A Return to the MVZ 1914-1920 Yosemite Transect

Results from the 2003 field work

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Chapters

Objectives

Between 1911 and 1919, Joseph Grinnell, Tracy Storer, and their colleagues from the University of California at Berkeley's Museum of Vertebrate Zoology (MVZ) surveyed the terrestrial vertebrates along a transect that stretched from the western foothills of the Sierra Nevada, through Yosemite National Park, to the area around Mono Lake. These surveys were part of a larger study of the fauna of California that Grinnell and his colleagues conducted for much of the first half of the twentieth century. The main emphasis of these studies was to characterize the fauna of California, as it existed at that time. But Grinnell also had the foresight to realize that these studies could serve as important baselines against which future studies could be compared in order to measure faunal change over time. Grinnell encouraged future scientists to make these comparisons. To that end, he and his

colleagues quantified their observations, and left a record that is rare or absent among the works of their contemporaries. Their compiled observations of the Yosemite area were published in 1924 as Animal Life In The Yosemite (credited to Grinnell and Storer). The original records of their observations were recorded as specimens, volumes of field notes and images archived in the MVZ.

In his final entries regarding Yosemite, Grinnell noted the effects that the growing number of visitors were having on the park. But it is unlikely that he could have imagined the tremendous amount of human-induced change that has taken place within the park and in the surrounding regions. Still, parts of Yosemite remain relatively undisturbed when compared to less protected areas outside of the park. This makes Yosemite a particularly interesting place to study, to try to assess the changes that may have taken place over the last 80 years.

In the first phase of this three year study, we examined seven of the 22 regions surveyed by Grinnell et al. with the aim of spanning as much as possible of the environmental diversity within the park. These were the first comprehensive surveys of small mammal diversity since Grinnell's time and one of the few intensive studies of reptile diversity at any time. The main aims were (i) to document the distributions and status of vertebrate species for which recent information is lacking, (ii) to resolve specific questions about the taxonomic identity of species for which this is uncertain, and (iii) to quantify changes in the diversity and distribution of the Park's vertebrate fauna over the past century and, where possible identify causes of such changes, and (iv) to establish a new baseline against which future changes in the fauna can be examined.

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2003 Field Season

During summer and fall of 2003, teams from the MVZ conducted a total of 14,840 mammal trap nights, 216 point counts of birds and 760 person-hours of searching for herpetofauna with over 300 person-days of overall effort. Click here for a map of the sites visited. Results are still being analyzed and will be extended in surveys planned for 2004 and 2005. Here we report on our initial observations with particular reference to species identified as data-deficient by the Park scientists and to changes – both new records and possible changes in distributions. Again, the latter should be regarded as tentative until the project is completed.

Findings
Several target taxa, as specified by NPS, were recorded for both mammals and the herpetofauna. These include for mammals the heather vole (*Phenacomys intermedius* (N = 3), several species of shrews (*Sorex lyelli,* N = 6; *S. monticolus*, N = 97; *S. palustris* N = 1; *S. trowbridgii* N = 13), broad-footed mole (*Scapanus latimanus*, N = 1), western harvest mouse (*Reithrodontomys megalotis*, N = 2), brush mouse (*Peromycus boylii*, N = 159), deer mouse (*P. maniculatus*, N = 272), pinyon mouse (*P. truei*, N = 21), the western Jumping mouse (*Zapus princeps*, N = 41), and several species of chipmunks (*Tamias speciosus*, N = 158; *T. alpinus*, N = 1; *T. quadrimaculatus*, N = 22). Of specified reptiles, we observed night snakes (*Hypsiglena torquata*, N = 13) and sharp-tailed snakes (*Contia tenuis*, N = 1).

Among the above observations are several new species records for the Park – for mammals,

Peromyscus truei and *Reithrodontomys megalotis* - and for the herpetofauna, the snakes *Diadophis punctatus* and *Contia tenuis*. Our avian surveys produced several new breeding records (relative to Grinnell & Storer 1924) - Brown-headed Cowbirds, Common Ravens, Song Sparrows, Bullock's Oriole, American Green-winged Teal and Blue-winged Teal.

We did not obtain records for the following taxa identified by NPS staff as possibly present or poorly known: *Sorex vagrans* (known from the east side of the park, previous MVZ records within the park were misidentifications), *Perognathus parvus*, *Onychomys leucogaster*, *Tamias minimus* (all known from east of the park); *Peromyscus californicus*, *Chaetodipus californicus*, *Sorex ornatus* (known from west of the park); and *Erethizon dorsatum*, *Tamias merriami*, *T. amoenus* and *T. senex* (known from the park, but not observed in 2003). The failure to detect *T. senex*, a species formerly widespread in the park was surprising and warrants special attention in ongoing surveys.

Our initial results suggest several substantial changes in altitudinal range of mammals. The dusky shrew, *Sorex monticolus*, was observed at lower elevations (Yosemite valley and Crane Flat) than was the case in Grinnell's time. Several other taxa show changes suggesting of increases in elevation or declines in the lower part of their ranges relative to Grinnell et al.. These include *Microtus californicus* (Merced Grove), *Reithrodontomys megalotis* (2 sites within Yosemite Valley), *Ochotona princeps* (now apparently absent from Glen Aulin) and *Tamias alpinus* (absent from Glen Aulin and rare at Lyell Canyon). The most remarkable observation is the presence of the pinyon mouse, *Peromyscus truei*, at both Glen Aulin and Lyell Canyon – this appears to be the result of expansion of the species range from the east, requiring an increase in elevation of ca. 2,000 ft relative to records from Grinnell's time.

Analyses of the bird survey data are ongoing. As found by other workers, our initial impression is that there has been considerable change in avian communities since Grinnell's time. The turnover seen at the lowest and highest elevation sites corresponds to colonization by new species in both cases, and extirpations in the low elevations (i.e., Yosemite Valley). In Yosemite Valley (elevation: 1208m), Grinnell et al found 24 species that were not found in 2003 (perhaps due to more extensive sampling), and we found 9 species in 2003 that Grinnell et al did not find. At the other extreme, at Lyell Fork Meadows (elevation: 2750 m), all but 5 of the species found in the original surveys were observed in 2003, and 17 species were added (out of a total species count of 38). Turnover is also evident at the mid-elevation sites Merced Grove + Crane Flat (elevation: 1756m) and Chinquapin + Mono Meadow (elevation: 2145m).

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For several species we have also examined genetic diversity by sequencing mtDNA from specimens from Yosemite specimens, where possible, other parts of the species range. For some species, notably *Thomomys monticola* and *Sceloporus occidentalis*, this has revealed strong genetic divergence between the Tuolomne and Merced drainages within the park. Several (the above and *Tamias speciosus*, *Zapus princeps*, and *Sorex trowbridgii*) show substantial genetic divergence between Yosemite and other parts of their range (eg. Lassen Volcanic National Park). Much more remains to be done, but these early results indicate that Yosemite National Park may be important to conservation of genetic, as well as species diversity. For *S. occidentalis*, the high elevation form (*S. o. taylori*) was not genetically distinct from low elevation fence lizards, indicating that these are members of a single species.

Mammal Surveys

Survey sites and records.—Of the 22 original “Grinnell” transect sites within Yosemite National Park, 7 general areas were visited during the course of terrestrial vertebrate resurveys in 2003. Fieldwork commenced in mid-May and ended for the year by mid-September. During this 4-month period and at a schedule of approximately 10 field days per site, a team of 3-6 individuals visited each of the following sites and regions. A total of 260 person-days were spent in the field on small mammal surveys during the 2003 field season. Sets of 40 Sherman live traps were set and run within each habitat at each locality for four consecutive day-night periods (the standard mammal “trap-night”) to provide data both on species presence and relative abundance. Within each meadow system, 25-50 32oz plastic cups were sunk in the soil, primarily within vole runways, to assess the presence and abundance of shrews (genus Sorex). Finally, 30 Tomahawk live traps were set at most localities of mixed conifer forest to survey for species of ground squirrels and chipmunks. We trapped pocket gophers (Thomomys) with the aid of Macabee gopher traps or assessed their presence at each locality by recording the presence of fresh mounds. Similarly, we determined the presence of moles (Scapanus) by noting fresh mounds and surface runways. Observations of the presence of gray squirrels (Sciurus), chickarees (Tamiasciurus), and other small mammals (pikas, marmots, and small carnivores such as pine marten and skunks) were also recorded. A few specimens of some of these species were salvaged as the result of road kills.

Yosemite Valley (20 May-1 June; 4-11 September)

Small mammal surveys were conducted at both ends of the Valley floor in mixed conifer and oak forest (Fern Spring on the west and Tenaya Creek and Mirror Lake area on the east), the forest on both north (lower Indian Creek, Rocky Point) and south (south of Sentinel Beach, south of Chapel Meadow) sides of the Valley floor, several of the major meadow complexes on both sides of the Merced River (south side: Sentinel Beach, Chapel Meadow, Stoneman Meadow; north side: Ahwahnee Meadow, Leidig Meadow, meadow south of Rocky Point, El Capitan Meadow), and the fen at Happy Isles. This diversity of sites covered the span of habitat available in the Valley floor and encompassed many of the specific sites sampled by the original Grinnell teams, primarily in 1914. Some of the latter could not be visited now, as they no longer exist. One specific site in the Valley floor that was of considerable interest to us was the base of Yosemite falls, which was noted by Grinnell and Storer to be the lowest elevation site for the Western jumping mouse, *Zapus princeps*. However, we did not survey this area because much of the stretch of Yosemite Creek below the falls was under heavy construction during 2003.

A total of 3661 trap nights of effort were extended with some 259 captures (7.07% trap success) encompassing 12 species (listed below). Additionally, one species (*Sciurus griseus*) was seen commonly, and two specimens were salvaged as road-kills; coyotes (*Canis latrans*) were both observed and heard on numerous occasions.

Notable observations: First: The specimens of the Western harvest mouse, *Reithrodontomys megalotis*, found at two localities on the east end of Yosemite Valley (Happy Isles Fen and along Tenaya Creek above Mirror Lake) represent the first records of this species of mouse from Yosemite National Park. The geographically closest records for this species are from El Portal, collected in 1914. Second: The common shrew present on the Valley floor during our surveys is the Montane shrew, *Sorex monticolus*. These are the first records of this species in the Valley; the Grinnell team found only

Trowbridge's shrew, *Sorex trowbridgii*, at this elevation during their surveys. Today, *Sorex trowbridgii* is apparently uncommon to rare, as we captured this species only at one locality (meadow south of Rocky Point) at the conifer forest-meadow interface. The presence of the Montane shrew in Yosemite Valley represents a significant depression in the lower elevational limits of this species, which was recorded by the Grinnell survey teams at elevations only above 6900 feet.

Species known from Yosemite Valley but not captured or observed by us include Merriam's chipmunk (*Tamias merriami*) and Western jumping mice (*Zapus princeps*).

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Crane Flat-Merced Grove Big Trees (8-16 June)

Small mammal surveys were undertaken at four general regions between the Oak Flat Entrance and Crane Flat Junction, including the meadows at Hodgdon Meadow, the meadow and forest at Crane Flat, the forest and riparian communities along Moss Creek in Merced Grove Big Trees, and on Tioga Pass Road above Crane Flat. Pocket gophers and other small mammals were also assess in the vicinity of Foresta, the former along the edge of Big Meadow and the latter by Sherman trapping on the post-burned slope east of Foresta. Again, we used separate lines of 40 Sherman live traps in both meadow and mixed conifer forest as well as 30 Tomahawk traps set within mixed conifer forests, each run for a period of 4 days/nights. These live traps were supplemented with 5 lines of 25 32oz cups established within separate meadow systems at Hodgdon and Crane Flat meadows, and along Moss Creek. Macabee traps were used at Big Meadow to capture the Valley pocket gopher, Thomomys bottae. Incidental trapping, using both Sherman live traps and Museum special traps occurred along North Crane Creek and Siesta Lake for the specific purposes of capturing Water shrews, Sorex palustris, but without success.

A total of 3761 trap nights of effort were extended with some 203 captures (5.39% trap success) encompassing 16 species (listed below). Sign of moles (Scapanus latimanus) was observed but individuals were not captured.

Notable observations: Golden-mantled ground squirrels (*Spermophilus lateralis*) were recorded by the Grinnell Survey teams at Merced Grove Big Trees and Crane Flat, but we captured no individuals during our intensive live trapping nor did we see any individuals scampering about at either locality. Individuals at the Yosemite Institute near Tuolumne Grove, and at the northern end of Crane Flat Meadow, noted that they see individuals on occasion, but the closest locality where we found individuals was along the Tioga Pass Road at 3 miles east of Crane Flat, at an elevation of 6910 feet, approximately 600 feet above Crane Flat. The Montane shrew, *Sorex monticolus*, was the only shrew encountered at Crane Flat; the Grinnell survey teams found only *S. trowbridgii* at this locality and did not record the Montane shrew at elevations below 6900 ft. Given our records of this species from both Yosemite Valley and Crane Flat, the Montane shrew has extended its lower elevational limits substantially over the past 80 years. We were unable to record water shrews, *Sorex palustris*, at either Crane Flat or Merced Grove, localities where they had been previously taken by the Grinnell survey team. However, this is a secretive animal and difficult to trap, so its absence during our survey period is most likely due to chance. No individuals of the Shadow chipmunk, *Tamias senex*, were observed anywhere between the Big Oak Flat Entrance and the trap site 3 miles east of Crane Flat. This species

had been taken with both *T. quadrimaculatus* and *T. speciosus* in the vicinity of Crane Flat. In fact, we neither captured nor saw the Shadow chipmunk at any site visited in our surveys of the Park in 2003.

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Chinquapin to Mono Meadow (8-17 July)

We worked both ends of the Glacier Point Road, with four separate trap lines in the immediate vicinity of Chinquapin on the west and multiple trap lines from Monroe Meadow at Badger Pass to Pothole Meadows. The habitats sampled ranged from riparian stream-side, meadow, and mixed conifer forest. The Grinnell survey teams sampled at Chinquapin and at a locality identified as “near Mono Meadow”, but which from their field notes (MVZ archives) included the forest on the divide between the drainages of Bridalveil Creek and Illilouette Creek, Ostrander Rocks, and Peregoy and probably McGurk meadows. As before, our standard trap effort included Sherman trap lines of 40 traps per line, run in a given site for a 4 day/night period before moving the line to another locality. These lines encompassed forest, meadow, and riparian stream-edge habitats. Similarly, lines of 30 Tomahawk traps were set in mixed conifer forest at two sites on the east end of the sample area (Pothole Meadows and Mono Meadow trailhead) and near Badger Pass. An additional set of 20 Tomahawk traps were set in mixed conifer forest and chinquapin-manzanita brush along the older Glacier Point road immediately above Chinquapin. 50 32oz pitfall cups were set in Peregoy Meadow for shrews, and Macabee traps were set in Peregoy and Monroe meadows for pocket gophers. The presence of pocket gophers and moles was also documented from sign of earthen mounds, snow cores, and surface runways.

Trap effort included 3375 trap nights, during which time we recorded 218 captures (6.46% trap success) of 15 species of small mammals and observed the presence of 2 additional species.

Notable observations: Our results along Glacier Point Road from Chinquapin to Pothole Meadows are notable for what we did not find, rather than for what we did. The Grinnell survey teams recorded each of the species we found at this group of sites. We failed, however, to observe or capture any specimens of the Shadow chipmunk, *Tamias senex*, a species we also failed to record between the Big Oak Flat Entrance and east of Crane Flat, another general region where it was taken by the Grinnell teams. Special effort should be extended in future survey years to ascertain the status of this chipmunk in Yosemite National Park.

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Upper Lyell Canyon (9800-10,400 ft; 23-31 July)

We packed into upper Lyell Canyon and established camp just below the footbridge that crosses Lyell Fork on the John Muir Trail at about 9700 feet elevation. There is a detailed topographic map in the field notes of Charles Camp (MVZ archives) that shows the placement of the camp of the Grinnell survey team as well as as the explicit sites where traps for small mammals were set. This map coupled with detailed descriptions and photographs (MVZ archives) of the trap sites allowed us to trap at the exact same talus slopes, streamside sites, and other localities. We established three Sherman trap lines at our campsite. One of these was on the conifer covered slopes to the immediate east of camp and the other two were places in the narrow meadows along Lyell Fork immediately above and below

camp. Macabee traps were set for pocket gophers in the meadow system immediately above camp. One additional trap line was established on a large talus slope to the east of the trail about half-way up the slope at 10,010 ft elevation, a site where Camp had trapped for Bushy-tailed woodrats and pikas, three trap lines were set within the complex meadow system along both the edge of Lyell Fork and talus slopes at 10,210 feet elevation, and a final trap line was established at the next meadow up the trail, at 10,565 feet elevation. All trap lines were run for a period of 4 day/nights. Observations were made on the presence of marmots, mountain beaver, and chickarees; no traps were set for any of these species. Pine martens were seen on two occasions, and tracks of a raccoon were observed on the trail at about 10,400 ft. A dead fawn, apparently killed by a coyote, was found in the meadow at 10,240 feet; the skull was salvaged.

We recorded 213 captures of 14 species of small mammals during 1531 trap-nights of effort (13.91% trap success) and 6 species by direct observation of individuals or from their sign.

Notable observations: The Piñon mouse, *Peromyscus truei*, was found at elevations from 9788 to 10,240 ft; these are the first records of this species in Yosemite National Park, and the highest elevations for the species in the central Sierra Nevada. The species has previously been recorded only at elevations up to 8,500 feet on the eastern side of the Sierra Nevada, within the piñon pine zone. This is a significant addition to the Park's small mammal fauna. This is a common mouse, easy to trap; had it been present during the original Grinnell surveys of this region, there is little doubt but that it would have been caught. Animals were trapped in a variety of habitats, from open granite slabs to the grassy edge of Lyell Fork and open lodgepole-whitebark pine forest. Two specimens of *Phenacomys intermedius*, the Heather vole, was captured; these represent only the 10th and 11th specimens of this species recorded from the Sierra Nevada of California; specimens were taken in upper Lyell Canyon by the Grinnell survey team. One specimen was captured in a patch of Phyllodoce near the side of Lyell Fork at camp; the second specimen was taken in the talus slope at 10,010 feet. The latter habitat is totally unexpected. Two species that were notably absent from our surveys were the Lyell shrew, *Sorex lyelli*, and the Bushy-tailed woodrat, *Neotoma cinerea*. There is no reason to believe that the Lyell shrew is not still present in this area, as it is apparently only rarely encountered within its relatively small geographic range. However, we neither trapped the Bushy-tailed woodrat in the granite slab or talus slopes nor did we observe any of its obvious sign (urine white-washed horizontal surfaces to rocks, piles of fecal pellets, or sticks accumulated as nest materials and stuffed into the interstices among larger rocks of talus. While we observed all other species originally recorded by the Grinnell survey team, the paucity of Alpine chipmunks during the time of our survey deserves special note. This species should be common in rocky areas from below 9000 feet to above timberline, and yet we failed to see any on the trek up Lyell Canyon from Tuolumne Meadows, and only observed three individuals during our work in the upper canyon, and then only at elevations above 10,200 feet. Rather, the Lodgepole chimpunk, *Tamias speciosus*, was superabundant everywhere along this entire route, including the open forest edges and talus-open meadow interface where Alpine chipmunks would be expected.

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Glen Aulin – McGee Lake (4-14 August)

We ran 9 separate trap lines in the Glen Aulin basin, including several meadow localities on both sides of the Tuolumne River on the floor of the basin to the higher reaches of the granite slabs and outcrops

among the open conifer forest on the east side. We also worked three localities around McGee Lake, on the western end of the lake, one along the southern shore, and the third on the more open, south-facing slope. Time was spent surveying for pikas in the talus slope on the west side of Glen Aulin. As at previous sites, each trap line was run for 4 consecutive days/nights before traps were moved to a second location.

We captured 234 individuals of 12 species of small mammals over 1844 trap-nights of effort (12.69% trap success), and either saw individuals or sign of two additional species.

Notable observations: Three species that we captured deserve special comment: First, the Lyell shrew, *Sorex lyelli*, which was one of the target species, was recorded here for the first time. This species has only been taken previously in Yosemite NP at elevations above 9800 feet, in upper Lyell Canyon and Vogelsang, although it is known from lower elevations east of the Sierran crest. Second, the capture of a single specimen of the Heather vole, *Phenacomys intermedius*, another of the target species, represents the first records of this species from Glen Aulin and only the 12th record of the species from California. The individual was trapped in a clump of huckleberry oak beneath a juniper next to an open granite slab. Third, as in upper Lyell Canyon, we recorded the presence of the Piñon mouse, *Peromyscus truei*, making Glen Aulin the second locality for this species in the Park. The presence of this mouse at such a low elevation and west of the Sierran crest suggests that the species will be found to be relatively common throughout most of the higher regions of the Park above 7500 or so feet in elevation.

The other notable observations are the apparent lack of four species in Glen Aulin that were previously taken there. We found no evidence (fresh diggings or the earthen “snow” cores left from winter activity) of pocket gophers anywhere in the area, except at the extreme western end of McGee Lake. *Thomomys monticola* was collected at Glen Aulin by the Grinnell survey team. Similarly, we found no evidence of Brush mice, *Peromyscus boylii*, at Glen Aulin. The present of this species there at the time of the Grinnell surveys is, itself, a surprise, so their absence now is perhaps to be expected. This elevation is much higher than Brush mice are typically found, and the habitat is quite different than the oak woodland that characterizes the species throughout its range in California. We neither heard nor say any pikas, Ochotona princeps, among the rock outcroppings on both sides of the Tuolumne River at Glen Aulin, and found no evidence (fecal pellets, hay piles) in the talus slope on the western margins where these animals were resident during the Grinnell survey period. Finally, we neither caught nor saw either Alpine (*Tamias alpinus*) nor Shadow (*Tamias senex*) chipmunks, both of which were reported from Glen Aulin by the earlier surveys.

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Molecular Genetic Analyses

We are still engaged in the analysis of genetic diversity within and among samples of most of the widely distributed small mammals species for which we obtained samples, but some highlights of the results to date can be summarized as follows:

There are a group of species that exhibit little, if any, pattern of molecular diversification, either among their sampled sites within Yosemite National Park or between samples taken from the Park and those

elsewhere along the length of the Sierra Nevada and elsewhere within California. Examples of these types of species include Deer mice, *Peromyscus manciculatus*; Piñon mice, *Peromyscus truei*; Montane voles, *Microtus montanus*; and Long-tailed voles, *Microtus longicaudus*.

On the other hand, there are other species that exhibit significant genetic structure among the sampled localities within the Park, as well as between these regions and other localities over the range of the species in the Sierra Nevada. The Mountain pocket gopher, *Thomomys monticola*, is one such species. The range of this species is limited to the higher elevations of the Sierra Nevada from Mt. Shasta to Fresno Co. Over this very limited geographic distribution the species is divided into at least four sharply-defined molecular clades, based on sequence divergence in the mitochondrial cytochrome-b gene (see figure). One group (=clade) is found from the Lassen Peak area south to Plumas Co., a second is known only from Nevada Co., and then two clades are present within Yosemite National Park. These comprise samples from north and south of Yosemite Valley, from Crane Flat to upper Lyell Canyon versus those from sites along Glacier Point Road. The level of molecular sequence is totally unexpected, especially given the limited geographic range of this species and the lack of demonstrable morphological differentiation among samples along this range. Other species that display significant genetic variation are *Zapus princeps* and *Tamias speciosus*. We are in the process of sampling more localities and sequencing DNA from more individuals.

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Bird Surveys

In order to sample the birds in Yosemite, we had the dual task of designing a survey that would be comparable to the original surveys and that could also serve as a baseline for future studies. Grinnell and Storer's observations were essentially timed counts of birds recorded along whatever route they happened to take within the area they were working. In their most detailed records, they kept "paper censuses" in which they recorded numbers of individuals of species, the duration of the census, and the route. This gave a record of birds per unit time. In the time since they did their work, there has been a tremendous amount of work done surveying birds and different methodologies now exist.

We carried out a series of variable distance point counts along several transects that overlapped as nearly as possible routes that Grinnell and colleagues had taken. The original researchers had several temporary camps over the years of the study. They sampled all of the terrestrial vertebrates within the immediate area of the camp. This gave them a picture of the fauna as it was at that particular time of year in that particular place. Instead of following this "snapshot in time" type of approach, we cycled through our transects, and in this way have multiple samples for each transect over a longer period of time. (More remote high elevation sites were an exception; these were sampled all at once per site, like the original surveys).

Starting at the beginning of June, we sampled 8 transects as a cycle: (1) the John Muir Trail above Nevada Falls, (2) Crane Flat to Tuolumne Grove, (3) the Old Glacier Point Road from Chinquapin junction nearly to Summit Meadow, (4) Yosemite Valley, (5) Porcupine Flat nearly to North Dome, (6) Mono Meadow, (7) Mirror Lake, and (8) Merced Grove. Between June 1 and July 16, 2003, We

sampled each of these sites 3 times (Nevada Falls was sampled twice). From July 23 to July 31, We sampled 3 transects in the Lyell Canyon area, twice each: (9) the John Muir Trail through Lyell Fork Meadows, (10) the John Muir Trail to Donohue Pass, and (11) Maclure Creek. From August 5 to August 13, we sampled 3 transects, twice each in the Glen Aulin area: (12) Glen Aulin to Waterwheel Falls, (13) McGee Lake, and (14) Cold Canyon. With the exception of the Glen Aulin sites, these sites were sampled at exactly or nearly exactly the same time of year as the original surveys (the original surveys of Glen Aulin were in late September).

Our sampling regime began within one hour of sunrise and concluded by 11:00 AM. Transects consisted of points from 200 to 300 meters apart, marked with GPS coordinates. The number of points varied but averaged 15 points per transect. Each point was taken as the center of a circle with a radius of 100 m, and using a range finder we determined increments of 0-10, 10-20, 20-30, 30-40, 40-50, 50-75, 75-100, and >100 meters from the center. Each point count lasted 7 minutes, within which we recorded every bird we saw or heard, and assigned it a distance increment. We spent 1 minute at the point before we began counting in order to allow birds to acclimate to our presence. There were 216 points total in all transects. Nearly 9000 individuals were counted during the course of the survey. We counted 91 species in total (including species identified outside of point counts). We also completed vegetation surveys at approximately _ of our points, which is mostly characterizing and quantifying vegetation structure. We identified trees and shrubs to the genus or species level, but in general did not identify herbaceous plants.

The records of Grinnell and colleagues provide accurate and detailed bird counts, and we were able to distill valuable information from their census data and ancillary field notes. For the period studied (spring and summer) and with respect to the sites surveyed both by Grinnell et al and in 2003, Grinnell et al identified a total number of 86 species. We shared 77 species in common.

In order to determine the routes that Grinnell et al used in their surveys, we examined all of the field notes related to the survey sites in Yosemite. The notes often describe routes in good detail, but at times they are vague. There are times as well in which a Grinnell et al census route falls partially within two of our transects. For example, the only data from Crane Flat is a census taken by Storer along a route that begins in Crane Flat and ends in Merced Grove. He assigns some species to one location or to the other, but other species he does not. In order to deal with this problem and others like it, we lumped some of our transects and the corresponding Grinnell sites for the analysis. We lumped the following transects / sites: Yosemite Valley + Mirror Lake; Merced Grove + Crane Flat to Tuolumne Grove; Chinquapin + Mono Meadow; Waterwheel Falls + McGee Lake + Cold Canyon (all three at Glen Aulin).

In order to quantify changes that may have occurred in the bird populations at these sites, we compared measures of species richness, relative abundance of species, and community similarity. Species richness is the number of species observed at a given site. For this measure, we included census data and ancillary observations for both Grinnell et al and for 2003. To examine changes in community structure, we calculated the Sorenson's Index for each site for both Grinnell et al and for 2003. Sorenson's Index is a measure of community similarity between two sites, or as is the case here, between two different samples from the same site. we calculated Sorenson's Index using the equation: $S = 2j/(a+b)$ where S = the index of similarity between the two sites (or times), j = the number of species observed in common (at both times), a = the number of species observed at time a, and b = the number of birds observed at time b. We also calculated an internal Sorenson's index for 7 of our

own sites, comparing two different samples for the same transect. These internal indices gave an average of 80% similarity between our samples. Values less than this 80% baseline could indicate significant community change

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Substantial changes seem to have taken place within the Yosemite avifauna, both in terms of relative abundance of species and in terms of community structure. The reasons for these changes are harder to interpret. Five possible reasons for these changes are:

1. Differences in the area surveyed by Grinnell and we (non-overlap of transects).
2. Differences in sampling effort.
3. Habitat change within the park.
4. A general warming trend in temperature.
5. Habitat change on the wintering ground of migrants.

Regarding the first two possibilities, we could not duplicate exactly the original censuses. Our surveys were close enough, however, that they should not mask major trends. Nevertheless, the changes that seem to have taken place at Merced Grove + Crane Flat and at Chinquapin + Mono Meadow should be examined in this light to determine whether they reflect real change in the avifauna or a difference in sampling effort.

Habitat change seems to have had a real effect on bird populations in the park. Fires and fire suppression have led to changes in habitat in the Valley and at Merced Grove + Crane Flat. In the case of Yosemite Valley, conifers seem to have increased and replaced oaks to some degree. This could be a result of fire suppression. At Merced Grove, fire has created a large brushy succession habitat that did not exist during Grinnell's time and has led to an increase in the birds that utilize that habitat, such as MacGillivray's Warblers, Nashville Warblers, Green-tailed Towhees, and Fox Sparrows. Likewise, the forest clearing that created the Badger Pass Ski Area along the Chinquapin transect has created a large meadow with brushy borders that probably did not exist during Grinnell's time and has allowed colonization by blackbirds, and similar birds that have appeared at Merced Grove. Other changes do not lend themselves to such an easy interpretation, however, such as the increase in forest insectivores like the Red-breasted Nuthatch, Golden-crowned Kinglet, and Yellow-rumped Warbler and the decrease in others like the Ruby-crowned Kinglet. Compare to this also, the stability of the Mountain Chickadee, which occupies a similar niche.

Regarding general warming trends, it is certainly intriguing to see the turnover at the highest and lowest elevations and the level of colonization that is taking place at the highest elevations. In fact, the swelling of the populations in the mid-elevations could represent a transition among species from lower elevations to higher elevations. That is, the mid-elevations could be a sort of way station along an upward shift in distribution.

Future sampling will undoubtedly help to fill in gaps in the picture. Sampling at lower and other high elevation sites will also give a more complete elevational gradient against which to compare changes.

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Amphibian and Reptile Surveys

Reptile and amphibian surveys were conducted in Yosemite National Park between 7 June - 10 August, and from 5-7 December, 2003. A total of 38 days were spent in the field, and an estimate of 760 man-hours were spent searching for reptiles and amphibians. A total of 23 species were recorded and 469 specimens were collected from 120 distinct localities. These localities are broadly encompassed by the following seven areas in the Park; 1. Hetch Hetchy, 2. Foresta, 3. Yosemite Valley, 4. Lyell Canyon, 5. Glen Aulin, 6. Bridalveil Creek, and 7. Wawona.

Major findings are listed below:

- 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.
- One rare snake species, the Night Snake (*Hypsiglena torquata*), was found in high abundace at Hetch Hetchy.
- The Mount Lyell Salamander (*Hydromantes platycephalus*) was rediscovered at the type locality at Mount Lyell (~3,200 meters).
- Our preliminary mitochondrial DNA sequence data (1 kb) for *Sceloporus occidentalis* (Western Fence Lizards) from throughout the Park reveals deep genetic divergence. It appears there are at least three lineages of *S. occidentalis* in the park and that two of these lineages are sympatric in the Foresta area. The sequence divergence between the lizards found at the Foresta contact zone is ~6%. Also, based on a large-scale phylogeny of *S. occidentalis* (unpublished data, Jim Archie, CSULB), all three of the lineages are distantly related to one another. The recent fires at Foresta may have mediated the secondary contact and genetic exchange between these lineages. In addition, the data suggest that other potential contact zones may exist along the Grand Canyon of the Tuolumne and between Tenaya Lake and Glen Aulin.
- 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 preliminary mtDNA sequence data reject this hypothesis. Multiple high elevation populations of this putative species do not form a monophyletic group. This result implies multiple, independent origins of the unique high-elevation phenotype exhibited by *S. o. "taylori"*.

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

   Hetch Hetchy contained the greatest amount of snake diversity of all sampled sites. Driving on roads at night proved to be the most productive method for finding both common and rare species. Three snake species believed to be scarce or even absent from the park were found driving the roads at night. These snakes include *Diadophis punctatus*, *Contia tenuis*, and *Hypsiglena torquata*. Of these three rare snakes species, *H. torquata* was surprisingly abundant in the Hetch Hetchy area.
2. Foresta Area, between Hodgon Meadows Campground and Foresta Road along Big Oak Flat Road, 1350 – 1850 meters (16 georeferenced localities).

Two genetic lineages of *Sceloporus occidentalis* are in secondary contact in the Foresta area. It is unclear if these lineages are exchanging genes. Additional sampling throughout the area is needed to refine the species limits of this complex.
One pitfall array was installed at Foresta and monitored for five days. The pitfall array trapped six individual lizards (*S. occidentalis* N=5, *Cnemidophorus 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, 1292 – 2277 meters (13 georeferenced localities).

   Yosemite Valley contained the highest lizard diversity of all the sampled sites. An array of pitfall traps (16 1 gallon paint cans) was installed at Sentinel Beach and monitored for five days. The only species trapped was *Sceloporus graciosus*. This species was abundant in the area and easily captured by noose. The amphibian and snake diversity in Yosemite Valley is also high based on Museum records, although this diversity is not reflected in our 2003 sampling.
4. Lyell Canyon, between Tuolumne Meadows and Mount Lyell, 2600 – 3200 meters (11 georeferenced localities).

   Hydromantes platycephalus were found at their type locality visited by Grinnell and colleagues at the base of Mount Lyell as originally described by Camp in 1916. This nocturnal salamander was only found after dusk following a day of continuous rain. The reptile and amphibian diversity at Lyell Canyon is low due to the high elevation. The only reptile species found was *Thamnophis elegans*. *Hyla regilla* and *Bufo canorus* tadpoles were found in several small ponds at high elevation, but were absent anywhere trout were present. *Hyla regilla* tadpoles and metamorphs were common in meadows along Lyell Canyon and were usually accompanied by *Thamnophis elegans*.
5. Glen Aulin, between McGee Lake and California Falls (including Tenaya Lake, Olmsted Point, and Siesta Lake) 2100 – 5600 meters (25 georeferenced localities).

   The high elevation subspecies of the Western Fence Lizard, *Sceloporus occidentalis taylori*, is common in Glen Aulin. The scientific literature suggests that this subspecies may warrant species status due to its unique morphological features (e.g., extensive blue ventral pigmentation, dark dorsal pigmentation, and large size). Our preliminary mtDNA sequence data reject this hypothesis. Multiple high elevation populations of this putative species do not form a monophyletic group. This result is intriguing because it implies multiple, independent origins of the unique high-elevation phenotype exhibited by *S. o. taylori.* Populations of *S. occidentalis* at lower elevation have light dorsal coloration, less ventral pigmentation, and are smaller in size. Specimens of *Sceloporus occidentalis* collected along an elevational transect following the Grand Canyon of the Tuolumne from Glen Aulin to Return Creek graded in morphology from the high-elevation “taylori” phenotype to the low-elevation phenotype. Additional sampling is required to extend this transect from Return Creek to Hetch Hetchy. A potential genetic contact zone exists along this portion of the Grand Canyon of the Tuolumne transect.
6. Bridalveil Creek, between Glacier Point and Chinquapin, 1800 – 2300 meters (15 georeferenced localities).

   Two pitfall arrays were installed at Bridalveil Creek and monitored for five days. The pitfall traps

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

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

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