Western Riverside County
Multiple Species Habitat Conservation Plan (MSHCP)
Biological Monitoring Program

Carnivore Survey Report 2010

23 March 2011

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NOTE TO READER:

This report is an account of survey activities conducted by the Biological Monitoring Program for the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP). The MSHCP was permitted in June 2004. The Monitoring Program monitors the distribution and status of the 146 Covered Species within the Conservation Area to provide information to Permittees, land managers, the public, and the Wildlife Agencies (i.e., the California Department of Fish and Game and the U.S. Fish and Wildlife Service). Monitoring Program activities are guided by the MSHCP species objectives for each Covered Species, the information needs identified in MSHCP Section 5.3 or elsewhere in the document, and the information needs of the Permittees.

MSHCP reserve assembly is ongoing and it is expected to take 20 or more years to assemble the final Conservation Area. The Conservation Area includes lands acquired for conservation under the terms of the MSHCP and other lands that have conservation value in the Plan Area (called public or quasi-public lands in the MSHCP). In this report, the term "Conservation Area" refers to the Conservation Area as understood by the Monitoring Program at the time the surveys were planned and conducted.

We would like to thank and acknowledge the land managers in the MSHCP Plan Area, who in the interest of conservation and stewardship facilitate Monitoring Program activities on the lands for which they are responsible. A list of the lands where data collection activities were conducted in 2010 is included in Section 7.0 of the Western Riverside County Regional Conservation Authority (RCA) Annual Report to the Wildlife Agencies. Partnering organizations and individuals contributing data to our projects are acknowledged in the text of appropriate reports.

While we have made every effort to accurately represent our data and results, it should be recognized that data management and analysis are ongoing activities. Any reader wishing to make further use of the information or data provided in this report should contact the Monitoring Program to ensure that they have access to the best available or most current data.

The primary preparer of this report was the 2010 Lead Biologist, Bill Kronland. If there are any questions about the information provided in this report, please contact the Monitoring Program Administrator. If you have questions about the MSHCP, please contact the Executive Director of the RCA. Further information on the MSHCP and the RCA can be found at www.wrc-rca.org.

Contact Information:

Executive Director
Western Riverside County
Regional Conservation Authority
4080 Lemon Street, 12th Floor
P.O. Box 1667
Riverside, CA 92502-1667
Ph: (951) 955-9700

Western Riverside County MSHCP
Monitoring Program Administrator
c/o Adam Malisch
4500 Glenwood Drive, Bldg. C
Riverside, CA 92501
Ph: (951) 248-2552

INTRODUCTION

Species-specific objectives of the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) for bobcat *(Felis rufus*), mountain lion *(Puma concolor*), coyote (*Canis latrans*), and long-tailed weasel (*Mustela frenata*) call for the maintenance of habitat conservation cores and linkages that provide an effective means of dispersal (Dudek & Associates 2003; Appendix A). Presence of covered carnivores, as measured at least once every 8 years, must be maintained on at least 75% of cores and linkages identified in individual species accounts, and movement of bobcat and mountain lion must be shown to occur across potential barriers to dispersal (e.g., freeway corridors) (Dudek & Associates 2003).

The MSHCP Biological Monitoring Program began surveying for covered mammalian carnivores in 2008 using scent-station transects, motion-triggered cameras, and area-search surveys. We also collaborated with local land managers and researchers to acquire data regarding carnivore presence and dispersal within the Conservation Area. After 2 years of collecting data, we have documented presence of bobcat and mountain lion on at least 75% of listed Core Areas, and coyote on all but 1 of 14 linkages (Appendix B). In contrast, 2008-2009 data did not include bobcat and mountain lion detections at a sufficient number of linkages or potential dispersal barriers to meet species-specific objectives. We also require long-tailed weasel detections on at least 5 Core Areas and 21,205 ha of habitat linkage. We present here results of the 2010 surveys to document presence/absence of long-tailed weasel in species-specific cores where data were lacking, and to record movement of bobcat and mountain lion across potential dispersal barriers and linkages not adequately surveyed prior to 2010.

Results from scent-station surveys in 2008-2009 indicated that bobcat and mountain lion seldom visited scent lures and were more reliably detected by walking transects and searching for sign. Conversely, long-tailed weasel were only observed at scent stations though probability of detecting the species was low (i.e., < 0.5). Poor detectability may be explained by the relatively large spacing between scent stations (150 m) compared to the small average home range size of the species [10 – 24 ha if prey is abundant or 80 – 160 ha when prey is scarce (Sheffield 1999)]. It is plausible that weasels were present on transects but difficult to detect given the likelihood that a scent station was present within a home range.

Scent-station surveys in 2010 targeted 6 Core Areas previously not surveyed for long-tailed weasel [Santa Margarita Ecological Reserve (Existing Core G), Banning Bench/San Gorgonio Wash (Existing Core I), southern Gavilan Hills (Proposed Core 1), Warm Springs (Proposed Core 2), Cactus Valley (Proposed Core 4), San Jacinto River near Hemet (Proposed Core 5)], and the Badlands (Proposed Core 3) where we had not detected the species during surveys in 2008. We increased the opportunity of recording weasel in 2010 by shortening the distance between scent stations and reducing the overall length of transects, thus increasing the likelihood that 1 or more scent stations occurred on a home range bisected by individual transects.

Camera stations have also been an effective means of documenting species presence at freeway undercrossings, as they allow for the entire width of corridors to be

surveyed continuously with 1 – 2 cameras and a minimal investment of field staff. Vandalism remains the largest threat to success of camera stations especially in areas similar to the I-15 crossing of Pechanga Creek, where human activity presents a near-constant danger to equipment. As a result, we shifted the focus of our 2010 camera-station effort away from the I-15 corridor near the San Diego County line to the relatively unpopulated corridor of CA-60 as it passes through the Badlands.

We began using focused area-search surveys in 2009 to document presence of larger carnivore species across incomplete habitat linkages where restrictively small areas of conserved land precluded more robust survey methods, but allowed entire conservation parcels to be examined. We continued using area-search surveys in 2010 to document mountain lion on habitat linkages where data were lacking (i.e., Tucalota Creek, Pechanga Creek, San Gorgonio Wash, Indian/Horsethief Canyons and the Badlands), recognizing that observations indicated use rather than dispersal, and that lack of detection does not necessarily translate into species absence. Specifically, our goals and objectives were as follows:

Goals and Objectives

1. Determine presence/absence of long-tailed weasel at species-specific Core Areas.
    a. Consider estimates of use that account for probability of detecting target species along scent-station transects to confirm presence/absence.

2. Determine presence of bobcat and mountain lion at species-specific habitat linkages.
    a. Consider observations of animal sign as evidence that habitat linkages are being used by targeted species.

3. Document movement of covered carnivore species across transportation corridors that may potentially impede dispersal.
    a. Consider recorded images of target species under bridges or passing through culverts as evidence of animal movement across transportation corridors.

METHODS

Training

Field personnel successfully completed an in-house training course focused on identifying animal sign before conducting scent-station surveys. Training consisted of office-based independent study of field guides, on-line material, and the survey protocol. Field personnel also attended a slide show presentation detailing Personal Digital Assistant (PDA) use, the survey protocol, and characteristics for identifying animal sign. Field personnel also participated in mock surveys on practice transects. Proficiency in identifying animal sign was assessed with an office-based quiz consisting of track and scat slides. Field personnel were required to correctly identify > 90 % of 24 quiz slides before conducting scent-station surveys.

Field staff (Table 1) that successfully completed the animal-sign training course were able to proficiently identify tracks and/or scat from the following species: opossum

(*Didelphus marsupialis*), black bear (*Ursus americanus*), raccoon (*Procyon lotor*), long-tailed weasel, badger (*Taxidea taxus*), spotted skunk (*Spilogale putorious*), striped skunk (*Mephitis mephitis*), coyote, gray fox (*Urocyon cinereoargenteus*), domestic dog (*Canis lupus familiaris*), bobcat, mountain lion, California ground squirrel (*Spermophilus beecheyi*), Desert cottontail (*Sylvilagus audubonii*), San Diego black-tailed jackrabbit (*Lepus californicus bennettii*), and black-tailed deer (*Odocoileus hemionus*). Field personnel were also able to conduct scent-station surveys according to protocol, accurately record data using a PDA, and proficiently use a Garmin GPS unit.

Table 1. Field staff that conducted carnivore surveys in 2010.

Name	Organization	Funding Source[1]
Bill Kronland	Biological Monitoring Program	RCA
Ashley Ragsdale	Biological Monitoring Program	RCA
Betsy Dionne	Biological Monitoring Program	RCA
Giovanni Arechavaleta	Santa Ana Watershed Association	Volunteer
Jonathan Reinig	Biological Monitoring Program	RCA
Lauren Ross	Biological Monitoring Program	CDFG
Nate Zalik	Biological Monitoring Program	RCA
Nicole Housel	Santa Ana Watershed Association	Volunteer
Tara Graham	Biological Monitoring Program	CDFG
Laura Magee	Biological Monitoring Program	CDFG
Joe Sherrock	Biological Monitoring Program	CDFG
Mike Robinson	Biological Monitoring Program	CDFG
Julie Golla	Biological Monitoring Program	CDFG
Espie Sandoval	Biological Monitoring Program	RCA
Jennifer Hoffman	Biological Monitoring Program	RCA

[1] RCA = Regional Conservation Authority; CDFG = California Department of Fish and Game; Santa Ana Watershed Association biologists were project volunteers, and were not funded through the Biological Monitoring Program.

Scent-station Surveys

Survey Design

We used the Hawth's Tools extension (Beyer 2004) for ArcGIS v.9.3 (ESRI 2006) to randomly distribute transect start points with a minimum spacing of 500 m across drainages and secondary roads in targeted Core Areas (Figures 1-4). We selected roads and drainages because they were known from previous surveys to be used by covered carnivores in the area (see 2008 and 2009 Biological Monitoring Program Carnivore Survey Reports), and could be easily identified with aerial imagery and existing GIS layers. We distributed points so that a sampling density of 1 transect per 1.5 – 1.7 km of secondary roads and drainages was maintained across Existing Core G and Proposed Cores 1, 2, 4, and 5 (Table 2). We surveyed Existing Core I with a sampling density of 1 transect per 3 km of roads and drainages because these landscape features were more abundant here than on other targeted Core Areas, and only targeted drainages in Existing Core 3 with a sampling density of 1 transect per 3 km because we surveyed roads here unsuccessfully in 2008. We also excluded State Park Lands from our survey of Proposed Core 3, focusing instead on lands managed by the Western Riverside County

Figure 1. Scent-station transects surveyed at Existing Core G and Existing Core I in 2010.

Figure 2. Scent-station transects surveyed at Proposed Core 1 and Proposed Core 2 in 2010.

Figure 3. Scent-station transects surveyed at Proposed Core 3 and Proposed Core 4 in 2010.

Figure 4. Scent-station transects surveyed at Proposed Core 5 in 2010.

Regional Conservation Authority and Riverside County Parks, because timing of the survey precluded acquisition of a state-park permit.

Table 2. Length (km) and number of transects (n) sampled during scent-station surveys at targeted MSCHP Core Areas.

		Secondary Roads		Off-road Drainages	
MSHCP Core	**Sampling Station**	**Total length**	***n***	**Total length**	***n***
Existing Core G	Santa Margarita Ecol. Reserve	11.4	7	10.2	6
Existing Core I	Banning Bench	36.7	11	26.8	8
Proposed Core 1	Southern Gavilan Hills	14.6	10	8	4
Proposed Core 2	Warm Springs	0.4	0	9.7	6
Proposed Core 3	Badlands	-	-	21.2	7
Proposed Core 4	Cactus Valley	8.2	5	8.1	5
Proposed Core 5	San Jacinto River near Hemet	0	0	11.7	8
	TOTAL	71.3	33	95.7	44

Accessing some off-road regions within an 8-hour field day was prohibited by terrain in Existing Cores G and I and Proposed Core 4, so we limited the distribution of points among drainages in these areas to < 1 km from roads. As a result, we surveyed across 56% (10.2 km), 68% (26.8 km) and 55% (8.1 km) of drainages in Existing Cores G and I and Proposed Core 4, respectively. We did not survey 0.3 km of drainages managed by the Center for Natural Lands Management (CNLM) in Proposed Core 2 because of potential disturbance to sensitive plant species there.

We extended a 225-m transect from each random start point along targeted drainage and road corridors. Transects were thrown out if any of the following occurred: the transect extended beyond the Conservation Area boundary, minimum spacing of 225 m between transects was violated (i.e., sample independence threatened), road transects crossed drainages, or drainage transects crossed roads. Each transect consisted of 4 scent stations distributed evenly at 75-m intervals.

We surveyed each transect with a single 4-day effort. We averaged 13 transects (range: 6 - 16) per week over 6 weeks (1 – 11 February, and 25 February – 18 March) for a total of 75 transects. We identified and recorded presence of covered carnivore sign at and between scent stations, and removed sign after each survey to maintain independence of detections on transects across survey nights.

Field Methods

We established transects on Mondays, the first day of each survey, by installing scent stations consisting of a fatty-acid scent disk (USDA Pocatello Supply Depot, Pocatello, Idaho) placed at the center of a pad of play sand approximately 1 m in diameter and 1 cm deep. The scent lure attracted carnivores in the immediate vicinity of the station, and tracks of investigating animals were subsequently recorded in the sand. We placed scent stations approximately 1 m from the edge of secondary roads or off-road drainage channels, and marked the opposite side of the road or channel with a piece of labeled flagging tape. We also noted the presence of carnivore sign, and removed it by rubbing out tracks and tossing scat to the side.

We visited transects 3 consecutive days following their initial set-up (i.e., Tuesday – Thursday), recording carnivore sign detected at and while walking between scent stations. We recorded observer, date, transect ID, location (scent station or transect ID), type (track, scat, kill site, visual), species of origin, certainty of identification (1 = certain, 2 = uncertain), and survey night (0 – 3) for detected sign. Data for each survey night were recorded the following day; data collected on Monday, during transect set-up, were recorded as survey night "0". We also recorded width (cm), length (cm) and, when possible, stride (cm) and straddle (cm) for carnivore tracks. Only one observation per species was recorded along transects and 1 track per species was measured at each scent station. We rubbed out tracks and tossed scat from transects after each survey, and reset scent stations by moistening sand, smoothing it with a hand trowel and replacing missing or partially consumed scent lures. We removed scent stations on Thursday, the final survey day of each effort, by spreading sand, collecting used scent lures and removing flagging tape.

We recorded data in the field using Pendragon Forms v.5.1 (Pendragon Software Corporation 2007) installed onto Palm T/X Handheld PDAs (Palm, Inc., Sunnyvale, California), and downloaded them daily to an interim MySQL v.5.0.51 (Sun Microsystems, Inc. 2005) database back at the office. Incoming data were queried each day for quality assurance using linked forms in Microsoft Access 2007 (Microsoft Corporation 2007), and added to the Biological Monitoring Program's multi-taxa database at the completion of surveys.

Play sand used in our surveys originated from a local quarry located in San Juan Capistrano just south of the Ortega Highway, and was sifted and washed by the manufacturer (Paragon Building Products, Inc., Corona, California). The product consisted of fine-grain silica sand of uniform size and color that performed well in recording readable tracks when moist, and was free of visible debris. Still, we sterilized sand by heating it to > 250^{o} F in an autoclave before surveying at Existing Core I, and removed it from certain sites following surveys because of concern by the US Forest Service of contamination by invasive plant seeds. We also examined the use of other materials (e.g., gypsum powder and more readily available sand products) at the office compound of the Biological Monitoring Program. Unfortunately, we found them to be difficult to work with over multiple days (i.e., gypsum powder would clump) or not able to record readable animal tracks (i.e., tracks in larger grain sand fell apart).

Camera Stations

We operated 7 motion-triggered camera stations at 5 locations in 2010, targeting carnivore linkages and potential dispersal barriers (e.g., freeway crossings) within linkages and cores (Figure 5). We placed cameras under bridges along I-15 at Horsethief Wash (n = 1; Proposed Constrained Linkage 5, Proposed Linkage 1), Indian Wash (n = 1; Proposed Constrained Linkage 5, Proposed Linkage 1), and Gavilan Wash (n = 1; Proposed Core 2). We also maintained a camera just to the west of I-15 near the confluence of Gavilan Wash and Temescal Wash to determine whether carnivore species were present in the core but not using the freeway undercrossing. We monitored the I-10 crossing at San Gorgonio Wash (n = 2; species-specific linkage for mountain lion).

Figure 5. Camera station sites and number (*n*) of units operated at each location.

We monitored Calimesa (n = 1; Constrained Linkage 23) angling the camera toward a water seep. We operated cameras from 1 January to 26 April 2010, continuous with our 2009 effort.

Our 2009 camera-station design performed well in deterring theft of units, so we implemented the same design in 2010. We encased each camera in a metal box (24 cm x 15 cm x 10.5 cm) made with 1/8-in steel and with an opening cut into the front for flash, lens, and motion-heat sensors (Figure 6). We attached each box to a 4 in x 4 in wood post buried in the ground at least 60 cm deep, positioning cameras on wood posts so that motion-heat sensors sat 46 cm off the ground. We then secured the steel boxes and wood posts to fixed objects (e.g., boulder, tree) with padlocks and ¼-in steel chain. We did not use steel boxes or chain for camera stations deployed in areas other than bridges because of the associated material cost; rather, we secured cameras to fixed objects with 3/8-in coated cable and concealed them with burlap (Figure 6).

Figure 6. Camera station designs for units placed under bridges with steel box and chain (A), and cameras deployed without steel box and concealed with burlap (B).

We used Cuddeback Expert Digital Scouting cameras (Non Typical, Inc., Park Falls, Wisconsin) equipped with either an infrared or incandescent flash for recording images at night. We used infrared flash on units placed under bridges to reduce the likelihood of distracting motorists or discouraging wildlife from using the corridor. We programmed cameras to operate 24 hours/day and to record a single high-resolution digital image (2048 x 1536 pixels) when triggered. Each photo-capture event was followed by a 1-minute delay to avoid recording multiple images of a single visit, or repeated photos of non-target movement (e.g., shadows, vegetation movement). Each image included the date and time when it was recorded and the camera station location.

We selectively installed cameras at locations that maximized coverage of bridge underpasses or captured landscape features most likely to be used by carnivores (e.g., game trails, drainages). We allowed human users of bridge undercrossings to become accustomed to the presence of camera stations by initially installing empty steel boxes chained to fixed objects, then returning after 2 to 3 weeks to add camera units and began recording data. We did not use an initiation period for stations placed away from freeway undercrossings but began recording data on the day of installation. Motion-heat sensor sensitivity on each camera, regardless of station placement, was initially set to 'high',

then adjusted 2 to 4 days later to a lower setting if many blank or non-target images (e.g., movement of shadows, shifting vegetation) were being recorded. We checked cameras on a 21-day cycle once motion-heat sensor sensitivity was adjusted appropriately, thus allowing human scent to dissipate from the site between visits (Séquin et al. 2007). We switched out Compact Flash Cards (2 gigabyte), changed batteries when < 50% power, cut back vegetation, and maintained the general condition of camera stations on each visit.

Area-search Surveys

A number of MSHCP-defined habitat linkages are too small or incomplete to survey with a rigorous presence/absence sampling design. We opportunistically conducted presence-only surveys in November and December 2010 in 4 of 6 habitat linkages defined by Species Objective 2 for mountain lion (Table 3). We visited as many conserved parcels within each linkage as possible, and searched trails, drainage channels, or any other landscape feature conducive to animal dispersal for covered carnivore sign. We searched each parcel for 15 to 90 minutes, depending on area and how quickly we detected sign. We recorded the species of origin and location (UTM waypoint) for covered carnivore sign detected, and measured the length, width, and, when possible, stride and straddle of each track. Each parcel was visited once so lack of detection should not be interpreted as evidence of absence.

Table 3. Parcels surveyed with area search surveys in 4 habitat linkages defined for mountain lion.

Linkage	Parcel Owner, Approximate Survey Location
Badlands	Regional Conservation Authority, N of Gilman Springs Rd near Bridge St
	Regional Conservation Authority, E of Mystic Lake
	Regional Conservation Authority, N of Victory Ranch Baptist Camp
Indian Canyon/Horsethief Canyon	Regional Conservation Authority, approx. 350 m SE from intersection of Indian Truck Trail and Temescal Canyon Rd
Pechanga Creek	Riverside County Flood Control, 600 m SE of 15/79 intersection
Tucalota Creek	Regional Conservation Authority, approx. 200 m S of Stanley Rd

Incidental Observations

We opportunistically recorded presence of covered carnivore species throughout 2010 across the MSHCP Plan Area during non-target surveys. We also collaborated with regional biologists and land managers to collect reliable observations made across the Plan Area by non-Monitoring Program staff. Incidental observations represent evidence of presence only, and lack of detections in any given area should not be interpreted as evidence of absence.

Data Analysis

We recorded too few observations of long-tailed weasel and mountain lion during scent-station surveys for meaningful statistical analysis, and considered detection/non-detection data per transect as evidence of species presence. Observations were more numerous for bobcat and coyote when pooled across road and drainage transects, and we estimated nightly detection probabilities for these species using closed-capture occupancy models in Program MARK (White and Burnham 1999, MacKenzie et al. 2006). We

pooled detections of bobcat tracks observed while walking transects across the entire survey period according to sampling density, and constructed a set of candidate models that examined the full combination of time- (i.e., survey night, excluding set-up) and site-varying effects on detection probability. We also pooled coyote track detections by sampling density across the survey period but examined time and site effects on detection probability separately for data collected at scent stations and along walking transects. We examined model fit by ranking each candidate set by Akaike's Information Criterion for small samples (AICc), and manually adjusted number of parameters used to calculate AICc when MARK failed to estimate the full parameter set for individual models. We considered weighted-average estimates from a model set containing > 0.95 Akaike weight when parameter estimates varied significantly among models with similar support, but otherwise considered estimates based on the model with lowest AICc value in each candidate set (Burnham and Anderson 2002, Arnold 2010). We also calculated a cumulative detection probability from our observations to estimate the probability of accounting for an individual that is present but not detected using model-based estimates of nightly detection probability (Burnham and Anderson 2002).

Variances for cumulative detection probability were calculated using R 2.11.1 (R Development Core Team 2007) according to the delta method (MacKenzie et al. 2006). Estimates represent probabilities of detecting target species present at Core Areas during the survey period. Finally, we calculated encounter rate as total detections divided by total observation days (product of transects surveyed and number of visits per transect) as a measure of observations per visit.

Data recorded via camera stations, area-search surveys, and incidental observations are added to the database and contribute to meeting MSHCP goals as documentation of species presence in given survey areas.

RESULTS

Scent-station Surveys

We detected bobcat and coyote at all Core Areas surveyed with scent-station transects in 2010, and long-tailed weasel at all sites except Proposed Core 4 (Table 4). We often observed mountain lion tracks at Existing Core G along the Santa Margarita River but did not detect the species at any other Core Area. Coyote were the most common users of transects, followed by bobcat, long-tailed weasel, and mountain lion. Non-covered species observed on scent-station transects included domestic dog (*Canis lupus familiaris*), Desert cottontail (*Sylvilagus audubonii*), gray fox (*Urocyon cinereoargenteus*), black-tailed deer (*Odocoileus hemionus*), California ground squirrel (*Spermophilus beecheyi*), striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), and San Diego black-tailed jack rabbit (*Lepus californicus bennettii*) (Appendix C).

Estimated cumulative detection probabilities for bobcat and coyote did not differ among top models, so we considered estimates based on a single model in each candidate set with the lowest AICc value. Nightly detection probability (p) was modeled as constant across survey nights and Core Areas for the top model in all but 1 candidate set, indicating that scent-station transects performed similarly in detecting bobcat and coyote across sites when sampled with the same density of transects (Appendix D). The

exception was in detecting coyote sampled with 1 transect per 1.5 ha of roads and drainage at scent stations, where *p* varied significantly across Core Areas. Cumulative detection probabilities across survey nights were generally low for bobcat and coyote, except for coyote observed with scent stations at Proposed Core 1 and 2 (Table 5).

Table 4. Number of transects (percent of total) used by 4 carnivore species surveyed across 7 Core Areas in western Riverside County. Includes observations made during transect set-up.

MSHCP Core	Location	Bobcat	Coyote	Long-tailed Weasel	Mountain Lion
Existing Core G	Santa Margarita Ecol. Reserve	4 (30.8)	8 (61.5)	1 (7.7)	5 (38.5)
Existing Core I	Banning Bench	7 (36.8)	10 (52.6)	1 (5.3)	0 (0)
Proposed Core 1	Southern Gavilan Hills	4 (28.6)	14 (100)	2 (14.3)	0 (0)
Proposed Core 2	Warm Springs	1 (16.7)	5 (83.3)	1 (16.7)	0 (0)
Proposed Core 3	Badlands	1 (14.3)	6 (85.7)	1 (14.3)	0 (0)
Proposed Core 4	Cactus Valley	1 (10)	6 (60)	0 (0)	0 (0)
Proposed Core 5	San Jacinto River near Hemet	2 (25)	8 (100)	1 (12.5)	0 (0)
	TOTAL	20 (25.6)	59 (75.6)	7 (9.0)	5 (6.4)

Table 5. Number of transects used, encounter rates (SE), and cumulative detection probabilities (SE) for bobcat, coyote, and long-tailed weasel detected on transects using 2 survey methods (scent station vs. walking transects) and 2 sampling densities. Does not include detections made during transect set-up.

	Scent Stations		Walking Transects	
	1.5 per ha	3 per ha	1.5 per ha	3 per ha
Used Transects[a]				
Bobcat	1	2	6	6
Coyote	27	9	32	12
Long-tailed weasel	5	1	1	1
Mountain lion	0	0	5	0
Encounter Rate				
Bobcat	0.01 (0.01)	0.02 (0.01)	0.04 (0.02)	0.12 (0.04)
Coyote	0.18 (0.03)	0.12 (0.04)	0.21 (0.03)	0.15 (0.04)
Long-tailed weasel	0.03 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
Mountain lion	-	-	0.14 (0.04)	-
Cumulative Detection				
Bobcat	-	-	0.15 (0.13)	0.38 (0.15)
Coyote[b]		0.41 (0.12)	0.44 (0.07)	0.33 (0.11)
Existing Core G	0.31(0.14)			
Proposed Core 1	0.99(0.02)			
Proposed Core 2	0.88(0.1)			
Proposed Core 4	0.56(0.2)			
Proposed Core 5	0.67(0.14)			

[a] Animals were detected on some transects with both survey methods.

[b] Separate detection probabilities for coyote observed at scent station were modeled for each Core Area sampled with 1.5 transects per ha.

Encounter rates were also low for all target species especially for long-tailed weasel and mountain lion. As we had found with previous carnivore surveys, bobcat and mountain lion sign was best detected walking along transects while long-tailed weasel was almost exclusively recorded at scent stations. Encounter rates and detection probabilities generally did not differ between survey method or sampling density for coyote.

Camera Stations

We surveyed 5 locations with 7 cameras for a total of 465 camera nights in 2010. Four of the 7 cameras were not in continuous operation during periods of intended use, and a total of 44 camera nights were not surveyed because of battery failure or field personnel not turning cameras on after routine checks (Table 6). The camera at the I-15 crossing of Gavilan Wash was buried in mud during a flash flood and was unusable as a result. The camera at Calimesa was not encased in a steel box; it was stolen after only a few weeks of collecting data.

Table 6. Operation summary of 7 camera stations used in 2010 to monitor dispersal across freeway undercrossings.

I-15	Unit	Date Installed	Date Removed	Camera Nights	Dates out of operation	Explanation
Gavilan Wash	X[a]	4/11/2008	3/24/2010	60	1/23 - 2/15	Batteries failed
	Y	5/13/2009	-	7	-	Flash flood buried in mud.
Horsethief Wash		5/7/2009	4/8/2010	95	3/21 - 3/23	Batteries failed
Indian Wash		5/7/2009	4/8/2010	90	3/14 - 3/22	Batteries failed
I-10						
San Gorgonio Wash	X	6/24/2009	4/8/2010	87	1/1 - 1/12	Unit not turned on
	Y	8/5/2009	4/8/2010	98	N/A	
Constrained Linkage 23						
Calimesa		12/23/2009	-	28	-	Stolen

[a] Camera was placed west of I-15 undercrossing near confluence of Gavilan Wash and Temescal Wash.

Coyote was the most common covered species photo-captured in 2010 ($n = 57$), and we detected them at every surveyed location (Table 7). We also regularly captured bobcat ($n = 18$), but did not detect the species at the I-10 crossing of San Gorgonio Wash. We also did not detect bobcat at the I-15 crossing of Indian Wash, though we only surveyed this site for 46 nights in 2010, and regularly recorded the species here throughout 2009. We did not photo-capture mountain lion or long-tailed weasel at any camera station. Humans were the most common non-target species detected ($n = 31$), followed by black-tailed deer ($n = 20$). We were unable to identify 20 photo-captured animals because of image quality. None of the unidentifiable images were the size of mountain lion, and most were likely medium-sized canines.

Table 7. Images recorded per species in 2010 at 5 locations using 7 remote cameras.

		Species[a]							
Site	**Unit**	**CALA**	**LYRU**	**PRLO**	**CLFA**	**LCBE**	**ODHE**	**HOSA**	**Total**
I-15									
Gavilan Wash	X[b]	16	14	-	-	-	3	-	33
	Y	-	1	-	-	-	-	3	4
Horsethief Wash		6	2	-	1	-	-	7	16
Indian Wash		4	-	1	4	-	-	3	12
I-10									
San Gorgonio Wash	X	1	-	-	-	-	-	4	5
	Y	-	-	-	-	1	-	5	6
Constrained Linkage 23									
Calimesa		30	1	-	4	-	17	9	66
TOTAL		57	18	1	9	1	20	31	142

[a] CALA = coyote; LYRU = bobcat; PRLO = raccoon; CLFA = domestic dog; LCBE = San Diego black-tailed jack rabbit; ODHE = black-tailed deer; HOSA = human

[b] Camera was placed west of I-15 undercrossing near confluence of Gavilan Wash and Temescal Wash.

Area-search Surveys

We did not record mountain lion tracks or scat in any of the 7 parcels surveyed in 2010. We recorded bobcat tracks in Pechanga Creek just north of Temecula Inn Creek Golf Course and in the Badlands northeast of Gilman Springs Road.

Incidental Observations

We recorded incidental observations of bobcat (n = 8), coyote (n = 21), long-tailed weasel (n = 2) and mountain lion (n = 3; tracks only) in 2010 (Appendix E). We observed bobcat at the Southwestern Riverside County Multi-Species Reserve near Lake Skinner (Existing Core J), along the Santa Ana River at Hidden Valley County Park and at the Rubidoux Nature Center (Existing Core A). We also recorded a set of well-defined tracks at Pechanga Creek (Constrained Linkage 14). Riverside County Parks personnel observed an individual bobcat in October 2010 on a road in Hidden Valley Reserve and another animal was seen in November 2010 running under Interstate 15 (Existing Core 1) (*Dustin McLain, Riverside County Parks, personal communication*). Orange County Water District staff flushed 2 bobcats from the brush in Sycamore Canyon (Existing Core D) (*Talula Barbee*, *Orange County Water District, personal communication*). The Center for Natural Lands Management photo-captured bobcat on a number of occasions in 2010 at Johnson/Roripaugh Ranch Preserve (Existing Core J) and in March 2010 at the March Air Force Base Stephens' Kangaroo Rat Preserve (Existing Core D)(*Kim Klementowski*, *Center for Natural Lands Management, personal communication*). Any donated photographs have been added to our database of images.

We incidentally observed coyote at multiple cores and linkages in the Plan Area throughout the year (Appendix E). We observed long-tailed weasel in March 2010 at San Timoteo Canyon and in April 2010 at the Hidden Valley Reserve. Carole Bell (*The Nature Conservancy, personal communication*) reported bobcat on the Santa Rosa Plateau Ecological Reserve in March, November, and December 2010.

Our incidental observations of mountain lion were only through sign and possible eyeshine. A set of well-defined tracks in mud was reported and photographed by Biological Monitoring Program staff in April 2010 at the Santa Rosa Plateau. The Nature Conservancy staff reported 2 mountain lion on the Santa Rosa Plateau in the same month (*Carole Bell, The Nature Conservancy, personal communication*). While mountain lion are known to occur in the Santa Margarita Ecological Reserve, our reports of tracks and den sites were not confirmed through track measurement or photographs. Similarly, eyeshine of a large mammal thought to be a mountain lion was reported at the Potrero Unit of the San Jacinto Wildlife Area during nocturnal Los Angeles pocket mouse surveys but was not confirmed.

DISCUSSION

The goals of 2010 carnivore surveys were to determine presence/absence of long-tailed weasel at Core Areas where data were lacking or insufficient, to record presence of mountain lion and bobcat at habitat linkages not surveyed during previous carnivore surveys, and to document movement of covered carnivores across potential dispersal barriers created by transportation corridors. We employed various survey methods in 2010 which often contributed to meeting more than one goal.

We modified the design of scent-station transects used in 2009 by decreasing interval length between stations to better reflect home range size of long-tailed weasel. As would be expected, encounter rates and estimated detection probabilities were low for far-ranging species like coyote and bobcat but counter to our expectations, also low for long-tailed weasel. Reported home ranges for long-tailed weasel are highly variable (e.g., 10 –160 ha) and dependent on food availability (Sheffield 1999). Variation in prey resources and size of weasel home ranges across the Plan Area will likely continue to pose a challenge to designing a scent-station transect that can consistently detect long-tailed weasel when present. Distribution of transects may also contribute to low encounter rate, as survey sites are stratified by geographic features conducive to animal travel rather than habitat suitability. Accounting for habitat quality would likely prove to be a difficult and costly task for long-tailed weasel, as it would require a measure of prey availability and knowledge of how the prey base interacts with local landscapes. Fortunately, expending effort and resources to quantify habitat quality may not be necessary despite poor encounter rates and detectability, given the scope of species-specific objectives and the ability of our methods to detect at least some individuals at targeted sites. Long-tailed weasel also use a wide range of landscapes (e.g., riparian, coastal sage scrub, grassland, chaparral) that are captured by targeting roads and drainages. More intensive survey methods (e.g., truly random distribution of transects, live trapping) could be implemented where scent-station efforts fail to produce detections.

Results from scent-station transects in 2010 supported our 2009 conclusions regarding the effectiveness of using transects to record presence/absence of covered carnivores. Bobcat and mountain lion were best detected by walking transects and searching for tracks. Detection probabilities did not differ between methods for coyote, while long-tailed weasel were primarily detected at scent stations. Two weasel detections were documented along transects in 2010, but these were recorded at atypical transect features (e.g., mud along a river and snow at higher elevation). The cost of 2010 carnivore monitoring methods was inexpensive relative to more intensive carnivore-monitoring methods (e.g., capture-recapture), with material for scent-station transects being approximately $7 per unit ($5 for sand, scent lures $0.50 each). Moreover, transects that target only bobcat, coyote, and mountain lion do not require scent stations, which further reduces costs.

Camera-station surveys in 2010 expanded the number of covered-carnivore detections at locations where we recorded them in 2009, and provided for almost a full year of data collection at targeted sites, but did not produce new observations where species presence had been lacking. We recorded bobcat dispersing across I-15 at Gavilan Wash, Indian Wash, and Horsethief Wash in 2009 – 2010, but have not adequately surveyed the crossing near Pechanga Creek to confirm dispersal there. We also have not surveyed CA-60 through the Badlands, and have not recorded mountain lion using any targeted freeway undercrossing.

Encasing camera units in steel boxes worked well in deterring theft of equipment and justified the estimated material cost of $90 - $100 per box. Still, the design left the lens, flash, and heat-motion sensors exposed, and failed to deter a vandal from shooting a unit at the Pechanga Creek crossing of I-15 with a BB gun on 25 December 2009. We have since attempted to use Plexiglas or a thin sheet of plastic laminate to protect exposed camera parts, but found that these materials impeded the heat-motion sensors from functioning properly. Safety of equipment, given the cost (approximately $400 per camera), precludes further surveys at Pechanga Creek until a design that provides more protection can be devised. Pechanga Creek remains the most probable means of large-mammal dispersal across the I-15 between the San Diego County line and CA-79, given that other road culverts in the area are not ideal for large-animal movement (e.g., steep slopes, contain erosion bars, and/or small diameters) and that mountain lion are known to occur in the Santa Margarita Gorge just to the west.

We recorded long-tailed weasel on 6 of 7 Core Areas (86%) in 2010, and have now documented the species in 15 of 18 (83%) species-specific cores since surveys began in 2008. These records satisfy the MSHCP Core Area occupancy objective for long-tailed weasel. We have not conducted surveys for long-tailed weasel at Existing Core F (Santa Rosa Plateau) and Existing Core M (Aqua-Tibia Wilderness), and can not confirm absences of the species at Proposed Core 4 based on 2010 results.

With the detection of bobcat at Pechanga Creek (Constrained linkage 14) during area-search surveys we can conclude that habitat-linkage objectives were met for this species with species presence having been documented on at least 75% of listed habitat-linkages and movement corridors. Habitat-linkage objectives were not met for mountain lion through area-search surveys.

To date, we are meeting most carnivore monitoring objectives outlined in the MSHCP. Core Area and habitat-block occupancy objectives are being met for all 4 covered carnivore species with species presence having been documented on at least 75% of Core Areas and habitat blocks described in individual species accounts (Appendix B). Habitat-linkage objectives remain to be met for mountain lion. Our coverage of mountain lion habitat-linkages and movement corridors is incomplete and surveys should continue until all areas are thoroughly surveyed.

Recommendations for Future Surveys

Transects should be used to document presence/absence of covered carnivores in listed Core Areas and habitat blocks for the next reporting requirement deadline. Scent stations add to the cost and effort of using transects, and should only be included when surveying Core Areas for long-tailed weasel. Transect length (450 m) and interval spacing between scent stations (4 stations, 150-m intervals) should also follow the 2009 survey design because it performed reasonably well in detecting bobcat, coyote, and mountain lion, while providing an adequate means of encountering at least some long-tailed weasel. Core Areas and habitat blocks should be surveyed with more intensive methods [e.g., truly random distribution of transects, live-trapping (weasel only), intensive area-search surveys] if objectives are not met for any 1 species due to lack of detections and poor detection probability.

Camera stations should also be used to monitor animal dispersal across freeway corridors that bisect habitat linkages and Core Areas, especially those named specifically in species accounts for bobcat and mountain lion. All cameras deployed should be encased in steel boxes and chained to fixed objects regardless of placement or perceived threat of vandalism. Moreover, attempts should be made to collaborate with Caltrans in designing camera stations that can monitor the Pechanga Creek undercrossing of I-15 with minimal risk of vandalism, perhaps by attaching steel-camera boxes directly to the top of abutments and pointing them downward. Other potential dispersal barriers that should be monitored are CA-60 through the Badlands, I-10 near Calimesa (Constrained Linkage 23), and a more complete survey of I-10 at San Gorgonio wash (species-specific linkage for mountain lion).

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Appendix A. Habitat Blocks, Linkages, and Dispersal Barriers Defined by MSHCP Species-Specific Objectives for Bobcat, Coyote, Long-tailed Weasel, and Mountain Lion.

	Bobcat	**Coyote**	**Weasel**	**Mountain Lion**
Habitat Blocks	Santa Rosa Plateau-Santa Ana Mnts., Agua Tibia Wilderness-Palomar Mnts., Vail Lake-Wilson Valley-Aguanga, Anza-Cahuilla Valleys, Badlands-San Jacinto Wildlife Area-Lake Perris, San Jacinto Mnts., Lake Mathews-Estelle Mnt., Lake Skinner-Diamond Valley Lake, Santa Ana River-Prado Basin.	None listed.	Existing Cores: A, B, C, F, G, H, I, J, K, L, and M. Proposed Cores: 1, 2, 3, 4, 5, 6, 7.	Santa Rosa Plateau-Santa Ana Mnts., Agua Tibia Wilderness-Palomar Mnts., Badlands-San Jacinto Mnts.-Santa Rosa Mnts., San Bernardino Mnts., Lake Mathews-Estelle Mnt., Lake Skinner-Diamond Valley Lake, and Vail Lake-Sage-Wilson Valley.
Linkages	Santa Ana Mnts. to Chino Hills via Fresno Canyon-Green River, Santa Ana Mnts. to Lake Mathews-Estelle Mnt. via Indian Canyon and Horsethief Canyon, Santa Ana Mnts. to Agua Tibia Wilderness-Palomar Mnts. via Pechanga Creek or future wildlife overpass (I-15), Santa Ana River, Lake Skinner-Diamond Valley Lake to Sage-Wilson Valley-San Jacinto Mnts. via Tucalota Creek and adjacent uplands, along Badlands to San Jacinto Wildlife Area-Lake Perris-San Jacinto Mnts., Badlands to San Bernardino Mnts. via Cherry Valley, San Jacinto Mnts. to San Bernardino Mnts. via Banning Canyon and San Gorgonio Wash.	Santa Ana River, San Timoteo Creek, Indian Canyon and Horsethief Canyon (I-15), Cole Canyon-Murrieta Creek, Warm Springs Creek, French Valley tributary to Warm Springs Creek, upland Lake Mathews to Wildomar, Gavilan Hills, San Jacinto River, Temecula Creek-Santa Margarita River, Kolb Creek/Arroyo Seco, Tucalota Creek, Wilson Creek, Tule Creek, San Gorgonio Wash.	52,400 acres of linkage habitat between Core Areas.	Santa Ana Mnts to Chino Hills via Fresno Canyon-Green River, Santa Ana Mnts to Lake Mathews-Estelle Mnt. via Indian Canyon and Horsethief Canyon, Santa Ana Mnts. to Agua Tibia Wilderness-Palomar Mnts. via Pechanga Creek or future wildlife overpass (I-15), Lake Skinner-Diamond valley Lake to Sage-Wilson Valley-San Jacinto Mnts. via Tucalota Creek and adjacent uplands, Badlands to San Jacinto Mnts. and Santa Rosa Mnts., San Jacinto Mnts. to San Bernardino Mnts. via San Gorgonio Wash.
Dispersal Barriers	State Highway 91 between Santa Ana Mnts. and Chino Hills, Interstate 15 between Santa Ana Mnts. and Lake Mathews- Estelle Mnt. via Indian Canyon and Horsethief Canyon, Interstate 15 between Santa Ana Mnts. and Agua Tibia Wilderness, State Highway 60 in Badlands.	None listed.	None listed.	State Highway 91 between Santa Ana Mnts. and Chino Hills, Interstate 15 between Santa Ana Mnts. and Lake Mathews- Estelle Mnt. via Indian Canyon and Horsethief Canyon, Interstate 15 between Santa Ana Mnts. and Agua Tibia Wilderness, State Highway 60 in Badlands.

Appendix B. Monitoring Status for Covered Carnivore Species, 2008 - 2010.

Objective	Location	Detections
Bobcat		
Habitat Blocks	Santa Rosa Plateau-Santa Ana Mnts	2008 transects, 2009 incidental
	Vail Lake-Wilson Valley-Aguanga	2009 transects
	Anza-Cahuilla Valley	2009 transects
	Badlands-SJWA-Lake Perris	2008 transects
	Lake Mathews-Estelle Mnt	2008 transects
	Santa Ana River-Prado Basin	2008 incidental
	San Jacinto Mnts	2008 incidental
	Lake Skinner-Diamond Valley Lake	2009 incidental
	Habitat Blocks Needed:	**0**
Linkages	Fresno Canyon/Green River	2008-2009 cameras
	Indian/Horsethief Canyons	2008-2009 cameras
	Santa Ana River	2008 incidental
	Badlands (southern half)	2008-2009 cameras
	Cherry Valley	2008-2009 cameras
	San Gorgonio Wash	None to date
	Pechanga Creek	2010 linkage survey
	Tucalota Creek	None to date
	Linkages Needed:	**0**
Dispersal Barriers	CA-9 - Fresno Canyon/Green River	2008-2009 USGS[a]
	I-15 - Indian/Horsethief Canyons	2009 – 2010 cameras
	I-15 - Pechanga/Temecula Creek	None to date
	CA-60 - Badlands	Not surveyed
	Barriers Needed:	**1**
Coyote		
Habitat Blocks	No objective.	
Linkages	Santa Ana River	2008 incidental
	Badlands/San Timoteo Creek	2008 incidental
	Cole Canyon-Murrieta Creek	2009 linkage survey
	Warm Springs Creek	2009 linkage survey
	Warm Sp. Ck, French Valley trib.	2009 linkage survey
	Lake Mathews to Wildomar	Incomplete linkage
	Gavilan Hills	2008 transects
	San Jacinto River	2009 linkage survey
	Temecula Ck-Santa Margarita River	2009 linkage survey
	Kolb Creek/Arroyo Seco	2009 linkage survey
	Tucalota Creek	2009 linkage survey
	Wilson Creek	2009 linkage survey
	Tule Creek	2009 linkage survey
	San Gorgonio Wash	2009 cameras
	Linkages Needed:	**0**
Dispersal Barriers	I-15 - Indian/Horsethief Canyons	2009 cameras
	Barriers Needed:	**0**

[a] Lisa Lyren, USGS, Western Ecological Research Center; camera-trap and radio-collar surveys.

Appendix B Cont.

Objective	Location	Detections
Long-tailed weasel		
Core Areas	Existing Core A	2008 OCWD[b]
	Existing Cores B, C, H, K	2008 transects
	Existing Core L	2009 transects
	Proposed Cores 6 and 7	2009 transects
	Existing Cores J	2009 CNLM[c]
	Proposed Core 1, 2, 3, 5	2010 transects
	Existing Cores G, I	2010 transects
	Proposed Core 4	None to date
	Existing Core F, M	Not surveyed
	Cores Needed:	**0**
Linkages	Plan Area linkages	None to date
	Total acreage:	**0**
	Acreage needed:	**52,400**
Dispersal Barriers	No Objective	
Mountain lion		
Habitat Blocks	Santa Rosa Plateau-Santa Ana Mnts	2005-2009 WHC[e]
	Aqua Tibia Wilderness-Palomar Mnts	2008 incidental
	Badlands-San Jacinto/Santa Rosa Mnts	2006-2008 WHC[e]
	San Bernardino Mnts	2009 incidental
	Vail Lake-Sage-Wilson Valley	2004-2006 WHC[e]
	Lake Mathews-Estelle Mnt	None to date
	Lake Skinner-Diamond Valley Lake	Not surveyed
	Habitat Blocks Needed:	**0**
Linkages	Fresno Canyon/Green River	2006-2007 WHC[e]
	Indian/Horsethief Canyons	None to date
	Pechanga Creek	None to date
	Tucalota Creek	None to date
	Badlands	None to date
	San Gorgonio Wash	None to date
	Linkages Needed:	**6**
Dispersal Barriers	CA-91 at Fresno Canyon/Green River	None to date
	I-15 at Indian/Horsethief Canyons	None to date
	I-15 at Pechanga Creek	None to date
	CA-60 through Badlands	Not surveyed
	Dispersal Barriers Needed:	**4**

[b] David McMichael, Orange County Water District

[c] Kim Klementowski, Center for Natural Lands Management

[d] Objective calls for 52,400 acres of non-specified conserved linkages across Plan Area.

[e] Winston Vickers, Wildlife Health Center, radio-collar surveys

Appendix C. Species Detected per Scent-station Transect at Core Areas Surveyed in 2010.

		Species											
MSHCP Core Area	**Transect**	**PRLO**	**MUFR**	**MEME**	**CALA**	**CLFA**	**URCI**	**PUCO**	**LYRU**	**SPBE**	**SYAU**	**ODHE**	**Other**
Existing Core G													
Road	CGRD-02	-	-	√	√	√	-	-	-	-	-	-	-
	CGRD-03	-	-	-	√	-	-	-	√	-	√	-	-
	CGRD-04	-	-	-	√	-	√	-	-	-	√	-	√
	CGRD-05	-	√	√	√	-		√	√	√	-	-	-
	CGRD-06	-	-	√	√	-	√	-	√	-	√	-	√
	CGRD-07	-	-		√	√	√	-	-	-	√	-	-
	CGRD-08	√	-	√	√	-	-	-	√	-	√	-	-
Drainage	CGST-01	-	-	-	-	-	√	-	-	-	-	-	√
	CGST-02	-	-	-	-	-	-	√	-	-	-	-	√
	CGST-04	-	-	-	√	-	-	√	-	-	-	-	√
	CGST-05	-	-	-	-	-	-	√	-	-	-	-	-
	CGST-07	-	-	-	-	-	-	√	-	-	-	-	√
Existing Core I													
Road	CIRD-01	-	-	-	√	-	-	-	-	-	-	-	-
	CIRD-02	-	-	-	-	-	-	-	-	-	-	√	√
	CIRD-03	-	-	-	-	-	-	-	-	-	√	√	√
	CIRD-04	-	-	-	√	-	√	-	-	-	-	-	-
	CIRD-05	-	-	-	√	√	-	-	√	-	-	-	-
	CIRD-06	-	-	-	√	-	-	-	-	-	-	-	√
	CIRD-07	-	-	-	-	-	-	-	-	√	-	-	√
	CIRD-09	-	√	-	-	-	-	-	√	√	√	-	√
	CIRD-10	-	-	-	√	-	-	-	-	-	-	-	√
	CIRD-11	-	-	-	-	-	√	-	√	-	-	-	√
	CIRD-12	-	-	-	√	√	√	-	-	√	-	-	-

[a] PRLO = raccoon; MUFR = long-tailed weasel; MEME = striped skunk; CALA = coyote; CLFA = domestic dog; URCI = gray fox; PUCO = mountain lion; LYRU = bobcat; SPBE = California ground squirrel; SYAU = cottontail; ODHE = black-tailed deer

Appendix C cont.

MSHCP Core Area	Transect	Species[a] PRLO	MUFR	MEME	CALA	CLFA	URCI	LYRU	SPBE	SYAU	ODHE	Other
Existing Core I												
Drainage	CIST-01	-	-	-	√	-	-	-	-	-	-	-
	CIST-02	-	-	-	-	-	-	√	-	-	-	-
	CIST-03	-	-	-	√	-	-	√	-	-	√	√
	CIST-04	-	-	-	√	-	-	√	√	-	-	√
	CIST-05	-	-	-	√	-	√	-	-	-	√	-
	CIST-06	-	-	-	-	-	-	-	-	-	√	-
	CIST-08	-	-	-	-	-	-	√	-	-	-	-
	CIST-09	-	-	-	-	-	√	-	-	-	-	√
Proposed Core 1												
Road	C1RD-01	-	-	-	√	-	√	-	-	√		√
	C1RD-02	-	-	-	√	-	√	-	-	√	-	√
	C1RD-03	-	-	-	√	-	√	-	-	-	-	√
	C1RD-04	-	-	-	√	√	-	-	-	√	-	√
	C1RD-05	-	√	-	√	-	-	√	-	-	-	√
	C1RD-06	-	-	-	√	√	-	-	-	-	-	√
	C1RD-07	-	-	-	√	√	-	-	-	-	-	√
	C1RD-08	-	-	-	√	√	√	-	-	-	-	√
	C1RD-09	-	-	-	√	√	√	-	-	-	√	√
	C1RD-10	-	-	-	√	-	√	-	-	-	√	√
Drainage	C1ST-01	-	-	-	√	-	√	-	-	-	-	√
	C1ST-03	√	-	-	√	-	-	√	-	-	√	-
	C1ST-04	-	√	-	√	-	√	√	-	-	-	√
	C1ST-05	-	-	-	√	-	-	√	-	-	√	√

[a] PRLO = raccoon; MUFR = long-tailed weasel; MEME = striped skunk; CALA = coyote; CLFA = domestic dog; URCI = gray fox; ; LYRU = bobcat; SPBE = California ground squirrel; SYAU = cottontail; ODHE = black-tailed deer

Appendix C cont.

		Species[a]											
MSHCP Core Area	**Transect**	**PRLO**	**MUFR**	**MEME**	**CALA**	**CLFA**	**URCI**	**LYRU**	**SPBE**	**SYAU**	**LCBE**	**ODHE**	**Other**
Proposed Core 2													
Drainage	C2ST-01	√	-	-	√	-	-	-	√	√	-	-	-
	C2ST-02	-	-	-	√	√	-	-	-	√	-	-	-
	C2ST-03	√	√	-	√	√	-	-	-	-	-	-	√
	C2ST-04	-	-	√	√	√	-	-	-	-	-	-	-
	C2ST-05	-	-	-	√	√	√	-	-	-	-	-	-
	C2ST-06	-	-	-	-	-	-	√	-	-	-	-	√
Proposed Core 3													
Drainage	C3ST-01	-	√	-	√	√	-	-	-	-	-	√	√
	C3ST-02	-	-	-	√	-	-	-	√	√	-	-	-
	C3ST-03	-	-	-	√	-	-	-	-	-	√	-	√
	C3ST-04	-	-	-	-	-	-	-	-	-	-	-	√
	C3ST-05	-	-	-	√	-	-	-	√	√	-	-	√
	C3ST-06	-	-	-	√	√	-	√	-	-	-	-	√
	C3ST-07	-	-	-	√	√	-	-	-	-	-	-	√
Proposed Core 4													
Road	C4RD-01	-	-	-	√	√	-	-	-	√	-	-	-
	C4RD-02	-	-	-	√	√	-	-	-	-	-	-	-
	C4RD-03	-	-	-	√	-	√	-	-	√	-	-	-
	C4RD-04	-	-	-	√	√	-	-	-	√	-	-	-
	C4RD-05	-	-	-	√	√	-	-	-	√	-	-	√
Drainage	C4ST-02	-	-	-	-	-	√	-	-	-	-	-	-
	C4ST-03	-	-	-	-	-	-	-	-	-	-	√	-
	C4ST-04	-	-	-	√	√	√	√	-	-	-	√	√
	C4ST-05	-	-	-	-	-	-	-	-	-	-	√	√

[a] PRLO = raccoon; MUFR = long-tailed weasel; MEME = striped skunk; CALA = coyote; CLFA = domestic dog; URCI = gray fox; ; LYRU = bobcat; SPBE = California ground squirrel; SYAU = cottontail; LCBE = San Diego black-tailed jack rabbit; ODHE = black-tailed deer

Appendix C cont.

		Species[a]									
MSHCP Core Area	**Transect**	**MUFR**	**CALA**	**CLFA**	**URCI**	**LYRU**	**SPBE**	**SYAU**	**LCBE**	**ODHE**	**Other**
Proposed Core 5											
Drainage	C5ST-01	-	√	√	-	-	-	√	-	-	√
	C5ST-02	-	√	-	-	√		√		√	-
	C5ST-03	√	√	-	-	√	√	√	√	-	√
	C5ST-04	-	√	√	-	-	√	√	-	-	-
	C5ST-05	-	√	√	-	-	-	√	-	-	√
	C5ST-06	-	√	√	-	-	-	√	√	-	-
	C5ST-07	-	√	√	√	-	-	√	√	-	√
	C5ST-08	-	√	√	-	-	-	√	-	-	-

a MUFR = long-tailed weasel; CALA = coyote; CLFA = domestic dog; URCI = gray fox; ; LYRU = bobcat; SPBE = California ground squirrel; SYAU = cottontail; LCBE = San Diego black-tailed jack rabbit; ODHE = black-tailed deer

Appendix D. Akaike's Information Criterion for Small Samples (AIC*c*), Akaike Weight (w_i), Model Likelihood, Parameters (K), and log likelihood of Models Used for Estimating Species-specific Detection Probabilities (*p*) of Scent-station and Transect Surveys at 2 Sampling Densities.

Bobcat Transects

1 per 3 ha

Model	AICc	ΔAICc	w_i	Model Likelihood	K	-2log(L)
{p(.) Psi(.) PIM}	55.3665	0	0.4839	1	2	50.8447
{p(t) Psi(.) PIM}	55.9308	0.5643	0.3650	0.7542	4	46.026
{p(g) Psi(.) PIM}	57.7837	2.4172	0.1445	0.2986	3	50.6928
{p(g*t) Psi(.) PIM}	63.961	8.5945	0.0066	0.0136	7	43.7387

1 per 1.5 ha

Model	AICc	Δ AICc	w_i	Model Likelihood	K	-2log(L)
{p(.) Psi(.) PIM}	59.9037	0	0.6181	1	2	55.6537
{p(g) Psi(.) PIM}	61.2857	1.382	0.3097	0.5011	6	47.3766
{p(t) Psi(.) PIM}	64.1969	4.2932	0.0722	0.1169	4	55.3274
{p(g*t) Psi(.) PIM}	90.2052	30.3015	0	0	16	42.2052

Coyote Transects

1 per 3 ha

Model	AICc	Δ AICc	w_i	Model Likelihood	K	-2log(L)
{p(.) Psi(.) PIM}	84.7377	0	0.6854	1	2	80.2159
{p(g) Psi(.) PIM}	86.7997	2.062	0.2444	0.3567	3	79.7088
{p(t) Psi(.) PIM}	89.4261	4.6884	0.0657	0.0959	4	79.5213
{p(g*t) Psi(.) PIM}	94.8145	10.0768	0.0044	0.0065	7	74.5923

1 per 1.5 ha

Model	AICc	Δ AICc	w_i	Model Likelihood	K	-2log(L)
{p(.) Psi(.) PIM}	195.1605	0	0.6243	1	2	190.9105
{p(g) Psi(.) PIM}	196.5803	1.4198	0.3069	0.4917	6	182.6712
{p(t) Psi(.) PIM}	199.5714	4.4109	0.0688	0.1102	4	190.7018
{p(g*t) Psi(.) PIM}	220.5481	25.3876	0	0	16	172.5481

Coyote Scent Stations

1 per 3 ha

Model	AICc	Δ AICc	w_i	Model Likelihood	K	-2log(L)
{p(.) Psi(.) PIM}	81.0132	0	0.4149	1	2	76.6799
{p(g) Psi(.) PIM}	81.3086	0.2954	0.3580	0.8627	3	74.6229
{p(t) Psi(.) PIM}	82.5819	1.5687	0.1893	0.4564	4	73.4054
{p(g*t) Psi(.) PIM}	85.8072	4.794	0.0378	0.091	7	68.1943

1 per 1.5 ha

Model	AICc	Δ AICc	w_i	Model Likelihood	K	-2log(L)
{p(g) Psi(.) PIM}	174.9302	0	0.9972	1	6	161.143
{p(.) Psi(.) PIM}	187.3183	12.3881	0.0020	0.002	2	183.083
{p(t) Psi(.) PIM}	189.7224	14.7922	0.0006	0.0006	4	180.9061
{p(g*t) Psi(.) PIM}	192.2701	17.3399	0.0002	0.0002	16	145.5674

Appendix E. Incidental Observations of Covered Carnivore Species Recorded by Biological Monitoring Program Staff.

Species	Core	Location	Date	Observation
Bobcat	Existing Core 3	San Timoteo Canyon	5/4/2010	Interrupted bobcat stalking a ground squirrel along dirt road
	Existing Core 3	Potrero	4/22/2010	Observed during loggerhead shrike surveys
	Existing Core 5	San Jacinto River	7/14/2010	Adult observed during arroyo chub surveys
	Existing Core A	Hidden Valley Wildlife Area	11/5/2010	Young animals seen twice
	Existing Core B	Santa Ana Mountains	5/11/2010	Crossed road in front of work vehicle
	Existing Core H	San Jacinto Wildlife Area	5/20/2010	Crossed road in front of work vehicle
	Existing Core J	Lake Skinner	12/1/2010	Adult female and two subadult kittens on dirt path retreated into scrub
	Existing Core K	Indian Creek	6/24/2010	Observed during stream surveys
Coyote	Constrained Linkage 23	San Timoteo Canyon	5/4/2010	Observed during burrowing owl surveys
	ECE* 6	El Sol	3/17/2010	Observed during Quino checkerspot surveys
	Existing Core 1	Alberhill	2/2/2010	Observed during carnivore surveys
	Existing Core 2	Warm Spring Creek	3/24/2010	Flushed large adult taking drink from the creek
	Existing Core 3	San Timoteo Canyon	1/14/2010	Adult observed during vegetation condition surveys
		San Timoteo Canyon	2/3/2010	Observed during loggerhead shrike surveys
		San Timoteo Canyon	5/4/2010	Observed during burrowing owl surveys
		San Timoteo Canyon	12/28/2010	Small group heard barking
	Existing Core 5	San Jacinto River	7/14/2010	Adult flushed down river bed
	Existing Core 7	Oak Mountain	4/13/2010	Flushed adult; also 5 deer in same field
		Oak Mountain	4/13/2010	Flushed adult during gecko diurnal surveys
	Existing Core A	Santa Ana River	10/7/2010	Four individuals crossing bike path as it bisects a patch of Baccharis.
	Existing Core C	Estelle	8/11/2010	Running/walking down road adjacent to recently burned plot
	Existing Core D	March Reserve	1/7/2010	Adults flushed from small stand of brush.
		March Reserve	11/9/2010	Observed traveling along fence line, about 100 m from a riparian area
		March Reserve	11/9/2010	Traveling along fuel break installed adjacent to riparian area
	Existing Core H	Mystic Lake	1/4/2010	Observed during vernal pool surveys
		San Jacinto Wildlife Area	5/20/2010	Bounding away along drainage berm in grassland
		Mystic Lake	12/28/2010	Observed during ground truthing for coastal sage scrub bird surveys
	Linkage 7	Quail Valley	5/19/2010	Flushed two individuals from vegetation
	NCH** 5	Lakeview Mountains	10/27/2010	Observed running across road

Appendix E cont.

Species	Core	Location	Date	Observation
Long-tailed weasel	Existing Core 3	San Timoteo Canyon	3/10/2010	Adult observed at hole in ground
	Existing Core A	Hidden Valley County Park	4/26/2010	Observed running across road
Mountain Lion	Existing Core G	Santa Margarita Ecological Reserve	3/11/2010	Tracks found during carnivore survey
		Santa Margarita Ecological Reserve	7/22/2010	Tracks seen where mountain lion jumped over Santa Margarita River
	Existing Core F	Santa Rosa Plateau	4/24/2010	Tracks in fresh mud on Punta Mesa trail

*ECE = extension of existing core; **NCH = Non contiguous habitat block