WILDLIFE CORRIDOR MONITORING STUDY FOR THE MULTIPLE SPECIES CONSERVATION PROGRAM

Prepared for:

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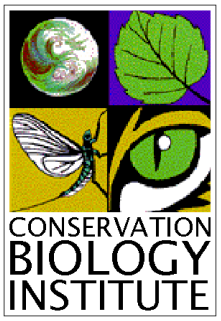

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TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

1.0 INTRODUCTION

1.1 BACKGROUND

The Multiple Species Conservation Program (MSCP) is a habitat conservation, management, and monitoring program designed to conserve multiple species and native vegetation communities in southwestern San Diego County. It is being implemented as part of the Natural Community Conservation Planning (NCCP) program initiated by the State of California. The MSCP is multi-jurisdictional and is being implemented through various subarea plans developed by each jurisdiction participating in the program. Each subarea plan prioritizes the resources most important for conservation and management in that portion of the MSCP planning area.

The MSCP preserve was designed to maintain connections between core habitat areas, including linkages between coastal lagoons and more inland habitats, and linkages between different watersheds. In addition to allowing for demographic and genetic exchange by all species between core preserve areas, linkages are intended to allow larger predators (mountain lions, coyotes, and bobcats) to move among conserved habitat blocks and reach coastal habitats. These top predators are particularly vulnerable to extirpation from fragmented habitats (Soulé et al. 1992, Noss 1983), which can precipitate further changes to ecological communities. Dominant carnivores can suppress smaller carnivores through both competition and predation. Consequently, the decline of top predators in fragmented areas may lead to increased populations of smaller predators ("mesopredators"), such as gray foxes, raccoons, striped skunks, opossums, and house cats (i.e., mesopredator release, Soulé et al. 1988, Crooks 2000). Thus, dominant carnivores such as coyotes may be fundamental in maintaining the ecological integrity of the coastal sage scrub and chaparral systems.

For purposes of this report, habitat linkages are defined as habitat areas that provide connectivity between habitat patches as well as year-round foraging, reproduction, and dispersal habitat for resident plants and animals (MSCP 1995). A wildlife corridor is a landscape feature, usually relatively narrow, that allows animal movement between two patches of habitat or between habitat and geographically discrete resources (Ogden 1996). Wildlife corridors must have species-specific characteristics to be functional for a given target species (e.g., Soulé 1991, Beier and Loe 1992). A "chokepoint" is a portion of a wildlife corridor that is constricted, generally due to encroachment of adjacent development or other land uses.

Monitoring species use of habitat linkages and wildlife corridors is one component of the MSCP Biological Monitoring Plan (Ogden 1996). The monitoring plan was developed to document compliance with the MSCP, measure the effectiveness of the conservation program, and inform adaptive management decisions.

1.2 LINKAGES EVALUATED IN THIS STUDY

The City of Poway, City of San Diego, and County of San Diego have completed and are implementing their subarea plans for the MSCP. The MSCP Biological Monitoring Plan and the Poway and San Diego subarea plans identify several corridors critical to regional wildlife movement in the MSCP preserve (Figure 1-1):

- West-east Los Peñasquitos Canyon—Beeler Canyon riparian linkage between coastal and interior habitats in the cities of San Diego and Poway.

- North-south linkage in Poway from San Pasqual Valley, through Sycamore Creek, Green Valley Creek, and Blue Sky Reserve, south to Sycamore and Clark canyons.

- North-south linkage in San Diego between Carmel Valley and Los Peñasquitos Canyon, through Big Shaw Valley, Little Shaw Valley, and lower Shaw Valley.

All of these habitat linkages are vulnerable to or have already been impacted by adjacent development. In addition, the Poway NCCP Subarea Plan specifies that the Scripps-Poway Parkway underpass be monitored to evaluate its effectiveness in facilitating movement of large mammals and reducing road mortality.

1.3 QUESTIONS ADDRESSED

This study was designed to address the following questions:

- Are the wildlife corridors identified in the subarea plans functional?
- What large mammals (deer, mountain lion, bobcat, coyote) and mesopredators use the linkages?
- What potential constraints to animal movement exist in these areas?
- Where are habitat restoration or other management actions needed to facilitate animal movement?
- Does the Scripps-Poway Parkway underpass function effectively for wildlife movement?
- What survey methods are most efficient in identifying corridor use and evaluating corridor function for each target species?

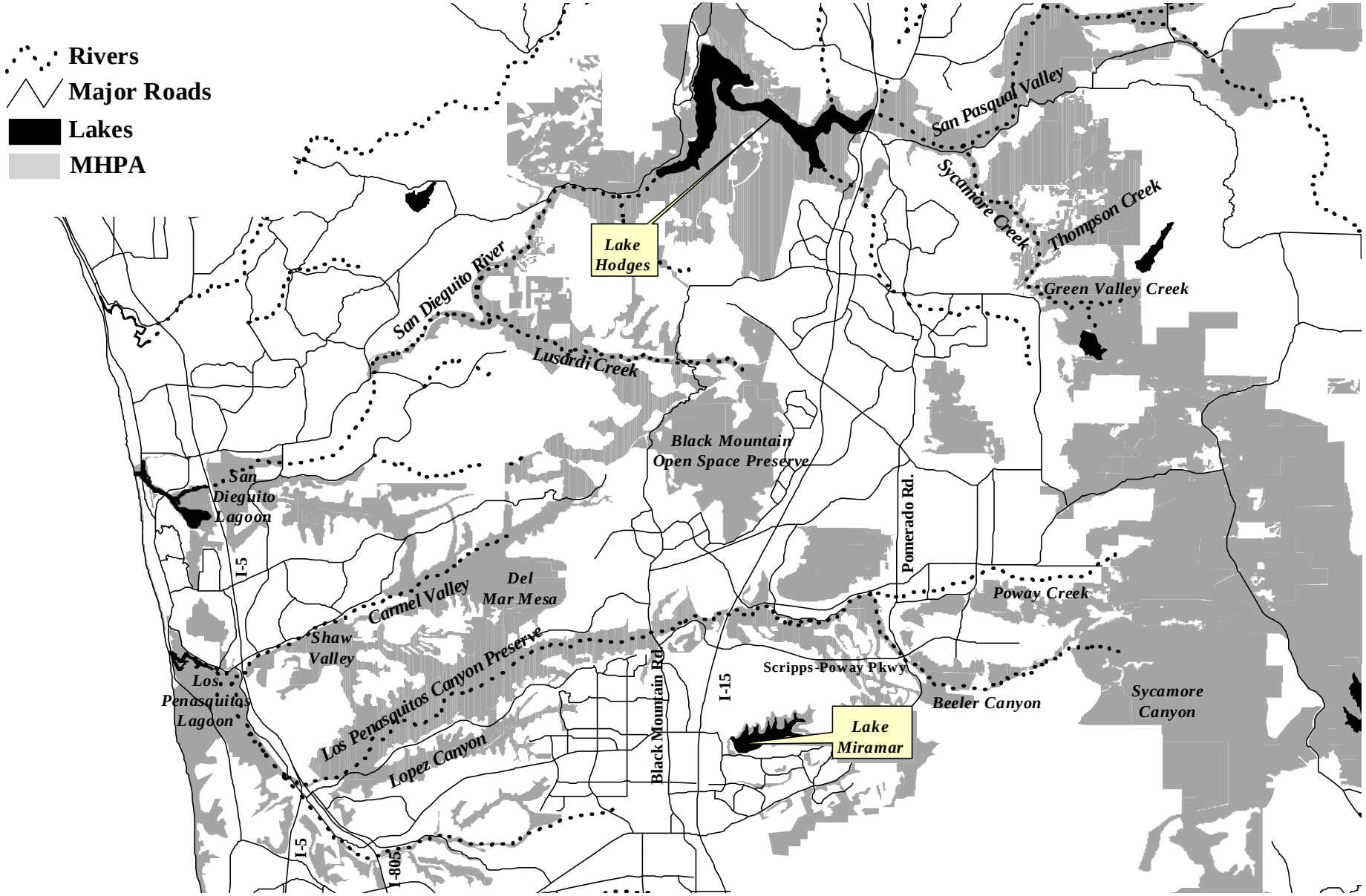


Figure 1-1
Vicinity Map and Generalized Linkage Locations

1.4 PROJECT TEAM

The Conservation Biology Institute (CBI), a 501(c)(3) organization with expertise in preserve design, management, and monitoring, worked with Mr. Jim Nessel of the City of Poway and Mr. Keith Greer of the City of San Diego to direct the study. Dr. Kevin Crooks of the University of Wisconsin, Madison, directed the field surveys, following protocols from his research on carnivores in San Diego, Riverside, and Orange counties. Ms. Sierra Hayden, a graduate student at San Diego State University, was the primary field biologist and conducted this study as part of her masters degree research. The San Diego Tracking Team (SDTT) contributed data from its efforts in Los Peñasquitos Canyon, the San Dieguito River Park, and the Scripps-Poway Parkway underpass. All of these participants have reviewed and contributed to this report. This report also benefited from discussions with and review by Dr. Jay Diffendorfer of San Diego State University.

Funding for this study was provided by the California Department of Fish and Game (CDFG) as part of a NCCP Local Assistant Grant to the City of Poway. Mr. David Lawhead served as the technical administrator of the grant and provided input to this study.

2.0 METHODS

2.1 STUDY AREA AND TRANSECT LOCATIONS

The majority of transects were located in or adjacent to riparian woodlands and riparian scrub, surrounded by coastal sage scrub, grasslands, and chaparral (Figure 2-1). Transect locations were mapped using a Global Positioning System (GPS) unit to determine coordinates. Track stations and cameras were placed along all of the transects, except Del Mar Mesa, where there was no camera. Segments of some track station and camera transects were also co-located with segments of SDTT wildlife sign transects. The SDTT surveys were not conducted as part of this study, but SDTT data were used in the analysis for comparing results of different survey methods.

Following is a list of the track station and camera transects, grouped by linkage, and numbered (in parentheses) as in Figure 2-1.

Carmel Creek

- Carmel Creek at I-5 bridge (Transect #1)
  (Carmel Creek Road exit; access from Carmel Valley Park 'n' Ride lot)

Shaw Valley

- Little Shaw Valley from mesa top (Transect #2)
  (Access from Carmel Mountain Road at west end of Del Mar Mesa)

- Big Shaw Valley from mesa top (Transect #3)
  (Access from Carmel Mountain Road at east end of Del Mar Mesa)

- Lower Shaw Valley at intersection of Big and Little Shaw valleys at Bougainvillea Golf Course double culverts under Carmel Country Road (Transect #4)
  (Access from Carmel Country Road)

Los Peñasquitos Canyon

Lower

- I-5/I-805 merge at western end of Los Peñasquitos Canyon (Transect #5)
  (Access from Sorrento Valley Road)

- Los Peñasquitos Canyon Preserve (LPCP) Interior 4 (canyon floor) near Little Shaw Valley (Transect #6)
  (Located on park access road at far west end of preserve, north side of creek)

- LPCP Interior 3 (north canyon wall) at Little Shaw Valley (Transect #7)
  (Located on park access road, west end of preserve, north side of creek)

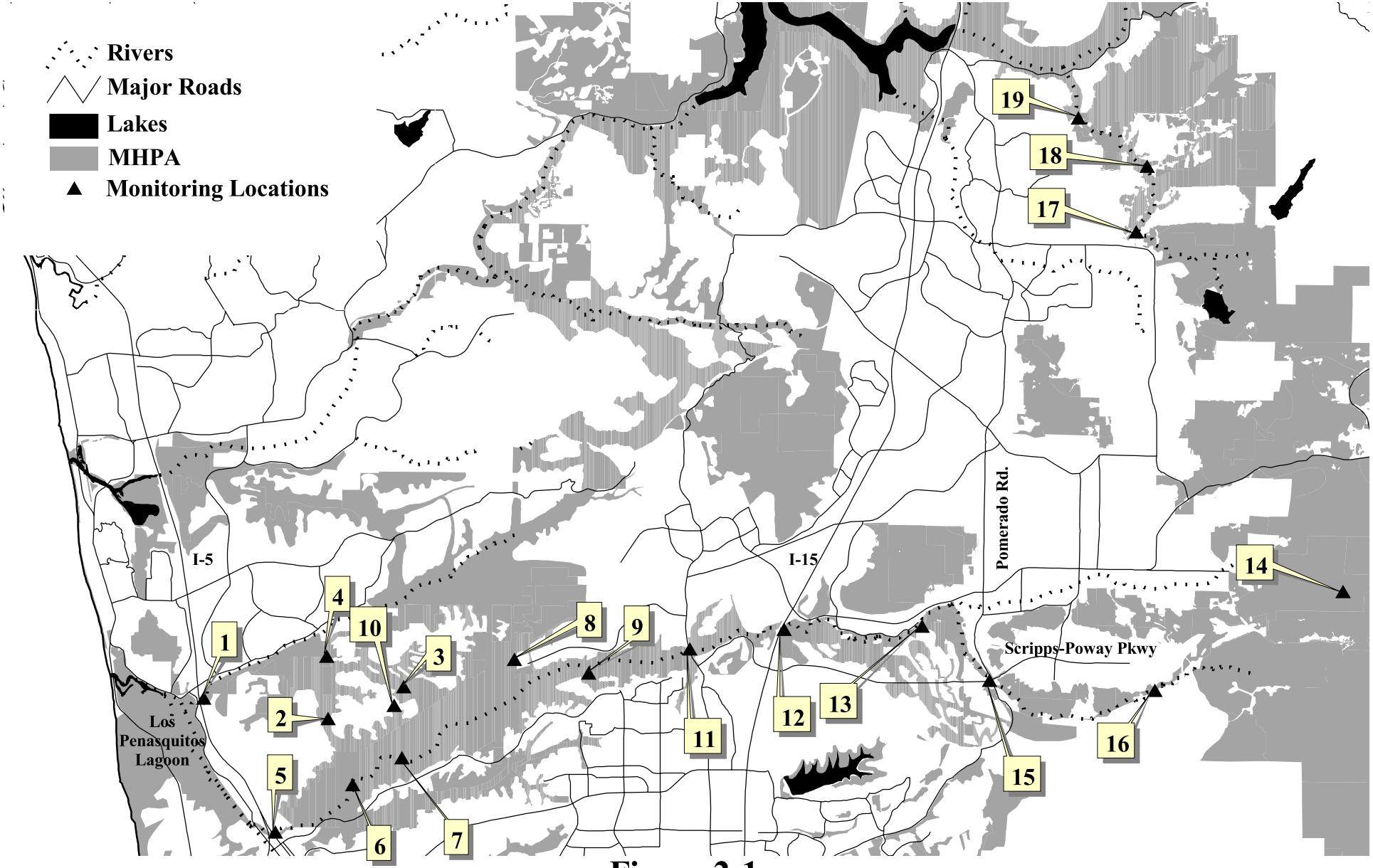


Figure 2-1
General Locations of Track Station and Camera Transects

1- Carmel Creek
2- Little Shaw Valley
3- Big Shaw Valley
4- Lower Shaw Valley
5- I-5/805 Merge
6- LPCP Interior 4
7- LPCP Interior 3
8- LPCP Interior 2
9- LPCP Interior 1
10- Del Mar Mesa
11- Black Mtn Rd Bridge
12- I-15 Bridge
13- Penasquitos Crk at Sabre Springs
14- Scripps-Poway Pkwy Underpass
15- Lower Beeler Canyon
16- Upper Beeler Canyon
17- Green Valley Crk near Blue Sky Reserve
18- Green Valley - Thompson Crks Confluence
19- San Dieguito River Park

- LPCP Interior 2 near Park Village Road (Transect #8)
  (Located on access road at end of Park Village Drive, north side of creek)

- LPCP Interior 1 (canyon floor) near Black Mountain Road (Transect #9)
  (Located just after park entrance at east end of preserve, south side of creek)

- Del Mar Mesa top, south side (Transect #10)
  (Access from Carmel Mountain Road)

Upper

- Black Mountain Road bridge over Los Peñasquitos Creek (Transect #11)
  (Near east end of Los Peñasquitos Canyon Preserve)

- I-15 bridge over Los Peñasquitos Creek (Transect #12)
  (Access from Scripps-Poway Parkway)

- Los Peñasquitos Creek at Sabre Springs (Transect #13)
  (Access from intersection of Poway Road and Springhurst Road)

Scripps-Poway Parkway underpass

- Scripps-Poway Parkway underpass (Transect #14)
  (Access from Scripps-Poway Parkway)

Beeler Canyon

- Lower Beeler Canyon at intersection of Scripps-Poway Parkway and Pomerado Road (Transect #15)

- Upper Beeler Canyon at Calmat gravel pit (Transect #16)

Sycamore Creek

- Green Valley Creek near Blue Sky Reserve and Butcher Property (Transect #17)
  (Access from Old Coach Road)

- Green Valley Creek and Thompson Creek confluence (Transect #18)
  (Access from Old Coach Road)

- San Dieguito River Park (lower Sycamore Creek, Transect #19)
  (Access from Highland Road)

2.2 SURVEY TECHNIQUES

2.2.1 Track Station Surveys

Transects were approximately 1 km long, generally following roads or trails (human and/or wildlife) at each study site (Linhart and Knowlton 1975). If no bridges intersected a transect, then five track stations were placed at 250-m intervals along the transect. At bridges, including the Scripps-Poway Parkway underpass, baited track stations were constructed near each opening of the underpass to detect wildlife movement on both sides of the undercrossing. Additional track stations were constructed when the track transect was located on both sides of a creek. In this situation, track station positions relative to the underpass were identical when possible. (See Appendix A for a more detailed description of placement of track stations.) Each track station consisted of a 1-m diameter circle of freshly sifted gypsum, 1 cm deep, scented with liquid carnivore scent lures (Russ Carman's Pro-Choice and Canine Call, Sterling Fur & Tool, Sterling, Ohio). Tracks on each station were measured and identified to species; tracks with ambiguous identifications were omitted from the analyses. Baited track station surveys are designed to survey for carnivores, and mule deer detections at track stations are largely opportunistic.

The track stations were sampled for five consecutive days during summer (June-August 2000) and fall (September-December 2000). For each track station, relative abundance was expressed as the total number of visits recorded for a species, divided by the total sampling effort (Linhart and Knowlton 1975, Diefenbach et al. 1994). A visit was defined as at least one track of a species found at a track station (Conner et al. 1983). An aggregated index (T) was calculated for each species to represent the species visitation rate at each track station transect in each study area. The track station transect index was calculated as (adapted from Crooks and Jones 1999):

$$T_i = v_i/(s_i\, n_i)$$

T_i = track station index of species visitation along transect i
v_i = total number of stations (s) visited across operative nights (n) by a species in transect i
s_i = number of stations in transect i
n_i = number of nights that stations were operative in transect i

2.2.2 Camera Surveys

A remotely triggered infrared camera was stationed at each transect and monitored for at least one month. Cameras were used to verify track identifications at track stations and to estimate the frequency of animals that pass by without visiting track stations. For each camera station, relative abundance was expressed as the total number of animals recorded for a species, divided by the total sampling effort (i.e., total number of animals seen in photographs divided by the total number of nights the camera station was operative). An

index (C) was calculated for each species to represent the species visitation rate for the camera station:

$$C_i = x_i/n_i$$

C_i = index of species visitation at camera station i
x_i = total number of animals of a species photographed at camera station i
n_i = number of nights that camera was operative at camera station i

2.2.3 Additional Surveys

The City of Poway provided roadkill data for city roads and Scripps-Poway Parkway. These data were entered into an Excel database but did not include specific enough locations for analysis (e.g., nearest mile marker). Caltrans does not record roadkill data. City of San Diego roadkill data were not organized by location of the city and were not readily available for review. Collection and analysis of roadkill data will be addressed as part of a separate CDFG study.

Dr. Kevin Crooks prepared a questionnaire with the intent of distributing it to property owners along the linkages. The questionnaire asked respondents about their perceptions toward urban wildlife and the types of wildlife they have seen in the area. The questionnaires were submitted to the CDFG for use in future studies. CBI and CDFG decided not to distribute the questionnaires because most of the property owners along the linkages used in this study do not live on the property; i.e., the land is publicly owned, currently undeveloped, or in the process of being developed. These questionnaires will prove useful for future monitoring efforts.

Potential crossing locations along SR-67 were evaluated for large mammal use. Culverts between Poway Road and Scripps-Poway Parkway, and animal trails leading to the culverts, were inspected for tracks and sign. These culverts are currently being monitored as part of a separate CDFG study.

2.3 SAN DIEGO TRACKING TEAM SURVEYS

The SDTT, a volunteer organization of trackers, has been conducting track and sign surveys in Los Peñasquitos Canyon since 1994. More recently, the SDTT has expanded into other areas of the county. For purposes of this study, we analyzed SDTT data for the year 2000 (summer and fall quarters where available) where transects or segments of transects overlap our study sites (shown in Figure 2-1). SDTT transect locations are currently being mapped as part of a separate CDFG study.

The SDTT conducts wildlife sign surveys on a quarterly basis, using an adaptation of the *Keeping Track* protocol that is used in other similar organizations across the country. Transects are variable in length and are typically divided into sections. Transects are located on existing trails and fire roads and traverse under bridges. All wildlife sign (e.g., tracks, scat, evidence of browse, prey caches, deer beds) is recorded along transects.

Theoretically, data are recorded for individual animals rather than total numbers of tracks observed along a transect. However, in practice, this is probably very difficult to do in a consistent fashion, particularly for sign other than tracks.

2.4 DATA ANALYSIS

Wildlife use of the corridors was evaluated using track station transect and camera station metrics, displayed graphically by location, as well as tabular species presence/absence data from SDTT sign transect surveys. No attempt was made in this report to quantitatively compare track station, camera station, or SDTT sign transect metrics.

We evaluated the three survey methods relative to detection of various wildlife species. Frequency of detection of each target wildlife species (i.e., the proportion of sampling units of each method at which a species was determined to be present) was determined for ten geographic locations where each of the three methods was used during the study. Frequency of detection was determined separately for each of the three methods using the total number of track station transects, camera stations, and sign transect segments in the ten geographic locations as the number of sampling units for each of the three methods. Track stations were aggregated for each transect, and the total number of track station transects was calculated as the total number of locations (ten) multiplied times the number of survey periods (two -- summer and fall), for a total of 20 track station transect sampling units. The total number of camera stations was calculated as the total number of locations (ten) times the number of survey periods (two), for a total of 20 camera station sampling units. For sign transects, only the portions of the sign transects that overlapped with the ten areas surveyed by the other methods were used to calculate a frequency of detection. The total number of sign transect sampling units used in the analysis was 16, because some sign transects were surveyed only during one period.

Frequency of detection (proportion of sampling units of each method detecting a given species) is displayed graphically by species, with error bars shown as 95% confidence intervals calculated for proportions (e.g., Zar 1974) as follows:

$$P_{(1-\alpha)} = p \pm Z_{\alpha(2)}\sqrt{(pq/n)}$$

$P_{(1-\alpha)}$ = $(1-\alpha = 95\%)$ confidence limits for p
p = proportion of sampling units where the target species was detected
q = proportion of sampling units where the target species was not detected
n = number of sampling units for given method
$Z_{\alpha(2)}$ = standard normal deviate for $\alpha/2$

We also evaluated whether the frequency of detection of individual wildlife species (presence or absence) is independent of the survey method, using a chi-square contingency table analysis. For each target wildlife species (mountain lion, opossum, coyote, gray fox, bobcat, raccoon, and mule deer), a 2x3 contingency table was constructed with two categories (detected or not detected) for each of the three methods (track stations, camera stations, sign transects). The actual frequencies for each of the

cells in the contingency tables were based on the proportion of the total number of sampling units for each of the three methods (as described above) in which the target species was either detected or not detected. The expected frequencies for each of the cells in the contingency table were determined assuming that the proportion of sampling units detecting a given species is independent of the survey method [i.e., expected frequency of detections for each respective method = (total number of detections/total number of sampling units) x total number of sampling units for each respective method].

3.0 RESULTS AND DISCUSSION

The MSCP preserve design includes habitat linkages to facilitate the movement of wildlife between core areas (especially large mammals), to provide foraging, sheltering, and breeding habitat within some of the larger linkages (especially mesopredators and smaller mammals), and to allow gene flow between subpopulations (for all species). Thus, a particular linkage may serve different uses for different species or even different individuals of the same species. For example, an individual linkage may allow frequent use by a predator through a single home range area as well as provide a movement corridor between two subpopulations for other individuals or species.

Ideally, a functional habitat linkage would provide for all of these movement types for all species. However, it is difficult to demonstrate empirically that linkages meet preserve design goals for all species. The data collected show whether particular wildlife species are using specific wildlife corridors. The data do not quantify the number of individuals, frequency of movement through corridors or chokepoints, the result of their movement through the corridor (e.g., whether they die or successfully breed or forage on the other side), or the persistence or long-term viability of the target populations in the core areas connected by the linkages. Therefore, in the discussion below, we consider a corridor functional for wildlife movement if it can be demonstrated that a species moves through it, without regard to the frequency or number of individuals.

Wildlife corridor monitoring has been focused within movement chokepoints, especially those created by road underpasses, because these physical constrictions represent limiting factors in preserve functionality. If we can demonstrate that a species uses or moves through the chokepoint, then we infer that the corridor is functional. We focused primarily on large mammals (mountain lion, bobcat, coyote, and mule deer), although we also documented the use of linkages by smaller mesopredators.

The specific techniques used to monitor corridor use vary in their detection rates for different species and in their ability to directly demonstrate movement through chokepoints, such as a bridge underpass or culvert. Sign transects can provide direct evidence of wildlife use *through* an underpass, whereas wildlife movement through the underpass must be *inferred* from track station data collected at either end of the underpass (as track stations were never located beneath an underpass). Cameras placed within chokepoints demonstrate that an animal was *in* the corridor but not necessarily that the animal was *moving through* the corridor.

This section presents results for track station, camera station, and, where available, SDTT sign transect monitoring at each location in the study area. We also use these results to infer functionality of these areas as wildlife movement corridors for these species and examine the efficacy of the various monitoring methods. The results are shown in Table 3-1 and the figures located at the end of Section 3. Where track and camera station indices overlap geographically, they are shown on the same graph to minimize the number of figures. However, the metrics generated by these two methods are not directly

comparable, and their presentation on the same graph should not be inferred as an attempt to directly compare the methods. Data from all track stations along a given transect are combined in the figures. Data for individual track stations are included in Appendix A. Results of the SDTT sign transects are presented in Table 3-1 as presence/absence data only.

3.1 CARMEL CREEK AT I-5

This linkage connects Los Peñasquitos Lagoon, west of I-5, with habitat along Carmel Creek and Shaw Valley, east of I-5. Monitoring was directed at the chokepoint where Carmel Creek flows under the I-5 bridge. Only mule deer and raccoons were detected by cameras, although other species were detected at track stations or along SDTT sign transects (Figure 3-1). No mountain lions, bobcats, gray foxes, or house cats were detected by any method under the I-5 bridge. All species detected at the Carmel Creek track stations were detected on both sides of the I-5 bridge, except for mule deer which were detected only on the west side of the bridge and raccoons which were detected only on the east side (Appendix A). Species sign recorded anecdotally under the bridge (not associated with track stations) included domestic dog, bobcat, mule deer, opossum, and raccoon.

SDTT surveys under the I-5 bridge over Carmel Creek detected bobcats, coyotes, mule deer, opossums, and raccoons (Table 3-1). In addition, mountain lion sign (tracks and scat) was detected between the I-5 bridge and Los Peñasquitos Lagoon during February and November 2000, and gray fox sign was detected periodically between January 1999 and February 2000.

From these data, it appears that mule deer, bobcats, and coyotes (and possibly a mountain lion and gray foxes) are moving to and from Los Peñasquitos Lagoon under the I-5 bridge at Carmel Creek or, alternatively, crossing under the I-5/I-805 merge and then traveling north to the Carmel Creek area (see Section 3.3). Therefore, this linkage appears to serve as a functional wildlife corridor for mule deer, bobcats, and coyotes. Gray foxes and mountain lions may use this same linkage occasionally.

3.2 SHAW VALLEY

Three track station transects are in this grouping: Little Shaw Valley (Figure 3-2), Big Shaw Valley (Figure 3-3), and Lower Shaw Valley (the culvert at the Big Shaw-Little Shaw junction, Figure 3-4). The Little and Big Shaw valleys provide a linkage between Los Peñasquitos Canyon Preserve, the Lower Shaw Valley (where Little and Big Shaw valleys join), and the habitat along Carmel Creek. No mountain lions, gray foxes, opossums, or house cats were detected in any of the transects. Bobcats were detected in all three transects, although only two tracks were detected, one in the culvert and one adjacent to a track station on the west side of the culvert (not at a track station). The Little Shaw Valley transect exhibited the highest track station index for bobcats of any

transect in the study. The transects in Big Shaw Valley and at the Lower Shaw Valley had relatively high track indices for domestic dogs. There are no SDTT transects in this area.

The use of the large double culverts under Carmel Country Road within the lower Shaw Valley provides a good example of the challenge in interpreting wildlife movement through a corridor using track station and camera data. The only use by bobcats detected in this study was a single set of tracks within a culvert but not associated with a track station (i.e., there were no photographs or visits to track stations by bobcats in this location). Using only track station and camera data, we would infer that bobcats are not using the culverts in lower Shaw Valley, when, in fact, a track was observed in the culvert. On the other hand, coyote tracks were not observed within the culverts, but coyotes were detected at track stations on either side of the culverts. As surveys for tracks within the culverts were not conducted regularly, a lack of tracks for a particular species may indicate a low survey effort. Based on camera data and tracks observed within the culvert, mule deer appeared to use the culvert frequently, and therefore the corridor appears to be functional for deer.

The ultimate functionality of the Big and Little Shaw Valley linkages as wildlife corridors is uncertain because of ongoing construction activities on Del Mar Mesa. Potential constraints to wildlife movement through this area can be evaluated only after buildout of Del Mar Mesa is complete. Currently, there is considerable illegal off-road vehicle activity, dumping, and off-leash dogs in this area. Future monitoring will provide an assessment of post-construction use of these linkages by target wildlife species.

3.3 LOWER PEÑASQUITOS CANYON AND DEL MAR MESA

Transects in this group include I-5/I-805 merge (Figure 3-5), Los Peñasquitos Canyon Preserve (LPCP) interior 4 (Figure 3-6), LPCP interior 3 (Figure 3-7), LPCP interior 2 (Figure 3-8), LPCP interior 1 (Figure 3-9), and Del Mar Mesa (Figure 3-10). Mountain lions were not detected in any of these track station and camera transects, and gray foxes were detected only at Del Mar Mesa (Figure 3-10). Coyotes were detected in all transects, and bobcats were detected in all except LPCP interior 3 and Del Mar Mesa. The highest mule deer camera index value recorded in the study was at the LPCP interior 1 transect (Figure 3-9). Relatively high track station indices for domestic dogs were noted at LPCP interior 4, LPCP interior 3, LPCP interior 2, and Del Mar Mesa transects. House cat tracks were recorded only at the I-5/I-805 merge transect (Figure 3-5)—one of only two transects in the study where house cats were recorded.

SDTT surveys in the vicinity of the I-5/I-805 merge and adjacent portions of Los Peñasquitos Canyon Preserve detected a wide variety of wildlife species, including bobcats, coyotes, mountain lion (single scat), mule deer, raccoons, opossums, long-tailed weasels, gray foxes, and woodrats (Table 3-1). The mountain lion sign was detected on the east side of the I-5/I-805 merge. In the remaining portion of lower Peñasquitos

Canyon, the SDTT detected bobcats, coyotes, gray foxes, mule deer, opossums, raccoons, and woodrats.

The lower part of Los Peñasquitos Canyon links Los Peñasquitos Lagoon with habitats in Peñasquitos and Lopez canyons and Del Mar Mesa. The Los Peñasquitos Canyon linkage is relatively wide in most places, except for road crossings. The canyon provides breeding and foraging habitat as well as movement opportunities for many wildlife species. The areas at either end of the I-5/I-805 merge chokepoint (i.e., Sorrento Valley Road bridge and the new Sorrento Valley Court extension bridge) are highly constrained in terms of available area for wildlife movement under the bridges. Very little area is available between the dense wetland vegetation along the creek and the bridge abutments. The creek bottom itself does not appear conducive to movement of large mammals, given the dense vegetation and presence of permanent water. During high flow periods in Los Peñasquitos Creek, surface water levels can rise high enough to inundate much of the area available for wildlife movement between the creek and the bridge abutments. In spite of these potential constraints, survey results show a wide diversity of wildlife species using the I-5/I-805 merge corridor, including bobcats, coyotes, mule deer, gray foxes, and, potentially, mountain lion.

The interior portion of Los Peñasquitos Canyon Preserve supports the full complement of wildlife species, including rare sign of mountain lion recorded during SDTT surveys. The camera index for mule deer was extremely high at the LPCP interior 1 transect, where mule deer commonly forage in the vicinity. Based on the three types of data analyzed, we can not distinguish between wildlife that are moving through Los Peñasquitos Canyon to adjacent areas (e.g., to and from Los Peñasquitos Lagoon, Shaw Valley, Poway) as opposed to those animals that reside permanently within the canyon. The canyon appears to support wildlife movement throughout the interior portion of the preserve.

The Del Mar Mesa track station transect is discussed with the Los Peñasquitos Canyon Preserve transects because it is contiguous with the preserve (Figure 2-1). There was not a camera at this transect. Results of the sampling at this transect are difficult to analyze because of the adjacent construction activity on Del Mar Mesa and the high domestic dog activity. This location was not designed as a movement corridor by the MSCP but is located at the northern edge of Los Peñasquitos Canyon Preserve. Coyotes and gray foxes were detected at this location, as were striped skunks and raccoons. Bobcats and mule deer were not detected at the northern edge of the preserve at Del Mar Mesa.

3.4 UPPER PEÑASQUITOS CANYON

The upper part of Los Peñasquitos Canyon links the canyon habitats west of Black Mountain Road with upland habitats in Poway. Track station and camera transects in this group include Black Mountain Road bridge (Figure 3-11), I-15 bridge (Figure 3-12), and Los Peñasquitos Creek at Sabre Springs (Figure 3-13). Mountain lions and gray foxes were not detected at any of these transects, whereas domestic dogs, coyotes, bobcats, and

mule deer were detected at all of them. House cats were detected only at the Los Peñasquitos Creek at Sabre Springs transect (Figure 3-13)—one of two transects at which cat tracks were detected.

The SDTT surveys under the Black Mountain Road bridge detected bobcats, coyotes, gray foxes, mule deer, opossums, raccoons, and woodrats (Table 3-1). Under the I-15 bridge, the SDTT detected all of these species except gray fox (Table 3-1). Species detected by the SDTT in areas of upper Peñasquitos Canyon outside of the bridges were the same as those detected under the Black Mountain Road bridge (Table 3-1).

While the Los Peñasquitos Creek linkage through Sabre Springs is constrained and appears to be a chokepoint, the track and camera station indices at Sabre Springs were relatively similar to the Black Mountain Road bridge and I-15 bridge track station and camera station results. Therefore, all three segments of this linkage appear to be functional movement corridors for bobcats, coyotes, and mule deer.

3.5 SCRIPPS-POWAY PARKWAY UNDERPASS

Coyotes and mule deer were the only large mammals detected at the Scripps-Poway Parkway underpass camera station and track stations (Figure 3-14 and Table 3-1). The SDTT recorded mule deer, bobcats, coyotes, and a single skunk track along its sign transect adjacent to the underpass (in areas where track stations were located) during the period of this study (Table 3-1).

The eastern end of the Scripps-Poway Parkway traverses rugged, undeveloped land, most of which is not conserved. Currently, wildlife movement does not appear to be constrained in this area, except for the parkway. The underpass, at the eastern end of Scripps-Poway Parkway, was designed to allow movement of wildlife between conserved habitat in the Sycamore Canyon County Park Reserve and Sycamore Valley Ecological Reserve (Gooden Ranch) to the south with undeveloped habitat in the central part of Poway to the north of the parkway. Equestrians also regularly use the underpass. Mule deer, coyotes, bobcats, and raccoons were detected within the underpass by the SDTT. The SDTT observed bobcat and raccoon sign within the underpass only during time periods prior to this study. The underpass appears to serve as a functional movement corridor for coyotes, mule deer, bobcats, and raccoons. The SDTT also frequently detected bobcat sign north and south of the underpass.

3.6 BEELER CANYON

Two camera and track station transects are in this group: lower Beeler Canyon (Figure 3-15) and upper Beeler Canyon (Figure 3-16). Mountain lions and gray foxes were not detected at either transect, and coyotes and bobcats were detected at both. Raccoons, striped skunks, and opossums were not detected in upper Beeler Canyon, and mule deer

were not detected in lower Beeler Canyon. Domestic dogs were detected at both transects and house cats at neither. There are no SDTT transects in this area.

Beeler Canyon links the open space along Los Peñasquitos Creek with undeveloped habitat in southeastern Poway and the unincorporated area, including the Sycamore Canyon County Park Reserve and Sycamore Valley Ecological Reserve. Lower Beeler Canyon is highly constrained by roads and high density development, while upper Beeler Canyon is bordered by low density residential development and a quarry. Lower Beeler Canyon appears to be a significant impediment to wildlife movement, although coyotes and bobcats were observed in parts of lower Beeler Canyon. Track station results and anecdotal observations of wildlife sign (S. Hayden pers. comm.) indicate that the area west of Pomerado Road is not being used frequently by wildlife. Culverts under Pomerado Road were blocked by vegetation, which likely impeded the movement of animals, and adjacent developments are a source of humans and domestic dogs. A game trail from the east side of the road appears to cross *over* Scripps-Poway Parkway rather than along the creek under the parkway. Coyotes and bobcats were detected at track stations east of Pomerado Road but not west of Pomerado Road (see Appendix A). Mule deer were not detected in this area. There is evidence that this portion of the linkage is not functional for wildlife movement.

Track station indices were generally low for most species in upper Beeler Canyon. No mesopredators were detected. This area burned three weeks prior to the start of the study, and this burn may be partially responsible for the low results. The area through upper Beeler Canyon is currently not constrained by adjacent development, so it is possible that wildlife use a broad area for movement and are not restricted to the area sampled. The data for this portion of the linkage are not conclusive enough to postulate whether the linkage is functional for wildlife movement.

3.7 SYCAMORE CREEK

Three track station and camera transects are in this group: Green Valley Creek near Blue Sky Reserve (Butcher property, Figure 3-17), confluence of Green Valley and Thompson creeks (Figure 3-18), and San Dieguito River Park (lower Sycamore Creek, Figure 3-19). Mountain lions and gray foxes were not detected at these transects, and coyotes and bobcats were detected at all of them. Domestic dogs were detected at all transects, and house cats were not detected. The SDTT surveys (in the vicinity of the lower Sycamore Creek track stations at the San Dieguito River Park) detected bobcats, coyotes, mule deer, gray foxes, opossums, raccoons, and woodrats (Table 3-1).

Green Valley Creek and Thompson Creek in northern Poway are tributaries to Sycamore Creek, which flows into San Pasqual Valley. This watershed links the Blue Sky Reserve with conserved open space in San Pasqual Valley. Except for conserved areas within the MSCP, this part of Poway is populated by low density residential development.

The section of the linkage along Green Valley Creek near Blue Sky Reserve is highly constrained but appears to be a functional movement corridor for both coyotes and bobcats, with use by coyotes being particularly heavy. Mule deer were not detected in this linkage.

The transect at the confluence of Green Valley Creek and Thompson Creek parallels the Maderas golf course in a riparian area. Signs warning golfers of rattlesnakes and poison oak may keep golfers out of the riparian area, although there is activity from golf carts, construction, and landscaping staff. There are four culverts side-by-side under Old Coach Road. The few data indicate that this part of the linkage is probably functional for wildlife movement, but additional monitoring is needed to confirm this.

The lower portion of Sycamore Creek is surrounded by conserved open space owned by the San Dieguito River Park. This transect parallels a road that is closed to vehicle traffic. The area is well used by bobcats, coyotes, and mule deer. Mesopredators (opossums, striped skunks, and raccoons) were also detected at this location. It appears that this section of the linkage is functional for wildlife movement at this time and that the terrain lends itself to sampling by the camera station method.

3.8 COMPARISON OF SURVEY METHODS

The three survey methods—camera stations, track stations, and SDTT wildlife sign transects—vary with respect to detection of different wildlife species, the sampling effort required, and ability to be standardized and produce comparable metrics. These variations affect the utility of the various methods for documenting wildlife use of corridors (i.e., assessing wildlife corridor functionality) and quantifying and analyzing trends in linkage use. The variations among the methods and their implications for MSCP wildlife corridor monitoring are discussed below.

3.8.1 Wildlife Species Detection

We determined frequency of detection for target wildlife species among the total sample of survey units (i.e., track station transects, camera stations, or SDTT sign transect segments), for each survey method, where the survey methods overlapped (see Section 2.4). Figure 3-20 plots the frequency of detection of target wildlife species by each of the three survey methods during the study period. SDTT sign transect surveys detected coyotes and mule deer in every location surveyed (thus the detection frequency of 1 and confidence interval of 0). Appendix B presents the results of chi-square tests of the species-specific contingency tables testing the independence of detection probability between the survey methods. These tests indicated that for all species, except mountain lion, frequency of detection was dependent on the survey method used.

No individual statistical comparisons between the methods for different species were made. However, a number of trends in the data and analyses presented in Figure 3-20 and Appendix B are apparent. Sign transects and camera stations appeared to be more

effective at detecting mule deer than were our track stations. This result is not unexpected given that baited track stations are designed for carnivore surveys and mule deer detections are generally fortuitous. Sign transects and track stations appeared to be more effective at detecting coyotes and opossums than were camera stations. Opossums were never detected at camera stations in this study, and coyotes were never detected only at a camera station in a particular location (i.e., if they were detected at a camera station, they were also detected at a track station). Coyotes are relatively curious and would generally visit at least one track station along the transect (S. Hayden pers. comm.). Sign transects may be somewhat more effective at detecting bobcats and raccoons than either camera stations or track stations. However, there was no obvious difference between camera or track station results for these two species.

Sign transects were as effective or more effective at detecting all wildlife species than camera and track stations. Sign transects were the only method that detected either mountain lions or gray foxes (with one exception), but the frequency of detection was low for both species and therefore cannot be interpreted as a significant difference between the methods. Counting scat as well as tracks and surveying a relatively larger area is likely to account for the higher frequency of detection by sign surveys relative to the other methods.

3.8.2 Survey Effort

The SDTT surveys a given sign transect on one day each quarter. Because a larger area is surveyed relative to the other two methods, and because both fresh and historic (old) sign is counted, this method results in a good sample of wildlife presence with a relatively low effort. However, there may be a higher potential for misidentifying sign in some areas using this method, due to weathering of the sign and variation in tracking substrates.

Track stations were monitored for a period of five days each quarter. Establishing and maintaining the track stations required a relatively higher level of effort, as gypsum and scent lure were brought to each individual station. In addition, track stations were refreshed following visitation/disturbance by wildlife, domestic dogs, or humans.

Camera stations were operated for one month each quarter. Stations were visited periodically to check the status of the film in the camera and replace it as necessary. During this study, cameras were checked every three to ten days during the month they were operating.

3.8.3 Survey Metrics

The SDTT sign transects are designed to estimate the number of individuals as evidenced by both fresh and historic sign along transect segments. In practice, it is probably impossible to accurately determine whether a set of tracks belongs to a single individual, particularly if the individual were to leave and then reenter the survey area during its

movement through the area. The boundaries of segments within transects are based on changes in terrain or habitat types and, therefore, are of very different lengths. In addition, some segments likely receive more survey effort than others because of the quality of tracking substrate and heavy use by wildlife. For example, areas under bridges comprise individual segments of transects. These segments often are surveyed more intensively, by design, than areas to either side of the bridge. Therefore, the results of the sign transect method do not lend themselves well to the development of metrics that are comparable between transects. Metrics generated by this method may be more appropriate for comparing the same area (transects or segments of transects) between different time periods. This method also provides a good estimate of whether a particular species is present in a particular area.

The track station transect results are summarized as the proportion of survey nights that a particular wildlife species visits each station, as evidenced by tracks. The method does not provide information on the number of individuals visiting a track station during a sampling period, but rather whether a species was detected or not detected on each night of the survey at each station. In this study, sign other than tracks (e.g., scat) was not recorded at the track station and therefore does not factor into the computation of track station survey metrics. The value of the track station metric always varies between 0 and 1. Track stations provide a standardized, quantitative method for both temporal and spatial comparisons. However, the existing track station method does not provide direct evidence of the use of corridors under bridges or roads and appears to be biased against detecting certain species (e.g., mule deer).

The camera station results are expressed as the number of animals of a given species detected per camera night. In contrast to the track station method, multiple animals in individual photographs are recorded and included in the calculation of the survey metric. Therefore, the camera station metric can have a value greater than 1. Camera station results would be more comparable to track station results if multiple animals of a given species in a single photograph were not counted separately, but rather counted as “present," regardless of the number of animals photographed. Camera stations also do not provide direct evidence of corridor use under bridges and roads and appear to be biased against detecting certain species (e.g., coyotes and opossums).

TABLE 3-1
Wildlife Species Detected in San Diego Tracking Team Surveys
at Areas Overlapping Track and Camera Stations

Species	Carmel Creek	I-5/805 Merge	LPCP Interior 4	LCP Interior 3	LPCP Interior 2	LPCP Interior 1	Black Mtn. Rd.	I-15 Bridge	Scripps-Poway Pkwy	SDRP
Coyote	X	X	X	X	X	X	X	X	X	X
Fox		X					X	X		X
Mountain lion		X								
Bobcat	X	X	X		X	X	X	X		X
Mule deer	X	X	X	X	X	X	X	X	X	X
Opossum	X	X			X	X	X	X		X
Raccoon	X	X	X	X	X	X	X	X		X
Striped skunk		X	X	X	X		X	X		
Long-tailed weasel		X								

* The results of San Diego Track Team surveys displayed here often represent a portion of one or two individual transects.

Figure 3-1
Carmel Creek at I-5

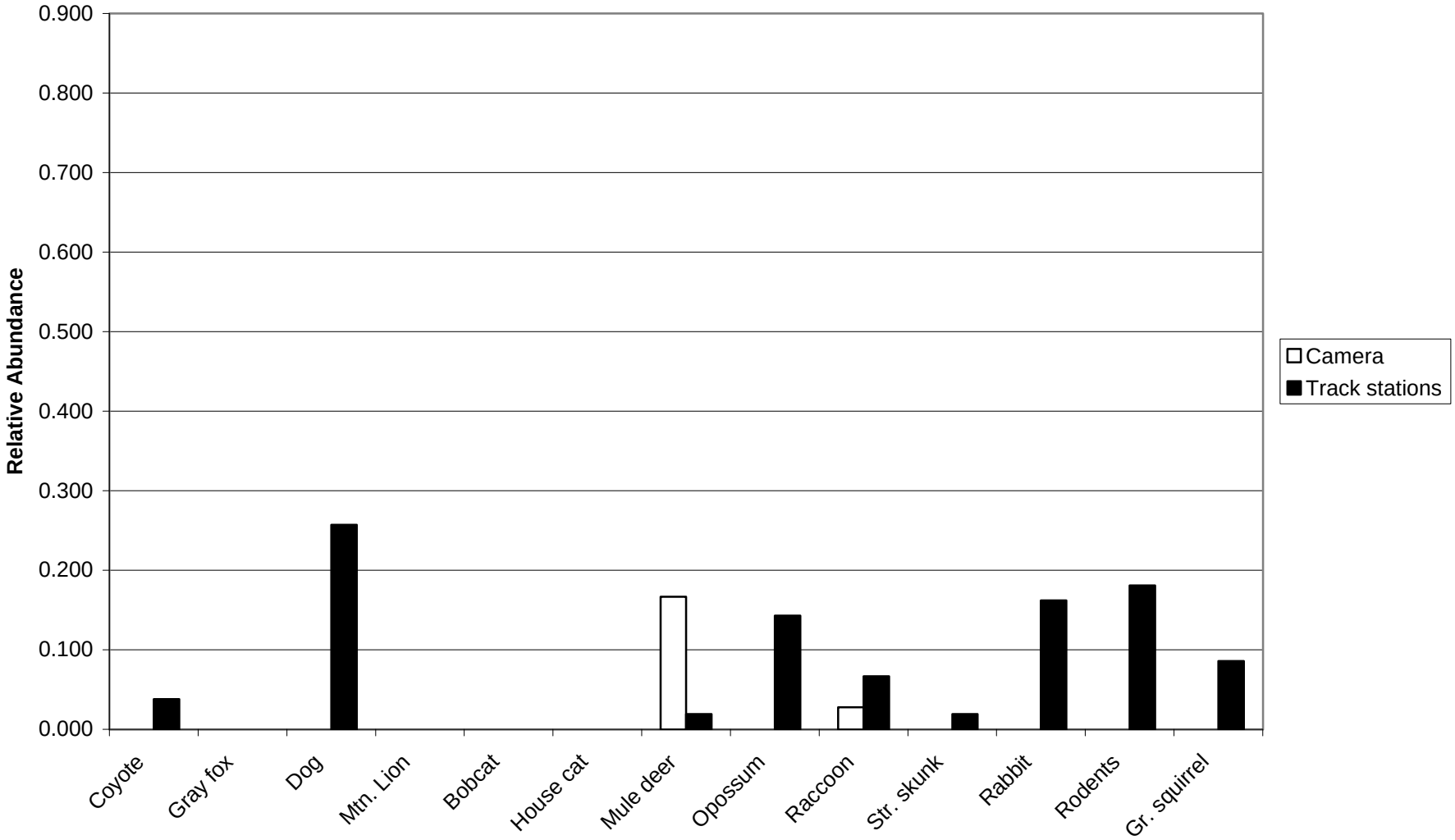


Figure 3-2
Little Shaw

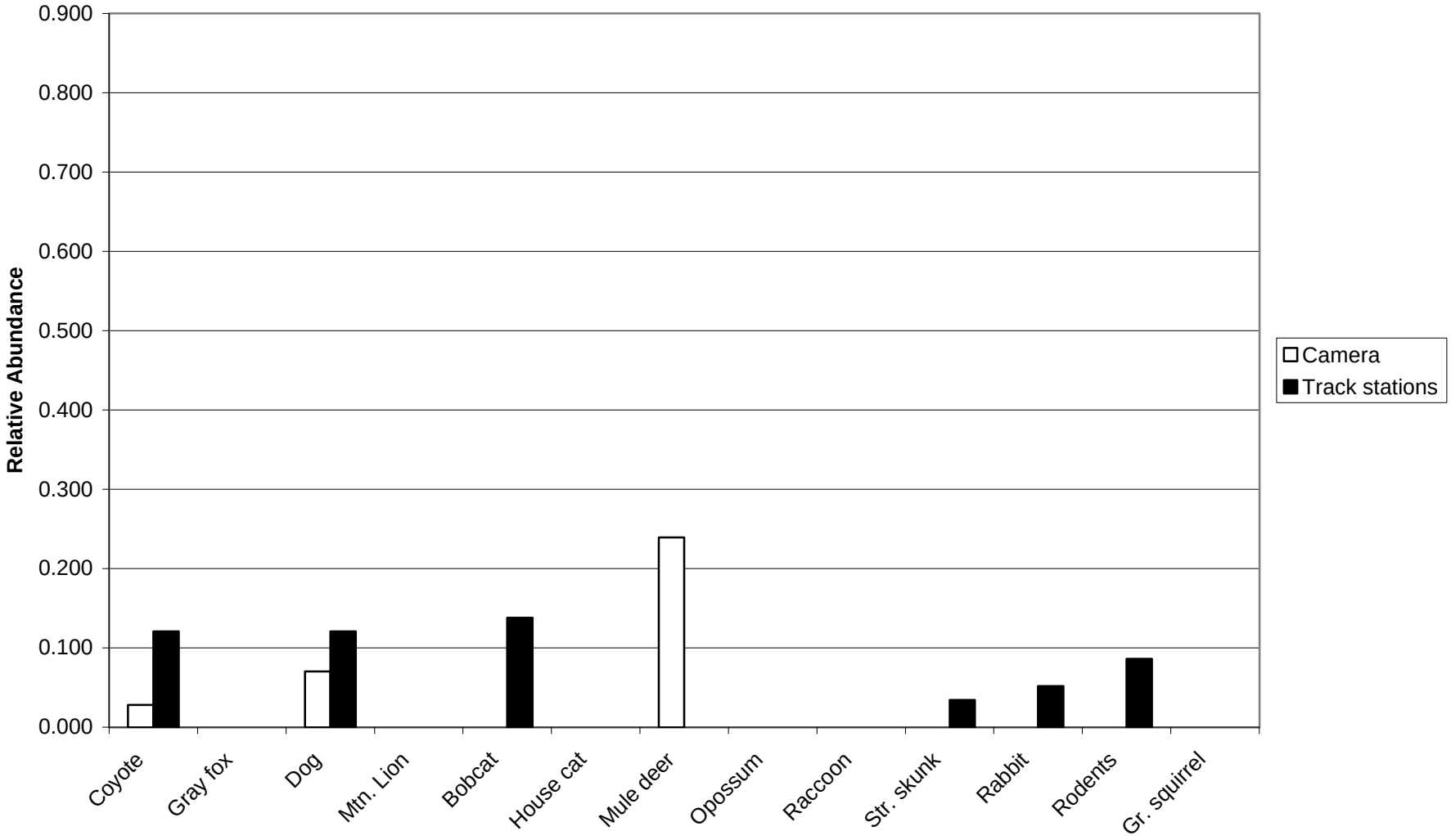


Figure 3-3
Big Shaw

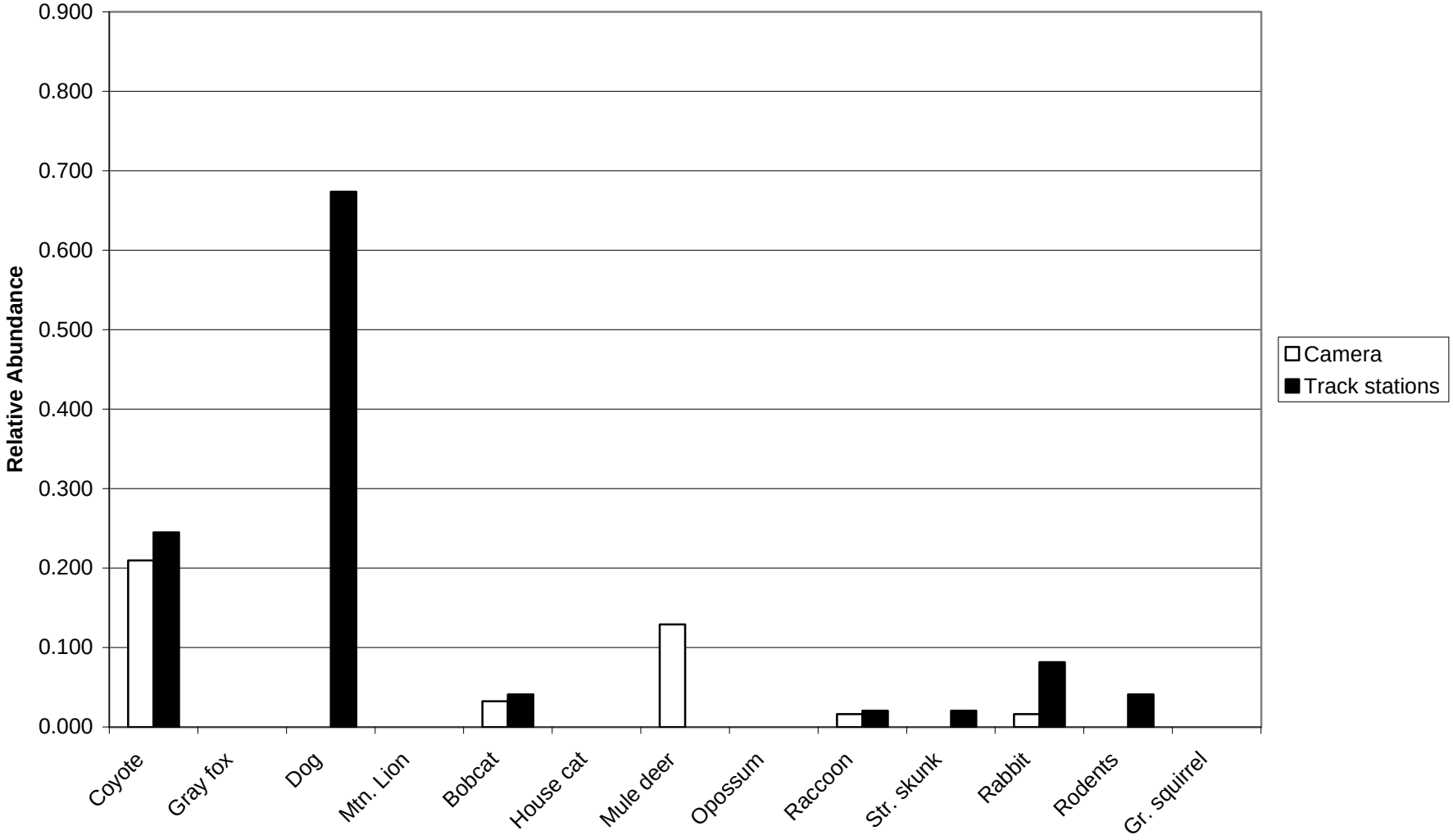


Figure 3-4
Big Shaw-Little Shaw Culvert

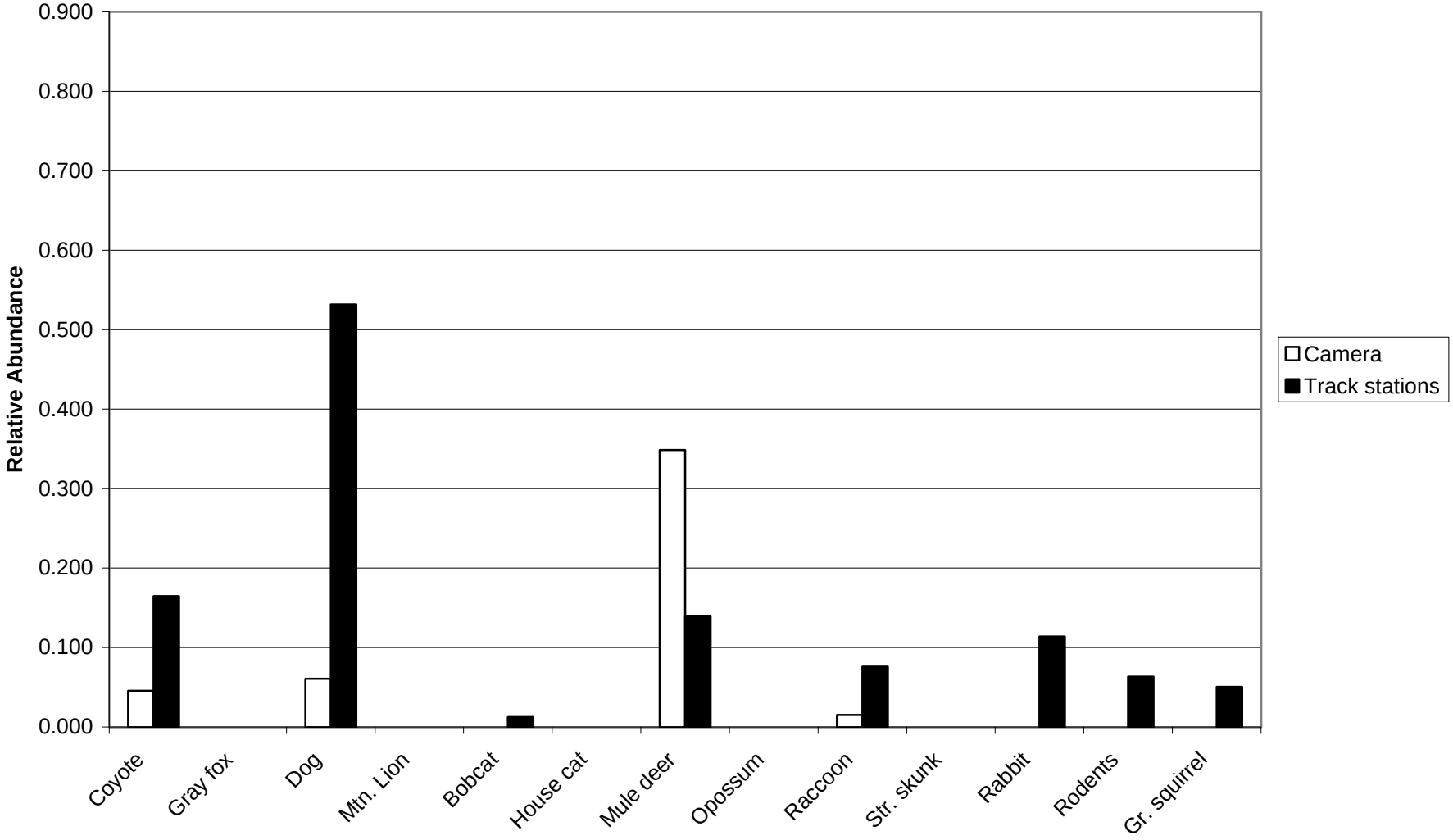


Figure 3-5
I-5/805 Merge

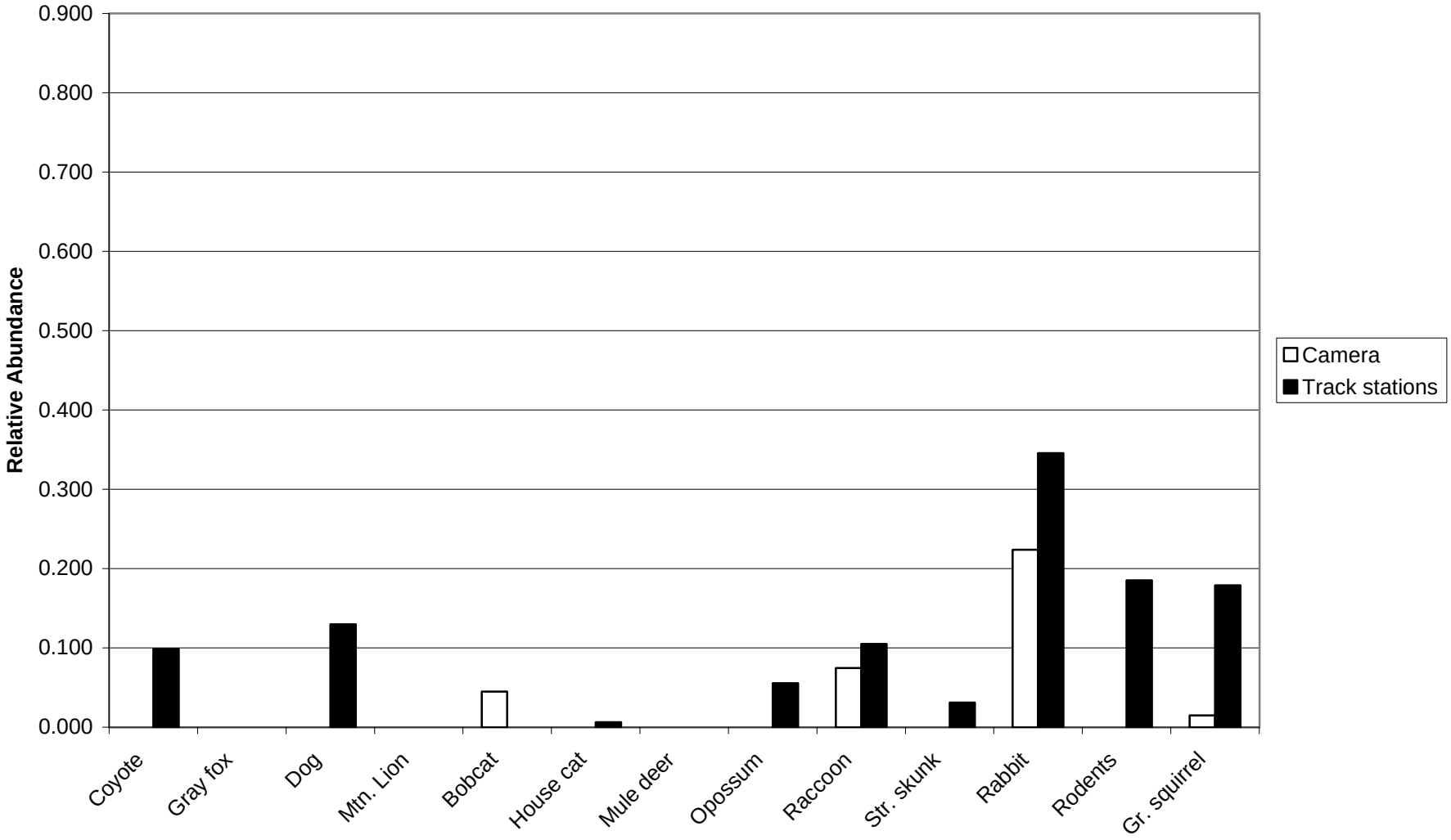


Figure 3-6
Los Penasquitos Cyn. Preserve Int. 4

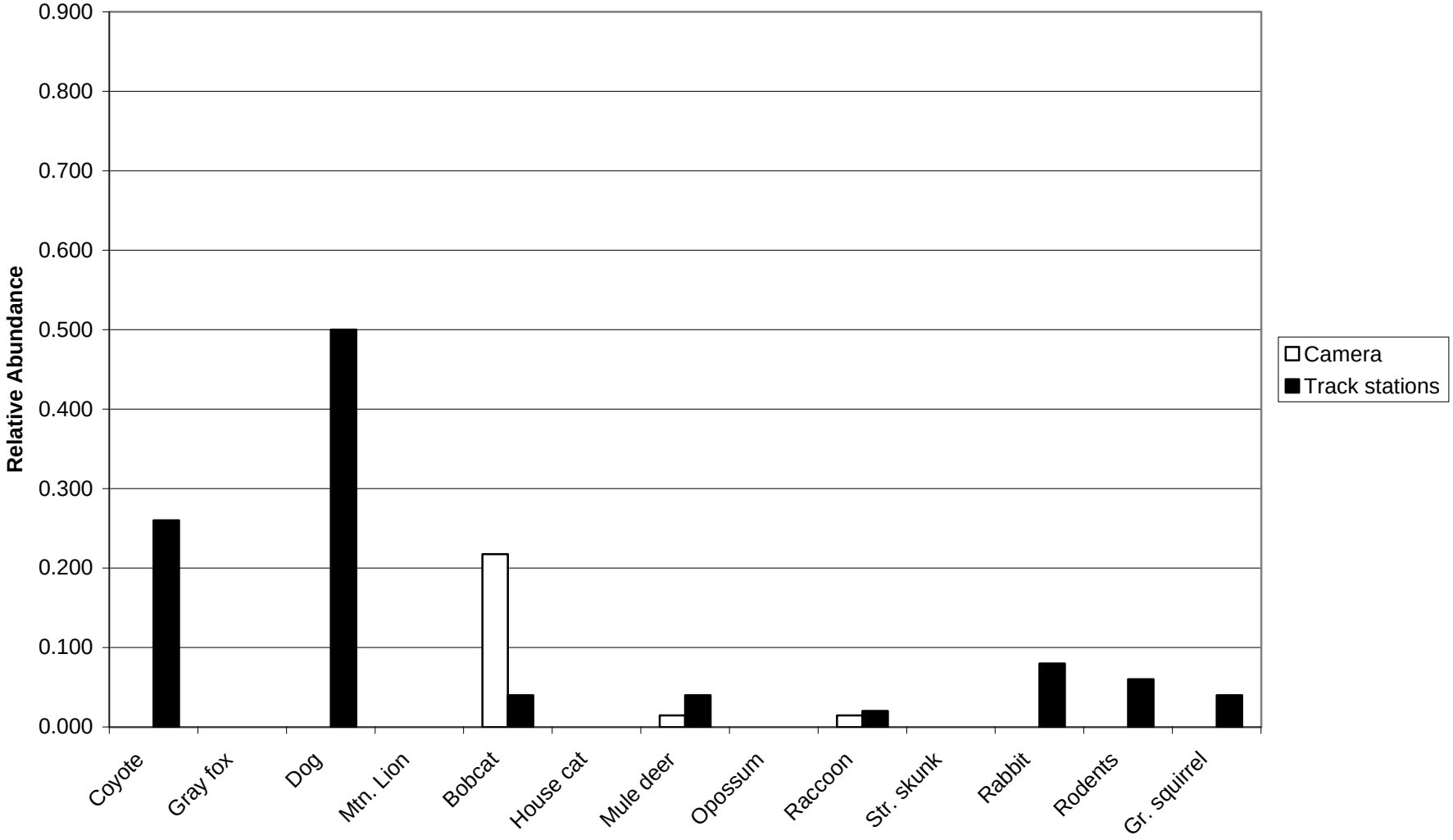


Figure 3-7
Los Penasquitos Cyn. Preserve Int. 3

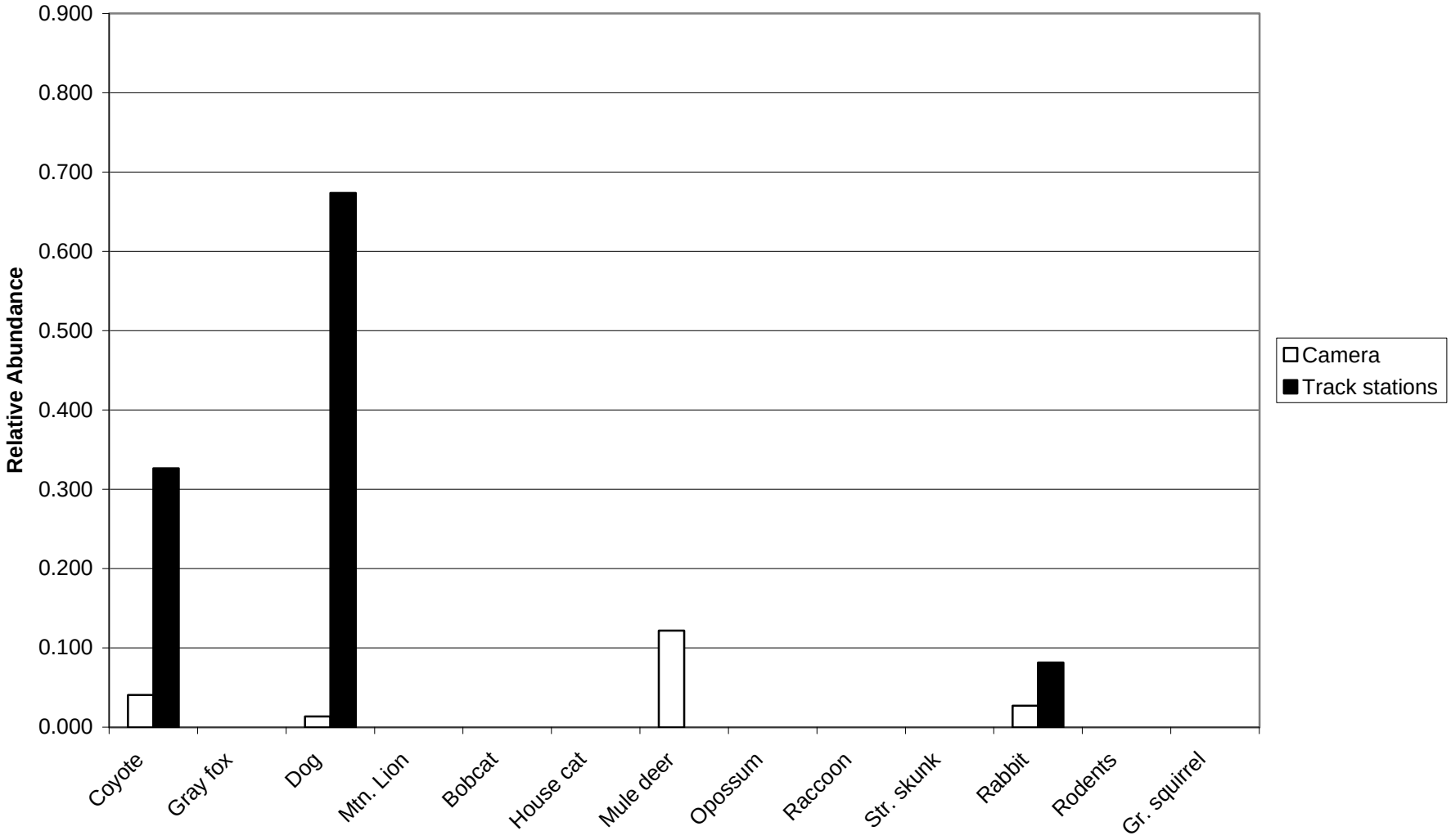


Figure 3-8
Los Penasquitos Cyn. Preserve Int. 2

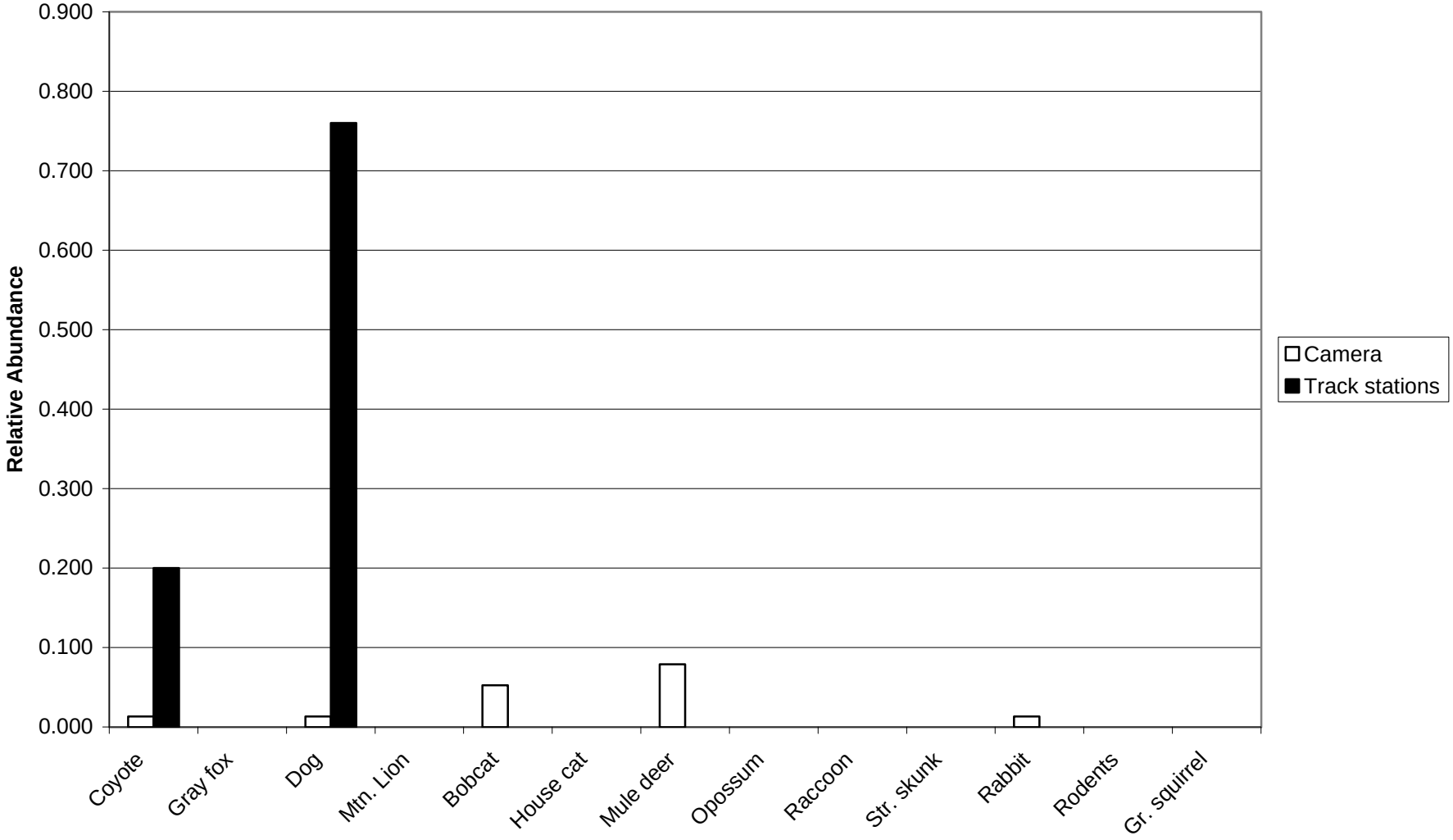


Figure 3-9
Los Penasquitos Cyn. Preserve Int. 1

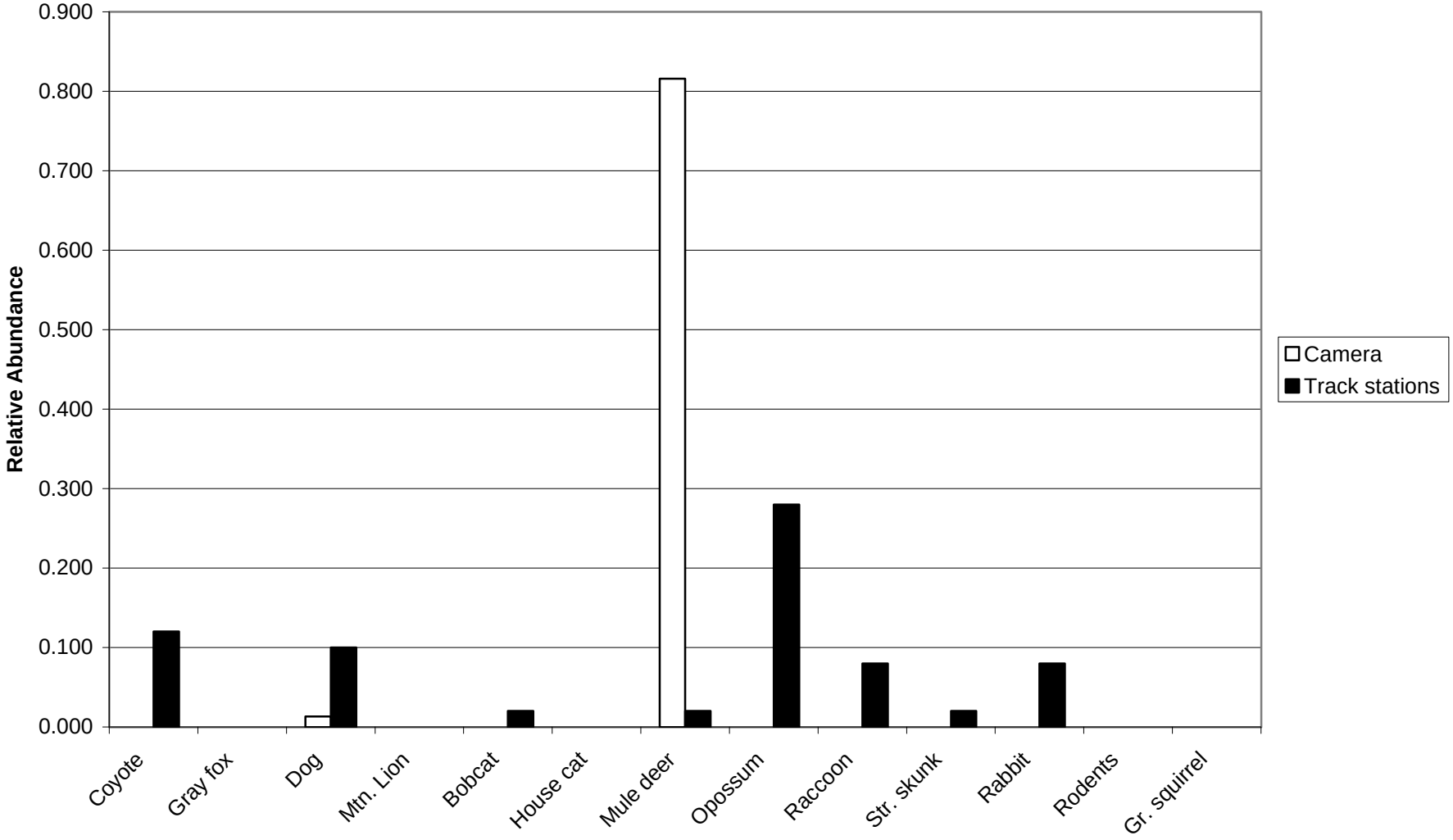


Figure 3-10
Del Mar Mesa

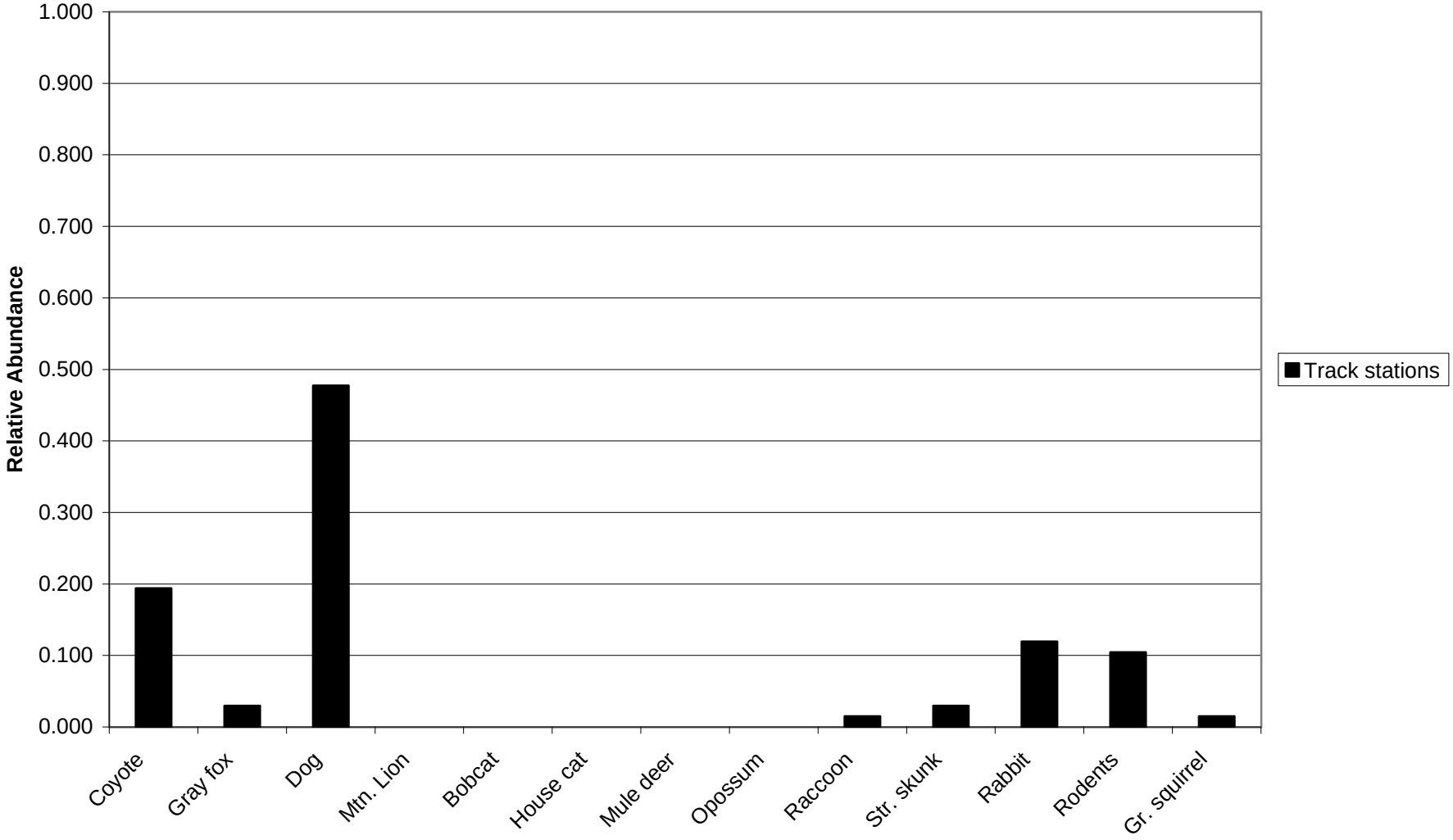


Figure 3-11
Black Mountain Rd Bridge

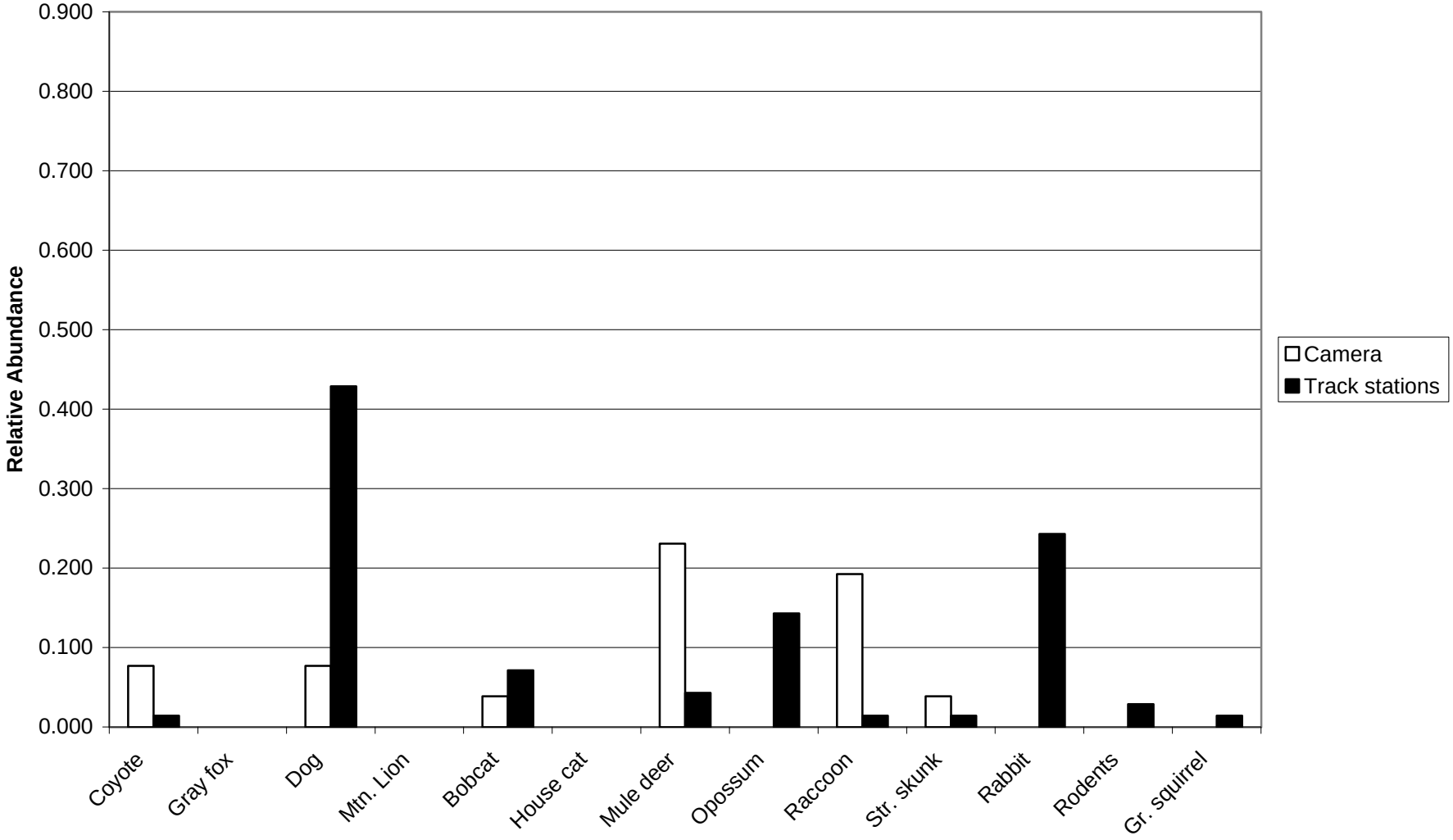


Figure 3-12
I-15 Bridge

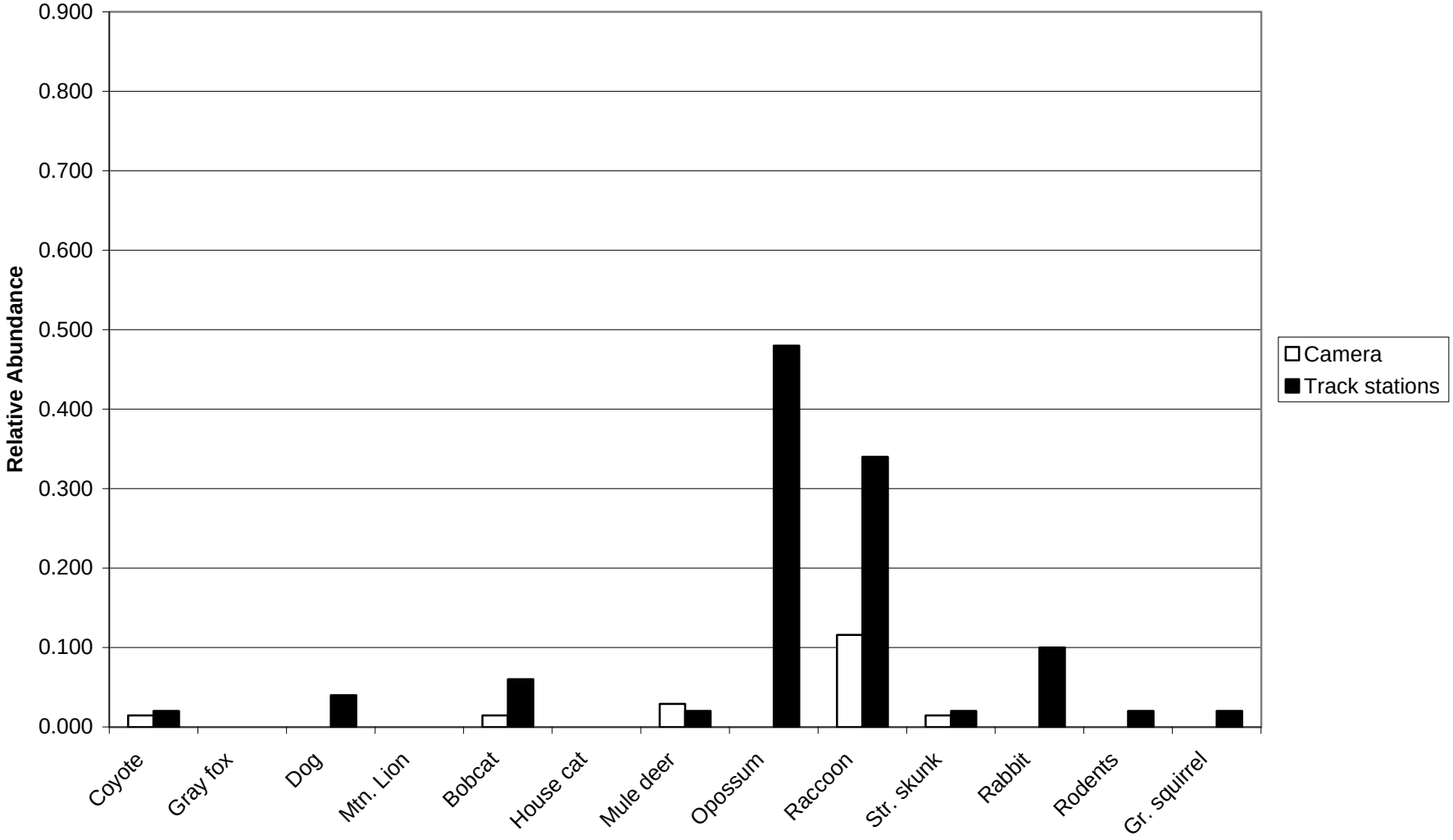


Figure 3-13
Los Penasquitos Creek at Sabre Springs

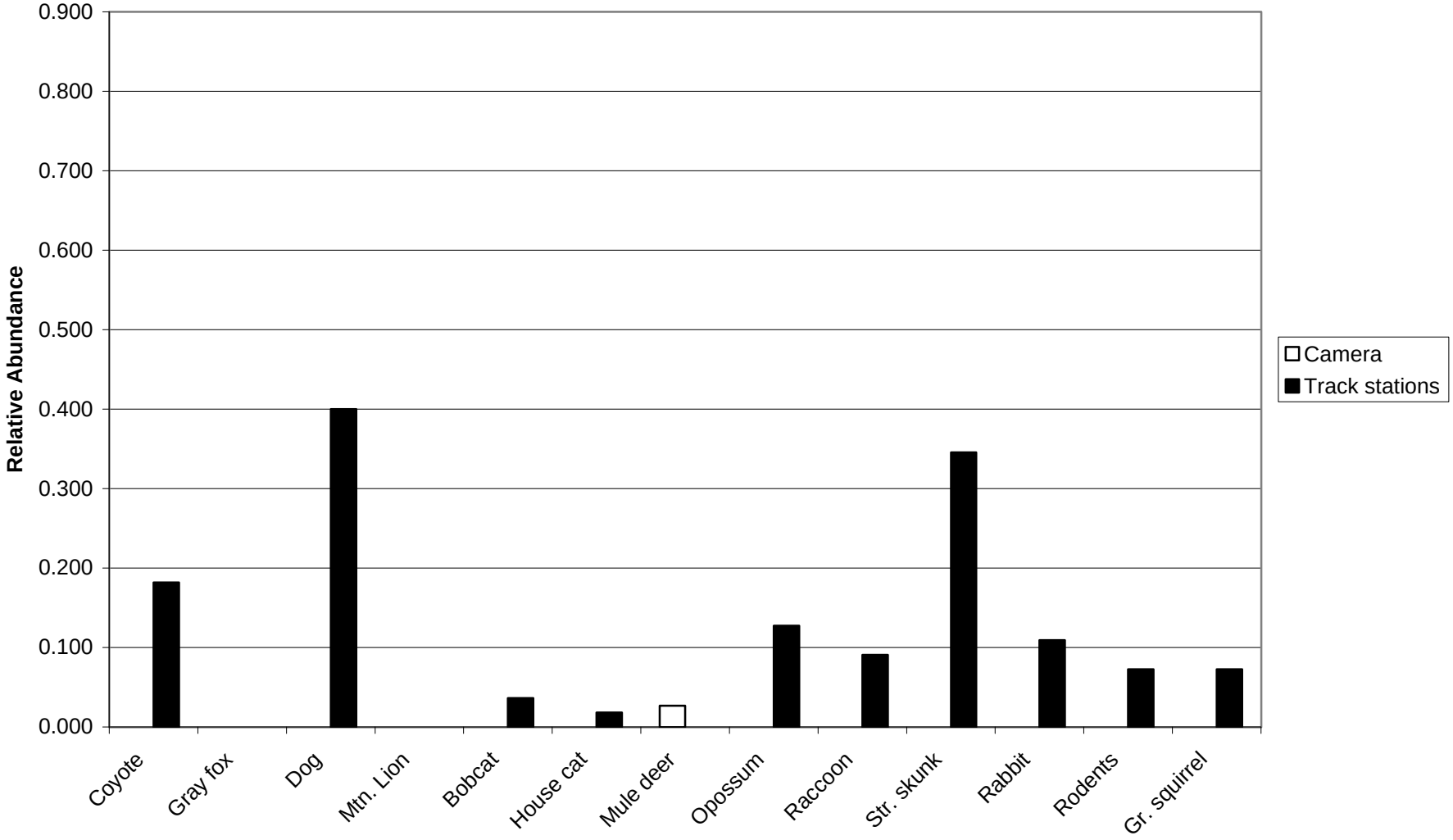


Figure 3-14
Scripps-Poway Pkwy Underpass

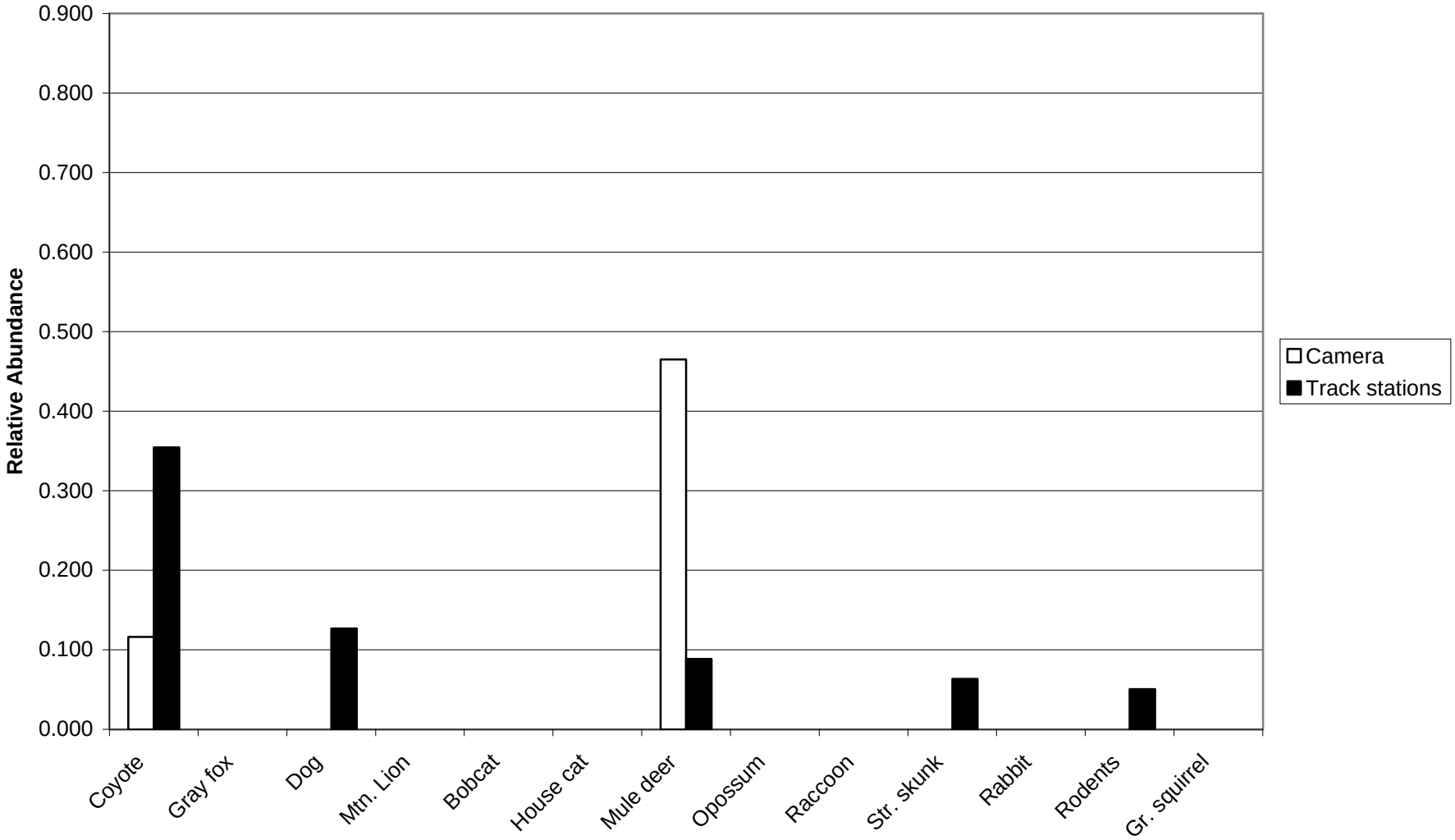


Figure 3-15
Lower Beeler Canyon

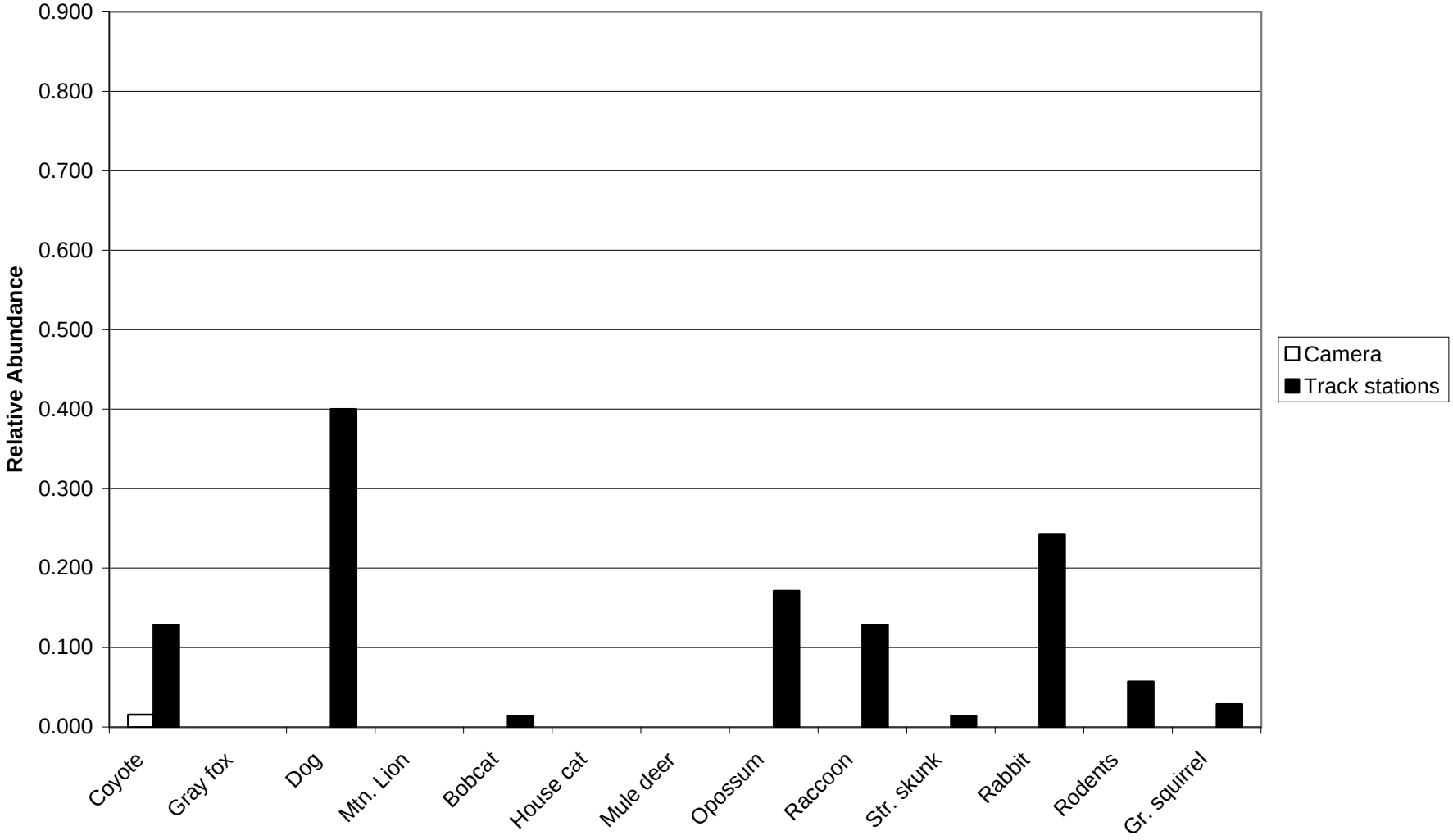


Figure 3-16
Upper Beeler Canyon

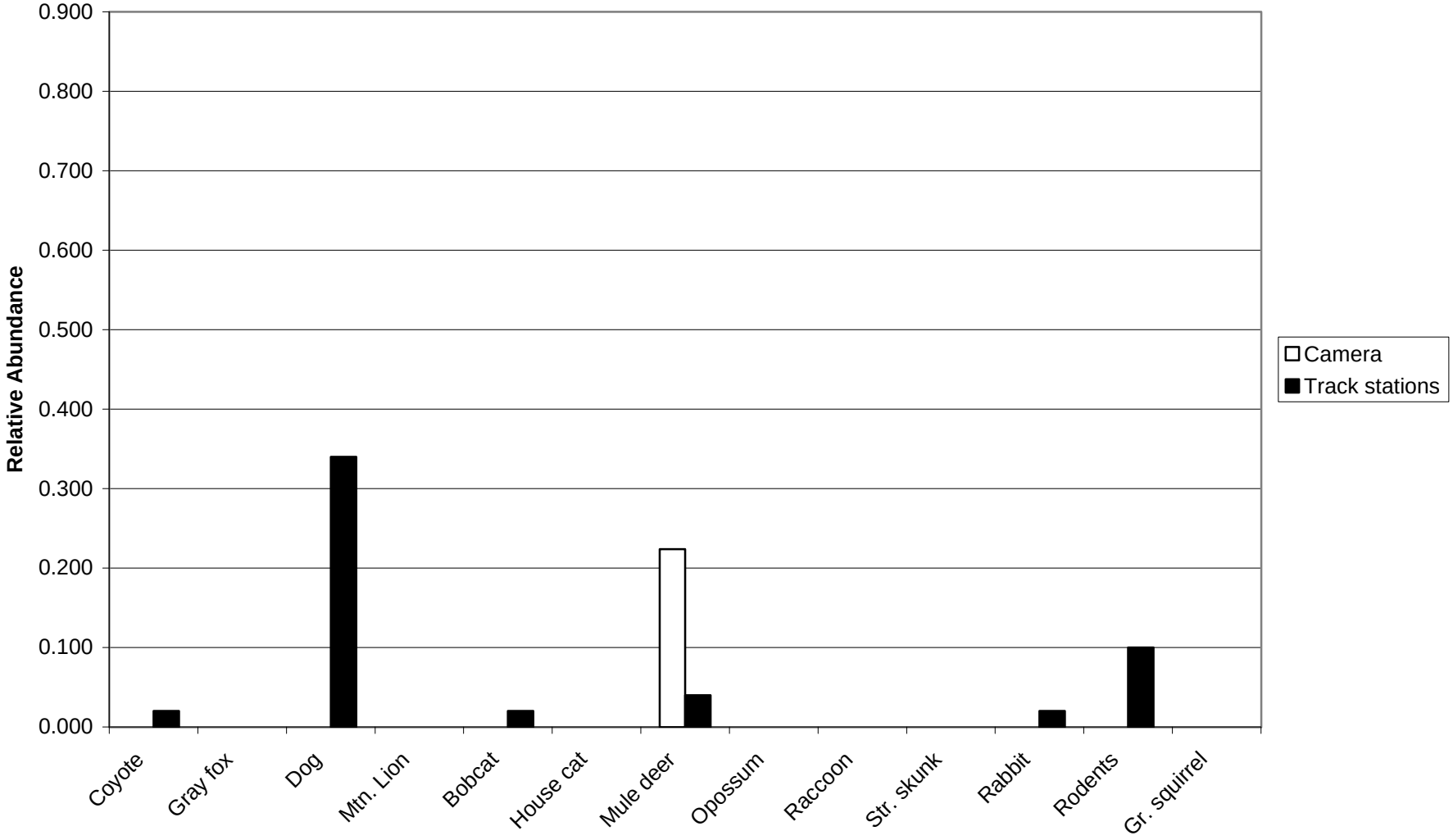


Figure 3-17
Green Valley Creek Near Blue Sky Reserve

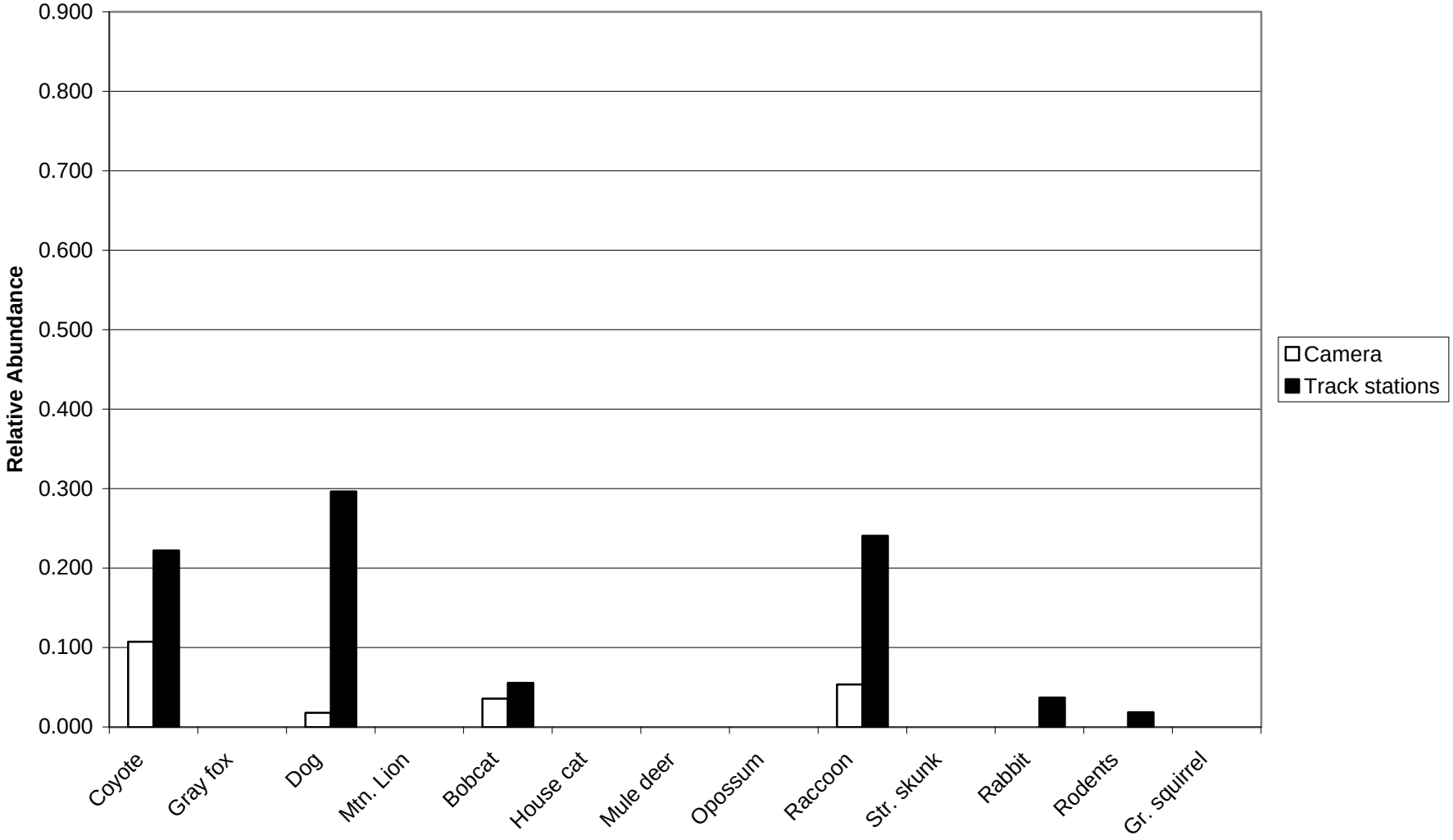


Figure 3-18
Green Valley and Thompson Creeks Confluence

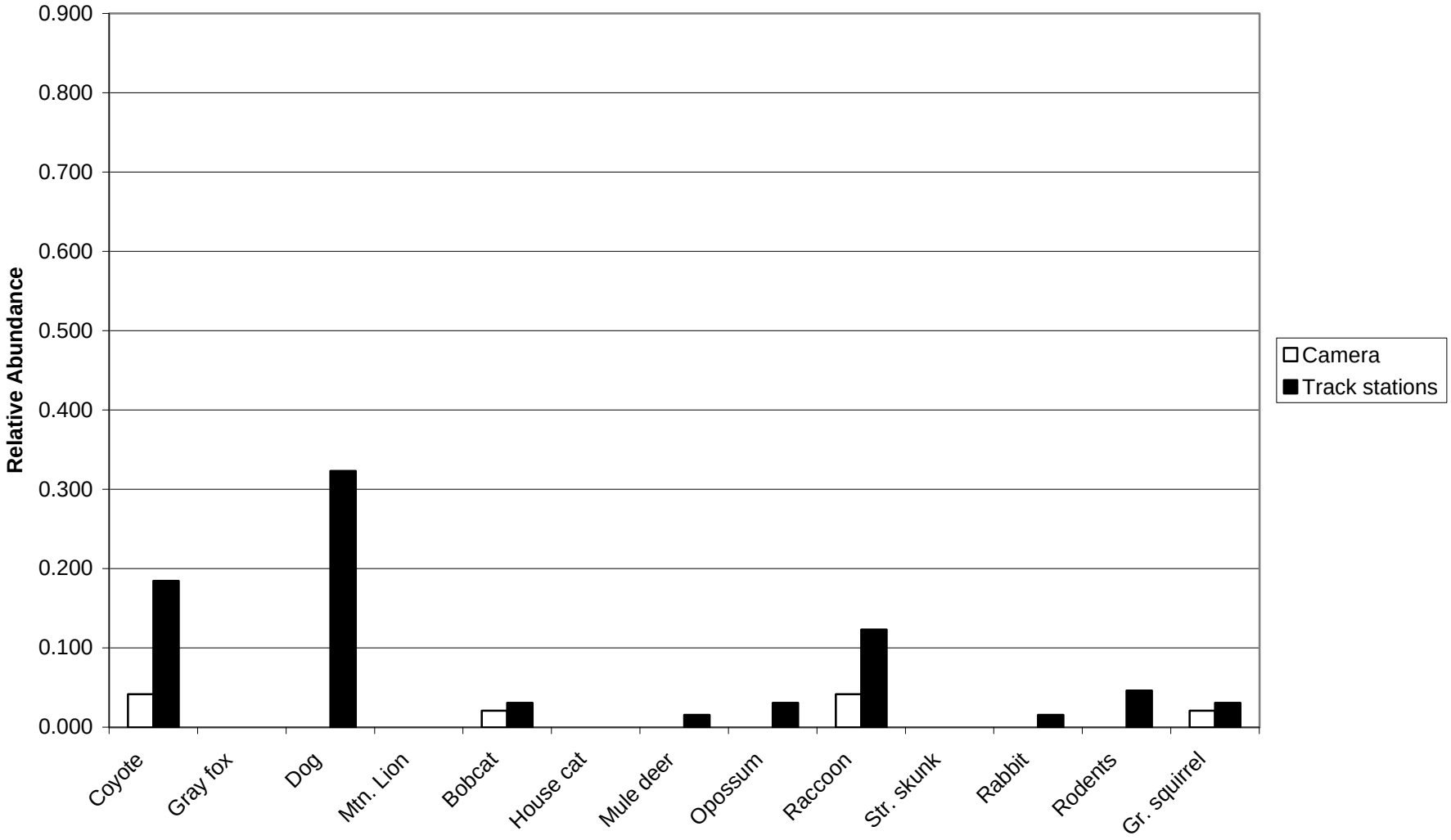


Figure 3-19
San Dieguito River Park

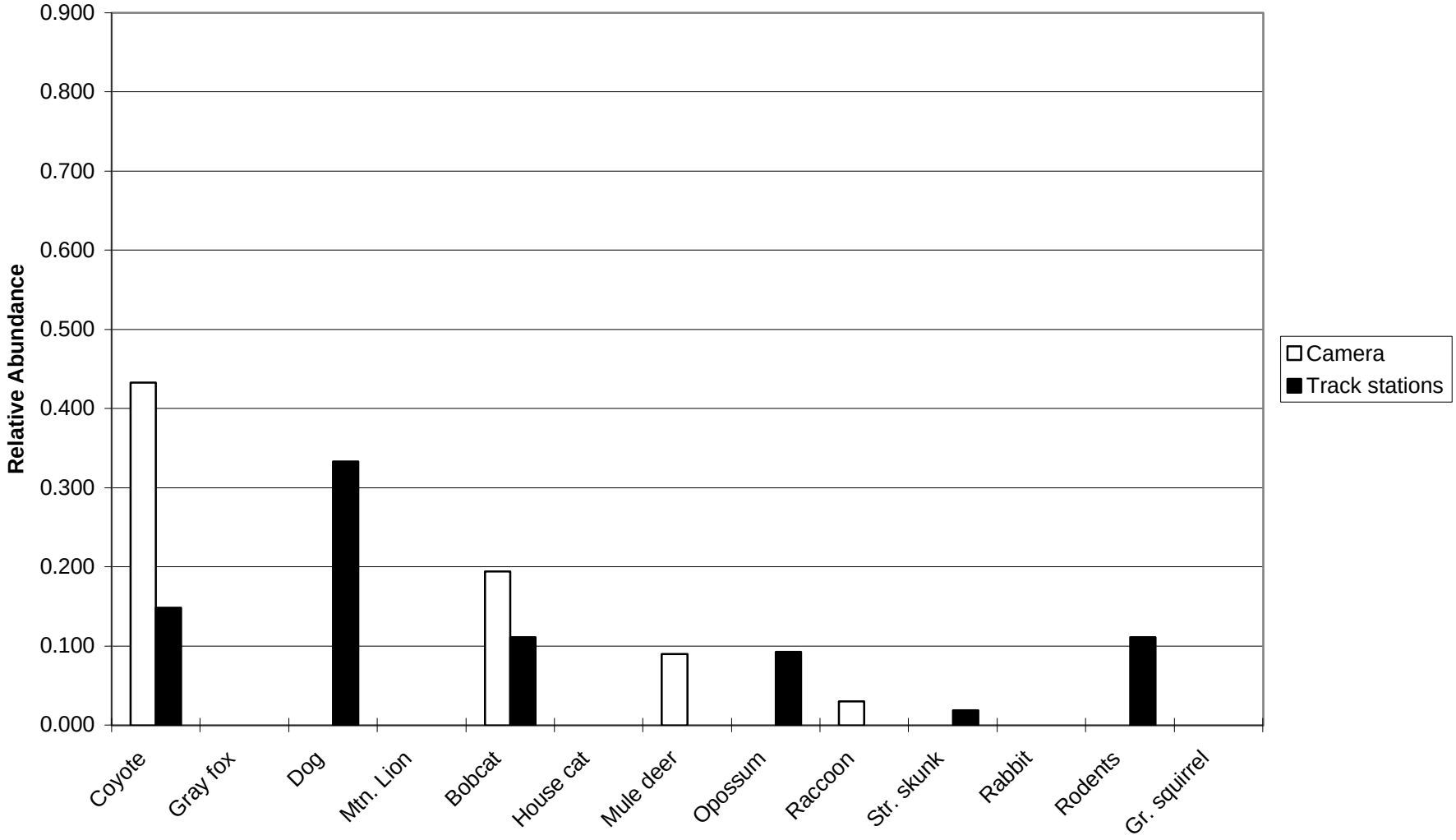
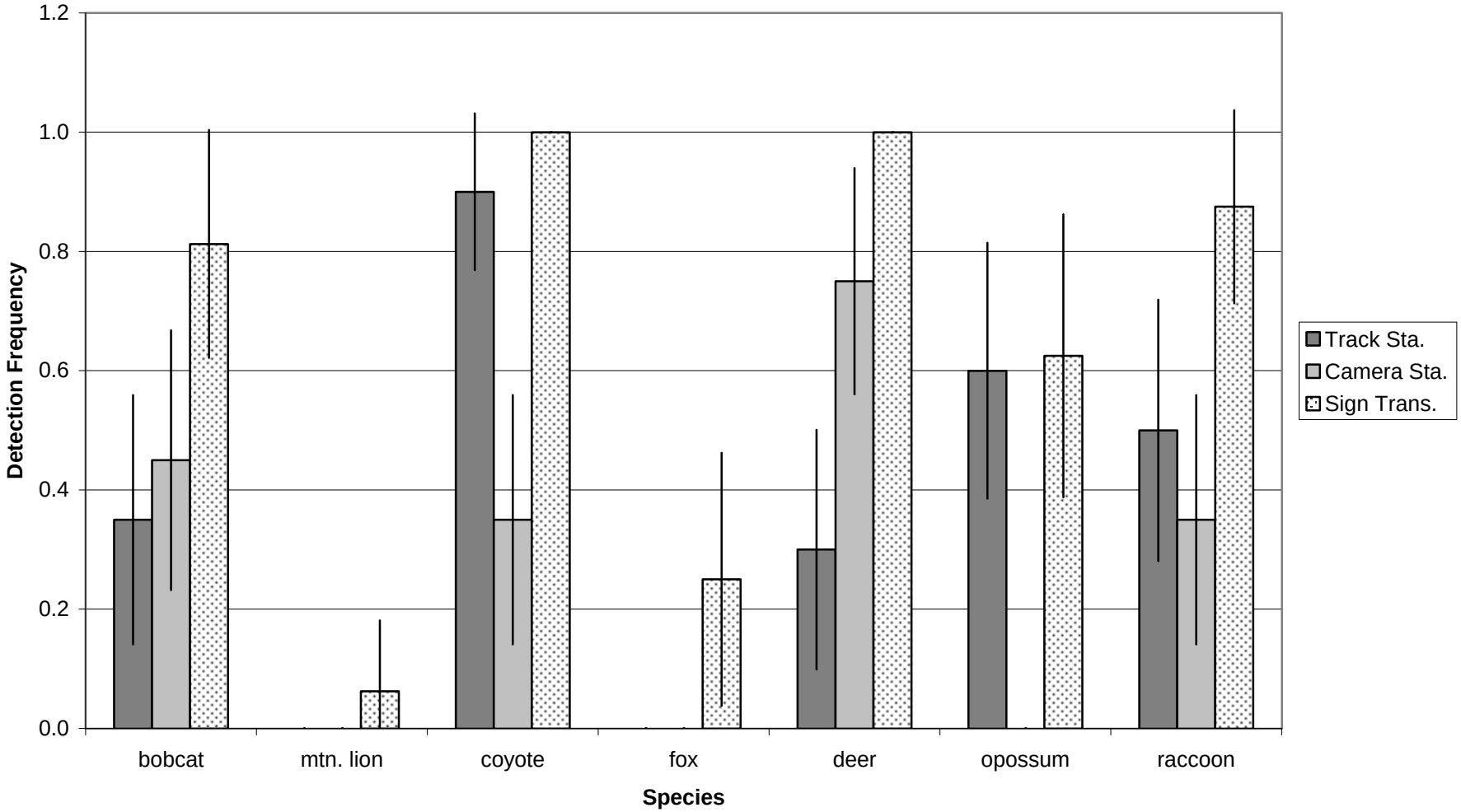


Figure 3-20
Frequency of Detection (+/- 95% C.I.)
of Target Wildlife Species



4.0 RECOMMENDATIONS

4.1 HABITAT MANAGEMENT NEEDS

The MSCP biological monitoring program is intended to assess compliance with the biological goals of the MSCP, measure the effectiveness of the preserve design, and inform adaptive management decisions. The following habitat management measures should be implemented as part of the MSCP adaptive management program. Future monitoring efforts must be conducted to evaluate the effectiveness of these measures.

4.1.1 Carmel Creek at I-5

This area is a constrained, but important movement corridor for large mammal dispersal between Carmel Valley and Los Peñasquitos Lagoon to Torrey Pines State Reserve. As Caltrans construction continues in this area, annual monitoring is necessary for the next several years.

1. Ensure that Sorrento Valley Road remains closed to motor vehicles.

2. Provide additional vegetative cover to encourage passage between the marsh habitat on either end of the bridges.

3. Monitor and control the deposition of sediment under the bridge, which may decrease the height of the bridge relative to ground surface in the corridor.

4. Continue wildlife monitoring in this area.

4.1.2 Shaw Valley

This area is undergoing rapid development. It is important to continue monitoring this area to evaluate effects on wildlife activity.

1. Require restoration of the area after construction.

2. Fence the open space linkage to preclude motor vehicles and bikes.

3. Remove fencing that restricts movement between this area and the eastern, undeveloped portion of Del Mar Mesa.

4. Erect signs that prohibit dumping of trash in the area.

5. Patrol this area to enforce restrictions requiring dogs to be on leashes and to enforce legal recreational uses.

6. Patrol this area to issue citations for illegal uses.

7. Maintain the culverts and surrounding irrigation systems to ensure that the culverts do not fill with water. Monitor and control the deposition of sediment in the culverts, which may decrease the height of the culverts.

8. Erect fencing along the edge of housing developments to discourage entrance by dogs, cats, and people into the habitat area.

4.1.3 Lower Peñasquitos Canyon and Del Mar Mesa

The SDTT heavily monitors the Los Peñasquitos Canyon Preserve. Thus, additional wildlife monitoring of some transects (Interior 1, Interior 2, Interior 3, Interior 4, and Black Mountain Road bridge) as part of the MSCP is not necessary once management recommendations are implemented and observed to be successful. SDTT data should be reviewed for any changes in wildlife activity.

Los Peñasquitos Canyon Preserve at I-5/I-805 Merge

This is a constrained, but important movement corridor between Los Peñasquitos Canyon Preserve and Los Peñasquitos Lagoon. The newly constructed bridge at Sorrento Valley Court, which is very low to the creek, further constrains this corridor.

1. Erect fencing and signs along the creek to discourage use by humans and dogs. Fencing is especially important along the new road extension/bridge. Do not fence between the creek and the meadow, as this meadow is a deer foraging area.

2. Remove debris in the creek and adjacent to the creek to decrease flooding of the corridor. Control the abundance of vegetation under the bridges to maintain passable areas for wildlife.

3. Monitor and control the deposition of sediment under the bridges, which may decrease the height of the bridges relative to ground surface in the corridor.

4. Continue wildlife monitoring in this area.

5. Continue coordination between Torrey Pines State Reserve, Los Peñasquitos Canyon Preserve, and the SDTT for monitoring and management of this corridor.

Los Peñasquitos Canyon Preserve Interior 4

The SDTT regularly monitors this area.

1. Increase ranger patrol in this area to enforce recreational restrictions and to ensure that construction activities and immigrant traffic do not encroach on conserved habitat areas.

2. Enforce the closure of this area to bikers.

Los Peñasquitos Canyon Preserve Interior 3

The SDTT regularly monitors this area. It is a relatively intact habitat area for wildlife but is adjacent to heavy construction activity on Del Mar Mesa.

1. Increase ranger patrol in this area to enforce recreational restrictions and to ensure that construction activities and immigrant traffic do not encroach on conserved habitat areas.

2. Enforce the closure of this area to bikers.

Los Peñasquitos Canyon Preserve Interior 2

The SDTT regularly monitors this area.

1. Enforce restrictions requiring dogs to be on leashes.

Los Peñasquitos Canyon Preserve Interior 1

The SDTT regularly monitors this area.

1. Enforce restrictions requiring dogs to be on leashes.

Del Mar Mesa

The SDTT regularly monitors this area. As this is an important, but constrained corridor between Del Mar Mesa and Los Peñasquitos Canyon, MSCP monitoring should continue until after development has been completed.

1. Erect a fence along the Los Peñasquitos Canyon Preserve boundary to decrease illegal vehicle and bike traffic in the preserve.

2. Increase ranger patrol in this area to enforce recreational restrictions and to ensure that construction activities and migrant worker traffic do not encroach on conserved habitat areas.

3. Enforce the closure of this area to bikers.

4. Enforce dumping restrictions.

5. Continue wildlife monitoring in this area.

4.1.4 Upper Peñasquitos Canyon

Los Peñasquitos Creek between Black Mountain Road and I-15

This area is heavily used by equestrians but also appears to function as a wildlife corridor. Additional MSCP wildlife monitoring in this area is not recommended because of conflicts with equestrians. The SDTT regularly monitors this area.

1. Work with Los Peñasquitos Canyon Preserve staff to monitor the effects of equestrian use in this area.

Los Peñasquitos Creek at I-15

This area is currently fairly secluded from hikers and bikers. However, the Trans-County Trail, including an 8-ft wide road for emergency vehicles, will be constructed parallel to an existing game trail. This will undoubtedly introduce more human activity in the area. There is a migrant camp near track station #3. The area receives trash from cars on the I-15 bridge.

1. Request the removal of a migrant camp in this area.

2. Initiate a regular trash removal program.

3. Ensure that the Trans-County Trail does not impede wildlife movement, and restrict people and dogs from the riparian area.

4. Work with Los Peñasquitos Canyon Preserve staff to monitor the effects of equestrian use and construction and use of the Trans-County Trail in this area.

5. Continue wildlife monitoring in this area.

Los Peñasquitos Creek at Sabre Springs

This transect runs parallel to a gravel hike/bike path through a newly finished subdivision. Houses and a school were built recently in the area. A fence along both sides of the riparian habitat restricts dogs and people from the creek area and seems to allow for adequate wildlife movement along the riparian corridor.

1. Continue wildlife monitoring in this area.

4.1.5 Scripps-Poway Parkway Underpass

The City of Poway asked that the camera be removed from this location, as the flash was a problem for equestrians. The SDTT regularly monitors this area for wildlife sign.

1. Extend the wing fencing on either side of the tunnel up towards the road.

2. Reposition the bat houses ("attic" spaces created for free-hanging bats) so that bats can access them.

3. Collect more spatially accurate information on roadkills on Scripps-Poway Parkway, i.e., use nearest mile marker.

4. Review new roadkill data to evaluate effectiveness of the tunnel.

5. Review SDTT data after the fencing has been extended.

6. Monitor tracks at the ends of the wing fences as well as in the underpass.

4.1.6 Beeler Canyon

Lower Beeler Canyon

Tracking stations are on both sides of Pomerado Road. The west side of the transect runs through a housing development with many loose dogs, and a wetlands restoration project was underway on the west side during the study period. A game trail shows evidence of wildlife crossing over Scripps-Poway Parkway instead of along the creek.

1. Establish an additional camera station on the game trail to document road crossings.

2. On the west side of the road, fence the riparian area to restrict pedestrian and dog use.

3. Clean out the culverts under Pomerado Road, and check for improper drainage that is allowing water to stand in the culverts. Evaluate the feasibility of providing an additional passageway under Pomerado Road in this area.

4. Monitor and control the deposition of sediment under the Scripps-Poway Parkway bridge, which may decrease the height of the bridge relative to ground surface in the corridor.

5. Continue wildlife monitoring in this area, and evaluate the effects of the wetlands restoration project on wildlife movement.

Upper Beeler Canyon

Construction of the Rancho Encantada development has been approved in this area, which may affect future wildlife movement.

1. Continue wildlife monitoring in this area to evaluate the effects of new development.

4.1.7 Sycamore Creek

Green Valley Creek near Blue Sky Reserve

This area is a critical chokepoint for wildlife movement between Blue Sky Reserve and San Pasqual Valley. Only one 4.5-acre parcel (the Butcher property) along the creek is conserved in this area.

1. Ensure that the riparian area remains intact. Evaluate the need for fencing to restrict people and dogs from the riparian habitat.

2. Establish a community education program to inform residents about the need to protect the wildlife corridor.

3. Require conservation of additional habitat in this portion of the linkage.

4. Monitor and control the deposition of sediment under the Old Coach Road bridge, which may decrease the height of the bridge relative to ground surface in the corridor.

5. Continue wildlife monitoring in this area.

Confluence of Green Valley Creek and Thompson Creek

There is continued construction in this area.

1. Continue wildlife monitoring in this area to evaluate the effects of new construction on wildlife movement.

2. Erect fences along the riparian area to restrict humans and dogs.

3. Establish a community education program to inform residents about the need to protect the wildlife corridor.

4. Provide restroom facilities for the golf course landscaping crew, and encourage them to stay out of the culvert area.

5. Monitor and control the deposition of sediment in the four culverts, which may decrease the height of the culverts relative to ground surface in the corridor.

San Dieguito River Park

The SDTT and San Dieguito River Park staff regularly monitor this area.

1. As new development encroaches on habitat in north Poway, continue wildlife monitoring in this area. Monitoring does not need to be annual unless there are disturbances or dramatic decreases in natural habitat on either end of this stream corridor.

2. Ensure that track and camera stations do not encroach on private property.

4.2 SURVEY METHODS

Of the three survey methods currently used to monitor wildlife movement, none by itself appears to provide an entirely suitable protocol for MSCP surveys. We recommend that the baited track station transect method be modified to combine some SDTT approaches. Specifically, in addition to the data collected at baited track stations, wildlife sign should be recorded along the entire length of the transect. In addition, sign other than tracks (e.g., scat) should be recorded at track stations. In this way, we can obtain additional evidence of wildlife use of the transect and directly compare track station results with results from intervening areas. Using this modified approach, the sign surveys along the track station transect will be similar to surveys conducted by the SDTT, except that the survey area will be more standardized than that currently conducted by the SDTT. This modified approach is currently being implemented for the second year of MSCP monitoring in the study area. Once the results of the second monitoring season are analyzed, MSCP protocols for wildlife corridor monitoring should be formally revised to include recommendations from these studies. We also recommend that the SDTT record standard distance increments (e.g., 50 m) along its sign transects so that the results can be quantified in a standardized format. The SDTT method may also benefit by using gypsum in areas of unsuitable substrate.

Camera stations should be restricted to chokepoints, e.g., underpasses or other constrained portions of the linkage (constrained either by natural topographic features or urban land uses). Ideally, cameras should be sited on both sides of a constriction to provide more conclusive evidence of animals moving through the constricted area. Camera station survey metrics would be more comparable to track station results if they were computed as the total number of photographs of a species divided by the number of survey nights (as opposed to the total number of animals divided by the number of survey nights).

Individuals who perform wildlife corridor surveys must have appropriate training and experience. Detecting and identifying wildlife sign, under variable conditions, can be extremely challenging and is not a standard skill possessed by most biological consultants and other professional wildlife biologists. The SDTT offers regularly scheduled wildlife

tracking training courses. These courses should be required for individuals conducting wildlife corridor monitoring, unless suitable experience can be demonstrated.

4.3 FUTURE MONITORING LOCATIONS

MSCP wildlife corridor monitoring should continue annually at the following locations in this study area until management recommendations (Section 4.1) are implemented and the data demonstrate that the section of the linkage is functional for wildlife movement. Thereafter, the wildlife agencies should determine the appropriate frequency of monitoring, but at least every third year. In areas undergoing construction or anticipating buildout in the near future, monitoring should continue annually for at least 3 years following completion of construction activities. At selected critical chokepoints, monitoring should be annual.

- Carmel Creek at I-5 bridge (annually)
- Little Shaw Valley (annually until 3 years after construction is completed)
- Big Shaw Valley (annually until 3 years after construction is completed)
- Intersection of Big and Little Shaw valleys (annually until 3 years after construction is completed)
- Los Peñasquitos Canyon at the I-5/I-805 merge (annually)
- Del Mar Mesa (annually until 3 years after construction is completed)
- Los Peñasquitos Creek at I-15 (every 3 years)
- Los Peñasquitos Creek at Sabre Springs (every 3 years)
- Lower Beeler Canyon (annually until management solutions are implemented and shown to be effective)
- Upper Beeler Canyon (annually through completion of Rancho Encantada and 3 years after construction)
- Green Valley Creek near Blue Sky Reserve (annually)
- Confluence of Green Valley Creek and Thompson Creek (annually)
- San Dieguito River Park (every 3 years until there is significant buildout in the area, i.e., north Poway)

4.4 SAN DIEGO TRACKING TEAM SUPPORT

The U.S. Fish and Wildlife Service (USFWS), CDFG, and MSCP jurisdictions should continue working with the SDTT to focus its transects in areas of the MSCP prioritized for wildlife corridor monitoring. USFWS and CDFG should work with the SDTT to standardize survey design so that results are more suitable for MSCP monitoring analyses. For areas that benefit the MSCP monitoring program, the wildlife agencies and jurisdictions should assist the SDTT with funding to support a volunteer coordinator, purchase cameras and related supplies, and conduct training workshops. The wildlife agencies should provide or assist in providing funding to enter and manage data collected by the SDTT, provide quality assurance review, and conduct data analyses. The SDTT is working toward expanding its membership to conduct surveys in other areas of San

Diego County. The wildlife agencies should incorporate SDTT efforts at the National Wildlife Refuges and state reserves by encouraging "Friends" groups in the vicinity of federal and state lands to participate in corridor training workshops. Integration of graduate student studies with SDTT research has proved successful in encouraging academic institutions to conduct applied research within the NCCP program, and this partnership should be continued.

4.5 DATA ANALYSIS AND DATA MANAGEMENT

The wildlife agencies should provide standardized data collection forms for future MSCP wildlife corridor monitoring. These should be adapted based on recommendations from the second year of monitoring (in progress). The wildlife agencies should provide a centralized database for incorporating results of SDTT and MSCP corridor monitoring that is accessible to the SDTT, jurisdictions, and academic institutions. The results of both the SDTT and MSCP monitoring should be analyzed to assist in formulating and evaluating implementation of management recommendations. The wildlife agencies should work with the MSCP jurisdictions to implement management recommendations to ensure that the MSCP linkages are functional for wildlife movement.

5.0 LITERATURE CITED

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Appendix A
Total Track Station Indices (Summer + Fall 2000)

		SPECIES											
TRANSECT	STATION	Opossum	Coyote	Dog	Fox	Bobcat	Cat	Skunk	Raccoon	Rodent	Rabbit	Ground squirrel	Mule deer
I-5/805 merge	1N	0.00	0.33	0.08	0.00	0.00	0.00	0.17	0.08	0.08	0.00	0.00	0.00
	2N	0.08	0.25	0.17	0.00	0.00	0.00	0.00	0.25	0.08	0.42	0.00	0.00
	3A-N	0.17	0.00	0.08	0.00	0.00	0.00	0.00	0.17	0.08	0.08	0.17	0.00
	3B-N	0.08	0.00	0.00	0.00	0.00	0.00	0.08	0.17	0.33	0.50	0.33	0.00
	3C-N	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.08	0.17	0.17	0.00
	4N	0.00	0.25	0.33	0.00	0.00	0.00	0.00	0.08	0.17	0.00	0.00	0.00
	5N	0.00	0.33	0.17	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.00	0.00
	3A-S	0.17	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.58	0.42	0.33	0.00
	3B-S	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.17	0.33	0.42	0.00
	3C-S	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.08	0.08	0.58	0.08	0.00
	4S	0.08	0.08	0.33	0.00	0.00	0.08	0.00	0.00	0.33	0.58	0.08	0.00
	5S	0.00	0.08	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00
Carmel Creek	1	0.08	0.17	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	0.08	0.08	0.83	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00
	3A-N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.25	0.08
	3A-S	0.17	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.67	0.08	0.33	0.08
	3B-N	0.25	0.00	0.08	0.00	0.00	0.00	0.00	0.17	0.17	0.00	0.08	0.00
	3B-S	0.00	0.00	0.25	0.00	0.00	0.00	0.08	0.08	0.17	0.17	0.00	0.00
	4	0.33	0.00	0.25	0.00	0.00	0.00	0.08	0.25	0.08	0.50	0.08	0.00
	5	0.33	0.08	0.08	0.00	0.00	0.00	0.00	0.08	0.17	0.08	0.00	0.00
Lower Shaw Valley	1	0.00	0.33	0.75	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.00	0.00
	2	0.00	0.17	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00
	3A	0.00	0.08	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.17
	TUNNEL	0.00	0.00	0.27	0.00	0.09	0.00	0.00	0.27	0.00	0.00	0.00	0.64
	3B	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00
	3C	0.00	0.08	0.33	0.00	0.00	0.00	0.00	0.08	0.00	0.17	0.08	0.17
	4	0.00	0.42	0.33	0.00	0.00	0.00	0.00	0.00	0.33	0.33	0.25	0.00
Little Shaw Valley	1	0.00	0.00	0.00	0.00	0.10	0.00	0.20	0.00	0.10	0.10	0.00	0.00
	2	0.00	0.10	0.20	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
	3A	0.00	0.30	0.10	0.00	0.00	0.00	0.00	0.00	0.20	0.10	0.00	0.00
	3B	0.00	0.20	0.30	0.00	0.20	0.00	0.00	0.00	0.10	0.10	0.00	0.00
	4	0.00	0.10	0.10	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix A
Total Track Station Indices (Summer + Fall 2000)

		SPECIES											
TRANSECT	STATION	Opossum	Coyote	Dog	Fox	Bobcat	Cat	Skunk	Raccoon	Rodent	Rabbit	Ground squirrel	Mule deer
Del Mar	1C	0.00	0.30	0.40	0.00	0.00	0.00	0.10	0.00	0.10	0.30	0.00	0.00
Mesa	1M	0.00	0.30	0.90	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.00	0.00
	2C	0.00	0.50	0.40	0.00	0.00	0.00	0.00	0.00	0.30	0.10	0.00	0.00
	2M	0.00	0.10	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00
	3M	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0.00	0.10	0.20	0.00	0.00
	4D	0.00	0.00	0.20	0.10	0.00	0.00	0.10	0.10	0.10	0.00	0.00	0.00
	4M	0.00	0.10	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Big Shaw	1	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Valley	2	0.00	0.30	0.80	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.00
	3	0.00	0.10	0.60	0.00	0.10	0.00	0.10	0.00	0.00	0.00	0.00	0.00
	4	0.00	0.50	0.60	0.00	0.10	0.00	0.00	0.10	0.10	0.00	0.00	0.00
	5	0.00	0.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00
LPCP	1	0.00	0.40	0.20	0.00	0.10	0.00	0.00	0.00	0.20	0.10	0.20	0.00
Interior 4	2	0.00	0.10	0.50	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.00
	3	0.00	0.30	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.10
	4	0.00	0.30	0.70	0.00	0.00	0.00	0.00	0.10	0.00	0.10	0.00	0.10
	5	0.00	0.20	0.60	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LPCP	1	0.00	0.40	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interior 3	2	0.00	0.20	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00
	3	0.00	0.30	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00
	4	0.00	0.30	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00
	5	0.00	0.40	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00
LPCP	1	0.00	0.30	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interior 2	2	0.00	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	0.00	0.40	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4	0.00	0.30	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LPCP	1	0.10	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interior 1	2	0.40	0.00	0.20	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00
	3	0.20	0.20	0.00	0.00	0.10	0.00	0.00	0.30	0.00	0.20	0.00	0.10
	4	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00
	5	0.10	0.40	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00

Appendix A
Total Track Station Indices (Summer + Fall 2000)

		SPECIES											
TRANSECT	STATION	Opossum	Coyote	Dog	Fox	Bobcat	Cat	Skunk	Raccoon	Rodent	Rabbit	Ground squirrel	Mule deer
Black Mtn. Road Bridge	1N	0.10	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.10
	1S	0.20	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00
	2N	0.00	0.00	0.50	0.00	0.40	0.00	0.10	0.00	0.20	0.20	0.00	0.10
	2S	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.00
	3A	0.20	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.10
	3B	0.30	0.00	0.20	0.00	0.00	0.00	0.00	0.10	0.00	0.30	0.00	0.00
	4	0.20	0.10	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00
	5	0.10	0.00	0.50	0.00	0.10	0.00	0.00	0.00	0.00	0.10	0.10	0.00
I-15 bridge	1	0.90	0.00	0.00	0.00	0.10	0.00	0.00	0.50	0.00	0.00	0.10	0.00
	2	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.30	0.00	0.00
	3	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.10	0.00	0.00	0.00
	4	0.20	0.00	0.20	0.00	0.20	0.00	0.10	0.60	0.00	0.20	0.00	0.00
	5	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.10
Los Penasquitos Creek at Sabre Springs	1	0.30	0.20	0.20	0.00	0.10	0.00	0.20	0.30	0.00	0.00	0.00	0.00
	2	0.20	0.20	0.20	0.00	0.10	0.00	0.60	0.00	0.00	0.30	0.10	0.00
	3	0.00	0.20	0.30	0.00	0.00	0.10	0.40	0.00	0.30	0.10	0.10	0.00
	4	0.00	0.00	0.30	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00
	5	0.10	0.00	0.80	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0.00
Upper Beeler Canyon	1	0.00	0.00	0.30	0.00	0.10	0.00	0.00	0.00	0.20	0.10	0.00	0.10
	2	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
	3	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4	0.00	0.10	0.30	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00
	5	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lower Beeler Canyon	1	0.20	0.00	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00
	2	0.20	0.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00
	3A	0.50	0.00	0.30	0.00	0.00	0.00	0.00	0.30	0.10	1.00	0.10	0.00
	3B	0.00	0.30	0.40	0.00	0.10	0.00	0.00	0.40	0.10	0.20	0.00	0.00
	3C	0.10	0.10	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00
	4	0.20	0.30	0.10	0.00	0.00	0.00	0.10	0.20	0.20	0.00	0.00	0.00
	5	0.00	0.20	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00
Scripps-Poway Pkwy underpass	1	0.00	0.30	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3A	0.00	0.45	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3B	0.00	0.44	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4	0.00	0.30	0.10	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00
	5	0.00	0.80	0.10	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00

Appendix A
Total Track Station Indices (Summer + Fall 2000)

		SPECIES											
TRANSECT	STATION	Opossum	Coyote	Dog	Fox	Bobcat	Cat	Skunk	Raccoon	Rodent	Rabbit	Ground squirrel	Mule deer
Green Valley Crk near Blue Sky	1	0.00	0.09	0.18	0.00	0.00	0.00	0.00	0.09	0.09	0.09	0.00	0.00
	2	0.00	0.36	0.36	0.00	0.09	0.00	0.00	0.36	0.00	0.00	0.00	0.00
	3	0.00	0.36	0.45	0.00	0.09	0.00	0.00	0.27	0.00	0.00	0.00	0.00
	4	0.00	0.27	0.36	0.00	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.00
	5	0.00	0.00	0.09	0.00	0.09	0.00	0.00	0.09	0.00	0.09	0.00	0.00
Green Valley & Thompson Crks confluence	1	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00
	2	0.00	0.09	0.18	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00
	3A	0.00	0.09	0.55	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.18	0.00
	3B	0.00	0.09	0.45	0.00	0.00	0.00	0.00	0.27	0.00	0.09	0.00	0.00
	4	0.00	0.27	0.36	0.00	0.09	0.00	0.00	0.09	0.00	0.00	0.00	0.00
	5	0.18	0.36	0.36	0.00	0.09	0.00	0.00	0.27	0.00	0.00	0.00	0.09
San Dieguito River Park	1	0.00	0.18	0.09	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	0.00	0.36	0.09	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00
	3	0.27	0.09	0.18	0.00	0.09	0.00	0.00	0.00	0.18	0.00	0.00	0.00
	4	0.18	0.00	0.36	0.00	0.18	0.00	0.00	0.00	0.09	0.00	0.00	0.00
	5	0.00	0.09	0.91	0.00	0.09	0.00	0.09	0.00	0.00	0.00	0.00	0.00

Stations are named as follows:

-If no bridges intersected a transect, then 5 stations are located 250 m apart and named 1-5 (west-east)

-When a bridge intersected the transect, then 6 stations are established: 1, 2, 3A are on the west side of the bridge and 3B, 4, and 5 are on the east side of the bridge. If the stations were also positioned on the north and south sides of the creek, then naming was 1N, 2N, 3A-N and 1S, 2S, and 3A-S, etc.

-Del Mar Mesa transect: 1C, 2C are stations running down the canyon wall of LPCP, 1M-4M are mesa top stations, and 4D was on a deer trail running down into LPCP

-Lower Shaw Valley transect: 1, 2, 3A are stations on west side of culvert, 3C on a deer trail running south from west end of culverts, and 3B, 4 on east end of culvert (no station 5)

-805/5 merge transect: no stations 1 or 2 on south side of creek

-Carmel Creek Transect: only stations closest to I-5 bridge were replicated on north and south sides (e.g., 3A-N, #A-S, 3B-N, 3B-S)

-I-15 bridge transect: stations 1, 2, and 3 on west side of bridge and 4 and 5 on east side of bridge

Appendix B
Contingency Chi-square Analysis
of Wildlife Species Detection Frequencies by Survey Method

Species	Transect Frequencies				Chi-Square Statistic	Prob.
bobcat	***actual***	track	camera	transect	8.19	0.017
	detect	7	9	13		
	not detect	13	11	3		
	expected	track	camera	transect		
	detect	10.4	10.4	8.3		
	not detect	9.6	9.6	7.7		
mtn. lion	***actual***	track	camera	transect	2.55	0.280
	detect	0	0	1		
	not detect	20	20	15		
	expected	track	camera	transect		
	detect	0.4	0.4	0.3		
	not detect	19.6	19.6	15.7		
coyote	***actual***	track	camera	transect	26.67	< 0.001
	detect	19	7	16		
	not detect	1	13	0		
	expected	track	camera	transect		
	detect	15.0	15.0	12.0		
	not detect	5.0	5.0	4.0		
fox	***actual***	track	camera	transect	10.77	0.005
	detect	0	0	4		
	not detect	20	20	12		
	expected	track	camera	transect		
	detect	1.4	1.4	1.1		
	not detect	18.6	18.6	14.9		
deer	***actual***	track	camera	transect	20.54	< 0.001
	detect	6	15	16		
	not detect	14	5	0		
	expected	track	camera	transect		
	detect	13.2	13.2	10.6		
	not detect	6.8	6.8	5.4		

Appendix B
Contingency Chi-square Analysis
of Wildlife Species Detection Frequencies by Survey Method

Species	Transect Frequencies				Chi-Square Statistic	Prob.
raccoon	***actual***	track	camera	transect	10.28	0.006
	detect	10	7	14		
	not detect	10	13	2		
	expected	track	camera	transect		
	detect	11.1	11.1	8.9		
	not detect	8.9	8.9	7.1		
opossum	***actual***	track	camera	transect	20.15	< 0.001
	detect	12	0	10		
	not detect	8	20	6		
	expected	track	camera	transect		
	detect	7.9	7.9	6.3		
	not detect	12.1	12.1	9.7		