



A Re-survey of the Historic Grinnell-Storer Vertebrate Transect through Yosemite National Park, California

Natural Resource Technical Report NPS/SIEN/NRTR—2011/439



ON THE COVER

Clockwise from upper left: Joseph Grinnell at Museum of Vertebrate Zoology, University of California, Berkeley; Joseph Grinnell preparing a specimen (historic photos courtesy of The Bancroft Library, University of California, Berkeley); Jim Patton weighing a deer mouse (*Peromyscus maniculatus*); and alpine chipmunk (*Tamias alpinus*) (modern photos courtesy of Leslie Chow).

A Re-survey of the Historic Grinnell-Storer Vertebrate Transect through Yosemite National Park, California

Natural Resource Technical Report NPS/SIEN/NRTR—2011/439

Craig Moritz^{1,2}

James L. Patton^{1,2}

Christopher J. Conroy¹

Adam Leache^{1,2}

Andrew Rush^{1,2}

Steven R. Beissinger^{1,3}

¹Museum of Vertebrate Zoology

²Department of Integrative Biology

³Department of Environmental Science, Policy, and Management

University of California

Berkeley, CA 94720

March 2011

U.S. Department of the Interior

National Park Service

Natural Resource Program Center

Fort Collins, Colorado

The National Park Service, Natural Resource Program Center publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Technical Report Series is used to disseminate results of scientific studies in the physical, biological, and social sciences for both the advancement of science and the achievement of the National Park Service mission. The series provides contributors with a forum for displaying comprehensive data that are often deleted from journals because of page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from the Sierra Nevada Network (<http://science.nature.nps.gov/im/units/sien/>) and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>).

Please cite this publication as:

Moritz, C., J. L. Patton, C. J. Conroy, A. Leache, A. Rush, and S. R. Beissinger. 2011. A re-survey of the Grinnell-Storer vertebrate transect through Yosemite National Park, California. Natural Resource Technical Report NPS/SIEN/NRTR—2011/439. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	v
Tables.....	vii
Appendixes	ix
Abstract.....	xi
Acknowledgments.....	xiii
Introduction.....	1
Methods.....	7
<i>Methodological Caveats</i>	9
Mammals	11
<i>Data Collection</i>	11
<i>Data Aggregation</i>	11
Amphibians and Reptiles	14
Birds.....	14
<i>Transect and Site Comparisons</i>	18
<i>Species Richness and Turnover</i>	19
<i>Species-level Change</i>	19
<i>Cluster Analysis</i>	20
Results.....	21
Overview.....	21
Mammals	21
<i>Priority Species</i>	23
<i>Expanded Ranges</i>	24
<i>Recently Rare Species</i>	25

Contents (continued)

	Page
<i>Shifts in Elevational Range</i>	27
Reptiles and Amphibians	33
Birds	34
<i>Number of Observations and Species</i>	34
<i>Species Richness and Turnover</i>	36
<i>Species Level Change</i>	39
<i>Habitat Associations and Change</i>	40
Conclusions and Prospectus	43
Literature Cited	47

Figures

	Page
Figure 1. The Grinnell Yosemite Transect (red rectangle) across the central Sierra Nevada.	2
Figure 2. Examples of survey documents and images.	8
Figure 3. Map of individual trap sites in upper Lyell Canyon from the fieldnotes of Charles Camp, July 1915.	10
Figure 4. Trapline aggregates for the historic (1914–1915) and modern (2003–2006) sampling eras.	12
Figure 5. Transect survey for avian species point-counts in 2003 (upper) and 2004 (lower).	17
Figure 6. Range (elevation) expansion of the Piñon mouse, <i>Peromyscus truei</i> , on both the western and eastern slopes of the Sierra Nevada into Yosemite National Park.	22
Figure 7. Locality records for the Lyell shrew, <i>Sorex lyelli</i> , from the Yosemite region based on the original 1914–1915 Grinnell surveys (orange circles) and the 2003–2008 resurveys (yellow triangles).	23
Figure 8. Locality records for the heather vole, <i>Phenacomys intermedius</i> , from the Yosemite region based on the original 1914–1915 Grinnell surveys (orange circles) and the 2003–2008 resurveys (yellow triangles).	24
Figure 9. Locality records for the alpine chipmunk, <i>Tamias alpinus</i> , from the Yosemite region based on the original 1914–1915 Grinnell surveys (orange circles) and the 2003–2008 resurveys (yellow triangles).	25
Figure 10. Locality records for the shadow chipmunk, <i>Tamias senex</i> , from the Yosemite region based on the original 1914–1915 Grinnell surveys (orange circles) and the 2003–2008 resurveys (yellow triangle).	26
Figure 11. Locality records for the bushy-tailed woodrat, <i>Neotoma cinerea</i> , from the Yosemite region based on the original 1914–1915 Grinnell surveys (orange circles) and the 2003–2008 resurveys (yellow triangles).	26
Figure 12. Elevational profiles for the montane shrew, <i>Sorex monticolus</i>	28
Figure 13. Elevational profiles of three species of mammals that have experienced a retraction of their lower and/or upper elevational range from the historic (H) to resurvey (M) period.	29

Figures (continued)

	Page
Figure 14. Range contractions in <i>Tamias alpinus</i> predicted under two models:	30
Figure 15. Map of survey localities for amphibians and reptiles.....	33
Figure 16. Regression of the number of birds encountered per hour along the same transect	35
Figure 17. 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.....	35
Figure 18. Species abundance distributions for the Grinnell survey period (1915– 1919) and the current surveys (2003–2004).	36
Figure 19. 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), rarefied, and Chao1 estimates, for each of the 11 comparable sites.....	37
Figure 20. 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).	39
Figure A-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 (source: Archives, Museum of Vertebrate Zoology, University of California, Berkeley).....	50
Figure A-2. Photograph comparisons of upper Lyell Fork meadow and Kuna Crest. Left, photo taken by Walter Taylor in July 1915 (source: Archives, Museum of Vertebrate Zoology, University of California, Berkeley).	51
Figure A-3. Photograph comparisons of the north end of Vogelsang Lake. Left, photo taken by Walter Taylor in July 1915 (source: Archives, Museum of Vertebrate Zoology, University of California, Berkeley).	52
Figure A-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 (source: Archives, Museum of Vertebrate Zoology, University of California, Berkeley).	53

Tables

	Page
Table 1. General localities within Yosemite National Park sampled by teams from the Museum of Vertebrate Zoology headed by Joseph Grinnell, 1911–1920.	2
Table 2. Sites visited and individual line transects per site for avian censuses in 2003 and 2004.....	16
Table 3. Avian transects and dates for the Grinnell era and 2003–2004 surveys.	18
Table 4. Estimated detectability per site in Grinnell (P*G) and present (P*P), significant changes in upper (U) and lower (L) elevation limits, percent change in elevation range, and original lifezone classification (Grinnell and Storer 1924).	31
Table 5. Number of observations (<i>n</i>), number of species (<i>Sobs</i>), estimates of number of species by bootstrapping (with 1 standard deviation), estimates of species richness from rarefaction and Chao1 estimates of species richness for 11 sites in our study area.	38

Appendixes

	Page
Appendix A: Photographs of Selected Grinnell-era Sites.....	50
Appendix B: Avian Surveys by Year and Site.....	55
Appendix C: Mammal Surveys by Year and Site.....	91
Appendix D: Herpetological Surveys by Year and Site.....	119

Abstract

In response to a need for more information about the condition of natural resources in national parks, the National Park Service (NPS) established an Inventory and Monitoring Program (I&M) to expand existing resource inventories and develop efficient ways to monitor the vital signs of natural systems (NPS 1999). The Sierra Nevada Network (SIEN) I&M program identified a vertebrate inventory as a high-priority need for all Sierra Nevada parks (Devils Postpile National Monument, Sequoia, Kings Canyon, and Yosemite National Parks) in its Biological Inventory Plan (NPS 2001). In Yosemite National Park, the historic vertebrate surveys conducted in the early 20th century by Joseph Grinnell and his colleagues at the Museum of Vertebrate Zoology at the University of California at Berkeley presented a unique opportunity to do a repeat inventory at the same locations, and examine changes that may have taken place in animal occurrence and distribution. From 2003 through 2005 we conducted a resurvey of the terrestrial vertebrate fauna (mammals, birds, reptiles, and amphibians) at 21 sites within Yosemite National Park (YNP). These 21 sites are part of a larger transect encompassing 41 total sites that extends from the margins of the San Joaquin Valley west of YNP to the shores of Mono Lake on the east side of the Sierra Nevada. Joseph Grinnell and his colleagues compiled the original data for the entire transect between 1911 and 1920. During the summers of 2005 through 2008 we extended surveys of small mammals to eight additional sites within YNP, all at elevations above 9,600 feet, which had not been previously studied. Until the present effort, the Grinnell-era survey has provided the majority of available knowledge of the vertebrate fauna of YNP, yet that information is now nearly a century old. 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 communities. The combined Grinnell-era and repeat surveys document both elevational and habitat stasis for many species of terrestrial vertebrates as well as substantial changes in the presence and elevational distribution of others.

Acknowledgments

This study could not have been undertaken without the direct, or indirect, aid of a number of individuals and organizations. Within the National Park System we are especially grateful to Linda Mutch (NPS Inventory and Monitoring Program), Les Chow and Jan van Wagtendonk (USGS Yosemite Field Station), and Steve Thompson and Niki Nicholas (Resources Management and Science, Yosemite National Park) for both initiating the resurvey project and supporting it materially as well as conceptually until its completion. Les Chow, Peggy Moore, Hanna Shohfi, Dou Yang, Ann Chang, Kim Tsao, Dershing Hellman, Emily Rubidge, and Cole Burton ably provided assistance during the fieldwork. Robert Hijmans, Michelle Koo, Bill Monahan, and Juan Parra mined the fieldnotes, built the data files, and performed many of the analyses. We are grateful for stock support provided by the NPS stables in Yosemite and by the Virginia Lakes Pack Station, which gave us access to sites in the northern tier of the Park. The NPS Inventory and Monitoring Program, The Yosemite Fund, the National Geographic Society, and the Museum of Vertebrate Zoology provided funding for the resurvey.

Introduction

Between 1911 and 1920, Joseph Grinnell and his students (primarily Charles L. Camp, Joseph Dixon, Gordon F. Ferris, Donald D. Holliger, Donald D. McLean, Tracy I. Storer, and Walter P. Taylor) 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 (Figure 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 goal 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 an important baseline against which future studies could be compared to measure faunal change over time, and he encouraged future scientists to make these comparisons (Grinnell 1910). 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 transect 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 fieldnotes, route maps, and photographic images archived in the MVZ, most of which are now accessible from the MVZ website (<http://mvz.berkeley.edu>).

Grinnell and his colleagues transected the central Sierra Nevada, surveying along a "...narrow rectangular area, 89¼ miles in length by 17⅓ miles in width..." (Grinnell and Storer 1924:1), a band that began on the eastern edge of the San Joaquin Valley at 76 meters (250 feet) elevation and proceeded across the high Sierra to the Great Basin along the edge of Mono Lake (Figure 1). The survey area encompassed some 1,547 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, Merced Lake, Vogelsang Lake, upper Lyell Basin, 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 2,000 pages of fieldnotes, 817 photographs, and 2,795 specimens. Collections within the park were most extensive for mammals (N = 1,572), followed by birds (722) and herpetofauna (501). Allowing for the extensive additional information captured in fieldnotes, the original data are quite comprehensive for small mammals, birds, and frogs, but less so for reptiles (e.g., snakes) and non-aquatic amphibians (especially salamanders). Table 1 lists Grinnell-era survey areas represented by the largest collections and highest known diversities of taxa.

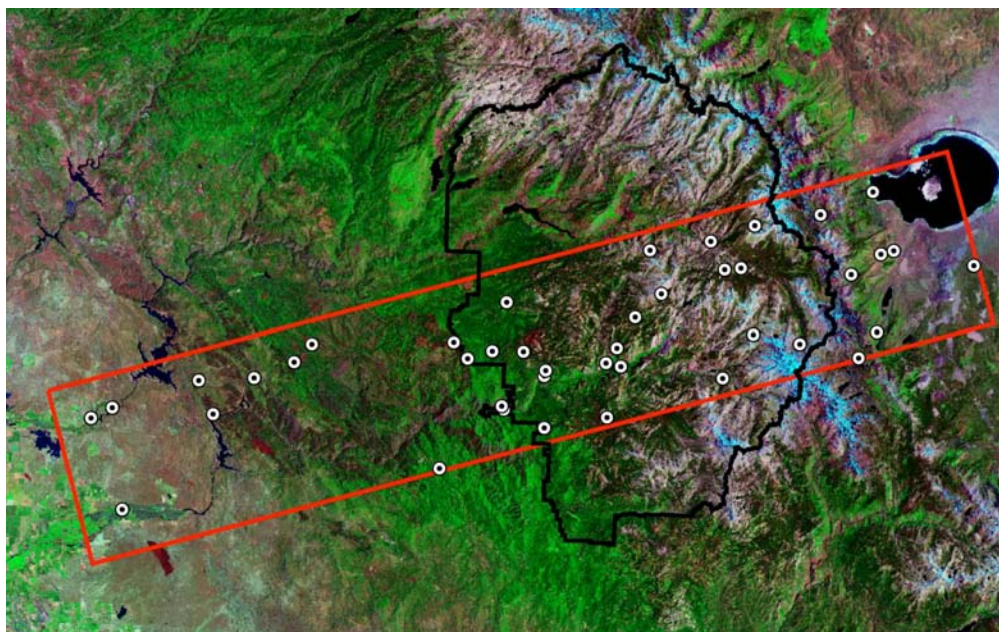


Figure 1. The Grinnell Yosemite Transect (red rectangle) across the central Sierra Nevada. White circles with black centers identify the 41 original sites surveyed, 21 of which are within the boundary of Yosemite National Park (black irregular polygon).

Table 1. General localities within Yosemite National Park sampled by teams from the Museum of Vertebrate Zoology headed by Joseph Grinnell, 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	1,219 m (4,000 ft)	Transition Zone: chaparral, meadow, oak woodland, conifer forest, riparian	13	<i>Hydromantes platycephalus Ensatina eschscholtzii</i> <i>Charina bottae Thamnophis couchii Thamnophis sirtalis Eumeces gilberti</i> <i>Sorex trowbridgii Tamias merriami Peromyscus boylii Microtus longicaudus Microtus montanus Zapus princeps</i>

Table 1. General localities within Yosemite National Park sampled by teams from the Museum of Vertebrate Zoology headed by Joseph Grinnell, 1911–1920 (continued).

General Locality	Elevation (range)	Habitat	Number of Known Non-volant Mammal Species	NPS Priority Species
Merced Big Trees to Crane Flat	1,646–1,920 m (5,400–6,300 ft)	Transition to Canadian Zone: oak woodland, conifer forest, meadow, riparian, talus	11	<i>Ensatina eschscholtzii</i> <i>Sceloporus graciosus</i> <i>Sorex trowbridgii</i> <i>Sorex vagrans</i> <i>Tamias quadrimaculatus</i> <i>Tamias senex</i> <i>Tamias speciosus</i> <i>Zapus princeps</i>
Big Oak Flat/Gentry's	1,768–1,920 m (5,800–6,300 ft)	Transition Zone: chaparral, yellow- pine, oak, talus	8	<i>Sorex trowbridgii</i> <i>Tamias quadrimaculatus</i> <i>Tamias speciosus</i>
Chinquapin	1,890–1,920 m (6,200–6,300 ft)	Canadian Zone: chaparral, conifer forest, riparian	13	<i>Sorex trowbridgii</i> <i>Tamias quadrimaculatus</i> <i>Tamias senex</i> <i>Tamias speciosus</i> <i>Zapus princeps</i>
Aspen Valley	1,951 m (6,400 ft)		11	<i>Tamias quadrimaculatus</i> <i>Tamias speciosus</i>
E Fork Indian Canyon	2,195–2,225 m (7,200–7,300 ft)		13	<i>Sorex monticolus</i> <i>Sorex trowbridgii</i> <i>Tamias quadrimaculatus</i> <i>Tamias senex</i> <i>Tamias speciosus</i> <i>Peromyscus boylii</i> <i>Zapus princeps</i>
Mono Meadow	2,225–2,256 m (7,300–7,400 ft)		13	<i>Sceloporus graciosus</i> <i>Sorex monticolus</i> <i>Tamias senex</i> <i>Tamias speciosus</i> <i>Zapus princeps</i>
Merced Lake	2,286 m (7,500 ft)	Canadian Zone: conifer forest, meadow	13	<i>Charina bottae</i> <i>Sceloporus graciosus</i> <i>Sceloporus occidentalis</i> <i>Sorex monticolus</i> <i>Sorex trowbridgii</i> <i>Tamias senex</i> <i>Tamias speciosus</i> <i>Zapus princeps</i>

Table 1. General localities within Yosemite National Park sampled by teams from the Museum of Vertebrate Zoology headed by Joseph Grinnell, 1911–1920 (continued).

General Locality	Elevation (range)	Habitat	Number of Known Non-volant Mammal Species	NPS Priority Species
Glen Aulin, Tuolumne River	2,347 m (7,700 ft)		12	<i>Sceloporus occidentalis</i> <i>Sorex monticolus</i> <i>Tamias alpinus</i> <i>Tamias senex</i> <i>Tamias speciosus</i> <i>Peromyscus boylii</i> <i>Phenacomys intermedius</i> <i>Ochotona princeps</i>
Porcupine Flat	2,469 m (8,100 ft)	Canadian-Hudsonian Zone boundary: conifer forest, meadow	22	<i>Thamnophis elegans</i> <i>Sceloporus graciosus</i> <i>Sorex monticolus</i> <i>Tamias senex</i> <i>Tamias speciosus</i> <i>Peromyscus boylii</i> <i>Zapus princeps</i>
Tuolumne Meadows	2,621–2,896 m (8,600–9,500 ft)	Canadian Zone: conifer forest, meadow, riparian	16	<i>Thamnophis elegans</i> <i>Sorex monticolus</i> <i>Tamias alpinus</i> <i>Tamias speciosus</i> <i>Zapus princeps</i>
Ten Lakes	2,896 m (9,500 ft)		10	<i>Tamias alpinus</i> <i>Tamias speciosus</i> <i>Phenacomys intermedius</i>
head Lyell Canyon	2,957–3,353 m (9,700–11,000 ft)	Hudsonian-Arctic Alpine Zone:	16	<i>Hydromantes platycephalus</i> <i>Sorex lyelli</i> <i>Sorex monticolus</i> <i>Tamias alpinus</i> <i>Tamias speciosus</i> <i>Phenacomys intermedius</i> <i>Zapus princeps</i>
Vogelsang Lake	3,155 m (10,350 ft)	Hudsonian-Arctic Alpine Zone	15	<i>Sorex lyelli</i> <i>Sorex monticolus</i> <i>Tamias alpinus</i> <i>Tamias speciosus</i> <i>Phenacomys intermedius</i>

The objectives of this inventory were as follows:

- 1) Intensively sample the original Grinnell-Storer transect sites in Yosemite National Park to document presence/absence and distribution for primarily non-volant small mammals, amphibians, and reptiles.
- 2) To the extent possible, replicate Grinnell-Storer bird surveys at these same sites.
- 3) Determine the current status of species that, based on the limited prior records, were either considered rare or of unknown status.
- 4) Compare the Grinnell-era and modern data to document changes in distribution.

With initial funding from the Inventory and Monitoring Program of the National Park Service and University of California at Berkeley's Museum of Vertebrate Zoology (MVZ), 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" from 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. As the resurvey work progressed, and range shifts of some species noted, we were also requested to establish baseline surveys of mammalian diversity at sites within the Park but outside of the original Grinnell transect, specifically localities at elevations above 2,296 m (or 9,600 ft). With funding support from the National Geographic Society, during the summers of 2005 through 2008 we visited eight areas, five to the north and three to the south of the Tioga Pass Road. The results of these surveys also are presented. Our goal in this report is primarily to detail the taxon and site-specific data for each terrestrial vertebrate group from our resurveys of the Grinnell-era sites (Grinnell and Storer 1924) plus those additional sites beyond the original transect. These data provide an ability to compare patterns of stasis and change over the past century, some of which have been published (Moritz et al. 2008, for mammals; Tingley et al. 2000, for birds), and to provide baseline and trends for future resurveys and projections. We conclude by presenting a set of recommendations for further monitoring studies or analyses.

Craig Moritz, MVZ Director, served as project coordinator. Andrew Rush, now a graduate student at the MVZ, worked specifically and independently on the bird surveys that are presented in this report. James L. Patton (Curator with MVZ and UC Berkeley Professor Emeritus) and Christopher J. Conroy (Staff Curator) were responsible for the mammal surveys; Patton compiled and wrote the mammal results. Adam Leache (then a graduate student at the MVZ, currently Assistant Professor at the University of Washington) undertook the surveys of reptiles and amphibians and compiled those results. Steven R. Beissinger, Professor with the Department of Environmental Science, Policy, and Management at UC Berkeley, was largely responsible for the detectability and occupancy analyses.

Methods

We identified the original field sites visited by the 1911–1920 Grinnell Survey team from a combination of their original fieldnotes and route maps archived in the MVZ and from descriptions and illustrations in Grinnell and Storer (1924, especially plates 61 and 62). These sources enabled us to relocate and resample many of the same avian transects and mammal trapping areas. Our resurvey field teams spent seven to 12 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 once during the six-year period, but several were revisited two or more times. Descriptions of habitats were made consistent with the level of detail in the fieldnotes from the original surveys, supplemented by photographs taken at the same locations. 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 waypoint along that line (Figure 2). All fieldnotes, photographs, datasheets, and maps are archived in the MVZ.

NATIONAL PARK VEGETATION MAPPING PROGRAM: ACCURACY ASSESSMENT POINT FORM

IDENTIFIERS/LOCATORS

Field Point Code TR Site (1) Tomahawk (1) Database Point Code _____

State CA Park Name Yosemite Park Site Name Mono Meadow trail head

Quad Name (7.5') _____ Quad Code _____

Primary Veg Assoc Name _____

Secondary Veg Assoc Name _____

Other Veg Assoc within 50 m _____

Classification Comments: _____

GPS file name _____ Field UTM X _____ m E Field UTM Y _____ m N

37.67122 / -119.58593 top 3 GPS Error 9 m

please do not complete the following information when in the field

Corrected UTM X _____ m E Corrected UTM Y _____ m N UTM Zone _____

Survey Date 7/13/03 Surveyors JP Patton + CP Patton

ENVIRONMENTAL DESCRIPTION

Elevation 7258 (ft) m Slope 2.5° Aspect 470 (south facing)

Topographic Position _____

Landform _____

Environmental Comments (including hydrology, fire history):
open mixed conifer forest - gentle rising
slope to NW. Distinct shrub understory;
gopher workings on exposed ground; fire
scars on live trees and burned trunks; some
large trees cast

Unvegetated Surface: (please use the cover scale below)

> 1% Bedrock	class 6
45 Litter, duff	
20 Wood (> 1 cm)	
1 Large rocks (cobbles, boulders > 10 cm)	
Small rocks (gravel, 0.2-10 cm)	
Sand (0.1-2 mm)	
30 Bare soil	
Other:	

VEGETATION DESCRIPTION

snags class 5 2

4 3

3 -

2 -

1 -

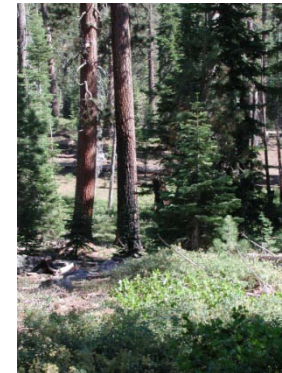
photos # 3303 - 3306



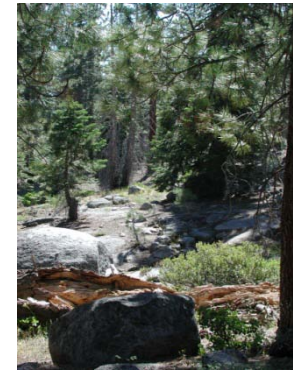
North



East



South



West

Figure 2. Examples of survey documents and images. 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 the GPS-determined center of one mammal trap line at the Mono Meadow trailhead.

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 locality, including Global Positioning System (GPS) coordinates, 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) also were taken from each specimen preserved for eventual molecular genetic analysis; these are all stored either at ultra-cold temperatures (-80° C) or in 95% ethanol. Complete data for all specimens that were collected and preserved during both the original Grinnell-era surveys and our resurveys can be accessed from the MVZ collection database at <http://mvzarctos.berkeley.edu/SpecimenSearch.cfm>. Queries can be built for each annual accession (2003 [accession 13817], 2204 [13948], 2005 [14091], 2006 [14191], 2007 [14349], and 2008 [14473]) or globally by specifying the inclusive years 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?>. Route maps and archived photographs, both from the original survey and resurvey periods, have been digitized and are being added to the MVZ public database as time allows.

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 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 resurvey teams primarily used live traps. Since these two sets of methods may result in biases of trapability, we used statistical methods to assess the comparability of survey success for each species across the two time periods. Detection probabilities (MacKenzie et al. 2002, MacKenzie and Nichols 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 in the section on Birds, pg.14.

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 make this task relatively simple in most cases. Thus, the position of all generalized sites, based on documentation of the actual campsite, is reasonably known, and even individual trap lines are often clearly demarcated on hand-drawn maps, based on USGS topographic maps of that era, and can be located with precision. As an example, Figure 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.

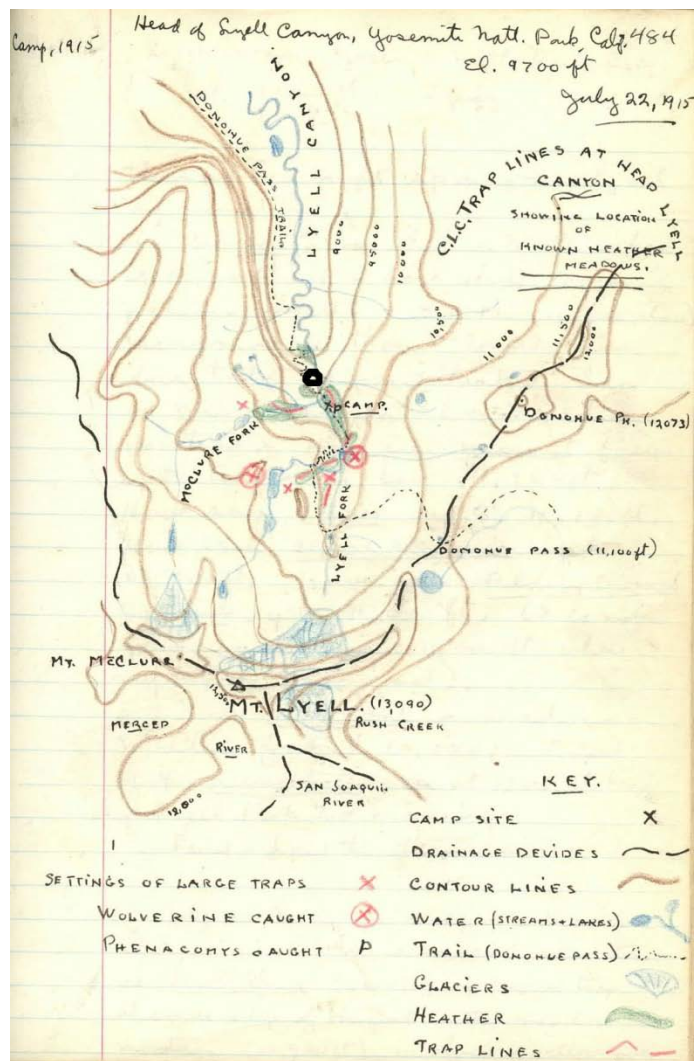


Figure 3. Map of individual trap sites in upper Lyell Canyon from the fieldnotes of Charles Camp, July 1915. Camp traced this map into his fieldnotes from the Mt. Lyell 30' USGS quadrangle, 1909 edition, then available.

The third caveat involves the natural year-to-year flux in species' abundances, a level of variation that may affect detectability, particularly of rare species, and the affect 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 reasonably consistent 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 sight or song) based on the temperature and snowfall of the previous winter. As noted below, we conducted many avian surveys on successive years at the same site, with the data reported summed 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 for the

original Grinnell data. Hence, caution should be used in assessing the significance of the comparative avian species richness data per site.

Mammals

Data Collection

We assessed medium to small-sized, non-volant, mammals using a variety of live traps. Spatially explicit trapping programs (e.g., grid or parallel line trap designs) inevitably fail to encompass all habitats with respect to the numbers of traps per habitat, especially so in topographically rich areas with a highly diverse fauna, such as the Yosemite transect (Figure 1). As a consequence, we standardized our program not by a spatial trap design but by using a standard trap effort (number of traps) for all major habitats identified within an approximately 1 km radius of each site. All live trap and pitfall trap lines were “run” for a minimum of four 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. We used commercial Macabee™ traps for pocket gophers and pitfall cups for diminutive mammals, such as shrews. Macabee traps were set where active gopher sign was evident (e.g., fresh earthen mounds). For pitfall traps, we established at least two meandering lines at every site, each comprising twenty-five 32-oz. plastic cups in the ground at approximately 10 m intervals using a 4-in diameter bucket soil auger. These were run during the same interval as trapping. Cups were retrieved as the survey at a given locality terminated with the hole refilled with the excavated dirt. The diversity of traps and methods employed ensured that we sampled the full range of target taxa likely in a given area. 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, WGS84 datum; those data are archived in fieldnotes for all individuals encountered, including those released as well as preserved.

Data Aggregation

The trapping effort and elevational range of sampling was similar between the Grinnell and contemporary periods. A total of 311 traplines where trapping effort could be quantified were identified in Grinnell’s time and 308 in the resurvey. For both periods, we aggregated traplines into sampling sites if they were within 2 km and 100 m elevation of each other to reduce spatial autocorrelation (Figure 4, Table S1 in Moritz et al. 2008). The higher level of aggregation in the Grinnell period reflects our generally conservative approach to grouping traplines and greater uncertainty in the exact location and elevation of traplines (mean point-radius error of georeference for historical traplines was 323 ± 425.9 m). Accordingly, there was a larger number of both traplines (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, sites were geographically matched between the Grinnell and re-survey periods. Those that were not paired were those at which the historic locality could not be accessed (i.e., the Grinnell site “Varain” is 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.

Following aggregation, on the western slope of the transect there were 54 sites with traplines in Grinnell's time and 121 sites in the contemporary resurvey where trapping effort could be quantified, spanning elevational ranges of 57–3,287 meters above sea level in the original survey and 48–3,278 m in the resurvey (Table S1 in Moritz et al. 2008). On the eastern slope there were nine sites during Grinnell's time and 13 in the resurvey, spanning elevational ranges of 1981–2,804 m and 2,155–3,212 m, respectively.

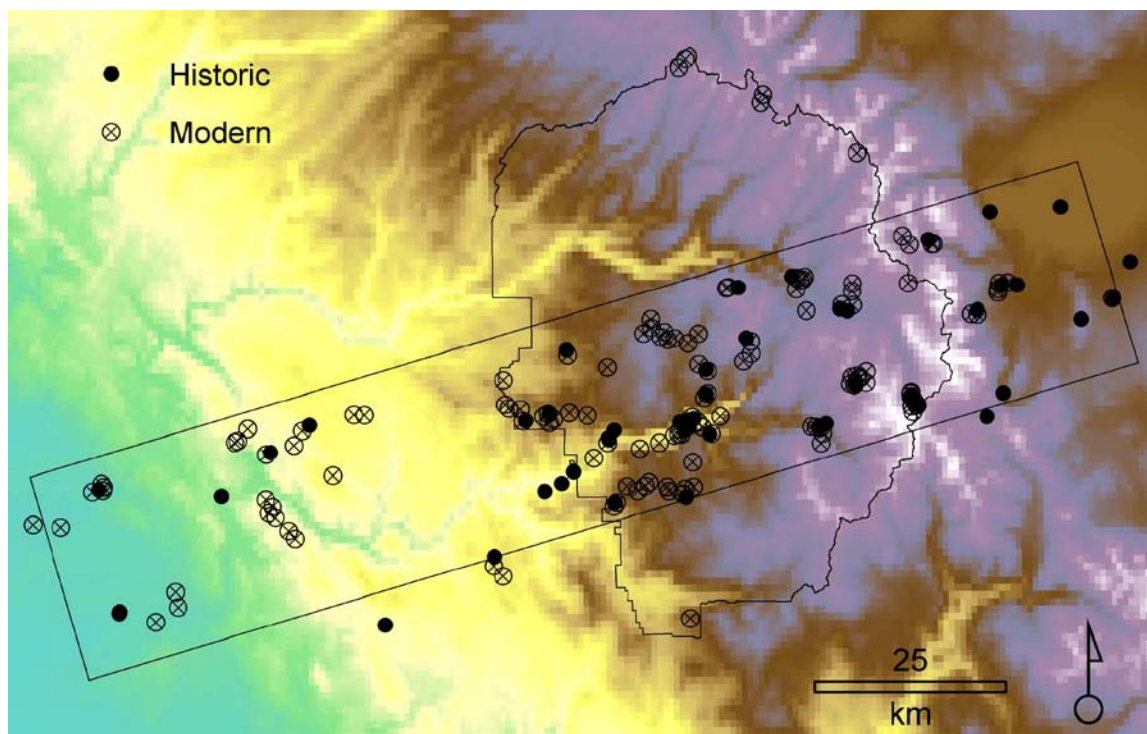


Figure 4. Trapline aggregates for the historic (1914–1915) and modern (2003–2006) sampling eras.

Estimating the probability of detection, false absence, and occupancy: Rigorous comparison for any measure between sample periods is complicated by differences in methods of trapping and uncertainty in geographic location of historical records (Rowe 2005). 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 fieldnotes provide sufficiently detailed information on trapping effort and captures, enabling us to use formal statistical models to estimate detectability and to incorporate differences in detectability between eras into our evaluations of change in elevational ranges.

Although the overall small-mammal survey methods were similar between periods, differences in trap types and effort per site could confound interpretation of absences and, thus, overall comparisons. To control for these effects, we estimated detection probabilities for each period and species from the temporal pattern of presence or “no-presence” records across sites. We then

incorporated any between-period difference in detectability into analyses of changes in elevational range limits and profiles of occupancy probability (ψ). Given prior evidence for distinct elevational distributions of small mammals on the east versus west sides of the Sierra crest (Grinnell and Storer 1924), we used only the west slope records to estimate parameters. The analyses of detectability and ψ employed the likelihood framework and Akaike Information Criterion (AIC) model-averaging methods described in MacKenzie et al. (2006) and implemented in Program MARK version 5.1 (White and Burnham 1999).

To estimate the probability of detection per trap night (p), we constructed 32 competing models with the following independent variables: era (Grinnell or resurvey), trend (linear decline in detections over sequential nights due to the collection of trapped individuals or to trap-shyness), trap effort (number of traps/100 and the $\log_{10}$ of the number of traps), the interaction between era and trend, and the interactions between era and trap effort variables. We also built detection models with all additive combinations of these independent variables, as well as a constant model. The candidate model set is listed in Moritz et al. (2008: Table S3). We examined the potential bias in the calculation of detection probabilities by comparing results for traplines where individuals were removed and vouchered during the sequential nightly trapping period with those where no removal occurred. These comparisons were only minimally different, if at all, with slightly higher probabilities in unperturbed lines relative to removal lines. Consequently, the results reported are conservative estimates, especially so for the Grinnell-era lines where the number of vouchered specimens was much higher than the resurvey period.

We ran each p model with a ψ_{era} term and selected the best detection model with the lowest AIC score for each species. We used the parameter values to estimate the overall probability of detection (6) for each site for each era based on its number of nights trapped and traps used, as $P^* = 1 - \prod_i (1 - p_i)$. To estimate the probability of false absence (P_{fa}) across a set of sites in an elevational band where a species was detected in one era but not the other, we first calculated the probability of a false absent for each site $P_{fa(\text{site})} = 1 - P_{(\text{site})}^*$ and then obtained the product of these values across the set of sites in question as $P_{fa} = \prod_{\text{site}} (1 - P_{fa(\text{site})})$.

To estimate elevational profiles of occupancy (ψ) for each era, we constructed a set of competing likelihood models incorporating era (Grinnell or present), elevation represented as linear (elev) or quadratic (elev+elev²) functions, and interactions between era and elevation functions. This resulted in eight competing ψ models. Five models had between-era effects: era, era+elev, era*elev, era+elev+elev², and era*(elev+elev²). Three models had no era effects: elev, elev+elev², and constant (.). These are listed and illustrated in Moritz et al. (2008: Table S3, Figure S2).

The eight occupancy models were each run with a set of 14 detection functions that included the best model for each species (Moritz et al. 2008: Table S3). This resulted in a total of 112 models per species in the occupancy model set. Models were compared using AIC_c (corrected for small sample size) scores (Burnham and Anderson 2002). Occupancy profiles were estimated across the range of elevations sampled by model-averaging ψ at 100-m increments using the AIC weights (w) of the 112 models. Finally, cumulative AIC weights were calculated for each

occupancy model. Moritz et al. (2008: [Supporting Online Material](#)), provided occupancy-elevation profiles for each species.

Amphibians and Reptiles

Amphibian and reptiles surveys were conducted mostly as 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). We also obtained some amphibians in the pitfall cups used for mammals and used timed surveys at given sites to determine relative abundances of some taxa, such as fence lizards. We obtained most amphibian and many reptile species by hand or by use of a noose tied to a fishing pole in the case of fence lizards.

Birds

Grinnell and Storer (1924) censused birds by walking a path and recording the number of individuals of each species encountered. For the most part, they recorded their observations on special census sheets inserted into their field notebooks (for example, see Grinnell and Storer 1924: 23, Figure 3), where they also detailed the duration of the census and information about the route, habitat, and weather. Descriptions of routes traveled for each census are sufficiently detailed to allow a reasonably exact resurvey of the same site. While they conducted censuses during all times of the year, they were aware of the advantage of taking bird censuses during the breeding season when species are fixed to some degree about a defined territory, allowing more accurate counts. Grinnell and Storer 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 early morning or late afternoon.

During 2003 and 2004, we re-surveyed 17 sites across the entire Yosemite Transect, 13 within Yosemite National Park (Figure 5, Table 2). Several sites comprised more than one transect. Twelve of these sites are directly comparable seasonally to the Grinnell-era surveys (Table 3). All analyses and comparisons reported below are based on this set of comparable transects. Because the Grinnell-era surveys often were combined with other activities (e.g., while running mammal trap lines) and were not explicitly replicated by method across their sites, it was impossible to replicate their surveys exactly. However, while our first aim was to collect data for comparison to those of the Grinnell era, we also wanted to conduct a systematic inventory of the birds encountered in 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 seven-minute, variable distance point counts along transects overlapping with the routes used by Grinnell and colleagues. We established 27 total transects (14 in 2003, 13 in 2004; Figure 5) made up of a total of 418 points. These transects consisted of points set at least 200 meters apart (avg. 250 m); the location of each point was recorded with a GPS device. 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 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 transects 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 seven of the 2003 transects in 2004 (for reasons described below). We undertook no bird surveys on the eastern slope or around

Mono Lake although Grinnell-era data are available for this portion of the original Yosemite transect.

In many cases, information in the Grinnell-era fieldnotes was sufficiently detailed to allow precise duplication of the original survey routes. Where the original route was obscure, we sampled near the original campsite, and in habitats similar to those described, 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 site of the Grinnell era is now under the impoundment of the Merced River that forms current Lake McClure. For circumstances such as this one, we duplicated the Grinnell-era survey by sampling similar habitat as geographically close to the original site as possible. Survey dates were chosen to bracket those of the original surveys at a particular site , i.e., we conducted surveys spanning the Grinnell-era survey dates [Table 3].

Table 2. 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 B-1 in Appendix B provides a list of birds recorded and numbers of each species on each transect.

Site	Individual Transect	Begin Transect			End Transect		
		LON	LAT	ELV (m)	LON	LAT	ELV (m)
Chinquapin	Chinquapin	-119.70187740	37.65244523	1,861.7	-119.65396820	37.66596557	2,278.4
Crane Flat	Crane Flat	-119.80164308	37.75322110	1,861.9	-119.81084164	37.77953089	1,597.6
Glen Aulin	Cold Canyon	-119.41683452	37.91325585	2,436.1	-119.40697380	37.94847024	2,677.9
Glen Aulin	McGee Lake	-119.42119210	37.90810056	2,415.2	-119.45353166	37.87937704	2,551.4
Glen Aulin	Waterwheel Falls	-119.42465022	37.91291270	2,372.9	-119.45942657	37.92920645	2,063.8
Indian Canyon	Indian Canyon	-119.56282657	37.78304466	2,330.1	-119.59293445	37.75648979	2,123.9
Merced Grove	Merced Grove	-119.84221753	37.76230993	1,809.1	-119.83230409	37.73562120	1,576.0
Mono Meadow	Mono Meadow	-119.58439782	37.67246222	2,205.4	-119.55970129	37.68240123	2,085.0
Mono Meadow	McGurk Meadow	-119.62806384	37.67057721	2,139.0	-119.60985064	37.70707545	2,226.8
Porcupine Flat	Porcupine Flat	-119.54528576	37.80391678	2,469.3	-119.55665162	37.77020996	2,464.4
Porcupine Flat	May Lake	-119.50932446	37.81842560	2,570.0	-119.49103314	37.84987685	2,828.1
Tamarack Flat	Tamarack Flat	-119.77265016	37.76418639	2,151.8	-119.72446260	37.74912210	1,942.0
Tuolumne Meadows	Tuolumne Meadows	-119.36983249	37.87252265	2,613.0	-119.33213094	37.88618993	2,822.5
upper Lyell	Donohue Pass	-119.25931869	37.77306023	3,006.6	-119.24737658	37.76009946	3,366.6
upper Lyell	Lyell Meadows	-119.26330798	37.78084961	2,971.8	-119.27734247	37.82501847	2,711.0
upper Lyell	Maclure Creek	-119.27623212	37.76536329	3,210.7	-119.26494194	37.77313323	3,055.2
Vogelsang	Evelyn Lake	-119.34299079	37.79688159	3,104.9	-119.30412608	37.81426583	3,228.7
Vogelsang	Vogelsang Lake	-119.34503304	37.79416636	3,090.7	-119.34367006	37.76860642	2,987.6
Yosemite Valley	North Yosemite Valley	-119.61861048	37.72617597	1,224.1	-119.66551544	37.72284869	1,392.3
Yosemite Valley	Yosemite Valley	-119.66002303	37.71607611	1,175.6	-119.62656667	37.72667100	1,185.7
Mirror Lake	Mirror Lake	-119.55091194	37.74893451	2,102.0	-119.54850164	37.74838952	1,240.9
Nevada Falls	Nevada Falls	-119.51415185	37.73465024	1,856.4	-119.54843836	37.72456807	1,525.7

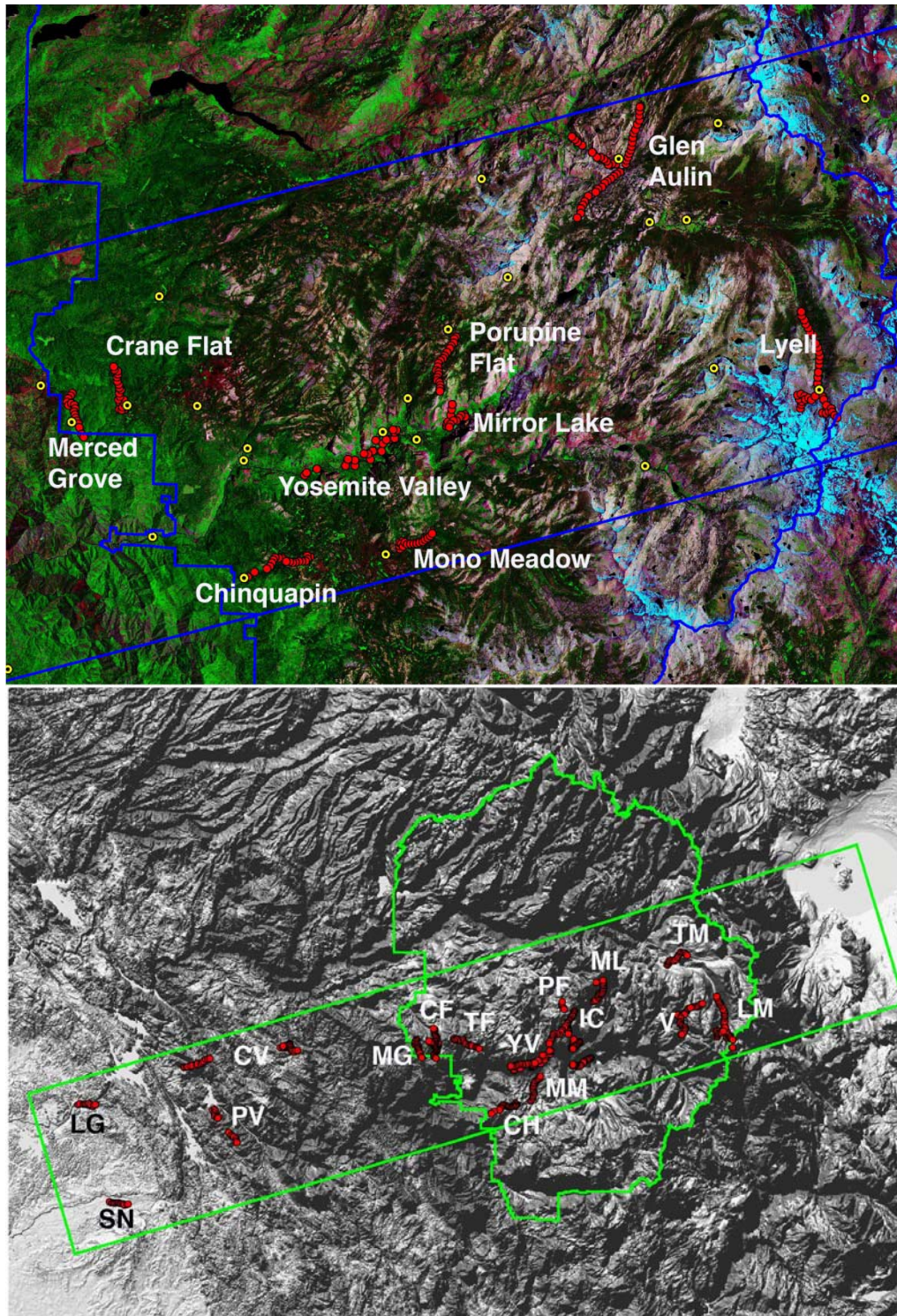


Figure 5. Transect survey for avian species point-counts in 2003 (upper) and 2004 (lower). The general location of each original Grinnell site is indicated in the upper map by the yellow dots with black centers. Only transects in Yosemite NP were done in 2003; western foothill localities outside of the 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 3, Figure 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 fieldnotes. Grinnell-era censuses were rarely replicated 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. All Grinnell-era surveys recorded both the species observed and numbers of individuals; they avoided use of 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 numerical counts.

Table 3. Avian transects and dates for the Grinnell era and 2003–2004 surveys. Transects are mapped in Figure 5 (above), by their codes or names.

Site	Code	Elevation Range (m)	Grinnell Survey (1915–1919)¹	Current Survey (2003–2004)¹
LaGrange	LG	57	6, 7, 9(2) May 1919	3, 13, 21 May 2004
Snelling	SN	83	26, 27(2), 29 May 1915	4, 19 May 2004
Pleasant Valley	PV	541	23(2), 24(2), 25(2), 26–30 May 1915	6, 12, 26 May 2004
Coulterville	CV	692–871	31 May; 1–4, 6 June 1915. 10, 11, 13 May 1919	5, 7, 14, 20, 22, 27 May 2004
Yosemite Valley	YV	1,176–1,392	31 May; 3, 8, 24 June; 22–25, 30 July 1915. 16(6), 17, 18(4), 21(4), 23, 25(2) May 1919	4, 13–14 June 2003. 11, 23 May, 4 June 2004
Merced Grove	MG	1,576–1,809	10, 12, 14 June 1915	10, 15 June 2003. 10 May. 12, 16 June 2004.
Mono Meadow	MM	2,085–2,560	16, 18, 20 June 1915	8, 15 June; 7 July 2003. 11, 17 June 2004
Chinquapin	CH	1,862–2,312	10–11, 12, 14 June 1915; 19, 20(3) May 1919	1, 11 June; 11 July 2003; 25 May, 2 June 2004
Indian Canyon	IC	2,124–2,466	19, 21, 23, 24–25 June 1915	5, 14 June, 13 July 2003; 6, 18, 20 June 2004
Porcupine Flat	PF	2,334–2,469	26(2), 27–28 June; 1, 2 July 1915	5, 14 June, 13 July 2003. 8, 21, 23 June 2004
Tuolumne Meadows	TM	2,612–2,822	4–7, 9, 26 July 1915	19, 22, 24 June 2004
Lyell Meadows	LM	2,711–2,972	16, 19–20, 23, 25 July 1915	21, 23–24, 28 July 2004

¹Numbers in parenthesis denote the number of censuses when there were multiple per day.

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 by 7 minutes for each count rather than by 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 compared directly 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 Grinnell-era observers 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 fieldnotes, we estimated the time actually spent counting birds for each 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 in the Grinnell era compared to our surveys (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 bootstrapped samples to calculate species richness and species turnover between the original and current surveys. With bootstrapping we implicitly assumed that there were 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 2004) to calculate both rarefaction and bias corrected Chao1 estimators of species richness. Rarefaction enables standardization and comparison of species richness computed from samples of different sizes. Chao1 is an estimator of the true number of species in an assemblage based on the number of rare species in the sample,

$$\text{Chao1} = S_{\text{obs}} + (a^2/2b),$$

where S_{obs} is the observed number of species in a sample, a is the number of observed species that are represented by only a single individual in that sample (i.e., the number of singletons), and b is the number of observed species represented by exactly two individuals in that sample (the number of 'doubletons') (Chao 1984, Colwell and Coddington 1994).

We also 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 seven 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 $(\text{current} - \text{original}) / (\text{current} + \text{original})$. 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

Overview

With minor exceptions, including the analysis of shifts 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, available online at <http://mvz.berkeley.edu/Grinnell/yosemite/index.html>. 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 online at <http://bscit.berkeley.edu/mvz/volumes.html?>. We summarize findings for each taxonomic group separately.

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 as a result of our survey efforts. 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 distributional data for 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. Finally, 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 (or observed) and estimates of relative abundance are given in Appendix C.

Additions to the mammalian fauna of Yosemite National Park: Five species have been added to the park’s mammalian fauna as a result of the 2003–2008 surveys:

1. Western harvest mouse (*Reithrodontomys megalotis*). Previously known from west of the Park at the Sweetwater Mine on Feliciana Mountain and the El Portal area along the Merced River, this species was collected both in the Happy Isles fen and on the margins of Mirror Lake in the eastern part of Yosemite Valley.
2. Piñon mouse (*Peromyscus truei*). This species is common throughout most of California in chaparral and oak woodland west of the Sierra Nevada and in the piñon-juniper belt on the eastern slope and desert mountain ranges. In 2003 we recorded this species in upper Lyell Basin at elevations from 2,960 to 3,100 m (9,700 to 10,240 ft) in lodgepole and whitebark pine communities and at Glen Aulin at 2,390 m (7,900 ft). Both localities are within the upper Tuolumne drainage. In 2005 we trapped this species in whitethorn ceonothus near Hazel Green and above Merced Grove, both on the western margins of the Park at about 1,788 m (5,900 ft) elevation; see Figure 6.

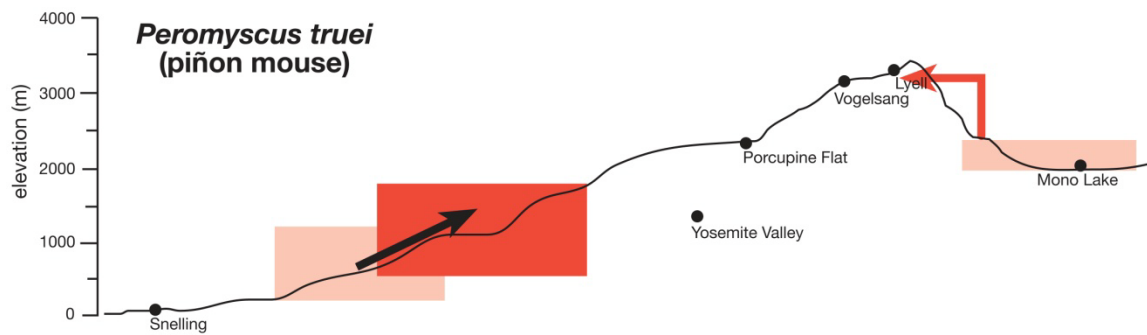


Figure 6. Range (elevation) expansion of the Piñon mouse, *Peromyscus truei*, on both the western and eastern slopes of the Sierra Nevada into Yosemite National Park. The expansion on the west is limited to a few hundred meters within the same habitat zone (chaparral); that on the east is more extensive in elevation (about 760 m [2,500 ft]) and horizontally (from Lee Vining on the west shore of Mono Lake to Glen Aulin in the middle Tuolumne River), and encompasses a significant expansion in habitat from the piñon-juniper to lodgepole and whitebark-pine zones.

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 whitethorn ceonothus dominated chaparral on a post-burn slope 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 in California (e.g., Lassen Volcanic National Park, Sweetwater Mountains, and White Mountains). In 2004 a specimen was obtained on Fletcher Creek below Vogelsang Lake; in both 2005 and 2006 the species was collected in upper Lyell Basin (a “Grinnell site” at 3,121 m or 10,240 ft); in 2005 a single individual was obtained in upper Virginia Canyon along Return Creek (at 3,018 m or 9,900 ft); and in 2008 a single specimen was trapped at Mono Pass (3,252 m or 10,670 ft). The addition of this species brings to four the number of sympatric shrews at Vogelsang, Lyell Basin, and Virginia Canyon, providing each locality 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*).

5. Yellow pine chipmunk (*Tamias amoenus*). This species is common throughout the central and northern Sierra Nevada and has a broad distribution across western North America. In the Yosemite region, historically it was limited to the mid-elevations (2,134–2,774 m or 7,000–9,100 ft) on the eastern slope of the Sierra Nevada in the piñon and Jeffrey pine belt. We trapped the *T. amoenus* at 2,987 m (9,800 ft) in 2007 on the north-facing slope above Ellery Lake east of Tioga Pass in the Inyo National Forest and on both sides of Mono Pass, 3,252 m (10,670 ft), in Yosemite National Park and the Inyo National Forest in 2008. At Mono Pass, the yellow pine chipmunk was found sympatric with both the lodgepole pine chipmunk (*Tamias speciosus*), with which it occurs commonly through the eastern Sierra Nevada, and the alpine chipmunk (*Tamias alpinus*). This is the first locality where sympatry between the yellow pine and alpine chipmunks has been recorded.

Priority Species

Biologists in Yosemite National Park expressed strong interest in the current status of a few species that, based on the limited prior records, were either considered rare or of unknown status. These species of special concern included the Lyell shrew (*Sorex lyelli*), which was previously known from only five specimens from two localities within the park and only a total of nine specimens from areas to the east of the park, and the heather vole (*Phenacomys intermedius*), which was known only from four localities and four specimens from the park (and, indeed, the entire central Sierra Nevada).

1. *Sorex lyelli* – Our recent surveys recorded this species at the two localities within the park where it was recorded in the Grinnell era (vicinity of upper Lyell Basin and Vogelsang Lake). We also expanded its range considerably beyond this limited area (Figure 7, left) with new records from four additional sites within the Park (Figure 7, right): Cathedral Pass (2,957 m or 9,700 ft), Glen Aulin (2,408 m or 7,900 ft), upper Return Creek in Virginia Canyon (9,900 ft), and Kerrick Meadow at the northeastern edge of the park (3,018 m or 9,600 ft). As in the Grinnell era, however, the species remains uncommon at each site so that detection probability cannot be calculated. This contrasts with the sympatric montane shrew, *Sorex monticolus*, where captures, and detection probabilities, were high everywhere ($P^* = 0.99$ for the Grinnell era, 0.97 for our survey period; Moritz et al. 2008:Table 1).

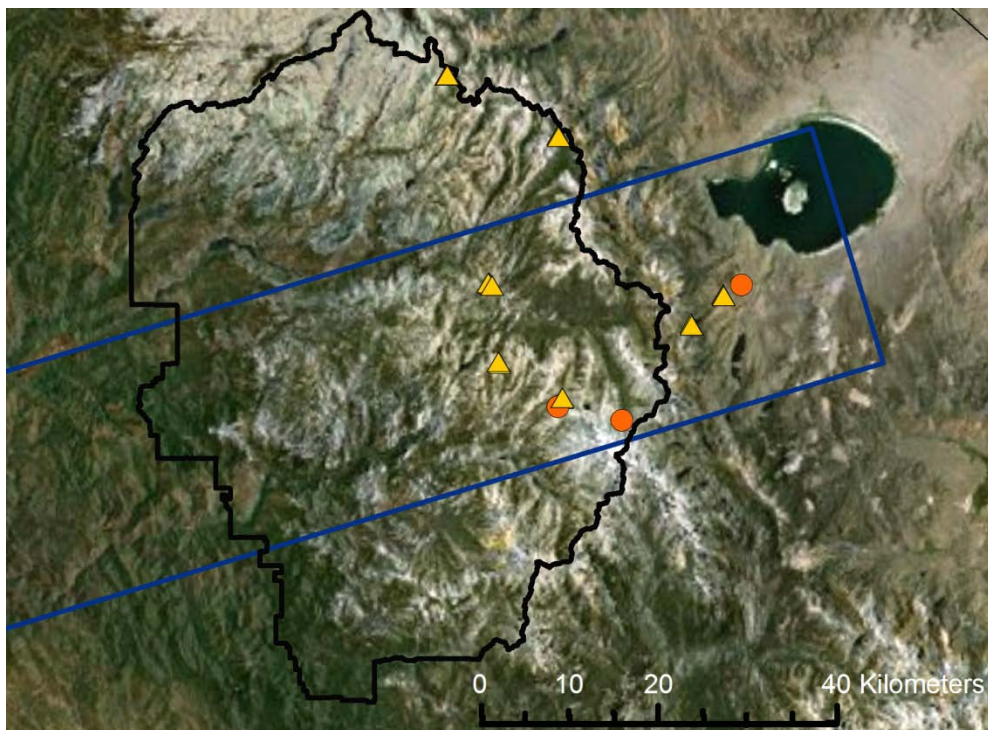


Figure 7. Locality records for the Lyell shrew, *Sorex lyelli*, from the Yosemite region based on the original 1914–1915 Grinnell surveys (orange circles) and the 2003–2008 resurveys (yellow triangles).

2. *Phenacomys intermedius* – Known historically from four localities in the park, we found the heather vole at most localities above 2,438 m (8,000 ft) while extending its historic range westward to Snow Flat (south of May Lake), northward to upper Return Creek and Kerrick Meadow, and south to Lower Ottaway Lake in the Clark Range (Figure 8). As with the Lyell shrew, however, the heather vole is rarely trapped at any locality despite its wide range within the Park. The scanty temporal trap records prevented calculation of detection probability for either the Grinnell era or resurvey periods (Mortiz et al. 2008).

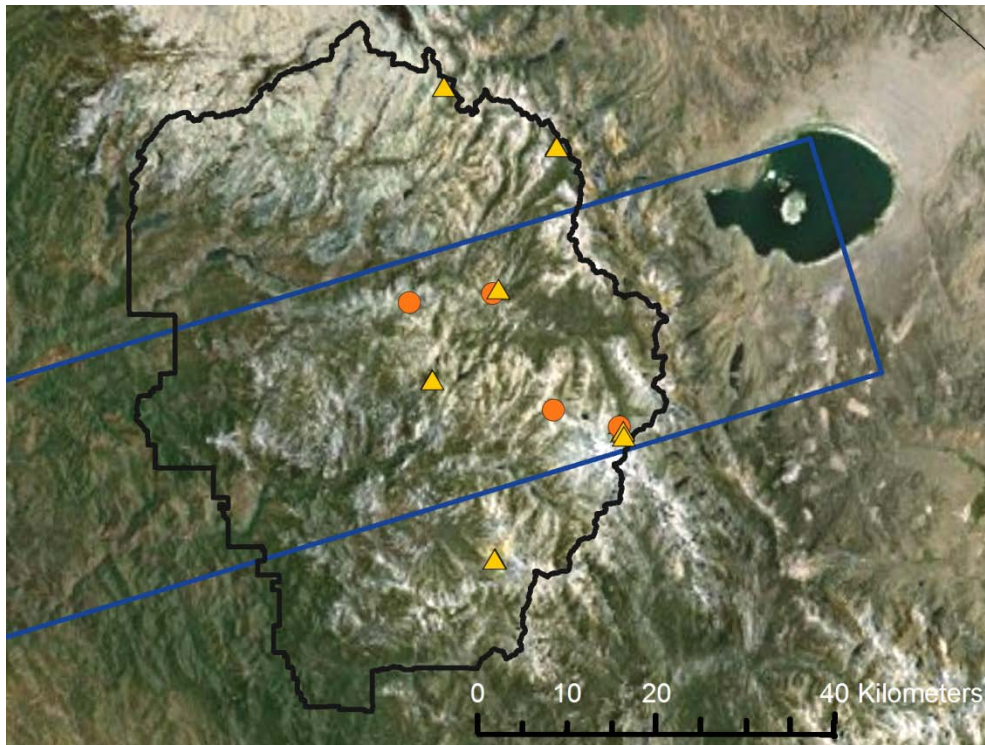


Figure 8. Locality records for the heather vole, *Phenacomys intermedius*, from the Yosemite region based on the original 1914–1915 Grinnell surveys (orange circles) and the 2003–2008 resurveys (yellow triangles).

Expanded Ranges

In addition to those species listed immediately above, we have recorded alpine chipmunks (*Tamias alpinus*) at both upper Return Creek, Virginia Canyon, and in upper Kerrick Meadow, localities in the northern part of the park and north of the previously known distributional limits of this high-elevation, Sierra Nevadan endemic species (Figure 9). The lower elevational range of this species, however, has retracted upwards significantly while its known range within the park has broadened due to the expanded geographic survey area (see below and Moritz et al. 2008).

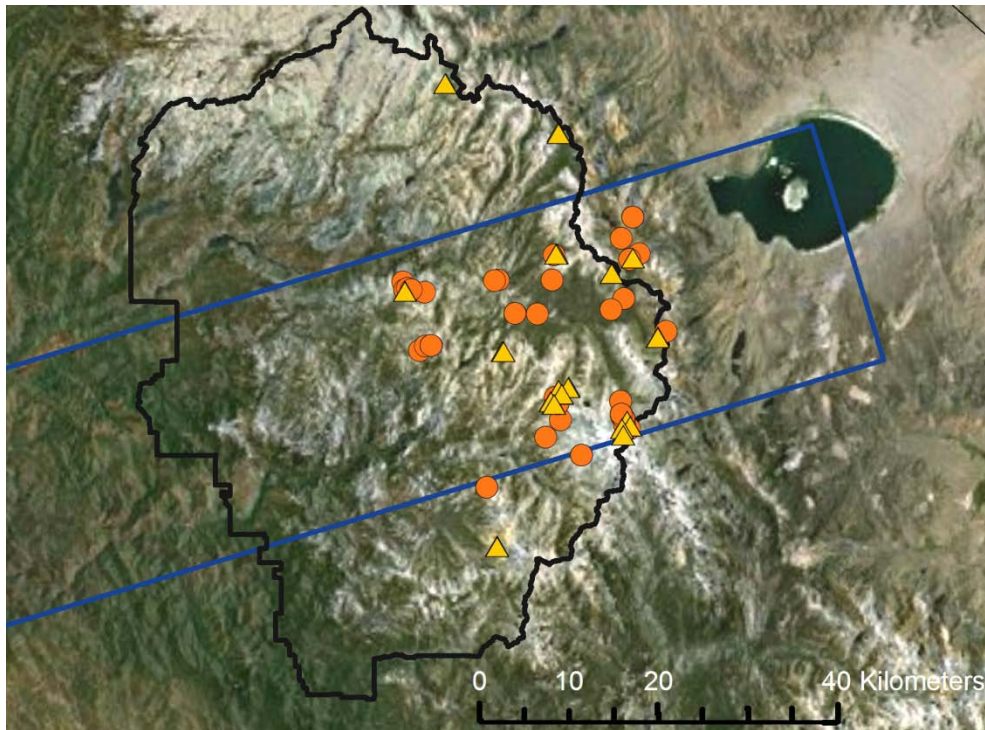


Figure 9. Locality records for the alpine chipmunk, *Tamias alpinus*, from the Yosemite region based on the original 1914–1915 Grinnell surveys (orange circles) and the 2003–2008 resurveys (yellow triangles).

Recently Rare Species

The resurvey efforts had very limited success in recording either the shadow chipmunk (*Tamias senex*; Figure 10) or bushy-tailed woodrat (*Neotoma cinerea*; Figure 11). Both species were widespread and abundant at nearly all localities encountered during the Grinnell-era survey and were highly detectable. However, we recorded the shadow chipmunk only at one locality and the bushy-tailed woodrat only at five. 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 within the Park. It is, however, unclear if the apparent decline in the bushy-tailed woodrat is simply an artifact of our emphasis on the relatively small Sherman live traps on this robustly bodied animal. Other species that also might 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.

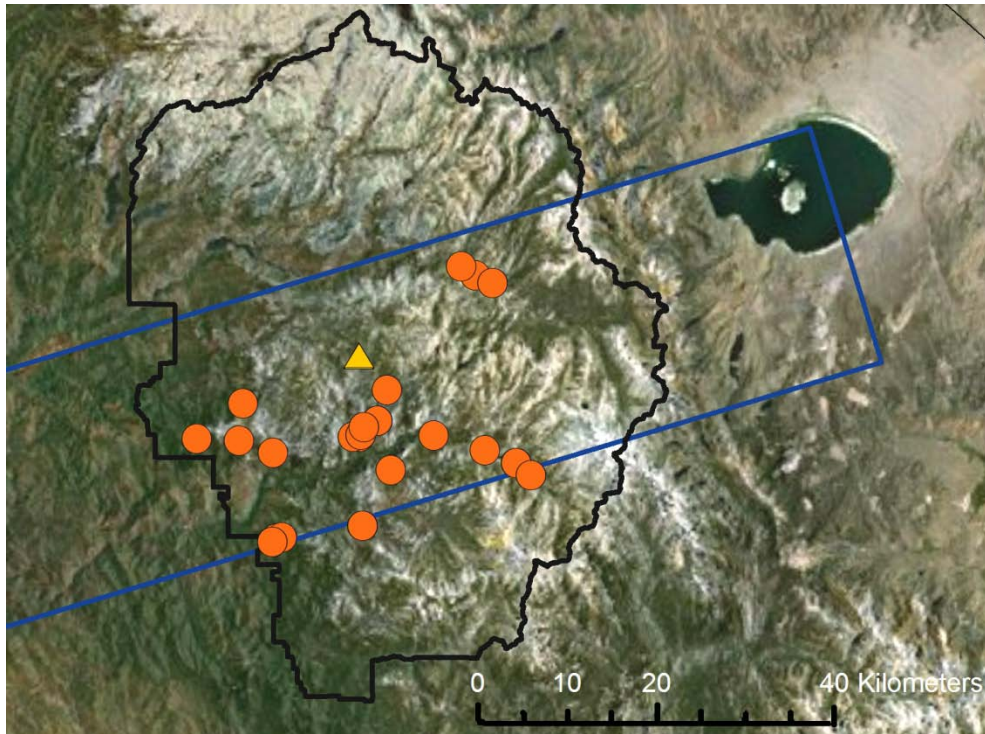


Figure 10. Locality records for the shadow chipmunk, *Tamias senex*, from the Yosemite region based on the original 1914–1915 Grinnell surveys (orange circles) and the 2003–2008 resurveys (yellow triangle).

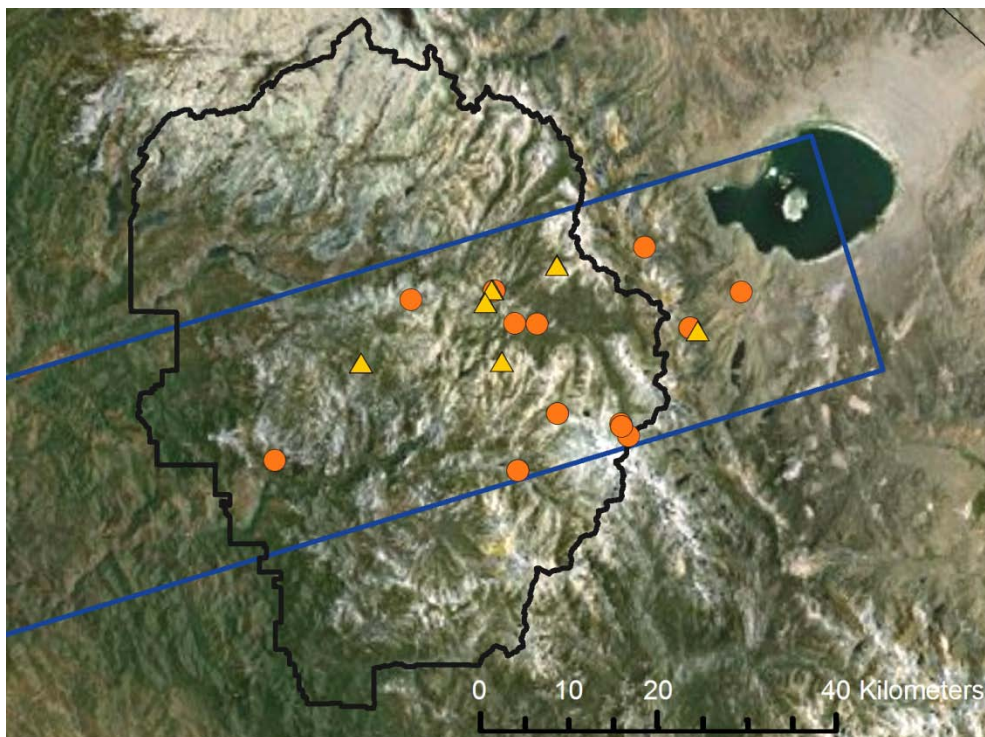


Figure 11. Locality records for the bushy-tailed woodrat, *Neotoma cinerea*, from the Yosemite region based on the original 1914–1915 Grinnell surveys (orange circles) and the 2003–2008 resurveys (yellow triangles).

Shifts in Elevational Range

Because of significant ecological differences as well as biogeographic histories of west and east slope species, sites for each slope must be analyzed separately. Unfortunately, the few numbers of sites from the Grinnell era from the eastern slope limits the power of occupancy modeling of across that steep gradient. As a result, we present data only for those west-slope species for which data are adequate. These are the same set of species examined by Moritz et al. (2008); adding data obtained subsequent to the cut-off point (2006) for the analyses presented in that publication did not change either the average detectability for the resurvey period, nor did it change either the upper or lower range limits detected in that period. As a consequence, the data presented in Table 4 are the same as those in Moritz et al. (2008:Table 1), with the addition of the Lyell shrew, *Sorex lyelli*, and heather vole, *Phenacomys intermedius*. The historic and recent elevational and occupancy profiles, and model scores, for each of the 28 species discussed by Moritz et al. (2008) are available in Figure S3 of that publication.

Of the 30 species examined here (Table 4), six exhibited an expansion of their range, 10 have suffered a range contraction, while most (14 species) have remained stable over the past century (Table 5). The pattern across those that have shifted their ranges is non-uniform and idiosyncratic, although the overall trend is for lower elevation species to have expanded upwards (4 of 6 species) and high-elevation species to have retracted upwards (10 of 10 species; Moritz et al. 2008).

Of those species that have expanded their elevational ranges over the past century, four have exhibited an upward expansion of their upper limits and two species exhibited a downward expansion of their lower limits. These expansions involved elevational changes from 112 to 1,003 m. For example, on the western slope the piñon mouse, *Peromyscus truei* (Figure 6) exhibited significant upward shifts of both its lower (L) and upper limits, (+486m L, + 589m U), yielding a modest (10%) overall expansion in its elevational range from the Grinnell era to the present. This species expanded its eastern slope range even more substantially by nearly 1,500 m (Figure 6). Alternatively, the montane shrew, *Sorex monticolus*, showed a substantial downward expansion (-1,003 m). Previously limited to meadows within the red fir–lodgepole pine belt above 2,134 m (7,000 ft), this species is now the common shrew throughout the meadows of Yosemite Valley at 1,219 m (4,000 ft) (Figure 12) where it was undetected during the Grinnell era (Grinnell and Storer 1924).

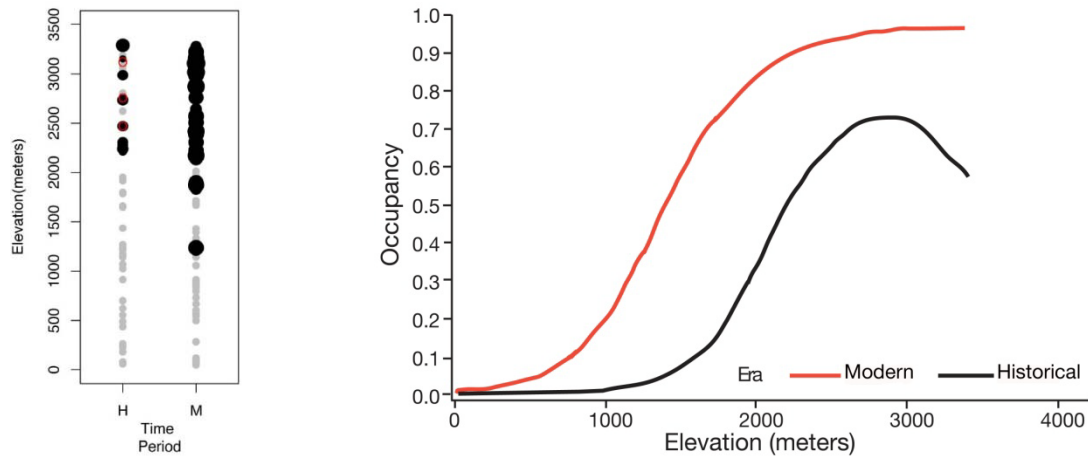


Figure 12. Elevational profiles for the montane shrew, *Sorex monticolus*. Left, elevational profile on the west (W) slope in the historic (H) and resurvey (M) periods. Gray circles are elevations surveyed where the species was not found; black circles are elevations where the species was detected in a standardized trapline; red circles are elevations where the species was detected in non-standard traps not included in the occupancy models. Right, elevational occupancy profiles for the historic period (black line) and resurvey period (red line). Note elevational shift to left, or to lower elevations in the resurvey period.

Data are available to calculate detection probabilities for eight of the 10 species that exhibited a contraction at either, or both, upper and lower range limits from the Grinnell era to the present (Table 4). Data are insufficient for the pika (*Ochotona princeps*; Figure 13A) to conclude that their apparent loss from Glen Aulin (elevation 2,377 m or 7,800 ft) is a false absence or a true absence, and the few resurvey captures of the shadow chipmunk (*Tamias senex*) precluded calculation of its occupancy profile. Nevertheless, all 10 species in this group experienced an upward retraction of their lower elevational limit, although for only five species (*Microtus longicaudus*, *Spermophilus lateralis*, *Sorex palustris*, *Neotoma cinerea*, and *Tamias alpinus* [Figure 13B]) is the retraction significant (where $P_{fa} < 0.05$). Three species had a downward shift in their upper limit, two of which were significant (*Dipodomys heermanni* and *Neotoma cinerea*). Finally, four had contractions at both their upper and lower limits (*Dipodomys heermanni*, *Zapus princeps*, *Tamias senex*, and *Neotoma cinerea* [Figure 13C]). The retraction of the Jumping mouse, *Z. princeps*, results entirely from its apparent loss from Yosemite Valley, where it was found in the Grinnell era at the base of Yosemite Falls and noted then to be an unexpectedly low-elevation occurrence (Grinnell and Storer 1924).

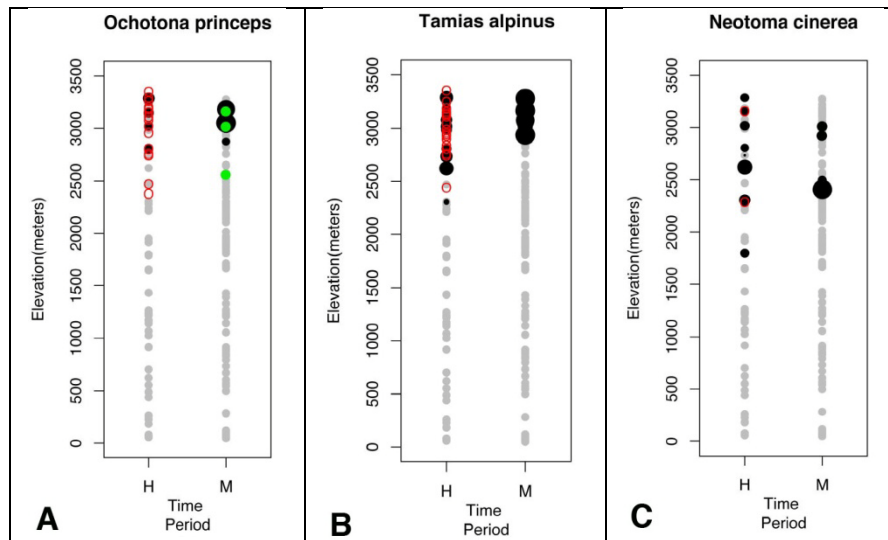


Figure 13. Elevational profiles of three species of mammals that have experienced a retraction of their lower and/or upper elevational range from the historic (H) to resurvey (M) period. Gray circles are elevations surveyed where the species was not found; black circles are elevations where the species was detected in a standardized trapline; red and green circles are elevations where the species was detected in non-standard traps not included in the occupancy models.

Overall, there are a similar number of increases ($N = 5$) and decreases ($N = 6$) in the upper limit of elevation ranges, but with larger upward (mean = 614 m; 112–1,062 m) than downward (mean = 391 m; 224–719 m) shifts. For lower range limits, upward contractions ($N = 3$, mean 522 m, 159–1,007 m) are more common than downward expansions ($N = 3$, mean 536 m, 112–1,003 m).

The impact on individual species of these range fluctuations varies widely (Table 5). Of the range expansions, five of eight have increased by $>20\%$, the most dramatic being the $>1,000$ m expansion of east slope *Peromyscus truei* (Figure 6). For range contractions, 14 of 17 have contracted by $>30\%$, with eight species losing $>50\%$ 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* (-54% W), *Spermophilus beldingi* (-35% W), 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 upward 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 (Figure 13C for *N. cinerea*). Given decreased habitat area with elevation, the upward shifts in elevation for some of these taxa are expected to result in sharply reduced range area and increased fragmentation. Projection of the occupancy models onto topography illustrates this phenomenon for *Tamias alpinus* (Figure 14).

Tamias alpinus

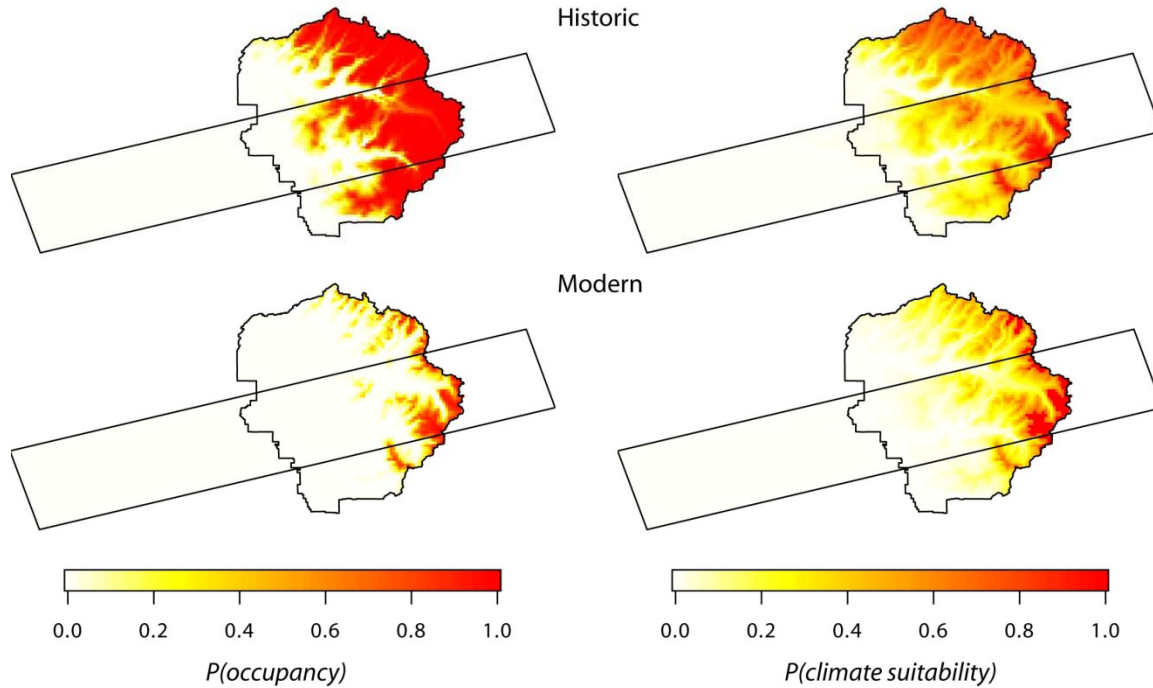


Figure 14. Range contractions in *Tamias alpinus* predicted under two models: site occupancy (left) and climate change (right). Red colors indicate areas where there is either a high probability of occupancy or a high probability that the climate was suitable for the species. The climate models were developed using the Maxent algorithm (Phillips et al. 2004); climate data were derived by Parra and Monahan (2008). Species data for climate models are the same as those used in the occupancy models. Nineteen standard bioclimatic variables are included in the climate models. Climate models were developed with the historic data and then projected onto the modern climate surfaces; unlike the occupancy models, which were fit only to the species data in both eras, the climate models were only fit to the historic data. Combined, the occupancy and climate models allow us to (1) quantify changes in distribution and (2) test whether the range changes are consistent with a signal of climate change.

Most (7 of 10) range expansions are of 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 downward expansion of *Sorex monticolus* and the more subtle range contraction of the low-elevation taxon, *Dipodomys heermanni* on the west slope.

Table 4. Estimated detectability per site in Grinnell (P*G) and present (P*P), significant changes in upper (U) and lower (L) elevation limits, percent change in elevation range, and original lifezone classification (Grinnell and Storer 1924). For elevation changes, * = confirmed by occupancy modeling; N = not analyzed. NA = appropriate data unavailable for site-specific detection.

Species	P*G	P*P	Change in Elevation	% Change in Elevation	Original Life Zone ¹
Range Expansions					
<i>Chaetodipus californicus</i> W	0.28	0.19	+800 m U*	109	Upper Sonoran
<i>Microtus californicus</i> W	0.81	0.58	+505 m U ^N	46	Lower and Upper Sonoran
<i>Reithrodontomys megalotis</i> W	0.99	0.87	+112 m U ^N	10	Lower and Upper Sonoran
<i>Peromyscus truei</i> W*	0.99	0.93	+589 m U*, +468m L*	10	Upper Sonoran (west slope)
<i>Peromyscus truei</i> E*	0.99	0.98	+1,062 m U ^N	>500	Transition (east slope)
<i>Sorex monticolus</i> W	0.99	0.97	-1,003 m L*	93	Canadian and Hudsonian
<i>Sorex ornatus</i> W	0.32	0.93	-485 m L*	133	Upper Sonoran
Range Contractions					
<i>Dipodomys heermanni</i> W	0.16	0.98	+63 m L -293 m U*	-37	Lower and Upper Sonoran
<i>Neotoma cinerea</i> W	0.90	0.71	+6,685 m L*, -245 m U*	-94	Canadian - Arctic-Alpine
<i>Microtus longicaudus</i> W	0.99	0.98	+614 m L*	-23	Transition - Hudsonian
<i>Ochotona princeps</i> W	NA	NA	+153 m L ^N	-33	Canadian - Arctic-Alpine
<i>Sorex palustris</i> W	0.39	0.23	+512 m L*	-34	Canadian and Hudsonian
<i>Spermophilus beldingi</i> W	0.98	0.98	+355 m L	-35	Canadian - Arctic-Alpine
<i>Spermophilus lateralis</i> W	0.70	0.89	+244 m L*	-16	Transition - Hudsonian
<i>Tamias senex</i> W	0.95	0.71	+1,007 m L ^N , -334 m U ^N	-92	Canadian
<i>Tamias alpinus</i> W	0.92	0.95	+629 m L*	-92	Hudsonian - Arctic-Alpine
<i>Zapus princeps</i> W	0.98	0.90	+159 m L*, -64 m U*	-14	Transition - Hudsonian
No Change					
<i>Microtus montanus</i> W	0.81	0.98	no change	0.00	Transition - Hudsonian

Table 4. Estimated detectability per site in Grinnell (P*G) and present (P*P), significant changes in upper (U) and lower (L) elevation limits, percent change in elevation range, and original lifezone classification (Grinnell and Storer 1924) (continued).

Species	P*G	P*P	Change in Elevation	% Change in Elevation	Original Life Zone ¹
<i>Neotoma macrotis</i> W	0.90	0.91	+67 m U	0.00	Lower Sonoran - Transition
<i>Peromyscus boylii</i> W	0.98	0.97	-122 m L	5.34	Upper Sonoran - Transition
<i>Peromyscus maniculatus</i> W	0.99	0.99	no change	0.00	Lower Sonoran - Arctic-Alpine
<i>Phenacomys intermedius</i> W	0.29	0.25	+185 L	0.00	Hudsonian
<i>Sorex lyelli</i> W	0.41	0.27	no change	0.00	Hudsonian
<i>Sorex trowbridgii</i>	0.71	0.88	no change	0.00	Transition - Canadian
<i>Tamias merriami</i> W	0.52	0.07	no change	0.00	Upper Sonoran - Transition
<i>Tamias quadrimaculatus</i> W	0.95	0.85	+50 m U	0.00	Transition - Canadian
<i>Tamias speciosus</i> W	1.00	1.00	+128mL, +65 m U	-4.54	Canadian - Hudsonian
<i>Tamiasciurus douglasi</i> W	NA	NA	no change	0.00	Transition - Hudsonian
<i>Thomomys bottae</i> W	NA	NA	no change	0.00	Lower Sonoran to Transition
<i>Thomomys monticola</i>	NA	NA	no change	0.00	Canadian - Hudsonian
<i>Marmota flaviventris</i> E	NA	NA	no change	0.00	Transition - Hudsonian

¹From Grinnell and Storer (1924).

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 D. Figure 15 maps localities surveyed. Reptile and amphibian resurveys were conducted over the three-year period, 2003–2005.

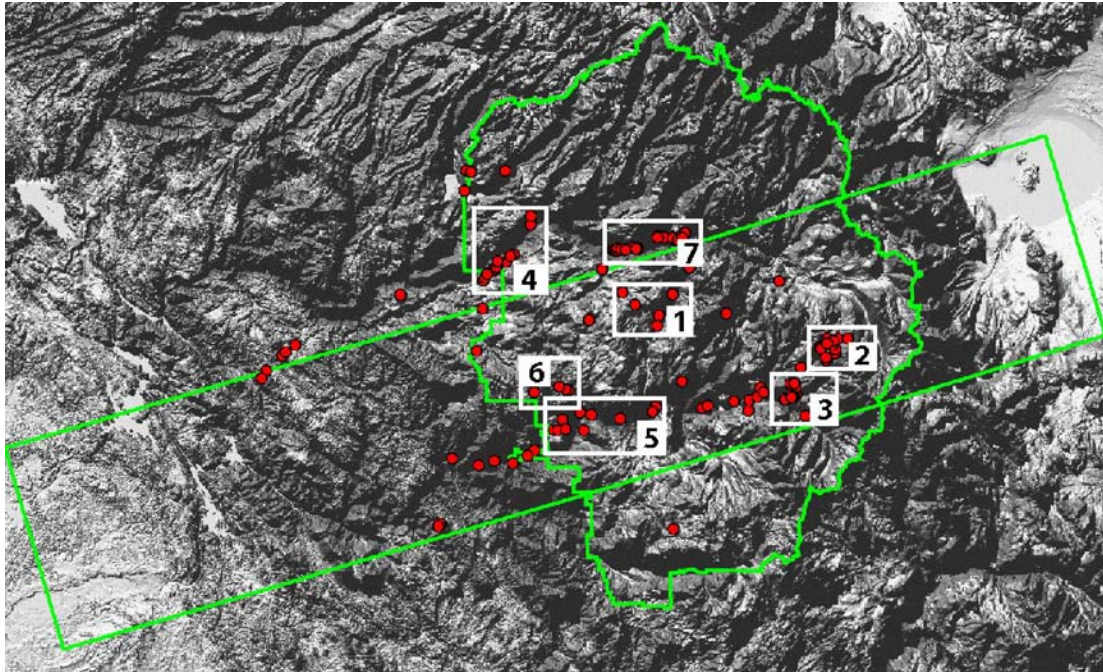


Figure 15. Map of survey localities for amphibians and reptiles. Numbers correspond to sites listed in Appendix D.

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 or ~10,500 ft).
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 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 separate localities).
6. Breeding populations of Sierra Nevada yellow-legged frog (*Rana sierrae*) (previously *R. muscosa*; see Vredenburg et al. 2007) and Yosemite toad (*Bufo canorus*) at an unnamed lake 0.5 km east of Evelyn Lake
7. Healthy populations of *Rana sierrae* at Dorothy Lake.

Birds

Number of Observations and Species

From the Grinnell-era surveys we tallied 133 species and 9,872 individual records from 58 separate censuses. In our resurveys we detected 140 species and 18,165 individuals (11,962 from point counts, 6,203 from line transect counts). We did not find 21 of the species found in the Grinnell era. Some of these were noted as “present,” i.e., detected, but not encountered during a formal census. We found 28 species not recorded in the Grinnell era census forms, although some of which were indicated as present in fieldnotes or in 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 B, Table B-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 Grinnell-era survey). The Chao1 estimator, however, was 153 species for our survey and 139 for that of the Grinnell era.

In our survey, the number of observations per hour was higher for point counts than for line transects (Figure 16). The relationship between the two survey methods is strong, and could be used to adjust data from our modern point-counts to match the line-transect data of the Grinnell era. 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 (Figure 17), making time an unsuitable basis of comparison. Moreover, there is considerable variation in birds observed per unit time among personnel in the original surveys. Grinnell, for example, had uniformly higher scores than did Storer when both individuals made observations in the same area. The counts of both Grinnell and Storer also had a larger variation among their censuses for a single site than did those of A. Rush, who performed all recent censuses.

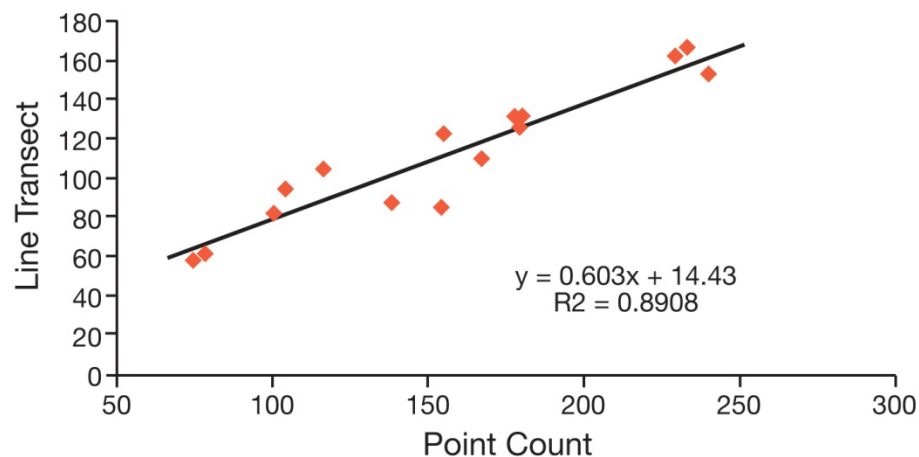


Figure 16. Regression of the number of birds encountered per hour along the same transect, as assessed by point counts (PC, employed by the 2003–2004 survey personnel) and line transect (LT; employed by the Grinnell-era personnel) methodologies.

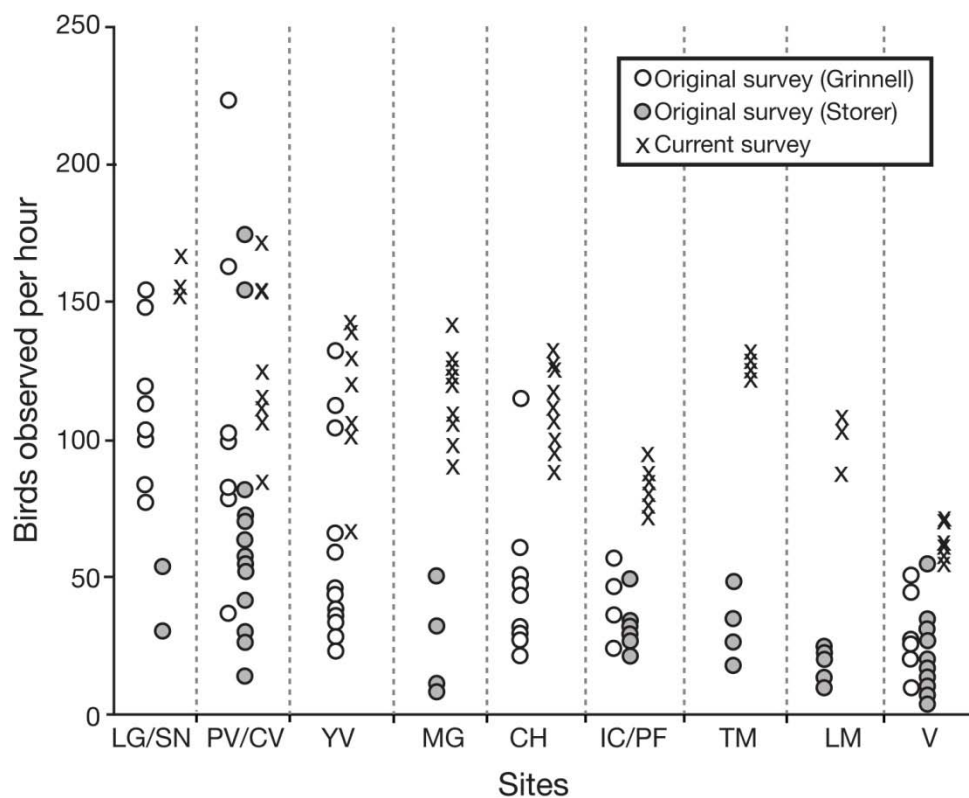


Figure 17. Number of birds observed per hour for the original survey (1915–1919) by Grinnell and Storer, and the current survey (2003–2004) for 12 sites. Sites are identified as in Table 3 and Figure 5.

The number of birds observed per unit time in the Grinnell era was likely affected by individual investigators who were engaged in other tasks while surveying birds. Their highest scores tended to be similar to our results, suggesting 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 (Figure 18).

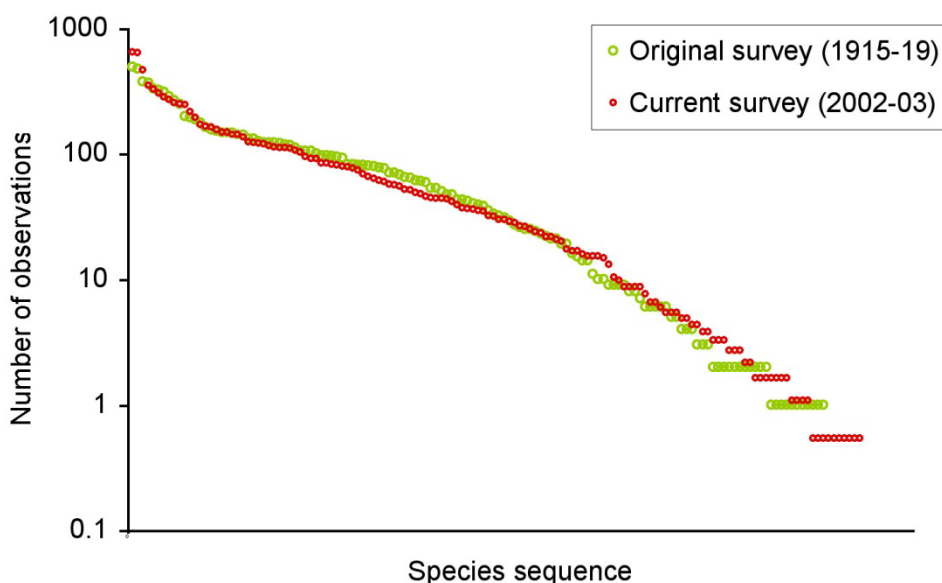


Figure 18. Species abundance distributions for the Grinnell survey period (1915–1919) and the current surveys (2003–2004).

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 the 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 6). This difference is perhaps not surprising, because 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 (Figure 19). 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.

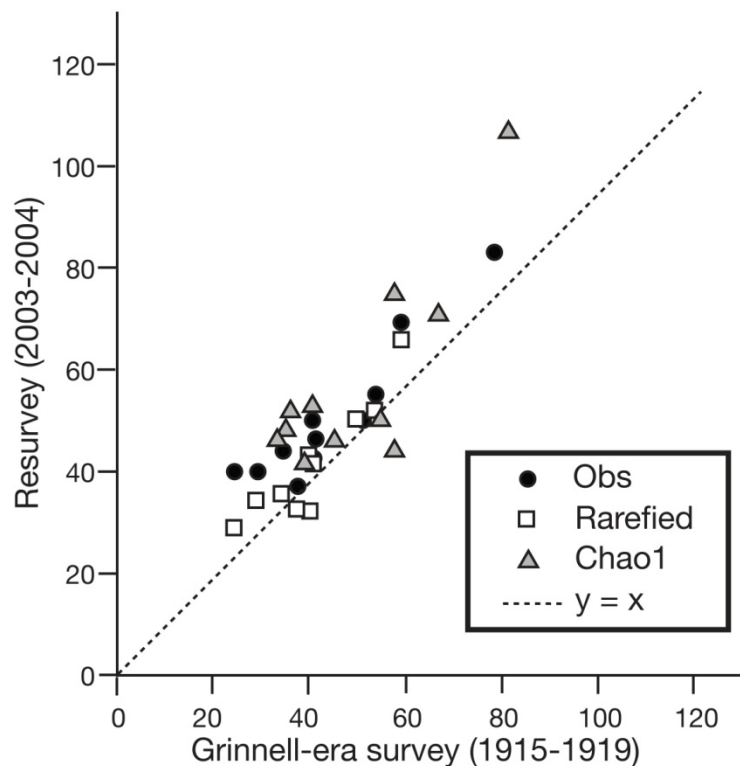


Figure 19. Change in species richness between the two sample periods (the original Grinnell survey of 1915–1919 and our resurvey during 2003–2004) for the raw data (Obs), rarefied, and Chao1 estimates, for each of the 11 comparable sites (Table 5).

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 species richness for 11 sites in our study area. Sites are identified as in Table 3 and Figure 5. Data for Pleasant Valley and Coulterville are combined.

Observed Data	Survey	LG	SN	PV/CV	YV	MG	MM	CH	IC	PF	TM	LM
<i>n</i>	Grinnell	897	942	3,516	1,557	267	505	606	359	493	453	277
	2003–2004	1,414	807	3,337	2,285	1,707	1,684	2,199	1,238	1,010	1,269	1,215
<i>Sobs</i>	Grinnell	58	50	77	52	39	40	39	33	36	28	23
	2003–2004	71	52	85	57	45	48	52	46	39	42	42
# singletons	Grinnell	10	7	5	5	10	6	5	2	4	5	6
	2003–2004	6	2	12	11	4	1	4	6	6	7	7
Bootstrap estimates												
mean # species	Grinnell	57.99	48.82	76.72	52.00	39.00	40.00	39.00	33.00	36.00	28.00	23.00
	2003–2004	67.29	52.00	84.99	53.12	34.00	43.02	44.59	36.63	34.22	35.77	30.25
std. dev.	Grinnell	0.58	1.12	0.92	0.52	0.39	0.40	0.39	0.33	0.36	0.28	0.23
	2003–2004	1.76	0.52	0.85	1.71	2.02	1.75	1.96	2.10	1.71	1.73	2.21
mean # shared		38.68	28.61	63.83	35.69	27.73	33.26	33.13	24.41	26.19	21.67	16.07
mean # unique	Grinnell	19.31	23.39	21.16	16.30	11.27	6.73	5.87	8.59	9.81	6.33	6.93
	2003–2004	28.61	20.21	12.90	17.43	6.27	9.76	11.46	12.22	8.03	14.10	14.17
Estimators												
rarefaction	Grinnell	64.8	55.9	79.0	55.8	39.1	43.3	42.2	33.7	37.9	32.3	29
	2003–2004	73.8	52.8	91.4	71.1	47.5	48.4	53.9	49.7	44.1	53.4	47.0
Chao1	Grinnell	63.6	53.1	78.7	55.5	37.1	42.5	45	33.25	37	31.33	28
	2003–2004	72.5	52.1	101.5	77.2	46	48	53.5	49	42	54.3	48.1
Chao1 95% CI	Grinnell	59.4–	50.6–	77.2–	53.4–	33.2–	40.4–	40.9–	33.0–	36.1–	28.5–	24.0–
	2003–2004	80.2	65.9	88.5	69.0	53.6	54.5	69.4	37.8	44.7	48.5	49.2
		71.2–	52.0–	90.0–	61.7–	45.1–	48.0–	52.2–	46.5–	39.5–	44.2–	43.2–
Chao1 SD (analytical)		80.7	55.2	138.9	144.2	53.7	48.0	64.0	62.8	55.8	110.2	73.0
	Grinnell	4.5	3.1	2.13	3.0	4.3	2.8	5.6	0.7	1.5	3.9	5.1
	2003–2004	1.8	0.5	11.0	17.4	1.5	0.1	2.2	3.2	3.2	13.2	6.1

We found high temporal turnover of species at all sites, despite the overall similarity in species richness (Figure 20). On average, only 46% of the species observed per site were present in both surveys. A large proportion of the species that turned over are rare species (five or fewer 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 B, Table B-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 (Tuolumne Meadow) and LC (upper Lyell Canyon) are riparian or wetland associated species: Four out of the total 68 (6%) 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 pseudo-turnover, or that resulting from chance (low detectability) 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.).

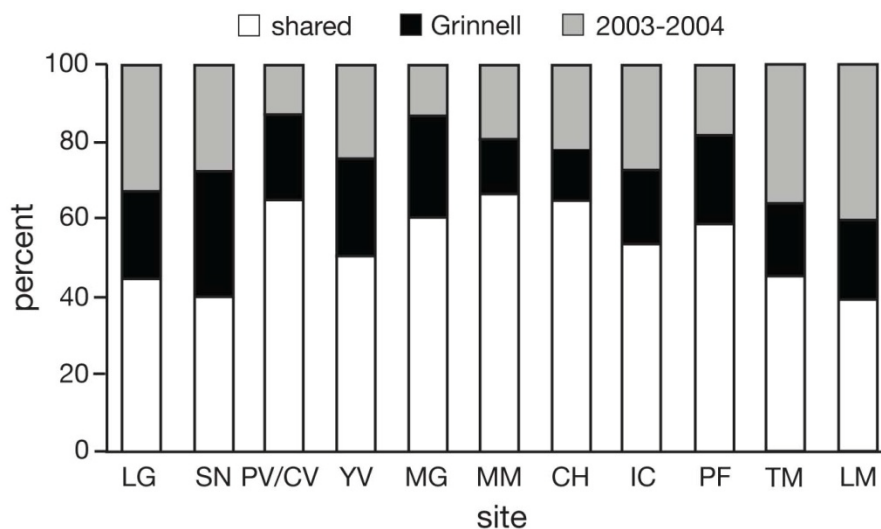


Figure 20. Avian species turnover at each of 11 sites surveyed across the Yosemite transect during the original Grinnell era (1915–1919) and the current surveys (2003–2004). Sites are identified as in Table 4 and Figure 5.

Species Level Change

We found minor changes in species abundances at each site sampled in both years of our 2003–2004 survey (Appendix B, Table B-3). Differences in abundances between the current survey and the original survey were much larger (Appendix B, Table B-4). Most low-elevation sites exhibited significant increases in the abundance of particular species (except PV/CV –Pleasant Valley/Coulterville) while all high-elevation sites (from CH – Chinquapin to LM – Lyell

Meadow) displayed more species exhibiting a decrease in abundance than gains. Statistical analyses of change in elevational distributions of the avian species are 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 D, Table D-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 recent 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– Yosemite Valley and TM – Tuolumne Meadow and LM – Lyell Meadow; 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 that have declined the most are included here.

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

Site-specific patterns of increase or decrease.

Conical-form evergreen + drought phenology shrubs subcluster:

Two species total (Fox sparrow and Green-tailed towhee); generally decreased or increased in a site-specific manner (increased where there has been fire?).

Conical-form evergreen subcluster:

Mostly increased; the generalist/conifer species that have increased the most are all included here.

Conclusions and Prospectus

The original Yosemite transect (Grinnell and Storer 1924) was one of the seminal studies in biogeography and community ecology of the early 20th century, one that emphasized the distributional limits of species and their assemblages defined by both biotic and abiotic factors. Grinnell's influence on basic concepts, such as the ecological niche, and his prescience in establishing a set of lenses through which the impact of changing landscapes and climates can be viewed and understood, formed the basis for an international symposium in 2008 sponsored by the National Academy of Sciences (see Wake et al. 2008, and other papers included within). Grinnell's vision has also formed the basis for the MVZ's "Grinnell Project," of which the resurvey of his Yosemite transect described in this report is the first in a series of similar studies along the length of the Sierra Nevada and elsewhere in California (see <http://mvz.berkeley.edu/Grinnell/index.html>).

In the nearly 100 years that have passed since the original fieldwork was completed, substantial changes in the terrestrial vertebrate fauna across the transect, including that within Yosemite National Park, have taken place. Although many species of small mammals have similar elevational distributions as they did in the past, others have undergone major shifts (Moritz et al. 2008). A broader analysis of avian distributions, which include data from the Yosemite transects, also found that many species have experienced changes in their distributional limits (Tingley et al. 2009). Importantly, this latter study showed that bird species have tracked changes in the geographical distribution of their climatic niches through time, which suggests that climatic niche modeling may prove of value in predicting future trends in species occurrence under varying models of climate change.

While the factors that underlie these changes remain elusive at the level of the individual species, several important conclusions are possible. The first point to emphasize is that the changes in species distributions, and thus in the communities they comprise, have been idiosyncratic even though general trends are apparent (i.e., there are more low-elevation species that have expanded their ranges upwards and more high-elevation species whose lower limits have retracted, than the reverse). Some of these trends might reflect the action of one or more environmental stressors that have been identified globally or for the Yosemite region in particular (e.g., warming temperatures over the past century, shifts in seasonality with resulting changes in phenology, changes in fire regime and fire management practices, and the like). A major goal of the "Grinnell Project" has been to use the Grinnell-era data to build models to predict to the present, validate these models with the resurvey data, and use the quality of validation to inform the plausibility of forecasting to the future. But even this seemingly reasonable approach is fraught with problems, in part because we know so little about the determinants of range limits for most species in all groups that predictions as to how particular species might respond to climate change or any other environmental stressor are difficult to assess.

The primary value of both the Grinnell-era and re-surveys are the data themselves, which form two temporal points against which future surveys at the same or near-by sites can be compared. This is the second point to emphasize. Two data points in time cannot define either a trajectory or rate of change. In our studies we have emphasized detection probabilities, derived from the historical and resurvey sampling protocols, which when sample size is adequate allow us to

distinguish between a true absence, and thus change, from one due to sampling artifact. What our survey efforts cannot do is determine when a particular change took place; our data cannot determine when a measured change actually commenced, which could have been anytime between the year following the completion of the Grinnell-era surveys or the year before ours began.

Williams et al. (2008) present a general framework to assess the vulnerability of species to climate change. The key component of this framework is the integration of studies across a diverse arena of disciplines. If the range shifts that we have identified for terrestrial vertebrate species have a climate signature, either directly or indirectly, implementation of this type of integrated framework will be essential if the park and other agencies are to mitigate, through some form of adaptive management, the impacts of regional climate change. As a consequence, we offer these recommendations for future studies:

1. Repeated, site-specific resurveys of the fauna of the park should be undertaken at regular intervals (every 10–20 years?) so that trend lines can be more clearly delineated. This also would allow direct tests of future predictions made with the Grinnell-era and current data. Because each modern trapline and avian transect line has been georeferenced and a standardized effort employed, both the location of specific sites and the use of a common protocol will enhance the comparisons of future surveys with those we have undertaken, and describe herein.
2. More extensive surveys for particular species are warranted, especially for those believed to be vulnerable on a larger scale than Yosemite National Park or the overall Yosemite transect area. The American pika (*Ochotona princeps*), for example has been identified by some as in threat of extinction due to global climate change, and listing petitions are currently before both the California Department of Fish and Game and the US Fish and Wildlife Service for consideration as Threatened and Endangered. Only by repeated visits to the talus in the Glen Aulin area can we distinguish between loss due to the simple mechanics of natural metapopulation dynamics and a wider range retraction due to climate change or other factors. Since 2,360 m (7,800 ft) was the lowest elevational limit of pika defined during the Grinnell-era, we would also encourage broader surveys of known talus throughout the Park from this elevation to at least 2,590 m (8,500 ft) to know if other extant populations of pika exist within this elevation band. If so, these should be monitored on a regular basis (at least on a five-year interval, if not more frequently) for sign of pika (visual sightings, listening for their distinctive calls, searches for active hay piles in the fall, detailed searches for fresh whitewashing and fecal pellets). Fortunately, standardized protocols for pika monitoring that are rapid and effective are available through the work of Erik Beever (erik_beever@usgs.gov) and Connie Millar (cmillar@fs.fed.us, Millar and Westfall 2009). Additional protocols are being developed, including one from the National Park Service Upper Columbia Basin Network (Jeffress et al. 2011), and another that can be utilized by “citizen scientists”, which has been developed by a newly formed consortium of pika biologists supported by the California Department of Fish and Game and the US Forest Service.
3. Autecological and other studies of key species, including both those which have shifted

their ranges in the past century and for which the future is problematic as well as those which have experienced no change. We know little of the explicit ecological requirements of most species and we know little about whether climate change, for example, will directly impact them, or do so only in an indirect manner. We also know little about how members of a community interact, either positively or negatively, in determining single species persistence, and how those patterns of interaction are likely to shift under different change scenarios. And, we have virtually no understanding of the buffering capacity of species to environmental change much less of their abilities to adapt successfully to whatever shifting conditions they might face in the near or long-term future. For example, 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 could illuminate potential responses to future climate change (e.g., Porter and Kearney 2009). This could be used further to identify critical habitats and to inform future vegetation and fire management in the park. Park biologists either could undertake such analyses themselves or in conjunction with collaborators at academic or within other federal or state institutions.

4. Encourage interdisciplinary studies of the fauna and flora at particular sites where facilities are in place to monitor physical environmental parameters (such as weather, snowpack, fire occurrence, soil moisture, or streamflow). We can understand the biological responses more explicitly when fauna and flora are monitored in close proximity to monitoring of the key physical drivers of biological change.

Literature Cited

- Burnham, K. P., and D. R. Anderson. 2002. Model selection and inference: A practical theoretic approach. Springer-Verlag, New York.
- Chao, A. 1984. Non-parametric estimation of the number of classes in a population. Scandanavian Journal of Statistics 11:265–270.
- Chao, A. 2005. A new statistical approach for assessing compositional similarity based on incidence and abundance data. Ecology Letters 8:148–159.
- Chao, A., R. L. Chazdon, R. K. Colwell, and T.-J. Shen. 2005. A new statistical approach for assessing compositional similarity based on incidence and abundance data. Ecology Letters 8:148–159.
- Colwell, R. K. 2004. EstimateS: Statistical estimation of species richness and shared species from samples, Version 7.5. Available from <http://viceroy.eeb.uconn.edu/EstimateS> (accessed 25 August 2010).
- Colwell, R. K. and J. A. Coddington. 1994. Estimating terrestrial biodiversity through extrapolation. Philosophical Transactions of the Royal Society (Series B) 345:101–118.
- Grinnell, J. 1910. The methods and uses of a research museum. Popular Science 163–169.
- Grinnell, J. and T. I. Storer. 1924. Animal life in the Yosemite. An account of the mammals, birds, reptiles, and amphibians in a cross section of the Sierra Nevada. University of California Press, Berkeley, California.
- Jeffress, M. R., J. Apel, L. K. Garrett, G. Holm, D. Larson, N. Nordensten, and T. J. Rodhouse. 2011. Monitoring the American pika (*Ochotona princeps*) in the Pacific West Region: Crater Lake National Park, Craters of the Moon National Monument and Preserve, Lassen Volcanic National Park, and Lava Beds National Monument: Narrative Version 1.0. Natural Resource Report NPS/UCBN/NRR—2011/XXX. National Park Service, Fort Collins, Colorado.
- MacKenzie, D. I., J. D. Nichols, G. B. Lachman, S. Droege, J. A. Royle, and C. A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83:2248–2255.
- MacKenzie, D. I., and J. D. Nichols. 2004. Occupancy as a surrogate for abundance estimation. Animal Biodiversity and Conservation 27:461–467.
- MacKenzie, D. I., J. D. Nichols, J. A. Royle, K. H. Pollock, L. L. Bailey, and J. E. Hines. 2006. Occupancy estimation and modeling: Inferring patterns and dynamics of species occurrence. Elsevier, San Diego.

- Millar, C.I. and R.D. Westfall. 2010. Distribution and climatic relationships of the American pika (*Ochotona princeps*) in the Sierra Nevada and western Great Basin, U.S.A.; Periglacial landforms as refugia in warming climates. *Arctic, Antarctic, and Alpine Research* 42(1): 76-88.
- Moritz, C., J. L. Patton, C. J. Conroy, J. L. Parra, G. C. White, and S. R. Beissinger. 2008. Impact of a century of climate change on small-mammal communities in Yosemite National Park, USA. *Science* 322:261–264. Abstract available at: <http://www.sciencemag.org/cgi/content/abstract/322/5899/261> (accessed 23 February 2011).
- National Park Service. 1999. Natural Resource Challenge: The National Park Service's action plan for preserving natural resources. U.S. Department of Interior, National Park Service, Natural Resource Stewardship and Science, Washington, D.C. Available at: <http://www.nature.nps.gov/challenge/index.cfm> (accessed 15 September 2010).
- National Park Service. 2001. Biological inventory plan for Sierra Nevada Network parks. Unpublished report for National Park Service Inventory & Monitoring Program, Three Rivers, CA. Available at http://science.nature.nps.gov/im/units/sien/Documents/Reports/SIEN_Biological_Inventory_Plan.pdf (accessed 9 August 2010).
- Parra, J. L., and W. B. Monahan. 2008. Variability in 20th century climate change reconstructions and its consequences for predicting geographic responses of California mammals. *Global Change Biology* 14:2215–2231.
- Phillips, S. J., M. Dudík, and R. E. Schapire. 2004. Maximum entropy approach to species distribution modeling. Pages 655–662 in *Proceedings of the 21st International Conference on Machine Learning*, The International Machine Learning Society. Banff, Alberta, Canada.
- Porter, W., and M. Kearney. 2009. Size, shape, and the thermal niche of endotherms. *Proceedings of the National Academy of Sciences (USA)* 106, suppl. 2:19,666–19,672.
- Rowe, R.J. 2005. Elevational gradient analysis and the use of historical museum specimens: A cautionary tale. *Journal of Biogeography* 32:1883-1897.
- Royle, J. A., et al. 2005. Modelling occurrence and abundance of species when detection is imperfect. *Oikos* 110:353–359.
- Tingley, M. W., W. B. Monahan, S. R. Beissinger, and C. Moritz. 2009. Birds track their Grinnellian niche through a century of climate change. *Proceedings of the National Academy of Sciences (USA)* 106, suppl. 2:19637–19643.
- Vredenburg, V. T., R. Bigham, R. Knapp, J. A. T. Morgan, C. Moritz, and D. Wake. 2007. Concordant molecular and phenotypic data delineate new taxonomy and conservation

- priorities for the endangered mountain yellow-legged frog. *Journal of Zoology* 271:361–374.
- White, R. J., and K. P. Burnham. 1999. Program MARK: Survival estimation from populations of marked individuals. *Bird Study* 46 (supplement):120–138.
- Williams, S. E., L. P. Shoo, J. L. Isaac, A. A. Hoffmann, and G. Langham. 2008. Towards an integrated framework for assessing the vulnerability of species to climate change. *PloSBiology* 6(12):2621–2626.

Appendix A: Photographs of Selected Grinnell-era Sites

“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 at the University of California at Berkeley.

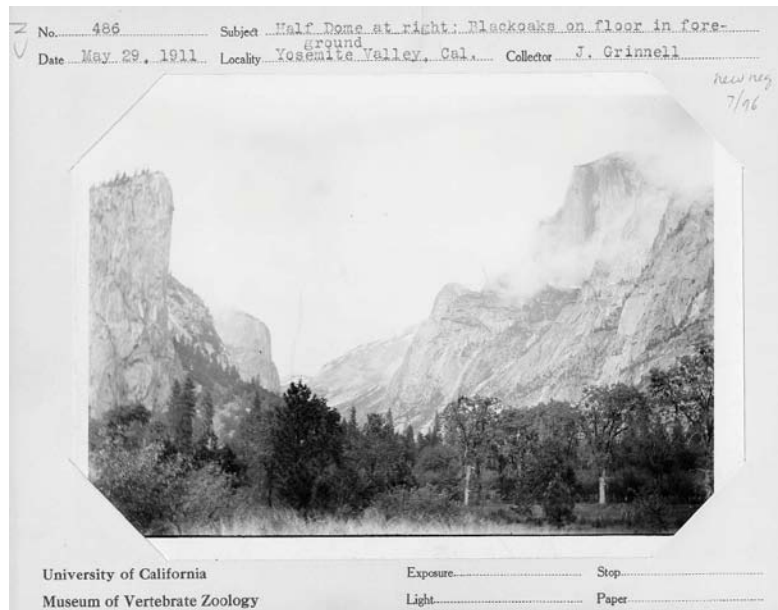


Figure A-1. Photograph comparisons of the east end of Stoneman Meadow, Yosemite Valley, looking towards Half Dome. Left, photo taken by Joseph Grinnell in May 1911 (source: Archives, Museum of Vertebrate Zoology, University of California, Berkeley). Right, photo taken by Robert Hijmans in May 2003. Note 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 A-2. Photograph comparisons of upper Lyell Fork meadow and Kuna Crest. Left, photo taken by Walter Taylor in July 1915 (source: Archives, Museum of Vertebrate Zoology, University of California, Berkeley). 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 A-3. Photograph comparisons of the north end of Vogelsang Lake. Left, photo taken by Walter Taylor in July 1915 (source: Archives, Museum of Vertebrate Zoology, University of California, Berkeley). 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 A-4. Photograph comparisons of Mt. Gibbs and Mt. Dana, from "Farrington's Ranch, south of Williams Butte, on the east side of the Sierra Nevada. Left, photo taken by Walter Taylor in June 1916 (source: Archives, Museum of Vertebrate Zoology, University of California, Berkeley). 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 B: Avian Surveys by Year and Site

Tables

Page

Table B-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..... 56

Table B-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. 69

Table B-3. Avian species and numbers of individuals encountered at repeated transect surveys during 2003 and 2004 in Yosemite National Park. 74

Table B-4. Change index $[(\text{current} - \text{Grinnell})/(\text{current} + \text{Grinnell})]$ and the binomial probability of species abundance for each site surveyed during the Grinnell 1915–1919 era and the current, 2003–2004 period. 78

Table B-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	Indian Canyon	IC	Lyell Meadows	LM
Transect	Total		Total		Cold Canyon	McGee Lake	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				

Table B-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 (continued).

Site	Chinquapin	CH	CraneFlat	CF	GlenAulin			GA	Indian Canyon	IC	Lyell Meadows	LM
Transect	Total		Total		Cold Canyon	McGee Lake	Waterwheel	Total		Total		Total
Species												
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 Chickadee												
Chipping sparrow	24	24	33	33					3	3	1	1
Clark's nutcracker					19	20	30	69			54	54
Common merganser												
Common raven	3	3	7	7					2	2	3	3
Dark-eyed junco	183	183	125	125	54	24	21	99	84	84	236	236
Downy woodpecker												
Dusky flycatcher	88	88	43	43	4	3	6	13	25	25	112	112
Evening grosbeak	23	23							19	19		
Fox sparrow	68	68				3	15	18	48	48		
Golden-crowned kinglet	166	166	88	88		7		7	108	108		
Green-tailed towhee	34	34					1	1	1	1		
Grey-crowned rosy-finch												
Hairy woodpecker	20	20	13	13	2	1	5	8	8	8	3	3
Hammond's flycatcher	32	32	64	64								
Hermit thrush	62	62	58	58					19	19	57	57
Hermit warbler	77	77	104	104	1	7	5	13	8	8		
Horned lark												
House wren	4	4	4	4		1	6	7			7	7
Hutton's vireo												
Killdeer												
Lazuli bunting	6	6	10	10	1			1	3	3		
Lesser goldfinch	3	3										
Lincoln's sparrow	27	27	31	31					3	3	10	10

Table B-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 (continued).

Site	Chinquapin	CH	CraneFlat	CF	GlenAulin			GA	Indian Canyon	IC	Lyell Meadows	LM
Transect	Total		Total		Cold Canyon	McGee Lake	Waterwheel	Total		Total		Total
Species												
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	2,199	2,199	1,419	1,419	313	306	270	889	1,238	1,238	1,215	1,215

Table B-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 (continued).

Site	Merced Grove	Mg	Mono Meadow		Mm	Nevada Falls	Nf	Mt. Lyell		Mly	Mirror Lake	Mla
Transect		Total	Mcgurk Meadow	Mono Meadow	Total		Total	Donohue Pass	Maclure Creek	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

Table B-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 (continued).

[illegible]

Table B-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 (continued).

Site	Merced Grove	Mg	Mono Meadow		Mm	Nevada Falls	Nf	Mt. Lyell		Mly	Mirror Lake	Mla
Transect		Total	Mcgurk Meadow	Mono Meadow	Total		Total	Donohue Pass	Maclure Creek	Total		Total
Species												
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

Table B-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 (continued).

Site	Merced Grove	Mg	Mono Meadow		Mm	Nevada Falls	Nf	Mt. Lyell		Mly	Mirror Lake	Mla
Transect		Total	Mcgurk Meadow	Mono Meadow	Total		Total	Donohue Pass	Maclure Creek	Total		Total
Species												
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	1,707	1,707	836	848	1,684	201	201	190	301	491	924	924

Table B-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 (continued).

[illegible]

Table B-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 (continued).

Site	Porcupine Flat			PF	Tamarack Flat	TF	Tuolumne Meadows	TM	Vogelsang		V	Yosemite Valley		YV
Transect	May Lake	PF	Total		Total		Total		Evelyn	Vogelsang	Total	North YV	YV	Total
Species														
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								

Table B-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 (continued).

Site	Porcupine Flat		PF	Tamarack Flat	TF	Tuolumne Meadows	TM	Vogelsang		V	Yosemite Valley		YV
Transect	May Lake	PF	Total		Total		Total	Evelyn	Vogelsang	Total	North YV	YV	Total
Species													
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			

Table B-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 (continued).

Site	Porcupine Flat		PF	Tamarack Flat	TF	Tuolumne Meadows	TM	Vogelsang		V	Yosemite Valley		YV
Transect	May Lake	PF	Total		Total		Total	Evelyn	Vogelsang	Total	North YV	YV	Total
Species													
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

Table B-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 (continued).

Site	Porcupine Flat			Tamarack Flat		Tuolumne Meadows		Vogelsang		V	Yosemite Valley		YV
Transect	May Lake	PF	Total		Total		Total	Evelyn	Vogelsang	Total	North YV	YV	Total
Species													
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	1,010	1,327	1,327	1,269	1,269	544	476	1,020	881	1,404	2,285

Table B-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
Acorn woodpecker	133	273
American crow	2	48
American goldfinch	96	55
American green-winged teal		3
American kestrel	11	10
American robin	322	643
Anna's hummingbird	8	46
Ash-throated flycatcher	156	261
Band-tailed pigeon	64	12
Barn Owl	1	
Barn swallow	60	7
Bell's vireo	38	
Belted kingfisher	6	16
Bewick's wren	70	302
Black phoebe	31	67
Black swift		1
Black-backed woodpecker	3	12
Black-chinned hummingbird	1	
Black-crowned night-heron	1	
Black-headed grosbeak	331	471
Black-throated grey warbler	105	64
Blue grosbeak	10	
Blue grouse	14	6
Blue-grey gnatcatcher	148	16
Blue-winged teal		16
Brewer's blackbird	122	457
Brewer's sparrow	2	
Brown creeper	76	203
Brown-headed cowbird	2	168
Bullock's oriole	118	103
Burrowing owl	2	
Bushtit	79	120
California gull	1	3

Table B-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 (continued).

Species	Grinnell	2003–2004
California quail	178	219
California thrasher	59	6
California towhee	116	154
Calliope hummingbird	23	5
Canada goose		9
Canyon wren	29	14
Cassin's finch	94	251
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	1,197
Double-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

Table B-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 (continued).

Species	Grinnell	2003–2004
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
Lazuli bunting	127	58
Lesser goldfinch	105	127
Lesser nighthawk	5	
Lewis' woodpecker	9	
Lincoln's sparrow	25	95
Loggerhead shrike	14	
Macgillivray's warbler	47	211
Mallard		59
Marsh wren		6
Mountain bluebird	33	3
Mountain chickadee	249	859
Mountain quail	65	204
Mourning dove	314	174
Nashville warbler	82	149
Northern flicker	68	196
Northern harrier	1	
Northern mockingbird	6	1
Northern pygmy-owl		1
Northern rough-winged swallow		19
Nuttall's woodpecker	32	44
Oak titmouse	95	143
Olive-sided flycatcher	42	55
Orange-crowned warbler	5	37
Osprey	1	3
Pacific-slope flycatcher	9	81

Table B-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 (continued).

Species	Grinnell	2003–2004
Phainopepla	22	31
Pied-billed grebe		5
Pileated woodpecker	10	32
Pine grosbeak		16
Pine siskin	121	359
Prairie falcon		1
Purple finch	61	40
Pygmy nuthatch		1
Red crossbill	2	52
Red-breasted nuthatch	80	565
Red-breasted sapsucker	7	84
Red-shouldered hawk	2	28
Red-tailed hawk	6	24
Red-winged blackbird	188	461
Rock wren	19	29
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	

Table B-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 (continued).

Species	Grinnell	2003–2004
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	1,174
Total Species	133	140
Number of Unique Species	21	28
Total Observations	9,872	18,165

Table B-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.

Species	CH		CF		IC		LC		LM		MG		MM		PF		YV	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
Acorn woodpecker																	45	8
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	24
Anna's hummingbird																	8	
Band-tailed pigeon		2									1						2	
Belted kingfisher									2									
Black phoebe									1								1	1
Black swift													1					
Black-backed woodpecker													1	5	1	1		
Black-headed grosbeak	8		8	5		2					9						49	17
Black-throated grey warbler			1	2													11	4
Blue grouse					1	1							3			1		
Blue-grey gnatcatcher																		1
Blue-winged teal									16									
Brewer's blackbird	37	21	39	12			5	8	23	7			16			14	67	25
Brown creeper	5	12	11	4	5	17	2	2	5	18	15	25	17	16	5	15	11	9
Brown-headed cowbird				1					1								7	7
Bullock's oriole																	8	11
Bushtit											10							
California gull									1									
Calliope hummingbird			1				2				3		1	1				
Canyon wren																	3	2
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	18
Chestnut-backed chickadee												9						1
Chipping sparrow	12	12	22	11	1	2			1			5	2	18	3	7		3

[illegible]

Table B-3. Avian species and numbers of individuals encountered at repeated transect surveys during 2003 and 2004 in Yosemite National Park (continued).

Species	CH		CF		IC		LC		LM		MG		MM		PF		YV	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
Olive-sided flycatcher	11	10			7	9	1					2	2	1		3		1
Orange-crowned warbler	3	1	2			5		1	3	2	1			2				
Pacific-slope flycatcher	1	3	6	2							35	30					1	2
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	1
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	44
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	25
Spotted sandpiper							1	2		4						3	31	7
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	31
Townsend's solitaire	6	12	2	3	18	8	4		1	5	3	4	13	4	3	3		
Violet-green swallow						4											12	5
Warbling vireo	15	23	30	19					3	4	28	28	42	14	1		46	21
Western bluebird	1																	
Western scrub-jay											2							
Western tanager	65	48	40	16	38	62					17	25	49	15	15	8	38	19
Western wood-pewee	4	3	2	3	6	12			1		2		22	12	2	1	67	26
White-breasted nuthatch	2				1	1			2	5	2		2			8		
White-crowned sparrow							33	17	30	30						1		

Table B-3. Avian species and numbers of individuals encountered at repeated transect surveys during 2003 and 2004 in Yosemite National Park (continued).

Species	CH		CF		IC		LC		LM		MG		MM		PF		YV	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
White-headed woodpecker	32	21	14	9	6	17					24	12	12	9	2		8	3
White-throated swift	1		2		2	26							1	3			29	22
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	16
Yellow-rumped warbler	162	101	133	43	82	98	35	11	73	101	46	60	74	99	61	116	9	1
Grand Totals	1,227	972	1,019	400	501	737	280	211	566	649	841	866	848	836	257	753	994	410

Table B-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, in main report document). Significant changes (p < 0.05) based on the binomial probability are in bold. LG = LaGrange, SN = Snelling, PV = Pleasant Valley, YV = Yosemite Valley, MG = Merced Grove, MM = Mono Meadow, CH = Chinquapin, IC = Indian Canyon, PF = Porcupine Flat, TM = Tuolumne Meadows, LM = Lyell Meadow.

Species	LG	SN	PV	YV	MG	MM	CH	IC	PF	TM	LM
Acorn woodpecker	0.22 (0.172)	0.65 (0.055)	0.23 (0.000)	0.54 (0.000)							
American crow	1.00 (0.000)	0.71 (0.019)	1.00 (0.125)								
American dipper											
American goldfinch	0.00 (0.430)	-0.41 (0.000)	1.00 (0.500)								
American green-winged teal										1.00	1.00
American kestrel	0.31 (0.500)	-0.39 (0.172)	0.36 (0.344)								
American pipit											
American robin	1.00 (0.016)	1.00 (0.002)	-0.33 (0.001)	-0.22 (0.001)	-0.12 (0.412)	0.05 (0.437)	0.08 (0.378)	-0.13 (0.339)	0.34 (0.013)	0.02 (0.500)	0.05 (0.432)
Anna's hummingbird	1.00 (0.002)	1.00 (0.125)	0.26 (0.192)	1.00 (0.000)							
Ash-throated flycatcher	0.41 (0.001)	0.60 (0.000)	0.12 (0.023)								
Band-tailed pigeon			1.00 (0.016)	-0.94 (0.000)	1.00		1.00 (0.500)				
Barn owl	-1.00 (0.500)										
Barn swallow	-1.00 (0.000)	-1.00 (0.008)	-0.66 (0.000)								

Table B-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 (continued).

Species	LG	SN	PV	YV	MG	MM	CH	IC	PF	TM	LM
Bell's vireo	-1.00 (0.000)	-1.00 (0.000)	-1.00 (0.016)								
Belted kingfisher	-0.08 (0.344)	1.00 (0.008)	0.52 (0.313)	-1.00 (0.250)							1.00
Bewick's wren	0.72 (0.000)	0.59 (0.000)	0.61 (0.000)	1.00 (0.500)							
Black phoebe	0.62 (0.004)	0.35 (0.061)	0.14 (0.243)	0.15 (0.250)	-1.00 (0.500)						1.00
Black swift							1.00				
Black-backed woodpecker					-0.05 (0.313)			1.00	0.18 (0.500)	(0.250)	
Black-chinned hummingbird	-1.00 (0.500)										
Black-crowned night-heron	-1.00 (0.500)										
Black-headed grosbeak	-0.27 (0.066)	-0.76 (0.000)	0.36 (0.000)	-0.07 (0.139)	-0.17 (0.500)	-1.00 (0.500)	-0.29 (0.344)	1.00 (0.500)			
Black-throated grey warbler		-0.96 (0.000)	0.12 (0.000)	-1.00 (0.181)	(0.000)		-1.00 (0.004)				
Blue grosbeak		-1.00 (0.002)									
Blue grouse				-1.00 (0.500)		-0.05 (0.250)		-0.88 (0.011)	-0.61 (0.250)		-1.00 (0.500)
Blue-grey gnatcatcher	-1.00 (0.016)		-0.80 (0.000)	1.00 (0.500)							
Blue-winged teal											1.00 (0.063)
Brewer's blackbird	-0.72 (0.000)	-1.00 (0.002)	-0.09 (0.223)	0.56 (0.000)		1.00 (0.031)	1.00 (0.000)		1.00 (0.008)	0.65 (0.000)	1.00 (0.008)
Brewer's sparrow	-1.00 (0.250)										

Table B-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 (continued).

Species	LG	SN	PV	YV	MG	MM	CH	IC	PF	TM	LM
Black phoebe	0.62 (0.004)	0.35 (0.061)	0.14 (0.243)	0.15 (0.250)	-1.00 (0.500)						1.00
Black swift						1.00					
Black-backed woodpecker						-0.05 (0.313)			1.00 (0.500)	0.18 (0.250)	
Black-chinned hummingbird		-1.00 (0.500)									
Black-crowned night-heron		-1.00 (0.500)									
Black-headed grosbeak	-0.27 (0.066)	-0.76 (0.000)	0.36 (0.000)	-0.07 (0.139)	-0.17 (0.500)	-1.00 (0.500)	-0.29 (0.344)	1.00 (0.500)			
Black-throated grey warbler			-0.96 (0.000)	0.12 (0.181)	-1.00 (0.000)			-1.00 (0.004)			
Blue grosbeak		-1.00 (0.002)									
Blue grouse				-1.00 (0.500)		-0.05 (0.250)		-0.88 (0.011)	-0.61 (0.250)		-1.00 (0.500)
Blue-grey gnatcatcher	-1.00 (0.016)		-0.80 (0.000)	1.00 (0.500)							
Blue-winged teal											1.00 0.063
Brewer's blackbird	-0.72 (0.000)	-1.00 (0.002)	-0.09 (0.223)	0.56 (0.000)		1.00 (0.031)	1.00 (0.000)		1.00 (0.008)	0.65 (0.0000)	1.00 (0.008)
Brewer's sparrow	-1.00 (0.250)										
Brown creeper			1.00 (0.125)	0.40 (0.010)	-0.38 (0.058)	0.42 (0.090)	-0.62 (0.002)	-0.50 (0.007)	0.10 (0.407)	1.00 (0.250)	1.00 (0.031)
Brown-headed cowbird	1.00 (0.000)	0.82 (0.000)	1.00 (0.000)	1.00 (0.000)						1.00 (0.031)	1.00
Bullock's oriole	0.63 (0.033)	-0.55 (0.001)	-0.13 (0.065)	1.00 (0.000)							

Table B-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 (continued).

Species	LG	SN	PV	YV	MG	MM	CH	IC	PF	TM	LM
Burrowing owl		-1.00 (0.250)									
Bushtit	0.91 (0.000)	1.00 (0.008)	-0.37 (0.000)		1.00 (0.250)						
California gull										-0.17 (0.750)	1.00
California quail	0.38 (0.025)	0.12 (0.345)	0.07 (0.108)								
California thrasher	-1.00 (0.002)		-0.78 (0.000)								
California towhee	-0.49 (0.021)	-1.00 (0.000)	0.29 (0.000)								
Calliope hummingbird				-1.00 (0.016)	-0.36 (0.500)	-0.86 (0.020)	-1.00 (0.063)	-1.00 (0.250)	-1.00 (0.250)		
Canada goose	1.00 (0.125)		1.00 (0.063)								
Canyon wren	1.00 (0.500)		-0.60 (0.002)	-0.25 (0.291)							
Cassin's finch						-0.25 (0.240)	-0.61 (0.000)	1.00 (0.008)	0.35 (0.011)	-0.16 (0.140)	0.11 (0.412)
Cassin's vireo	-1.00 (0.016)	-1.00 (0.250)	-0.87 (0.000)	0.04 (0.359)	-0.10 (0.412)	1.00 (0.031)	0.14 (0.387)	-0.33 (0.344)			
Cedar waxwing	1.00 (0.125)										
Chestnut-backed chickadee				1.00 (0.500)	1.00 (0.500)						
Chipping sparrow	-1.00 (0.250)	-1.00 (0.250)	-1.00 (0.000)	-0.88 (0.000)	-0.82 (0.020)	-0.56 (0.003)	0.25 (0.274)	-0.39 (0.500)	-0.70 (0.000)	-0.41 (0.012)	-0.89 (0.063)
Cinnamon teal	1.00 (0.500)										
Clark's nutcracker									-0.12 (0.500)	-0.30 (0.119)	-0.30 (0.045)

Table B-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 (continued).

Species	LG	SN	PV	YV	MG	MM	CH	IC	PF	TM	LM
Cliff swallow	-0.36 (0.000)	0.49 (0.010)	-1.00 (0.000)								
Common merganser				1.00 (0.004)							
Common moorhen		1.00 (0.250)									
Common nighthawk										-1.00 (0.125)	
Common poorwill		-1.00 (0.500)	-1.00 (0.500)								
Common raven	1.00 (0.500)		1.00 (0.000)	1.00 (0.000)	1.00 (0.250)	1.00 (0.125)	1.00 (0.500)	1.00 (0.500)	1.00	1.00 (0.250)	1.00 (0.500)
Common yellowthroat	-0.47 (0.172)	-1.00 (0.000)									
Cooper's hawk			-1.00 (0.250)	-1.00 (0.063)							
Dark-eyed junco			-0.63 (0.011)	0.24 (0.014)	-0.15 (0.153)	-0.31 (0.000)	-0.24 (0.003)	-0.28 (0.014)	-0.06 (0.290)	-0.20 (0.014)	0.11 (0.155)
Double-crested cormorant	-1.00 (0.500)										
Downy woodpecker	1.00 (0.250)	1.00 (0.063)	1.00 (0.500)	-0.49 (0.500)							
Dusky flycatcher			1.00 (0.500)	-0.63 (0.063)	0.76 (0.035)	-0.21 (0.080)	-0.30 (0.008)	-0.28 (0.132)	0.74 (0.035)	1.00 (0.000)	1.00 (0.000)
European starling	1.00 (0.000)	1.00 (0.000)	1.00 (0.000)								
Evening grosbeak				-0.43 (0.072)		0.67 (0.109)	-0.34 (0.084)	1.00 (0.016)	1.00 (0.250)	1.00	
Fox sparrow				1.00 (0.500)	-0.11 (0.271)	-0.58 (0.003)	-0.59 (0.000)	-0.38 (0.008)	0.14 (0.324)		
Golden eagle			-1.00 (0.031)							-1.00 (0.250)	-1.00 (0.250)

Table B-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 (continued).

Species	LG	SN	PV	YV	MG	MM	CH	IC	PF	TM	LM
Golden-crowned kinglet				1.00 (0.125)	0.89 (0.000)	0.68 (0.000)	0.70 (0.000)	0.20 (0.106)	0.04 (0.437)		
Golden-crowned sparrow			1.00 (0.500)								
Great blue heron	0.12 (0.250)	0.40 (0.254)	1.00 (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 (0.063)	1.00 (0.500)	-1.00 (0.063)	0.22 (0.304)	-0.92 (0.008)	-1.00 (0.016)		
Grey-crowned rosy-finch											
Hairy woodpecker			0.10 (0.500)	0.39 (0.058)	0.48 (0.313)	0.73 (0.063)	0.29 (0.254)	1.00 (0.250)	0.61 (0.055)	1.00 (0.500)	1.00 (0.500)
Hammond's flycatcher					0.68 (0.109)	0.58 (0.055)	1.00 (0.002)		-1.00 (0.016)	-1.00 (0.016)	-1.00 (0.004)
Hermit thrush				-1.00 (0.001)	0.02 (0.344)	0.68 (0.002)	0.48 (0.017)	-0.24 (0.304)	-0.04 (0.437)	-0.17 (0.332)	-0.13 (0.292)
Hermit warbler	-1.00 (0.250)		0.03 (0.250)	-0.72 (0.000)	1.00 (0.000)	-0.36 (0.172)	0.00 (0.439)	-0.13 (0.500)			
Horned lark											
House finch	-0.53 (0.000)	-0.84 (0.000)	-0.58 (0.000)								

Table B-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 (continued).

Species	LG	SN	PV	YV	MG	MM	CH	IC	PF	TM	LM
House sparrow	1.00 (0.500)	-1.00 (0.000)	-1.00 (0.002)								
House wren	1.00 (0.000)	1.00 (0.000)	0.86 (0.000)	1.00 (0.500)	1.00	1.00 (0.500)	1.00 (0.500)				0.23 (0.500)
Hutton's vireo	1.00 (0.031)		1.00 (0.000)	1.00 (0.016)							
Killdeer	-0.34 (0.084)	0.27 (0.500)	-0.43 (0.0390)							0.03 (0.363)	
Lark sparrow	-1.00 (0.004)	-1.00 (0.004)	-0.75 (0.000)								
Lawrence's goldfinch	1.00 (0.500)		0.30 (0.274)								
Lazuli bunting	1.00 (0.500)	-1.00 (0.000)	-0.28 (0.001)	-0.92 (0.000)	-1.00 (0.125)		1.00 (0.250)	1.00 (0.500)	1.00		
Lesser goldfinch	0.56 (0.001)	0.25 (0.124)	-0.05 (0.307)	-0.82 (0.035)			1.00 (0.500)	-1.00 (0.500)			
Lesser nighthawk	-1.00 (0.031)										
Lewis' woodpecker		-1.00 (0.500)	-1.00 (0.004)								
Lincoln's sparrow						-0.04 (0.500)	0.20 (0.387)	1.00 (0.500)	-1.00 (0.125)	1.00 (0.125)	0.07 (0.313)
Loggerhead shrike	-1.00 (0.000)		-1.00 (0.500)								
Macgillivray's warbler	1.00 (0.500)		-1.00 (0.063)	-0.28 (0.124)	0.90 (0.000)	0.44 (0.227)	0.32 (0.105)	-0.89 (0.000)			
Mallard	1.00 (0.016)	1.00 (0.000)	1.00 (0.063)	1.00 (0.001)						1.00 (0.250)	1.00 (0.500)
Marsh wren	1.00 (0.063)										
Mountain bluebird									1.00 (0.500)	-0.97 (0.000)	-1.00 (0.002)

Table B-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 (continued).

Species	LG	SN	PV	YV	MG	MM	CH	IC	PF	TM	LM
Mountain chickadee				-0.06 (0.396)	0.17 (0.271)	0.21 (0.042)	0.20 (0.060)	0.14 (0.133)	0.32 (0.001)	-0.46 (0.000)	-0.31 (0.015)
Mountain quail			0.48 (0.000)	0.39 (0.172)	-0.77 (0.063)	0.16 (0.279)	0.03 (0.500)	-0.61 (0.063)	0.30 (0.166)		
Mourning dove	-0.81 (0.000)	-0.39 (0.000)	0.02 (0.396)					1.00			
Nashville warbler			-0.09 (0.364)	0.11 (0.171)	-0.01 (0.363)	1.00 (0.008)	-0.84 (0.000)	1.00 (0.500)			1.00
Northern flicker	-0.22 (0.500)	-0.16 (0.271)	0.55 (0.000)	0.55 (0.001)	-0.16 (0.500)	-0.14 (0.313)	0.35 (0.194)	-0.07 (0.344)	-0.51 (0.145)	0.56 (0.188)	-0.30 (0.500)
Northern goshawk											
Northern harrier				-1.00 (0.500)							
Northern mockingbird	-1.00 (0.063)	-1.00 (0.500)	0.03 (0.250)								
Northern pygmy-owl					1.00						
Northern rough-winged swallow	1.00 (0.000)			1.00 (0.500)							
Nuttall's woodpecker	0.80 (0.011)	0.58 (0.011)	-0.20 (0.111)								
Oak titmouse	0.39 (0.012)	1.00 (0.000)	-0.01 (0.468)								
Olive-sided flycatcher			-0.06 (0.500)	1.00 (0.125)	-0.88 (0.031)	-0.69 (0.109)	-0.41 (0.058)	-0.27 (0.291)	-0.47 (0.188)	1.00	
Orange-crowned warbler	1.00 (0.500)		0.58 (0.005)		1.00	1.00 (0.500)	1.00 (0.500)	1.00 (0.500)			1.00 (0.500)
Osprey		1.00 (0.125)		-1.00 (0.500)							
Pacific-slope flycatcher	1.00 (0.500)		0.14 (0.500)	0.06 (0.344)	0.67 (0.019)		1.00 (0.500)				

Table B-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 (continued).

Species	LG	SN	PV	YV	MG	MM	CH	IC	PF	TM	LM
Phainopepla	1.00 (0.500)		0.18 (0.131)								
Pied-billed grebe	1.00 (0.500)	1.00 (0.250)	1.00 (0.250)								
Pileated woodpecker				1.00 (0.500)	-0.23 (0.500)	-0.47 (0.227)	1.00 (0.500)	0.13 (0.500)			
Pine grosbeak						1.00 (0.500)			1.00 (0.016)		
Pine siskin				-1.00 (0.000)	-1.00 (0.500)	-0.01 (0.363)	0.05 (0.250)	1.00 (0.500)	0.11 (0.208)	0.28 (0.001)	0.00 (0.377)
Prairie falcon										1.00	
Purple finch			-0.45 (0.048)	-1.00 (0.000)	-0.12 (0.250)		1.00 (0.250)		1.00 (0.500)	0.07 (0.500)	1.00 (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)

Table B-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 (continued).

Species	LG	SN	PV	YV	MG	MM	CH	IC	PF	TM	LM
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)			

Table B-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 (continued).

Species	LG	SN	PV	YV	MG	MM	CH	IC	PF	TM	LM
Virginia rail			1.00 (0.500)								
Warbling vireo	0.63 (0.188)	0.40 (0.500)	-0.84 (0.000)	-0.26 (0.000)	-0.32 (0.084)	-0.09 (0.371)	-0.39 (0.012)	-1.00 (0.002)	-0.92 (0.000)	1.00 (0.031)	1.00 (0.250)
Western bluebird	-0.73 (0.000)	0.63 (0.004)	-0.53 (0.000)				1.00				
Western kingbird	-0.45 (0.018)	-0.51 (0.021)	-0.24 (0.004)								
Western meadowlark	-1.00 (0.000)	-1.00 (0.000)	-1.00 (0.000)								
Western scrub-jay	0.43 (0.039)	0.02 (0.407)	0.36 (0.000)		1.00						
Western tanager	-0.30 (0.274)	1.00 (0.000)	0.25 (0.024)	0.20 (0.013)	-0.39 (0.067)	-0.07 (0.378)	0.07 (0.347)	0.23 (0.072)	-0.41 (0.007)	0.03 (0.250)	
Western wood-pewee	1.00 (0.250)	-1.00 (0.000)	-0.56 (0.000)	0.01 (0.500)	-0.96 (0.000)	-0.35 (0.035)	-0.77 (0.001)	-0.43 (0.048)	-0.89 (0.000)	-0.64 (0.000)	-0.97 (0.000)
White-breasted nuthatch	0.42 (0.032)	1.00 (0.016)	-0.07 (0.349)		1.00	1.00 (0.500)	-0.29 (0.250)	-0.79 (0.109)	1.00 (0.063)	1.00 (0.063)	1.00 (0.250)
White-crowned sparrow	-1.00 (0.000)					-1.00 (0.250)			-0.61 (0.250)	-0.32 (0.022)	-0.59 (0.000)
White-headed woodpecker				1.00 (0.000)	-0.03 (0.387)	0.35 (0.254)	0.35 (0.067)	-0.02 (0.395)	-0.01 (0.250)		-1.00 (0.500)
White-tailed kite	1.00 (0.500)										
White-throated swift			-1.00 (0.016)	0.44 (0.000)		1.00 (0.500)	1.00	-0.05 (0.500)			
Wild turkey			1.00 (0.500)								
Williamson's sapsucker						-0.38 (0.344)		1.00 (0.250)	-0.38 (0.072)	-0.87 (0.031)	1.00
Willow flycatcher		-1.00 (0.000)	1.00 (0.500)	-1.00 (0.000)							

Table B-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 (continued).

Species	LG	SN	PV	YV	MG	MM	CH	IC	PF	TM	LM
Wilson's warbler	0.52 (0.007)	1.00 (0.500)	0.92 (0.000)	-0.49 (0.188)	-1.00 (0.002)	-0.61 (0.002)	-0.71 (0.000)		-1.00 (0.031)	-1.00 (0.500)	-0.80 (0.020)
Winter wren					0.69 (0.109)	1.00 (0.500)	1.00 (0.125)	1.00			
Wood duck		1.00 (0.125)									
Wrentit	1.00 (0.500)		0.46 (0.000)	-1.00 (0.250)							
Yellow warbler	-0.44 (0.048)	-0.88 (0.000)	-0.89 (0.000)	-0.44 (0.000)	-1.00 (0.008)		-1.00 (0.500)			1.00 (0.063)	
Yellow-breasted chat	0.23 (0.500)	-0.87 (0.000)	-0.88 (0.000)								
Yellow-rumped warbler				-0.49 (0.001)	0.47 (0.017)	0.44 (0.000)	0.68 (0.000)	0.86 (0.000)	0.45 (0.000)	0.22 (0.076)	0.40 (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 C: Mammal Surveys by Year and Site

Tables

Page

Table C-1. Sites trapped for small mammals in Yosemite Valley, Yosemite National Park, during the 2003 field season.....	94
Table C-2. Mammal species present across all sites trapped in Yosemite Valley, Yosemite National Park, in 2003, by habitat.	95
Table C-3. Sites trapped for small mammals in the vicinity of Hodgen Meadow, Merced Grove, and Crane Flat, Yosemite National Park, in 2003.	96
Table C-4. Mammal species present across all sites trapped in the vicinity of Hodgen Meadow, Merced Grove, and Crane Flat, Yosemite National Park, in 2003, by habitat.....	97
Table C-5. Record of sites trapped for small mammals along Glacier Point Road, from Chinquapin to Pothole Meadow, Yosemite National Park, in 2003.	98
Table C-6. Mammal species present across all sites trapped along Glacier Point Road, from Chinquapin to Pothole Meadow, Yosemite National Park in 2003, by habitat.....	99
Table C-7. Sites trapped for small mammals in upper Lyell Canyon (9,800–11,500 ft), Yosemite National Park, in 2003.	99
Table C-8. Mammal species present across all sites trapped in upper Lyell Canyon (9,800–11,500 ft), Yosemite National Park in 2003, by habitat.	100
Table C-9. Sites trapped for small mammals in the vicinity of Glen Aulin and McGee Lake, Yosemite National Park, in 2003.	101
Table C-10. Mammal species present across all sites trapped in the vicinity of Glen Aulin and McGee Lake, Yosemite National Park, in 2003, by habitat.	101
Table C-11. Sites trapped for small mammals in the region between White Wolf and Mt. Hoffman, Yosemite National Park, in 2004.....	102
Table C-12. Mammal species present across all sites trapped in the region between White Wolf and Mt. Hoffman, Yosemite National Park, in 2004, by habitat.	103
Table C-13. Sites trapped for small mammals in the vicinity of Vogelsang and Merced Lake, Yosemite National Park, in 2004.....	104

Table C-14. Mammal species present across all sites trapped in the vicinity of Vogelsang and Merced Lake, Yosemite National Park, in 2004, by habitat.	105
Table C-15. Sites trapped for small mammals at Tamarack Flat, Aspen Valley, and Cascades, Yosemite National Park, in 2004.	105
Table C-16. Mammal species present across all sites trapped Tamarack Flat, Aspen Valley, and Cascades in 2004, by habitat.	106
Table C-17. Sites trapped for small mammals at vicinity of Hazel Green, Crane Flat, and Merced Grove, Yosemite National Park, in 2004.	107
Table C-18. Mammal species present across all sites trapped at vicinity of Hazel Green, Crane Flat, and Merced Grove, Yosemite National Park, in 2004, by habitat.....	107
Table C-19. General area trapped for small mammals in upper Return Creek, Yosemite National Park, in 2004.	107
Table C-20. Mammal species present in upper Return Creek, Yosemite National Park, in 2005, by habitat.	108
Table C-21. Sites trapped for small mammals in the vicinity of Tuolumne Meadows, Yosemite National Park, in 2005.	108
Table C-22. Mammal species present across all sites trapped in the vicinity of Tuolumne Meadows, Yosemite National Park, in 2005, by habitat.	109
Table C-23. Sites trapped for small mammals in upper Lyell Canyon (10,240–10,600 ft), Yosemite National Park, in 2005.	109
Table C-24. Mammal species present across all sites trapped in upper Lyell Canyon (10,240–10,600 ft), Yosemite National Park, in 2005, by habitat.	110
Table C-25. Sites trapped for small mammals in the vicinity of Dorothy Lake and Grace Meadows, Yosemite National Park, in 2005.	110
Table C-26. Mammal species present across all sites trapped in the vicinity of Dorothy Lake and Grace Meadows, Yosemite National Park, in 2005, by habitat.	111
Table C-27. Sites trapped for small mammals in the vicinity of Kerrick Meadow, Yosemite National Park, in 2005 (trapping by Adam Leache during herpetological surveys).	111
Table C-28. Mammal species present across all sites trapped in the vicinity of Kerrick Meadow, Yosemite National Park, in 2005, by habitat (trapping by Adam Leache during herpetological surveys).	111

Table C-29. Sites trapped for small mammals in the vicinity of Tuolumne Meadow, Yosemite National Park, in 2006.....	112
Table C-30. Sites trapped for small mammals in the vicinity of Ten Lakes and Ten Lakes Pass, Yosemite National Park, in 2006.	112
Table C-31. Sites trapped for small mammals in the vicinity of Kerrick Meadow, Yosemite National Park, in 2006.....	112
Table C-32. Mammal species present across all sites trapped in the vicinity of Kerrick Meadow, Yosemite National Park, in 2006.....	113
Table C-33. Sites trapped for small mammals in upper Lyell Canyon (10,240–10,750 ft), Yosemite National Park, in 2006.	113
Table C-34. Mammal species present across all sites trapped in upper Lyell Canyon (10,240-10,750 ft), Yosemite National Park, in 2006.....	114
Table C-35. Sites trapped for small mammals in the vicinity of Upper Cathedral Lake, Yosemite National Park, in 2007.....	114
Table C-36. Mammal species present across all sites trapped in the vicinity of Upper Cathedral Lake, Yosemite National Park, in 2007.	115
Table C-37. Sites trapped for small mammals in the vicinity of Upper and Lower Ottaway Lakes, Yosemite National Park, in 2007.....	115
Table C-38. Mammal species present across all sites trapped in the vicinity of Upper and Lower Ottaway Lakes, Yosemite National Park, in 2007.....	116
Table C-39. Sites trapped for small mammals in the vicinity of Mono Pass, Yosemite National Park, in 2008.	117
Table C-40. Mammal species present across all sites trapped in the vicinity of Kerrick Meadow, Yosemite National Park, in 2008.....	117
Table C-41. Sites trapped for small mammals in the vicinity of Middle and Upper Young Lakes, Yosemite National Park, in 2008.....	118
Table C-42. Mammal species present across all sites trapped in the vicinity of Middle and Upper Young Lakes, Yosemite National Park, in 2008.....	118

2003

Table C-1. Sites trapped for small mammals in Yosemite Valley, Yosemite National Park, during the 2003 field season.

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

Table C-2. Mammal species present across all sites trapped in Yosemite Valley, Yosemite National Park, in 2003, by habitat.

Family	Species	Habitat	Relative Abundance	Remarks
Talpidae	<i>Scapanus latimanus</i>	meadow	common	*
Soricidae	<i>Sorex monticolus</i>	meadow	very common	
	<i>Sorex trowbridgii</i>	meadow-forest	rare	
Sciuridae	<i>Glaucomys sabrinus</i>	conifer forest	uncommon	
	<i>Sciurus griseus</i>	oak-conifer forest	common	**
	<i>Spermophilus beecheyi</i>	conifer forest	common	***
Geomyidae	<i>Thomomys bottae</i>	meadow	common	
Cricetidae	<i>Peromyscus boylii</i>	oak-conifer forest	very common	
	<i>Peromyscus maniculatus</i>	oak-conifer forest, fen, riparian	common	
	<i>Reithrodontomys megalotis</i>	fen, riparian	rare	
	<i>Neotoma macrotis</i>	oak-conifer forest	rare	
	<i>Microtus longicaudus</i>	fen, riparian	uncommon	
	<i>Microtus montanus</i>	meadow	very common	
Mustelidae	<i>Spilogale putorius</i>	oak-conifer forest	common	
Canidae	<i>Canis latrans</i>	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.

Table C-3. Sites trapped for small mammals in the vicinity of Hodgen Meadow, Merced Grove, and Crane Flat, Yosemite National Park, in 2003.

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

Table C-4. Mammal species present across all sites trapped in the vicinity of Hodgen Meadow, Merced Grove, and Crane Flat, Yosemite National Park, in 2003, by habitat.

Family	Species	Habitat	Relative Abundance	Remarks
Talpidae	<i>Scapanus latimanus</i>	meadow	common	*
Soricidae	<i>Sorex monticolus</i>	meadow	very common	
	<i>Sorex trowbridgii</i>	meadow-forest	rare	
Sciuridae	<i>Glaucomys sabrinus</i>	conifer forest	uncommon	
	<i>Tamiasciurus douglasi</i>	conifer forest,	common	
	<i>Spermophilus beecheyi</i>	conifer forest	common	**
	<i>Spermophilus lateralis</i>	conifer forest	common	
	<i>Tamias quadrimaculatus</i>	conifer forest	common	
	<i>Tamias speciosus</i>	conifer forest	common	
Geomyidae	<i>Thomomys monticola</i>	meadow	common	
Cricetidae	<i>Peromyscus boylii</i>	chaparral	rare	***
	<i>Peromyscus maniculatus</i>	oak-conifer forest, fen, riparian	very common	
	<i>Microtus californicus</i>	riparian	rare	
	<i>Microtus longicaudus</i>	fen, riparian	uncommon	
	<i>Microtus montanus</i>	meadow	rare	
Dipodidae	<i>Zapus princeps</i>	meadow, riparian	locally common	
Mustelidae	<i>Mustela erminea</i>	Meadow	rare	

*Fresh mounds and surface runways observed only.

**Individuals 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.

Table C-5. Record of sites trapped for small mammals along Glacier Point Road, from Chinquapin to Pothole Meadow, Yosemite National Park, in 2003.

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

Table C-6. Mammal species present across all sites trapped along Glacier Point Road, from Chinquapin to Pothole Meadow, Yosemite National Park in 2003, by habitat.

Family	Species	Habitat	Relative Abundance	Remarks
Talpidae	<i>Scapanus latimanus</i>	meadow	uncommon	*
Soricidae	<i>Sorex monticolus</i>	meadow	common	
	<i>Sorex trowbridgii</i>	conifer forest	rare	**
	<i>Sorex palustris</i>	streamside	rare	
Aplodontidae	<i>Aplodontia rufa</i>	riparian, streamside	locally common	
Sciuridae	<i>Otospermophilus beecheyi</i>	conifer forest	common	***
	<i>Callospermophilus lateralis</i>	conifer forest	common	
	<i>Tamiasciurus douglasi</i>	conifer forest	uncommon	****
	<i>Tamias quadrimaculatus</i>	conifer forest	rare	
	<i>Tamias speciosus</i>	conifer forest	common	
Geomyidae	<i>Thomomys monticola</i>	meadow	common	*****
Cricetidae	<i>Peromyscus boylii</i>	conifer forest	rare	
	<i>Peromyscus maniculatus</i>	conifer forest, riparian	common	
	<i>Microtus longicaudus</i>	meadow, riparian	common	
	<i>Microtus montanus</i>	meadow	common	
Dipodidae	<i>Zapus princeps</i>	meadow, riparian	locally common	
Mustelidae	<i>Mustela erminea</i>	conifer forest	rare	

*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.

Table C-7. Sites trapped for small mammals in upper Lyell Canyon (9,800–11,500 ft), Yosemite National Park, in 2003.

Specific Locality	Latitude	Longitude	Habitat
upper Lyell Canyon, 9,788 ft	37.77801	-119.26115	mixed conifer
upper Lyell Canyon, 9,788 ft	37.77719	-119.26395	mixed conifer
upper Lyell Canyon, 9,788 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

Table C-8. Mammal species present across all sites trapped in upper Lyell Canyon (9,800–11,500 ft), Yosemite National Park in 2003, by habitat.

Family	Species	Habitat	Relative Abundance	Remarks
Talpidae	<i>Scapanus latimanus</i>	meadow	uncommon	*
Soricidae	<i>Sorex monticolus</i>	meadow	very common	
Ochotonidae	<i>Ochotona princeps</i>	talus	locally common	
Aplodontidae	<i>Aplodontia rufa</i>	stream side	locally common	**
Sciuridae	<i>Tamiasciurus douglasi</i>	conifer forest	common	***
	<i>Marmota flaviventris</i>	talus	Common	****
	<i>Urocitellus beldingi</i>	meadow	common	
	<i>Callospermophilus lateralis</i>	conifer forest, talus	common	
	<i>Tamias alpinus</i>	talus, meadow edge	rare	*****
	<i>Tamias speciosus</i>	conifer forest, meadow	very common	
Geomyidae	<i>Thomomys monticola</i>	meadow	common	*****
Cricetidae	<i>Peromyscus maniculatus</i>	conifer forest, meadow	very common	
	<i>Peromyscus truei</i>	conifer forest, talus	uncommon	
	<i>Microtus longicaudus</i>	meadow, riparian	common	
	<i>Microtus montanus</i>	meadow	rare	
	<i>Phenacomys intermedius</i>	heather, talus	rare	
Dipodidae	<i>Zapus princeps</i>	riparian, meadow	uncommon	
Mustelidae	<i>Martes americana</i>	conifer forest		=
Procyonidae	<i>Procyon lotor</i>	trail		=
Cervidae	<i>Odocoileus hemionus</i>	meadow		

*Mole sign was observed along the John Muir Trail above the footbridge, at approximately 9,850 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 9,788 feet to the highest trapline at 10,565 feet.

*****Alpine chipmunks were encountered 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 9,788 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.

= Footprints of a raccoon were seen on the trail between the two meadows at 10,240 and 10,565 feet elevation.

Table C-9. Sites trapped for small mammals in the vicinity of Glen Aulin and McGee Lake, Yosemite National Park, in 2003.

Specific Locality	Latitude	Longitude	Habitat
Glen Aulin, 7,914 ft	37.91355	-119.42225	mixed conifer, shrub, granite slab
Glen Aulin, 8,175 ft	37.91586	-119.41835	mixed conifer, shrub, granite slab
Glen Aulin, 7,880 ft	37.91360	-119.42421	mixed conifer, shrub, granite slab
Glen Aulin, 2,389 m	37.91170	-119.42495	meadow, burn
Glen Aulin, 2,389 m	37.91245	-119.42653	meadow, burn
Glen Aulin, 2,400 m	37.91311	-119.42397	meadow, burn
Glen Aulin, 7,850 ft	37.91042	-119.41607	meadow, burn
Glen Aulin	37.91343	-119.42860	meadow, burn
Glen Aulin	37.91543	-119.43118	meadow, burn
McGee Lake, 8,190 ft	37.90070	-119.43209	mixed conifer
McGee Lake, 8,171 ft	37.90236	-119.42969	riparian (lake edge)
McGee Lake, 2,510 m	37.90344	-119.43121	open conifer forest, granite outcrops

Table C-10. Mammal species present across all sites trapped in the vicinity of Glen Aulin and McGee Lake, Yosemite National Park, in 2003, by habitat.

Family	Species	Habitat	Relative Abundance	Remarks
Talpidae	<i>Scapanus latimanus</i>	meadow	common	*
Soricidae	<i>Sorex monticolus</i>	meadow	common	
	<i>Sorex lyelli</i>	meadow-forest	uncommon	
Sciuridae	<i>Callopermophilus lateralis</i>	forest, slab	common	
	<i>Tamias speciosus</i>	forest, slab	very common	
	<i>Tamiasciurus douglasi</i>	open forest	common	**
Geomyidae	<i>Thomomys monticola</i>	meadow	rare	
Cricetidae	<i>Peromyscus maniculatus</i>	forest, meadow, slab	very common	
	<i>Peromyscus truei</i>	forest, scrub, slab	common	
	<i>Neotoma cinerea</i>	oak-conifer forest	uncommon	
	<i>Microtus longicaudus</i>	meadow, riparian	common	
	<i>Microtus montanus</i>	meadow, riparian	rare	
	<i>Phenacomys intermedius</i>	slab edge	rare	
Dipodidae	<i>Zapus princeps</i>	meadow, riparian	uncommon	
Mustelidae	<i>Mustela erminea</i>	conifer, scrub	rare	

*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

Table C-11. Sites trapped for small mammals in the region between White Wolf and Mt. Hoffman, Yosemite National Park, in 2004.

Specific Locality	Latitude	Longitude	Habitat
0.9 mi W Porcupine Flat	37.81435	-119.57728	mixed conifer
3.8 mi E. White Wolf entrance	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
<i>Old Tioga Mine Rd.</i>	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	37.84970	-119.57801	mixed conifer, oak, chaparral

Table C-12. Mammal species present across all sites trapped in the region between White Wolf and Mt. Hoffman, Yosemite National Park, in 2004, by habitat.

Family	Species	Habitat	Relative Abundance	Remarks
Soricidae	<i>Sorex monticolus</i>	forest, meadow	common	
	<i>Sorex palustris</i>	riparian	rare	*
	<i>Sorex trowbridgii</i>	riparian	uncommon	
Sciuridae	<i>Spermophilus beecheyi</i>	roadsides, granite outcrops	uncommon	
	<i>Spermophilus beldingi</i>	dry meadows	uncommon	
	<i>Spermophilus lateralis</i>	conifer forest	common	
	<i>Tamiasciurus douglasii</i>	conifer forest	common	**
	<i>Marmota flaviventris</i>	conifer forest, meadow	common	***
	<i>Glaucomys sabrinus</i>	conifer forest	uncommon	****
	<i>Tamias senex</i>	conifer forest	uncommon	*****
	<i>Tamias speciosus</i>	conifer forest	common	
Geomyidae	<i>Thomomys monticola</i>	meadows	common	
Cricetidae	<i>Peromyscus boylii</i>	forest, riparian	uncommon	=
	<i>Peromyscus maniculatus</i>	grassland, forest, riparian	very common	
	<i>Neotoma cinerea</i>	riparian, forest	uncommon	==
	<i>Microtus longicaudus</i>	riparian, meadow	common	
	<i>Microtus montanus</i>	wet meadows	common	===
	<i>Phenacomys intermedius</i>	meadow- conifer interface	rare	====
Dipodidae	<i>Zapus princeps</i>	riparian	common	

*Grinnell 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.

**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.

****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.

******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).

= 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.

Table C-13. Sites trapped for small mammals in the vicinity of Vogelsang and Merced Lake, Yosemite National Park, in 2004.

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	37.79650	-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

Table C-14. Mammal species present across all sites trapped in the vicinity of Vogelsang and Merced Lake, Yosemite National Park, in 2004, by habitat.

Family	Species	Habitat	Relative Abundance	Remarks
Soricidae	<i>Sorex monticolus</i>	forest, meadow	uncommon	
	<i>Sorex lyelli</i>	meadow, stream edge	uncommon	
	<i>Sorex palustris</i>	riparian	rare	
	<i>Sorex trowbridgii</i>	riparian	uncommon	
Talpidae	<i>Scapanus latimanus</i>	conifer forest	common	*
Sciuridae	<i>Spermophilus beecheyi</i>	aspen/conifer forest	common	**
	<i>Spermophilus beldingi</i>	dry meadows, lake shores	common	
	<i>Spermophilus lateralis</i>	conifer forest	common	
	<i>Tamiasciurus douglasii</i>	conifer forest	common	***
	<i>Marmota flaviventris</i>	conifer forest, meadow	common	****
	<i>Tamias alpinus</i>	talus, meadow edge	common	
	<i>Tamias quadrimaculatus</i>	conifer forest	rare	
	<i>Tamias speciosus</i>	conifer forest	common	
Geomyidae	<i>Thomomys monticola</i>	meadows	common	
Cricetidae	<i>Peromyscus boylii</i>	forest, riparian	uncommon	
	<i>Peromyscus maniculatus</i>	grassland, forest, riparian	very common	
	<i>Microtus longicaudus</i>	riparian, meadow	common	
	<i>Microtus montanus</i>	wet meadows	common	
Dipodidae	<i>Zapus princeps</i>	riparian	common	
Mustelidae	<i>Mustela erminea</i>	meadow	uncommon	

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

***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.

Table C-15. Sites trapped for small mammals at Tamarack Flat, Aspen Valley, and Cascades, Yosemite National Park, in 2004.

Specific Locality	Latitude	Longitude	Habitat
Aspen Valley	37.82534	-119.77221	mixed conifer, meadow
Aspen Valley	37.82085	-119.77466	mixed conifer, meadow
Cascades	37.72400	-119.71115	mixed oak/conifer
Merced River at Wildcat Creek	37.72060	-119.71456	willows, streambank
Tamarack Flat	37.75456	-119.74298	chaparral

Table C-16. Mammal species present across all sites trapped Tamarack Flat, Aspen Valley, and Cascades in 2004, by habitat.

Family	Species	Habitat	Relative Abundance	Remarks
Soricidae	<i>Sorex monticolus</i> .	forest, meadow	common	
Sciuridae	<i>Spermophilus beecheyi</i>	aspen/conifer forest	common	*
	<i>Spermophilus lateralis</i>	conifer forest	common	
	<i>Sciurus griseus</i>	conifer forest	common	
	<i>Tamiasciurus douglasii</i>	conifer forest	common	**
	<i>Tamias quadrimaculatus</i>	conifer forest	uncommon	***
	<i>Tamias speciosus</i>	conifer forest	common	****
Geomyidae	<i>Thomomys monticola</i>	meadows	common	=
Cricetidae	<i>Peromyscus boylii</i>	forest, riparian	common	==
	<i>Peromyscus maniculatus</i>	meadow, forest, riparian	very common	
	<i>Microtus longicaudus</i>	riparian, meadow	common	
	<i>Microtus montanus</i>	wet meadows	rare	===
Mustelidae	<i>Mustela erminea</i>	meadow	uncommon	
	<i>Spilogale putorius</i>	forest	common	====

*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

Table C-17. Sites trapped for small mammals at vicinity of Hazel Green, Crane Flat, and Merced Grove, Yosemite National Park, in 2004.

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	<i>Ceonothus</i> chaparral, old burn
Merced Grove Trailhead	37.76208	-119.84264	mixed forest, <i>Ceonothus</i> chaparral
Merced Grove	37.74782	-119.84052	mixed forest
Merced Grove	37.74899	-119.83862	mixed forest, riparian

Table C-18. Mammal species present across all sites trapped at vicinity of Hazel Green, Crane Flat, and Merced Grove, Yosemite National Park, in 2004, by habitat.

Family	Species	Habitat	Relative Abundance	Remarks
Soricidae	<i>Sorex trowbridgii</i>	dry meadow, chaparral	common	
Sciuridae	<i>Tamias quadrimaculatus</i>	mixed conifer	common	
	<i>Tamias speciosus</i>	mixed conifer	very common	
	<i>Spermophilus beecheyi</i>	mixed conifer	common	
Heteromyidae	<i>Chaetodipus californicus</i>	<i>Ceonothus</i> chaparral	uncommon	*
Cricetidae	<i>Neotoma macrotis</i>	<i>Ceonothus</i> chaparral	uncommon	**
	<i>Peromyscus boylii</i>	oak, mixed conifer, chaparral	very common	
	<i>Peromyscus truei</i>	<i>Ceonothus</i> chaparral	very common	***
	<i>Peromyscus maniculatus</i>	oak, mixed conifer, chaparral	abundant	

*First record for California pocket mouse from the Park, on YNP edge east of Hazen Green; elevational range increase of about 3,000 ft.

**Elevational range increase of 1,500 ft.

***First record for piñon mouse on west side of Park, on YNP edge east of Hazen Green; elevational range increase of about 3,000 ft.

Table C-19. General area trapped for small mammals in upper Return Creek, Yosemite National Park, in 2004.

Specific Locality	Latitude	Longitude	Habitat
Upper Return Creek, Virginia Canyon, 9,900 ft	38.06129	-119.33899	lodgepole and whitebark pine, willows along creek

Table C-20. Mammal species present in upper Return Creek, Yosemite National Park, in 2005, by habitat.

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

*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.

Table C-21. Sites trapped for small mammals in the vicinity of Tuolumne Meadows, Yosemite National Park, in 2005.

Specific Locality	Latitude	Longitude	Habitat
Juniper Ridge, Tuolumne Meadows, 8,665 feet	37.88358	-119.36340	lodgepole pine forest; open granite, talus
west base Fairview Dome, 8,385 feet	37.87649	-119.41609	lodgepole pine, western white pine, red fir, mountain hemlock; open granite

Table C-22. Mammal species present across all sites trapped in the vicinity of Tuolumne Meadows, Yosemite National Park, in 2005, by habitat.

Family	Species	Habitat	Relative Abundance	Remarks
Soricidae	<i>Sorex monticolus</i>	forest-talus edge	uncommon	
Talpidae	<i>Scapanus latimanus</i>	open meadows; forest edge	common	*
Sciuridae	<i>Urocitellus beldingi</i>	open meadows	common	
	<i>Callospermophilus lateralis</i>	open conifer forest	common	
	<i>Tamias speciosus</i>	open conifer forest	very common	
Geomyidae	<i>Thomomys monticola</i>	meadows, forest edge	common	*
Cricetidae	<i>Peromyscus maniculatus</i>	open conifer forest	uncommon	

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

Table C-23. Sites trapped for small mammals in upper Lyell Canyon (10,240–10,600 ft), Yosemite National Park, in 2005.

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

Table C-24. Mammal species present across all sites trapped in upper Lyell Canyon (10,240–10,600 ft), Yosemite National Park, in 2005, by habitat.

Family	Species	Habitat	Relative Abundance	Remarks
Soricidae	<i>Sorex monticolus</i>	meadow, talus, stream edge	very common	
	<i>Sorex palustris</i>	stream edge	uncommon	
	<i>Sorex tenellus</i>	stream edge	uncommon	*
Sciuridae	<i>Marmota flaviventris</i>	talus	common	**
	<i>Urocitellus beldingi</i>	open meadow	common	
	<i>Callospermophilus lateralis</i>	open conifer forest	common	
	<i>Tamias alpinus</i>	open conifer forest	uncommon	
	<i>Tamias speciosus</i>	open conifer forest	uncommon	
Cricetidae	<i>Peromyscus maniculatus</i>	open conifer forest	uncommon	
	<i>Microtus longicaudus</i>	open conifer forest	common	
	<i>Microtus montanus</i>	stream edge	uncommon	
	<i>Phenacomys intermedius</i>	open conifer forest	uncommon	
Ochotonidae	<i>Ochotona princeps</i>	talus	uncommon	
Mustelidae	<i>Mustela erminea</i>	talus edge	uncommon	

*Second record of the Inyo shrew, *Sorex tenellus*, from Yosemite National Park.

**Marmots were commonly seen or heard in all boulder fields and talus slopes.

Table C-25. Sites trapped for small mammals in the vicinity of Dorothy Lake and Grace Meadows, Yosemite National Park, in 2005.

Specific Locality	Latitude	Longitude	Habitat
Dorothy Lake, 9,444 ft	38.176090	-119.59468	willow, lodgepole pine forest
Dorothy Lake, 9,395 ft	38.170610	-119.59460	stream edge, lodgepole pine forest
Dorothy Lake, 9,430 ft	38.169080	-119.59505	talus, willows
northeastern Grace Meadow, 9,060 ft	38.162540	-119.60461	riparian

Table C-26. Mammal species present across all sites trapped in the vicinity of Dorothy Lake and Grace Meadows, Yosemite National Park, in 2005, by habitat.

Family	Species	Habitat	Relative Abundance	Remarks
Soricidae	<i>Sorex monticolus</i>	open meadow, talus, stream edge	common	
	<i>Sorex palustris</i>	stream edge	common	
Sciuridae	<i>Marmota flaviventris</i>	talus, meadow edge	common	*
	<i>Spermophilus beldingi</i>	open meadow	common	
	<i>Tamias speciosus</i>	open conifer forest	uncommon	
	<i>Tamiasciurus douglasi</i>	open conifer forest	common	*
Geomyidae	<i>Thomomys monticola</i>	meadow, forest edge	common	*
Cricetidae	<i>Microtus longicaudus</i>	open conifer forest	common	
Dipodidae	<i>Zapus princeps</i>	Riparian	common	
Ochotonidae	<i>Ochotona princeps</i>	talus	common	
Mustelidae	<i>Martes americana</i>	conifer forest	uncommon	*

*Observed, but not trapped.

Table C-27. Sites trapped for small mammals in the vicinity of Kerrick Meadow, Yosemite National Park, in 2005 (trapping by Adam Leache during herpetological surveys).

Specific Locality	Latitude	Longitude	Habitat
Kerrick Meadow, 9,476 ft	38.11129	-119.48180	lodgepole pine forest
Kerrick Meadow, 9,368 ft	38.11107	-119.48164	lodgepole pine forest
Kerrick Meadow, 9,509 ft	38.11332	-119.48162	lodgepole pine forest

Table C-28. Mammal species present across all sites trapped in the vicinity of Kerrick Meadow, Yosemite National Park, in 2005, by habitat (trapping by Adam Leache during herpetological surveys).

Family	Species	Habitat	Relative Abundance	Remarks
Sciuridae	<i>Spermophilus lateralis</i>	lodgepole pine forest	common	
	<i>Tamias alpinus</i>	lodgepole pine forest	uncommon	*

*Northern-most record of the alpine chipmunk, *Tamias alpinus*, in the Sierra Nevada.

2006

Table C-29. Sites trapped for small mammals in the vicinity of Tuolumne Meadow, Yosemite National Park, in 2006. Four hundred trap “nights” of effort, specifically to search for alpine chipmunks (*Tamias alpinus*). None were trapped, or seen; mammals trapped included lodgepole pine chipmunk (*Tamias speciosus* – common), *Spermophilus lateralis* (common), *Peromyscus maniculatus* (very common), and *Sorex monticolus* (uncommon).

Specific Locality	Latitude	Longitude	Habitat
Lembert Dome, 9,261 ft	37.88270	-119.34655	lodgepole pine, granite slab
Delaney Meadow, 9,409 ft	37.89922	-119.34770	lodgepole pine, meadow, granite slab
Dingley Dome, 9,737 ft	37.90828	-119.34750	lodgepole, whitebark pine, talus

Table C-30. Sites trapped for small mammals in the vicinity of Ten Lakes and Ten Lakes Pass, Yosemite National Park, in 2006. Two sites in the Ten Lakes basin were trapped, for a total of 296 trap “nights,” with specific emphasis on obtaining a sample of alpine chipmunks (*Tamias alpinus*) for genetic analyses. *Tamias alpinus* were common, with only two *Tamias speciosus* trapped. Other mammals trapped included *Sorex monticolus* (uncommon), *Spermophilus beldingi* (common), *Microtus longicaudus* (common), and *Peromyscus maniculatus* (very common).

Specific Locality	Latitude	Longitude	Habitat
Ten Lakes, 9,278 ft	37.90458	-119.53220	lodgepole, whitebark pine, granite slab
Ten Lakes Pass, 9,631 ft	37.90350	-119.53493	whitebark pine, talus

Table C-31. Sites trapped for small mammals in the vicinity of Kerrick Meadow, Yosemite National Park, in 2006. Five Sherman trap lines were set for a total of total of 400 trap “nights,” and two 25-cup pitfall lines for a total of 250 pitfall “nights.”

Specific Locality	Latitude	Longitude	Habitat
Upper Kerrick Meadow, 9,495 ft	38.12290	-119.47851	lodgepole pine, granite slab
Upper Kerrick Meadow, 9,473 ft	38.12444	-119.48238	riparian, hemlock
Upper Kerrick Meadow, 9,470 ft	38.11821	-119.48570	lodgepole pine, boulder field
Upper Kerrick Meadow, 9,472 ft	38.11973	-119.48435	lodgepole pine, boulder field
Upper Kerrick Meadow, 9,362 ft	38.12110	-119.48235	meadow
Upper Kerrick Meadow, 9,355 ft	38.11740	-119.48120	meadow
Buckeye Pass, 9,650 ft	38.13027	-119.47916	lodgepole pine, granite slab

Table C-32. Mammal species present across all sites trapped in the vicinity of Kerrick Meadow, Yosemite National Park, in 2006.

Family	Species	Habitat	Relative Abundance	Remarks
Soricidae	<i>Sorex lyelli</i>	meadow, riparian	uncommon	*
	<i>Sorex monticolus</i>	meadow, riparian	common	
Sciuridae	<i>Marmota flaviventris</i>	boulder fields, slab	common	**
	<i>Callospermophilus lateralis</i>	lodgepole, slab	common	
	<i>Tamias speciosus</i>	lodgepole, slab	common	
	<i>Tamiasciurus douglasi</i>	lodgepole forest	common	**
Geomyidae	<i>Thomomys monticolus</i>	meadow	common	
Cricetidae	<i>Microtus longicaudus</i>	riparian	common	
	<i>Peromyscus maniculatus</i>	all habitats	very common	
	<i>Phenacomys intermedius</i>	lodgepole, slab	uncommon	
Dipodidae	<i>Zapus princeps</i>	riparian	uncommon	

*Northern-most record of Lyell shrew in the Sierra Nevada.

**Observed only, not trapped.

Table C-33. Sites trapped for small mammals in upper Lyell Canyon (10,240–10,750 ft), Yosemite National Park, in 2006. Mammals were collected with Sherman live traps (480 trap “nights”) and pitfall cups (150 pitfall “nights”).

Specific Locality	Latitude	Longitude	Habitat
Upper Lyell Canyon, 10,240 ft	37.76807	-119.25506	whitebark pine, talus
Upper Lyell Canyon, 10,240 ft	37.76807	-119.25506	whitebark pine, talus, riparian
Upper Lyell Canyon, 10,754 ft	37.76460	-119.25210	whitebark pine, slab
Upper Lyell Canyon, 10,565 ft	37.76358	-119.25996	whitebark pine, talus
Upper Lyell Canyon, 10,710 ft	37.75675	-119.25855	meadow, granite slab

Table C-34. Mammal species present across all sites trapped in upper Lyell Canyon (10,240-10,750 ft), Yosemite National Park, in 2006.

Family	Species	Habitat	Relative Abundance	Remarks
Soricidae	<i>Sorex monticolus</i>	meadow, riparian	common	
	<i>Sorex palustris</i>	meadow, riparian	uncommon	
	<i>Sorex tenellus</i>	meadow, riparian	uncommon	*
Sciuridae	<i>Marmota flaviventris</i>	boulder fields, talus	common	**
	<i>Urocitellus beldingi</i>	whitebark, meadow	common	
	<i>Callospermophilus lateralis</i>	whitebark, meadow	common	
	<i>Tamias aplanus</i>	whitebark, slab	common	
	<i>Tamias speciosus</i>	whitebark, hemlock, slab	common	
	<i>Tamiasciurus douglasi</i>	lodgepole	common	**
Cricetidae	<i>Microtus longicaudus</i>	meadow, lodgepole	common	
	<i>Peromyscus maniculatus</i>	all habitats	very common	
	<i>Phenacomys intermedius</i>	whitebark, slab	uncommon	
Ocotonidae	<i>Ochotona princeps</i>	talus	common	
Mustelidae	<i>Martes americana</i>	whitebark, slab	uncommon	**

*Second record of the Inyo shrew (*Sorex tenellus*) for Yosemite National Park.

**Observed only, not trapped.

2007

Table C-35. Sites trapped for small mammals in the vicinity of Upper Cathedral Lake, Yosemite National Park, in 2007.

Specific Locality	Latitude	Longitude	Habitat
Upper Cathedral Lake, 9,790 ft	37.83649	-119.41675	lodgepole, hemlock
Upper Cathedral Lake, 9,662 ft	37.83904	-119.41888	lodgepole, granite slab
Upper Cathedral Lake, 9,768 ft	37.83931	-119.42018	open granite slab
Upper Cathedral Lake, 9,820 ft	37.84141	-119.41012	open granite slab
Upper Cathedral Lake, 9,790 ft	37.84255	-119.41116	open granite slab
Cathedral Pass, 9,670 ft	37.83051	-119.41489	wet meadow

Table C-36. Mammal species present across all sites trapped in the vicinity of Upper Cathedral Lake, Yosemite National Park, in 2007.

Family	Species	Habitat	Relative Abundance	Remarks
Soricidae	<i>Sorex lyelli</i>	meadow, riparian	uncommon	
	<i>Sorex monticolus</i>	meadow, riparian	common	
	<i>Sorex palustris</i>	meadow, riparian	uncommon	
Sciuridae	<i>Marmota flaviventris</i>	lodgepole, slab	common	*
	<i>Callospermophilus lateralis</i>	lodgepole, slab	common	
	<i>Tamias speciosus</i>	lodgepole, hemlock	common	
	<i>Tamias amoenus</i>	lodgepole, slab	common	
	<i>Tamiasciurus douglasi</i>	lodgepole	common	*
Geomyidae	<i>Thomomys monticola</i>	meadow	common	
Cricetidae	<i>Microtus longicaudus</i>	meadow, lodgepole	common	
	<i>Microtus montanus</i>	meadow	common	
	<i>Neotoma cinerea</i>	slab	uncommon	
	<i>Peromyscus maniculatus</i>	all habitats	common	

*Observed only, not trapped.

Table C-37. Sites trapped for small mammals in the vicinity of Upper and Lower Ottaway Lakes, Yosemite National Park, in 2007.

Specific Locality	Latitude	Longitude	Habitat
Lower Ottaway Lake, 9,807 ft	37.64294	-119.41531	lodgepole pine, granite slab
Lower Ottaway Lake, 9,890 ft	37.64240	-119.41354	lodgepole pine, granite slab
Lower Ottaway Lake, 9,820 ft	37.64693	-119.42018	lodgepole pine, granite slab
Lower Ottaway Lake, 9,880 ft	37.64740	-119.41599	lodgepole, whitebark pine, granite slab
Lower Ottaway Lake, 9,735 ft	37.64501	-119.42034	riparian, meadow
Lower Ottaway Lake, 9,935 ft	37.64345	-119.41016	wet meadow, riparian
Lower Ottaway Lake, 9,790 ft	37.63694	-119.41675	lodgepole, whitebark pine, granite slab
Lower Ottaway Lake, 9,650 ft	37.64245	-119.42148	riparian

Table C-38. Mammal species present across all sites trapped in the vicinity of Upper and Lower Ottaway Lakes, Yosemite National Park, in 2007.

Family	Species	Habitat	Relative Abundance	Remarks
Soricidae	<i>Sorex monticolus</i>	meadow, riparian, lodgepole	common	
Sciuridae	<i>Marmota flaviventris</i>	lodgepole, slab	common	*
	<i>Callospermophilus lateralis</i>	lodgepole, slab	common	
	<i>Tamias speciosus</i>	lodgepole, hemlock	common	
	<i>Tamias aplanus</i>	lodgepole, slab	common	
	<i>Tamiasciurus douglasi</i>	lodgepole	common	*
Geomyidae	<i>Thomomys monticola</i>	meadow	common	
Cricetidae	<i>Microtus longicaudus</i>	meadow, lodgepole	common	
	<i>Peromyscus maniculatus</i>	all habitats	common	
	<i>Phenacomys intermedius</i>	hemlock, slab	uncommon	
Ochotonidae	<i>Ochotona princeps</i>	slab, talus	common	

*Observed only, not trapped. Note that Belding ground squirrels (*Urocitellus beldingi*), montane voles (*Microtus montanus*) and jumping mice (*Zapus princeps*) were not encountered, either by trapping, by direct observation, or by sign. The apparent lack of all three of these species was a surprise.

2008

Table C-39. Sites trapped for small mammals in the vicinity of Mono Pass, Yosemite National Park, in 2008.

Specific Locality	Latitude	Longitude	Habitat
east slope Mono Pass, 10,670 ft*	37.85461	-119.21362	whitebark pine, metavolcanic and granite outcrops, riparian
west slope Mono Pass, 10,490 ft	37.85799	-119.22569	meadow, riparian
north slope Mono Pass, 10,727 ft	37.85794	-119.21818	sagebrush slope

*Composite of five separate Sherman live trap lines and one pitfall cup line.

Table C-40. Mammal species present across all sites trapped in the vicinity of Kerrick Meadow, Yosemite National Park, in 2008.

Family	Species	Habitat	Relative Abundance	Remarks
Soricidae	<i>Sorex monticolus</i>	meadow, riparian	common	
	<i>Sorex tenellus</i>	riparian	uncommon	
Sciuridae	<i>Marmota flaviventris</i>	boulder fields, slab	common	*
	<i>Urocitellus beldingi</i>	meadow	common	
	<i>Callospermophilus lateralis</i>	whitebark pine, slab	common	
	<i>Tamias speciosus</i>	lodgepole, whitebark, slab	common	
	<i>Tamias amoenus</i>	whitebark pine, slab	common	
	<i>Tamias aplanus</i>	whitebark pine, slab	common	
Geomyidae	<i>Thomomys monticola</i>	meadow	common	
Cricetidae	<i>Microtus longicaudus</i>	meadow	common	
	<i>Microtus montanus</i>	meadow	uncommon	
	<i>Peromyscus maniculatus</i>	all habitats	common	
Leporidae	<i>Lepus townsendii</i>	meadow, alpine	uncommon	*
Ochotonidae	<i>Ochotona princeps</i>	slab, talus	common	**
Mustelidae	<i>Martes americana</i>	slab, whitebark pine	uncommon	*
	<i>Mustela frenata</i>	alpine	uncommon	*

*Pine marten tracks were observed in mud flats around small ponds; marmots were common on large boulders; chickarees were heard or observed in the lodgepole pine forest on the trail below Mono Pass; white-tailed jackrabbits (*Lepus townsendii*) were seen on multiple occasions; a long-tailed weasel (*Mustela frenata*) was seen foraging around the edge of Summit Lake.

**Sign of pika was observed in every large talus and scree slope with sufficiently large rocks throughout the area.

Table C-41. Sites trapped for small mammals in the vicinity of Middle and Upper Young Lakes, Yosemite National Park, in 2008.

Specific Locality	Latitude	Longitude	Habitat
Middle Young Lake, 10,020 ft*	37.93876	-119.34047	whitebark pine, granite outcrops, lodgepole pine, riparian
Upper Young Lake, 10,295 ft**	37.94019	-119.33483	whitebark pine, granite slab, lake edge

*Composite of five separate Sherman live trap lines and two pitfall cup lines.

**Composite of five separate Sherman live trap lines.

Table C-42. Mammal species present across all sites trapped in the vicinity of Middle and Upper Young Lakes, Yosemite National Park, in 2008.

Family	Species	Habitat	Relative Abundance	Remarks
Soricidae	<i>Sorex monticolus</i>	meadow, riparian	uncommon	
Sciuridae	<i>Marmota flaviventris</i>	boulder field, slab	common	*
	<i>Urocitellus beldingi</i>	meadow	common	
	<i>Callospermophilus lateralis</i>	whitebark pine, slab	common	
	<i>Tamias speciosus</i>	lodgepole, whitebark, slab	common	
	<i>Tamias aplanus</i>	whitebark pine, slab	common	
Geomyidae	<i>Thomomys monticola</i>	meadow	common	
Cricetidae	<i>Microtus montanus</i>	meadow	uncommon	
	<i>Neotoma cinerea</i>	rock outcrops	uncommon	
	<i>Peromyscus maniculatus</i>	all habitats	common	
Ochotonidae	<i>Ochotona princeps</i>	talus	common	*
Mustelidae	<i>Martes americana</i>	lodgepole, meadows		*
	<i>Mustela frenata</i>	lodgepole, boulders		*

*Observed directly or by sign (feces, footprints), not trapped.

Appendix D: Herpetological Surveys by Year and Site

Tables

Page

Table D-1. Reptile and amphibian species collected in Yosemite National Park.....	123
Table D-2. Amphibian and reptile species recorded during the 2004 field season.....	124
Table D-3. Sites visited and reptile and amphibian species observed and/or collected in the vicinity of Porcupine Flat, Yosemite National Park, in 2004.	125
Table D-4. Relative abundances of reptile and amphibian species in the vicinity of Porcupine Flat, Yosemite National Park, in 2004.....	125
Table D-5. Sites visited and reptile and amphibian species observed and/or collected in the vicinity of Vogelsang Lake, Yosemite National Park, in 2004.	126
Table D-6. Relative abundances of reptile and amphibian species in the vicinity of Vogelsang Lake, Yosemite National Park, in 2004.....	126
Table D-7. Sites visited and reptile and amphibian species observed and/or collected in the vicinity of Merced Lake, Yosemite National Park, in 2004.	127
Table D-8. Relative abundances of reptile and amphibian species in the vicinity of Merced Lake, Yosemite National Park, in 2004.....	128
Table D-9: Sites visited and reptile and amphibian species observed and/or collected in the vicinity of Hetch Hetchy, Yosemite National Park, in 2004.	128
Table D-10. Relative abundances of reptile and amphibian species in the vicinity of Hetch Hetchy, Yosemite National Park, in 2004.....	129
Table D-11. Sites visited and reptile and amphibian species observed and/or collected in Yosemite Valley, Yosemite National Park, in 2004.....	129
Table D-12. Relative abundances of reptile and amphibian species in Yosemite Valley, Yosemite National Park, in 2004.	130
Table D-13. Sites visited and reptile and amphibian species observed and/or collected on Foresta Road, Big Oak Flat Road, Hodgdon Meadow, Tamarack Creek, and Tamarack Flat, Yosemite National Park, in 2004.....	130
Table D-14. Relative abundances of reptile and amphibian species on Foresta Road, Big Oak Flat Road, Hodgdon Meadow, Tamarack Creek, and Tamarack Flat, Yosemite National Park, in 2004.	131

Table D-15. Sites visited and reptile and amphibian species observed and/or collected along the Tuolumne River between Hetch Hetchy and Pate Valley, Yosemite National Park, in 2004.	131
Table D-16. Relative abundances of reptile and amphibian species along the Tuolumne River between Hetch Hetchy and Pate Valley, Yosemite National Park, in 2004.....	131
Table D-17. Sites visited and reptile and amphibian species observed and/or collected in the vicinity of Dorothy Lake, Yosemite National Park, in 2005.	132
Table D-18. Relative abundances of reptile and amphibian species in the vicinity of Dorothy Lake, Yosemite National Park, in 2005.....	133

Notes and comments on reptile and amphibian species, including comments on abundance or rarity, at seven general sites in Yosemite National Park surveyed in 2003.

1. Hetch Hetchy Area, between Ranger Station and O'Shaughnessy Dam along Hetch Hetchy Road, 1,175–1,704 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.

2. Foresta Area, between Hodgdon Meadows Campground and Foresta Road along Big Oak Flat Road, 1,350–1,850 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.

3. Yosemite Valley, between Arch Rock entrance station and Happy Isles Nature Center, 1,292–2,277 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.

4. Lyell Canyon, between Tuolumne Meadows and Mount Lyell, 2,600–3,200 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*. *Pseudacris regilla* and *Bufo canorus* tadpoles were found in several small ponds at high elevation, but were absent anywhere trout were present. *Pseudacris regilla* tadpoles and metamorphs were common in meadows along Lyell Canyon and were usually accompanied by *Thamnophis elegans*.

5. Glen Aulin, between McGee Lake and California Falls (including Tenaya Lake, Olmsted Point, and Siesta Lake) 2,100–5,600 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.

6. Bridalveil Creek, between Glacier Point and Chinquapin, 1,800–2,300 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. Sierra Nevada yellow-legged frogs (*Rana sierrae*) 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 *Pseudacris regilla* tadpoles and *Thamnophis elegans*. These species were common in all wet meadows throughout the Park.

7. Wawona Area, between Mariposa Grove and Rail Creek along Wawona Road, 1,200–2,000 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 D-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)							
<i>Bufo canorus</i>				13			
<i>Pseudacris regilla</i>	6	1		14	29	26	
<i>Rana sierrae</i>						8	
Salamanders (3 species)							
<i>Batrachoseps gregarius</i>							4
<i>Ensatina eschscholtzii</i>						2	20
<i>Hydromantes platycephalus</i>				5			
Lizards (6 species)							
<i>Aspidoscelis tigris</i>		5					
<i>Elgaria coerulea</i>		2	3		4	1	1
<i>Elgaria multicarinata</i>	1		1				
<i>Eumeces gilberti</i>			3				
<i>Sceloporus graciosus</i>		1	15		21	14	
<i>Sceloporus occidentalis</i>	12	24	15		99*	11	11
Snakes (13 species)							
<i>Charina bottae</i>	1				3		
<i>Coluber constrictor</i>			1				
<i>Contia tenuis</i>	1						
<i>Crotalus viridis</i>	1				1		
<i>Diadophis punctatus</i>	1						
<i>Hypsiglena torquata</i>	13						
<i>Lampropeltis zonata</i>	2						
<i>Masticophis lateralis</i>	1	2					
<i>Pituophis catenifer</i>	5	1					
<i>Thamnophis couchii</i>	2		1				1
<i>Thamnophis elegans</i>				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

Table D-2. Amphibian and reptile species recorded during the 2004 field season.

Common Name	Scientific Name
Mount Lyell salamander	<i>Hydromantes platycephalus</i>
Yosemite toad	<i>Bufo canorus</i>
Pacific treefrog	<i>Pseudacris regilla</i>
Bullfrog*	<i>Rana catesbiana</i>
Mountain yellow-legged frog	<i>Rana sierrae</i>
Western whiptail lizard	<i>Aspidoscelis tigris</i>
Gilbert skink	<i>Eumeces gilberti</i>
Northern alligator lizard	<i>Elgaria coerulea</i>
Southern alligator lizard	<i>Elgaria multicarinata</i>
Sagebrush lizard	<i>Sceloporus graciosus</i>
Western fence lizard	<i>Sceloporus occidentalis</i>
Rubber boa	<i>Charina bottae</i>
Gopher snake	<i>Pituophis catenifer</i>
Night snake	<i>Hypsiglena torquata</i>
California whipsnake	<i>Masticophis lateralis</i>
Western aquatic garter snake	<i>Thamnophis couchii</i>
Western terrestrial garter snake	<i>Thamnophis elegans</i>
Western rattlesnake	<i>Crotalus viridis</i>

Table D-3. Sites visited and reptile and amphibian species observed and/or collected in the vicinity of Porcupine Flat, Yosemite National Park, in 2004.

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

Table D-4. Relative abundances of reptile and amphibian species in the vicinity of Porcupine Flat, Yosemite National Park, in 2004.

Family	Species	Relative abundance	# Localities
Hylidae	<i>Pseudacris regilla</i>	common	4
Bufoidea	<i>Bufo canorus</i>	uncommon	1
Phrynosomatidae	<i>Sceloporus graciosus</i>	common	7
Phrynosomatidae	<i>Sceloporus occidentalis</i>	common	4
Anguidae	<i>Elgaria coerulea</i>	uncommon	2
Colubridae	<i>Thamnophis elegans</i>	common	1

Table D-5. Sites visited and reptile and amphibian species observed and/or collected in the vicinity of Vogelsang Lake, Yosemite National Park, in 2004.

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

Table D-6. Relative abundances of reptile and amphibian species in the vicinity of Vogelsang Lake, Yosemite National Park, in 2004. Notable observations included the discovery of a new population of *Hydromantes platycephalus* at two localities at Vogelsang Lake and breeding populations of *Rana sierrae* and *Bufo canorus* at an unnamed lake 0.5 km east of Evelyn Lake.

Family	Species	Relative abundance	# Localities
Bufonidae	<i>Bufo canorus</i>	uncommon	6
Hylidae	<i>Pseudacris regilla</i>	common	10
Ranidae	<i>Rana sierrae</i>	rare	1
Plethodontidae	<i>Hydromantes platycephalus</i>	rare	2
Colubridae	<i>Thamnophis elegans</i>	uncommon at high elevation	1

Table D-7. Sites visited and reptile and amphibian species observed and/or collected in the vicinity of Merced Lake, Yosemite National Park, in 2004.

Locality	Latitude	Longitude	Species
~0.2 mi S jct Vogelsang Pass and Merced Lake, ~1.6 mi E Merced Lake	37.74199	-119.39129	<i>Pseudacris regilla</i> , <i>Sceloporus occidentalis</i>
~1 mi NE Merced Lake	37.7412	-119.39444	<i>Sceloporus graciosus</i>
~1.2 mi NE of Merced Lake	37.74214	-119.39345	<i>Sceloporus graciosus</i>
~100 m E Merced Lake High Sierra Camp	37.73821	-119.40529	<i>Charina bottae</i>
~300 m W Little Yosemite Valley Campground	37.72992	-119.52447	<i>Sceloporus graciosus</i> , <i>Sceloporus occidentalis</i>
0.7 mi N Echo Valley junction, Echo Valley	37.75249	-119.44099	<i>Elgaria coerulea</i>
1 km E Merced Lake	37.73946	-119.40217	<i>Thamnophis elegans</i>
100 m E Merced High Sierra Camp	37.73811	-119.40462	<i>Sceloporus graciosus</i> , <i>Sceloporus occidentalis</i>
Babcock Lake	37.7569	-119.39650	<i>Hyla regilla</i> , <i>Thamnophis elegans</i> , <i>Pseudacris regilla</i>
base of Moraine Dome along trail	37.73639	-119.48036	<i>Pseudacris regilla</i> , <i>Sceloporus graciosus</i> , <i>Sceloporus occidentalis</i>
Merced River, 0.6 mi W Echo Valley	37.7413	-119.44614	<i>Pseudacris regilla</i>
E side of Bunnell Point along trail	37.73778	-119.45824	<i>Pseudacris regilla</i>
Echo Valley	37.74715	-119.43634	<i>Sceloporus graciosus</i> , <i>Sceloporus occidentalis</i>
Jct John Muir and Mist trails	37.7252	-119.45930	<i>Sceloporus graciosus</i>
Jct Vogelsang Pass and Merced Lake trails	37.74397	-119.38708	<i>Sceloporus graciosus</i>
Near Little Yosemite Valley Campground	37.73116	-119.52009	<i>Sceloporus graciosus</i> , <i>Sceloporus occidentalis</i>
NW end Washburn Lake	37.71835	-119.37406	<i>Sceloporus occidentalis</i>
trail between Babcock Lake trail and Merced Ranger Station	37.74231	-119.39352	<i>Elgaria coerulea</i> , <i>Sceloporus occidentalis</i>
W side Fletcher Creek, SE Babcock Lake	37.75745	-119.39050	<i>Pseudacris regilla</i> , <i>Thamnophis elegans</i>

Table D-8. Relative abundances of reptile and amphibian species in the vicinity of Merced Lake, Yosemite National Park, in 2004.

Family	Species	Relative abundance	# Localities
Hylidae	<i>Pseudacris regilla</i>	common	6
Anguidae	<i>Elgaria coerulea</i>	uncommon	2
Phrynosomatidae	<i>Sceloporus graciosus</i>	common	9
Phrynosomatidae	<i>Sceloporus occidentalis</i>	common	8
Colubridae	<i>Thamnophis elegans</i>	common	3
Boidae	<i>Charina bottae</i>	rare	1

Table D-9: Sites visited and reptile and amphibian species observed and/or collected in the vicinity of Hetch Hetchy, Yosemite National Park, in 2004.

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

Table D-10. Relative abundances of reptile and amphibian species in the vicinity of Hetch Hetchy, Yosemite National Park, in 2004.

Family	Species	Relative abundance	# Localities
Hylidae	<i>Pseudacris regilla</i>	common	2
Teiidae	<i>Aspidozelis tigris</i>	common	2
Phrynosomatidae	<i>Sceloporus graciosus</i>	uncommon	1
Phrynosomatidae	<i>Sceloporus occidentalis</i>	common	4
Colubridae	<i>Thamnophis elegans</i>	uncommon	1
Colubridae	<i>Hypsiglena torquata</i>	uncommon	1
Colubridae	<i>Pituophis catenifer</i>	uncommon	2
Colubridae	<i>Masticophis lateralis</i>	uncommon	1
Viperidae	<i>Crotalus viridis</i>	uncommon	2

Table D-11. Sites visited and reptile and amphibian species observed and/or collected in Yosemite Valley, Yosemite National Park, in 2004.

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

Table D-12. Relative abundances of reptile and amphibian species in Yosemite Valley, Yosemite National Park, in 2004.

Family	Species	Relative abundance	# Localities
Plethodontidae	<i>Hydromantes platycephalus</i>	rare	1
Anguidae	<i>Elgaria multicaudata</i>	uncommon	1
Phrynosomatidae	<i>Sceloporus graciosus</i>	common	2
Phrynosomatidae	<i>Sceloporus occidentalis</i>	common	3
Colubridae	<i>Thamnophis couchii</i>	common	1

Table D-13. Sites visited and reptile and amphibian species observed and/or collected on Foresta Road, Big Oak Flat Road, Hodgdon Meadow, Tamarack Creek, and Tamarack Flat, Yosemite National Park, in 2004.

Locality	Latitude	Longitude	Species
~1.5 mi by road off Big Oak Flat Road on Foresta Road	37.70284	-119.74478	<i>Sceloporus occidentalis</i>
~2.0 mi by road off Big Oak Flat Rd. on Foresta Rd.	37.70265	-119.70567	<i>Sceloporus occidentalis</i>
~2.0 mi by road off Big Oak Flat Rd. on Foresta Rd.	37.70265	-119.70567	<i>Elgaria multicaudata</i> , <i>Sceloporus occidentalis</i>
1 mi E of Crane Flat, Big Oak Flat Rd.	37.74808	-119.78035	<i>Masticophis lateralis</i>
Big Oak Flat Road, 0.4 mi W of Foresta Rd.	37.71557	-119.73821	<i>Masticophis lateralis</i>
Foresta Rd.	37.70403	-119.73315	<i>Aspidoscelis tigris</i> , <i>Eumeces gilberti</i> , <i>Sceloporus occidentalis</i>
Hodgdon Meadows Campground	37.7976	-119.86618	<i>Sceloporus graciosus</i>
Tamarack Creek	37.7505	-119.72898	<i>Sceloporus graciosus</i>
Tamarack Flat	37.7512	-119.73296	<i>Sceloporus graciosus</i>

Table D-14. Relative abundances of reptile and amphibian species on Foresta Road, Big Oak Flat Road, Hodgdon Meadow, Tamarack Creek, and Tamarack Flat, Yosemite National Park, in 2004.

Family	Species	Relative abundance	# Localities
Teiidae	<i>Aspidoscelis tigris</i>	uncommon	1
Anguidae	<i>Elgaria multicarinata</i>	uncommon	1
Phrynosomatidae	<i>Sceloporus graciosus</i>	common	3
Phrynosomatidae	<i>Sceloporus occidentalis</i>	common	4
Scincidae	<i>Eumeces gilberti</i>	uncommon	1
Colubridae	<i>Masticophis lateralis</i>	uncommon	2

Table D-15. Sites visited and reptile and amphibian species observed and/or collected along the Tuolumne River between Hetch Hetchy and Pate Valley, Yosemite National Park, in 2004.

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

*Represents 21 separate GPS localities.

**Represents 12 separate GPS localities.

Table D-16. Relative abundances of reptile and amphibian species along the Tuolumne River between Hetch Hetchy and Pate Valley, Yosemite National Park, in 2004.

Family	Species	Relative abundance	# Localities
Hylidae	<i>Pseudacris regilla</i>	common	6
Phrynosomatidae	<i>Sceloporus occidentalis</i>	common	18
Colubridae	<i>Thamnophis couchii</i>	common	3
Viperidae	<i>Crotalus viridis</i>	common	8

2005

Table D-17. Sites visited and reptile and amphibian species observed and/or collected in the vicinity of Dorothy Lake, Yosemite National Park, in 2005.

Locality	Latitude	Longitude	Species
On trail south of Leavitt Meadows, N Roosevelt Lake	38.29783	-119.54221	<i>Thamnophis elegans</i>
On trail south of Leavitt Meadows, S Lane Lake	38.28542	-119.53897	<i>Elgaria coerulea</i>
~100m S of Dorothy Lake	38.17303	-119.59591	<i>Thamnophis elegans</i> , <i>Pseudacris regilla</i>
On east side of ridge ~750m S Bond Pass	38.16594	-119.61033	<i>Pseudacris regilla</i>
On top of ridge, about 0.5km S Bond Pass	38.16776	-119.61063	<i>Pseudacris regilla</i>
Grizzly Meadow, about 0.5km SW Emigrant Pass	38.19185	-119.62918	<i>Pseudacris regilla</i> , <i>Bufo canorus</i> , <i>Thamnophis elegans</i>
About 500m NW of Middle Emigrant Lake	38.19456	-119.65882	<i>Hydromantes platycephalus</i>
On ridge above Grace Meadow	38.14054	-119.61824	<i>Thamnophis elegans</i>
Grace Meadow, SE Bigelow Peak	38.14326	-119.61478	<i>Pseudacris regilla</i>
0.5km NW Dorothy Lake Pass	38.18458	-119.58434	<i>Pseudacris regilla</i>
Pond at NW end of Grace Meadow	38.1416	-119.61604	<i>Pseudacris regilla</i>
About 0.5km S Emigrant Pass	38.19545	-119.63547	<i>Bufo canorus</i>
About 100m E Emigrant Meadow Lake on trail from Grizzly Meadow	38.20243	-119.64116	<i>Bufo canorus</i>
Outflow dam on west side of Emigrant Meadow Lake	38.20068	-119.65139	<i>Bufo canorus</i>
About 0.75km NW of outflow dam on west side of Emigrant Meadow Lake	38.20648	-119.6553	<i>Bufo canorus</i>
About 0.75km SW of Emigrant Pass	38.19543	-119.63842	<i>Bufo canorus</i>
S end of Grace Meadow	38.13468	-119.61919	<i>Thamnophis elegans</i>
about 400m N Grace Meadow along PCT	38.14632	-119.61263	<i>Elgaria coerulea</i>
SE side of Dorothy Lake	38.17303	-119.59293	<i>Rana sierrae</i>

Table D-18. Relative abundances of reptile and amphibian species in the vicinity of Dorothy Lake, Yosemite National Park, in 2005. Notable observations include the discovery of a new population of *Hydromantes platycephalus* from Middle Emigrant Lake and healthy adult *Rana sierrae* found at Dorothy Lake.

Family	Species	Relative abundance	# Localities
Bufonidae	<i>Bufo canorus</i>	uncommon	6
Hylidae	<i>Pseudacris regilla</i>	common	7
Ranidae	<i>Rana sierrae</i>	rare	1
Plethodontidae	<i>Hydromantes platycephalus</i>	rare	1
Colubridae	<i>Thamnophis elegans</i>	common	4
Anguidae	<i>Elgaria coerulea</i>	uncommon	2

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 104/106993, March 2011

National Park Service
U.S. Department of the Interior



Natural Resource Program Center

1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov