Terrestrial Vertebrate Inventory, Point Reyes National Seashore, 1998 – 2001

Prepared for:

National Park Service

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

Terrestrial Vertebrate Inventory, Point Reyes National Seashore, 1998 – 2001

By Gary M. Fellers[1] and David Pratt[2]

U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

Prepared for:

National Park Service

[1] Point Reyes Field Station
USGS Western Ecological Research Center
Point Reyes National Seashore
Point Reyes, CA 94956

[2] Point Reyes National Seashore
Point Reyes, CA 94956

Sacramento, California
2002

U.S. DEPARTMENT OF THE INTERIOR
GALE A. NORTON, SECRETARY

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

For additional information, contact:

Center Director
Western Ecological Research Center
U.S. Geological Survey
7801 Folsom Blvd., Suite 101
Sacramento, CA 95826

Executive Summary

Since 1998, we have used automatic cameras to detect large- and medium-sized mammals, and arrays of pitfall traps, cover boards, and Sherman traps to document small mammals, reptiles, and amphibians in or near Point Reyes National Seashore. We inventoried vertebrates at 16 sites that represent eight of the primary habitats within the park. We present data to address several questions:

- What species of terrestrial vertebrates are present within the park?
- What techniques are most effective at detecting each group of vertebrates?
- How does detectability vary among different habitats?
- How much seasonal and annual variability is there?
- Are the inventory techniques we used adequate and appropriate?
- Are the techniques we used suitable for inventories in other park areas?

The first eight inventory sites were set up in January and February 1998. The cameras and traps were operated nearly continuously for 3 years. An additional eight sites were added in February 2001. Cameras at these sites have been in nearly continuous operation, while the traps were in operation for six months. The automatic cameras have been in operation for 8,525 camera days (83 % of the time); we have obtained 7,485 identifiable photographs of wildlife (plus additional photographs of people and domestic animals). There were 24,072 checks of Sherman traps, yielding 3,920 captures; 28,952 checks of pitfall traps, yielding 4,597 captures; and 3,144 checks of cover boards, yielding 2,020 captures. The photography and trapping combined detected 31 species of mammals, nine reptiles, and seven amphibians, for a total of 47 species of terrestrial vertebrates. There were significant differences in detection rates between individual species, not only in their overall rates of detection, but also in how well various species were detected with different techniques. Most obviously, large- and medium-sized mammals were detected only by photography. Interestingly, when comparing techniques for detecting small mammals, reptiles, and amphibians, there were also strong differences in detection rates for different species. For example, California slender

salamanders were found almost exclusively under cover boards while other species like the vagrant shrew were almost exclusively in pitfall traps; deer mice were captured primarily in Sherman traps. Our results clearly show that photography and the various types of traps are all essential for an inventory.

Strong habitat preferences were greater for the small mammals, reptiles, and amphibians than for the more mobile large- and medium-sized mammals. The habitats we sampled could be divided into two distinct types: *wooded*, (pine, fir, and redwood forests plus riparian zones), and *non-wooded* (scrub, undisturbed grasslands, pastures, and dunes). With few exceptions, species that showed a preference were found in most or all of the habitats of one group, but rarely in the habitats of the other group. For example, the Ensatina salamander was found in all of the wooded habitats but rarely in any of the non-wooded ones. Vagrant shrews were the opposite. Among the frequently captured small vertebrates, only the deer mouse was consistently captured in all habitats. Fewer species of small vertebrates were found at the iceplant/dune site (I1) and at the heavily grazed pasture site (C1) than at any other sites. The capture rates for nearly all small vertebrates at the heavily grazed pasture site were notably lower than at the moderately grazed pasture site (C2).

Seasonal changes in activity were most pronounced in the smaller vertebrates. Reptiles were captured much more frequently in summer and amphibians were much more common in the winter. Most of the frequently captured small mammals were captured at higher rates in summer than in winter, but the opposite was true for the western harvest mouse, a species that is sometimes associated with moist environments. Our data demonstrate that an inventory at Point Reyes could be accomplished with two trapping sessions in mid-summer and two in mid winter. This would be much more cost-effective than nearly continuous surveys.

From our results at the first eight inventory sites, it appears that two years of trapping and photography provide a good inventory of the local fauna; very few additional species were detected during the third year of our inventories.

We did not document all terrestrial vertebrates known to occur within the park. Most notably, this would include mountain beaver, porcupines, and ringtail cats. It might be possible to modify our use of automatic cameras to increase the likelihood of detecting these species, especially mountain beaver.

We believe that our data clearly demonstrate that the combination of automatic cameras, pitfall traps, cover boards, and Sherman traps are effective and cost-effective for park inventories. Some minor modifications in our technique would make the inventory even more efficient and effective. Our protocol would be effective in other parks as well. It has been successfully implemented at Lassen Volcanic NP and we are using a modification of it at both John Muir NHS and Eugene O'Neill NHS.

We present an example to show that the trapping arrays could be used to monitor the relative size of populations.

Introduction

Why should parks inventory their resources? There are several answers to this:

- It is generally assumed that parks are the place where various plants and wildlife are best protected. Parks are where the public goes to see large heroic species such as bears, wolves, elk, and deer as well as the smaller, less conspicuous wildlife such as chipmunks, butterflies, and weasels. It is also reassuring just to know that the rarely seen, and little appreciated species such as salamanders, shrews, and voles are present and playing their role in the function of the ecosystem.

- Inventories are necessary in order to determine what species of wildlife are present and to develop a basic understanding of their relative abundance and habitat preferences. Without knowing what species are present, it is not possible for park managers to understand the impacts of their actions and policies on the very resources they are responsible for protecting.

- A basic inventory provides the foundation for identifying and protecting endangered species. Since parks are often the best or only places where this can be done, parks often form the foundation for the preservation of our most endangered wildlife. Without an inventory, some of the more cryptic, endangered species might be overlooked entirely.

Biologists have employed a wide variety of techniques for inventorying and monitoring amphibians, reptiles, and mammals. Recently, two books were published that summarize the most commonly used techniques for amphibians (Heyer et al., 1994) and mammals (Wilson et al., 1996). Both books, however, are more of a tool catalog than a guidebook; they do not make recommendations on how to integrate the various techniques into a comprehensive inventory program. We have selected the best techniques and used them in a standardized protocol that provides a comprehensive, cost-effective scheme for inventorying and monitoring terrestrial vertebrates. The sampling scheme we used is readily adapted to a variety of habitats and topographies, and is thus appropriate for use in a wide variety of parks and similar areas.

Implementation of such inventory and monitoring protocols would assist I&M programs elsewhere, not only by providing a practical model, especially for medium and small parks, but also by allowing for meaningful comparisons between park areas. This is an important advantage since the inventory and monitoring being conducted at some parks (e.g. Channel Islands NP) are not readily adaptable for other areas.

All sampling regimes have biases in what species they are most efficient at sampling. By using a combination of techniques that overlap in the species they are likely to capture, the overall bias is reduced, but not eliminated. Some species (e.g. mountain beaver) are unlikely to be sampled or captured at all and hence specialized techniques would be needed to include these taxa in an inventory or monitoring program. Our sampling regime utilizes a combination of pitfall traps (primarily for salamanders, frogs, lizards, small snakes), artificial cover boards (amphibians and reptiles), Sherman live traps (small mammals), and automatic cameras (large- and medium-sized mammals). Drift fences running between the pitfall traps and funnel traps were used to increase capture efficiency.

Methods

<u>Automatic Camera and Array Setup</u> - We inventoried terrestrial invertebrates at the 16 sites listed in Table 1 and mapped in Figure 1. At each site, we installed one automatic camera and four arrays consisting of pitfall traps, cover boards, and Sherman traps. Our arrays use a combination of standard capture techniques for amphibians, reptiles, and mammals (Heyer et al., 1994; Wilson et al. 1996).

Figure 2a shows an array. Each array consists of three equally spaced arms radiating out from a central pitfall trap. Each arm is a “drift fence” 10m long, with one pitfall trap 5m out from the center (Fig. 2b) and a second pitfall trap 10m out, at the end of each drift fence. A cover board (Fig. 2c) is located 5m past the end of each drift fence, 15m from the array center.

Each pitfall trap is a white, 5-gallon plastic bucket, buried with its top flush with the ground (Fig. 2b). Three short wooden legs are mounted on the top (outside) of each bucket lid. The trap is opened by inverting the lid so that the legs rest on the rim of the bucket, holding the lid about two inches above the rim. This allows small animals to go under the lid and into the bucket. About 15g of Dry C.O.B. (sterile mixture of rolled corn, rolled oats, and rolled barley, without molasses) is put into each pitfall trap, to sustain mice that are captured. With the pitfall traps (as with the Sherman traps) it has been necessary to protect animals captured in pitfall traps from marauding raccoons. Neither elastic bungie cords nor weights to hold the lids down were sufficient to keep raccoons out, so we devised a more secure system (Fig. 2b). A one ft. square of ½" thick exterior grade plywood is placed on top of the lid and fastened to the bucket with two 5/16 x 5" hook bolts, each hooked into a 1/4 x 2" eye bolt mounted on the bucket. One of the hook bolts is secured with a wing nut so that it can be quickly loosened, allowing access to the trap.

The drift fences help direct animals into the pitfall traps. Fences are made of 1 ft. (finished-width) of “closed mesh polypropylene” (Wind & Shade Screens, San Marcos, CA 92069). The fence is supported by fastening it to ½" rebar stakes with weather-resistant cable ties. The fence is installed in a shallow trench, about 3" deep. A finished fence extends from about 3" in the ground to 9" above ground level.

Each cover board is actually two pieces of 2' x 4' (½" thick) pieces of exterior grade plywood placed side-by-side. The pair of plywood pieces makes a 4' x 4' cover board. A 40" long, 6" diameter PVC drainpipe is fastened to each of the two pieces of plywood (Fig. 2c). The pipes are used to protect Sherman traps (3 x 3½ x 9", H.B. Sherman, Gainesville, Florida; Fig. 2d) from disturbance by large- and medium-sized mammals, especially raccoons. Each Sherman trap was baited with about 15g of Dry C.O.B and placed inside the pipe, equidistant from each end. The PVC pipes were “closed” at each end with a ¼" threaded rod (Fig. 2c). The rods allow entry of small mammals (even ones as large as woodrats and young brush rabbits) but eliminates disturbance by raccoons. One end of one each threaded rod has a wing nut that can be quickly removed, allowing removal of the rod and the trap.

The four arrays at each site were placed at least 75m apart, center-to-center, sometimes at the four corners of a square. In some habitats, it was not possible to arrange the four arrays in a square (e.g. riparian areas), so a linear or other suitable arrangement was used.

We used automatic cameras to document the occurrence of large- and medium-sized mammals. The camera was a modified Olympus Mini DLX, triggered by a Trailmaster 1500 unit (Goodson & Associates, Lenexa, KS 66215). The Trailmaster is comprised of a transmitter and receiver. The transmitter produces a beam of infrared light that is not visible to humans or wildlife. The Trailmaster is situated so that the infrared beam crosses a wildlife trail at a height of about 8". When the beam is broken for at least 3/20 second by a passing animal (or vegetation), the camera is triggered and a single picture is taken. We have configured the Trailmaster so that the camera cannot be triggered again until at least one minute passes, thus reducing the number of photographs taken of a single animal that lingers in the area. We chose sites for cameras by selecting the wildlife trail (in the vicinity of the arrays) that appeared to have the most activity. The camera was set to take pictures 24 hours per day. We checked the Trailmaster units every two weeks to replace film and batteries, as needed.

The time requirement to assemble the materials and install the four arrays and camera at each site was approximately 12 person days. In some habitats, this time could be shortened by about two days if a power post hole digger was used to dig the holes for the pitfall trap buckets and a power ditch digger was used to dig the trench for the drift fence. The time required for maintenance of the arrays has been negligible except at the two sites in pastures, where the cattle often damage the drift fences, and at the Tomales Point site (S3) where bull elk occasionally damage the fence, and sometimes the buckets and cover boards.

The cost of equipment and supplies per site (a set of four arrays and one camera) was approximately $1,400. More than half the cost is for the Trailmaster camera unit and the Sherman traps. Almost all parts of the arrays could be reused at a different site if inventories at the initial site were discontinued.

Trapping Protocol - Each trapping session consisted of opening the Sherman traps and pitfall traps on a Monday, checking them on each of the next four days, and closing them on Friday. The cover boards were checked only once during the week. Each four-day sampling period at a site consisted of the following number of trap checks: pitfalls = 7 traps x 4 arrays x 4 days = 112; Sherman traps = 6 x 4 x 4 = 96; cover boards = 3 x 4 x 1= 12. For calculations of capture efficiency, the number of Sherman trap checks was corrected by ignoring half of the traps that were closed but empty (Fellers, 1994).

The captured vertebrates were identified to species, weighed, and, depending on the species, measured and classified as to sex and age. Small mammals (other than the insectivores) were ear-tagged for individual identification; lizards and larger salamanders were marked by toe clipping; snakes were marked by cauterizing ventral scales with a fine-tip cautery tool (Model J-313, Jorgensen Laboratories, Inc., Loveland, CO 80538). These procedures followed standard animal handling and marking protocols (American Society of Ichthyologists and Herpetologists, 2001; American Society of Mammalogists, 2001). Our protocol has been endorsed by USGS, Western Ecological Research Center following an Animal Care and Handling program review.

All data collected in the inventory process were entered into a FoxPro database for analysis and graphed using Excel.

Sampling Intensity - We began inventories at eight sites in January and February 1998 and continued approximately monthly until late 2000. In February 2001, we installed arrays at eight additional sites and moved our eight automatic cameras to the new sites. We have operated the arrays at the new sites on four occasions between early spring and fall 2001. Note that this initial sampling has not included a winter season when amphibians are most active. The cameras at the new sites have been running continuously for the last 10 months.

Results

Small Mammals, Amphibians, and Reptiles - Table 2 lists the 16 small mammals, seven amphibians, and nine reptile species captured at our 16 sites. The next-to-last column in Table 2 gives the total number of individuals captured for each species; this number ranged from one for Norway rat, black rat, and western skink to 3,632 for deer mouse. The last column shows the capture rate, expressed as the number of captures divided by the number of trap checks, for all three types of traps combined. The other columns show the capture numbers and rates for each type of trap: Sherman trap, pitfall trap, and cover board.

Figures 3-13 show the capture rates for each type of trap for each of the 11 species for which we captured at least 100 individuals. Figures 3-5 show that pitfall traps were by far the most effective type of trap for capturing the three species of shrews, especially the two smaller species (vagrant and Trowbridge shrews). The smallest mouse (western harvest mouse) was also caught much more efficiently by pitfall traps (Fig. 8). The deer mouse (Fig. 6) and California meadow vole (Fig. 7) are larger, and these species were caught most frequently with Sherman traps. Among the amphibians with more than 100 captures, the relatively sedentary Ensatina and California slender salamanders were caught most frequently under cover boards (Fig. 9-10), while the migratory rough-skinned newt was caught most often in pitfall traps (Fig. 11).

The only two reptiles caught more than 100 times (alligator lizard and western terrestrial garter snake) were both caught most frequently under the cover boards (Fig. 12-13), although the lizards were also caught fairly often in pitfall traps. (The few snakes caught in pitfall traps were small and probably not able to escape as easily as larger snakes.)

Figures 14-24 show the capture rates at each of the 16 *sites* for the same 11 species for which more than 100 individuals were caught. In all of these figures, capture rates at the nine non-wooded sites are shown on the left side (light shades of gold, ivory, orange and yellow) and at the seven wooded sites are shown on the right (in dark shades of green and blue). Table 1 describes the habitat for each site and provides the site designation.

Ten of the 11 species had a strong habitat preference, while the 11th (deer mouse) had a near-total lack of preference. Figures 14-18 show species caught predominantly in the seven wooded sites: Ensatina salamander, California slender salamander, rough-skinned newt, fog shrew, and Trowbridge shrew while Figures 19-23 show species caught predominantly in the non-wooded sites: vagrant shrew, California meadow vole, western harvest mouse, northern alligator lizard, and western terrestrial garter snake. Figure 24 shows that the deer mice were caught at relatively high rates at all 16 sites. Appendices A-K provide the detailed data from which these 11 figures were derived.

We examined the capture rates for the most commonly caught vertebrates (Appendix L) to see if there were seasonal differences in capture rates. For this analysis, we used only the data from the first eight sites where we have data for all seasons over several years. As expected, there were strong trends in seasonal activity. Five species (northern alligator lizard, western terrestrial garter snake, and the three species of shrews) all had markedly higher capture rates in the summer than in the winter (Fig. 25-29). Two species (deer mouse and California meadow vole) were captured at similar rates in both the summer and winter (although the results were somewhat erratic for the vole (Fig. 30-31). For the remaining four species (western harvest mouse, Ensatina, California slender salamander, and rough-skinned newt), the capture rates were markedly higher in the winter than the summer (Fig. 32-35).

<u>Large- and Medium-Sized Mammals</u> - Table 3 lists the 18 species of mammals that were photographed at the 16 sites. The table shows both the number of photographs and the photographic rate, expressed as photographs per camera day. More than

93% of the 7,485 photographs of identifiable wildlife (taken between February 1998 and October 2001) were of the seven most common species. The rate for the most-photographed species (mule deer) was 0.2 photographs per camera day. This means that a mule deer was photographed once for every five days that a camera was in operation. At the opposite extreme is the red fox that was photographed only once during our entire study. Hence, the photographic rate for the red fox was almost 2,000-fold lower than for the mule deer. In addition to documenting wildlife, the cameras took 292 pictures of people, 195 cattle (2 of the 16 sites are in pastures), 102 dogs, 29 horses, and 12 domestic cats. Note that the photographs do not represent unique individuals, e.g. some individual animals (and people) were photographed on multiple occasions.

The large- and medium-sized mammals showed distinctly less habitat preference compared with the smaller species discussed above (Appendix M, Fig. 36-49). For example, mule deer, bobcat, striped skunk, and raccoon (Fig. 36-39) were all among the commonly photographed species, yet none of them had a strong habitat preference. Neither did the coyote or opossum, species photographed much less often (Fig. 40-41).

By contrast, brush rabbits were frequently photographed, and almost exclusively in the scrub sites (Fig. 42); black-tailed jackrabbits and badgers were photographed predominantly in non-wooded sites, although at relatively low rates (Fig. 43-44). Gray foxes were predominantly in the wooded sites (Fig. 45), as were the less-photographed western gray squirrel (Fig. 46) and the much-less-photographed mountain lion (Fig. 47).

The Figures 48 and 49 summarize the data for two species of particular concern to the park, the non-native fallow deer (introduced to Point Reyes before the park was established), and the native tule elk that were extirpated in the 1800s and reintroduced in 1979. Fallow deer were photographed in both wooded and non-wooded habitats. The two sites at which the tule elk were photographed is not a reflection of limited habitat preference. The site with the highest photo rate for the elk is inside the fenced-in elk range on Tomales Point, and the other site is adjacent to where a free-ranging elk herd was released in 1999.

Cumulative Number of Species - Figure 50 shows the cumulative number of small vertebrate species that have been captured at each of the first eight array sites during the first 3+ years of trapping. After a rapid accumulation of new species during the first six months, the addition of new species has slowed, and almost stopped after 2½ years. The "Sum" curve on this figure shows the data for all sites combined.

At the second set of eight sites, after less than 12 months, the number of small vertebrates per site ranged from only seven at the iceplant/dunes site (I1) and the heavily grazed pasture site (C1) to 14 at the scrub sites S3 and S4.

Figure 51 shows the cumulative number of species of large- and medium-sized mammals that have been photographed at each of the first eight sites. The number of species found in the photographs increased for about two years before leveling off. The "Sum" curve on this figure shows the same data for all sites combined.

Monitoring Changes in a Population - Figure 52 shows the capture rates for California meadow voles at G1, a grassland site that is particularly suitable for voles. Each point in the figure represents the results of one of the 25 one-week trapping sessions conducted from May 1998 until August 2001. While the data do not represent absolute population densities (e.g., animals per hectare), it appears that population density decreased dramatically over the first 1+ year and then remained below the level of detection for the next 2+ years. We presume that continued trapping at this site would detect another population boom such as that seen in 1998.

Discussion

In the discussion we will consider the species of terrestrial vertebrates that we have and have not found, and the suitability of our methods for inventory and monitoring, both at Point Reyes NS and at other parks.

Mammals - We detected 18 species of large- and medium-sized wild mammals with automatic cameras, and 16 species by trapping at the arrays. The combined total was 31 species. Three species were found both by photography and by trapping (brush rabbits, long-tailed weasels, and dusky-footed woodrats). In addition, we photographed five domestic species: people, cattle, horses, dogs, and cats.

Twelve species of wild mammals were either photographed or captured more than 500 times each (Tables 2 and 3). These results are generally in good agreement with expectations based on the checklist of mammals for Point Reyes, a compilation of the observations of many people over many years (Fellers and Dell'Osso, 1986). Only the vagrant shrew had a significant disparity between our results (817 captures) and the checklist designation of "uncommon."

Fourteen species of wild mammals were either photographed or captured between 10 and 150 times. Tule elk were photographed 145 times, but almost exclusively at site S3, which is located on Tomales Point inside the "elk range." This is a large, fenced pasture containing more than 450 elk. Only a few pictures taken at site G1 represent free-ranging elk, animals that were released in that area in 1999.

Coyotes were photographed 15 times. Coyotes were once a common, native species at Point Reyes, but they almost entirely disappeared from the area prior to the 1900s (Evens, 1993). Within the last 10 years, they have become reestablished, presumably via natural dispersal from the north. Coyote numbers have been increasing over the last decade. Mountain lion sightings are occasionally reported by park staff and visitors, but our photographs are the first pictures of this species in Marin County since the park was established in the 1960s. Dusky-footed woodrats were photographed 21 times, but they never triggered the camera themselves. Instead, they were always being carried (as prey) by gray foxes and bobcats.

There were six wild mammals that we photographed or captured five or fewer times: long-tailed weasel (5 captures/photographs), Pacific jumping mouse (2), spotted skunk (1), red fox (1), Norway rat (1), and black (roof) rat (1). Hence, these are species that were nearly missed.

We know of at least seven species that were never documented as part of our inventory: mountain beaver, river otter, muskrat, ringtail, porcupine, short-tailed weasel, and house mouse. How should the inventory protocol be modified to detect species that have been missed or to increase the frequency of detection for the species that were rarely detected? One modification would be to do “supplemental” photography and Sherman trapping, specifically targeting species that are not expected at our arrays or along animal trails where we deploy our automatic cameras. For example, as part of some unrelated research, we have found that cameras set up outside mountain beaver burrows can readily photograph species that were missed or rarely detected in our inventory (e.g. mountain beaver, spotted skunks, and long-tailed weasels). None of these species frequent animal trails, and hence are difficult to detect with our standard techniques.

We could almost certainly photograph river otters and muskrats by locating their haul-out places along watercourses, and deploying automatic cameras in those areas. Similarly, Sherman trapping near ranch buildings would likely result in the capture of the house mouse and lead to increased rates of detection for Norway rats and black (roof) rats.

It is likely, however, that some species of mammals are sufficiently rare that no inventory technique will reliably document their presence as part of a broad-scale inventory. At Point Reyes, these species include red fox, short-tailed weasel, ringtail, and porcupine. Fortunately, we have one photograph of a red fox, but the other species have been missed.

<u>Amphibians</u> - Our inventories were designed to detect terrestrial salamanders and newts but not pond-breeding frogs and toads (which are best detected by observations and dip netting at ponds). The results from our arrays were in keeping with the design; we detected hundreds of California slender salamanders, Ensatina salamanders, and rough-skinned newts, and small numbers of arboreal and Pacific giant salamanders. There were also a few captures of pond-breeding Pacific tree frogs and red-legged frogs, but no bullfrogs, a species that is common in some local areas of the park. A species that we expected to capture but did not is the California newt, known to occur in the southern part of the park. This species will likely be documented once we operate our eight new arrays during the winter months, since

some of the new sites are in areas where this newt has been observed as part of other research.

Reptiles - We captured two reptiles at high frequency in our inventories (northern alligator lizard and western terrestrial garter snake) and we captured seven other species at relatively low frequencies [western fence lizard, western skink, rubber boa, racer (snake), gopher snake, common garter snake, and aquatic garter snake]. We did not detect several reptiles that are known to occur in Marin County, but are of unknown status at Point Reyes: southern alligator lizard, ring-necked snake, striped racer, and western rattlesnake. There are two old, seemingly reliable, sight records of rattlesnakes at Point Reyes, both from the Olema Valley. We have no observations for the other four species. Additionally, it is not clear how one could target these rare reptiles, though additional inventories in more places would certainly increase the probability of finding them, if in fact they occur.

Habitat-Specific Locations of Some Terrestrial Vertebrates - Five of the 11 most frequently captured small vertebrates were found predominantly in the wooded habitats and rarely in non-wooded habitats: California slender salamander, Ensatina salamander, rough-skinned newt, Trowbridge shrew, and fog shrew. The reverse distribution was true for another five species: northern alligator lizard, western terrestrial garter snake, vagrant shrew, California meadow vole, and western harvest mouse. Only the deer mouse was found at high frequency in all habitats, appropriately for the most widespread mammal species in North America. For all six mammal species, the habitat preferences we documented correspond well with the descriptions given by Jameson and Peeters (1988). For reptiles and amphibians, our results did not correspond well with the habitat descriptions of Stebbins (1985). Based on Stebbins field guide, one would not expect the northern alligator lizard and western terrestrial garter snake to be found primarily in non-wooded sites. Similarly, one would not expect the slender salamander and newt to be found primarily in wooded sites.

We found little habitat preference among the large- and medium-sized mammals compared with the smaller vertebrate species. This would be expected since the larger animals are generally more mobile and have larger home ranges. To the extent that there were preferences, they were in good agreement with the descriptions in Jameson and Peeters (1988); brush rabbits, black-tailed jackrabbits, and badgers all preferred non-wooded habitats while gray foxes and western gray squirrels were found primarily in wooded habitats. Our photographs of mountain lions were from four different wooded sites, but since we have only 11 photographs, it is not clear that our data actually represent a preference for that type of habitat.

<u>Small Vertebrates in Grazed Pastures</u> - In 2001, we installed trapping arrays C1 and C2 in beef cattle pastures, in part because the extensive pasture lands within the seashore have been little studied. These two sites are similar in being on gently sloping eastward-facing ends of ridges, at approximately 200 ft. elevation, and slightly less than one mile from Drake's Bay. They are only two miles apart and differ primarily in the level of grazing; C1 is heavily grazed and C2 is moderately grazed.

The species present at C1 and C2 are characteristic of other non-wooded sites (Fig. 14-24). However, the northern alligator lizard, which is plentiful at all of the other non-wooded sites, was not found at either C1 or C2. The western harvest mouse was commonly found at most non-wooded sites, especially the two grassland sites (G1 and G2). None were found at C1, and only a single individual was caught at C2, the less heavily grazed of the two pastures.

Six species were present at one or both of the pasture sites (C1 and C2). Five of the six were captured at greater rates at the less-heavily grazed site (C2). The sixth species (deer mouse) was captured slightly more often at C1, the more heavily grazed site.

Though our sampling of grazed pastures is limited, our data indicate that the pastures are somewhat impoverished with respect to both the number of species present and population size. That is especially true for the more heavily grazed site (C1).

Seasonal Capture Rates for Small Vertebrates - Seasonal changes in the capture rates (for the 11 most-frequently captured vertebrates; Figures 25-35) mostly follow the expected pattern. Reptiles were captured infrequently in the winter and amphibians were captured infrequently in the summer. These patterns reflect winter hibernation for snakes and summer estivation for amphibians (Stebbins, 1985).

For most small mammals, the seasonal pattern of capture rates reflects seasonal patterns in reproduction (Jameson and Peeters, 1988). All three species of shrews breed in the spring, and hence it is not unexpected that we found higher capture rates in the summer. The deer mouse and California meadow vole both breed throughout most of the year, and we had relatively high capture rates year-around. The western harvest mouse, however, breeds “in spring and sometimes again in autumn” (Jameson and Peeters, 1988). It is not obvious how this pattern would lead to high capture rates only in the winter, unless fall breeding predominates at Point Reyes.

How Suitable is our Protocol for Inventories and Monitoring? - Heyer et al. (1994) edited a book entitled “Measuring and Monitoring Biological Diversity, Standard Methods for Amphibians." Below, we quote from their book and compare their recommendations with our methods.

> “Drift fences with pitfall or funnel traps and pitfall traps without fences are commonly used to inventory and monitor populations of amphibians and reptiles.” (Chapter 6)

During the first year, we used hardware cloth funnel traps in addition to the pitfall traps, but we noted a number of significant problems:

1. While the funnel traps were effective in capturing both lizards and snakes, the cover boards were better,
2. There was a high mortality rate among mice and voles that were caught in funnel traps,

3. Snakes were sometimes wounded by the sharp ends of the hardware cloth wires, and
4. Raccoons occasionally crushed the funnel traps in attempts to get the captured animals.

Due to these problems, we abandoned funnel traps in favor of our other techniques. Also, our preliminary data indicated that funnel traps captured no species that were not caught with other techniques.

> "Drift fences with pitfall traps can be used to determine species richness at a site and to detect the presence of rare species. They can also yield data on relative abundances and habitat use of selected species." (Chapter 6)

We have used the combination of these two techniques in all our inventory work, and have no evidence to suggest that the statement by Heyer et al. is not true.

> "Drift fence arrays or pitfall grids can be left in place for long-term monitoring." (Chapter 6)

Our original arrays have been in place for almost four years and have remained in good condition during that time (although the arrays in cow pastures and the elk range have required frequent repair). Though the intent of our work was to inventory vertebrate species within the park, our work is similar to what might be done for a long-term monitoring program. For example, the capture data on California meadow voles at the grassland site G1 (Fig. 52) is similar to what one would acquire as part of a monitoring program.

> "If one accepts the untested assumption that capture rates do not vary among habitats, trap data can be used to compare relative abundance of individual species among study areas." (Chapter 6)

We have not attempted to evaluate capture rates across habitat types. While capture rates almost certainly vary with habitat, it is generally not known by how much. Nonetheless, we have presented our data on capture rate vs. site for small terrestrial vertebrates (Fig. 14-24) with the implicit assumption that capture rates are sufficiently similar to make the comparisons appropriate.

Wilson et al. (1996) have edited a companion volume on mammals: “Measuring and Monitoring Biological Diversity, Standard Methods for Mammals." We quote, below, from their book and compare our methods with their recommendations.

> “In general, we recommend capture techniques mainly for small mammals such as rodents and bats. We recommend observational techniques primarily for mammals of medium and large sizes.” (Chapter 1)

We have followed these recommendations by capturing small mammals with a combination of pitfall traps and Sherman live traps, and by using automatic cameras to photograph medium- and large-sized mammals.

> “Mammal box traps (e.g. those manufactured by Sherman, Longworth, Allcock, and Tomahawk . . .) are the most effective means for capturing small terrestrial mammals unharmed.” (Chapter 8)

As recommended, we used Sherman traps, the most commonly used small mammal trap in the U.S.

> “Pitfall traps provide the most effective means of capturing the smallest (<10g) terrestrial mammals, such as shrews . . .” (Chapter 8)

We used both pitfall and Sherman traps to capture small mammals. We independently discovered that the smaller the mammal, the more effective were the pitfall traps compared with Sherman traps. For fog shrews and western harvest mice (typically weighing about 10g), the capture rates for pitfall traps were four and eight times higher (respectively) than for Sherman traps. For the Trowbridge and vagrant shrews (typically weighing about 5 g), the capture rates in pitfall traps were 21 and 28 times higher.

> "Capture rates of most species of small terrestrial mammals are enhanced greatly if pitfall traps are operated in conjunction with a drift fence that crosses the open pits . . . " (Chapter 8)

We used drift fences with the pitfall traps in exactly the fashion described.

> "Pitfall trap and drift fence arrays vary in length from 2 - 20 m, usually with at least one pitfall trap per 5m of drift fence." (Chapter 8)

We installed pitfall traps at 5m intervals along the drift fences. At one site we tested a simpler pitfall trap and drift fence array than the one shown in Figure 2a, using only two pitfall traps, connected by 5m of drift fence. However, we found this simpler arrangement resulted in fewer captures per pitfall trap, so we abandoned the modified design.

> "Pitfalls designed for live capture must be at least 40 cm deep because some small mammals are excellent jumpers and can escape from shallower containers . . ." (Chapter 8)

The 5-gallon plastic buckets that we used as pitfall traps are 38cm deep; it would have been preferable to have deeper traps since non-pregnant, adult deer mice were able to escape. We considered switching to 6-gallon buckets (which are 42cm deep) but decided not to since we had already installed hundreds of 5-gallon buckets, and because deer mice were being caught quite readily in Sherman traps. Western harvest mice and juvenile deer mice apparently cannot jump out of our 5-gallon pitfall traps, nor can most California meadow voles.

> "Even many large diurnal mammals are secretive and cannot be observed directly. Learning how to identify, interpret, and preserve tracks and other signs left by mammals can provide information about their habits that cannot be obtained in any other way." (Chapter 9)

Wilson et al. (1996) go on to describe various ways to obtain animal tracks, including track boards and track plates. While these techniques would be less expensive than automatic cameras, there are at least two serious disadvantages to the track methods:

1. At Point Reyes, either rain or fog drip occur frequently throughout the year. Rain and fog will either smudge or wash away tracks, making the technique far less effective.
2. Correct identification of tracks requires a great deal more skill than correct identification of animals in a photograph.

In addition, while tracks can be photographed or otherwise preserved, photographs require no extra steps or special preservation.

Conclusions

<u>Arrays for Inventory</u> - We believe that our array design which uses drift fences, pitfall traps, and cover boards, has worked well for inventories of small terrestrial vertebrates at Point Reyes NS. A few additional species might be captured with supplemental Sherman trapping. This is especially true for species that have very specific habitat requirements, and for which it is not feasible to install an array.

Cameras for Inventory - Our data indicate that automatic cameras positioned across wildlife trails in each habitat are an efficient technique for inventorying large- and medium-sized mammals. However, the camera should occasionally be moved from place to place rather than kept in a fixed position along a single animal trail, as has been our practice. Additionally, a few species (e.g. river otters, muskrats, mountain beavers) could be documented with cameras targeted for those specific species.

Arrays for Long-Term Monitoring - We believe that the arrays are suitable for monitoring populations of small terrestrial vertebrates. Each array covers a relatively large area and there are multiple arrays at each site. Arrays remain essentially unchanged year after year, and the arrays have the same structure in all habitats. If inventories are repeated at appropriate intervals (e.g. twice each winter and twice each summer, for Point Reyes) and if captured animals are counted, marked, weighed, and measured (as has been our practice), the results would form the basis of a monitoring program.

Cameras for Long-term Monitoring - Automatic cameras are problematic for long-term monitoring, in part because they only record the passage of an animal in a small segment of its home range, and because the quality of a wildlife trail can change significantly (and rapidly) over time. For example, a tree might fall across a trail and divert animals away from the camera. On the other hand, there appears to be no clearly superior alternative.

It might be possible to regularly move cameras between sites in a local area, but deploying a camera is somewhat time-intensive, and having photographs from a variety of locations makes it more difficult to evaluate trends over time.

Using any sampling regime, it is difficult to compare results across habitat types. This may be a more significant problem when monitoring with cameras since the extent to which wildlife use trails is clearly habitat-related, e.g. animals are more likely to use trails in dense habitat than in open grasslands.

In spite of limitations, automatic cameras have much to offer (e.g. clear documentation of each species, less weather dependence than track plates) and provide a useful tool in both inventory and monitoring programs.

<u>Applicability of Methods for other National Park Service Areas</u> - The combination of pitfall traps with drift fences, Sherman traps, cover boards, and automatic cameras has worked well at Point Reyes NS. This combination has many advantages for inventory programs. One of the primary benefits is that it integrates a number of well-tested techniques that are quite effective at documenting a wide variety of terrestrial vertebrates. The combination of trapping and cameras can be utilized in many types of habitats and can be easily adapted to local topography. Our experience at Point Reyes strongly supports the idea that these techniques would be effective in other park areas.

Lassen Volcanic National Park has initiated a monitoring program patterned after the one at Point Reyes. Like Point Reyes, Lassen is approximately 100 mi^2 and is composed of a variety of quite different habitats. Their experience has been similar to that of ours at Point Reyes, and suggests that the techniques are generally suitable for inventories.

Within the past year, we have begun inventories at two small parks: Eugene O'Neil and John Muir National Historic Sites. At O'Neil, the non-developed area is about two hectares and is visible from the O'Neil house, the main attraction for park visitors. Clearly, drift fence arrays in such a place would be an unacceptable visual intrusion. Even at the John Muir, with only 125 ha of undeveloped lands, arrays are not ideal, especially since the entire area is intensively used for hiking and horseback riding. Hence, we have foregone the use of drift fences and pitfall traps at O'Neil and Muir and deployed only cover boards, Sherman traps, and automatic cameras. We see no reason, however, to limit the inventories at Point Reyes or other large parks where much of the park is rarely seen by park visitors.

Acknowledgements

We thank the staff of the Point Reyes National Seashore, in particular Dr. Sarah Allen, for encouraging and financially supporting this study. Dr. Robert Fisher kindly hosted us and showed us the equipment and procedures he uses in a similar inventory and monitoring program in the San Diego area. Scott Berendt, John Carpenter, Douglas Klier, and Patrick Kleeman assisted in installing the arrays.

Literature Cited

American Society of Ichthyologists and Herpetologists, Guidelines for use of live amphibians and reptiles in field research, http://199.245.200.110/pubs/herpcoll.html

American Society of Mammalogists, Guidelines for the capture, handling, and care of mammals, http://www.mammalsociety.org/committees/commanimalcareuse/98acucguidelines.PDF

Evens, Jules G. 1993. The Natural History of the Point Reyes Peninsula. Point Reyes National Seashore Association. 224 pages.

Fellers, Gary M. 1994. Species Diversity, Selectivity, and Habitat Associations of Small Mammals from Coastal California. Southwestern Naturalist. 39(2): 128-136.

Fellers, G.M. and J. Dell'Osso. 1986. An Annotated Checklist of Mammals, Point Reyes National Seashore. Coastal Parks Association. 48 pages.

Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.A.C. Hayek, and M.S. Foster (eds.) 1994. Measuring and Monitoring Biological Diversity, Standard Methods for Amphibians. Smithsonian Institution Press. 364 pages.

Jameson, E.W., Jr. and H.J. Peeters. 1988. California Mammals. University of California Press. 403 pages.

Stebbins, R.C. 1985. A Field Guide to Western Reptiles and Amphibians. Houghton Mifflin Company. 336 pages.

Wilson, D.E., F.R. Cole, J.D. Nichols, R. Rudran, and M.S. Foster (eds.). 1996. Measuring and Monitoring Biological Diversity, Standard Methods for Mammals. Smithsonian Institution Press. 409 pages.

Table 1. Inventory sites at Point Reyes National Seashore.

Habitat Type	Site	Description
Scrub	S1	flat; low-density bush lupine and coyote brush; near Abbott's Lagoon
	S2	slight slopes, moderate to high density coyote brush; on Mt. Vision
	S3	slight slopes; low to moderate density coyote brush; in the elk range on Tomales Point
	S4	flat; moderate to high-density coyote brush and poison oak; at Palo Marin
Grassland	G1	flat; introduced annual grasses; next to South Limantour Beach
	G2	slight slopes; introduced annual grasses and native perennial grasses; west slope of Bolinas Ridge
Pasture	C1	flat to slight slopes; heavily grazed; N Ranch
	C2	flat to slight slopes; moderately grazed; Home Ranch
Ice Plant/Dunes	I1	flat to slight slopes; introduced ice plant and small native shrubs and forbs; near North Beach
Bishop Pine Forest	P1, P2	slight to moderate slopes; Bishop Pine, salal, huckleberry; on Mt. Vision
Douglas Fir Forest	F1	flat to slight slopes: mature Douglas fir; southwest of Divide Meadow
	F2	flat to slight slopes; young Douglas fir; huckleberry; on Firtop
Riparian	R1	flat, mature Douglas fir and California bay; upper Coast Creek
	R2	flat, California bay; Olema Creek
Redwood Forest	W1	flat to slight slopes; coastal redwoods; on the crest of Bolinas Ridge near McCurdy Trail

Table 2. Captures of each species in each trap type.

	Sherman Traps		Pitfall Traps		Boards		Totals	
	24,072 checks		28,952 checks		3,144 checks		56,168 checks	
Mammals	Captures	Rate	Captures	Rate	Captures	Rate	Captures	R
Deer mouse	3255	0.13522	333	0.01150	44	0.0140	3632	0.064
Trowbridge shrew	46	0.00191	1159	0.04003	2	0.0006	1207	0.021
California meadow vole	455	0.01890	468	0.01616	1	0.0003	924	0.016
Vagrant shrew	24	0.00100	817	0.02822	1	0.0003	842	0.014
Western harvest mouse	60	0.00249	547	0.01889	0	0.0000	607	0.010
Fog shrew	18	0.00075	87	0.00300	0	0.0000	105	0.001
Shrew mole	2	0.00008	32	0.00111	1	0.0003	35	0.000
Botta's pocket gopher	1	0.00004	34	0.00117	0	0.0000	35	0.000
Dusky-footed woodrat	26	0.00108	0	0.00000	0	0.0000	26	0.000
Broad-footed mole	0	0.00000	13	0.00045	2	0.0006	15	0.000
Sonoma chipmunk	15	0.00062	0	0.00000	0	0.0000	15	0.000
Brush rabbit	5	0.00021	0	0.00000	0	0.0000	5	0.000
Long-tailed weasel	3	0.00012	0	0.00000	0	0.0000	3	0.000
Pacific jumping mouse	1	0.00004	1	0.00003	0	0.0000	2	0.000
Norway rat	1	0.00004	0	0.00000	0	0.0000	1	0.000
Black (roof) rat	0	0.00000	1	0.00003	0	0.0000	1	0.000
Amphibians								
California slender salamander	1	0.00004	247	0.00853	1550	0.4930	1798	0.032
Ensatina salamander	0	0.00000	289	0.00998	167	0.0531	456	0.008
Rough-skinned newt	1	0.00004	295	0.01019	10	0.0032	306	0.005
Pacific tree frog	1	0.00004	2	0.00007	11	0.0035	14	0.000
Red-legged frog	0	0.00000	13	0.00045	0	0.0000	13	0.000
Pacific giant salamander	0	0.00000	12	0.00041	0	0.0000	12	0.000
Arboreal salamander	0	0.00000	3	0.00010	1	0.0003	4	0.000
Reptiles								
Alligator lizard	2	0.00008	186	0.00642	40	0.0127	228	0.004
Western terrestrial garter snake	2	0.00008	24	0.00083	144	0.0458	170	0.003
Western fence lizard	0	0.00000	33	0.00114	2	0.0006	35	0.000
Racer (snake)	1	0.00004	0	0.00000	29	0.0092	30	0.000
Common garter snake	0	0.00000	0	0.00000	5	0.0016	5	0.000
Rubber boa	0	0.00000	0	0.00000	4	0.0013	4	0.000
Gopher snake	0	0.00000	0	0.00000	3	0.0010	3	0.000
Western aquatic garter snake	0	0.00000	0	0.00000	3	0.0010	3	0.000
Western skink	0	0.00000	1	0.00003	0	0.0000	1	0.000
Totals	**3,920**	**0.16284**	**4,597**	**0.15878**	**2,020**	**0.6425**	**10,537**	**0.187**

Table 3. Photographs of large- and medium-sized mammals.

Species	Total Number of Photos	Photos per Camera Day
Mule deer	1704	0.1999
Gray fox	1499	0.1758
Raccoon	1178	0.1382
Brush rabbit	859	0.1008
Bobcat	603	0.0707
Striped skunk	578	0.0678
Fallow deer	554	0.0650
Tule elk	145	0.0170
Opossum	99	0.0116
Black-tailed jackrabbit	94	0.0110
Western gray squirrel	83	0.0097
Badger	38	0.0045
Dusky-footed woodrat	21	0.0025
Coyote	15	0.0018
Mountain lion	11	0.0013
Long-tailed weasel	2	0.0002
Spotted skunk	1	0.0001
Red fox	1	0.0001
Total	7,485	0.8780

Figure 1. Array sites at Point Reyes National Seashore. Site descriptions are given in Table 1.

Figure 2. a. Array situated in grazed field. b. Drift fence and 5-gallon pitfall trap. c. Cover boards with PVC housing for Sherman small mammal traps. d. View into PVC pipe showing baited Sherman live trap.

a.

b.

c.

d.

Figure 3. Capture rates for type of trap for vagrant shrews.

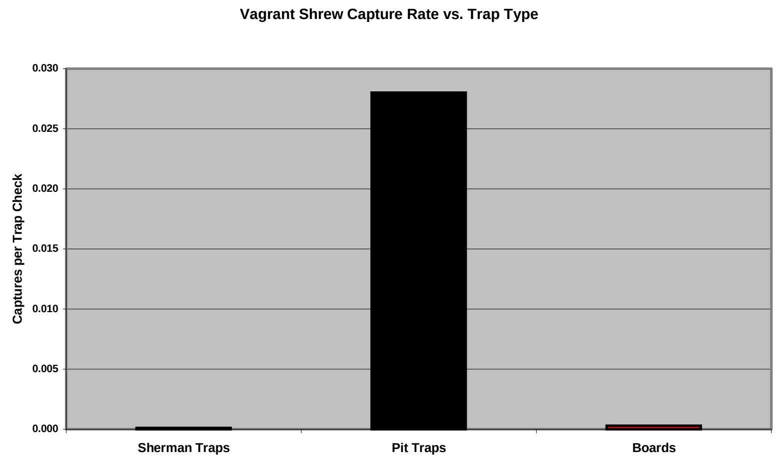


Figure 4. Capture rates for type of trap for Trowbridge shrews.

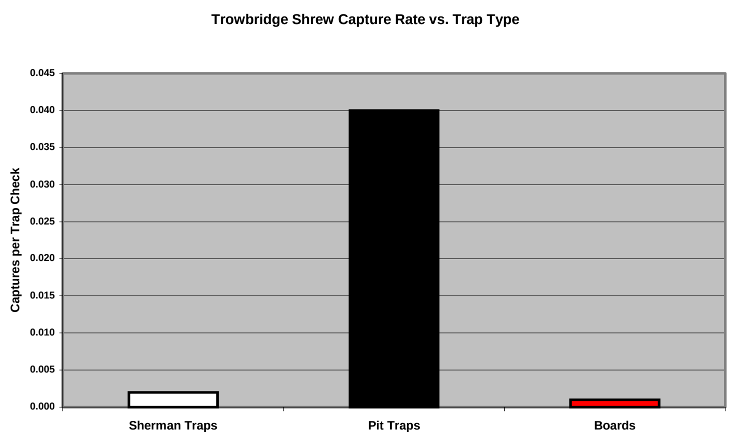


Figure 5. Capture rates for type of trap for fog shrews.

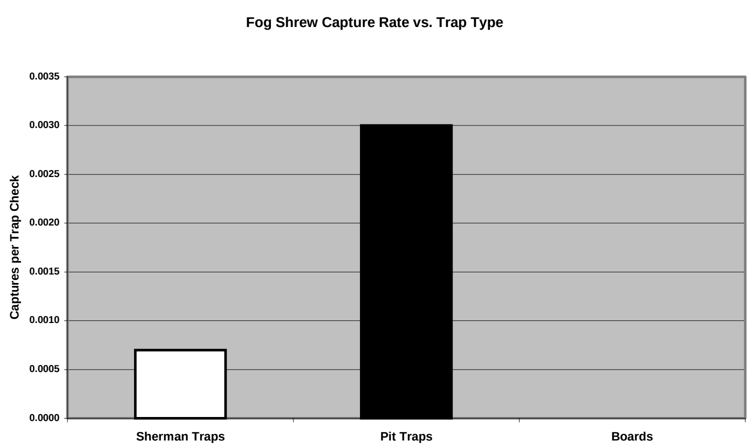


Figure 6. Capture rate for type of trap for deer mouse.

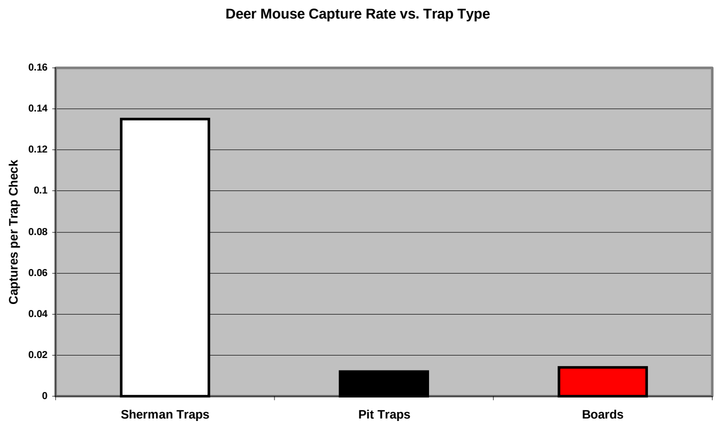


Figure 7. Capture rate for type of trap for California meadow voles

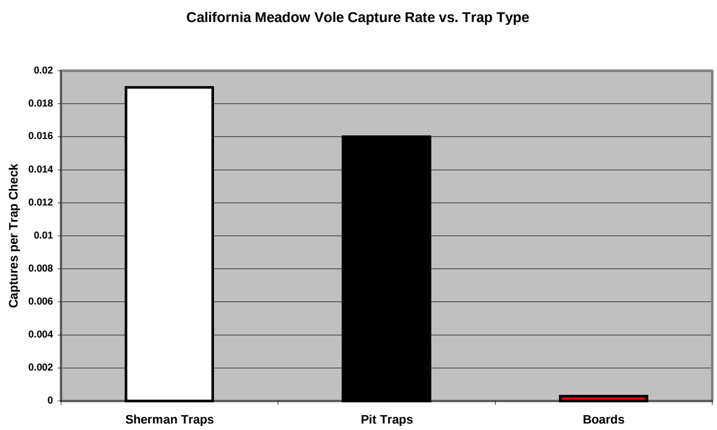


Figure 8. Capture rate for type of trap for Western harvest mouse.

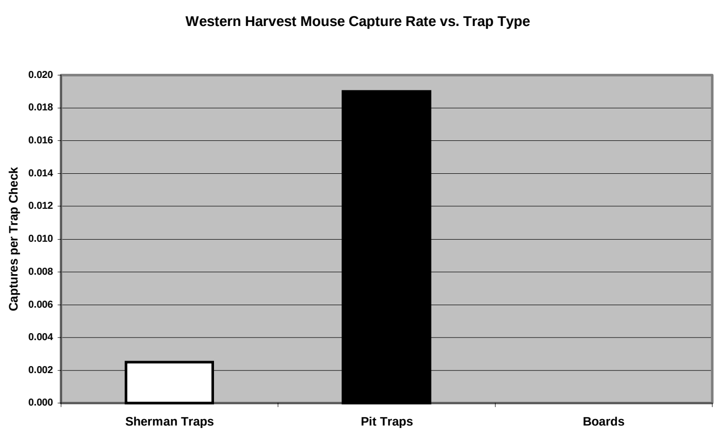


Figure 9. Captures rate for type of trap for Ensatina salamanders.

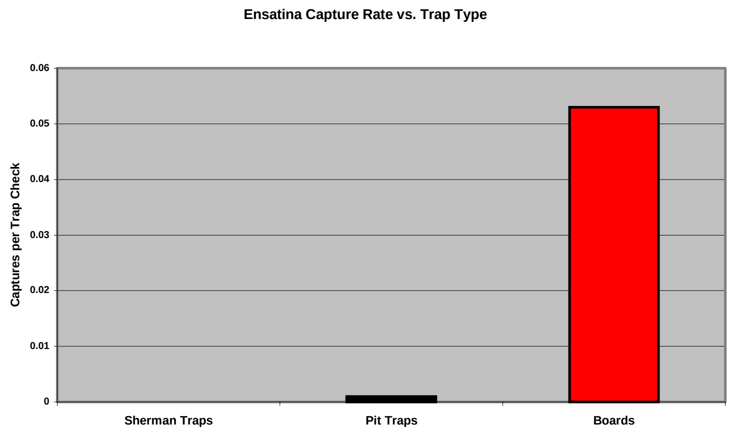


Figure 10. Captures rate for type of trap for California slender salamanders.

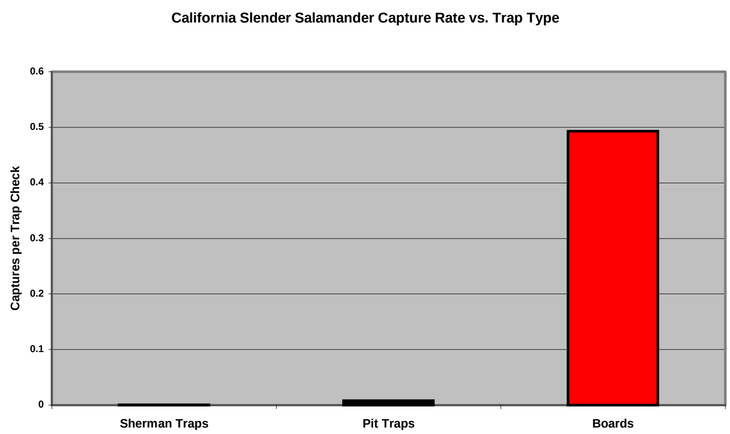


Figure 11. Captures rate for type of trap for rough-skinned newts.

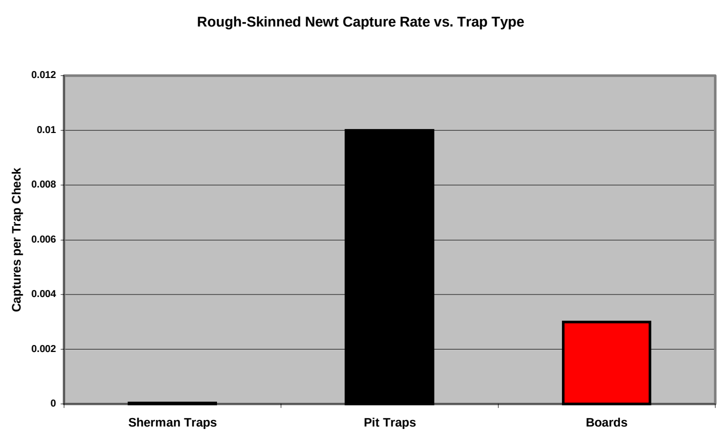


Figure 12. Capture rate for type of trap for alligator lizards.

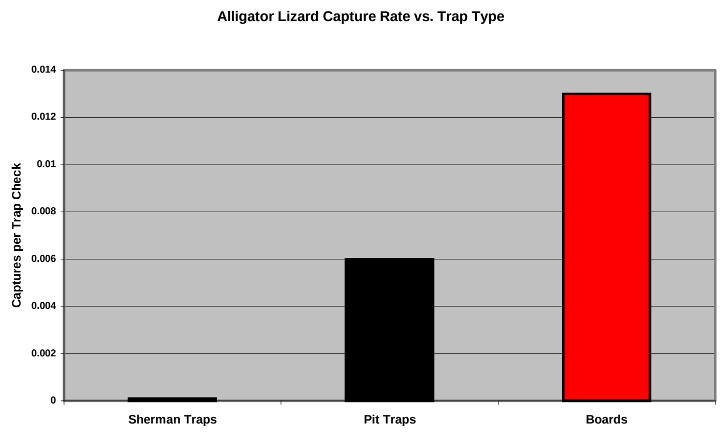


Figure 13. Capture rate for type of trap for western terrestrial garter snakes.

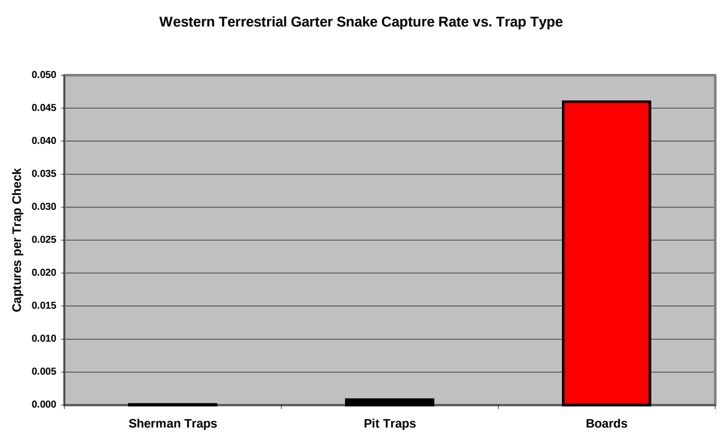


Figure 14. Capture rate for each site for Ensatina salamanders.

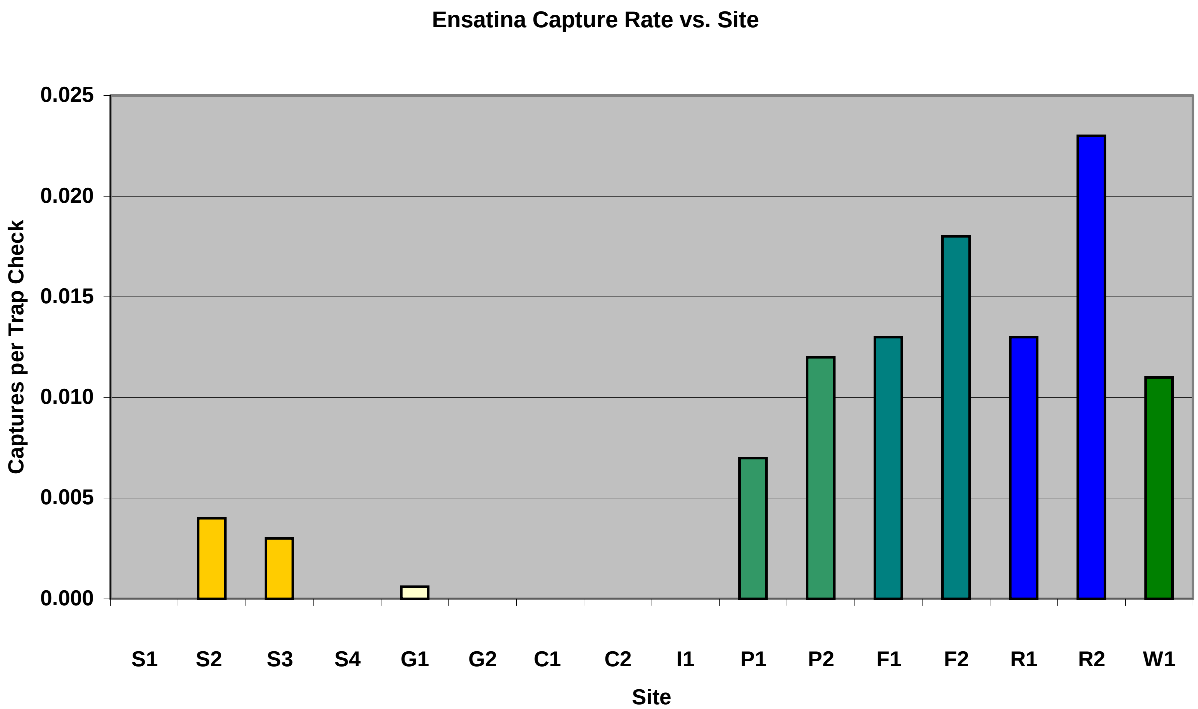


Figure 15. Capture rate for each site for California slender salamanders.

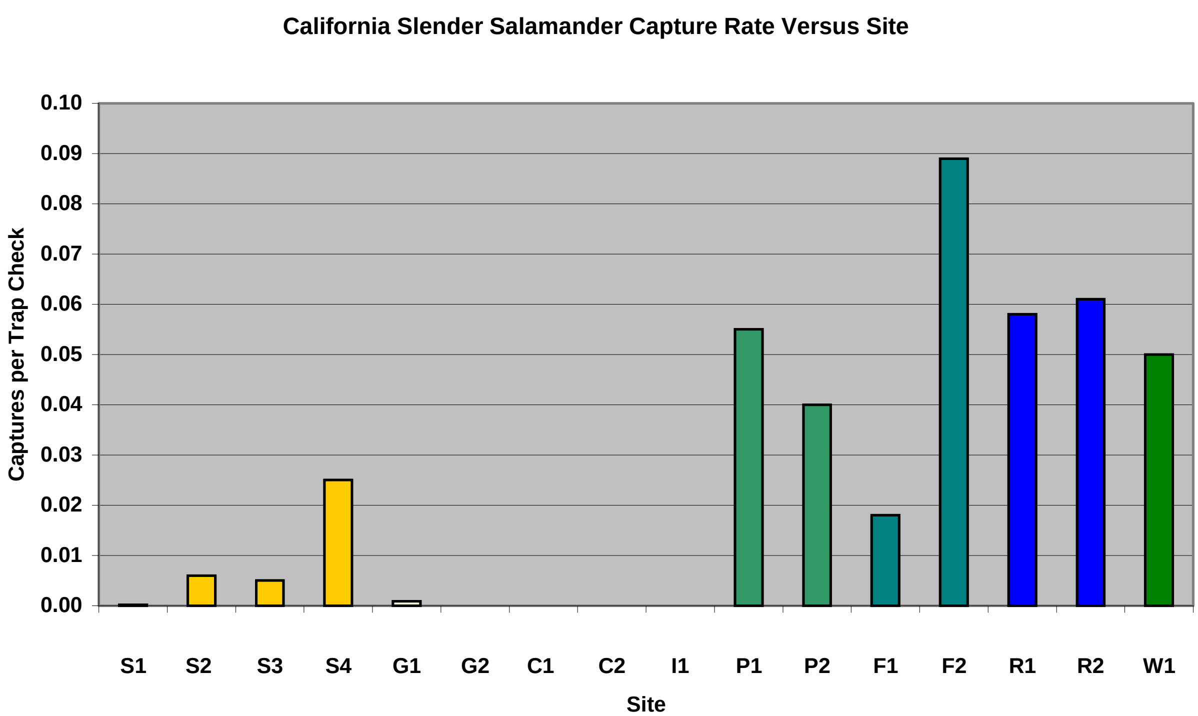


Figure 16. Capture rate for each site for rough-skinned newts.

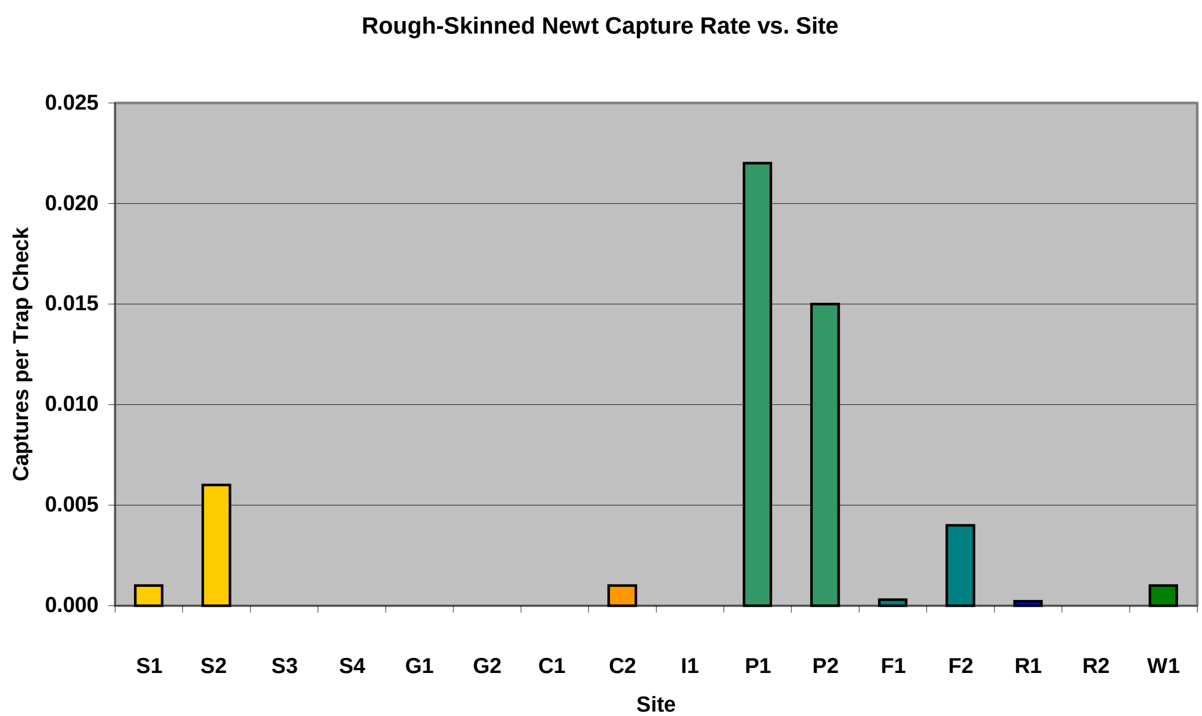


Figure 17. Capture rate for each site for fog shrews.

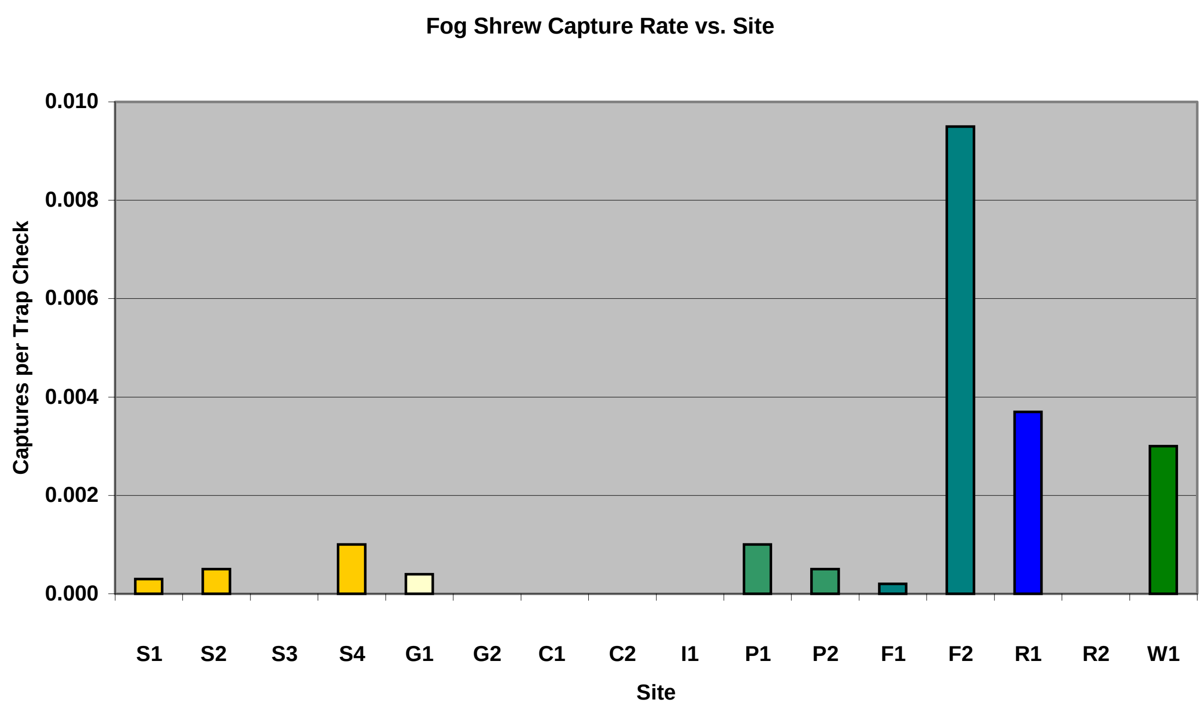


Figure 18. Capture rate for each site for Trowbridge shrews.

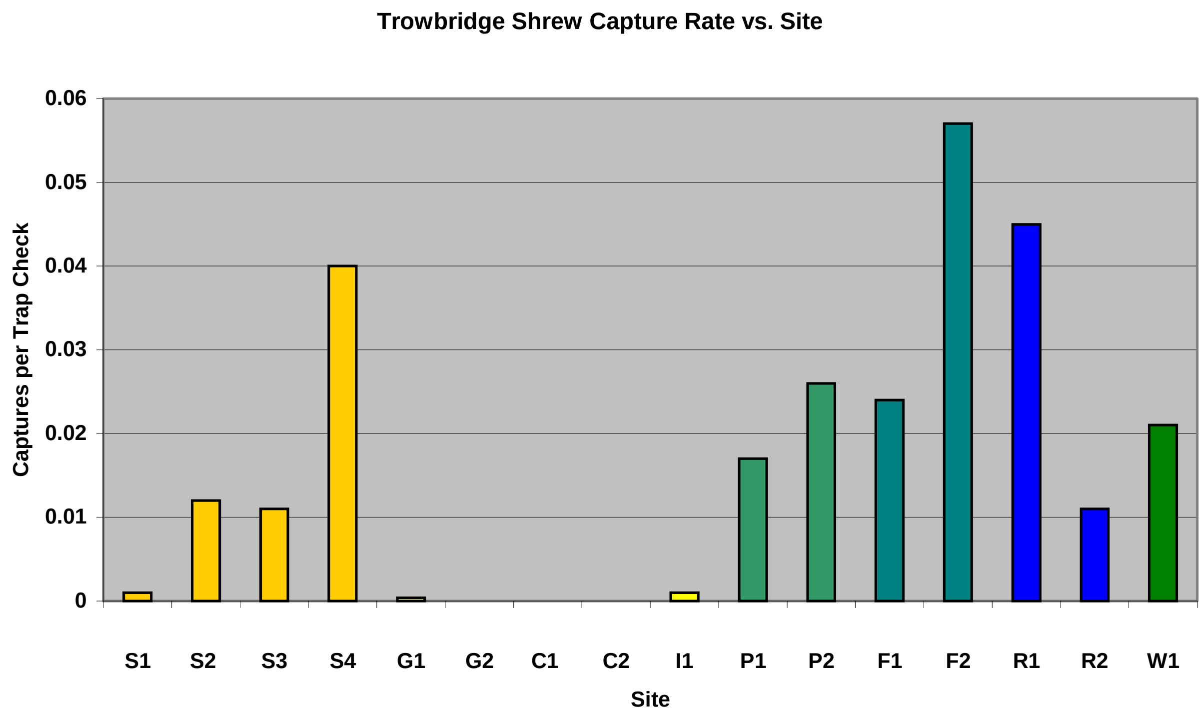


Figure 19. Capture rate for each site for vagrant shrews.

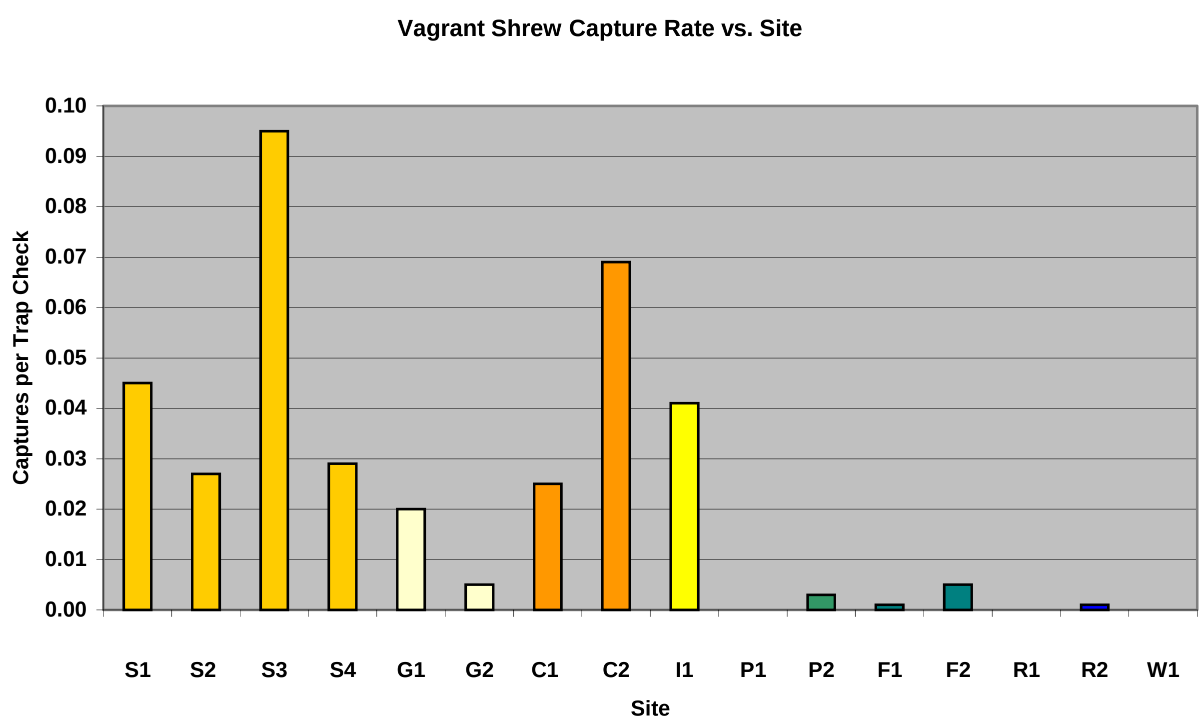


Figure 20. Capture rate for each site for meadow vole.

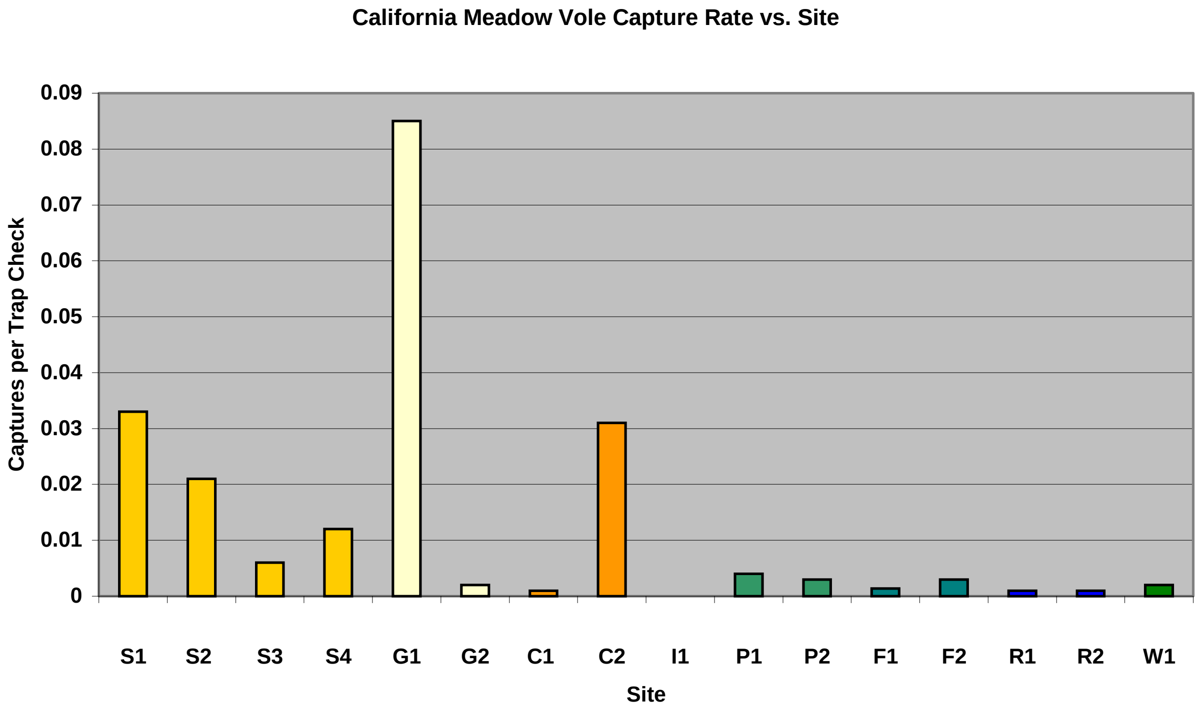


Figure 21. Capture rate for each site for western harvest mouse.

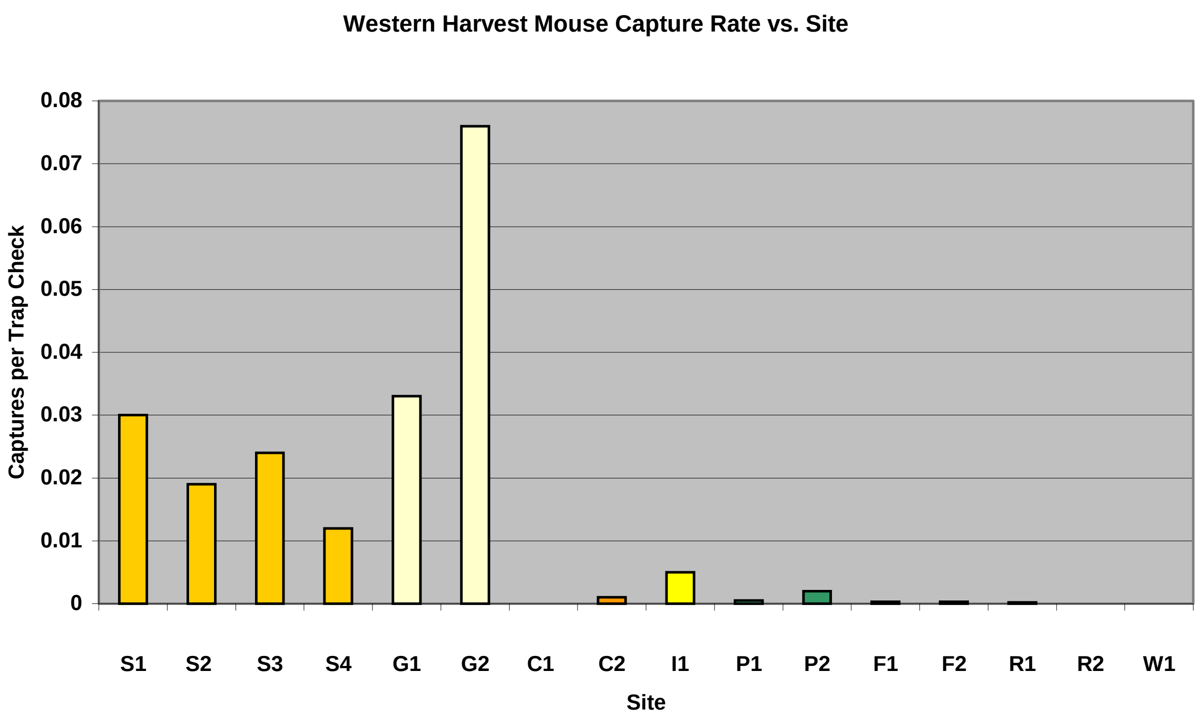


Figure 22. Capture rate for each site for northern alligator lizard.

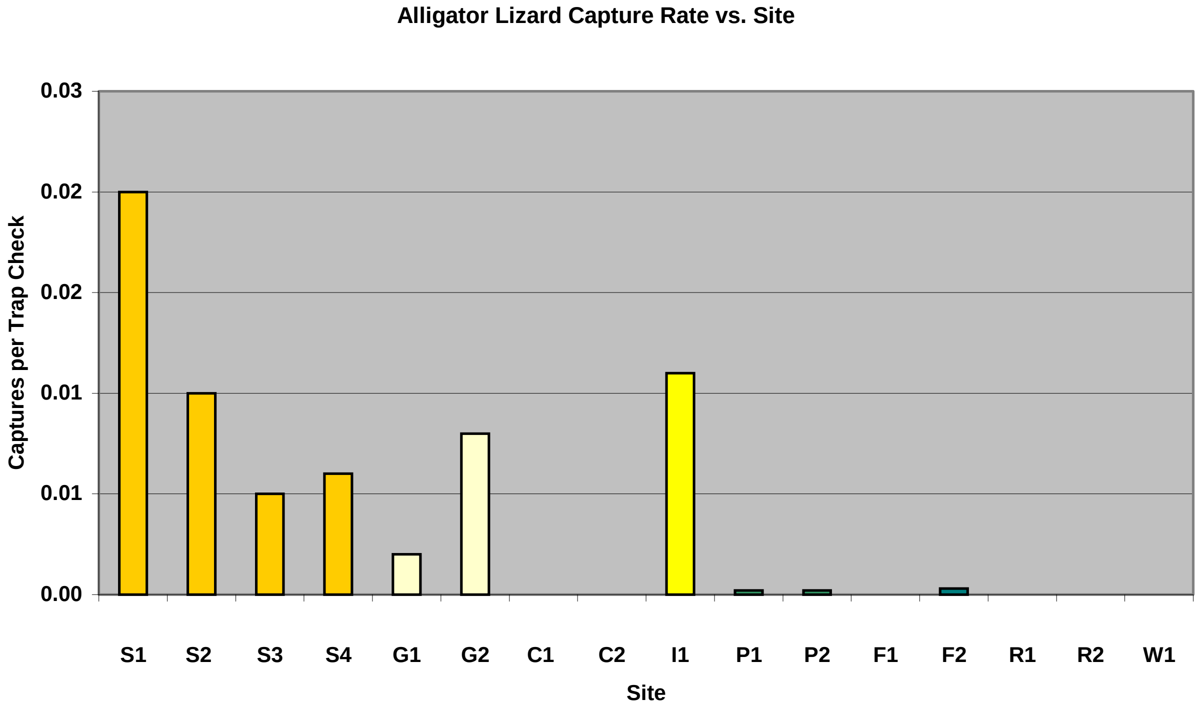


Figure 23. Capture rate for each site for western terrestrial garter snake.

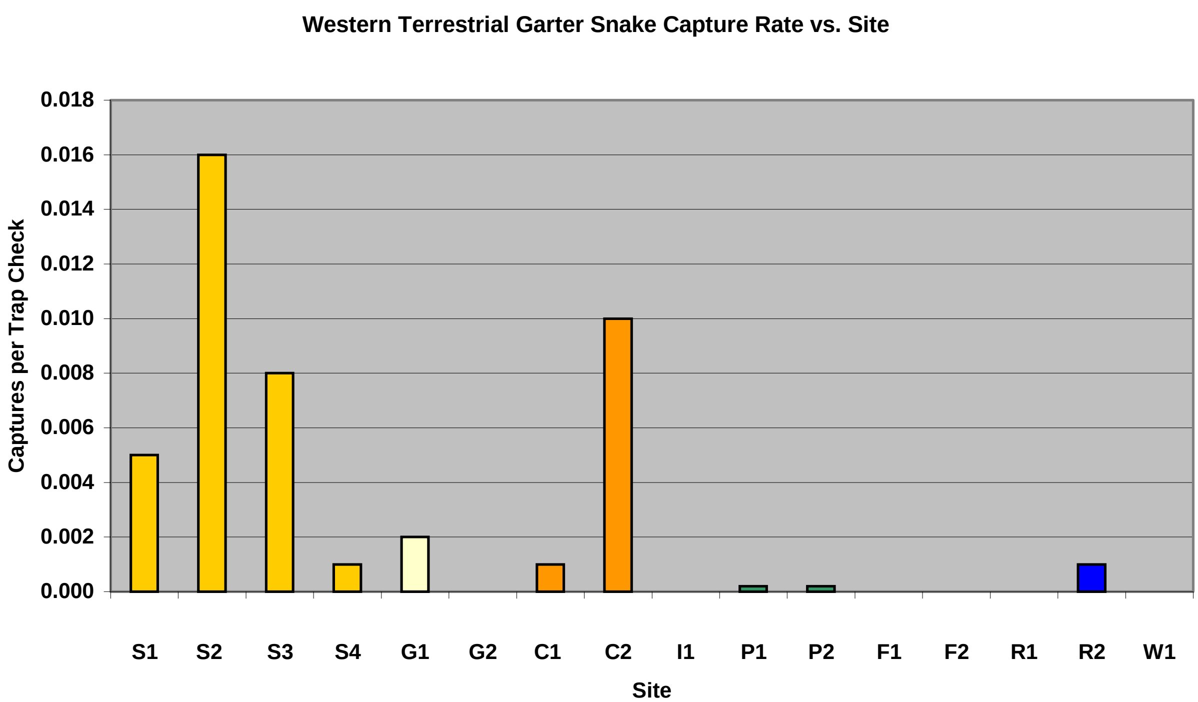


Figure 24. Capture rate for each site for deer mouse.

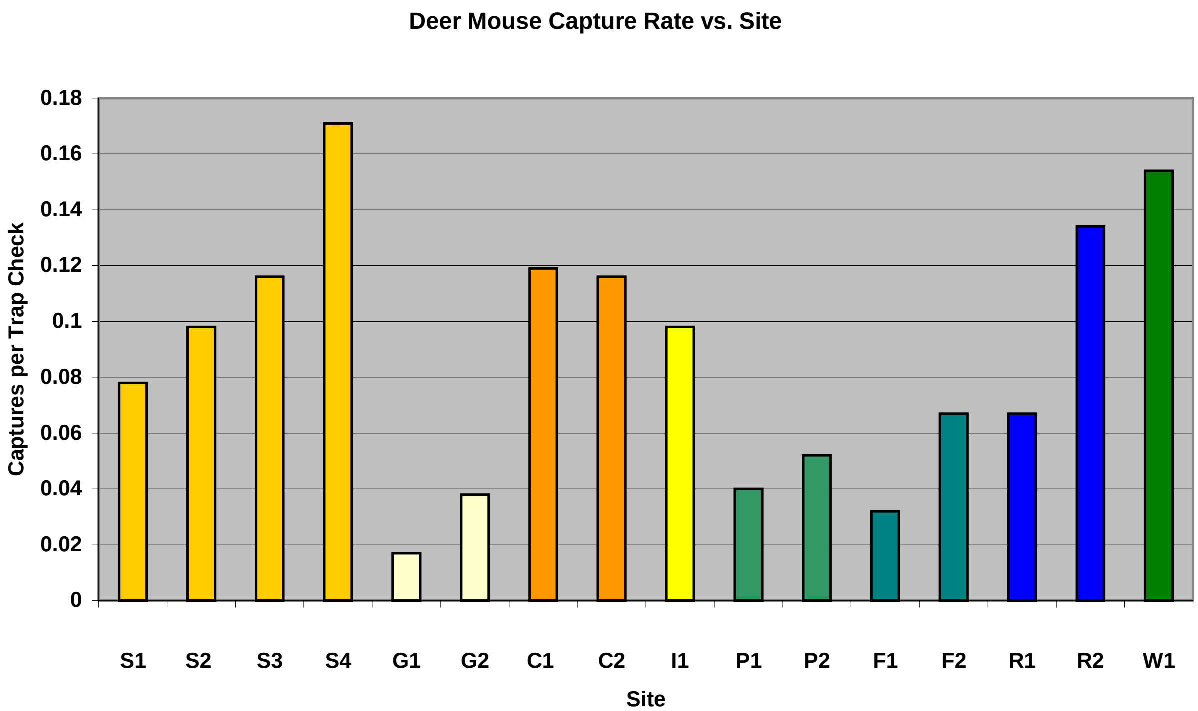


Figure 25. Capture rate for each month for northern alligator lizard.

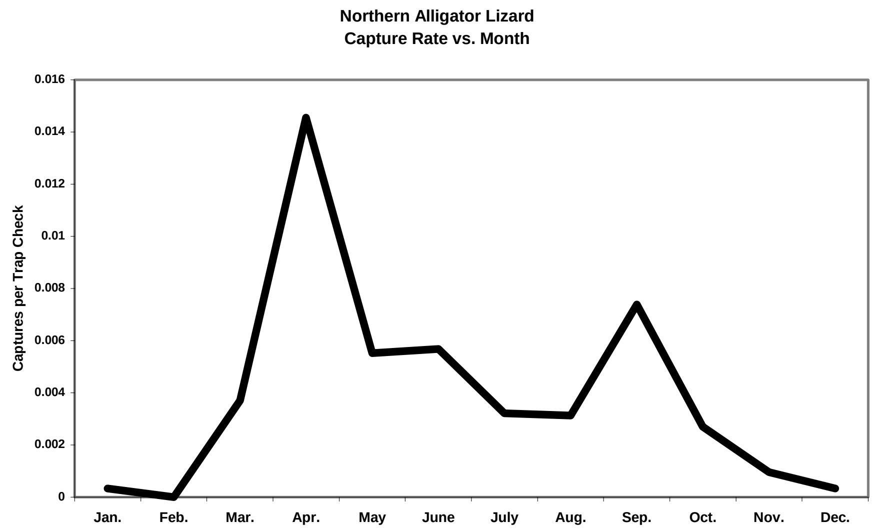


Figure 26. Capture rate for each month for western terrestrial garter snake.

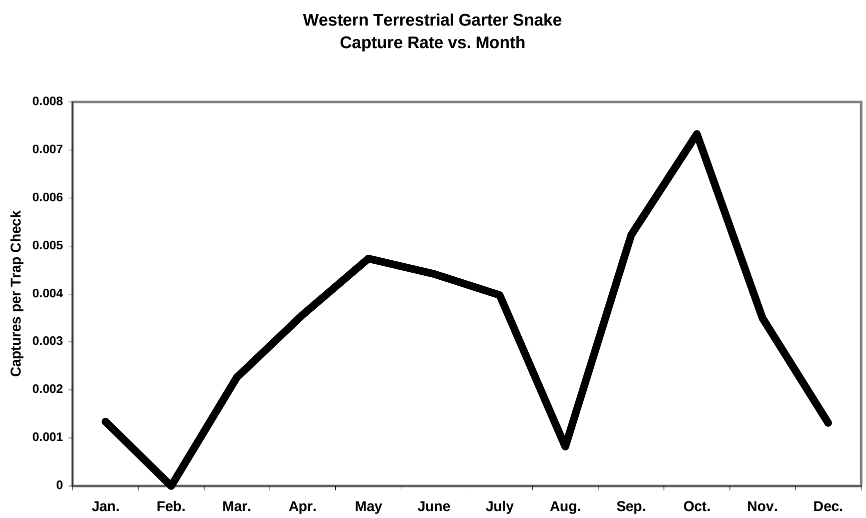


Figure 27. Capture rate for each month for vagrant shrews.

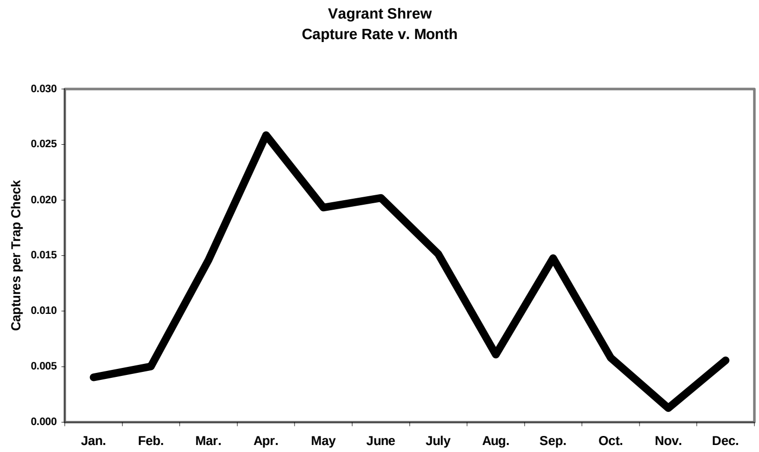


Figure 28. Capture rate for each month for Trowbridge shrews.

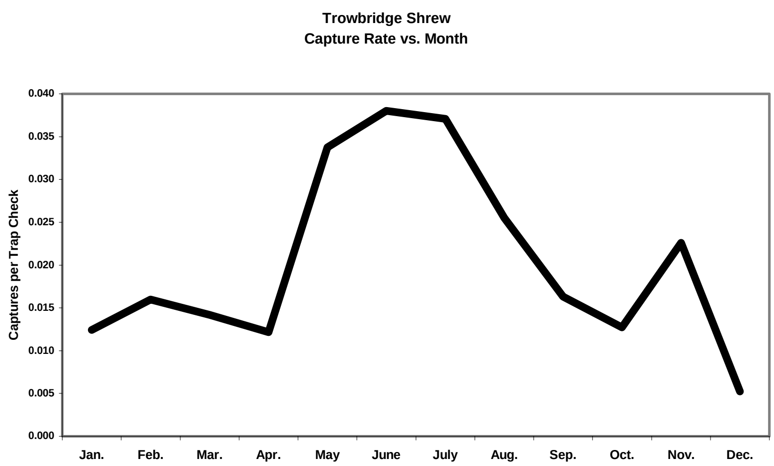


Figure 29. Capture rate for each month for fog shrews.

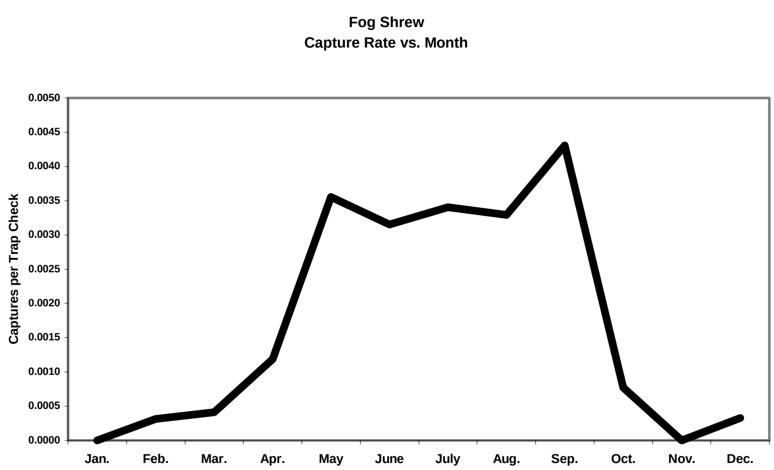


Figure 30. Capture rate for each month for deer mice.

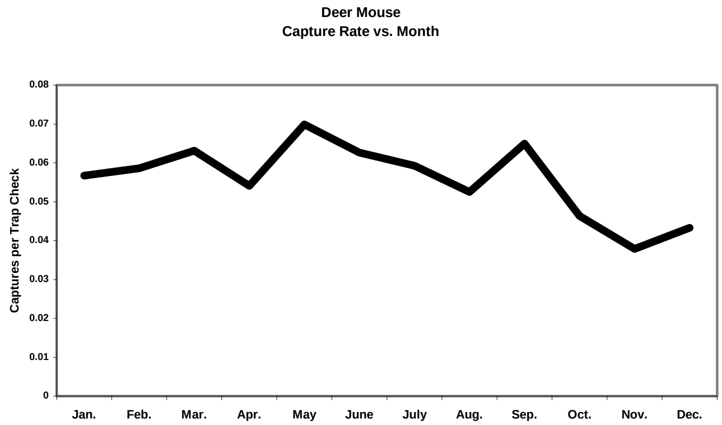


Figure 31. Capture rate for each month for California vole.

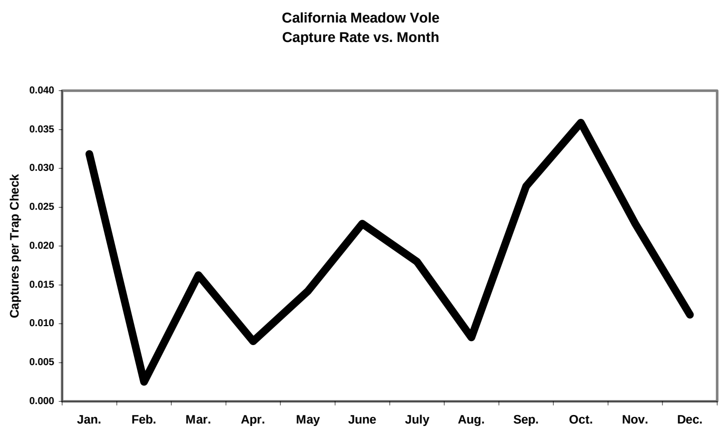


Figure 32. Capture rate for each month for western harvest mouse.

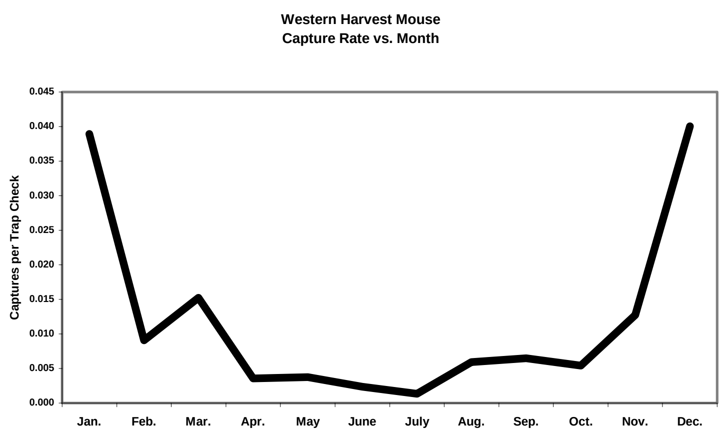


Figure 33. Capture rate for each month for Ensatina salamanders.

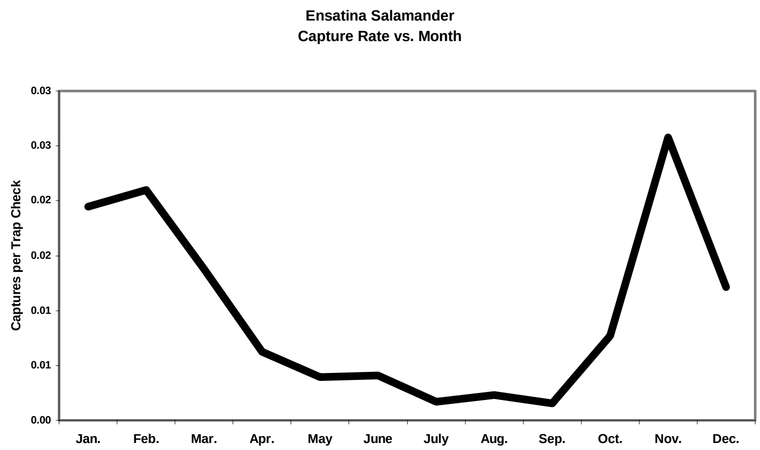


Figure 34. Capture rate for each month for California slender salamanders.

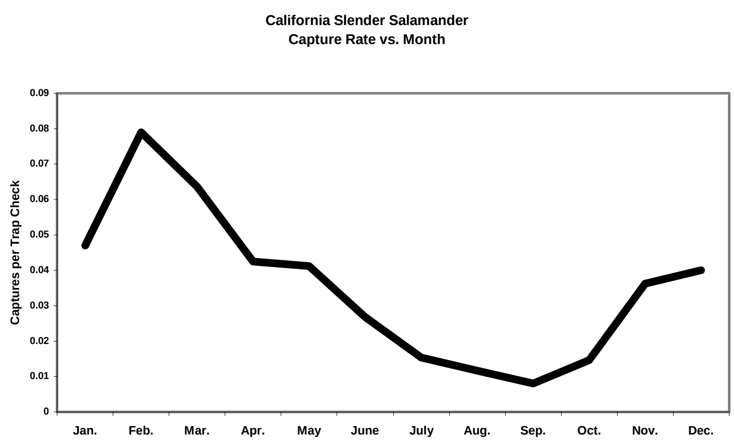


Figure 35. Capture rate for each month for rough-skinned newts.

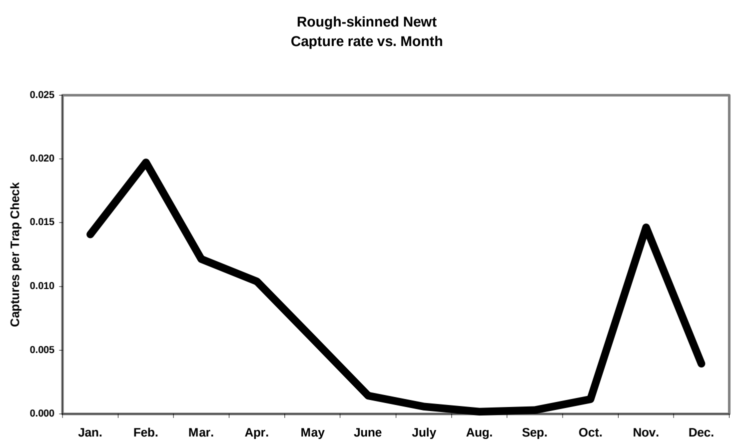


Figure 36. Photographic rate for each site for mule deer.

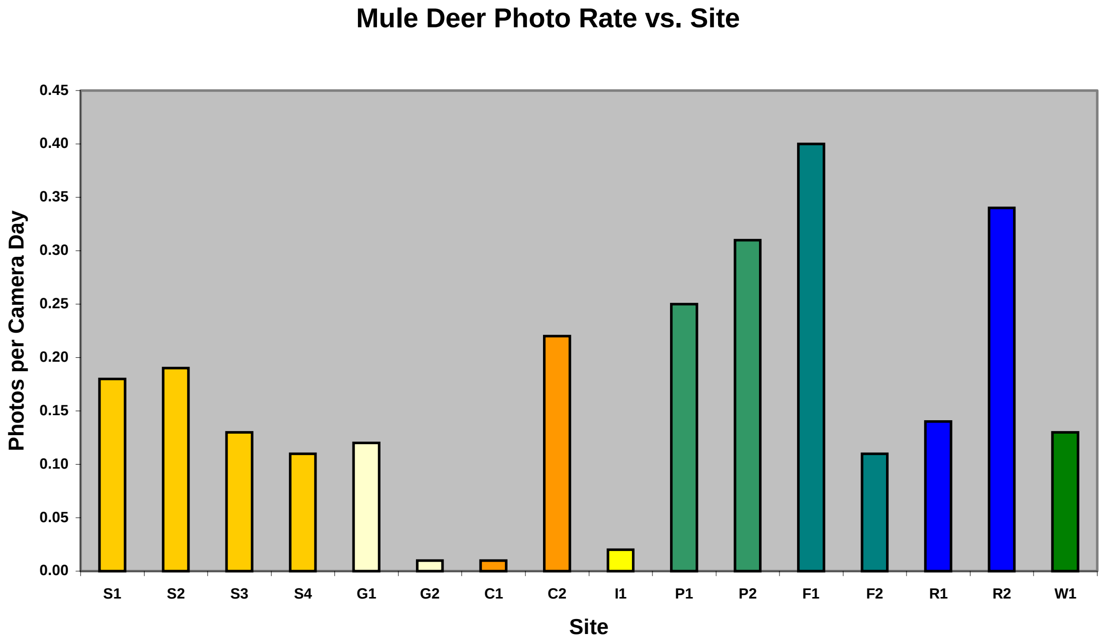


Figure 37. Photographic rate for each site for bobcat.

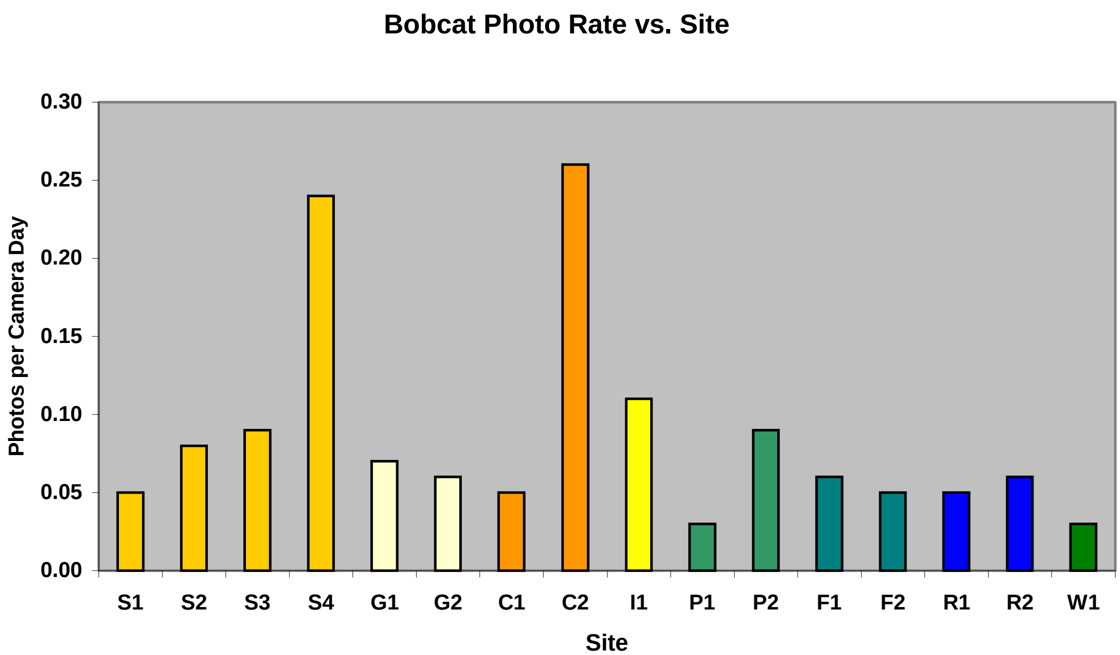


Figure 38. Photographic rate for each site for striped skunk.

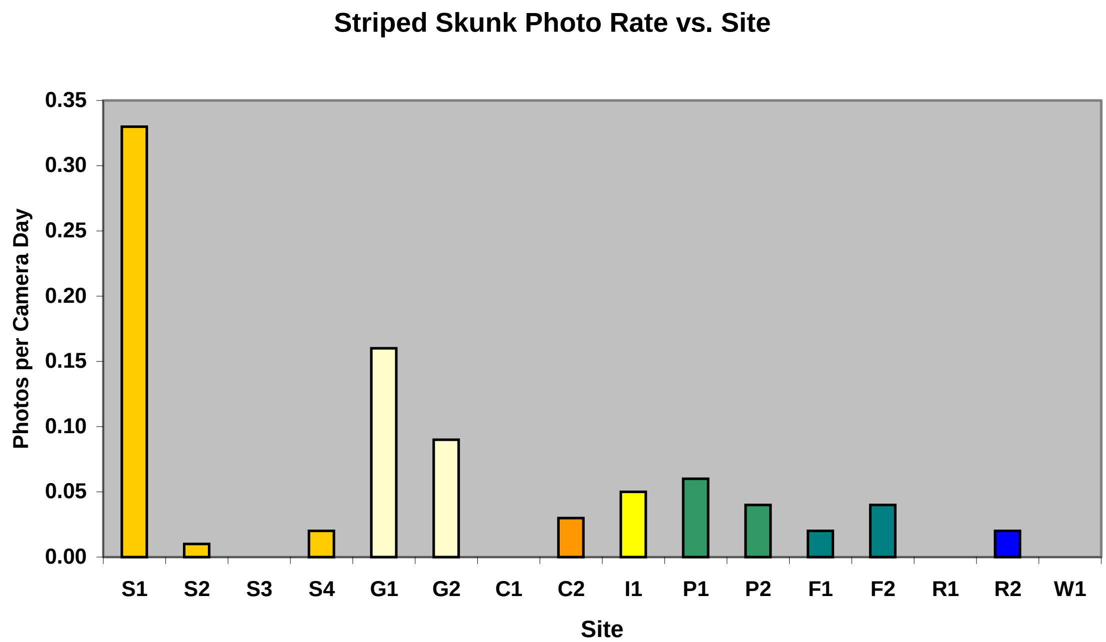


Figure 39. Photographic rate for each site for raccoon.

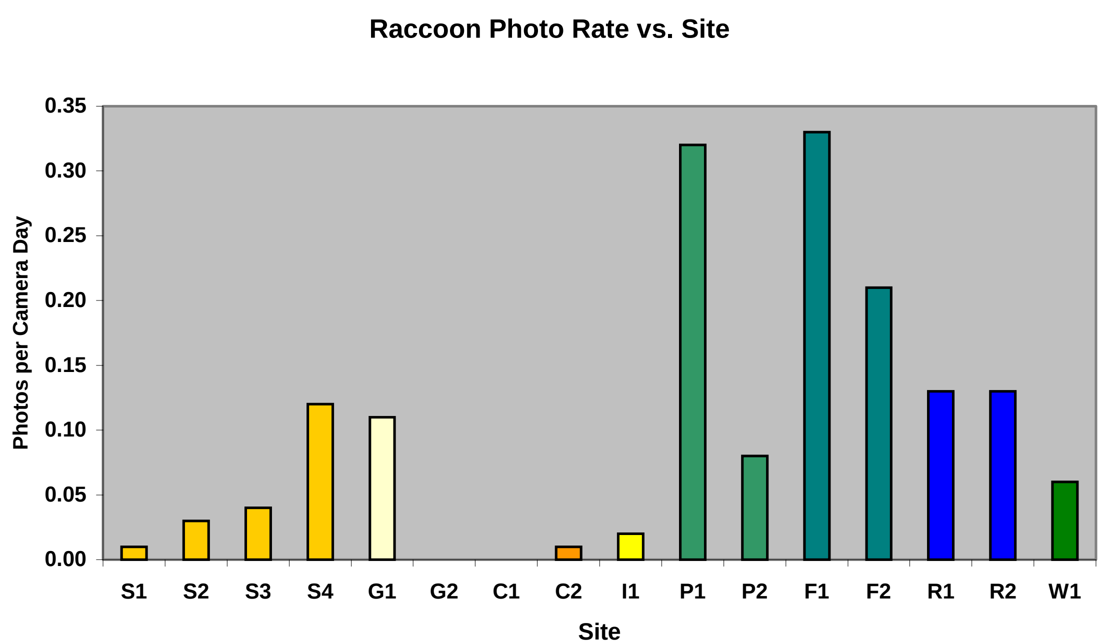


Figure 40. Photographic rate for each site for coyote.

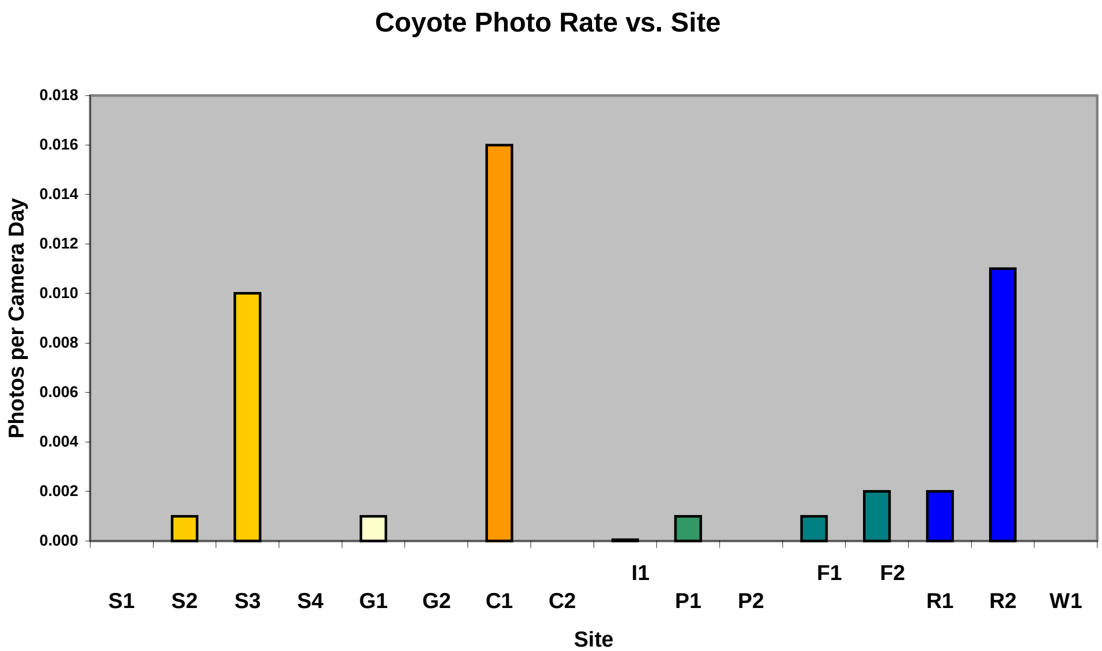


Figure 41. Photographic rate for each site for opossum.

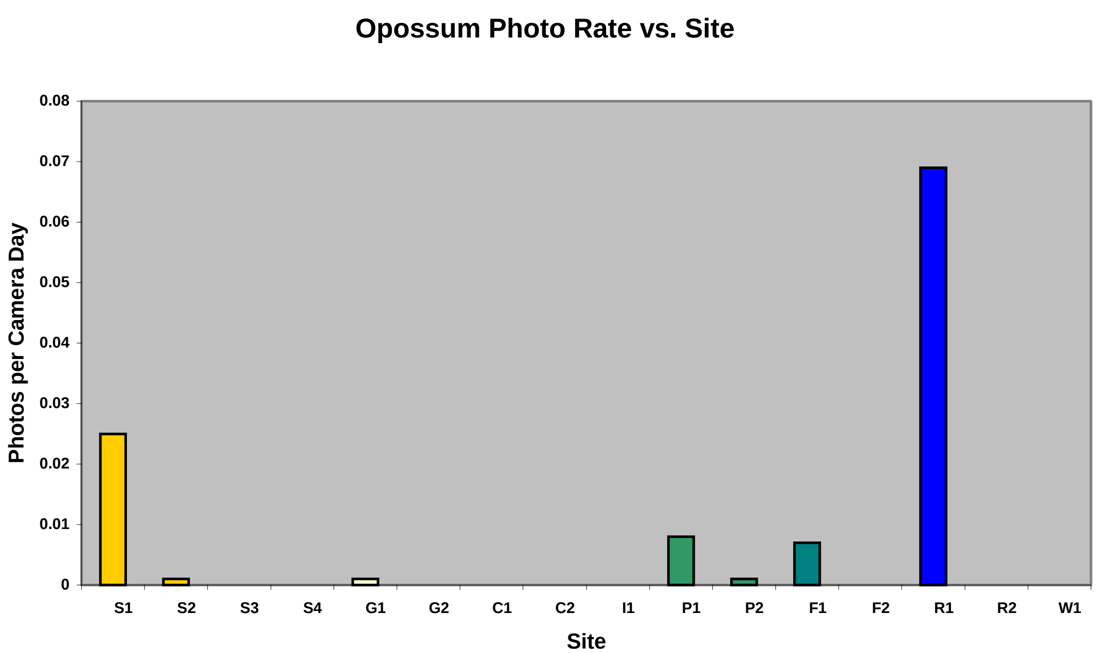


Figure 42. Photographic rate for each site for brush rabbit.

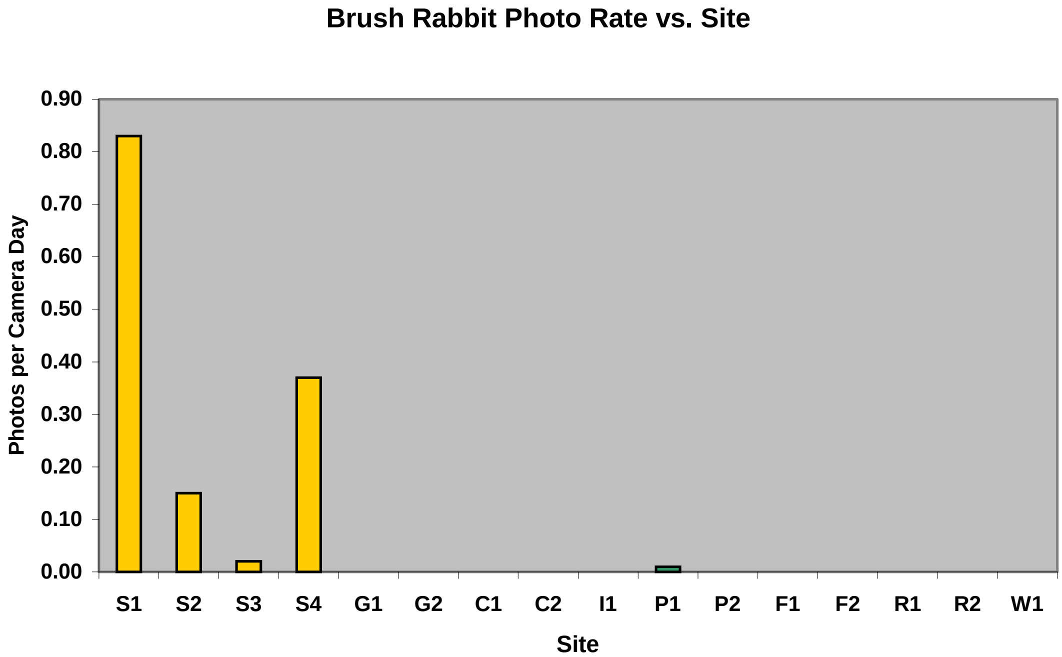


Figure 43. Photographic rate for each site for black-tailed jackrabbit.

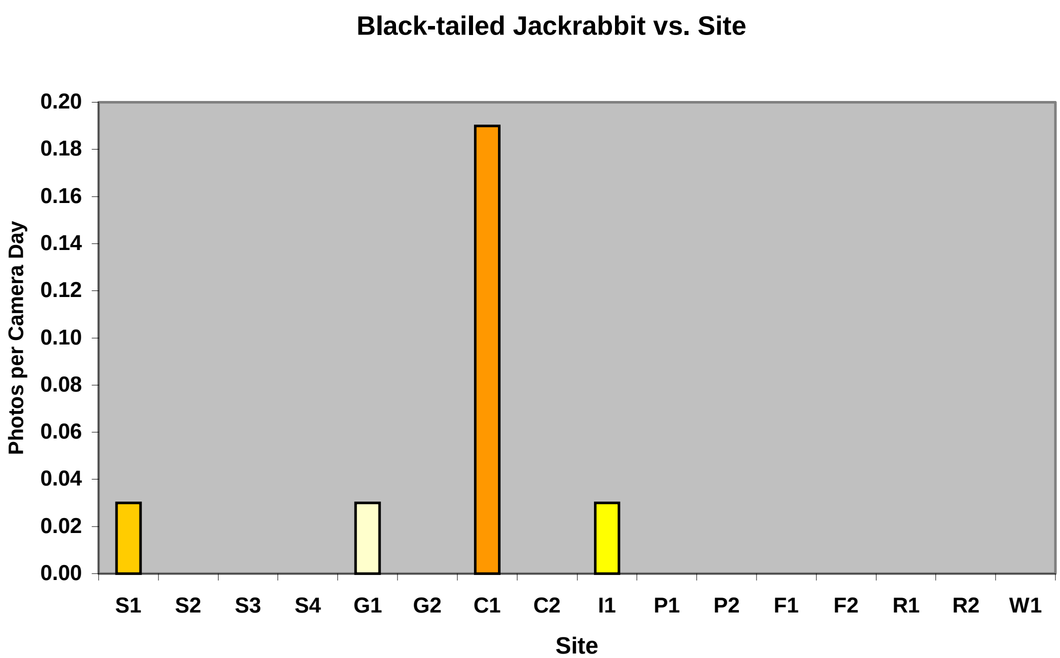


Figure 44. Photographic rate for each site for badger.

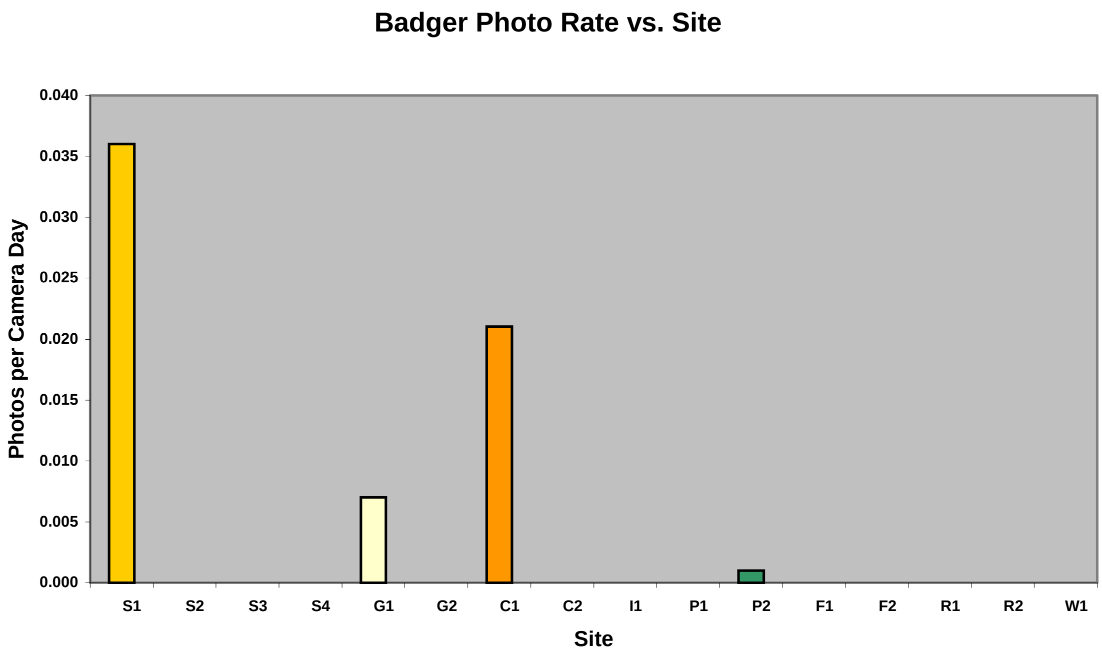


Figure 45. Photographic rate for each site for gray fox.

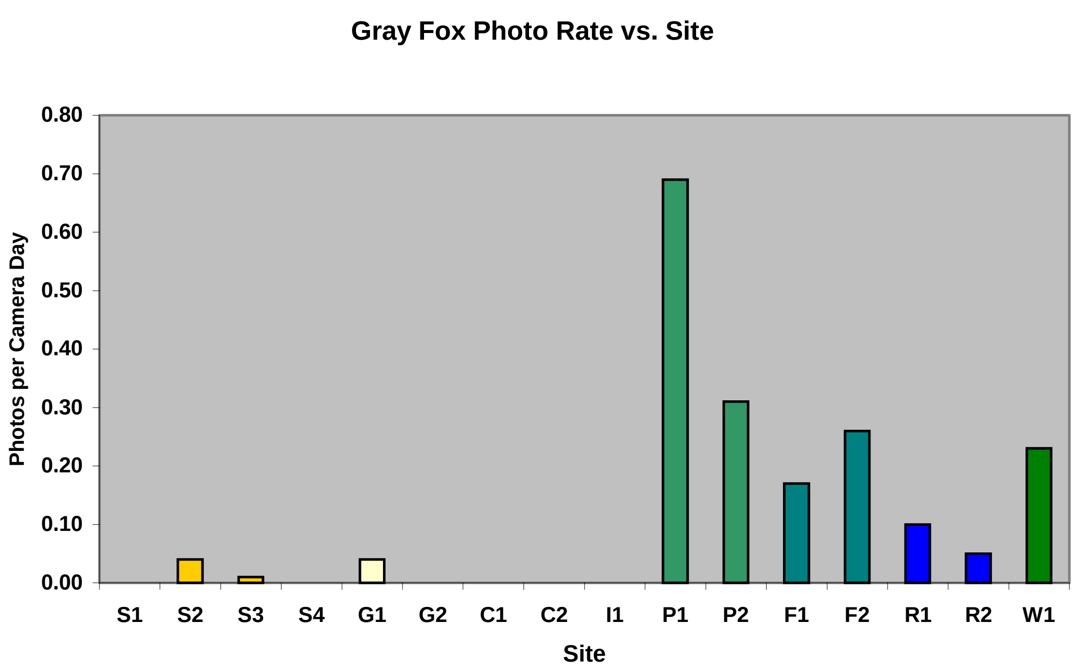


Figure 46. Photographic rate for each site for western gray squirrel.

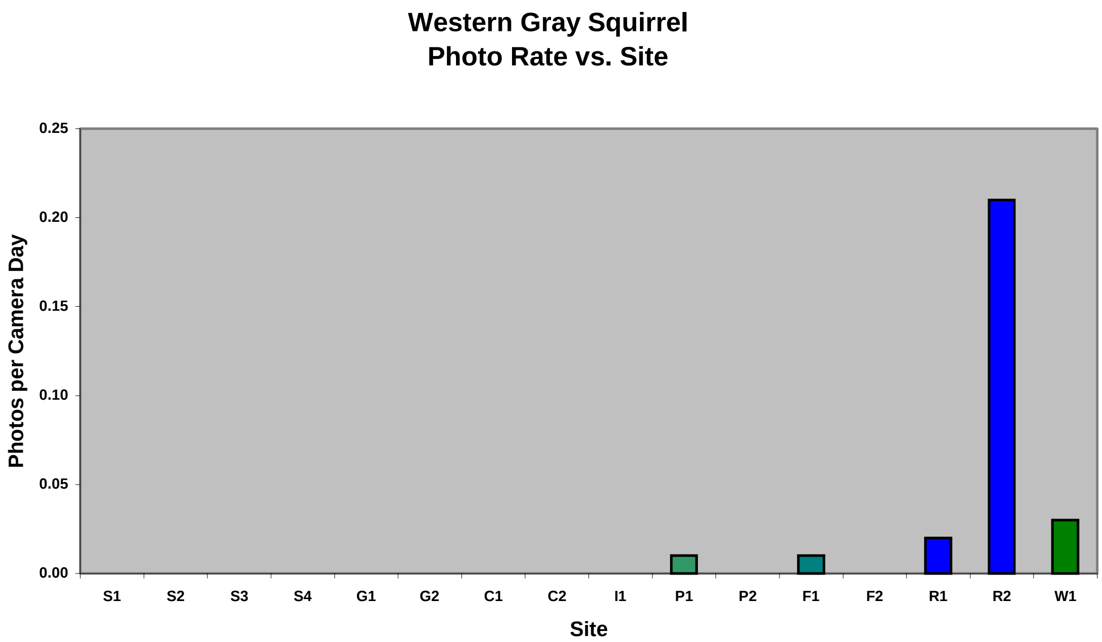


Figure 47. Photographic rate for each site for mountain lion.

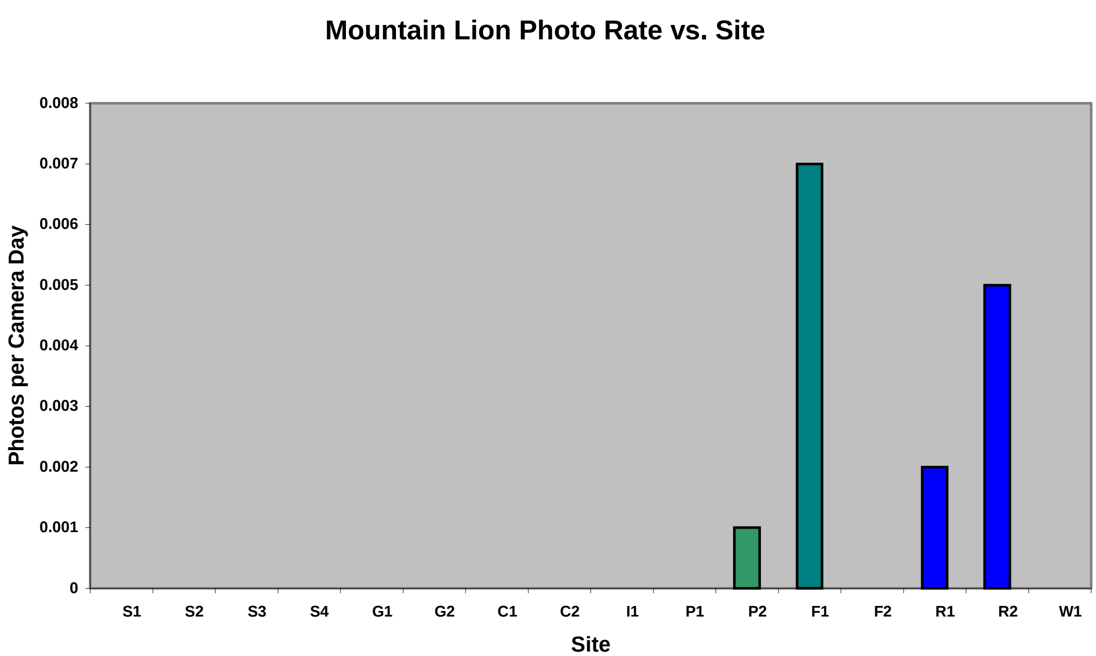


Figure 48. Photographic rate for each site for fallow deer.

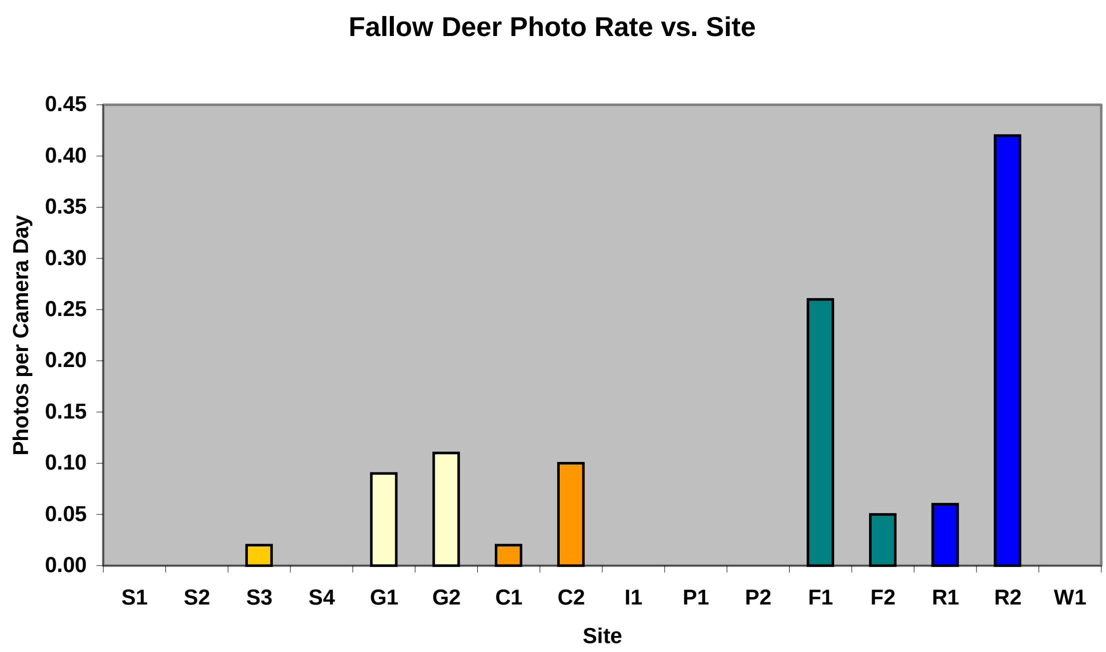


Figure 49. Photographic rate for each site for tule elk.

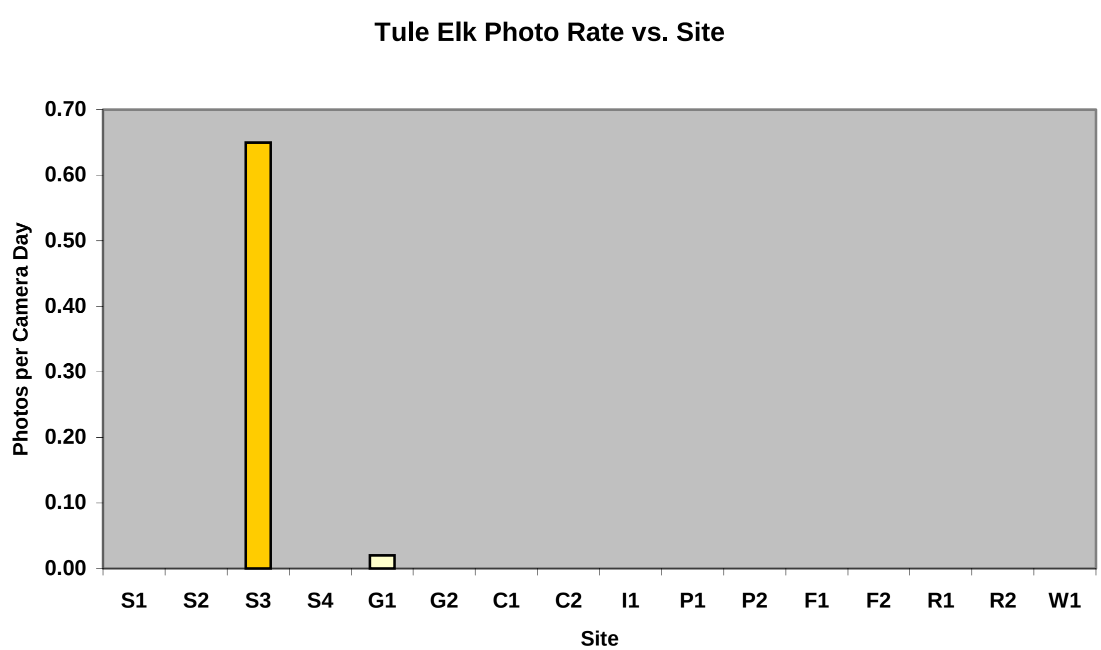


Figure 50. Species accumulation curves for small mammals, reptiles, and amphibians at the first eight sites sampled.

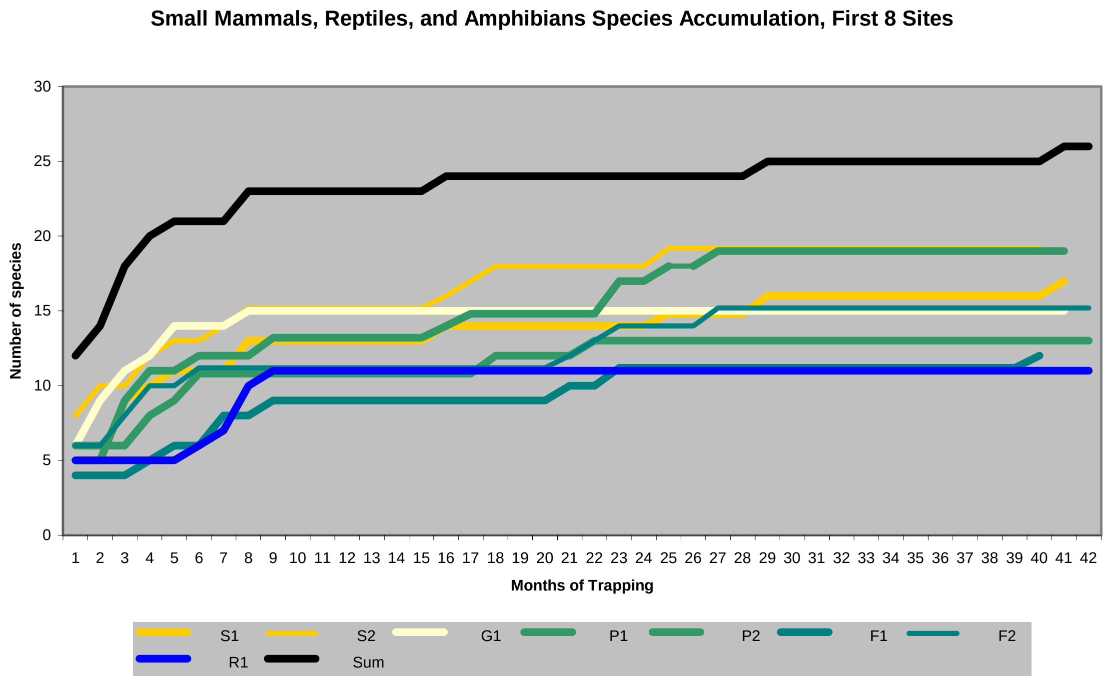


Figure 51. Species accumulation curves for large- and medium-sized mammals at the first eight sites sampled.

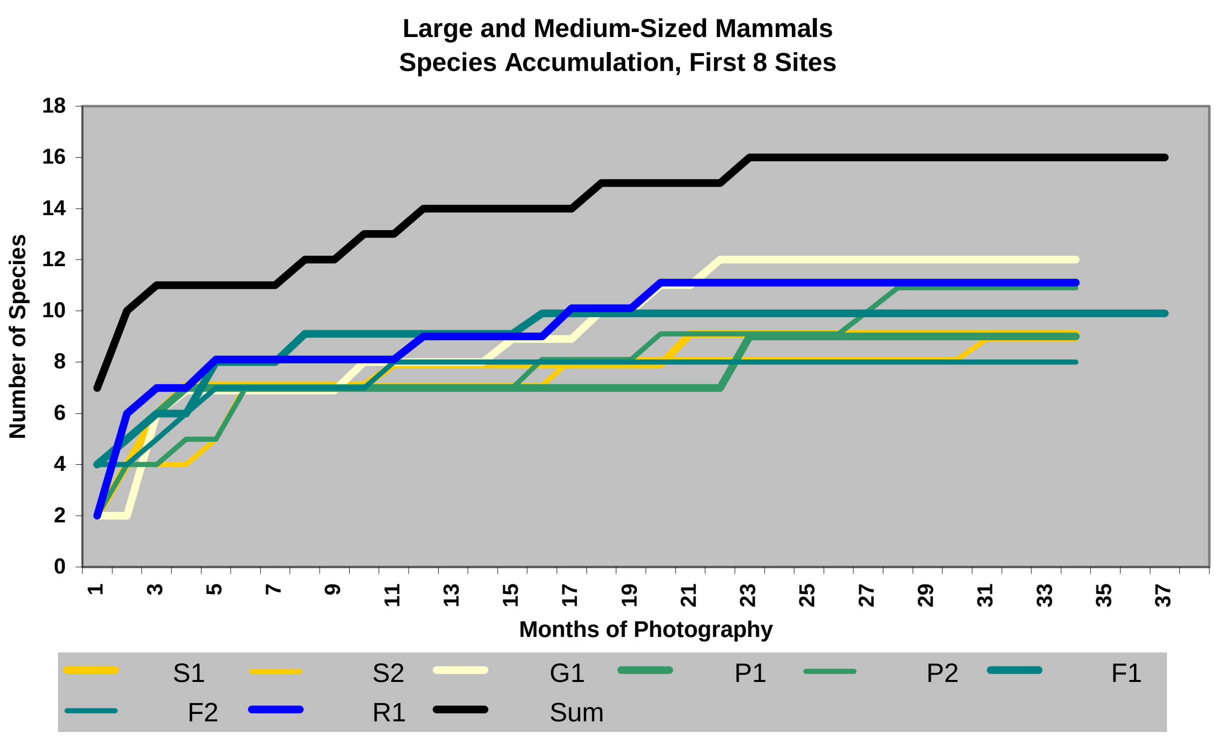
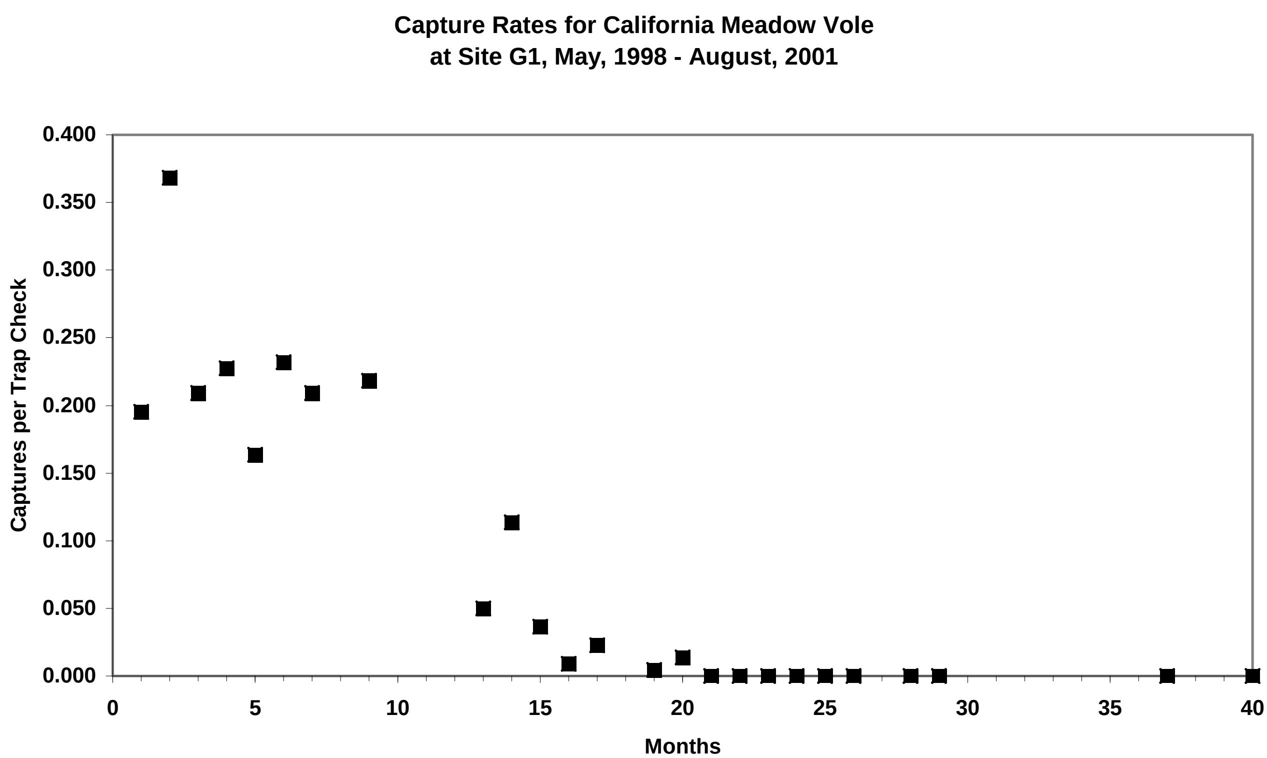


Figure 52. Capture rate for California meadow vole at site G1 (grassland).



Appendix A. Capture rate for alligator lizards.

	Sherman Traps			Pitfall Traps			Boards			All Traps Combined		
Site	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate
S1	2,691	1	0.0004	3,248	111	0.0340	348	11	0.0300	6,287	123	0.0200
S2	2,711	0	0.0000	3,248	44	0.0140	348	21	0.0600	6,307	65	0.0100
S3	376	0	0.0000	448	4	0.0090	48	0	0.0000	872	4	0.0050
S4	373	0	0.0000	448	4	0.0090	48	1	0.0200	869	5	0.0060
G1	2,478	0	0.0000	2,632	9	0.0030	324	1	0.0030	5,434	10	0.0020
G2	375	0	0.0000	448	4	0.0090	48	3	0.0600	871	7	0.0080
C1	354	0	0.0000	448	0	0.0000	48	0	0.0000	850	0	0.0000
C2	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
I1	378	1	0.0030	448	8	0.0200	48	1	0.0200	874	10	0.0110
P1	2,678	0	0.0000	3,248	1	0.0003	348	0	0.0000	6,274	1	0.0002
P2	2,678	0	0.0000	3,248	0	0.0000	348	1	0.0030	6,274	1	0.0002
F1	2,601	0	0.0000	3,248	0	0.0000	348	0	0.0000	6,197	0	0.0000
F2	2,701	0	0.0000	3,248	1	0.0003	348	1	0.0030	6,297	2	0.0003
R1	2,547	0	0.0000	3,248	0	0.0000	348	0	0.0000	6,143	0	0.0000
R2	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
W1	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
Total	24,072	2	0.0001	28,952	186	0.0060	3,144	40	0.0130	56,168	228	0.0040

Appendix B. Capture rate for California meadow vole.

	Sherman Traps			Pitfall Traps			Boards			All Traps Combined		
Site	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate
S1	2,691	77	0.0290	3,248	129	0.0400	348	0	0.0000	6,287	206	0.0330
S2	2,711	47	0.0170	3,248	88	0.0270	348	0	0.0000	6,307	135	0.0210
S3	376	2	0.0050	448	3	0.0070	48	0	0.0000	872	5	0.0060
S4	373	5	0.0130	448	5	0.0100	48	0	0.0000	869	10	0.0120
G1	2,478	290	0.1170	2,632	170	0.0650	324	1	0.0030	5,434	461	0.0850
G2	375	0	0.0000	448	2	0.0040	48	0	0.0000	871	2	0.0020
C1	354	0	0.0000	448	1	0.0020	48	0	0.0000	850	1	0.0010
C2	378	1	0.0030	448	26	0.0600	48	0	0.0000	874	27	0.0310
I1	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
P1	2,678	14	0.0050	3,248	8	0.0020	348	0	0.0000	6,274	22	0.0040
P2	2,678	4	0.0010	3,248	16	0.0050	348	0	0.0000	6,274	20	0.0030
F1	2,601	2	0.0010	3,248	5	0.0020	348	0	0.0000	6,197	7	0.0014
F2	2,701	10	0.0040	3,248	7	0.0020	348	0	0.0000	6,297	17	0.0030
R1	2,547	3	0.0010	3,248	5	0.0020	348	0	0.0000	6,143	8	0.0010
R2	378	0	0.0000	448	1	0.0020	48	0	0.0000	874	1	0.0010
W1	378	0	0.0000	448	2	0.0040	48	0	0.0000	874	2	0.0020
Total	24,072	455	0.0190	28,952	468	0.0160	3,144	1	0.0003	56,168	924	0.0165

Appendix C. Capture rate for California slender salamanders.

	Sherman Traps			Pitfall Traps			Boards			All Traps Combined		
Site	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate
S1	2,691	0	0.0000	3,248	1	0.0003	348	0	0.0000	6,287	1	0.0002
S2	2,711	0	0.0000	3,248	20	0.0060	348	16	0.0460	6,307	36	0.0060
S3	376	0	0.0000	448	3	0.0070	48	1	0.0200	872	4	0.0050
S4	373	0	0.0000	448	6	0.0100	48	16	0.3300	869	22	0.0250
G1	2,478	0	0.0000	2,632	3	0.0010	324	2	0.0060	5,434	5	0.0009
G2	375	0	0.0000	448	0	0.0000	48	0	0.0000	871	0	0.0000
C1	354	0	0.0000	448	0	0.0000	48	0	0.0000	850	0	0.0000
C2	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
I1	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
P1	2,678	0	0.0000	3,248	35	0.0110	348	313	0.8990	6,274	348	0.0550
P2	2,678	0	0.0000	3,248	23	0.0070	348	228	0.6550	6,274	251	0.0400
F1	2,601	0	0.0000	3,248	28	0.0090	348	85	0.2440	6,197	113	0.0180
F2	2,701	0	0.0000	3,248	72	0.0220	348	491	1.4100	6,297	563	0.0890
R1	2,547	0	0.0000	3,248	43	0.0130	348	315	0.9050	6,143	358	0.0580
R2	378	0	0.0000	448	11	0.0200	48	42	0.8800	874	53	0.0610
W1	378	1	0.0030	448	2	0.0040	48	41	0.8500	874	44	0.0500
Total	24,072	1	0.0004	28,952	247	0.0090	3,144	1,550	0.4930	56,168	1,798	0.0320

Appendix D. Capture rate for deer mouse.

	Sherman Traps			Pitfall Traps			Boards			All Traps Combined		
Site	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate
S1	2,691	442	0.1640	3,248	33	0.0100	348	13	0.0400	6,287	488	0.0780
S2	2,711	590	0.2180	3,248	26	0.0080	348	2	0.0060	6,307	618	0.0980
S3	376	89	0.2370	448	12	0.0270	48	0	0.0000	872	101	0.1160
S4	373	130	0.3500	448	19	0.0400	48	0	0.0000	869	149	0.1710
G1	2,478	90	0.0360	2,632	1	0.0004	324	3	0.0100	5,434	94	0.0170
G2	375	32	0.0850	448	0	0.0000	48	1	0.0030	871	33	0.0380
C1	354	77	0.2180	448	18	0.0400	48	6	0.1200	850	101	0.1190
C2	378	79	0.2090	448	11	0.0200	48	11	0.2300	874	101	0.1160
I1	378	76	0.2010	448	10	0.0200	48	0	0.0000	874	86	0.0980
P1	2,678	235	0.0880	3,248	16	0.0050	348	1	0.0030	6,274	252	0.0400
P2	2,678	310	0.1160	3,248	13	0.0040	348	2	0.0060	6,274	325	0.0520
F1	2,601	183	0.0700	3,248	15	0.0050	348	0	0.0000	6,197	198	0.0320
F2	2,701	409	0.1510	3,248	14	0.0040	348	0	0.0000	6,297	423	0.0670
R1	2,547	334	0.1310	3,248	72	0.0220	348	5	0.0100	6,143	411	0.0670
R2	378	68	0.1800	448	49	0.1100	48	0	0.0000	874	117	0.1340
W1	378	111	0.2940	448	24	0.0500	48	0	0.0000	874	135	0.1540
Total	24,072	3,255	0.1350	28,952	333	0.0120	3,144	44	0.0140	56,168	3,632	0.0650

Appendix E. Capture rate for Ensatina salamander.

	Sherman Traps			Pitfall Traps			Boards			All Traps Combined		
Site	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate
S1	2,691	0	0.0000	3,248	0	0.0000	348	0	0.0000	6,287	0	0.0000
S2	2,711	0	0.0000	3,248	25	0.0080	348	1	0.0030	6,307	26	0.0040
S3	376	0	0.0000	448	3	0.0070	48	0	0.0000	872	3	0.0030
S4	373	0	0.0000	448	0	0.0000	48	0	0.0000	869	0	0.0000
G1	2,478	0	0.0000	2,632	3	0.0010	324	0	0.0000	5,434	3	0.0006
G2	375	0	0.0000	448	0	0.0000	48	0	0.0000	871	0	0.0000
C1	354	0	0.0000	448	0	0.0000	48	0	0.0000	850	0	0.0000
C2	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
I1	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
P1	2,678	0	0.0000	3,248	23	0.0070	348	22	0.0600	6,274	45	0.0070
P2	2,678	0	0.0000	3,248	42	0.0100	348	32	0.0900	6,274	74	0.0120
F1	2,601	0	0.0000	3,248	61	0.0190	348	19	0.0500	6,197	80	0.0130
F2	2,701	0	0.0000	3,248	49	0.0150	348	64	0.1840	6,297	113	0.0180
R1	2,547	0	0.0000	3,248	68	0.0210	348	14	0.0400	6,143	82	0.0130
R2	378	0	0.0000	448	13	0.0300	48	7	0.1500	874	20	0.0230
W1	378	0	0.0000	448	2	0.0040	48	8	0.1700	874	10	0.0110
Total	24,072	0	0.0000	28,952	289	0.0100	3,144	167	0.0530	56,168	456	0.0080

Appendix F. Capture rate for Fog shrew.

	Sherman Traps			Pitfall Traps			Boards			All Traps Combined		
Site	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate
S1	2,691	0	0.0000	3,248	2	0.0006	348	0	0.0000	6,287	2	0.0003
S2	2,711	0	0.0000	3,248	3	0.0009	348	0	0.0000	6,307	3	0.0005
S3	376	0	0.0000	448	0	0.0000	48	0	0.0000	872	0	0.0000
S4	373	0	0.0000	448	1	0.0020	48	0	0.0000	869	1	0.0010
G1	2,478	0	0.0000	2,632	2	0.0008	324	0	0.0000	5,434	2	0.0004
G2	375	0	0.0000	448	0	0.0000	48	0	0.0000	871	0	0.0000
C1	354	0	0.0000	448	0	0.0000	48	0	0.0000	850	0	0.0000
C2	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
I1	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
P1	2,678	1	0.0004	3,248	6	0.0020	348	0	0.0000	6,274	7	0.0010
P2	2,678	0	0.0000	3,248	3	0.0009	348	0	0.0000	6,274	3	0.0005
F1	2,601	0	0.0000	3,248	1	0.0003	348	0	0.0000	6,197	1	0.0002
F2	2,701	14	0.0050	3,248	46	0.0140	348	0	0.0000	6,297	60	0.0095
R1	2,547	3	0.0010	3,248	20	0.0060	348	0	0.0000	6,143	23	0.0037
R2	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
W1	378	0	0.0000	448	3	0.0070	48	0	0.0000	874	3	0.0030
Total	24,072	18	0.0007	28,952	87	0.0030	3,144	0	0.0000	56,168	105	0.0019

Appendix G. Capture rate for rough-skinned newt.

	Sherman Traps			Pitfall Traps			Boards			All Traps Combined		
Site	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate
S1	2,691	0	0.0000	3,248	6	0.0020	348	0	0.0000	6,287	6	0.0010
S2	2,711	1	0.0004	3,248	34	0.0100	348	0	0.0000	6,307	35	0.0060
S3	376	0	0.0000	448	0	0.0000	48	0	0.0000	872	0	0.0000
S4	373	0	0.0000	448	0	0.0000	48	0	0.0000	869	0	0.0000
G1	2,478	0	0.0000	2,632	0	0.0000	324	0	0.0000	5,434	0	0.0000
G2	375	0	0.0000	448	0	0.0000	48	0	0.0000	871	0	0.0000
C1	354	0	0.0000	448	0	0.0000	48	0	0.0000	850	0	0.0000
C2	378	0	0.0000	448	1	0.0020	48	0	0.0000	874	1	0.0010
I1	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
P1	2,678	0	0.0000	3,248	137	0.0420	348	3	0.0100	6,274	140	0.0220
P2	2,678	0	0.0000	3,248	87	0.0270	348	6	0.0200	6,274	93	0.0150
F1	2,601	0	0.0000	3,248	2	0.0006	348	0	0.0000	6,197	2	0.0003
F2	2,701	0	0.0000	3,248	26	0.0080	348	1	0.0030	6,297	27	0.0040
R1	2,547	0	0.0000	3,248	1	0.0003	348	0	0.0000	6,143	1	0.0002
R2	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
W1	378	0	0.0000	448	1	0.0020	48	0	0.0000	874	1	0.0010
Total	24,072	1	0.0000	28,952	295	0.0100	3,144	10	0.0030	56,168	306	0.0050

Appendix H. Capture rate for Trowbridge shrew.

	Sherman Traps			Pitfall Traps			Boards			All Traps Combined		
Site	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate
S1	2,691	1	0.0004	3,248	6	0.0020	348	0	0.0000	6,287	7	0.0010
S2	2,711	6	0.0020	3,248	69	0.0200	348	0	0.0000	6,307	75	0.0120
S3	376	0	0.0000	448	10	0.0200	48	0	0.0000	872	10	0.0110
S4	373	3	0.0080	448	32	0.0700	48	0	0.0000	869	35	0.0400
G1	2,478	0	0.0000	2,632	2	0.0010	324	0	0.0000	5,434	2	0.0004
G2	375	0	0.0000	448	0	0.0000	48	0	0.0000	871	0	0.0000
C1	354	0	0.0000	448	0	0.0000	48	0	0.0000	850	0	0.0000
C2	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
I1	378	0	0.0000	448	1	0.0020	48	0	0.0000	874	1	0.0010
P1	2,678	6	0.0020	3,248	97	0.0300	348	1	0.0030	6,274	104	0.0170
P2	2,678	4	0.0010	3,248	158	0.0490	348	0	0.0000	6,274	162	0.0260
F1	2,601	5	0.0020	3,248	143	0.0440	348	0	0.0000	6,197	148	0.0240
F2	2,701	8	0.0030	3,248	348	0.1070	348	0	0.0000	6,297	356	0.0570
R1	2,547	11	0.0040	3,248	267	0.0820	348	1	0.0030	6,143	279	0.0450
R2	378	0	0.0000	448	10	0.0200	48	0	0.0000	874	10	0.0110
W1	378	2	0.0050	448	16	0.0400	48	0	0.0000	874	18	0.0210
Total	24,072	46	0.0020	28,952	1,159	0.0400	3,144	2	0.0010	56,168	1,207	0.0210

Appendix I. Capture rate for vagrant shrew.

	Sherman Traps			Pitfall Traps			Boards			All Traps Combined		
Site	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate
S1	2,691	9	0.0030	3,248	271	0.0830	348	0	0.0000	6,287	280	0.0450
S2	2,711	9	0.0030	3,248	159	0.0490	348	0	0.0000	6,307	168	0.0270
S3	376	0	0.0000	448	83	0.1900	48	0	0.0000	872	83	0.0950
S4	373	1	0.0030	448	24	0.0500	48	0	0.0000	869	25	0.0290
G1	2,478	1	0.0004	2,632	106	0.0400	324	1	0.0030	5,434	108	0.0200
G2	375	0	0.0000	448	4	0.0090	48	0	0.0000	871	4	0.0050
C1	354	1	0.0030	448	20	0.0400	48	0	0.0000	850	21	0.0250
C2	378	0	0.0000	448	60	0.1300	48	0	0.0000	874	60	0.0690
I1	378	2	0.0050	448	34	0.0800	48	0	0.0000	874	36	0.0410
P1	2,678	0	0.0000	3,248	0	0.0000	348	0	0.0000	6,274	0	0.0000
P2	2,678	0	0.0000	3,248	20	0.0060	348	0	0.0000	6,274	20	0.0030
F1	2,601	0	0.0000	3,248	6	0.0020	348	0	0.0000	6,197	6	0.0010
F2	2,701	1	0.0004	3,248	29	0.0090	348	0	0.0000	6,297	30	0.0050
R1	2,547	0	0.0000	3,248	0	0.0000	348	0	0.0000	6,143	0	0.0000
R2	378	0	0.0000	448	1	0.0020	48	0	0.0000	874	1	0.0010
W1	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
Total	24,072	24	0.0001	28,952	817	0.0280	3,144	1	0.0003	56,168	842	0.0150

Appendix J. Capture rate for western harvest mouse.

	Sherman Traps			Pitfall Traps			Boards			All Traps Combined		
Site	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate
S1	2,691	8	0.0030	3,248	179	0.0550	348	0	0.0000	6,287	187	0.0300
S2	2,711	8	0.0030	3,248	114	0.0350	348	0	0.0000	6,307	122	0.0190
S3	376	0	0.0000	448	21	0.0500	48	0	0.0000	872	21	0.0240
S4	373	0	0.0000	448	10	0.0200	48	0	0.0000	869	10	0.0120
G1	2,478	37	0.0150	2,632	140	0.0530	324	0	0.0000	5,434	177	0.0330
G2	375	5	0.0130	448	61	0.1400	48	0	0.0000	871	66	0.0760
C1	354	0	0.0000	448	0	0.0000	48	0	0.0000	850	0	0.0000
C2	378	0	0.0000	448	1	0.0020	48	0	0.0000	874	1	0.0010
I1	378	0	0.0000	448	4	0.0090	48	0	0.0000	874	4	0.0050
P1	2,678	0	0.0000	3,248	3	0.0009	348	0	0.0000	6,274	3	0.0005
P2	2,678	1	0.0004	3,248	10	0.0030	348	0	0.0000	6,274	11	0.0020
F1	2,601	0	0.0000	3,248	2	0.0006	348	0	0.0000	6,197	2	0.0003
F2	2,701	1	0.0004	3,248	1	0.0003	348	0	0.0000	6,297	2	0.0003
R1	2,547	0	0.0000	3,248	1	0.0003	348	0	0.0000	6,143	1	0.0002
R2	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
W1	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
Total	24,072	60	0.0025	28,952	547	0.0190	3,144	0	0.0000	56,168	607	0.0110

Appendix K. Capture rate for western terrestrial garter snake.

	Sherman Traps			Pitfall traps			Boards			All Traps Combined		
Site	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate	Checks	Captures	Rate
S1	2,691	0	0.0000	3,248	4	0.0010	348	29	0.0800	6,287	33	0.0050
S2	2,711	0	0.0000	3,248	6	0.0020	348	97	0.2800	6,307	103	0.0160
S3	376	0	0.0000	448	1	0.0020	48	6	0.1200	872	7	0.0080
S4	373	0	0.0000	448	0	0.0000	48	1	0.0030	869	1	0.0010
G1	2,478	1	0.0004	2,632	4	0.0010	324	8	0.0200	5,434	13	0.0020
G2	375	0	0.0000	448	0	0.0000	48	0	0.0000	871	0	0.0000
C1	354	0	0.0000	448	1	0.0020	48	0	0.0000	850	1	0.0010
C2	378	1	0.0030	448	6	0.0100	48	2	0.0400	874	9	0.0100
I1	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
P1	2,678	0	0.0000	3,248	0	0.0000	348	1	0.0030	6,274	1	0.0002
P2	2,678	0	0.0000	3,248	1	0.0003	348	0	0.0000	6,274	1	0.0002
F1	2,601	0	0.0000	3,248	0	0.0000	348	0	0.0000	6,197	0	0.0000
F2	2,701	0	0.0000	3,248	0	0.0000	348	0	0.0000	6,297	0	0.0000
R1	2,547	0	0.0000	3,248	0	0.0000	348	0	0.0000	6,143	0	0.0000
R2	378	0	0.0000	448	1	0.0020	48	0	0.0000	874	1	0.0010
W1	378	0	0.0000	448	0	0.0000	48	0	0.0000	874	0	0.0000
Total	24,072	2	0.0001	28,952	24	0.0008	3,144	144	0.0460	56,168	170	0.0030

Appendix L. Small Mammal, reptile, and amphibian capture rate for each month.

		Deer Mouse		California Meadow Vole		Western Harvest Mouse		Trowbridge Shrew		Vagrant Shrew	
Month	Trap Checks	Captures	Rate	Captures	Rate	Captures	Rate	Captures	Rate	Captures	Rate
Jan.	2,981	169	0.0567	95	0.0319	116	0.0389	37	0.0124	12	0.0040
Feb.	3,193	187	0.0586	8	0.0025	29	0.0091	51	0.0160	16	0.0050
Mar.	4,860	307	0.0632	79	0.0163	74	0.0152	69	0.0142	71	0.0146
Apr.	3,367	182	0.0541	26	0.0077	12	0.0036	41	0.0122	87	0.0258
May	5,067	354	0.0699	72	0.0142	19	0.0037	171	0.0337	98	0.0193
June	6,340	397	0.0626	145	0.0229	15	0.0024	241	0.0380	128	0.0202
July	5,285	313	0.0592	95	0.0180	7	0.0013	196	0.0371	80	0.0151
Aug.	6,072	319	0.0525	50	0.0082	36	0.0059	155	0.0255	37	0.0061
Sep.	3,251	211	0.0649	90	0.0277	21	0.0065	53	0.0163	48	0.0148
Oct.	2,592	120	0.0463	93	0.0359	14	0.0054	33	0.0127	15	0.0058
Nov.	3,144	119	0.0378	72	0.0229	40	0.0127	71	0.0226	4	0.0013
Dec.	3,048	132	0.0433	34	0.0112	122	0.0400	16	0.0052	17	0.0056
Totals	49,198	2810	0.0567	859	0.0175	505	0.0103	1134	0.0230	613	0.0125

Appendix L. - continued

		Fog Shrew		Slender Salamander		Ensatina		Rough-skinned Newt		W. Terr. Garter Snake	
Month	Trap Checks	Captures	Rate	Captures	Rate	Captures	Rate	Captures	Rate	Captures	Rate
Jan.	2,981	0	0.0000	140	0.0470	58	0.0195	42	0.0141	4	0.0013
Feb.	3,193	1	0.0003	252	0.0789	67	0.0210	63	0.0197	0	0.0000
Mar.	4,860	2	0.0004	309	0.0636	67	0.0138	59	0.0121	11	0.0023
Apr.	3,367	4	0.0012	143	0.0425	21	0.0062	35	0.0104	12	0.0036
May	5,067	18	0.0036	209	0.0412	20	0.0039	30	0.0059	24	0.0047
June	6,340	20	0.0032	170	0.0268	26	0.0041	9	0.0014	28	0.0044
July	5,285	18	0.0034	81	0.0153	9	0.0017	3	0.0006	21	0.0040
Aug.	6,072	20	0.0033	71	0.0117	14	0.0023	1	0.0002	5	0.0008
Sep.	3,251	14	0.0043	26	0.0080	5	0.0015	1	0.0003	17	0.0052
Oct.	2,592	2	0.0008	38	0.0147	20	0.0077	3	0.0012	19	0.0073
Nov.	3,144	0	0.0000	114	0.0363	81	0.0258	46	0.0146	11	0.0035
Dec.	3,048	1	0.0003	122	0.0400	37	0.0121	12	0.0039	4	0.0013
Totals	49,198	100	0.0020	1675	0.0340	425	0.0086	304	0.0062	156	0.0032

Appendix L. - continued

Month	Trap Checks	North. Alligator Lizard Captures	North. Alligator Lizard Rate	Shrew Mole Captures	Shrew Mole Rate	Dusky-footed Woodrat Captures	Dusky-footed Woodrat Rate	Broad-footed Mole Captures	Broad-footed Mole Rate	Pocket Gopher Captures	Pocket Gopher Rate
Jan.	2,981	1	0.0003	0	0.0000	0	0.0000	0	0.0000	0	0.0000
Feb.	3,193	0	0.0000	2	0.0006	0	0.0000	0	0.0000	0	0.0000
Mar.	4,860	18	0.0037	2	0.0004	1	0.0002	0	0.0000	1	0.0002
Apr.	3,367	49	0.0146	7	0.0021	0	0.0000	1	0.0003	2	0.0006
May	5,067	28	0.0055	6	0.0012	0	0.0000	6	0.0012	3	0.0006
June	6,340	36	0.0057	5	0.0008	4	0.0006	1	0.0002	8	0.0013
July	5,285	17	0.0032	2	0.0004	1	0.0002	2	0.0004	2	0.0004
Aug.	6,072	19	0.0031	1	0.0002	7	0.0012	1	0.0002	0	0.0000
Sep.	3,251	24	0.0074	1	0.0003	4	0.0012	2	0.0006	0	0.0000
Oct.	2,592	7	0.0027	1	0.0004	0	0.0000	0	0.0000	0	0.0000
Nov.	3,144	3	0.0010	2	0.0006	1	0.0003	0	0.0000	1	0.0003
Dec.	3,048	1	0.0003	0	0.0000	0	0.0000	0	0.0000	0	0.0000
Totals	49,198	203	0.0041	29	0.0006	18	0.0004	13	0.0003	17	0.0003

Appendix L. - continued

		Sonoma Chipmunk		Pacific Giant Salamander		Racer		Red-legged Frog	
Month	Trap Checks	Captures	Rate	Captures	Rate	Captures	Rate	Captures	Rate
Jan.	2,981	2	0.0007	5	0.0017	0	0.0000	2	0.0007
Feb.	3,193	1	0.0003	1	0.0003	0	0.0000	0	0.0000
Mar.	4,860	3	0.0006	0	0.0000	0	0.0000	0	0.0000
Apr.	3,367	2	0.0006	2	0.0006	0	0.0000	0	0.0000
May	5,067	0	0.0000	3	0.0006	2	0.0004	0	0.0000
June	6,340	5	0.0008	0	0.0000	5	0.0008	0	0.0000
July	5,285	1	0.0002	0	0.0000	12	0.0023	0	0.0000
Aug.	6,072	0	0.0000	0	0.0000	4	0.0007	4	0.0007
Sep.	3,251	0	0.0000	0	0.0000	4	0.0012	1	0.0003
Oct.	2,592	1	0.0004	0	0.0000	2	0.0008	5	0.0019
Nov.	3,144	1	0.0003	1	0.0003	0	0.0000	1	0.0003
Dec.	3,048	0	0.0000	0	0.0000	0	0.0000	0	0.0000
Totals	49,198	16	0.0003	12	0.0002	29	0.0006	13	0.0003

Appendix M. Photographs of large- and medium-sized mammals for each species for each month.

		Mule deer		Gray fox		Raccoon		Brush rabbit		Bobcat	
Site	Camera days	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
S1	768.45	141	0.183	1	0.001	8	0.010	634	0.825	41	0.053
S2	865.26	166	0.192	33	0.038	27	0.031	129	0.149	73	0.084
S3	199.56	26	0.130	1	0.005	7	0.035	4	0.020	17	0.085
S4	211.84	24	0.113	0	0.000	25	0.118	79	0.373	51	0.241
G1	756.93	93	0.123	28	0.037	85	0.112	2	0.003	54	0.071
G2	174.86	1	0.006	0	0.000	0	0.000	0	0.000	11	0.063
C1	188.28	2	0.011	0	0.000	0	0.000	0	0.000	9	0.048
C2	155.76	35	0.225	0	0.000	1	0.006	0	0.000	41	0.263
I1	222.77	4	0.018	0	0.000	5	0.022	0	0.000	25	0.112
P1	894.03	227	0.254	614	0.687	284	0.318	5	0.006	30	0.034
P2	887.83	273	0.307	271	0.305	67	0.075	4	0.005	80	0.090
F1	977.86	389	0.398	168	0.172	324	0.331	1	0.001	56	0.057
F2	906.42	99	0.109	237	0.261	189	0.209	0	0.000	49	0.054
R1	919.30	133	0.145	90	0.098	119	0.129	1	0.001	48	0.052
R2	188.14	64	0.340	9	0.048	25	0.133	0	0.000	11	0.058
W1	207.93	27	0.130	47	0.226	12	0.058	0	0.000	7	0.034
Totals	8525.22	1704	0.1999	1499	0.1758	1178	0.1382	859	0.1008	603	0.0707

Appendix M. - continued.

Site	Striped skunk		Fallow deer		Tule elk		Opossum		Black-tailed jackrabbit		Western gray squirrel	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
S1	253	0.329	0	0.000	0	0.000	19	0.025	26	0.034	0	0.000
S2	10	0.012	4	0.005	0	0.000	1	0.001	0	0.000	0	0.000
S3	0	0.000	4	0.020	130	0.651	0	0.000	0	0.000	0	0.000
S4	4	0.019	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
G1	120	0.159	69	0.091	15	0.020	1	0.001	25	0.033	0	0.000
G2	16	0.092	19	0.109	0	0.000	0	0.000	0	0.000	0	0.000
C1	0	0.000	3	0.016	0	0.000	0	0.000	36	0.191	0	0.000
C2	5	0.032	15	0.096	0	0.000	0	0.000	0	0.000	0	0.000
I1	11	0.049	0	0.000	0	0.000	0	0.000	7	0.031	0	0.000
P1	54	0.060	0	0.000	0	0.000	7	0.008	0	0.000	5	0.006
P2	39	0.044	2	0.002	0	0.000	1	0.001	0	0.000	1	0.001
F1	24	0.025	257	0.263	0	0.000	7	0.007	0	0.000	12	0.012
F2	34	0.038	43	0.047	0	0.000	0	0.000	0	0.000	0	0.000
R1	3	0.003	59	0.064	0	0.000	63	0.069	0	0.000	20	0.022
R2	4	0.021	79	0.420	0	0.000	0	0.000	0	0.000	39	0.207
W1	1	0.005	0	0.000	0	0.000	0	0.000	0	0.000	6	0.029
Totals	578	0.0678	554	0.0650	145	0.0170	99	0.0116	94	0.0110	83	0.0097

Appendix M. - continued.

Site	Badger		Dusky-footed woodrat		Coyote		Mountain lion		Long-tailed weasel		Spotted skunk	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
S1	28	0.036	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
S2	0	0.000	0	0.000	1	0.001	0	0.000	0	0.000	0	0.000
S3	0	0.000	0	0.000	2	0.010	0	0.000	2	0.010	0	0.000
S4	0	0.000	1	0.005	0	0.000	0	0.000	0	0.000	0	0.000
G1	5	0.007	0	0.000	1	0.001	0	0.000	0	0.000	0	0.000
G2	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
C1	4	0.021	0	0.000	3	0.016	0	0.000	0	0.000	0	0.000
C2	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
I1	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
P1	0	0.000	0	0.000	1	0.001	0	0.000	0	0.000	1	0.001
P2	1	0.001	0	0.000	0	0.000	1	0.001	0	0.000	0	0.000
F1	0	0.000	0	0.000	1	0.001	7	0.007	0	0.000	0	0.000
F2	0	0.000	0	0.000	2	0.002	0	0.000	0	0.000	0	0.000
R1	0	0.000	0	0.000	2	0.002	2	0.002	0	0.000	0	0.000
R2	0	0.000	1	0.005	2	0.011	1	0.005	0	0.000	0	0.000
W1	0	0.000	19	0.091	0	0.000	0	0.000	0	0.000	0	0.000
Totals	38	0.0045	21	0.0025	15	0.0018	11	0.0013	2	0.0002	1	0.0001

Appendix M. - continued.

	Red fox		Wildlife total	
Site	Number	Rate	Number	Rate
S1	0	0.000	1151	1.498
S2	0	0.000	444	0.513
S3	0	0.000	193	0.967
S4	0	0.000	184	0.869
G1	0	0.000	498	0.658
G2	0	0.000	47	0.269
C1	0	0.000	57	0.303
C2	0	0.000	97	0.623
I1	0	0.000	52	0.233
P1	0	0.000	1228	1.374
P2	0	0.000	740	0.833
F1	0	0.000	1246	1.274
F2	1	0.001	654	0.722
R1	0	0.000	540	0.587
R2	0	0.000	235	1.249
W1	0	0.000	119	0.572
Totals	1	0.0001	7485	0.8780