed conifer, chaparral	very common	2
	Peromyscus truei	*Ceonothus* chaparral	very common	2***
	Peromyscus maniculatus	oak, mixed conifer, chaparral	abundant	7

* First record for California pocket mouse from the Park, on YNP edge east of Hazen Green; elevational range increase of about 3000 ft
** Elevational range increase of 1500 ft
*** First record for piñon mouse on west side of Park, on YNP edge east of Hazen Green; elevational range increase of about 3000 ft

2. Upper Return Creek, Virginia Canyon

Specific Locality	Latitude	Longitude	Habitat
Upper Return Creek, Virginia Canyon, 9900 ft	38.06129	-119.33899	lodgepole and whitebark pine, willows along creek

Mammal species present, by habitat

Family	Species	Habitat	Commonness	# Localities
Soricidae	*Sorex lyelli*	stream edge	rare	1
	Sorex monticolus	stream edge	common	1
	Sorex palustris	stream edge	rare	1
	Sorex tenellus	stream edge	rare	1*
Sciuridae	*Spermophilus beldingi*	open meadows	abundant	1
	Spermophilus lateralis	open conifer forest	uncommon	1
	Tamias alpinus	open conifer forest	uncommon	1
	Tamias speciosus	open conifer forest	uncommon	1
Geomyidae	*Thomomys monticola*	open meadow	common	1
Cricetidae	*Peromyscus maniculatus*	open conifer forest	uncommon	1
	Microtus longicaudus	open forest, riparian	uncommon	1
	Phenacomys intermedius	open conifer forest	uncommon	1
Dipodidae	*Zapus princeps*	riparian	common	1
Mustelidae	*Mustela frenata*	gopher burrow	uncommon	1
Talpidae	*Scapanus latimanus*			1**
Ochotonidae	*Ochotona princeps*			1***

* first record for Inyo shrew from Yosemite National Park
** sight record of fresh mole runway systems
*** sight records of animals, fecal piles, hay piles, and vocalizations on two talus slopes, one adjacent to Virginia Pass and the second at the eastern base of Virginia Peak, both in the upper part of the Return Creek basin

3. Vicinity of Tuolumne Meadows

Specific Locality	Latitude	Longitude	Habitat
Juniper Ridge, Tuolumne Meadows 8665 feet	37.88358	-119.36340	lodgepole pine forest; open granite, talus
west base Fairview Dome, Yosemite 8385 feet	37.87649	-119.41609	lodgepole pine, western white pine, red fir, mountain hemlock; open granite

Mammal species present, by habitat:

Family	Species	Habitat	Commonness	# Localities
Soricidae	*Sorex monticolus*	forest-talus edge	uncommon	1
Sciuridae	*Spermophilus beldingi*	open meadows	common	1
	Spermophilus lateralis	open conifer forest	common	2
	Tamias speciosus	open conifer forest	very common	2
Cricetidae	*Peromyscus maniculatus*	open conifer forest	uncommon	1

note: sign (active burrows) of both moles (*Scapanus latimanus*) and pocket gophers (*Thomomys monticola*) were observed at both the Juniper Ridge and Fairview Dome trap sites.

4. Upper Lyell Canyon (10 ,240 – 10,600 ft)

Specific Locality	Latitude	Longitude	Habitat
upper Lyell Canyon, 10,240 ft	37.76807	-119.25506	whitebark pine, open meadow, talus, stream edge
upper Lyell Canyon, 10,565 ft	37.76358	-119.25996	whitebark pine, open meadow, talus, stream edge

Mammal species present, by habitat:

Family	**Species**	**Habitat**	**Commonness**	**# Localities**
Soricidae	*Sorex monticolus*	open meadow, talus, stream edge	very common	1
	Sorex palustris	stream edge	uncommon	1
	Sorex tenellus	stream edge	uncommon	1
Sciuridae	*Spermophilus beldingi*	open meadow	common	2
	Spermophilus lateralis	open conifer forest	common	1
	Tamias alpinus	open conifer forest	uncommon	1
	Tamias speciosus	open conifer forest	uncommon	2
Cricetidae	*Peromyscus maniculatus*	open conifer forest	uncommon	1
	Microtus longicaudus	open conifer forest	common	2
	Microtus montanus	stream edge	uncommon	1
	Phenacomys intermedius	open conifer forest	uncommon	1
Ochotonidae	*Ochotona princeps*	talus	uncommon	1
Mustelidae	*Mustela erminea*	talus edge	uncommon	1

note: marmots were common; the specimen of the Inyo shrew, *Sorex tenellus*, is the second record of this rare shrew for Yosemite National Park.

5. Dorothy Lake, northeast end Grace Meadows

Specific Locality	Latitude	Longitude	Habitat
Dorothy Lake, 9444 ft	38.176090	-119.59468	willow, lodgepole pine forest
Dorothy Lake, 9395 ft	38.170610	-119.59460	stream edge, lodgepole pine forest
Dorothy Lake, 9430 ft	38.169080	-119.59505	talus, willows
northeastern Grace Meadow, 9060 ft	38.162540	-119.60461	riparian

Mammal species present, by habitat:

Family	Species	Habitat	Commonness	# Localities
Soricidae	*Sorex monticolus*	open meadow, talus, stream edge	common	2
	Sorex palustris	stream edge	common	2
Sciuridae	*Spermophilus beldingi*	open meadow	common	2
	Tamias speciosus	open conifer forest	uncommon	2
Cricetidae	*Microtus longicaudus*	open conifer forest	common	3
Dipodidae	*Zapus princeps*	Riparian	common	2

Ochotonidae	*Ochotona princeps*	talus	common	1

note: *Peromyscus maniculatus*, a typically highly abundant species was absent from this locality and was rare in other high elevation sites this year. Sign of pocket gophers, *Thomomys monticola*, was abundant. We also observed pine marten, marmots, black bear, and deer. Chickaree were observed in camp and elsewhere, but were not common.

6. Kerrick Meadow

Specific Locality	Latitude	Longitude	Habitat
Kerrick Meadow, 9476 ft	38.11129	-119.48180	lodgepole pine forest
Kerrick Meadow, 9368 ft	38.11107	-119.48164	lodgepole pine forest
Kerrick Meadow, 9509 ft	38.11332	-119.48162	lodgepole pine forest

Mammal species present, by habitat:

Family	Species	Habitat	Commonness	# Localities
Sciuridae	*Spermophilus lateralis*	lodgepole pine forest	common	2
	Tamias alpinus	lodgepole pine forest	uncommon	1*

- northern-most record of the Alpine chipmunk from the Sierra Nevada.

APPENDIX 5: Comparisons of elevational range from the Grinnell Period (H) to the present (M) for species of small mammals across the Yosemite transect. Species are grouped into those that have shown range expansion, range contraction, or no change, and are listed in the same order as in Table 6 (except that west [W] and east [E] slope shifts are illustrated in the same figure for each species). In the elevation plots (left), the pale gray circles represent the elevation of each site surveyed, the large black circles are those sites where the standardized trapping effort detected the species, and the red or green open circles are records of occurrence not obtained from the standardized trapping (sight observations, specimens that were shot in the Grinnell period, etc.). Plots from the occupancy modeling are illustrated to the right in each figure. The black line represents the elevational occupancy during the Grinnell (= historic) period; the red line that of the modern resurvey period.

Range Expansion

Range Contraction

No Change