June 30, 2014

Re: SANDAG contract UCD 12-00606 – Mountain Lion Connectivity Study
Report prepared by T. Winston Vickers, DVM, MPVM
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U.C. Davis Wildlife Health Center Southern California Mountain Lion Study

As prescribed in the above listed contract with the San Diego County Association of Governments (SANDAG), personnel from the UC Davis Wildlife Health Center (UCD-WHC) and Wildlife Tracking Company (WTC) (collectively UC Davis Team) have been conducting field activities relating to the study of connectivity of conserved lands in portions of San Diego County for mountain lions (*Puma concolor*, cougars, pumas). The aforementioned contract was finalized in May, 2012 and field activities began almost immediately. Some pre-contract field scouting and trail camera placement and monitoring was conducted in the fall of 2011 and early 2012. The results from trail cameras placed originally during that time and subsequently incorporated in this field effort are also reported here.

Data are reported as of June 23, 2014 except where noted. This report is the final report required by this contract.

**Introduction:**

Mountain lions exist in areas containing suitable wild habitat throughout southern California, including in habitat that is adjacent to human development and roads. However, because of their wide-ranging nature and large territories, as well as the need for dispersal (especially of young males) to maintain genetic diversity, large blocks of conserved habitat and safe travel corridors between them are essential for long term population persistence and stability. Certain linkages in the broader landscape (Figure 1), and others at the more local level (Figure 2) are key to the long term genetic health and persistence of these wide-ranging carnivores on the landscape.

Nearly half of mountain lion habitat in southern California is on private lands, and approximately 1/3 of those lands that were present in 1970 will be developed by 2030 (Burdett et al. 2010). Additionally, some habitat that is currently contiguous will become fragmented, with potential loss of connectivity and increased risk to mountain lions (Burdett et al. 2010).

This study was conducted in approximately the southern 2/3rds of western San Diego County in order to assess the viability and connectivity of certain core conserved lands there for mountain lions (Figure 2). The study area exists in the much larger landscape of southern California that incorporates mountain lion habitat to the east, north, and south (Figures 1, 3, and 4).

Our ongoing UC Davis Wildlife Health Center southern California mountain lion study has raised serious questions about future demographic stability and genetic diversity in the regional population. Our study has shown that connectivity between some conserved habitat areas is severely compromised, especially between San Diego, Orange, and Riverside Counties habitat areas east and west of I-15. This has led to partial genetic isolation of the mountain lion population west of this freeway. Our study has also shown unusually low annual survival rates for mountain lion populations both east and west of I-15, primarily due to interactions with humans - collisions with vehicles and mortalities secondary to depredation permits being the most prominent causes of death.

The current study that is the focus of this report was conducted in an area of the county that extends from north of the Ramona area in the north, to the U.S. – Mexico border in the south, east to the Cuyamaca Mountains, and west to urban areas of the county (Figures 2-4).

Mountain lion captured on trail camera prior to initiation of baiting and trapping effort


**Executive summary:**

This assessment of mountain lion use of core conserved lands and linkages in western San Diego County (Figures 2 – 4, Tables 1 and 2) was undertaken by the UC Davis Wildlife Health Center as a part of its ongoing Southern California Mountain Lion project. GPS-collaring of mountain lions was undertaken in order to acquire location and movement data from individual lions utilizing core conserved areas and linkages that have been designated by the county. Certain cores and linkages were not judged by experts advising the county to be likely to accommodate regular use by mountain lions (primarily those cores west of I-15), thus those areas were not a focus of this study. However, some trail camera monitoring was done west of I-15 to evaluate the validity of this expectation.

The 8 core areas that were the initial focus of this study included Core Areas: #1 (Hollenbeck-Otay area); #2 (Crestridge-Cleveland National Forest-Sycuan Peak area); #3 (El Capitan reservoir-Cleveland National Forest area); #5 (Sycamore Canyon area); #6 (San Vicente reservoir-Boulder Oaks-San Vicente Highlands area); #7 (Canada de San Vicente); #12 (Boden Canyon-Pamo Valley area); #13 (Mt. Woodson-Blue Sky Ecological Reserve area) (Figure 2, Table 1). Later in the study, camera monitoring was added in Core area #8 (Penasquitos-Deer Canyon). Additional conserved and unconserved lands adjacent to these core areas and their linkages were utilized by GPS-collared lions, especially to the north of Hwy 78, and to the east of Loveland Resevoir.

Six mountain lions were GPS-collared in this study (5 males and 1 female). All 6 circulated extensively in one or more of the targeted conserved cores and linkages, as well as on adjacent conserved and unconserved lands (Figure 5). Complete data sets have been recovered from the collars of 3 animals, and partial data sets from 3 individuals that are still circulating at this time. Data from those collars will be retrieved after they automatically drop off the animals in the Fall-Winter of 2014-2015.

Of the 9 core conserved areas assessed by the UCD team (Figure 2, Table 1), 6 were used regularly by collared mountain lions, and 1 was used briefly (by M107) (Figure 12, Table 2). Of the 11 linkages identified for assessment (Figure 2, Table 1), only 3 were demonstrated to be utilized by GPS-collared mountain lions for regular movement from one core area to another (Figure 12, Table 2). One other linkage between core conserved areas (linkage between Core areas 7 and 3) was demonstrated that was not pre-identified on the connectivity maps, and 1 additional linkage (between Core areas 5 and 6) was used once (Figures 2 and 12, Tables 1 and 2). That mountain lion (M107) was killed by a vehicle on his second trip through the linkage (Figure 8).

Of the 6 mountain lions that were GPS-collared in this study, 2 have been killed on roads, 1 was apparently struck by a vehicle but not killed, 1 suffered a broken foot and loss of collar function (probably due to road or other trauma), and 1 depredated a domestic animal and was subject to being killed, but was not killed due to refusal of a depredation permit by the animal owner. During the study period (May 2012 – June, 2014), an additional 11 mountain lions are known to have died in San Diego County from the two primary causes found throughout our longer term study (4 secondary to vehicles, and 6 secondary to depredation permits). One additional animal is known to have died of disease. Given that this total of 13 mountain lion mortalities detected in a 2 year period is only a portion of the likely total mortalities, it reinforces concerns about mountain lion mortality rates in the region that have been raised by our broader regional study.

Roads and associated development, even rural development, appear to be the primary limiters of connectivity between conserved lands. Highways in the study area that contain sections that are implicated as partial barriers to movement or present higher risks for vehicle strikes include Interstates 8 and 15, Valley Center Rd (S6), SR 67, SR 78, Wildcat Canyon / Barona Road, and SR 94. Conserved lands exist adjacent to or near both sides of the highway at some crossing locations but not others, and exist adjacent to the highway on one or both sides in some areas where the highway appears to exert a barrier effect.

No puma use was documented via GPS collars or trail cameras on conserved lands west of I-15, reinforcing findings from our broader southern California study that I-15 is relatively rarely crossed by mountain lions. In addition only 1 mountain lion mortality has been recorded west of I-15 in the Cores 8-11 areas (M103, a mountain lion with genetics suggesting origins in the northern Santa Anas – Figures 22 – 23), tending to reinforce the hypothesis that these cores are rarely utilized by mountain lions. Also, very minimal use of conserved lands was noted west of SR 67 south of Poway Road. The one crossing

of a GPS-collared mountain lion onto conserved lands west of SR 67 was a one-time brief crossing from east to west followed by the animal involved (M107) being killed by a vehicle collision when trying to cross back to the east (Figure 8). No other mountain lion use of this area was recorded by trail cameras (Figure 5, Appendix A). Crossing of Wildcat Canyon / Barona Road was limited almost entirely to one short section north of the Barona Casino, despite the presence of conserved lands on both sides of the road over a much more substantial distance (Figures 6, 7, 9, 10, 12-15). No puma crossing of I-8 was detected west of the Sweetwater River bridge (Figures 12 - 15) , and no crossings of Hwy 94 were detected in the GPS data nor activity south of Hwy 94 (via GPS data and trail cameras) (Figures 12 - 15).

It is apparent that in order for pumas to occupy normally sized territories (often over 100 square miles – Table 3) in this landscape, regular crossings of busy highways are required of essentially all individuals, and this fact should be taken into account in highway / development and conservation planning. In order for highway crossings by pumas to safely occur consistently, adequately sized crossing structures as well as fencing that is adequate to funnel animals to safe crossings is often required. It appears that numerous sections of the named highways and other roads and development in the study area likely pose an increased risk for pumas, and are at least partial barriers to connectivity between blocks of conserved habitat. Likewise, habitat fragmented by rural and peri-urban development increases risks for mountain lions from other types of interactions with humans and domestic animals.

It is also apparent that some connectivity remains the current study area and some conserved lands to the east, north, and northwest. Genetic findings relating to genetic separation between mountain lions residing east and west of I-15 in San Diego, Riverside, and Orange counties, and serious genetic restriction of the entire mountain lion population west of I-15, emphasizes that there are compelling conservation challenges for this species in the region. Findings in our larger mountain lion study emphasize the need for a variety of conservation and education actions that could potentially improve connectivity between the east and west populations. Failure to address this issue will almost certainly cause this situation to worsen over time, and could ultimately result in more drastic management and / or conservation requirements to support the species and others connectivity restrictions for the same reasons.

Because mountain lions are to some degree “guides” to what may be expected to happen with certain other species in restricted connectivity scenarios, and can help inform conservation prioritization of various types, it is our team’s belief that further data accumulation and analysis, modeling, and genetic analysis should be a continuing focus in the north San Diego County area. Due to the wide ranging nature of these animals, we also feel that in order to address mountain lion conservation issues in northern San Diego County, cooperative efforts with Orange and Riverside Counties and other stakeholders are essential.

Figure 1. Critical wildlife linkages throughout southern California

Mountain lion on conserved lands managed by California Department of Fish and Wildlife (CDFW). Though hunting of mountain lions is illegal in California, southern California mountain lions have lower annual survival than many hunted populations (UC Davis southern California mountain lion project)


**Study area:**

The study area (SANDAG study area) with conserved lands and corridors to be assessed is depicted in Figures 2 and 12. Explanations of the names of the various numbered cores are contained in Tables 1 and 2. Broadly speaking, the study area extends from north of the Ramona area in the north, to the U.S. – Mexico border in the south, east to the Cuyamaca Mountains region, and west to urban areas of the county. Due to the wide ranging nature of mountain lions the UC Davis team expects mountain lions to utilize multiple conserved cores and corridors that may include areas outside the primary study area. Thus, some field activities (camera monitoring and baiting for mountain lion capture) were conducted immediately north and east of Ramona where previous field camera monitoring by Megan Jennings of the US Forest Service had indicated periodic mountain lion movement. Due to their large ranges, mountain lions captured adjacent to the primary study area also informed our assessment of connectivity in the study region.

**Figure 2. San Diego County Core Conserved Areas and Linkages assessed in the current study**

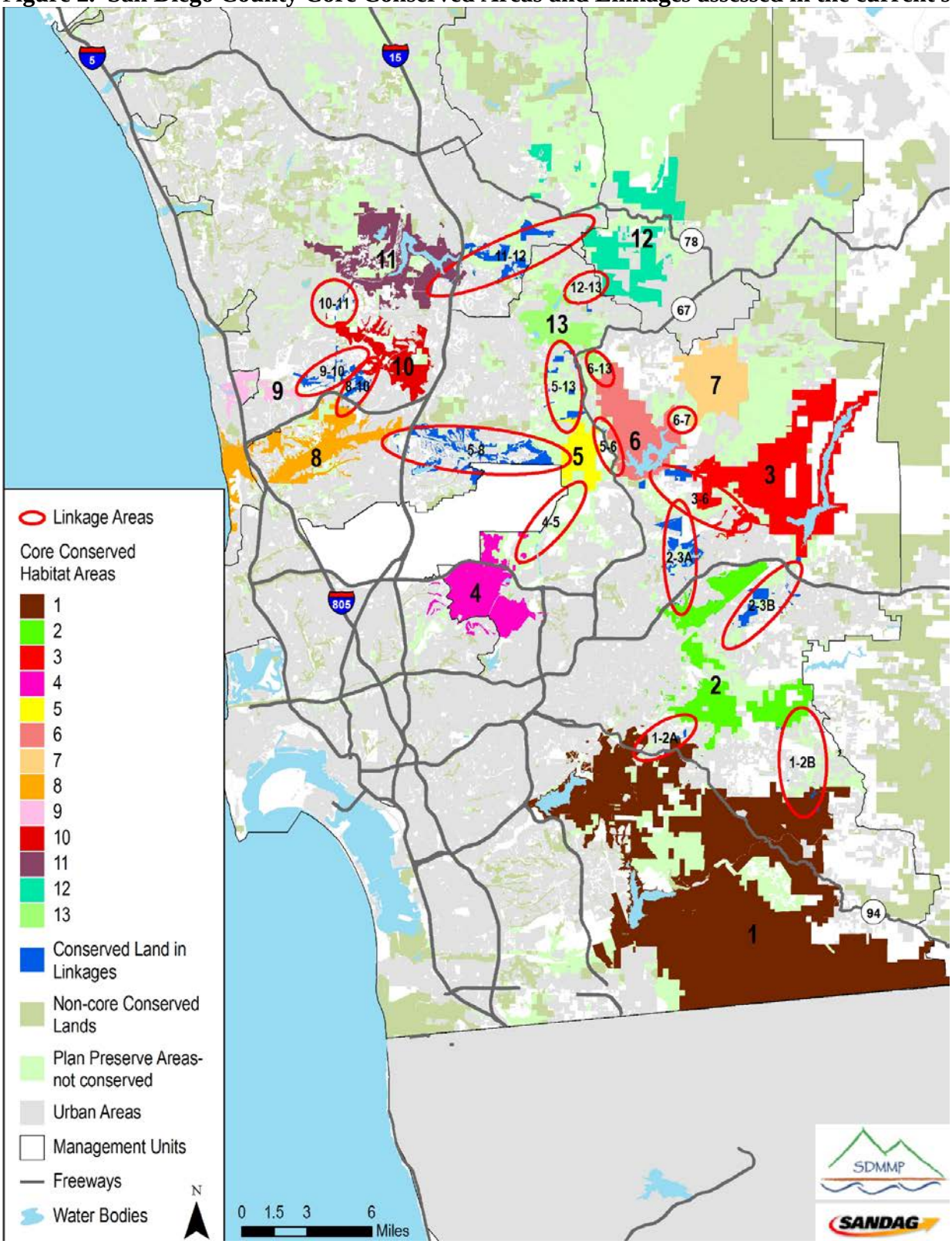


**Table 1.** Core Conserved Areas and Linkages evaluated by UCD team (blue)

| Core Conserved Area | Targeted in this study for assessment of mountain lion use | Linkages | Targeted in this study for assessment of mountain lion use |
|---|---|---|---|
| **1. Hollenbeck-Otay** | Yes | **1-2A**<br>**1-2B** | Yes<br>Yes |
| **2. Crestridge-Cleveland Nat. For.-Sycuan Peak** | Yes | **2-3A**<br>**2-3B** | Yes<br>Yes |
| **3. El Capitan reservoir-Cleveland National Forest** | Yes | **3-6** | Yes |
| **4. Mission Trails** | No | **4-5** | No |
| **5. Sycamore Canyon** | Yes | **5-6**<br>**5-8**<br>**5-13** | Yes<br>Yes<br>Yes |
| **6. San Vicente reservoir-Boulder Oaks-San Vicente Highlands** | Yes | **6-7**<br>**6-13** | Yes<br>Yes |
| **7. Canada de San Vicente** | Yes | **7-3 (not prev. ID'd** | Yes (during study) |
| **8. Penasquitos-Deer Canyon** | Not originally but added mid-study | **8-10** | No |
| **9. Del Mar Heights area** | No | **9-10** | No |
| **10. Black Mountain** | No | **10-11** | No |
| **11. Lake Hodges** | No | **11-12** | No |
| **12. Boden Canyon-Pamo Valley area** | Yes | **12-13** | Yes |
| **13. Mt. Woodson-Blue Sky Ecological Reserve area** | Yes | | |

**Figure 3.** San Diego County conserved lands and pre-approved MSHCP/MSCP mitigation area lands, with collected mountain lion GPS datapoints (red dots). The limits of the study area that is the subject of this contract is outlined (dark blue box. Figure 4 depicts an overview of this study area with data points collected from mountain lions GPS-collared as part of the study, as well as previously collected data in the area.

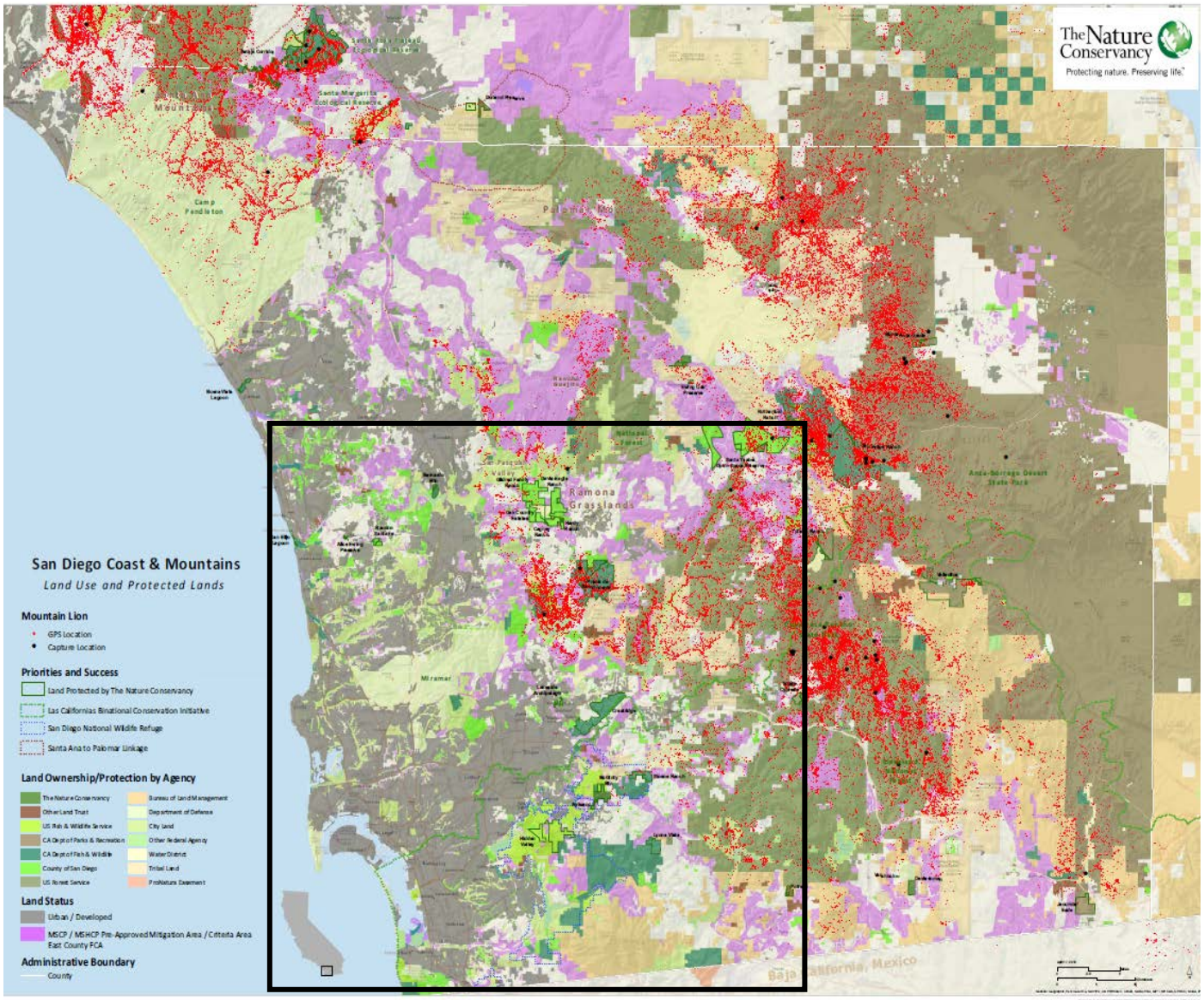
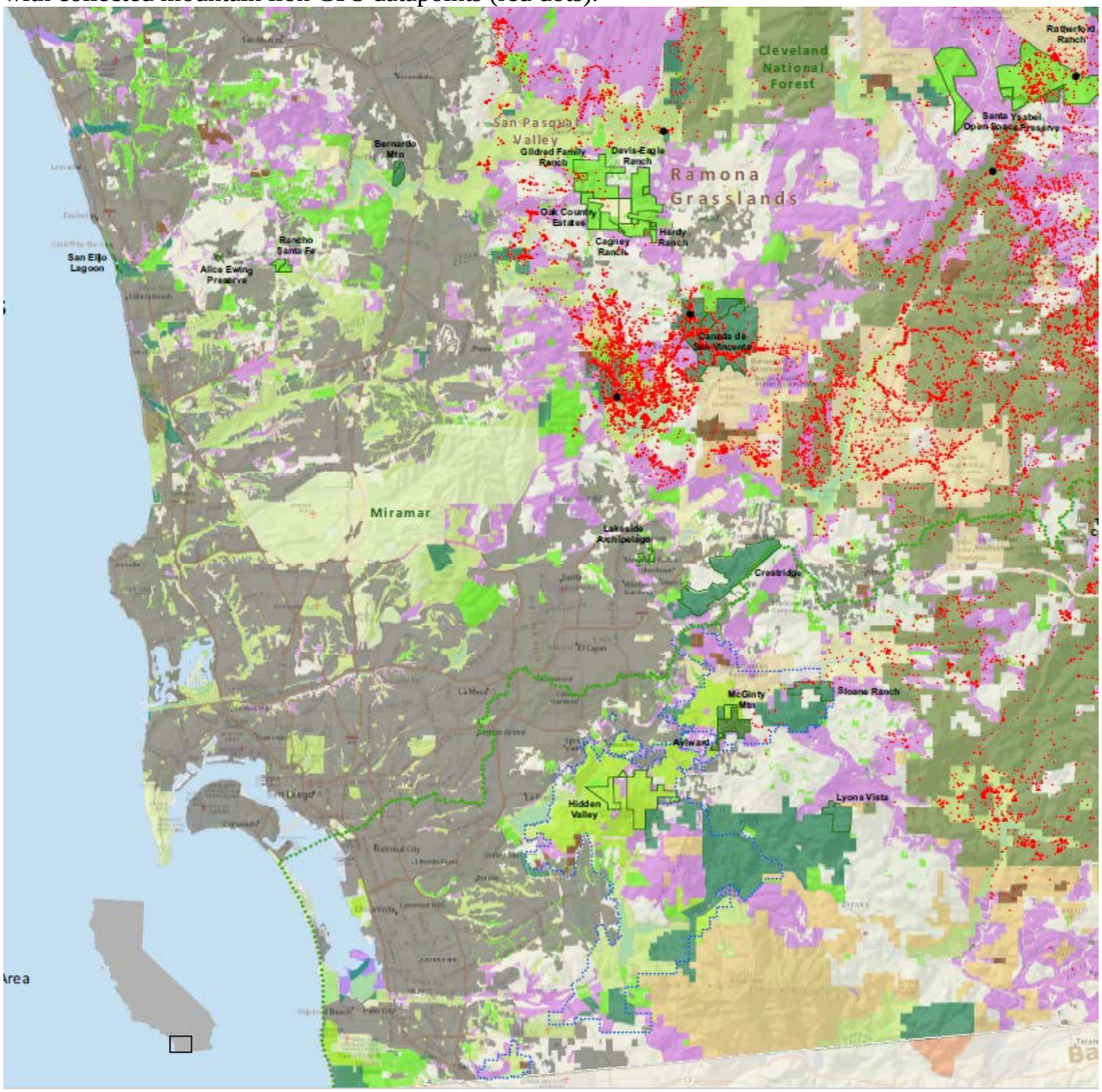


**Figure 4.** San Diego County conserved lands and pre-approved MSHCP/MSCP mitigation area lands, with collected mountain lion GPS datapoints (red dots).



**From the scope of work / task list *(in italics):***

***Task 1 - Determine the locations within the study area for baiting and potential trapping***

*To optimize the capture of mountain lions in potential linkages or adjacent core areas, UCD WHC will place trail cameras in 30+ locations along likely mountain lion travel paths. GPS locations of these camera / potential bait stations will be recorded. These stations will be utilized for attempted mountain lion captures in Task 2 if camera monitoring indicates regular mountain lion activity in the area. Monitoring of these stations will continue during Task 2 activities (mountain lion baiting and trapping) and those costs will be incorporated into the Task 2 budget.*

*A short summary report (1 hard copy and a PDF) on the selected locations, including a map with GPS coordinates of the camera/potential bait stations will be provided to SANDAG every 6 months beginning November 1, 2012 and will also be included in the final report of the project. No GIS analysis of the site characteristics is included in this task. The GPS location of the stations will be included in the appendix and provided in an Excel spreadsheet to SANDAG, along with the number of photos of each wildlife species that are captured by each camera station. Photos will be imprinted with date and time information, and photo archives will be made available to SANDAG-SDMMP for downloading if desired.*

**Activity to date:**

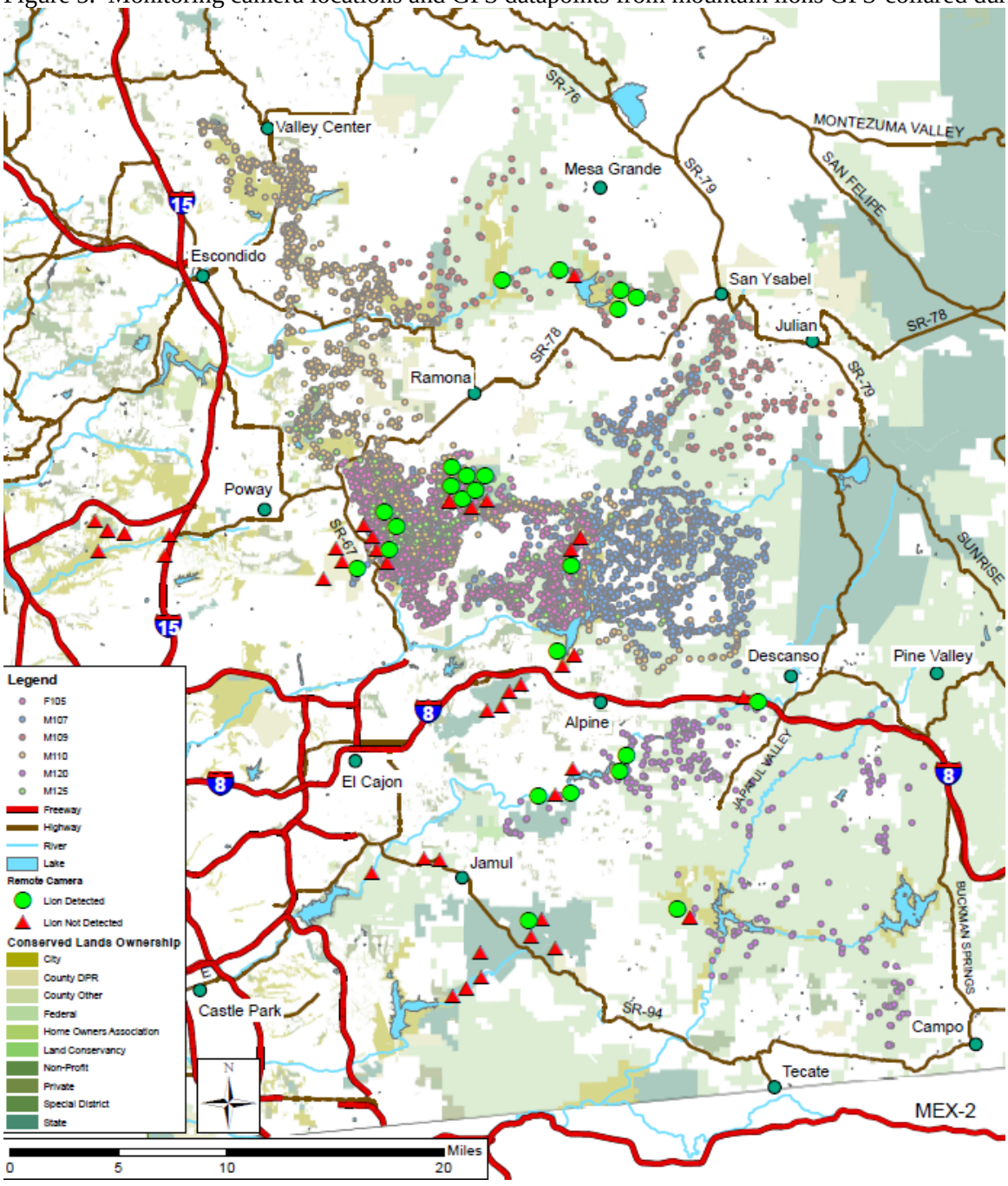
During the period August 2011 – November 2011 (prior to initiation of this contract), the UC Davis Team conducted initial scouting of various locations in the study area where mountain lion activity had been reported historically or where GPS data from mountain lions captured outside the current study area suggested mountain lion movement might be occurring. Trail cameras were placed in some locations in order to get information about whether mountain lion movement was ongoing in those areas. Mountain lion activity was detected during that period at the south end and on the west side of El Capitan Reservoir.

Once work under this contract was authorized in mid-May, 2012, an array of sites were identified where mountain lion activity might be expected based on historical and current evidence of tracks, sightings, road kills of mountain lions, etc. Camera placement and monitoring began almost immediately, and by early July the majority of trail cameras that have continued to be monitored by the UC Davis team were in place in locations scattered over the study area. Since that time, there has been some fluctuation in the number of cameras that were active at any point in time due to scattered loss of cameras to theft or mechanical failure, cameras being added in some areas west of the primary study area, and shifting of cameras based on study focus at any given time. Cameras have been checked on average once per month, and have been serviced by both paid staff and volunteers.

A database file (excel format) that details the locations where monitoring cameras are located has been provided to SANDAG. A listing of monitoring sites where mountain lions have been detected to date, as well as other species that have been detected, is provided in Appendix A. To date, 63 cameras have

been placed for monitoring (Figure 4), and as of the date of this final report, 21 trail cameras remain active in the San Vicente and Sycamore Canyon areas and north and northeast of Ramona at the request of the SANDAG SDMMP. This is in order to allow possible future continuation of monitoring in the northern portion of the study area. Some monitoring sites have been decommissioned due to camera theft, camera failure, extended lack of detection of mountain lions, or because of the study period ending. For all camera sites combined (active and inactive) over 24,000 total camera trap nights of data have been accumulated as of the end of June, 2014.

Figure 5. Monitoring camera locations and GPS datapoints from mountain lions GPS-collared during this study



To date, mountain lions have been detected on the UC Davis Team's cameras 141 times at 24 of the camera sites (Figure 5 and Appendix A). Those sites where mountain lions have been detected on camera to date are in 13 general areas, with the majority of mountain lion photos having been acquired north of I-8. These general areas are:

- Pamo Valley
- Sutherland Lake
- San Diego Country Estates
- Boulder Oaks County Park
- Canada de San Vicente / San Vicente Highlands
- San Vicente Reservoir
- Sycamore Canyon
- Chocolate Canyon
- Sweetwater River S of I-8
- Barrett Lake
- Loveland Reservoir
- Sloane Canyon
- Hollenbeck Canyon

Only 1 mountain lion was detected on the Hollenbeck Canyon and Sycamore Canyon Reserve cameras. In the case of Sycamore Canyon, the animal detected was the collared male M107 on his one documented trip onto the reserve. General areas where no mountain lion photos have been taken by monitoring cameras have been Deer Canyon and Penasquitos Canyon west of I-15, and most of Rancho Jamul. These camera findings suggest that mountain lion frequency of use is likely less on conserved lands south of I-8 than north of I-8, and low in the areas assessed west of I-15 (Core 8 – Penasquitos-Deer Canyon).

Uncollared mountain lions were rarely detected after the mountain lions after collaring of the 6 mountain lions in the study. This suggests that use of the cores utilized by the collared mountain lions in this study, were rarely utilized by other mountain lions. One female mountain lion was detected south of I-8 after M120 was collared, but only once, and she was not captured. We feel that these findings suggest that the mountain lions we captured and collared represented the majority of the mountain lions in the study area at the time.

Megan Jennings of USFS, who previously had camera stations operating in the northern portion of the study area has communicated to our team the locations where her cameras have detected mountain lion presence. Mountain lions have been captured on camera 18 times at 5 sites that Megan Jennings was monitoring concurrent to the beginning of our study. Those cameras were in Pamo Valley north of Ramona, in Boden Canyon, in Boulder Oaks County Park, and in the San Vicente highlands (M. Jennings personal communication).

Other notable findings from monitoring cameras (Appendix A) were:

- Mule deer, the primary prey of mountain lions, were recorded most often by the cameras, were recorded at least once on nearly every camera (over 6,000 detections total), and numbers of detections were extremely variable. Because camera placement was intended to detect mountain lions (placed often in areas of heavy cover favored by mountain lions but not deer) deer detections did not necessarily correspond with deer density in a given area. Interestingly, the camera that did record the highest number of deer (>2 per 24 hour period - one of the Deer Canyon cameras) also recorded one of the highest numbers of human passages (~3 per 24 hour period).
- Coyotes were the second most frequently detected animal (over 4,000 detections total) and were also detected on the majority of the cameras.
- Bobcats were detected over 870 times.
- Numerous other animal species were detected to varying degrees, including some species considered more rare in the study area such as ringtail cats, brush rabbits, and jack rabbits.
- Feral pigs were seen on only one camera during the study period (one of the cameras in the San Diego Country Estates area). Pictures were taken of pigs in that location on several occasions from Oct 2013 through Jan 2014. A few pictures of feral pigs were also taken by cameras in Chocolate Canyon south of El Capitan Reservoir in late 2011 during initial scouting for the study, but not since then.
- No badgers were detected on camera at any time during the study.
- Humans, either on foot, mountain bike, or horseback were detected nearly 4,000 times, with the vast majority of detections coming from 3 cameras (from 3 – 7 human passages per day). These cameras were in Penasquitos Canyon, Deer Canyon, and Sycamore Canyon County Parks. None of the cameras with high human passage recorded mountain lion activity, though as noted above, one camera in Deer Canyon (aptly named) recorded both high human and deer use.

Additional cameras were used to monitor bait carcasses (road killed deer) that were placed near monitoring stations. Photos were taken of a variety of species that also fed on bait carcasses (bobcats, coyotes, gray fox, striped skunks, spotted skunks, opossums, woodrats, crows, and vultures). These photos were documented but not included in Appendix A due to numerous photos being taken of the same animals as they fed at bait sites.

***Task 2 - Place bait, trap, and GPS-collar captured mountain lions***

*The project will capture mountain lions in the study area using road-killed deer placed at selected camera/bait stations where mountain lion activity has been detected. Bait stations will be monitored daily once bait is placed, and if mountain lion feeding is noted, cage traps will be set at the site and monitored constantly via radio transmitters and/or cameras. Mountain lions captured will be anesthetized and fitted with GPS collars. GPS collars will be Lotek 4400S remotely-downloadable collars or Lotek satellite-communicating collars. Each collar will be equipped with 2 timed drop-off*

*mechanisms. This redundancy will increase the likelihood that all data collected by the collars is retrieved, and reduce the likelihood that the animals will wear collars indefinitely if not recaptured. Programming of the time-till-dropoff will vary dependent on various factors such as expected collar battery life with a given program (frequency and timing of GPS acquisitions).*

Mountain lion investigating road-killed deer placed as bait in area where trial cameras had indicated regular mountain lion visitation

Winston Vickers sedating mountain lion in trap with Dan Sforza (CDFW) assistance

Mountain lion after placement of GPS collar and release at the capture site

**Baiting and capturing activity to date:**

Prior to initiation of the project in 2012, one mountain lion was captured to the east of the current study area in Carrizo Gorge in the southeast corner of the county in a separate project evaluating mountain lion movement in the U.S.-Mexico border region. That mountain lion did not enter the SANDAG study area, and after approximately 4 months was found to have died of disease. Additionally, 1 mountain lion was captured at the far northwest portion of the county on the Santa Margarita River Reserve, and 1 mountain lion that was captured originally in Orange County dispersed into northern San Diego County, also in the area of the Santa Margarita River drainage.

During the current study period 4 mountain lions have been collared or re-collared in the Santa Margarita River drainage and Rainbow areas in northern San Diego County as part of the broader UCD mountain lion study. However, none of these mountain lions entered the current SANDAG project study area. These mountain lions did, however, emphasize the barrier effect being exerted by I-15 in north San Diego County, findings echoed in this study of the western part of the county further south.

Mountain lion baiting and capture activity was scheduled to commence November 1, 2012 but was delayed due to administrative delays at the California Department of Fish and Wildlife (CDFW) relating to issuing the project's permit. The UC Davis Team's permit for conducting mountain lion baiting and capture activities became active on January 25, 2013 and baiting efforts were instituted on January 29 at sites where camera monitoring had indicated mountain lion activity in the previous 9 months of camera monitoring. In the 3 1/2 month baiting and trapping period from February 1 – May 15, 2013 and the approximately 5 1/2 month baiting and trapping period from late October, 2013 – early April, 2014 the UC Davis team placed road killed deer carcasses as bait at 40 sites that were at or near camera locations where mountain lion activity had been recorded previously. These sites were active and checked daily or every other day for variable periods of time for a total of 767 bait nights.

These baiting efforts resulted in 10 mountain lion capture attempts in which 6 adult mountain lions (5 males and 1 female) were GPS collared, and 1 was re-collared. The gender distribution was slightly different than in the broader UCD mountain lion study where roughly equal numbers of males and females have been captured.

The first capture attempt was in San Diego Country Estates in early February, 2013 when a male mountain lion fed on a bait carcass there. This attempt was unsuccessful due to the mountain lion not returning to the bait site after traps were set. The other 2 unsuccessful capture attempts were efforts to re-collar one animal (F105). All data from collars to date is displayed on Figure 6 below and subsequent maps.

**Capture activity:**

1. On February 4, 2013, an adult female was captured (designated F105) in the San Vicente Highlands. She circulated initially west of El Capitan Reservoir both east and west of Barona / Wildcat Canyon Road (Figures 5 – 10, 13 – 15, 18, 24, 25). Due to a dramatic reduction in her rate of movement on the landscape on the night of May 4, 2013 immediately after crossing Barona Rd from east to west, and damage noted on her collar when it was retrieved, it is our belief that she was struck and injured by a vehicle as she crossed the highway. The area where her May 4 crossing occurred is where most of her (and other collared cougar) crossings of that highway have occurred (Figures 5 - 7). F105 did not cross Barona Rd. again after this incident during the 9 remaining months that she was monitored, despite having crossed multiple times in the 3 months previous to the incident. She restricted her circulation to the area bounded by Barona / Wildcat Cyn Rd.'s and Hwy 67 until her collar dropped off in early February 2014. Recapture of F105 was attempted in January 2014 prior to her collar dropping off but two attempts were unsuccessful. No kittens have been detected following this female on camera during the period she was collared or after.

   As will also be noted later, F105 (as well as M107, M110, and M125) never crossed Wildcat Canyon / Barona Road south of the Barona Casino despite circulating extensively in the conserved habitat on both sides of the highway. This suggests a barrier effect is being exerted by the highway in that area.

Figure 6. Only documented crossing area of Barona / Wildcat Canyon Rd. (north of Barona Casino) – F105 likely struck by vehicle here (Yellow cross)

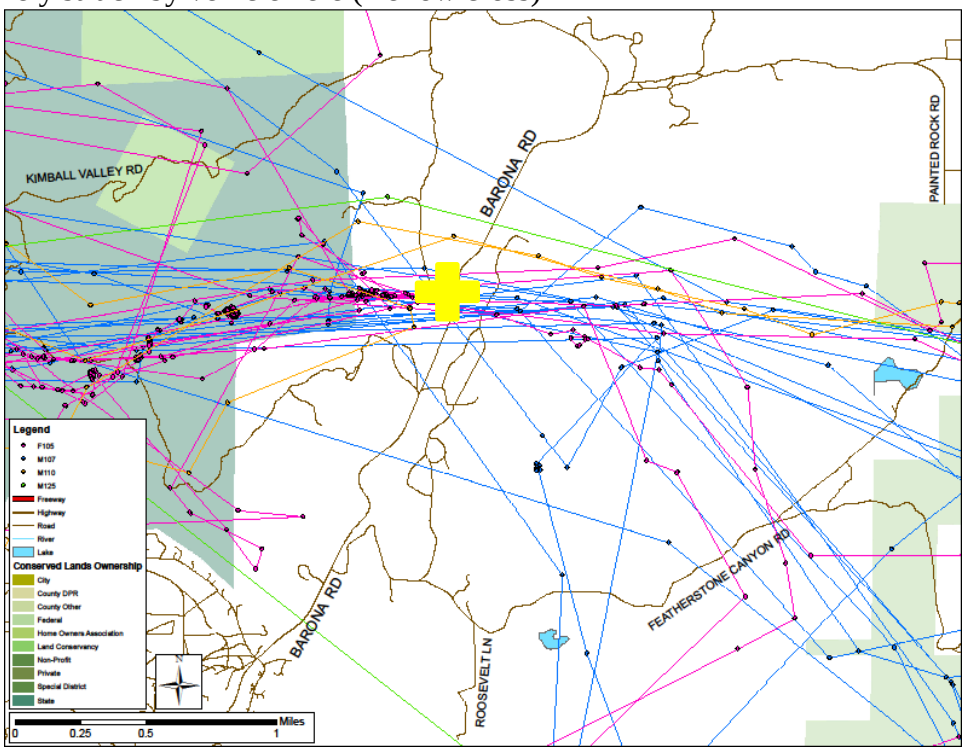
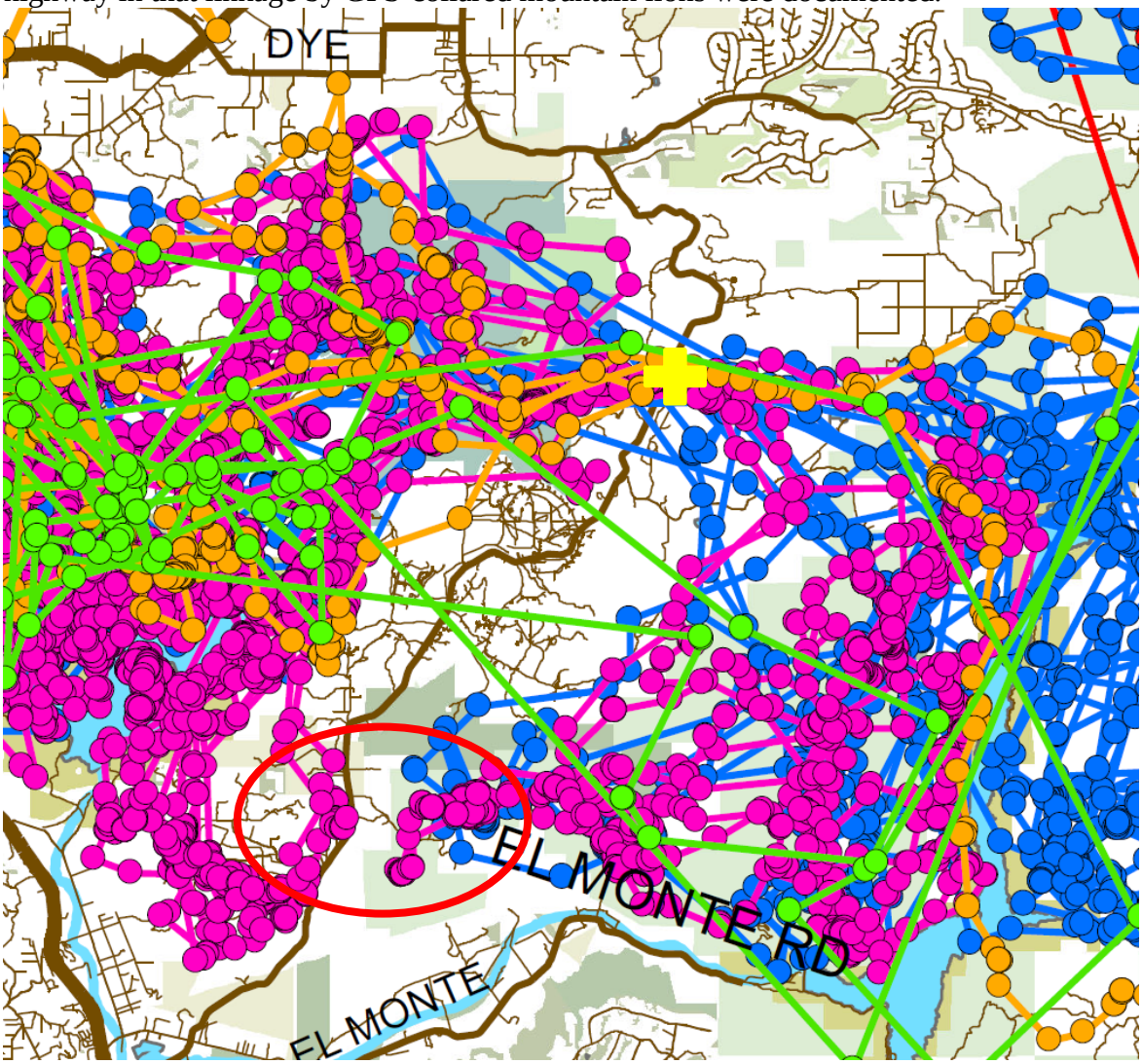


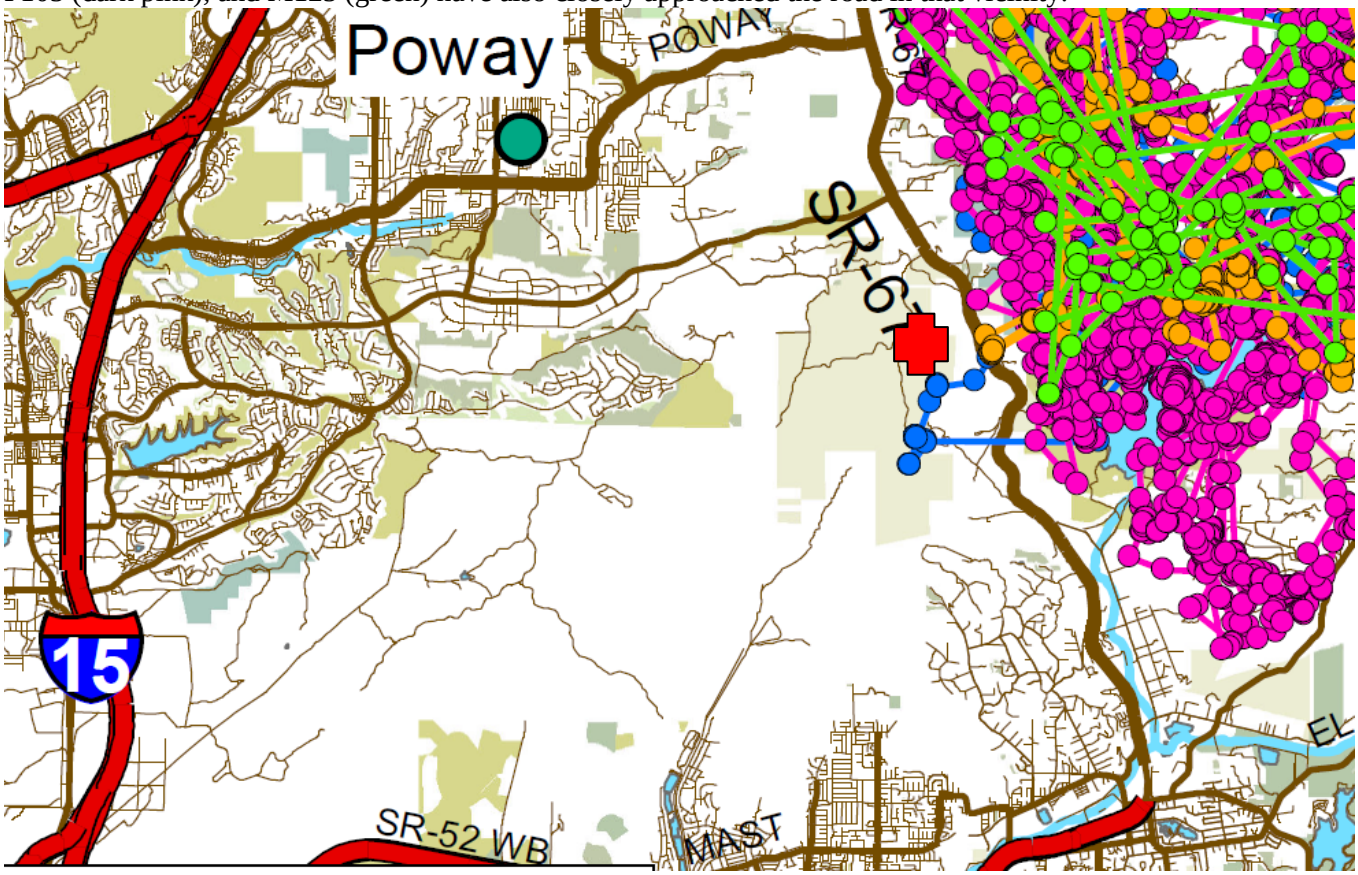
Figure 7. Wildcat Canyon / Barona Road major crossing point north of Barona Casino with yellow cross marking point where F105 likely struck by vehicle. Data points with lines between subsequent points of F105 (pink), M107 (blue), M110 (yellow), and M125 (green). Except for M125 (data points 12-24 hrs apart on average), data points are typically 1-2 hrs apart. Red circle denotes designated linkage "3-6" between the El Capitan Reservoir-Cleveland National Forest area and the San Vicente-Boulder Oaks-San Vicente Highlands area. No crossings of the highway in that linkage by GPS-collared mountain lions were documented.



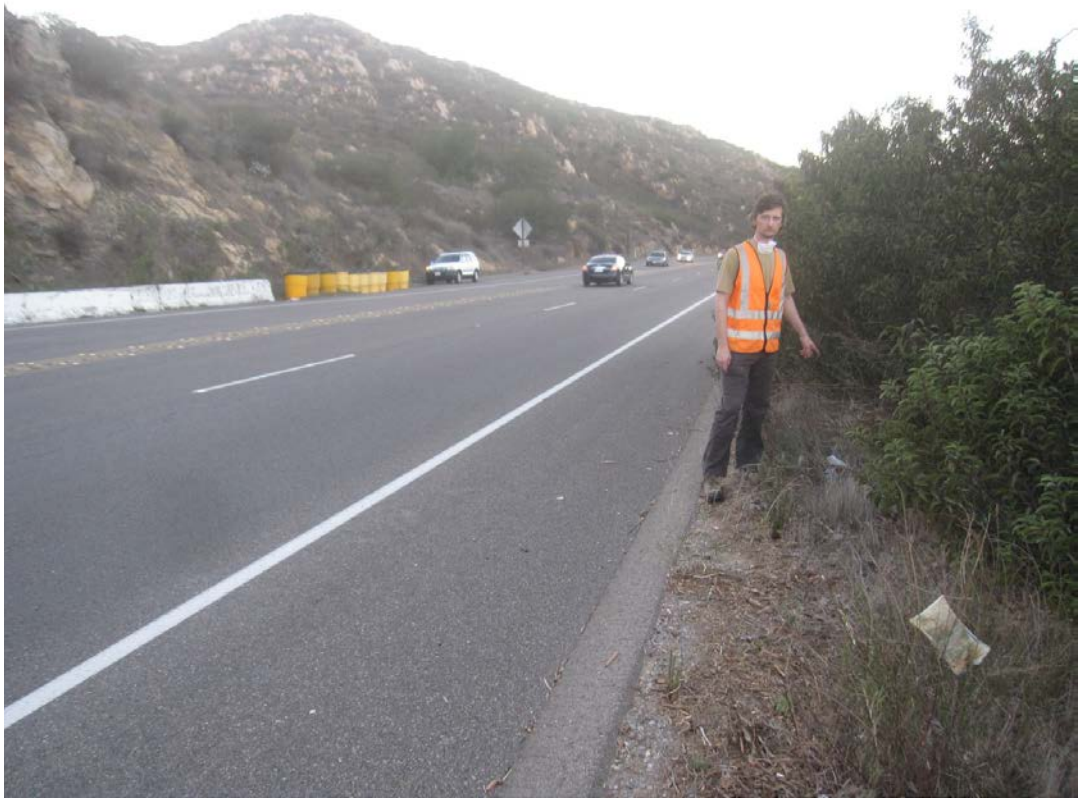

2. A mature adult male mountain lion (designated M107) was captured on Feb 21, 2013 north of San Vicente Reservoir. He circulated over a large area east and south of Hwy's 67 and 78, and north of I-8 (Figures 5 – 10, 13 – 15, 18, 20, 21, 23 - 25). M107 was killed by a car on Hwy 67 south of the intersection with Foster Truck Trail on 12/31/13 (Figures 8, 13, 20, 21, 23). He was struck and killed while traveling west to east toward his normal range after he had made his first recorded crossing from east to west the day previous. His body and collar were recovered and all

data from the collar retrieved. Necropsy revealed that death had occurred due to head and stomach trauma with secondary findings of mild kidney disease secondary to active *Leptospira sp* infection, and the presence of 3 anticoagulant rodenticides in the liver. Kidney disease at low to moderate levels has been detected in other deceased mountain lions from the study area, though this was the only case to date confirmed to be caused by *Leptospira sp*. Anticoagulant rodenticides have been detected in 100% of the deceased mountain lions that the UCD team has necropsied from the area (n=30+) but no bleeding or other symptoms have been detected that would be ascribed to these compounds.

Figure 8. Map of location where M107 (blue) was struck and killed by a vehicle (red cross). M110 (yellow), F105 (dark pink), and M125 (green) have also closely approached the road in that vicinity.



Location on SR 67 where M107 was struck and killed.  Biologist Dale Ritenour points to location where M107 body was found.



M107 at roadside after recovery

Data collected to date suggests that F105 is, and M107 was, the resident adult female and male in the region of the study area that is bounded by Interstate 8, Hwy 67, the city of Ramona, and the El Capitan Reservoir area including its major watersheds to the north. Since M107's death, another male mountain lion (captured in 2014 and designated M125) appears to have migrated into the area and taken a position as the new resident male in that area.

3. Another adult male mountain lion was captured on April 1, 2013 (designated (M109) west of Sutherland Lake. M109 appears to have a territory that stretches east-west on the north side of Hwy 78 from Guejito Creek east to Santa Ysabel (including Pamo Valley and Boden Canyon), and then north-south from Santa Ysabel across Hwy 78 to the southern end of El Capitan reservoir (Figures 5, 9, 10, 13 – 15, 18, 24, 25). Baiting was initiated in early March, 2014 to attempt to recapture M109 prior to his scheduled collar drop-off date of April 1st or 2nd. M109's collar had stopped transmitting to the satellites and appeared to have also stopped sending a VHF signal on Dec 31, 2013 (coincidentally the same day of M107's death). This loss of both signals suggested that the collar had undergone some sort of trauma and had been damaged. M109 was detected on camera after that time with the collar present, but when he was detected feeding on a carcass on 4/1/14 no collar was present.

   M109 was recaptured on 4/2/14 and re-collared. At recapture it was noted that he had sustained a significant injury to his left rear foot (multiple mid-shaft fractures of his metatarsals) that had apparently stabilized with a large bony callous, and that he had lost 17 pounds since his first capture. It is highly likely that the foot fractures significantly hindered M109's hunting ability for several months, but the apparently stabilized fractures may now be enabling more normal activities. Whether the foot injury and apparent collar damage occurred at the same time or not is unknown, but it is possible based on usual stabilization times for fractures of this type. Subsequent ground searches for the collar in the area of the recapture were unsuccessful.

M109 – site of rear foot bone fractures after healing. Note the large bony lump formed to stabilize the fractures.

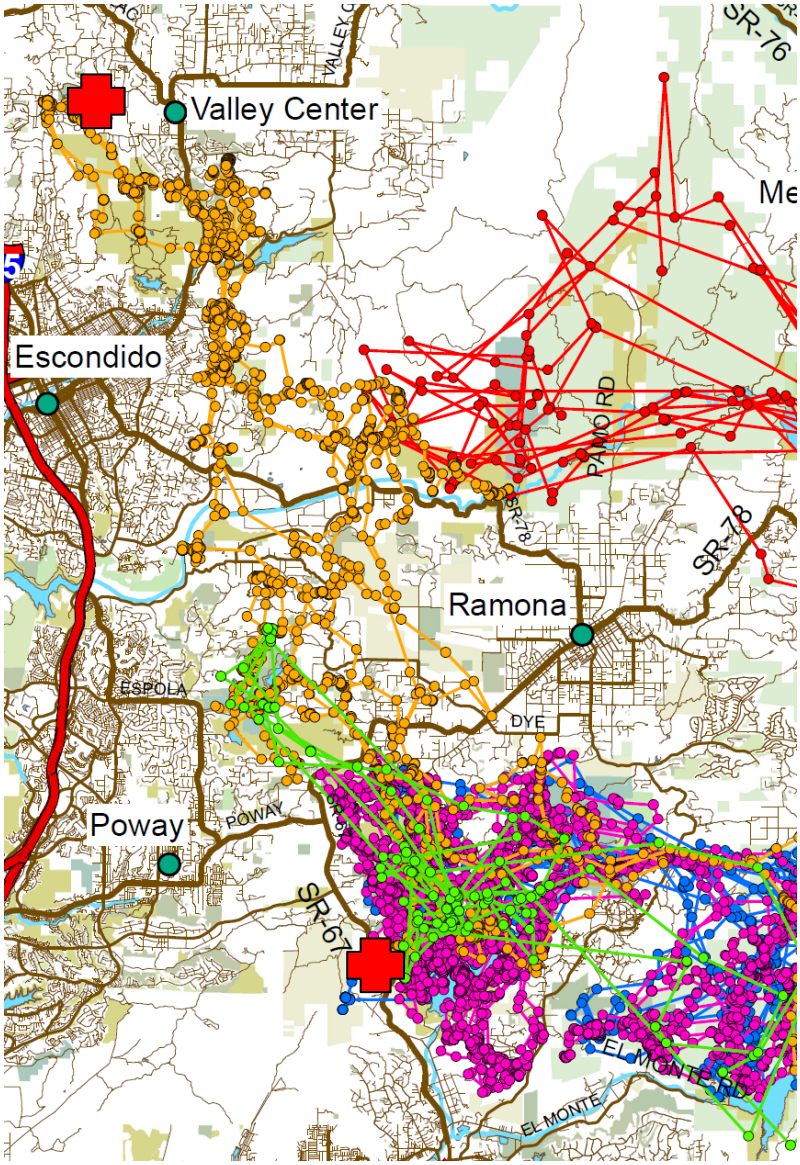
4. The fourth individual captured was a young (estimated 2-3 yr old) male (designated M110) that was captured on May 7, 2013 in Black Canyon north of Ramona. M110 was thinner than normal for his estimated age but otherwise had no obvious signs of ill health except for a healing foot wound. Subsequent analysis of blood samples taken at capture suggested that this male had been suffering from chronic infection of some type, but serology to detect antibodies to some of the more serious diseases known to affect mountain lions was negative. M110 circulated over the widest total area of any of the mountain lions that have entered the study, even though he was collared for a relatively short period. M110 circulated primarily from the NW section of Valley Center south along the eastern edge of Escondido, and around San Vicente Reservoir. M110 also made one foray further southeast past El Capitan Reservoir nearly to Descanso (Figures 5 – 10, 13 – 15, 18, 20, 21, 23 – 25)

   On October 24th, 2013 M110's collar transmitted a mortality signal that was communicated via satellite link to the UC Davis Team. Upon ground investigation, M110 was located and visualized and was still alive and mobile. Investigation in the neighborhood where he was located south of Woods Valley Rd. found that he had been shot and wounded by a livestock owner after a depredation incident over a week previously. Ultimately, M110 was killed by a CDFW warden on October 26th due to public safety concerns secondary to his wounded status and location near homes just south of Woods Valley Rd in Valley Center (Figures 9, 20, 21, 23). Upon examination and necropsy, it was determined that M110 also had recent fractures of both rear legs that were most consistent with injury from vehicle collision. Had he not been

euthanized, he would doubtless have died from starvation due to these injuries. Necropsy results indicated no evidence of the previous episode of apparent chronic infection. The analysis for anticoagulant rodenticide residues detected 4 different compounds, but there was no evidence of active bleeding episodes or other symptoms ascribable to rodenticide presence prior to him being killed.

Data downloaded from M110's collar suggested that he had crossed busy highways (Hwy 67, Hwy 78, Wildcat Canyon / Barona Rd, and Valley Center Rd) a minimum of 20 times in the 5 ½ months since his initial capture, as well as numerous other roads of various sizes.

Figure 9. M110 (yellow) movements across roads. Map includes all roads (major and minor) in M110's area of circulation west of El Capitan reservoir, as well as data from F105 (dark pink), M107 (blue), M109 (red), and M125 (green). Red crosses are mortality sites for M110 and M107.



M110 after being euthanized by CDFW. Both rear legs were broken – necropsy revealed fractures were likely secondary to a vehicle collision. Open wound on upper right flank was a non-fatal bullet wound from an illegal shooting incident 10 days previously.

5. Baiting for captures south of I-8 began October 29, 2013 at, or in the vicinity of, sites where cameras have recorded mountain lion activity. This baiting activity resulted in the capture of one cougar (M120) on November 11, 2013 near Barrett Lake. Since his capture M120 has circulated from I-8 to Hwy 94 predominantly down the Sweetwater drainage and southeast to the Barrett Lake and Lake Morena areas (Figures 5, 11 13 – 15, 18, 24).

   M120 at bait site prior to capture


M120 is known to have depredated one domestic animal (a turkey) that was taken from an inadequately constructed pen. The owner of the turkey visualized M120 and got his picture on a trail camera, confirming that he was the individual that killed the turkey. The owner did not request a depredation permit, though he could have legally. The owner reported to a CDFW warden and UCD researchers that he realized he had a responsibility to adequately protect his animal and had failed in that. Thus he did not feel it was appropriate to have the mountain lion killed.

In an earlier phase of the UCD study, we found that approximately half of 18 mountain lions whose feeding sites were investigated over a 3 year period had killed domestic animals. It is our team's feeling that virtually all mountain lions depredate domestic animals opportunistically, but our findings did not support the idea that mountain lions become habitual with such behavior over long periods, in that none

of the animals we followed did so. Mountain lion energetic needs are too great to be dependent on the occasional unguarded or poorly housed sheep, goat, or other domestic animal.

One (apparently female) mountain lion had visited a bait site north of Loveland Reservoir in January 2014 but did not feed so no capture attempt was initiated.

6. After an uncollared cougar that was not one of the previously collared study animals was detected on camera near the north end of San Vicente Reservoir, bait was placed and the un-collared individual, an adult male (designated M125) was captured and GPS-collared on March 18, 2014. His area of circulation since that time has been in a portion of the areas previously utilized by M107 and M110 prior to their deaths, with several crossings of Hwy 67 north of the Poway Rd. (S4) intersection in the area of Mt. Woodson (Figures 5 – 10, 13 – 15, 18, 24, 25)

M125 at bait site prior to capture


Extensive baiting activity continued until early April 2014 but no further mountain lion feeding, and no further captures, occurred at any of the sites.

All individuals other than M110 appeared to be healthy at the time of capture and were fitted with Lotek Globalstar S satellite-communicating GPS collars, or in the case of M125, a Globalstar M satellite-communicating collar. The Globalstar M collar has a longer battery life. All GPS collars functioned

normally after placement (with the exception of the previously noted probable damage-related function loss of M109's collar). Four of the GPS-collars were programmed to collect data points every hour (M107, M109, M110, M120) throughout each 24 hour period. M107's collar was programmed to collect data every 2 hours, and M125's collar was programmed to collect data every ½ hour due to its greater battery life. So as to preserve collar battery life, the collars were programmed to only send a subset of their total collected GPS data points to the Globalstar satellite system for regular retrieval. It is expected that remaining data in the GPS collars that are currently circulating (M109, M120, and M125) will be collected from the collars after they drop off the animals, or upon recapture or death. All GPS collars were equipped with timed drop-off units that are programmed to release the collars from the animal in 1 year. Two drop-off units are placed on each collar for redundancy.
Data that has been collected from all collars placed to date is displayed in Figure 5 below, along with data collected in the area from previously collared mountain lions.

***Task 3 - Download data from GPS collars***

*Data will be downloaded during flights in fixed wing aircraft, via close approach to the animal on the ground, or via satellite on regular schedules. Data download frequency from either remote-downloadable or satellite-communicating collars will be based on balancing the need to extend battery life of the collar for as long as possible, with the timing of needs for the data. Budgeted costs are based on acquiring data from all Lotek 4400S collars every 2 months and more frequently from satellite collars.*

**Activity to date:**

The UC Davis Team has regularly downloaded and mapped the subset of the GPS data that has been transmitted via the Globalstar satellite system, as well as more complete data sets from recovered collars. Access to this data has been given to Ron Rempel and SANDAG so as to allow timely use of the data if desired.

All datapoints that are available up to June 24, 2014 from F105, M107, M109, M110, M120, and M125 are depicted on various maps throughout this report. On several of the maps datapoints generated by mountain lions previously GPS-collared by the UC Davis Team are also depicted, and individual ID's noted in the map legend if indicated. Inclusion of previous data is intended to provide context to the current data and movement patterns, and to help illuminate previously established connectivity patterns for mountain lions within the current study area, as well as between the current study area and larger habitat blocks to the east. Maps are also included that depict current and previous mountain lion data overlaid on conserved lands whose use by mountain lions are the subject of the current study, as well as maps depicting road crossing areas in more detail. All 6 individuals used conserved lands and regularly traveled between conserved areas, however all collared individuals also utilized unconserved lands during some portion of their regular movements.

Figure 10. All datapoints north of I-8 to date from mountain lions GPS-collared in this study with major and minor roads depicted

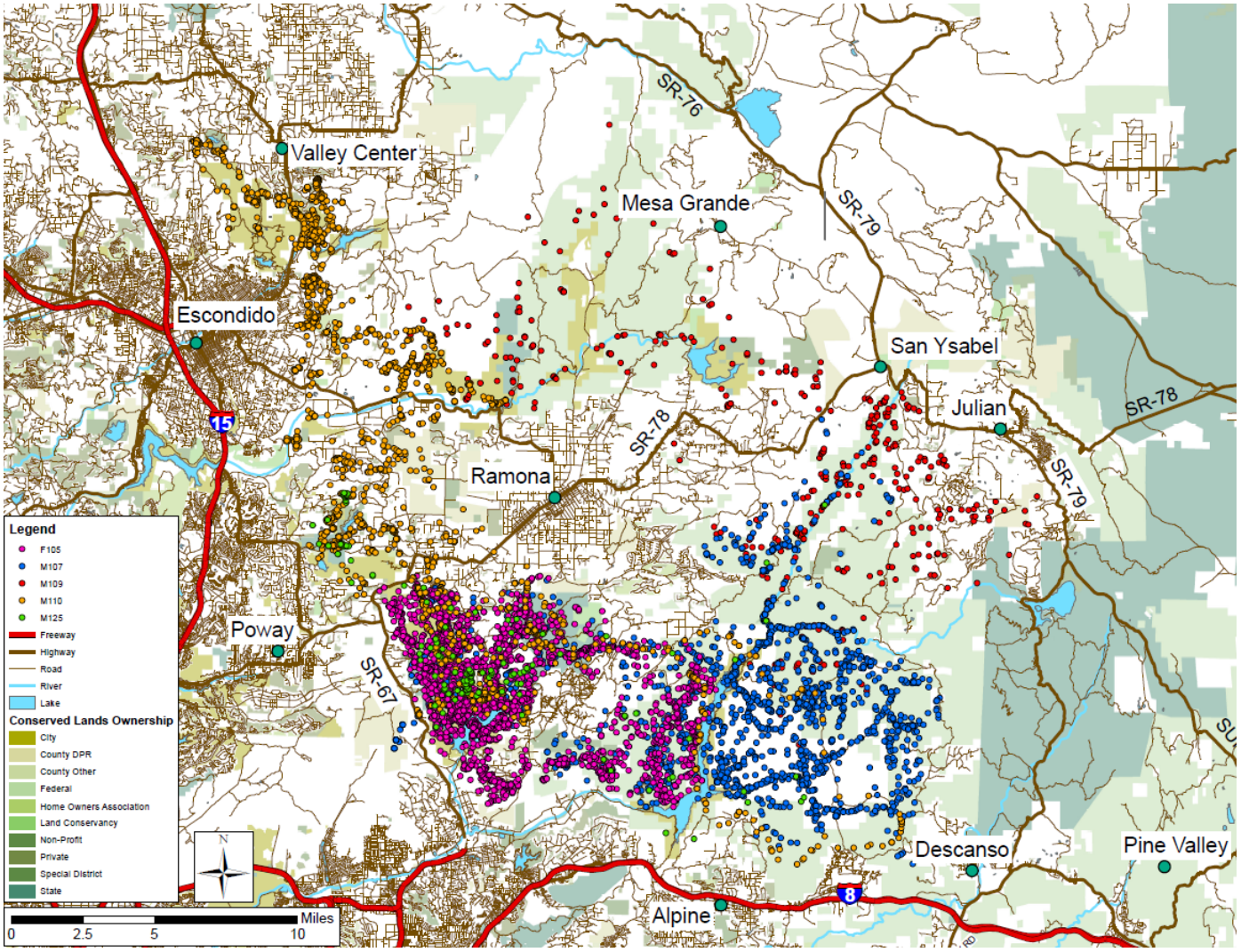
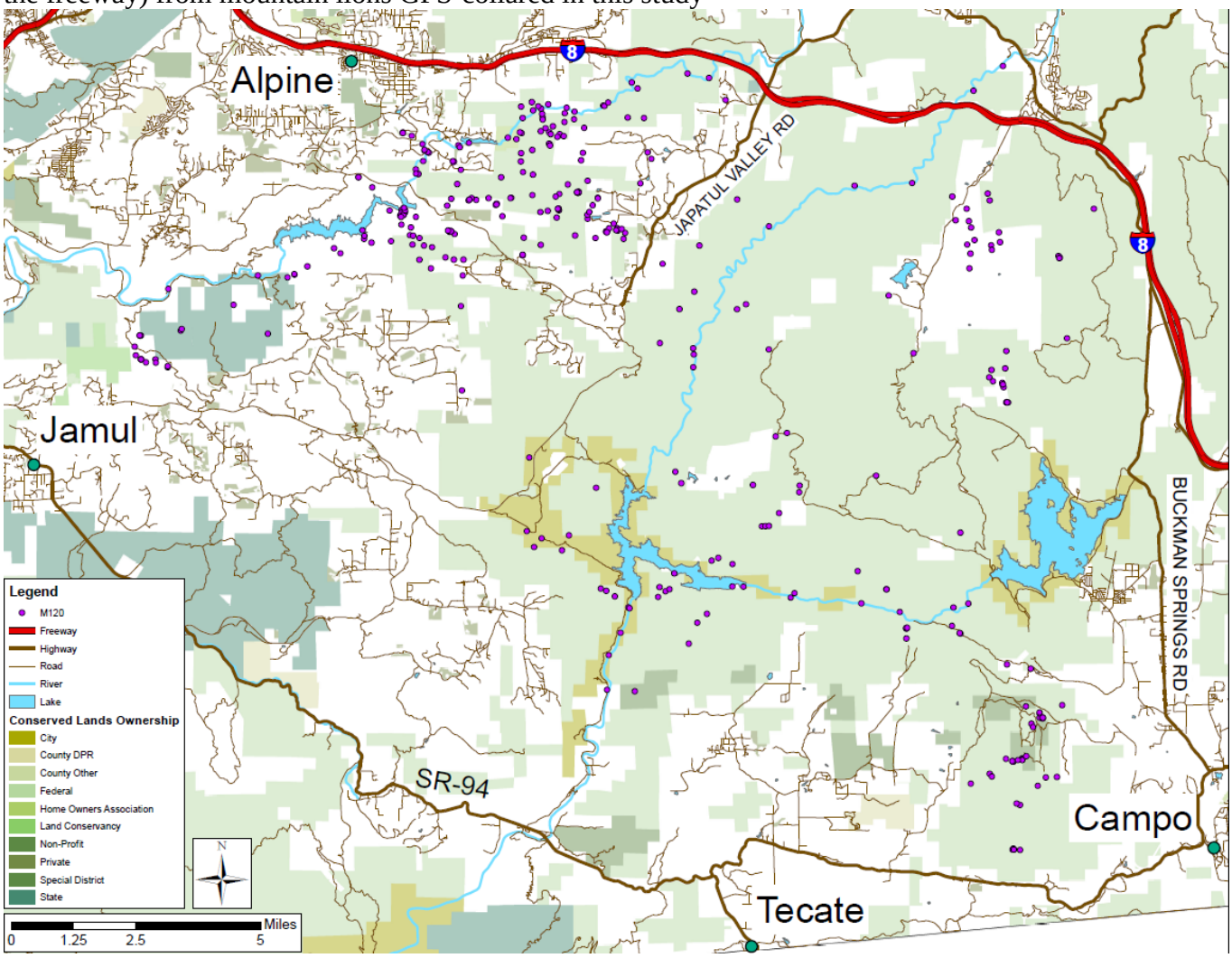


Figure 11. All datapoints to date south of I-8, and 2 datapoints north of I-8 (M120 brief foray north of the freeway) from mountain lions GPS-collared in this study




**Use of Cores and Linkages:**

Of the 13 Core Conserved Areas identified on Figures 2 and 12, 9 were targeted for assessment by the UCD team (Tables 1 and 2). Six of the 9 were utilized regularly by collared mountain lions, and 1 was utilized once (Sycamore Canyon briefly by M107). Of the 16 linkages designated in Figure 2 and Table 1, 12 were assessed for mountain lion usage. Only 3 of the originally designated linkages were utilized regularly by GPS- collared mountain lions, 1 linkage was utilized that was not identified previously (Linkage 7-3), 1 linkage was used once (Linkage 5-6 by M107 resulting in mortality), and one linkage was partially used (Linkage 11-12) in its eastern half east of I-15 (Figure 12, Table 2)

Figure 12. Conserved Core Areas and Linkages with green arrows indicating confirmed linkage use, dark blue arrows indicate no confirmed use (including data from other UCD GPS-collared mountain lions)

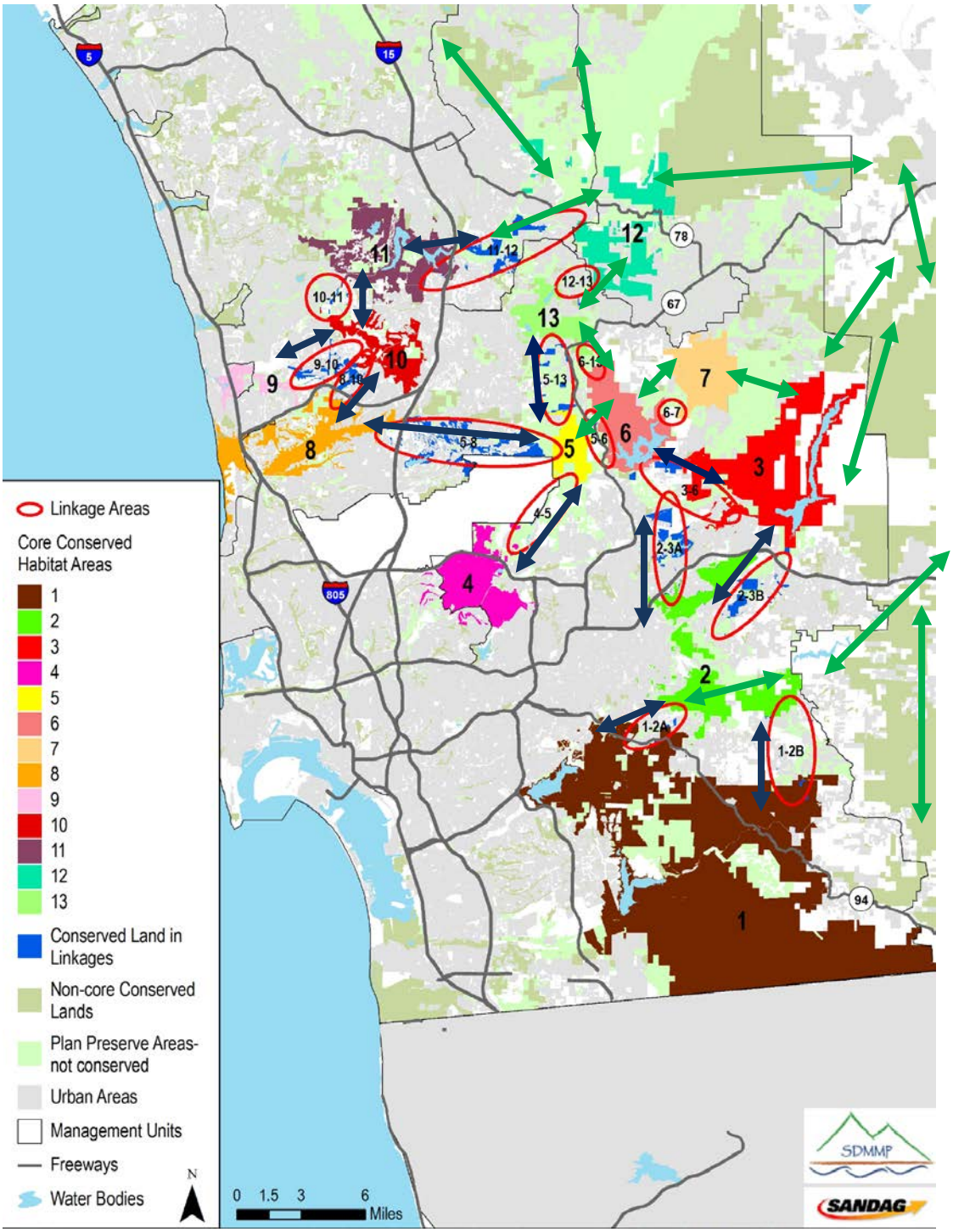


Table 2. Core Conserved Areas and Linkages evaluated by UCD team (blue) and results

| Core Conserved Area | Utilized by mountain lions in this study | Linkages | Utilized by mt. lions in this study |
|---|---|---|---|
| **1. Hollenbeck-Otay** | No (but some historical use) | **1-2A**<br>**1-2B** | No<br>No |
| **2. Crestridge-Cleveland Nat. For.-Sycuan Peak** | Yes (southern and eastern portions) | **2-3A**<br>**2-3B** | No<br>No |
| **3. El Capitan reservoir-Cleveland National Forest** | Yes | **3-6** | No |
| **4. Mission Trails** | No | **4-5** | No |
| **5. Sycamore Canyon** | Yes (briefly eastern section) | **5-6**<br>**5-8**<br>**5-13** | Yes (1 time)<br>No<br>No |
| **6. San Vicente reservoir-Boulder Oaks-San Vicente Highlands** | Yes | **6-7**<br>**6-13** | Yes<br>Yes |
| **7. Canada de San Vicente** | Yes | **7-3 (not prev. ID'd** | Yes |
| **8. Penasquitos-Deer Canyon** | No (but one mountain lion killed by car in this core in 2011 – was a dispersal age male with genetic signature suggesting origin west of I-15 | **8-10** | No |
| **9. Del Mar Heights area** | No | **9-10** | No |
| **10. Black Mountain** | No | **10-11** | No |
| **11. Lake Hodges** | No | **11-12** | Partial – section east of I-15 |
| **12. Boden Canyon-Pamo Valley area** | Yes | **12-13** | Yes |
| **13. Mt. Woodson-Blue Sky Ecological Reserve area** | Yes | | |

To date, all GPS-collared mountain lions have crossed busy highways and moderately busy secondary roads numerous times. These include (Hwys 67, 78, Valley Center Rd (S6), Wildcat Canyon / Barona Rd., Japatul Valley Rd., Japatul Rd., and Lyons Valley Rd. To date, no crossings of Wildcat Canyon / Barona Road south of the Barona Casino or I-15 have been documented, and only 1 crossing of I-8.

It is notable that all crossings of Hwy 67 appear to have occurred in a relatively short stretch of highway north of the Poway Rd. (S4) intersection and west of Ramona (Figures 9, 13, 15); of Hwy 78 in an approximately 3 mile stretch between eastern Ramona and Santa Ysabel and in two specific short sections in San Pasqual Valley (Figures 13, 15); of Valley Center Rd in a short section just south of Valley Center proper (Figures 9, 13, 15); and of Barona Rd. in a short section just north of the Barona Casino (Figures 6 – 9, 13, 15).

Road crossing points in some instances appeared to be at locations where conserved lands abutted the road on both sides, and in other cases conserved lands existed only on one side, or on neither.

Figures 13 and 14. Major roads crossing points (blue circles) for mountain lions GPS-collared in this study. Red circles are road crossings within identified corridors where crossings did not occur. Red crosses are approximate locations where collared mountain lions were struck by vehicles (M110 – yellow), M107 (blue), yellow crosses are approximate locations where GPS data suggests collared mountain lions suffered trauma, likely from a vehicle in the case of F105 (dark pink), and possibly from a vehicle in the case of M109 (red).

Figure 13

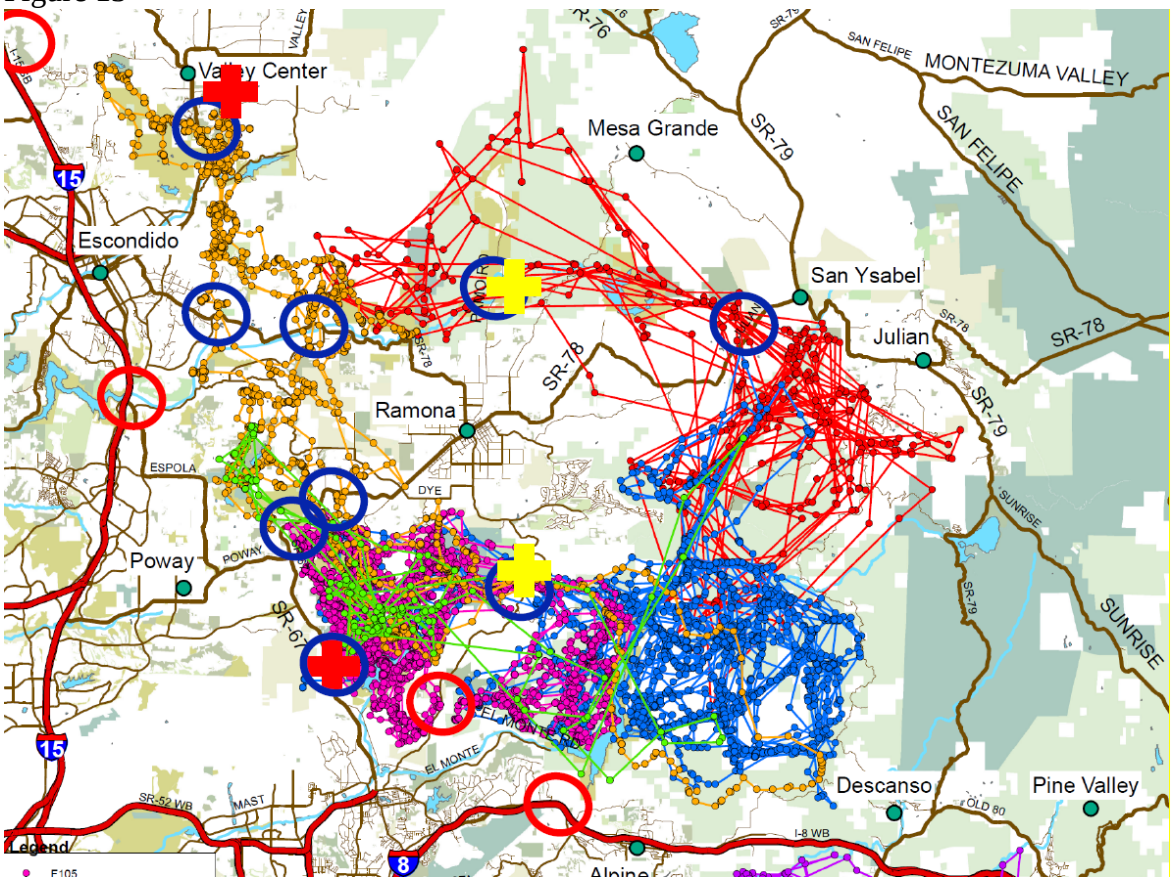


Figure 14

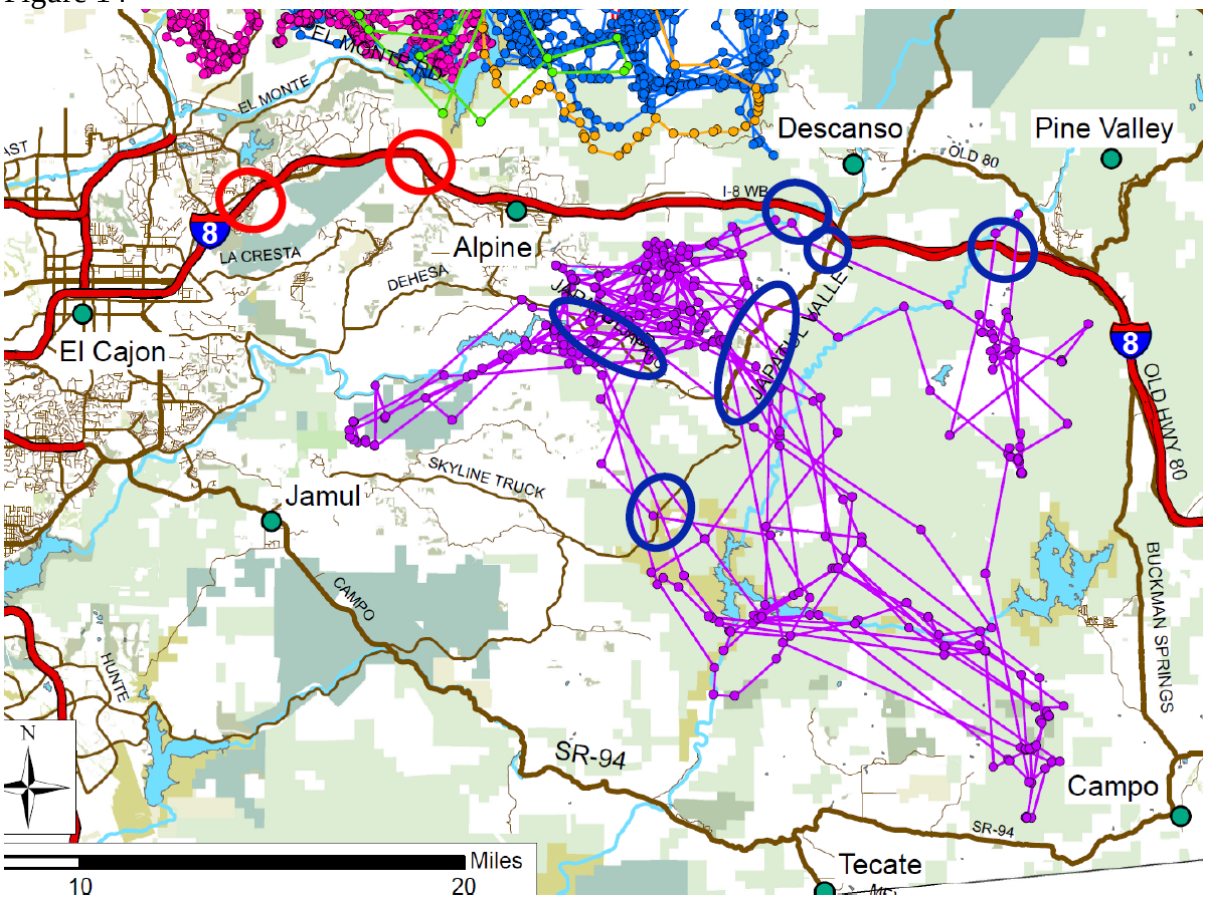

Descanso
Pine Valley
Alpine
El Cajon
Jamul
Campo
Tecate
LA CRESTA
DEHESA
SKYLINE TRUCK
CAMPO
HUNTE
SR-94
OLD HWY 80
BUCKMAN SPRINGS
I-8 WB
N
Miles
10
20

Figure 15. GPS-collared mountain lion data points and lines between subsequent points in relation to all regional roads (major and minor). Data points for F105 and M107 are at 1-2 hour intervals, data points for M109, M120, and M125 are at 12-24 hour intervals (1 hr interval data to be available after GPS-collars are retrieved).

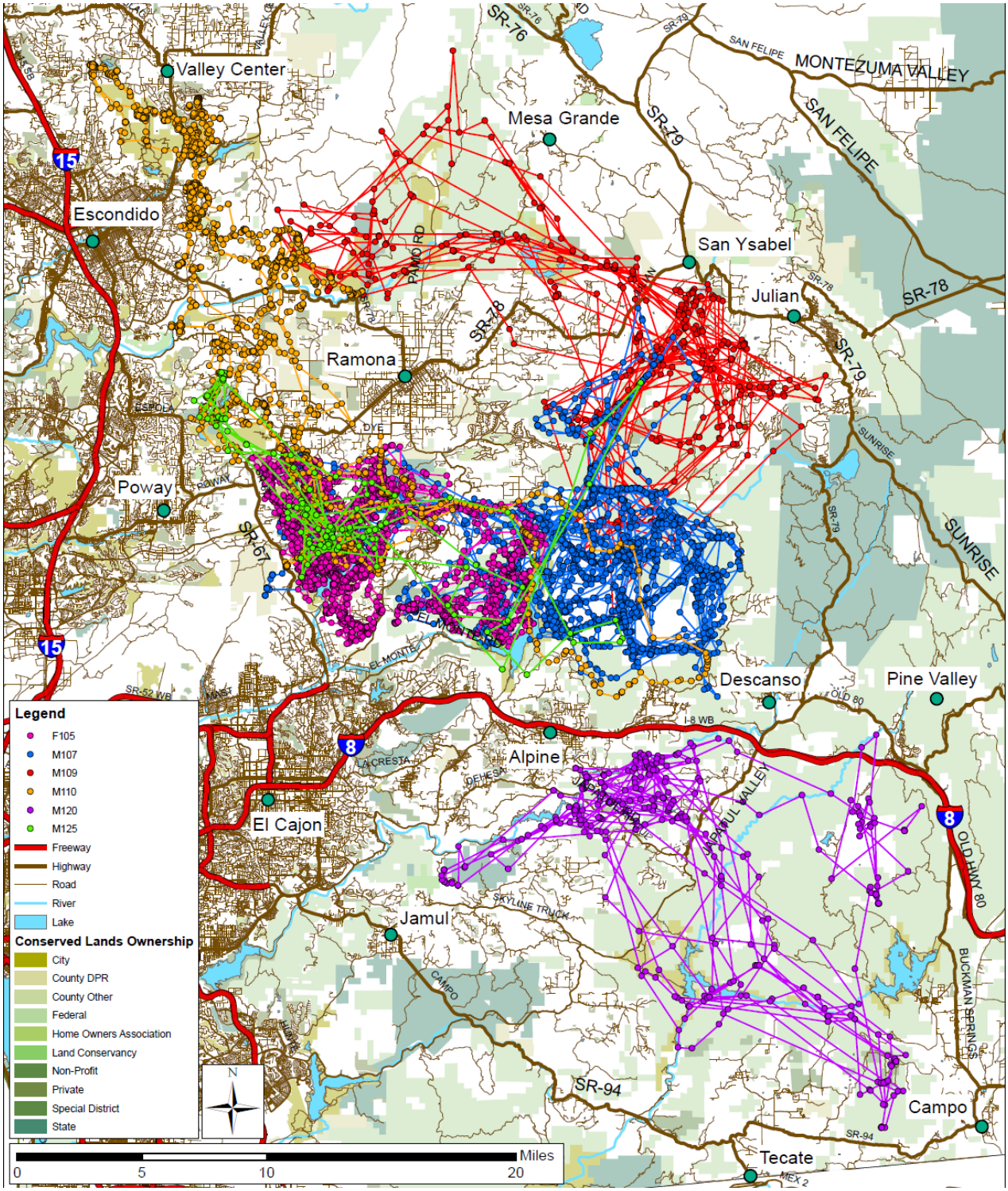


Figure 16. All mountain lion GPS points to date (current study and previous)(red dots) in relation to conserved lands and MSCP / MSHCP pre-approved mitigation / criteria lands (purple) in northern portion of current study area.

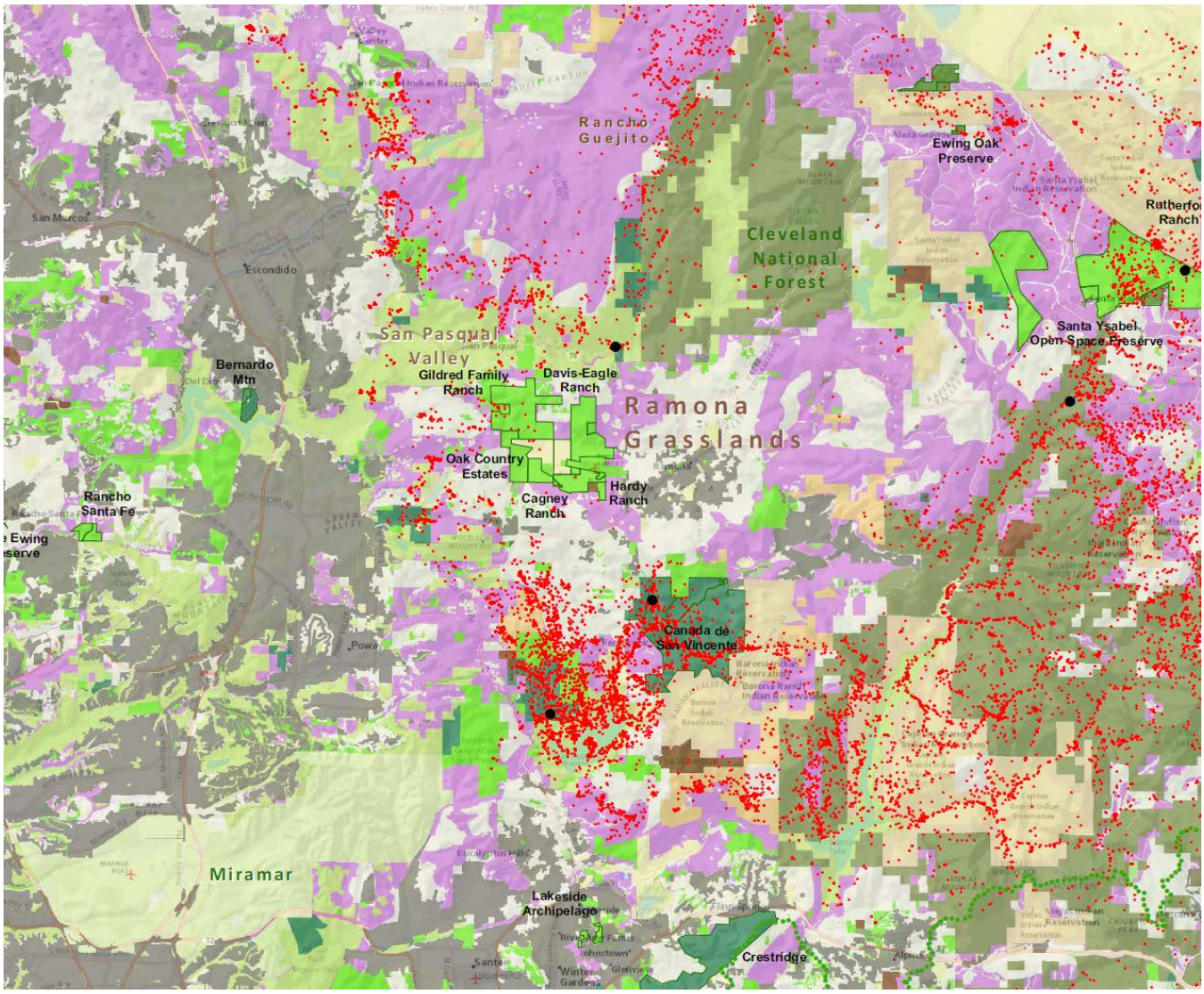
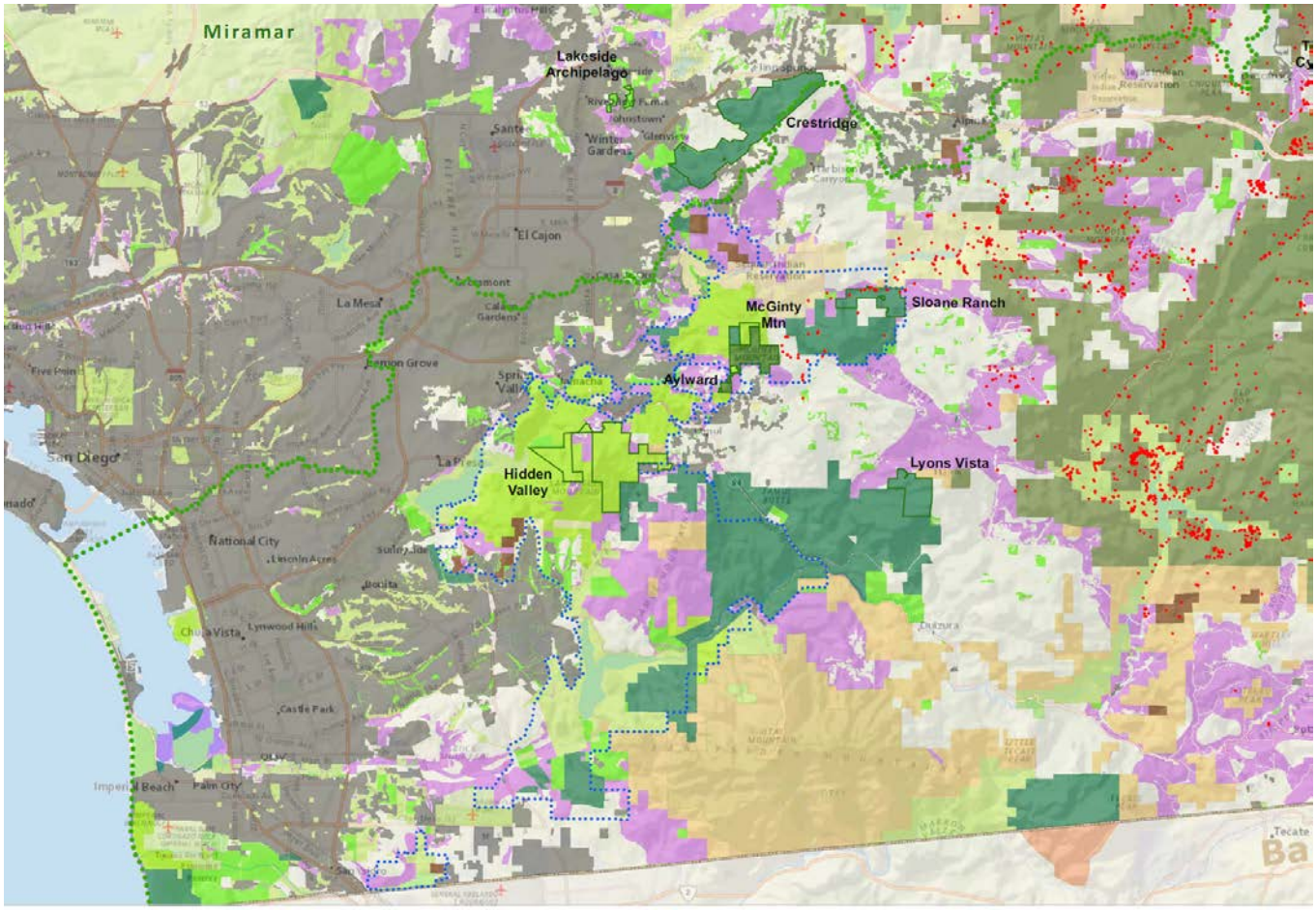


Figure 17. All mountain lion GPS points to date (current study and previous)(red dots) in relation to conserved lands and MSCP / MSHCP pre-approved mitigation / criteria lands (purple) in southern portion of current study area.




**Minimum convex polygon calculation:**

Minimum convex polygons (100% MCP's) were calculated for GPS-collared mountain lions in the current study as well as selected animals collared for the broader UCD regional study. Minimum convex polygons denote the general size of areas of use of individual animals, and are not intended to denote core home ranges. MCP's are often quite variable and animals that are dispersing, shifting home ranges, or ranging in desert areas are expected to have polygons that are larger than average.

Average MCP size for males collared in the current study (all apparently territorial males) was 536 square kilometers (207 square miles). F105 (the lone female GPS-collared during this study) had an MCP that was calculated as 188 square kilometers (73 square miles). The 100% MCP's calculated for several territorial males collared earlier in Cuyamaca Rancho State Park and circulating in that area of less fragmentation were somewhat smaller than those in the current study. two territorial males from the southern Santa Ana Mountains had MCP's that were approximately the same or slightly larger than the average of males in this study. Statistical comparisons could not be made due to low sample sizes.

Figure 18. 100% Minimum convex polygons for GPS-collared mountain lions in the current study as well as selected animals collared for the broader UCD regional study.

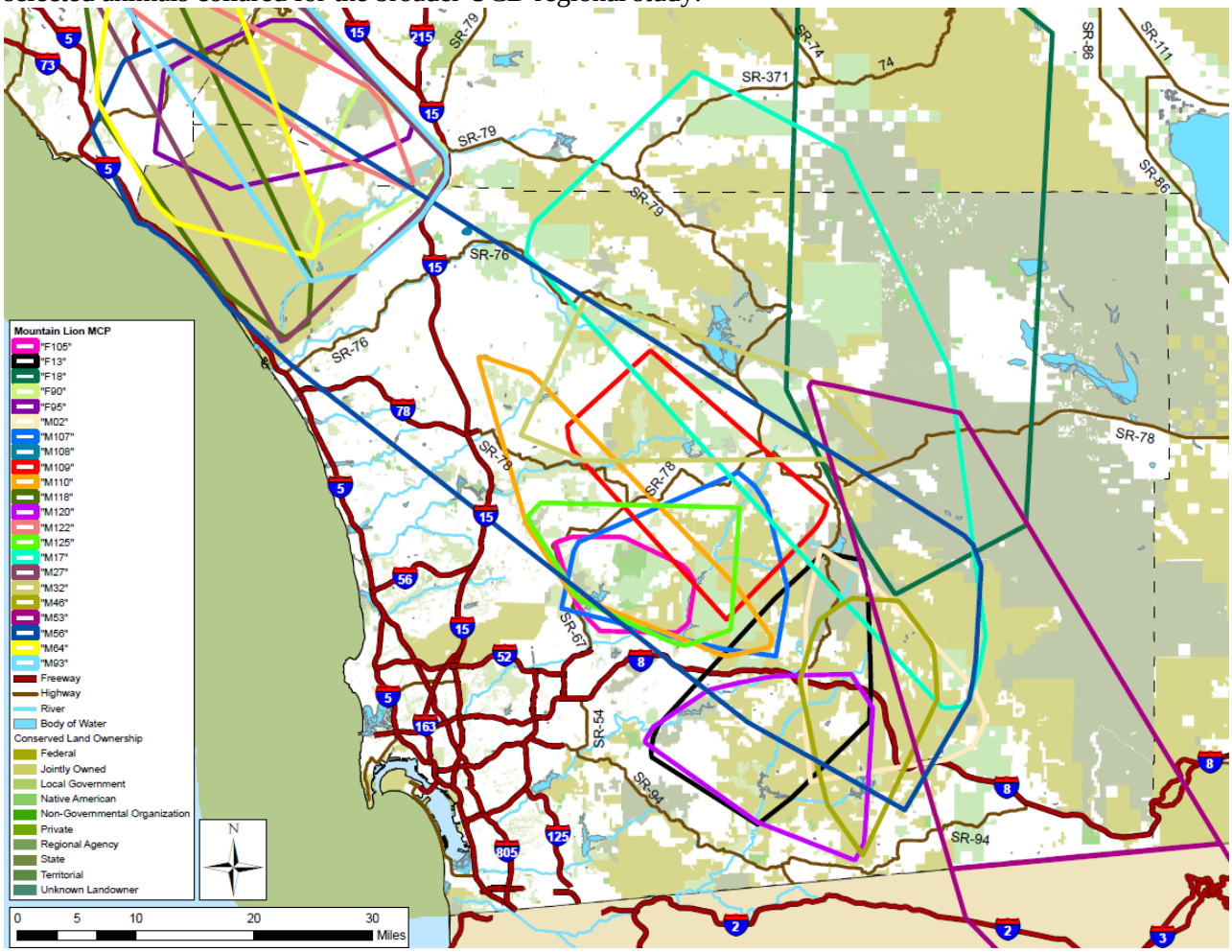



Table 3. Minimum convex polygon size for mountain lions GPS-collared in the current study and selected mountain lions previously GPS-collared in the region for comparison (current study animals highlighted yellow)

| Lion_ID | Area_sq_km | Area_sq_mi | Area_hactares |
|---|---|---|---|
| "F105" | 188 | 73 | 18825 |
| "F13" | 645 | 249 | 64530 |
| "F18" | 2783 | 1074 | 278275 |
| "F90" | 227 | 88 | 22668 |
| "F95" | 541 | 209 | 54110 |
| "M02" | 504 | 194 | 50360 |
| "M107" | 508 | 196 | 50836 |
| "M109" | 631 | 244 | 63128 |
| "M110" | 623 | 241 | 62326 |
| "M118" | 817 | 315 | 81691 |
| "M120" | 512 | 198 | 51216 |
| "M122" | 369 | 143 | 36943 |
| "M125" | 407 | 157 | 40728 |
| "M17" | 2645 | 1021 | 264459 |
| "M27" | 1665 | 643 | 166530 |
| "M32" | 672 | 259 | 67188 |
| "M46" | 429 | 166 | 42866 |
| "M53" | 3534 | 1364 | 353361 |
| "M56" | 4370 | 1687 | 436979 |
| "M64" | 757 | 292 | 75700 |
| "M93" | 1361 | 525 | 136054 |

**Mountain lion mortalities recorded in the county during the study period:**

As mentioned previously, both M107 and M110 died as the result of vehicle strikes, and F105 and M109 were likely also suffered vehicle-induced trauma. M120, had a "near-miss" when he depredated a domestic animal (turkey) but was not killed on a depredation permit. In addition to these 2 mortalities of collared mountain lions during the study period, another collared mountain lion from the broader UCD study was killed in the Rainbow area on a depredation permit, and 1 died of disease (coccidioidomycosis or "Valley fever", a disease caused by a soil-borne fungal organism).

CDFW and UCD records also confirmed that another 9 un-collared mountain lions were killed in the county secondary to human interactions during the same 2 year period (4 from vehicle strikes, and 5 secondary to depredation permits).

This brings the total for the 2 year period to 13 confirmed mortalities, and 3 likely near misses, during the period May 2012- June 2014 (Figures 19 – 21). Overall, vehicles accounted for 6 of the 13 mortalities, and 6 were secondary to depredation permits. The one death from disease likely would not have been detected if that animal had not been GPS-collared. Based on previous data from the broader UCD mountain lion study, it is expected that other mortalities occurred during the period from other causes but went undetected.

Figure 19. Locations of all mountain lions recorded by CDFW as killed secondary to depredation permits during the study period May 2012-June 2014. M120 depredation site also noted.

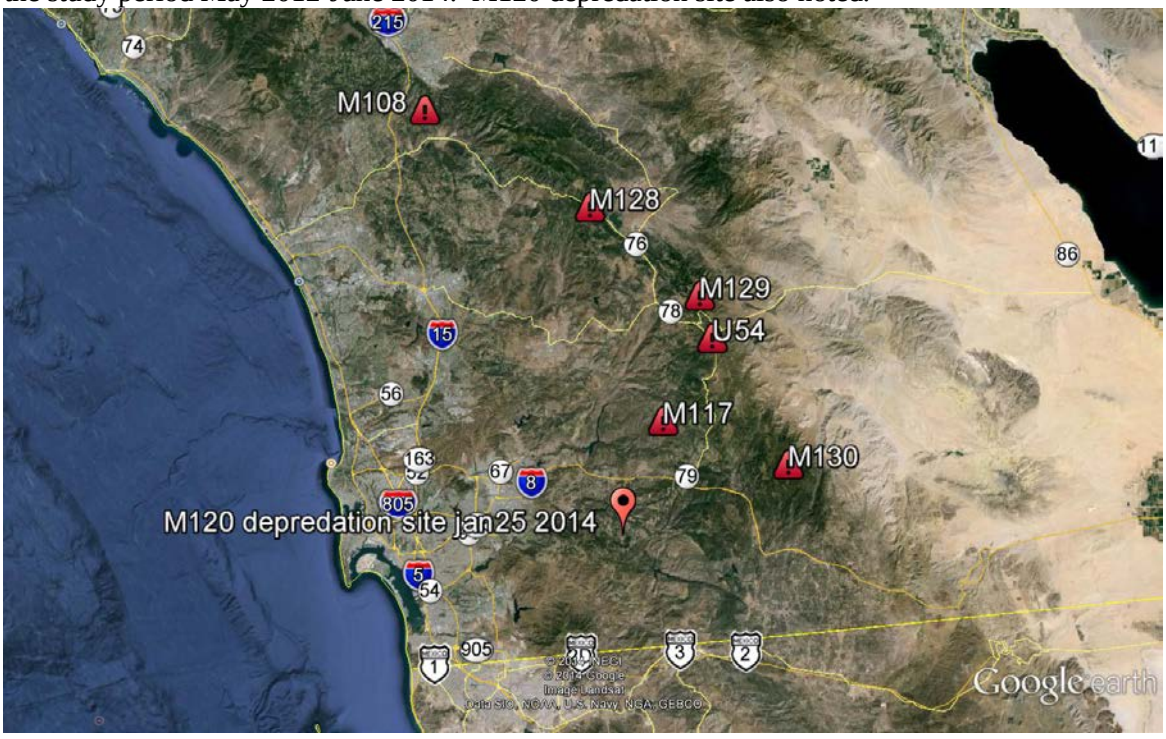


Figure 20. Locations of all vehicle-related mortalities recorded by CDFW during the current study period (May 2012 – June 2014).

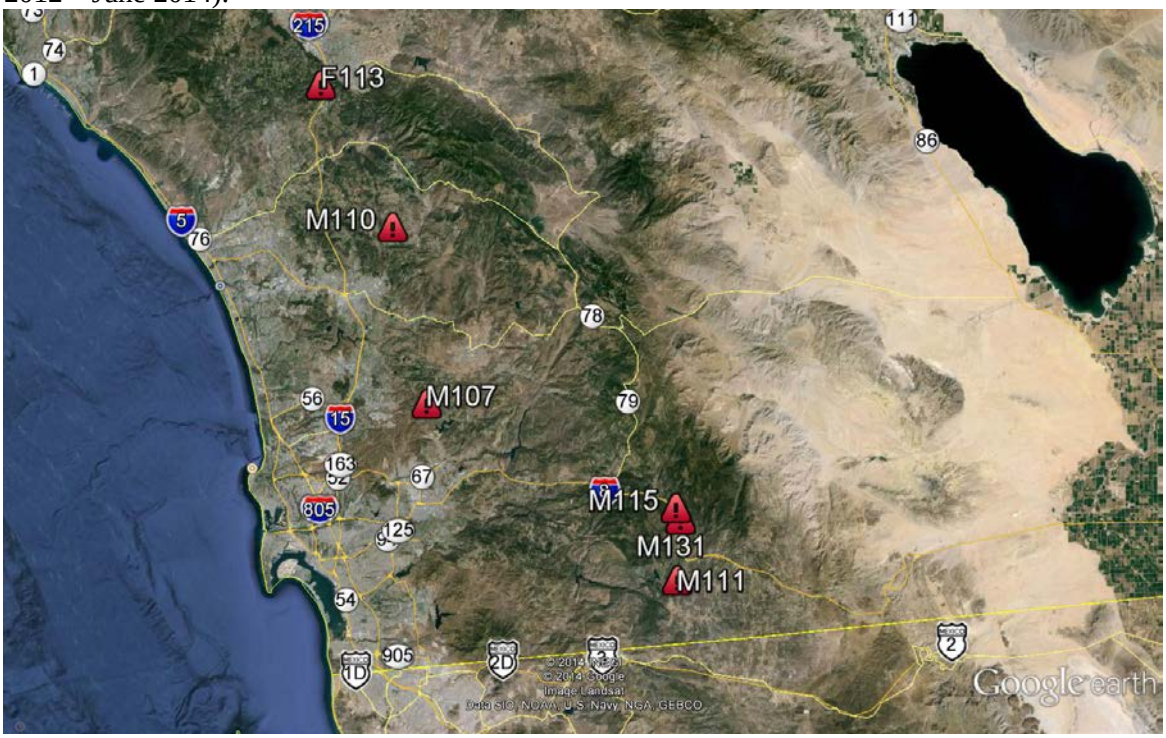



Figure 21. All mortalities recorded by CDFW during the current study period. Red circles denote dispersal age or pre-disperal animals. These animals are the primary gene dispersers in the population.

**Historical vehicle-related mountain lion mortalities:**

Twenty eight years of historical vehicle-related mortality data from the study area that was provided by CDFW biologist Randy Botta (Figure 22) suggests that mortalities have occurred county-wide and in a somewhat random-seeming pattern over the years, but there are a few highway sections where mortalities have been more common. I-8 from the SR 79 junction east to approximately Buckman Springs Road appears to have the highest mortality rate per mile of highway in the county. Highway sections that have a history of mortalities, and that cross linkages, are of greatest concern. These include Highways 94, 67, and 78. Also (not shown in Figure 22), I-15 near Temecula.

It is notable that only one mountain lion has been killed west of I-15 and south of Highway 78 in the last 10 years (M103, a dispersal age male, in 2011). Given levels of mortality elsewhere in the county over that time period, this supports the hypothesis that though Core areas 8 - 11 have had confirmed mountain lion presence periodically over the years, frequency of use is likely relatively low. In addition, M103's genetic analysis suggests that he originated from the northern Santa Ana Mountains. So his most likely pathway to his mortality site in Core 10 (Black Mountain area) on Carmel Valley Road, and whether he crossed I-15 to the east and then crossed back to the west is unknown. The most recent mortality in that area prior to M103's death was an illegal killing in Penasquitos Canyon nearly 20 years before.

Figure 22. Mountain lion vehicle-related mortalities recorded by CDFW over the last 28 years in the current study area and adjacent regions. Depredation permit-related mortalities were also scattered in the county, but tended to concentrate most heavily down the Hwy 79 corridor from the Julian area to the Descanso area.

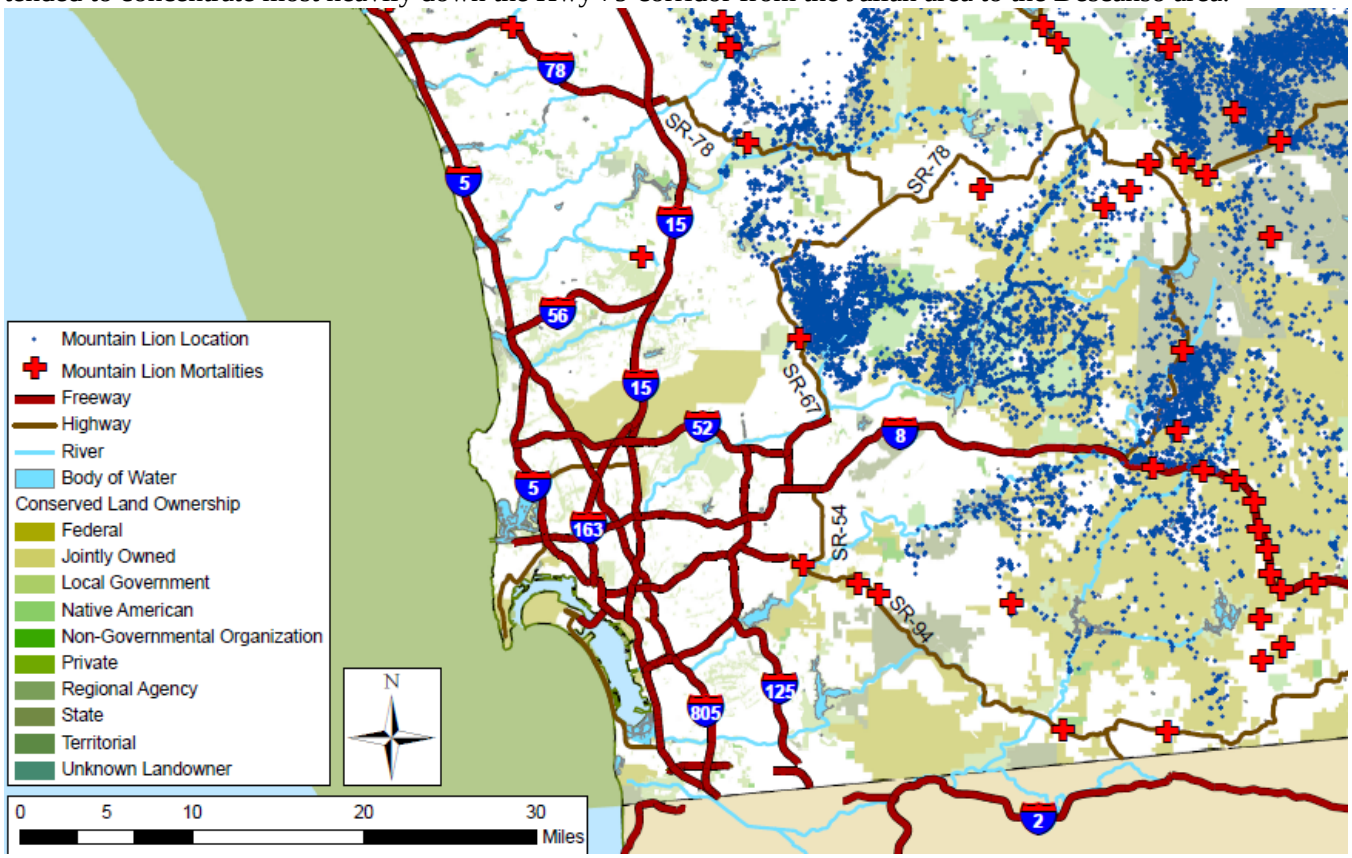
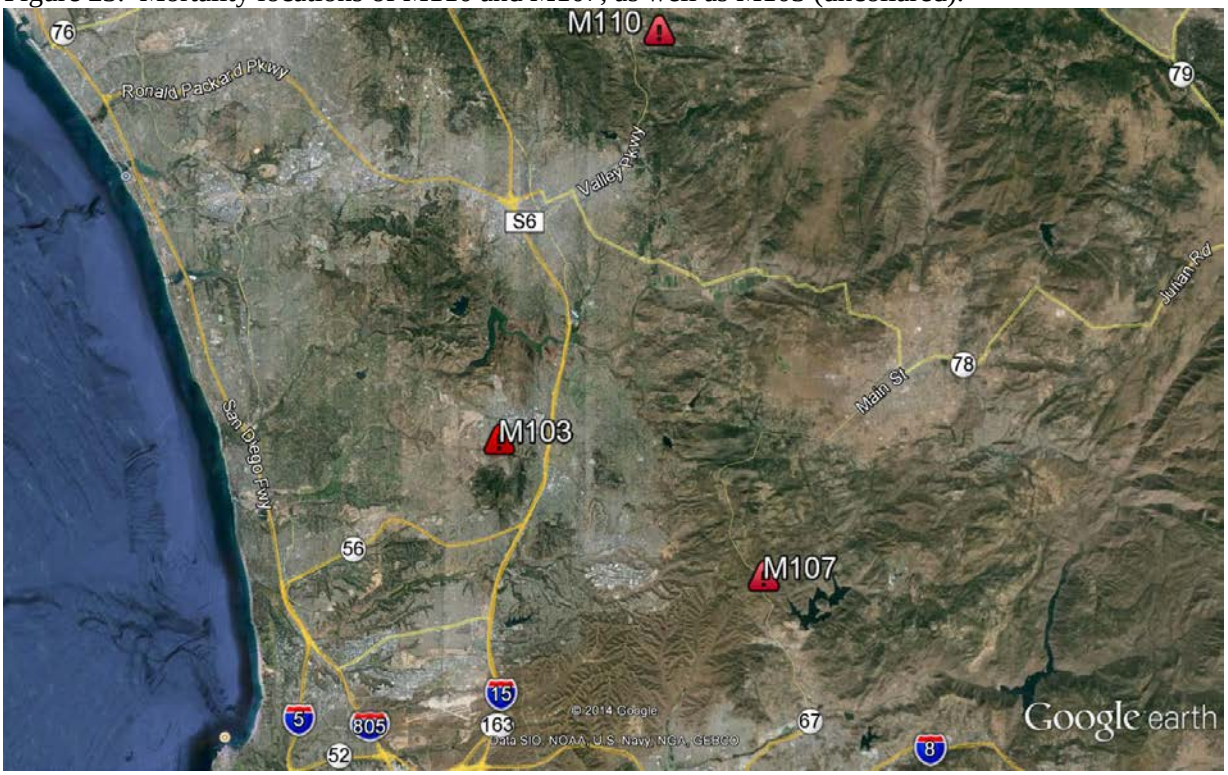


Figure 23. Mortality locations of M110 and M107, as well as M103 (uncollared).




***Task 4 - Data Entry and Quality Control***

*The raw GPS data will be entered into an Excel database containing all information collected by the GPS collars. Data from the ongoing UCD WHC mountain lion study is currently curated by Brian Cohen of the San Diego office of The Nature Conservancy (TNC). The UCD WHC team will work with TNC to assure quality control of the data. For each collared animal, all attributes associated with that animal (e.g. age, sex, other samples collected, etc.) will be included in a separate Excel sheet that will also be included in reports in Task 5.*

**Activity to date:**

GPS data from all 6 GPS collars is being accumulated in an excel database after examination for quality control and removal of any datapoints that are not reliable. This database will be provided in its entirety to the SANDAG SDMMP after full downloads of all GPS collars. To date, all of F105's, M107's, and M110's datapoints have been provided, along with the more limited data that is directly accessible from the Lotek website from the satellite uploads from M109, M120, and M125.

***Discussion:***

Connectivity between conserved lands for mountain lions, as with many other species, is dependent on both physical and behavioral factors. They include physical impediments to movement (such as busy highways), the effects of noise, light, and activity around any kind of human development, and the attractiveness of the habitat (ie containing favored cover and prey) both within a corridor and on either end.

Adequate or "good" connectivity also requires definition – does the movement and successful breeding of one animal per generation suffice, or is regular movement as part of territorial circulation required? Connectivity also implies movement between habitat patches without incurring substantial risk. Mortalities from vehicle strikes are the number one cause of death in the UC Davis southern California cougar study to date, and caused mortality of 2 (33%) of collared mountain lions in this study, as well as likely injury to at least 1 other collared study lion. The number of crossings of busy (as well as minor) roads recorded in our data is a concern.

Linkages in the current study area that have confirmed mountain lion use are relatively narrow (on mountain lion scales), absolutely required crossing busy roads regularly in order to circulate in a normal territory, and / or require movement through fragmented habitat. All of these factors increase risk during routine movement when compared to movement through larger areas of unbroken habitat.

In the course of this project, the UCD team has found evidence of regular use of some conserved cores and linkages and not others. Lack of evidence does not preclude the possibility that these cores and corridors are used to some degree by mountain lions. "Temporary emptying" of one or more mountain lion territories can occur due to mortalities. The 13 mountain lion mortalities recorded in San Diego County is confirmation that some areas normally occupied by mountain lions may have been unoccupied during our assessment. However, on balance we feel that we GPS-collared the majority of the mountain lions circulating regularly in the study area.

The UCD team feels that because virtually all the linkages between cores are bisected by busy highways, that all linkages that had demonstrated current use by mountain lions are at significant risk of further degradation and possible severing over the medium to long term. Road expansions, steadily increasing traffic, and rural / peri-urban development all have the potential to precipitate this degradation. Road expansions provide an opportunity to improve crossing structures and place funneling fencing to direct animals to safe crossing points. Rural and peri-urban development in fragmented corridors can be managed via various means (conservation purchases, easements, development restrictions, etc) and should be a high priority.

In other locations within the broader UCD mountain lion project area, genetic and movement data show that connectivity has been severely degraded. The Santa Ana Mountain population of mountain lions in

San Diego, Riverside, and Orange Counties shows significant genetic separation from populations to the east, and only one GPS-collared mountain lion has crossed I-15 (west to east crossing) during the 13 years of the study, and there is similar genetic evidence of crossings east to west being rare. Likewise, no GPS-collared mountain lions have crossed the 91 Freeway into the Chino Hills, and camera monitoring has also failed to document any crossings over the last 4 years (CDFW – personal communication). Further study of the genetic connectivity between other conserved lands in San Diego County and habitat to the north is the subject of a pending study proposal.

Besides the apparent barriers noted earlier in the core study area, it is also noteworthy that M110 did not cross Cougar Pass Road west of Turner Lake even though M56, a puma collared in the Santa Ana Mountains, had crossed that road going southeast after dispersing from Orange County (Figures 10, 13, 15). That road may also be a barrier at that location, especially for animals traveling northwest toward I-15.

All 4 animals captured in the spring of 2013 suffered lethal (M107, M110) or sublethal (F105, M109) trauma and injury during the year since their initial collarings. Vehicles are confirmed or are the highest-likelihood source of the trauma for all 4. It is also notable that since capture, M120 killed a domestic animal (turkey) that could have resulted in his death on a depredation permit. Fortunately, the owner of the turkey took responsibility for his lack of proper protective housing in mountain lion habitat and did not request a permit. Otherwise, it is likely that the mortality rate in this study would have been higher.

These data from this study, and the broader UCD regional study, graphically illustrate the primary hazards that our team has determined face mountain lions in the San Diego County (and broader regional) landscape. Our findings that vehicle strikes and depredation permits, both tightly linked to human development, are the most prominent causes of death, as well as movement disruption, emphasize the need for concerted conservation measures. The fact that annual survival rates of mountain lions in San Diego County are as low as in heavily hunted populations should spur concern and action. Genetics analysis data we have presented should do the same.

South of I-8, Highway 94 could not be assessed as vigorously as highways to the north due to lack of crossing by the currently collared cougar in the area (M120). However, previous cougar movement and road mortality data suggest that this highway poses some risk to cougar connectivity and is a cause of periodic vehicle mortality. Also, habitat in the study area south of I-8 shifts some in character toward less suitable habitat for mountain lions (more open) and is also fractured by rural and peri-urban patterns of development. Mountain lion mortality records also suggest moderate levels of mortality of mountain lions south of I-8 due to depredation permits and other human-related mortality sources. Overall, our camera and baiting data suggests less common mountain lion presence in the study area south of I-8 when compared to north of I-8 during the study period. Since the collaring of M120 in November, 2013, photos of other mountain lions have only been taken in the entire study area to the south of I-8 on

1 occasion (January 2014), supporting the view that mountain lion activity in that area is relatively low at this time.

Camera data from this study suggests that long term monitoring with trail cameras placed in well-chosen locations can be a valid method for detecting mountain lion use of conserved areas and / or linkages over time, and can suggest relative frequency of use. Comparison of current collar data with data from cameras monitoring larger wildlife crossing structures in the area suggests that monitoring of crossing structures may or may not be an effective method to detect mountain lion movement across roads and through linkages if opportunities exist or behavioral tendencies lead to mountain lions crossing roads at grade instead of through structures. This will continue to be the case in the absence of construction of exclusionary fencing that will funnel mountain lions to safe crossing structures (existing or new).

***Recommendations:***

The UCD team believes that data to date suggests that conservation prioritization should be given to expansion of existing cores and linkages to the extent possible, conservation of additional lands on the approaches to crossings that are indicated by our data, and modification of road crossings in those areas to increase safe crossing opportunities and funnel animals to them with appropriate fencing.

It is important to note that the linkages assessed in this study were almost all bisected by busy roads, and / or fragmented. Fragmentation alone presents elevated risks to mountain lions from other human interactions that are independent of risks posed by the highway crossings.

Continued close monitoring of mortalities recorded in the area by CDFW can help track mortality trends. Long term camera monitoring of key linkages and cores in areas shown to be frequented by mountain lions in this study can provide information about relative frequency of use over time and be a rough gauge of population stability.

As in this study, camera monitoring, accumulation of GPS-collar data from additional animals, use of genetic data (previous and new samples) to construct pedigrees and conduct landscape genetics modeling, and corridor modeling based on GPS data, can all help inform conservation actions in the critically important (to mountain lions) northwest portion of San Diego County (Figures 24 – 28). Good conserved linkages and core areas in the eastern approaches to potential I-15 crossing points between Temecula and Escondido are critical for mountain lion genetic health in the Santa Ana Mountains. That area should have a high priority conservation focus in our opinion.

Figure 24. Data points from current study animals, as well as selected animals from the broader UCD mountain lion study. The area of highest focus (and likely containing the only remaining viable linkages) for mountain lion connectivity across I-15 is circled in red.

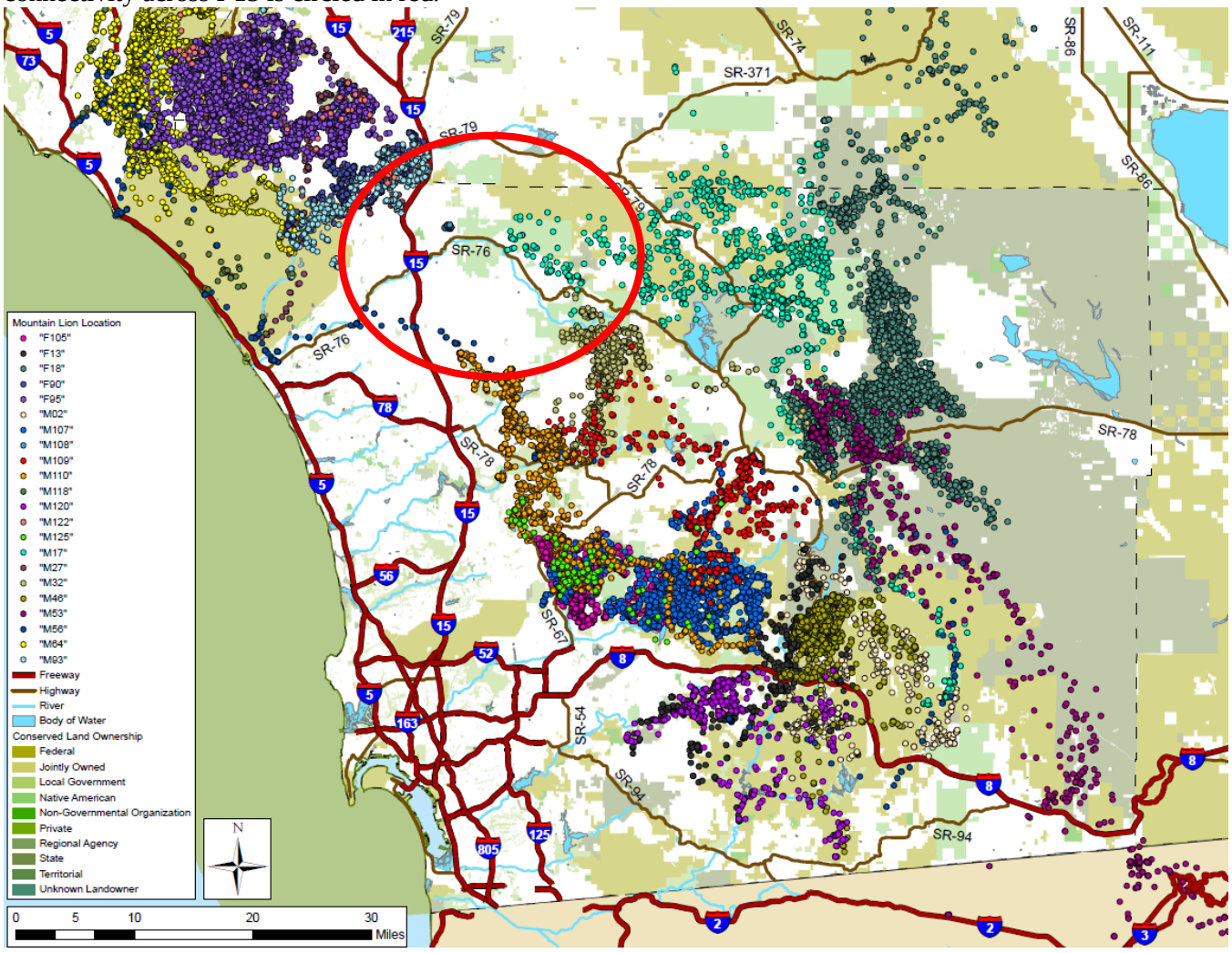


Figure 25. A closer view of the area denoted in Figure 24.

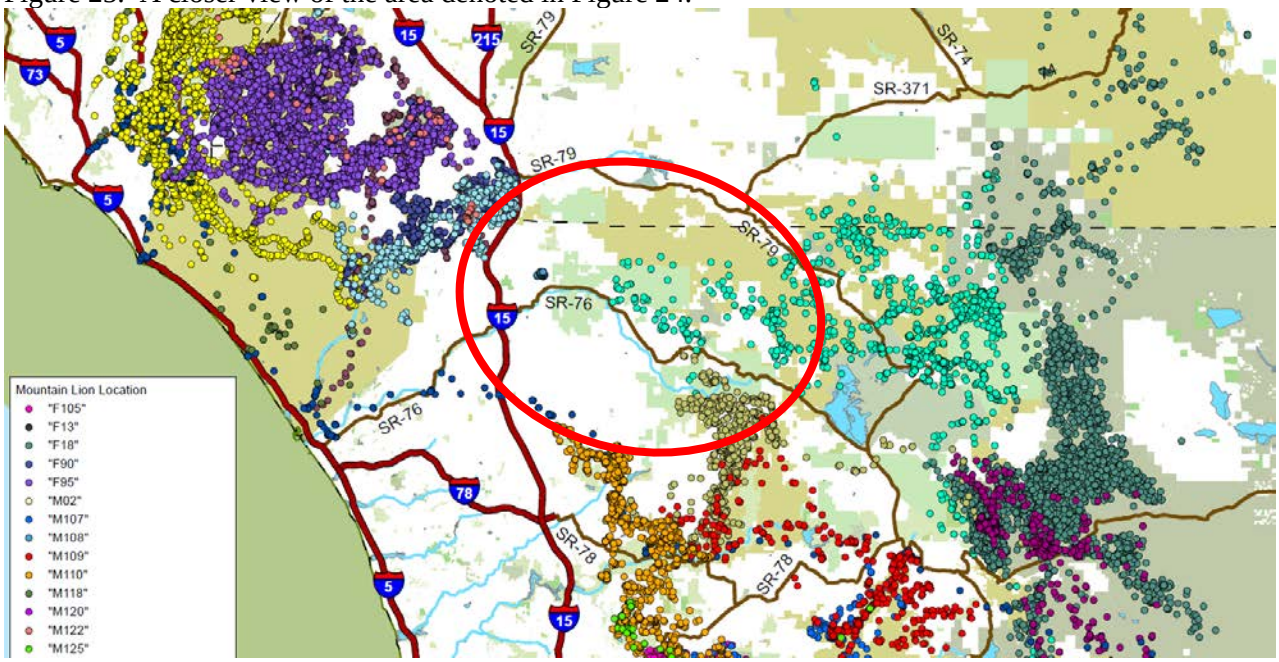



Figure 26. All mountain lion GPS points to date (current study and previous)(red dots) in relation to conserved lands and MSCP / MSHCP pre-approved mitigation / criteria lands (purple) in NW San Diego County

/

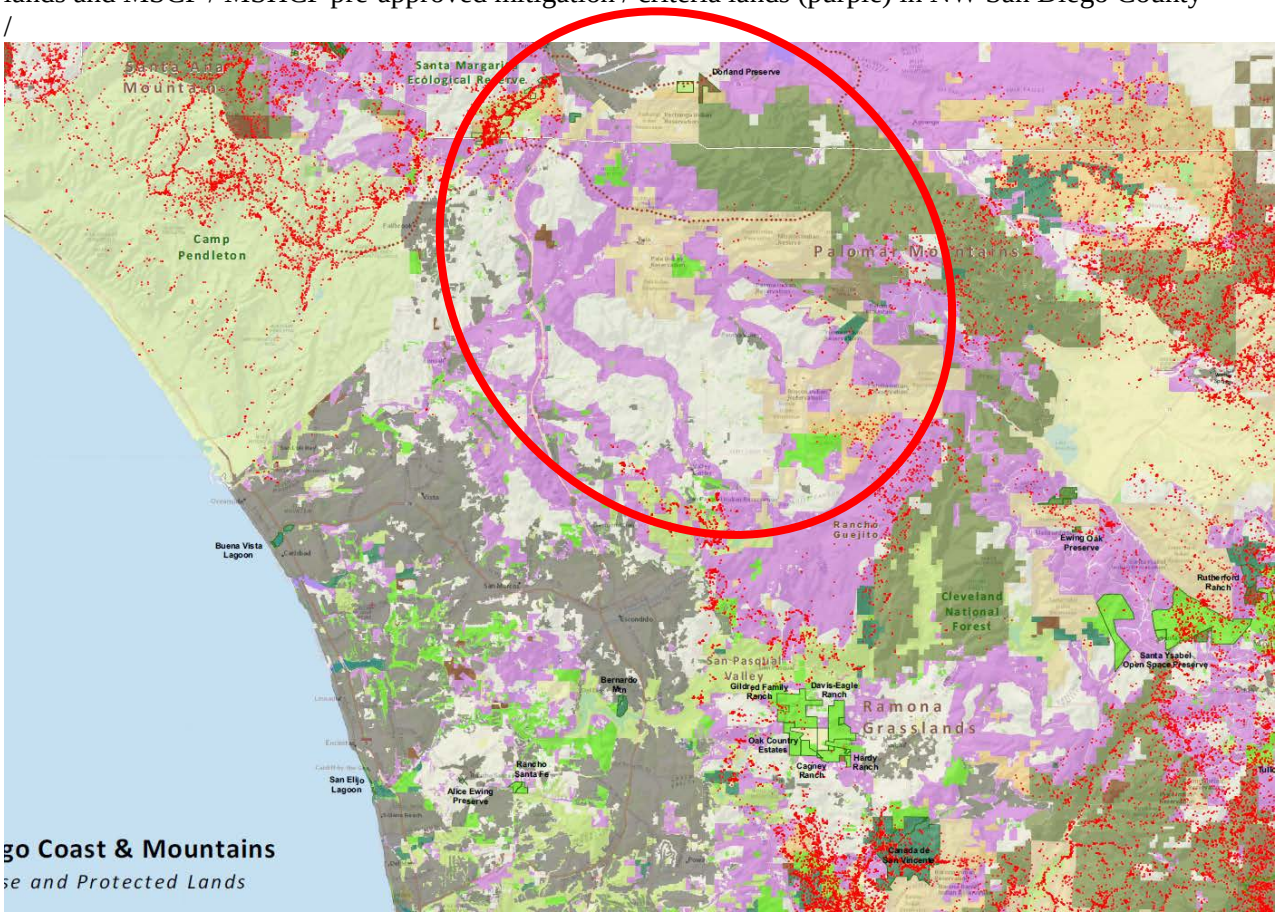


Figure 27. All mountain lion GPS points to date (current study and previous)(red dots) in relation to conserved lands and MSCP / MSHCP pre-approved mitigation / criteria lands (purple) in NW San Diego County and SW Riverside County. Note "datapoint pile-up" against the western side of I-15 at Temecula Creek bridge and to the south.

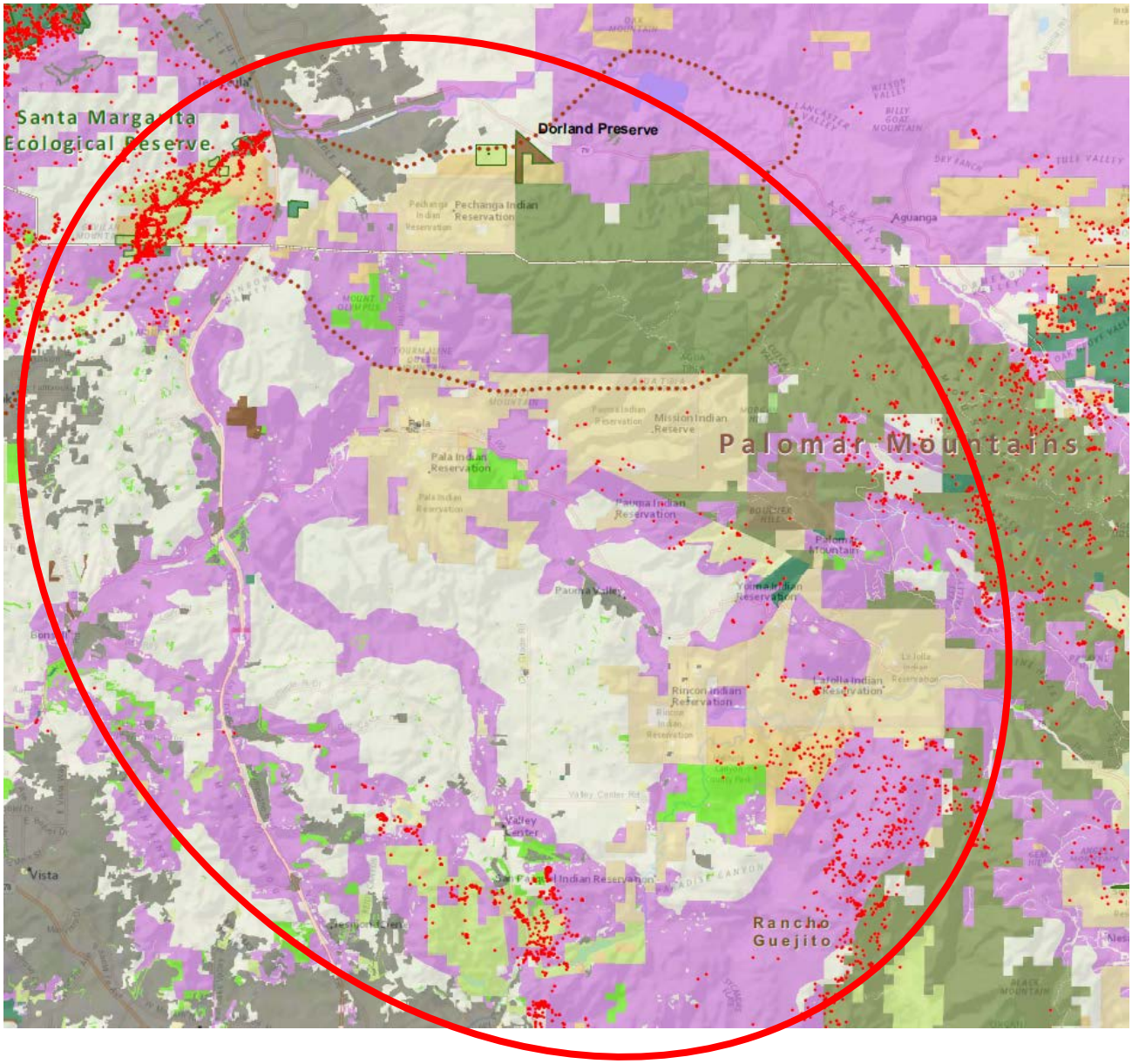
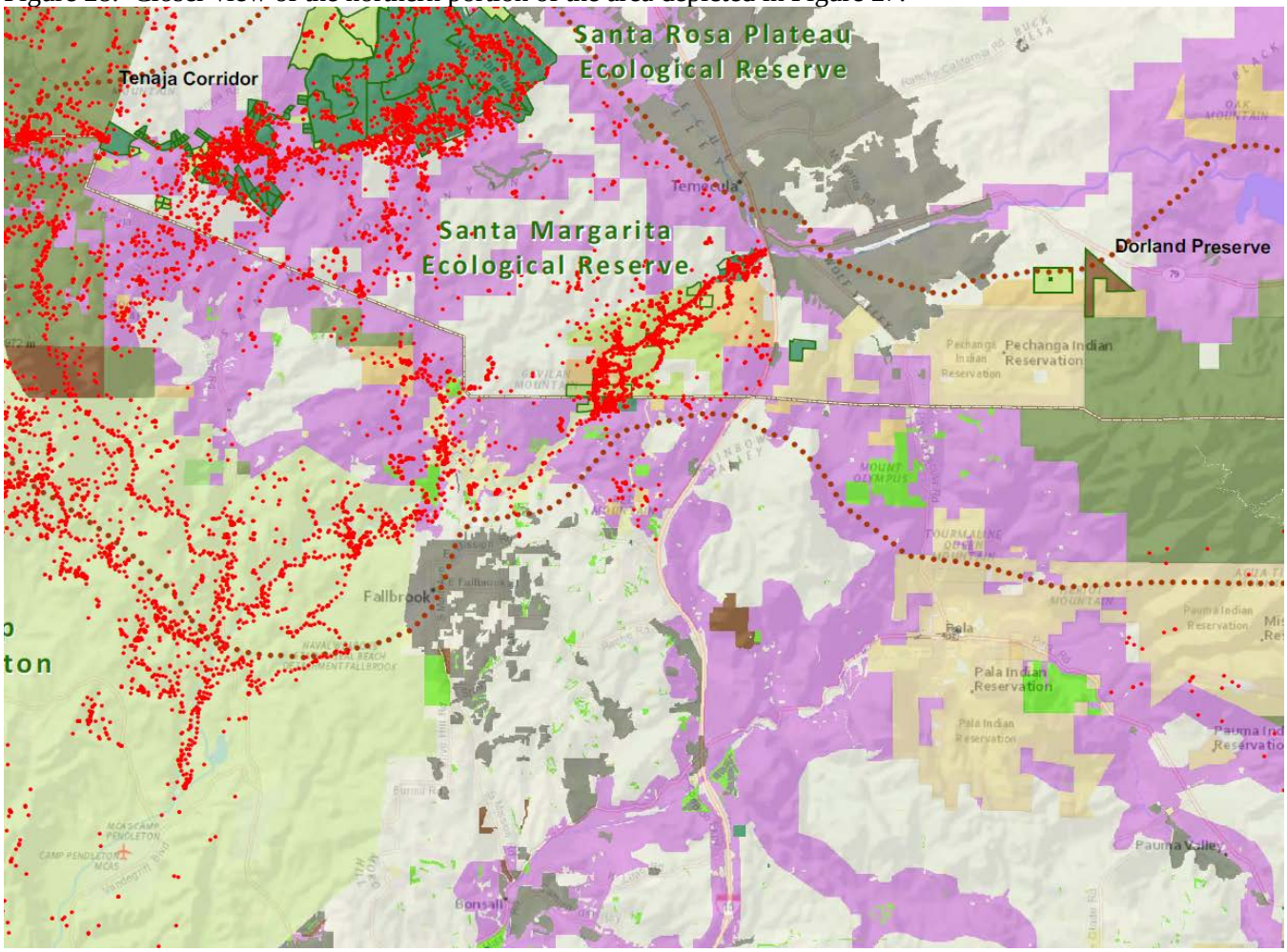


Figure 28. Closer view of the northern portion of the area depicted in Figure 27.



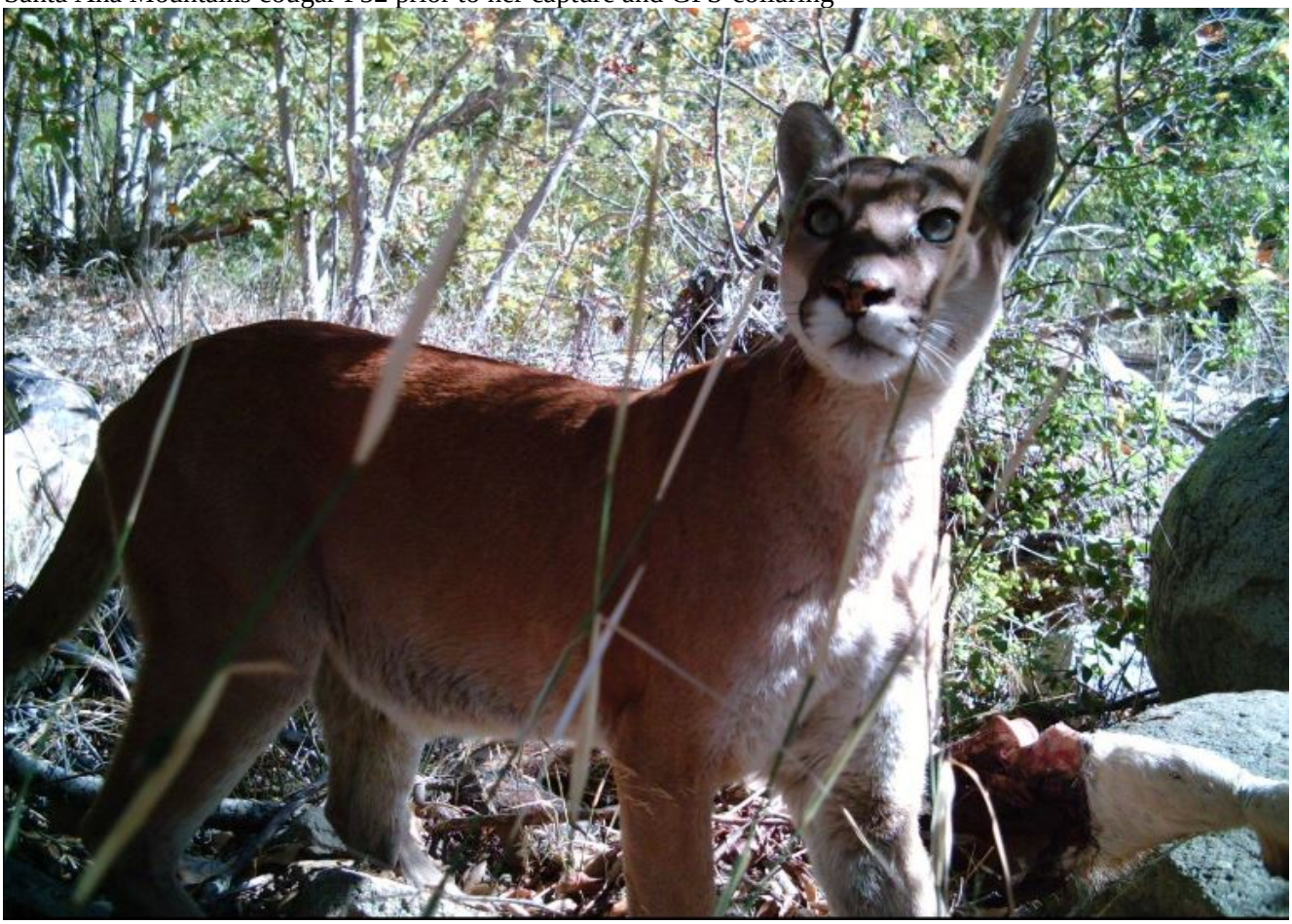

The primary "designated linkage" between the Palomar and Santa Ana Mountains is in southern Riverside County just across the county line from San Diego County, however this linkage is significantly degraded and development proposals are under consideration at the City of Temecula that would further degrade it. The need for enhancing linkages across I-15 and approaches to those linkages is significant, and not limited to Riverside County.

Mountain lions on the west side of I-15 that are genetically isolated and likely deteriorating in their genetic status circulate in all 3 counties (San Diego, Riverside, and Orange), and all 3 counties have an equal stake in preserving the health of that population. Loss or decline of that sub population secondary to genetic, demographic, stochastic, or other factors will deprive that important ecosystem of the services of its primary top-down regulator. As a "natural experiment" in biodiversity / ecosystem shift it would be interesting if mountain lion populations trended toward local extirpation, but is not an experiment most ecologists and conservationists would want to conduct. Decline of that population of

this iconic predator, if partially due to connectivity loss, would be a significant defeat for the MSCP/MSHCP process as carried out in this region.

While options for conservation of additional lands on approaches to 1-15 on both sides of the freeway exist, as well as options to enhance crossing structures and erect directional fencing, we feel that it is important for efforts to be significantly increased. Multiple species can benefit from conservation and crossing enhancements in this area, and in our opinion the area should get high priority for conservation efforts.

Santa Ana Mountains cougar F52 prior to her capture and GPS-collaring



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Randy Botta of CDFW for assistance and access to mortality data. We also thank The Nature Conservancy office in San Diego and other supporters for their monetary contributions to the broader southern California mountain lion project that has provided the necessary equipment to successfully carry out this effort. We appreciate the cooperation of all of the land managers for the California Dept. of Fish and Wildlife, US Fish and Wildlife Service, US Forest Service, US Bureau of Land Management, San Diego County, the City of San Diego, Sweetwater Authority, the Endangered Habitats League, and others for their cooperation. Finally, we want to thank the San Diego County Association of Governments for providing primary support for this project.

References:

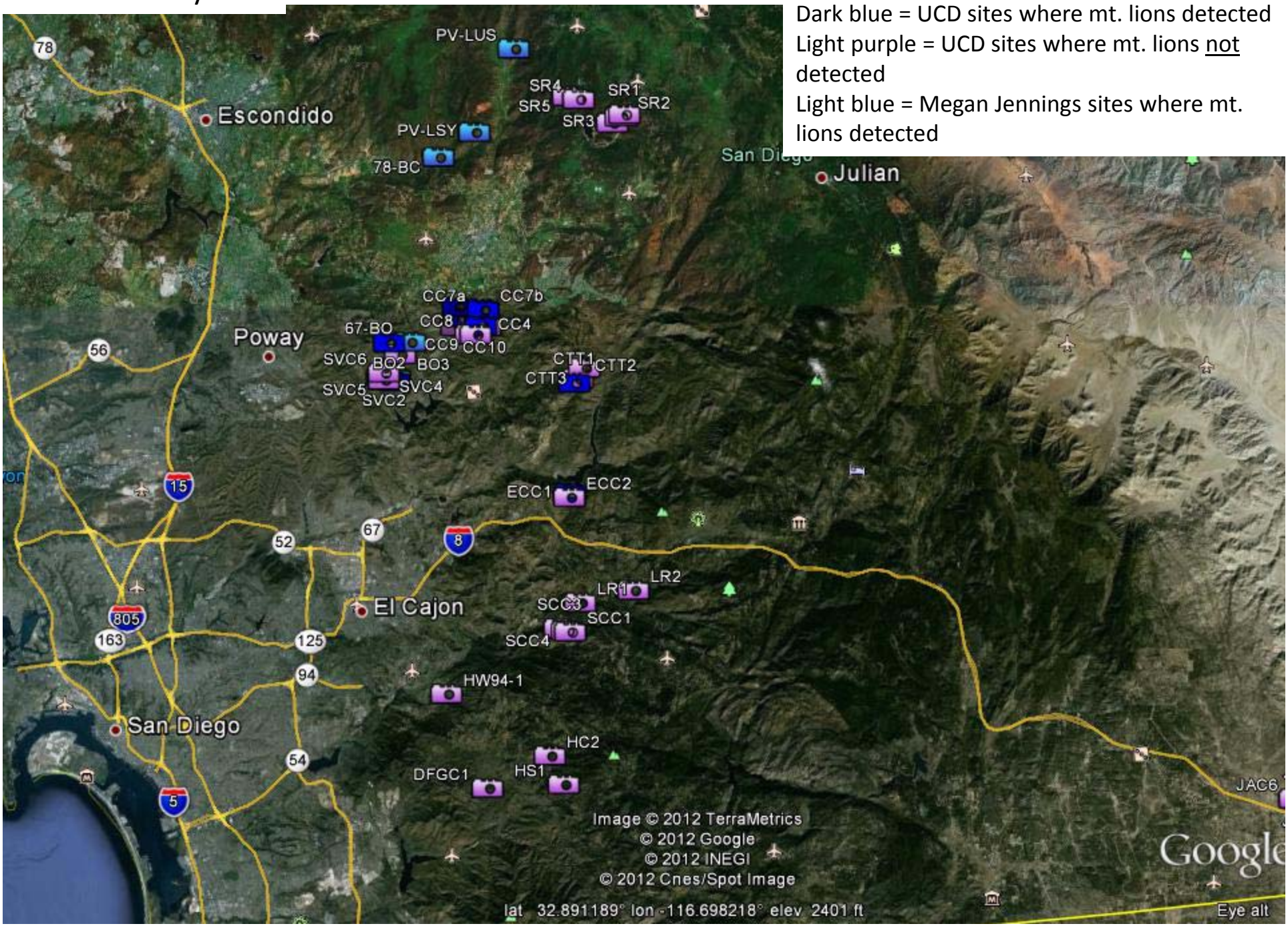
Sweanor LL, Logan KA, Boyce WM. 2005. Final report for Interagency Agreement No. C0043050 (Southern California Ecosystem Health Project) between California State Parks and the UC Davis Wildlife Health Center

Sweanor LL, Logan KA, Bauer JW, Millsap B, Boyce WM. 2008. Puma and human spatial and temporal use of a popular California state park. Journal of Wildlife Management, 72: 1076-1084.

Burdett CL, Crooks KR,Theobald DM, Wilson K, Boydston E, Lyren L, Fisher R, Vickers W, Morrison S, Boyce WM. 2010. Interfacing of wildlife habitat and human development to predict the future distribution of puma habitat. Ecosphere, 1(1): 4. 230.

| Site Name | General area | Mountain Lion | Bobcat | Coyote | Deer | Feral Pig | Fox | Striped Skunk | Spotted Skunk | Opossum | Raccoon | Ringtail | Ground Squirrel | Gray Squirrel | Woodrat | Mouse | Cottontail | Brush rabbit | Jackrabbit | Quail | Turkey | Other bird | Other animals | Dog | Cat | Human on foot | Mtn Biker | Equestrian | Vehicle | Total camera nights |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BL1 | Barrett Lake 1 | 2 | 1 | 10 | 121 | 0 | 4 | 9 | 0 | 15 | 24 | 1 | 0 | 0 | 0 | 0 | 58 | 0 | 0 | 1 | 11 | 1 | 4 | 0 | 0 | 2 | 0 | 0 | 0 | 139 |
| BO1 | Boulder Oaks | 4 | 0 | 3 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 433 |
| BO2 | Boulder Oaks | 6 | 0 | 8 | 35 | 0 | 77 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 160 | 0 | 19 | 0 | 3 | 0 | 0 | 0 | 533 |
| BO3 | Boulder Oaks | 9 | 34 | 73 | 95 | 0 | 47 | 1 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 19 | 0 | 0 | 4 | 1 | 6 | 0 | 19 | 0 | 21 | 2 | 6 | 85 | 562 |
| CC1 | Canada de San Vicente | 0 | 15 | 0 | 45 | 0 | 0 | 4 | 0 | 6 | 0 | 0 | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 8 | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 448 |
| CC2 | Canada de San Vicente | 13 | 20 | 12 | 143 | 0 | 2 | 18 | 0 | 14 | 8 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 4 | 1 | 0 | 1 | 0 | 6 | 0 | 0 | 0 | 652 |
| CC3 | Canada de San Vicente | 2 | 4 | 6 | 519 | 0 | 34 | 8 | 0 | 86 | 0 | 0 | 191 | 0 | 0 | 0 | 3 | 0 | 2 | 112 | 35 | 16 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 701 |
| CC4 | Canada de San Vicente | 6 | 53 | 501 | 198 | 0 | 0 | 1 | 0 | 1 | 2 | 0 | 201 | 0 | 0 | 0 | 33 | 0 | 0 | 365 | 582 | 67 | 0 | 2 | 0 | 19 | 0 | 0 | 242 | 691 |
| CC7a | Canada de San Vicente | 4 | 23 | 21 | 5 | 0 | 0 | 1 | 0 | 14 | 2 | 1 | 43 | 0 | 0 | 0 | 79 | 0 | 0 | 21 | 1 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 197 |
| CC7b | Canada de San Vicente | 5 | 6 | 18 | 25 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 3 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 16 | 386 | 1 | 4 | 0 | 133 | 0 | 0 | 54 | 658 |
| CC8 | Canada de San Vicente | 1 | 6 | 3 | 54 | 0 | 1 | 2 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 471 |
| CC9 | Canada de San Vicente | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CC10 | Canada de San Vicente | 0 | 0 | 1 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22 |
| CER1 | Crestridge Ecological Reserve | 0 | 15 | 1086 | 2 | 0 | 54 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 9 | 0 | 0 | 0 | 0 | 34 | 0 | 31 | 0 | 11 | 5 | 0 | 1 | 343 |
| CER2 | Crestridge Ecological Reserve | 0 | 0 | 455 | 8 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 85 | 0 | 1 | 1 | 0 | 13 | 2 | 26 | 0 | 4 | 1 | 0 | 0 | 307 |
| CER3 | Crestridge Ecological Reserve | 0 | 9 | 29 | 0 | 0 | 91 | 9 | 1 | 0 | 13 | 0 | 0 | 0 | 2 | 0 | 5 | 0 | 0 | 16 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 343 |
| CER4 | Crestridge Ecological Reserve | 0 | 0 | 11 | 1 | 0 | 18 | 1 | 0 | 0 | 23 | 0 | 1 | 0 | 3 | 0 | 9 | 0 | 0 | 0 | 0 | 36 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 300 |
| CTT1 | San Diego Country Estates | 24 | 14 | 37 | 4 | 0 | 32 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 1 | 0 | 0 | 1 | 13 | 12 | 0 | 7 | 0 | 0 | 3 | 487 |
| CTT2 | San Diego Country Estates | 0 | 19 | 3 | 9 | 6 | 98 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 13 | 0 | 6 | 0 | 3 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 451 |
| CTT3 | San Diego Country Estates | 0 | 2 | 2 | 5 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 556 |
| DRCN1 | Deer Canyon 1 | 0 | 241 | 138 | 605 | 0 | 1 | 0 | 1 | 0 | 11 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 51 | 0 | 245 | 629 | 0 | 0 | 259 |
| DRCN2 | Deer Canyon 2 | 0 | 7 | 37 | 189 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 19 | 1 | 16 | 0 | 0 | 6 | 0 | 6 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 280 |
| DRCN3 | Deer Canyon 3 | 0 | 33 | 10 | 41 | 0 | 0 | 0 | 0 | 2 | 10 | 0 | 0 | 0 | 33 | 0 | 1 | 0 | 0 | 0 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 280 |
| DESC1 | Sweetwater River S of Descanso | 3 | 21 | 37 | 84 | 0 | 18 | 2 | 0 | 3 | 100 | 0 | 14 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 410 | 0 | 6 | 0 | 7 | 0 | 0 | 0 | 310 |
| DFG1 | Rancho Jamul | 0 | 1 | 42 | 216 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 63 | 0 | 32 | 0 | 1 | 6 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 562 |
| DC1 | Dulzera Creek | 0 | 12 | 51 | 283 | 0 | 0 | 0 | 0 | 14 | 5 | 0 | 10 | 0 | 4 | 0 | 8 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 243 |
| DC2-A | Dulzera Creek | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 91 |
| DC2-B | Dulzera Creek | 0 | 0 | 9 | 14 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 3 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 3 | 1 | 1 | 0 | 21 | 0 | 0 | 0 | 304 |
| ECC1 | Chocolate Canyon | 2 | 2 | 46 | 509 | 5 | 14 | 0 | 0 | 4 | 0 | 0 | 12 | 0 | 4 | 0 | 2 | 0 | 0 | 0 | 6 | 4 | 0 | 5 | 0 | 5 | 0 | 0 | 1 | 819 |
| ECC2 | Chocolate Canyon | 0 | 12 | 29 | 8 | 0 | 9 | 0 | 0 | 1 | 27 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 31 | 0 | 3 | 0 | 4 | 0 | 0 | 0 | 600 |
| ECC3 | Chocolate Canyon | 0 | 13 | 62 | 240 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 30 | 0 | 0 | 21 | 299 |
| HC1 | Hollenbeck Cyn | 0 | 0 | 9 | 0 | 0 | 0 | 2 | 0 | 7 | 0 | 0 | 14 | 0 | 18 | 0 | 55 | 0 | 0 | 0 | 0 | 2 | 2 | 5 | 0 | 3 | 0 | 0 | 0 | 378 |
| HC2 | Hollenbeck Cyn | 1 | 1 | 4 | 14 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 327 |
| HS1 | Rancho Jamul | 0 | 2 | 330 | 522 | 0 | 6 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 7 | 0 | 31 | 0 | 0 | 4 | 684 |
| HS2 | Rancho Jamul | 0 | 0 | 0 | 57 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 44 |
| HW94-1 | Rancho Jamul | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 44 | 0 | 0 | 34 | 0 | 18 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 451 |
| HWY94-2 | Rancho Jamul | 0 | 0 | 31 | 0 | 0 | 0 | 1 | 0 | 1 | 16 | 0 | 0 | 0 | 15 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 384 |
| PQ1 | Penasquitos Canyon | 0 | 6 | 29 | 123 | 0 | 0 | 18 | 2 | 8 | 131 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 214 |
| PQ2 | Penasquitos Canyon | 0 | 20 | 112 | 47 | 0 | 0 | 1 | 0 | 57 | 331 | 0 | 0 | 0 | 3 | 0 | 14 | 0 | 0 | 0 | 0 | 12 | 0 | 98 | 0 | 726 | 607 | 4 | 0 | 205 |
| PQ3 | Penasquitos Canyon | 0 | 80 | 13 | 173 | 0 | 0 | 0 | 0 | 0 | 35 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 24 | 0 | 1 | 0 | 2 | 0 | 52 | 0 | 0 | 0 | 214 |
| PV 1 | Pamo Valley | 1 | 25 | 35 | 138 | 0 | 5 | 2 | 0 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 2 | 233 | 2 | 0 | 36 | 0 | 0 | 0 | 389 |
| SCC-1 | Sloane Canyon | 1 | 2 | 36 | 71 | 0 | 119 | 47 | 3 | 139 | 119 | 9 | 48 | 36 | 1 | 0 | 0 | 0 | 0 | 7 | 0 | 33 | 3 | 47 | 1 | 33 | 3 | 0 | 2 | 658 |
| SCC-3 | Sloane Canyon | 2 | 0 | 15 | 24 | 0 | 9 | 2 | 0 | 0 | 2 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 10 | 0 | 1 | 0 | 0 | 0 | 674 |
| SCC-4 | Sloane Canyon | 0 | 2 | 43 | 15 | 0 | 12 | 0 | 0 | 6 | 34 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 66 | 2 | 79 | 0 | 84 | 0 | 0 | 0 | 670 |
| SR1 | Sutherland Reserve | 5 | 15 | 0 | 2 | 0 | 11 | 1 | 0 | 0 | 38 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 1 | 1 | 0 | 0 | 5 | 0 | 0 | 0 | 653 |
| SR2 | Sutherland Reserve | 1 | 26 | 2 | 302 | 0 | 24 | 1 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 44 | 0 | 16 | 1 | 0 | 14 | 0 | 7 | 0 | 656 |
| SR3 | Sutherland Reserve | 1 | 42 | 54 | 53 | 0 | 7 | 0 | 0 | 1 | 2 | 0 | 64 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 7 | 7 | 0 | 0 | 0 | 32 | 0 | 0 | 0 | 617 |
| SR4 | Sutherland Reserve | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 |
| SR5 | Sutherland Reserve | 13 | 17 | 0 | 219 | 0 | 9 | 0 | 0 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 555 |
| SVC2 | San Vicente | 0 | 1 | 16 | 54 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 13 | 0 | 0 | 1 | 0 | 14 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 462 |
| SVC4 | San Vicente | 0 | 0 | 14 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 9 | 0 | 0 | 1 | 0 | 8 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 90 |
| SVC5 | San Vicente | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SVC6 | San Vicente | 0 | 0 | 1 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 64 |
| LR1 | Loveland Reservoir | 0 | 15 | 9 | 4 | 0 | 31 | 10 | 0 | 0 | 3 | 0 | 15 | 0 | 25 | 0 | 12 | 0 | 0 | 0 | 0 | 3 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 322 |
| LR2 | Loveland Reservoir | 3 | 7 | 30 | 443 | 0 | 57 | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 86 | 0 | 0 | 0 | 0 | 2 | 4 | 0 | 0 | 7 | 0 | 0 | 0 | 510 |
| LR4 | Loveland Reservoir | 31 | 3 | 20 | 98 | 0 | 11 | 3 | 0 | 0 | 0 | 0 | 17 | 0 | 0 | 0 | 10 | 0 | 0 | 10 | 3 | 3 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 301 |
| SW1 | Sweetwater Canyon 1 | 0 | 5 | 140 | 0 | 0 | 0 | 0 | 0 | 2 | 71 | 0 | 8 | 0 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 11 | 20 | 55 | 2 | 0 | 0 | 240 |
| SYC1 | Sycamore Cyn | 0 | 11 | 43 | 27 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 219 | 0 | 984 | 83 | 68 | 0 | 451 |
| SYC2 | Sycamore Cyn | 0 | 3 | 26 | 34 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4 | 0 | 1 | 0 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 452 |
| SYC3 | Sycamore Cyn | 1 | 10 | 313 | 44 | 0 | 2 | 0 | 0 | 0 | 5 | 0 | 3 | 0 | 0 | 0 | 19 | 0 | 3 | 6 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 400 |
| SYC4 | Sycamore Cyn | 0 | 7 | 19 | 70 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 3 | 0 | 0 | 1 | 0 | 1 | 0 | 5 | 1 | 0 | 0 | 447 |
| DESC 2 | | 0 | 0 | 23 | 0 | 0 | 4 | 55 | 39 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 |
| BL2 | | 0 | 9 | 9 | 0 | 0 | 0 | 3 | 0 | 66 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 133 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 68 |
| **Total Camera Events** | | 141 | 872 | 4130 | 6077 | 11 | 835 | 208 | 48 | 497 | 1040 | 11 | 699 | 40 | 148 | 1 | 743 | 13 | 45 | 621 | 743 | 1565 | 301 | 665 | 23 | 2652 | 1334 | 87 | 413 | 24009 |

SANDAG study area




**Trail Camera Locations**

Dark blue = UCD sites where mt. lions detected

Light purple = UCD sites where mt. lions not detected

Light blue = Megan Jennings sites where mt. lions detected

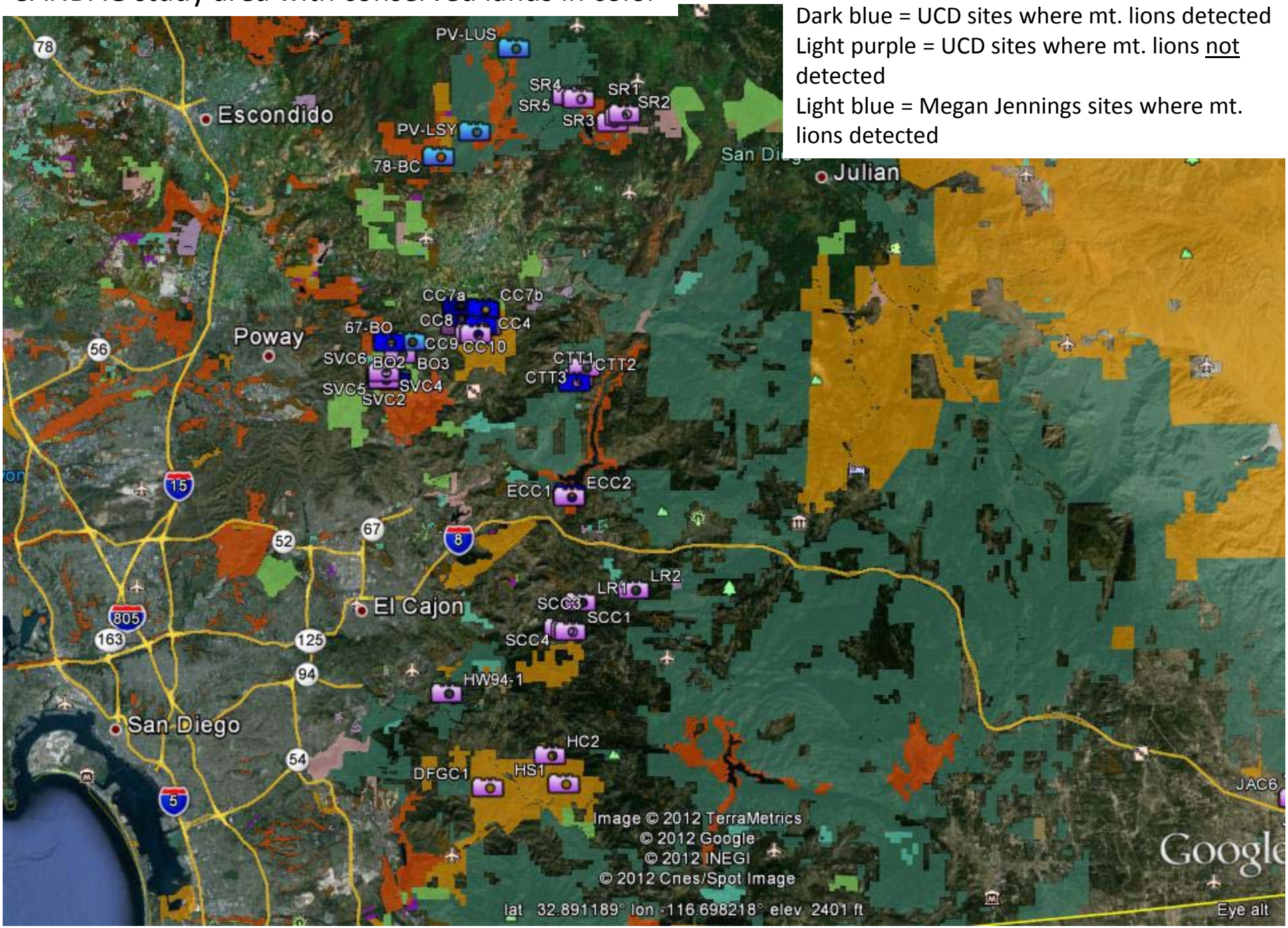
SANDAG study area with conserved lands in color

**Trail Camera Locations**

Dark blue = UCD sites where mt. lions detected

Light purple = UCD sites where mt. lions not detected

Light blue = Megan Jennings sites where mt. lions detected



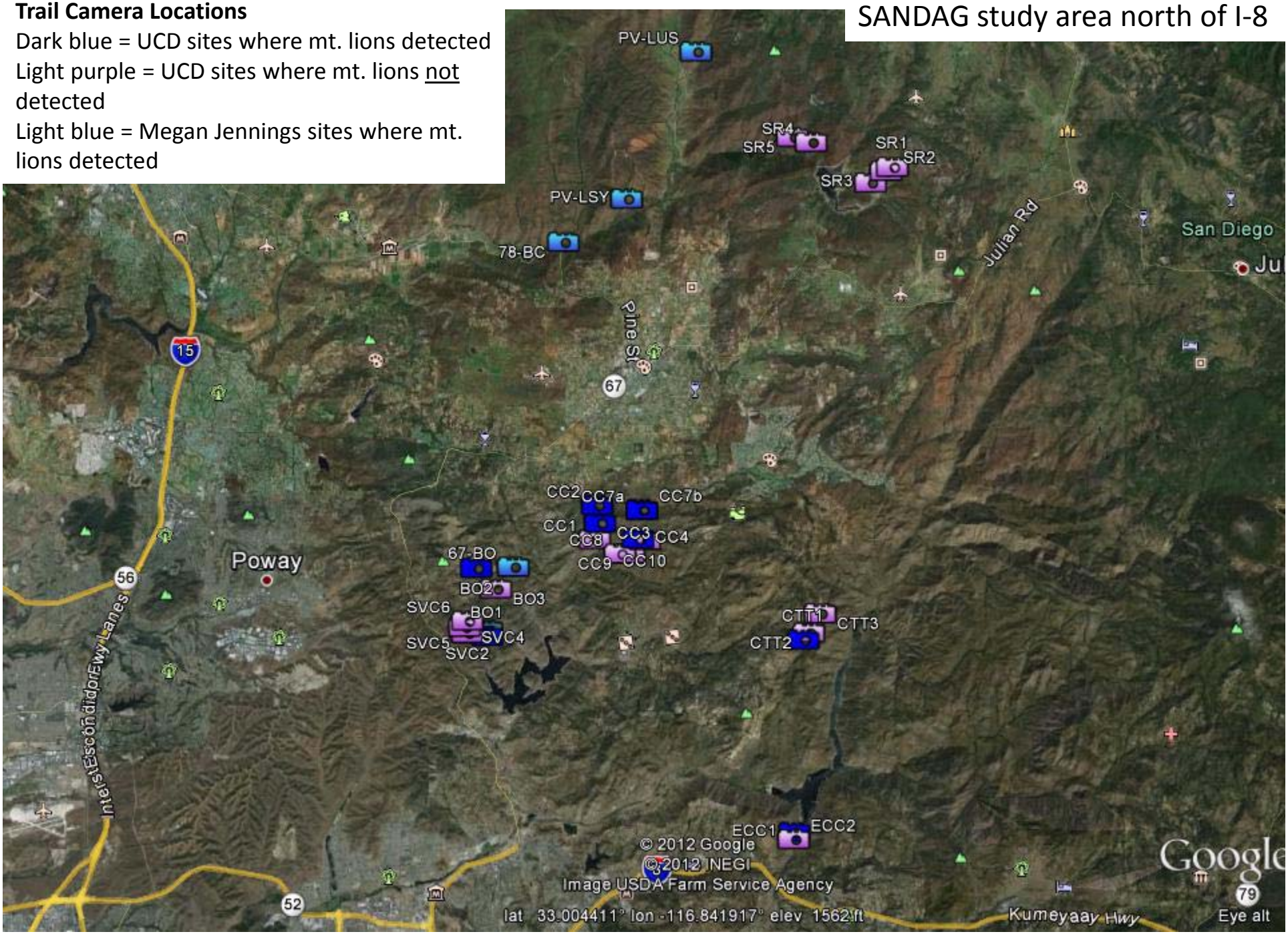
**Trail Camera Locations**

Dark blue = UCD sites where mt. lions detected

Light purple = UCD sites where mt. lions not detected

Light blue = Megan Jennings sites where mt. lions detected

SANDAG study area north of I-8



**Trail Camera Locations**

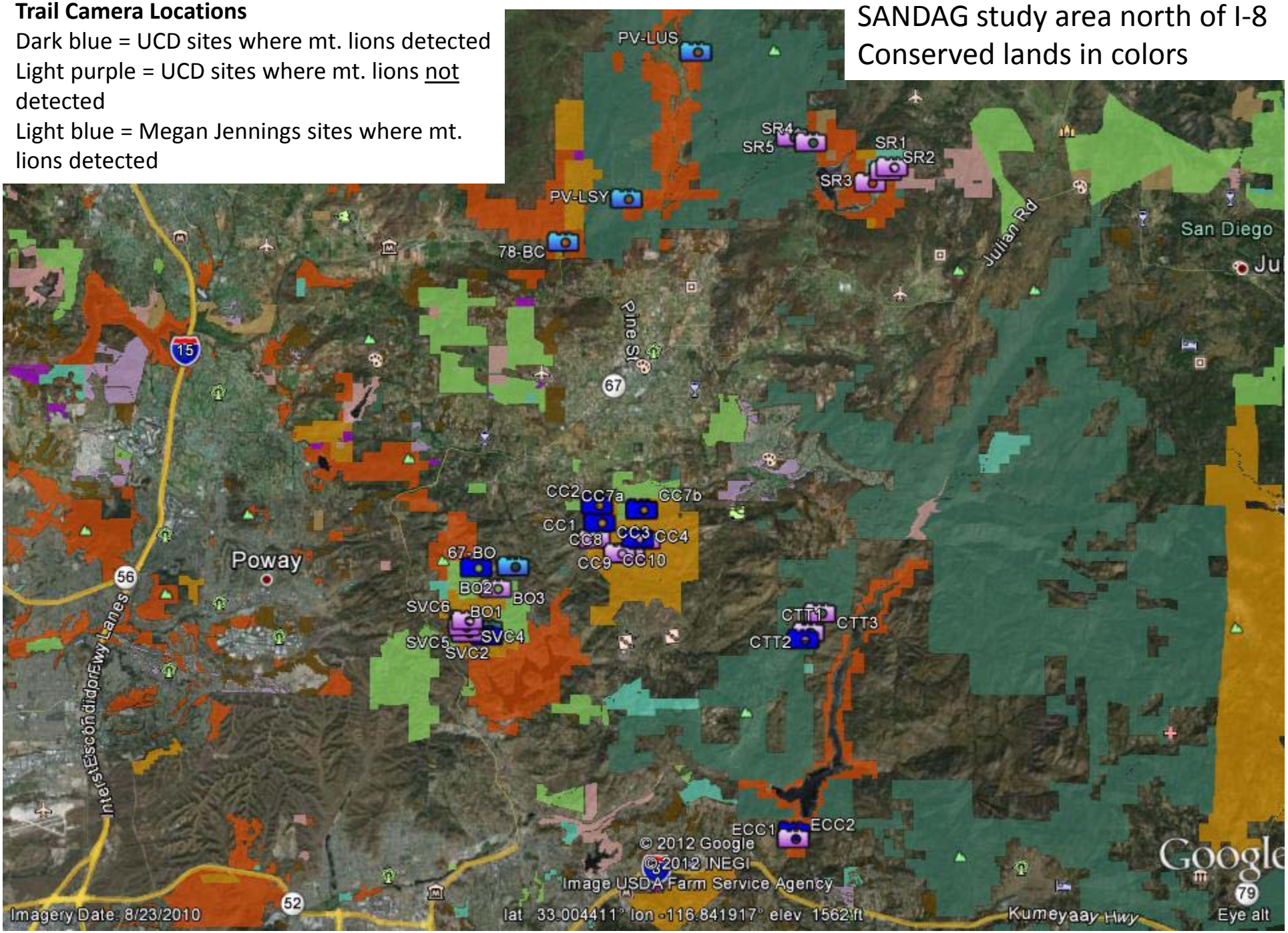
Dark blue = UCD sites where mt. lions detected

Light purple = UCD sites where mt. lions not detected

Light blue = Megan Jennings sites where mt. lions detected

SANDAG study area north of I-8

Conserved lands in colors



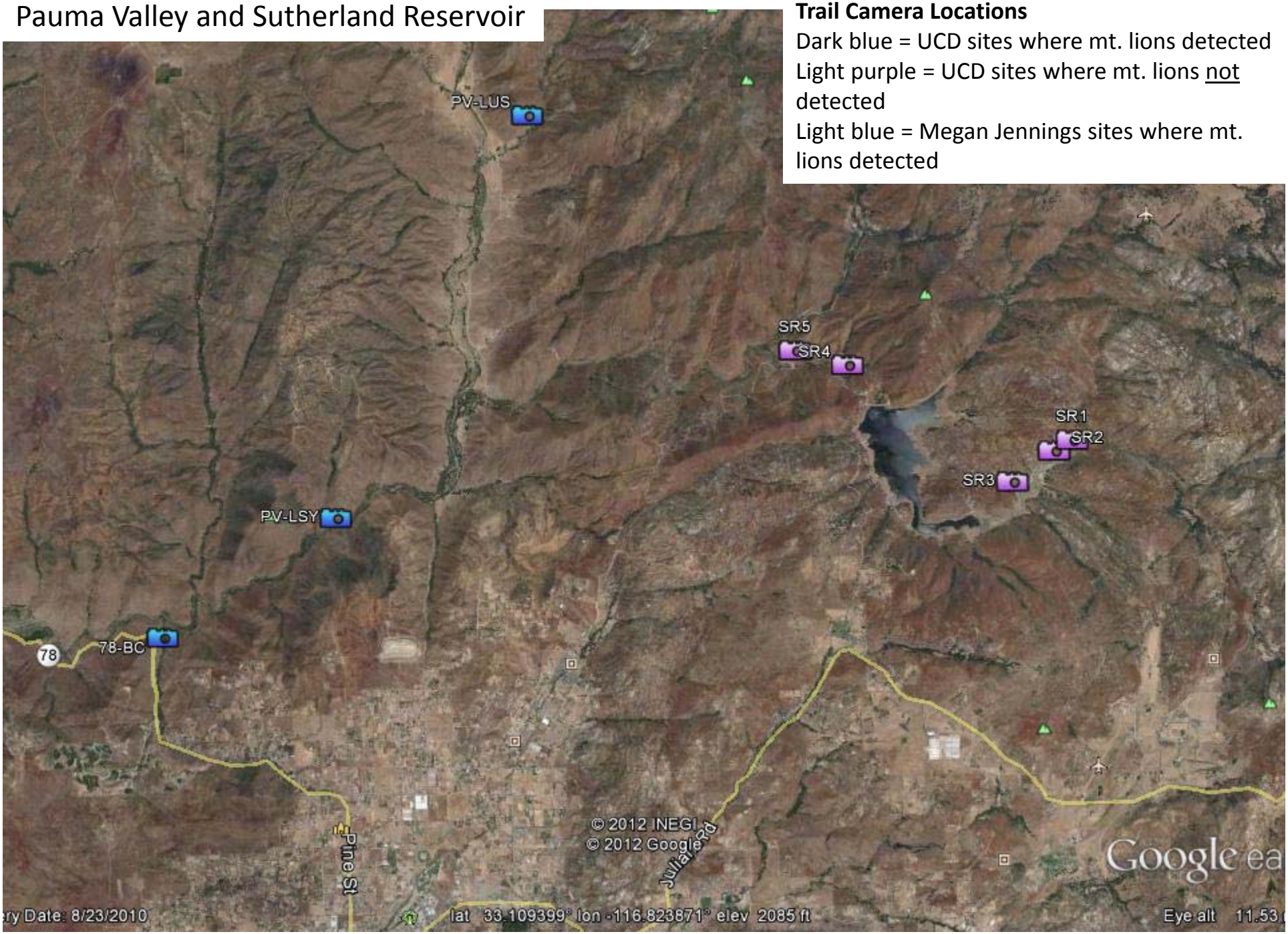
Pauma Valley and Sutherland Reservoir

**Trail Camera Locations**

Dark blue = UCD sites where mt. lions detected

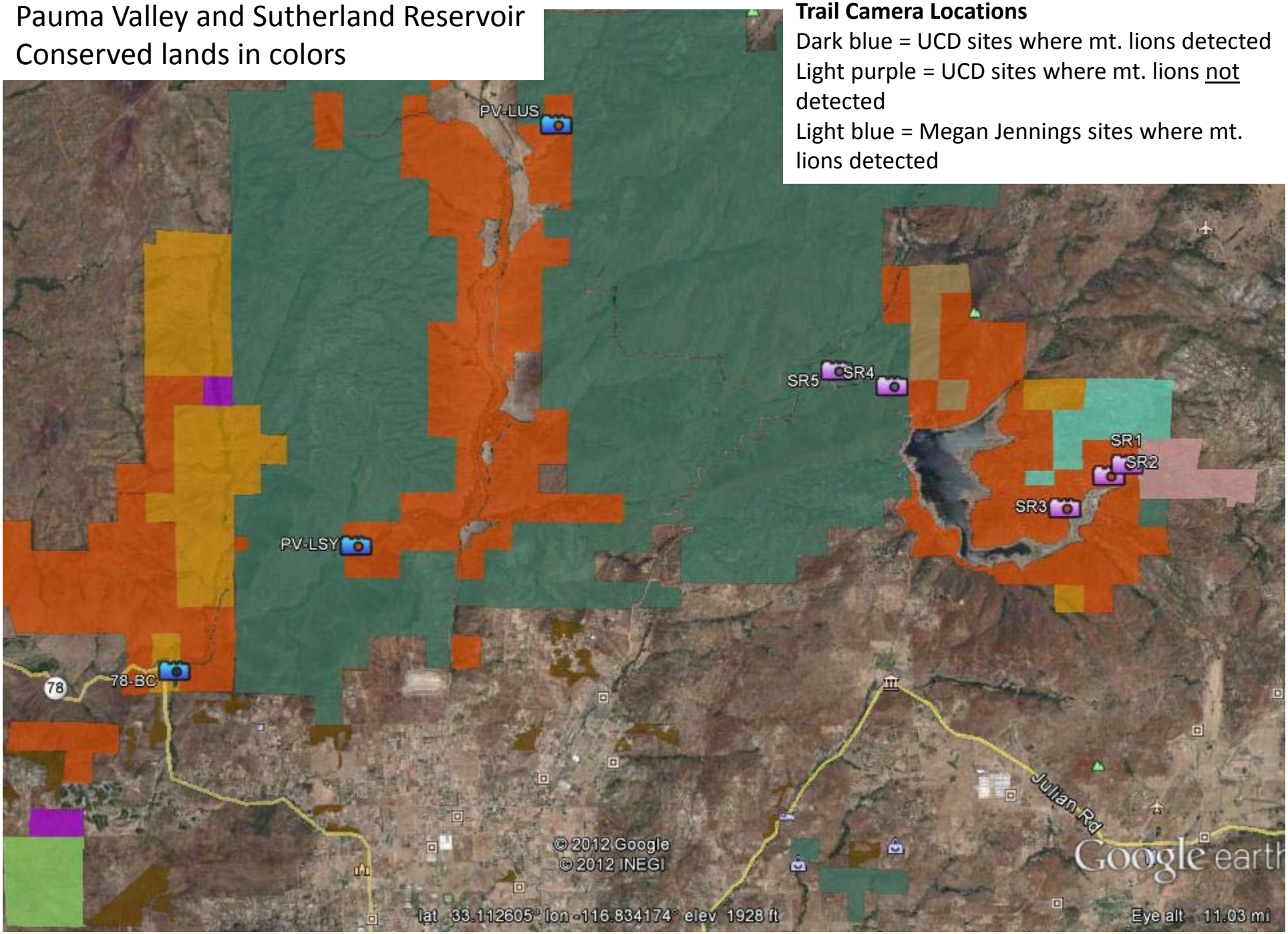
Light purple = UCD sites where mt. lions <u>not</u> detected

Light blue = Megan Jennings sites where mt. lions detected



Pauma Valley and Sutherland Reservoir
Conserved lands in colors

**Trail Camera Locations**
Dark blue = UCD sites where mt. lions detected
Light purple = UCD sites where mt. lions not detected
Light blue = Megan Jennings sites where mt. lions detected



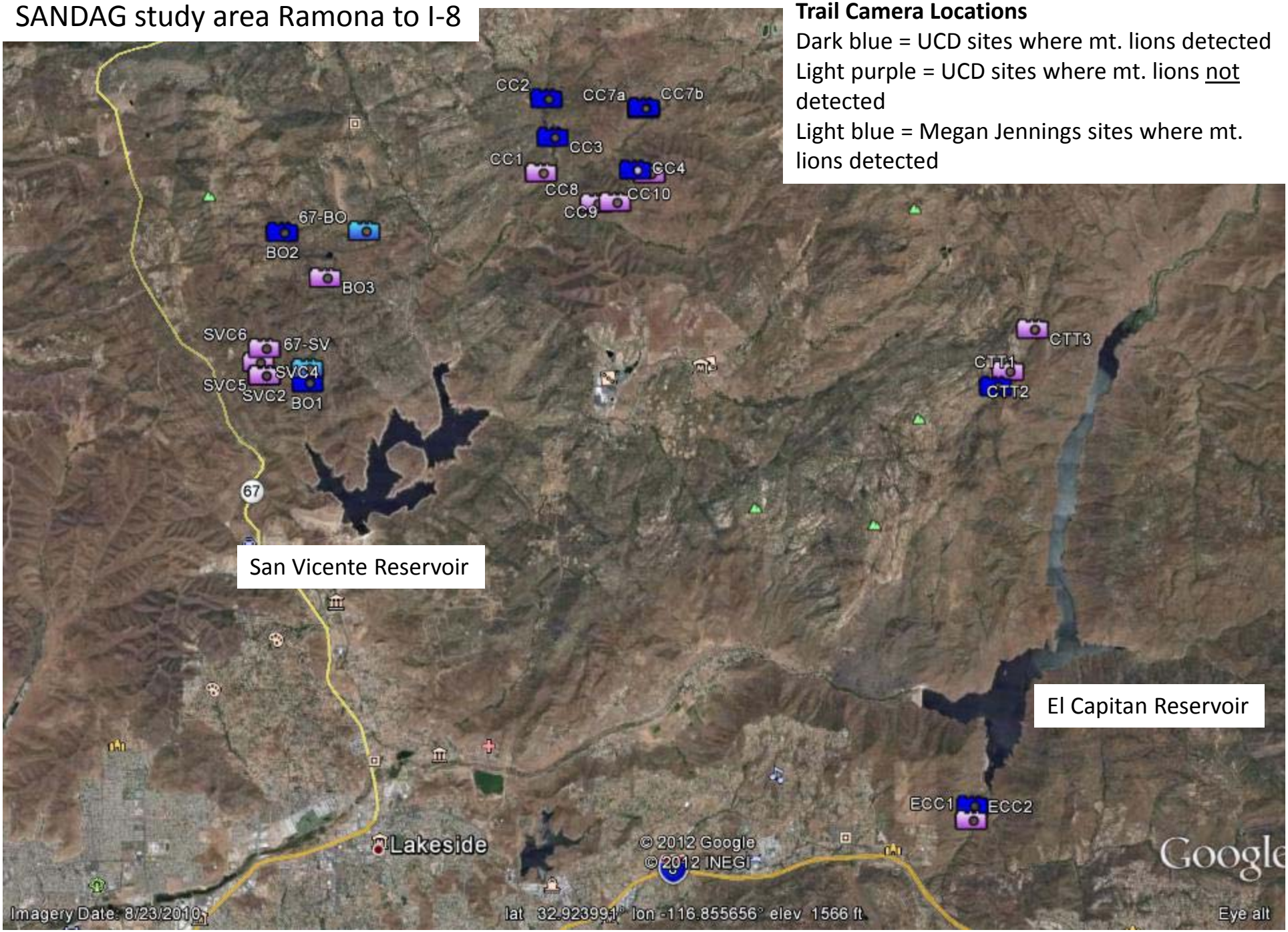
SANDAG study area Ramona to I-8

**Trail Camera Locations**

Dark blue = UCD sites where mt. lions detected

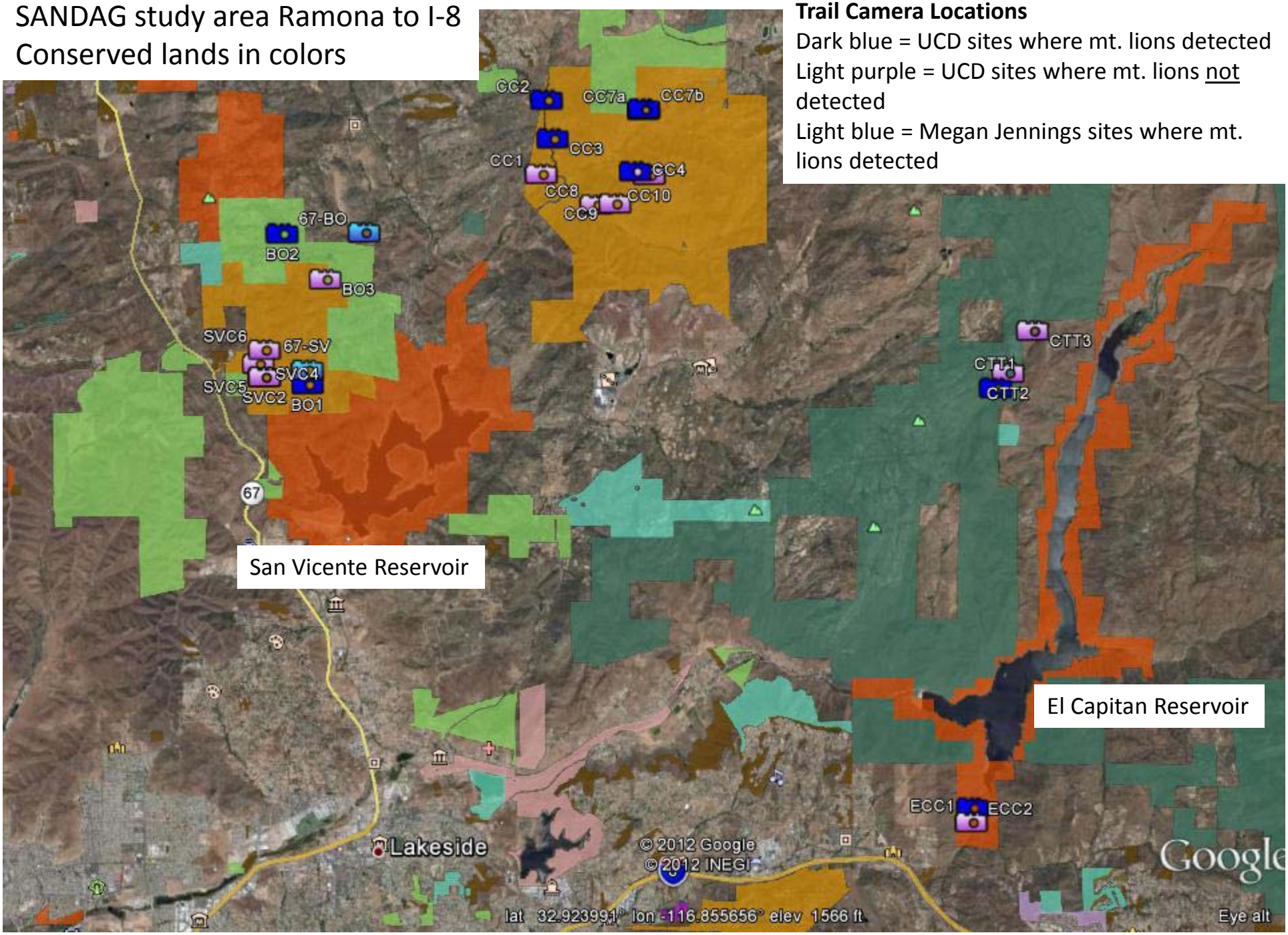
Light purple = UCD sites where mt. lions not detected

Light blue = Megan Jennings sites where mt. lions detected



SANDAG study area Ramona to I-8
Conserved lands in colors

**Trail Camera Locations**
Dark blue = UCD sites where mt. lions detected
Light purple = UCD sites where mt. lions not detected
Light blue = Megan Jennings sites where mt. lions detected



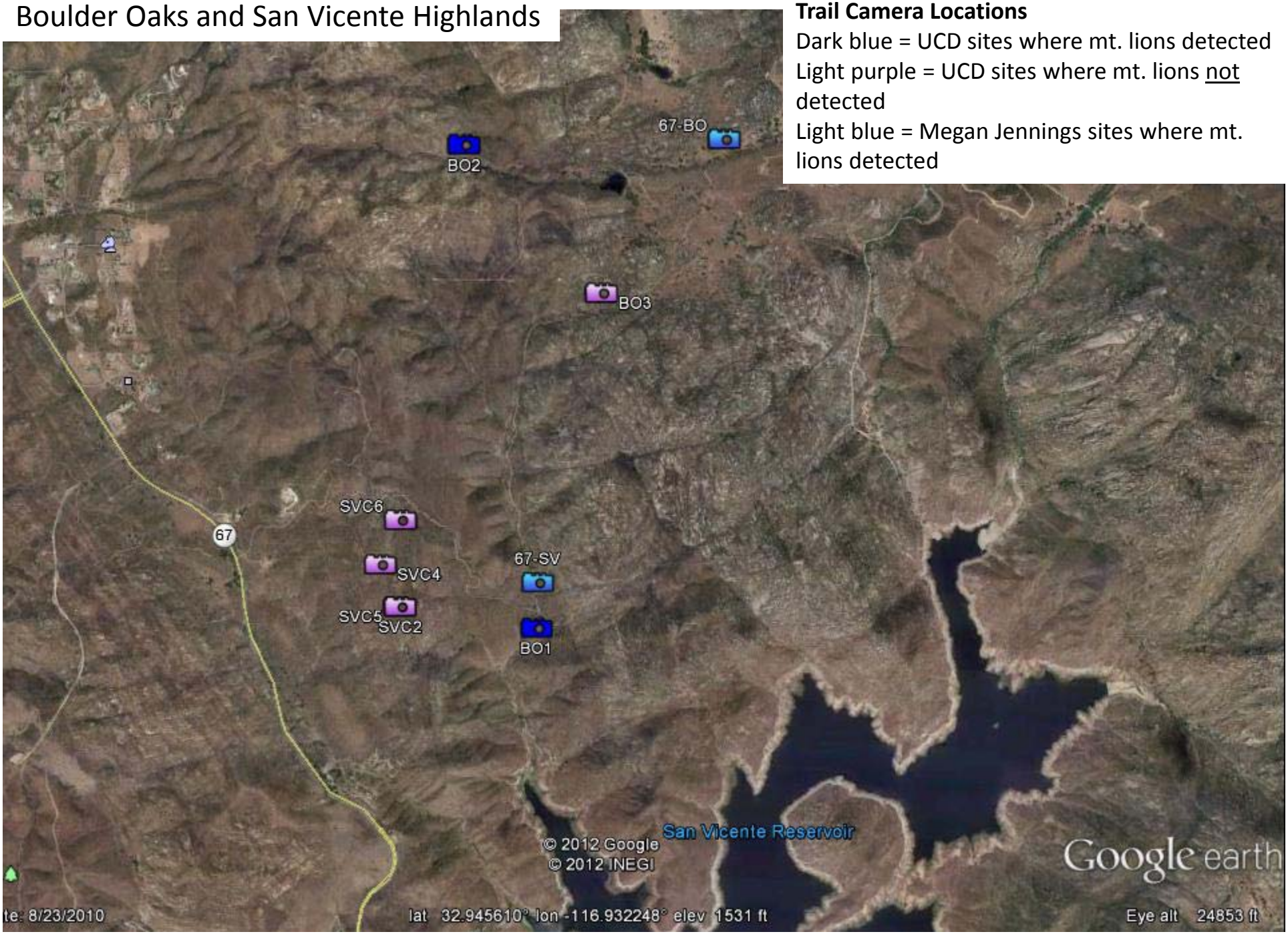
# Boulder Oaks and San Vicente Highlands

**Trail Camera Locations**

Dark blue = UCD sites where mt. lions detected

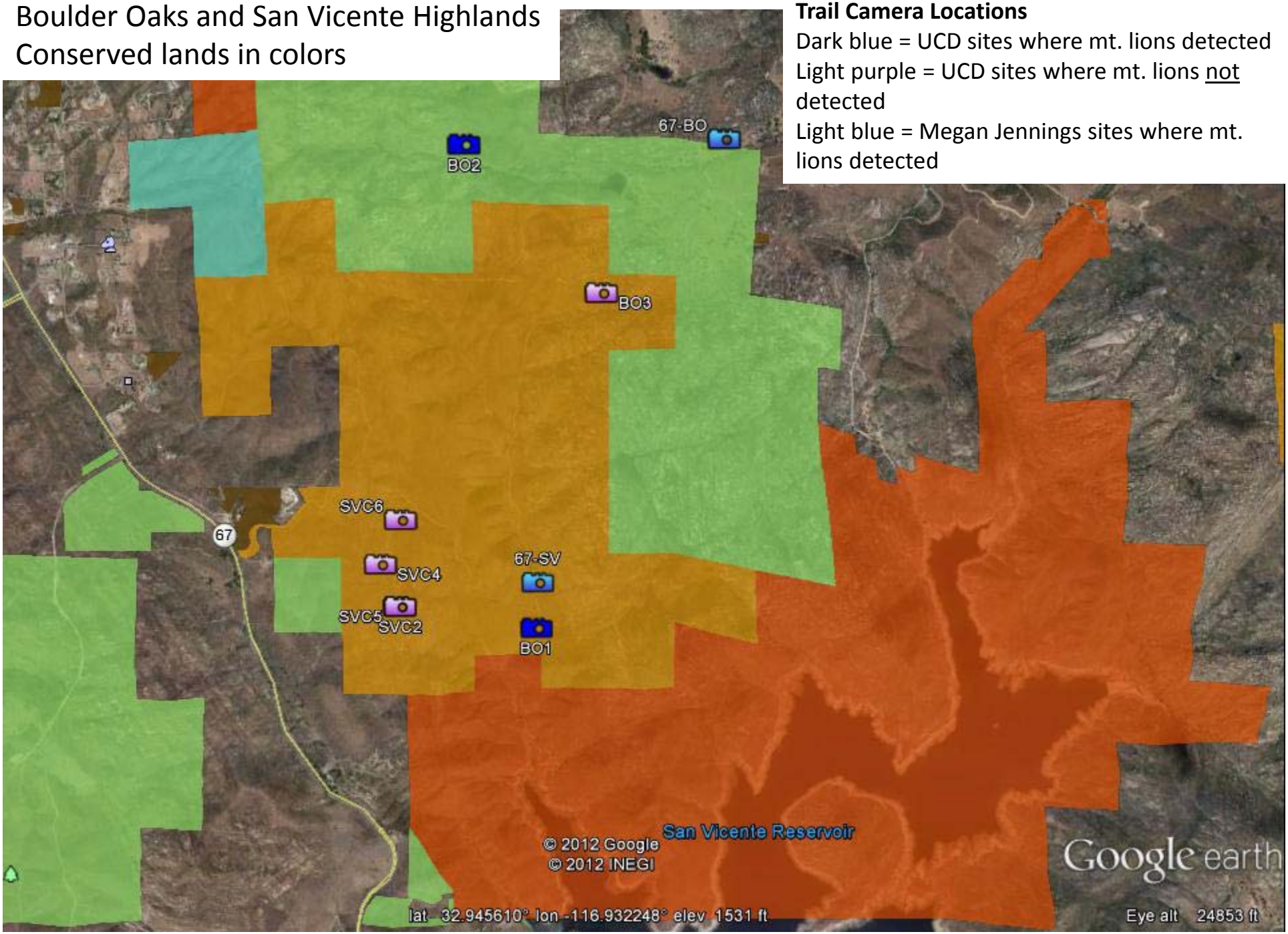
Light purple = UCD sites where mt. lions not detected

Light blue = Megan Jennings sites where mt. lions detected



Boulder Oaks and San Vicente Highlands
Conserved lands in colors

**Trail Camera Locations**
Dark blue = UCD sites where mt. lions detected
Light purple = UCD sites where mt. lions not detected
Light blue = Megan Jennings sites where mt. lions detected



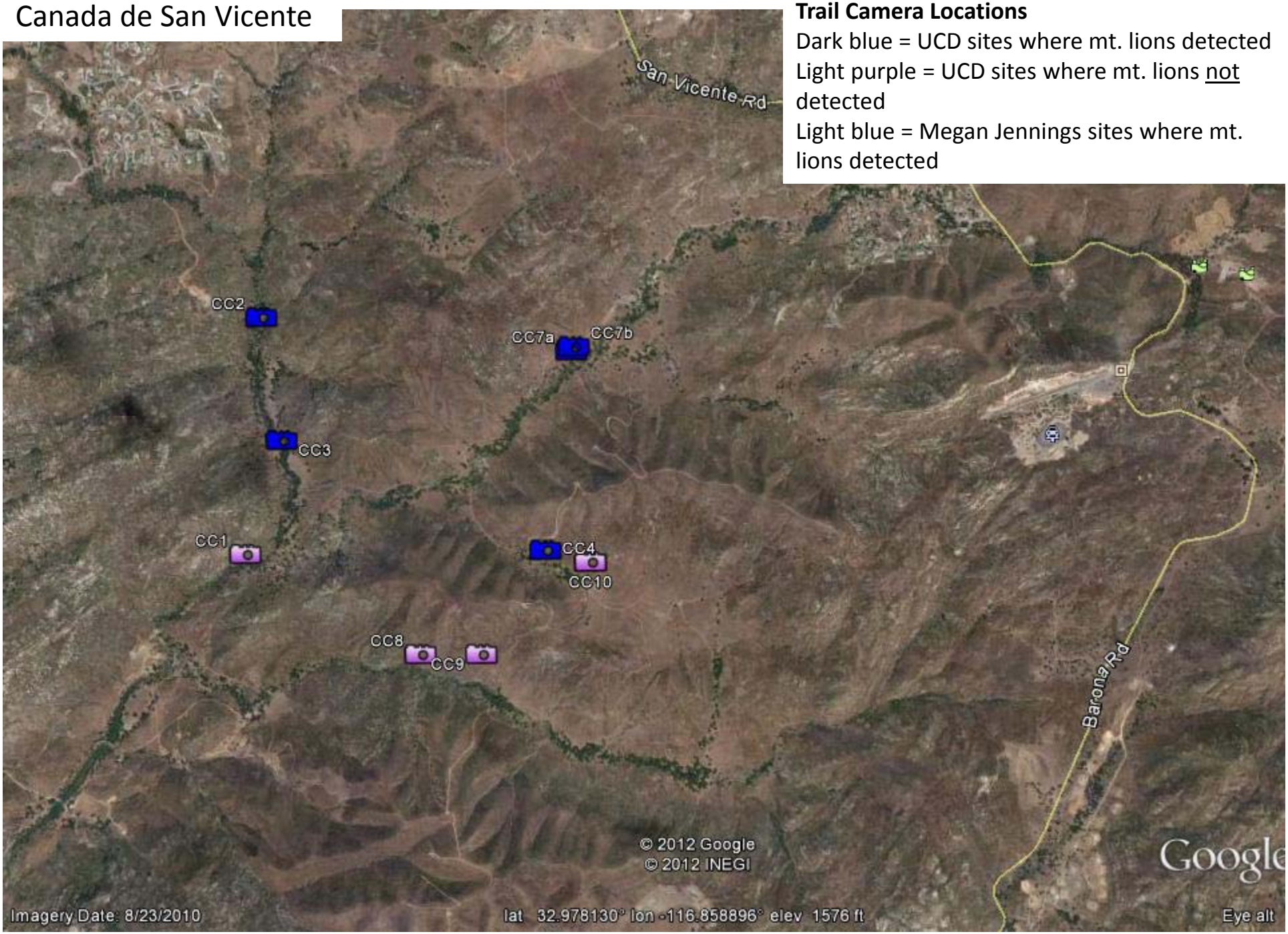
Canada de San Vicente

**Trail Camera Locations**

Dark blue = UCD sites where mt. lions detected

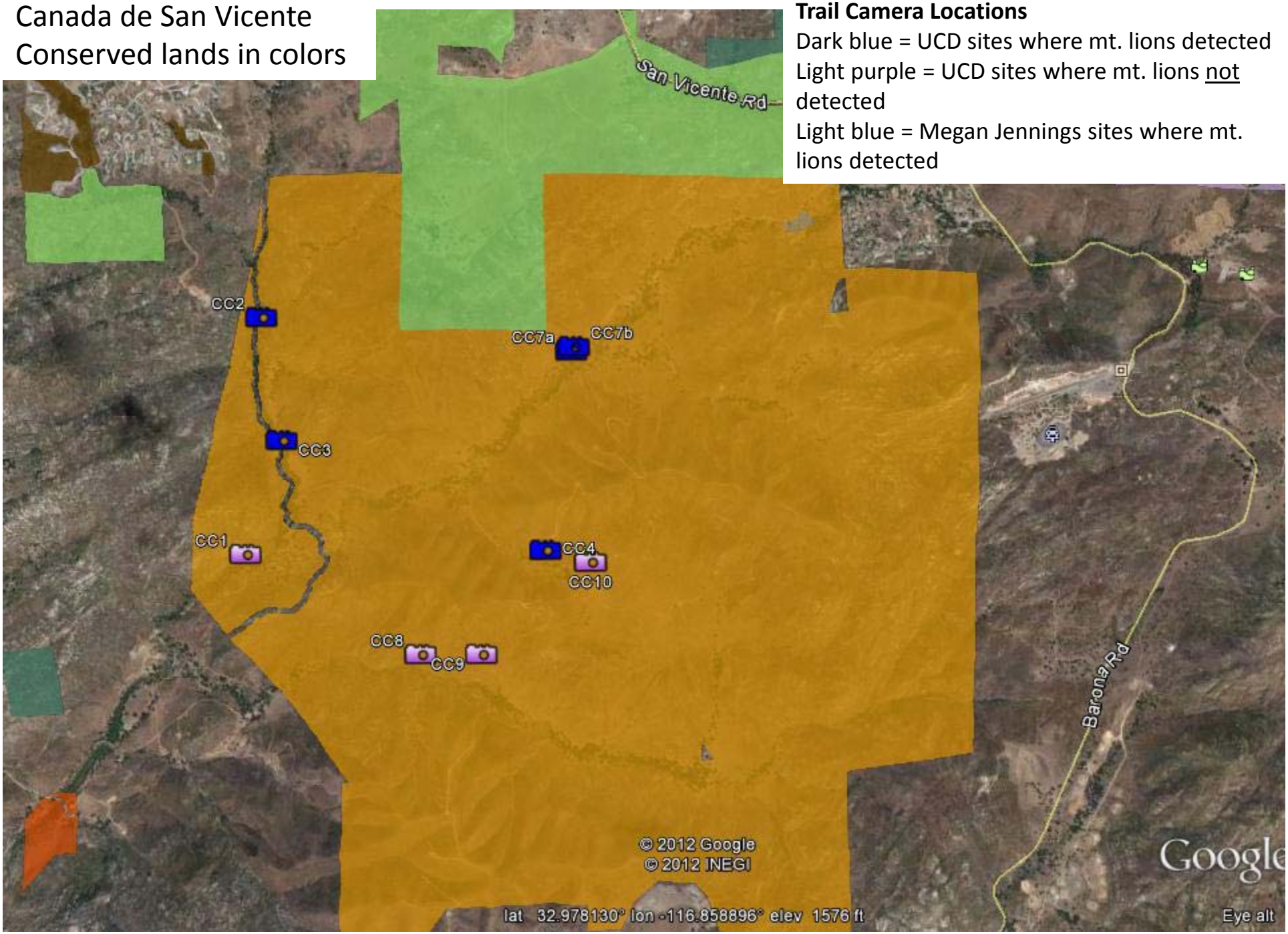
Light purple = UCD sites where mt. lions not detected

Light blue = Megan Jennings sites where mt. lions detected



Canada de San Vicente
Conserved lands in colors

**Trail Camera Locations**
Dark blue = UCD sites where mt. lions detected
Light purple = UCD sites where mt. lions not detected
Light blue = Megan Jennings sites where mt. lions detected



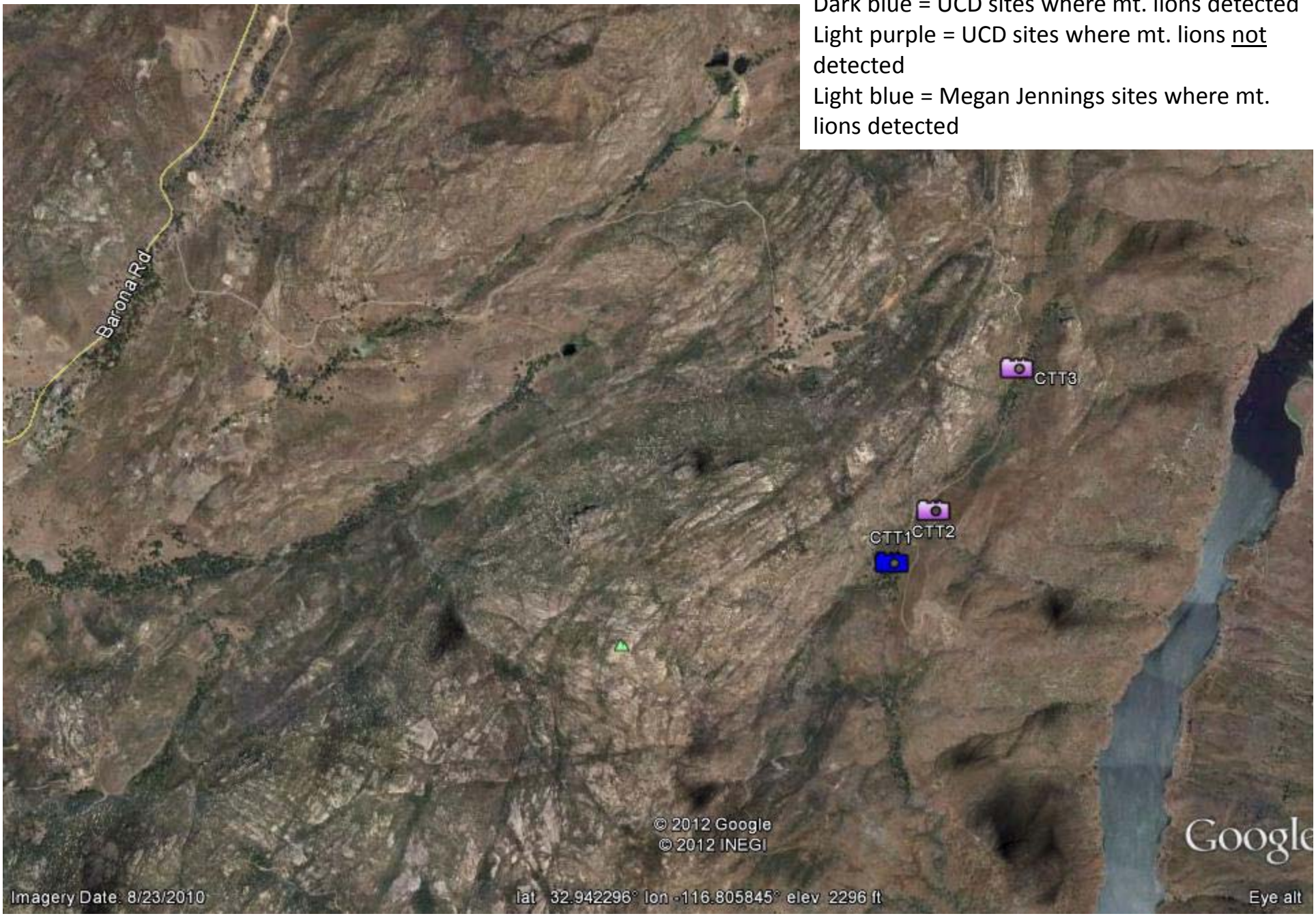
Cleveland National Forest near San Diego Country Estates

**Trail Camera Locations**

Dark blue = UCD sites where mt. lions detected

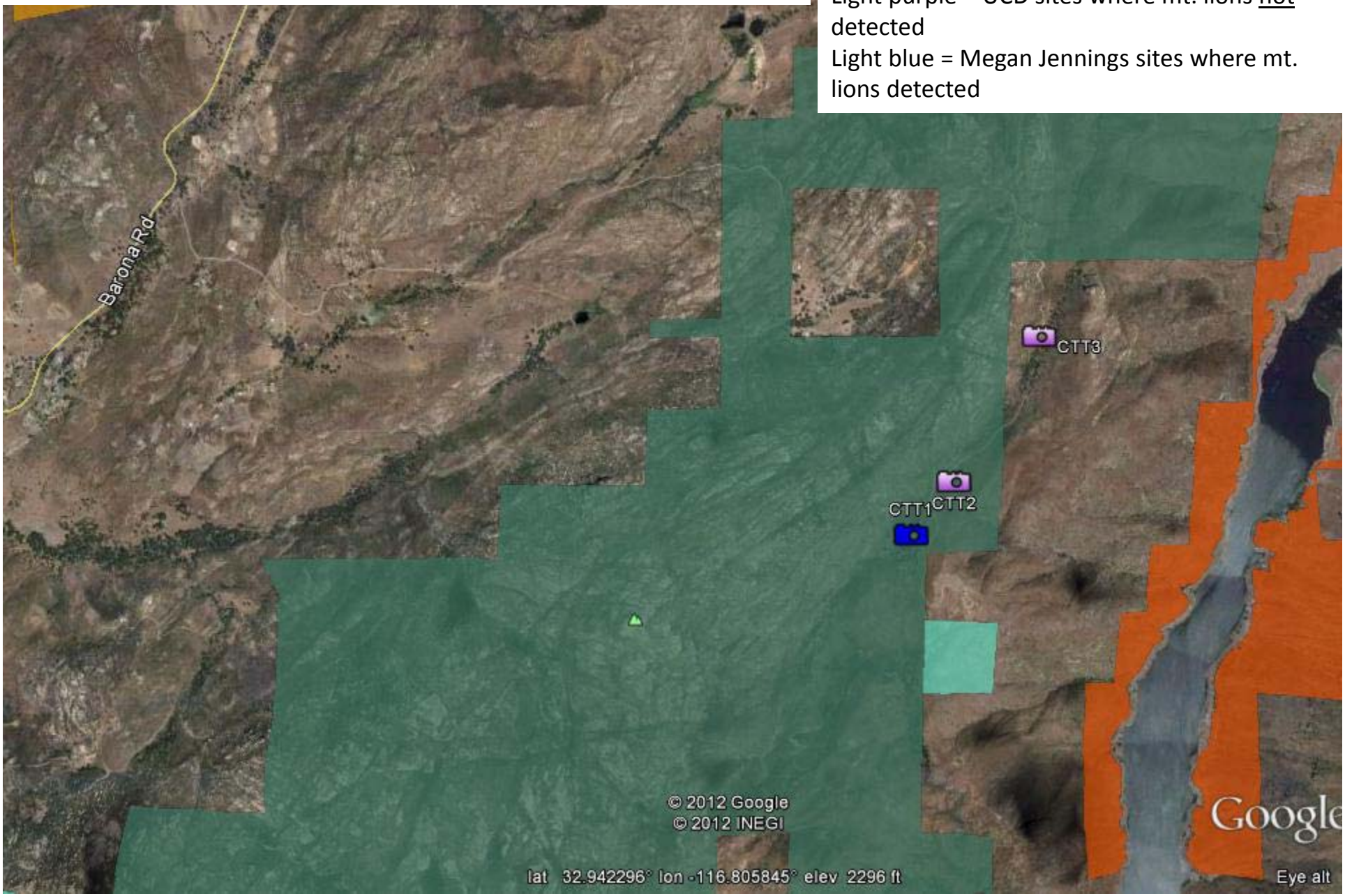
Light purple = UCD sites where mt. lions not detected

Light blue = Megan Jennings sites where mt. lions detected



Cleveland National Forest near San Diego Country Estates
Conserved lands in colors

**Trail Camera Locations**
Dark blue = UCD sites where mt. lions detected
Light purple = UCD sites where mt. lions not detected
Light blue = Megan Jennings sites where mt. lions detected



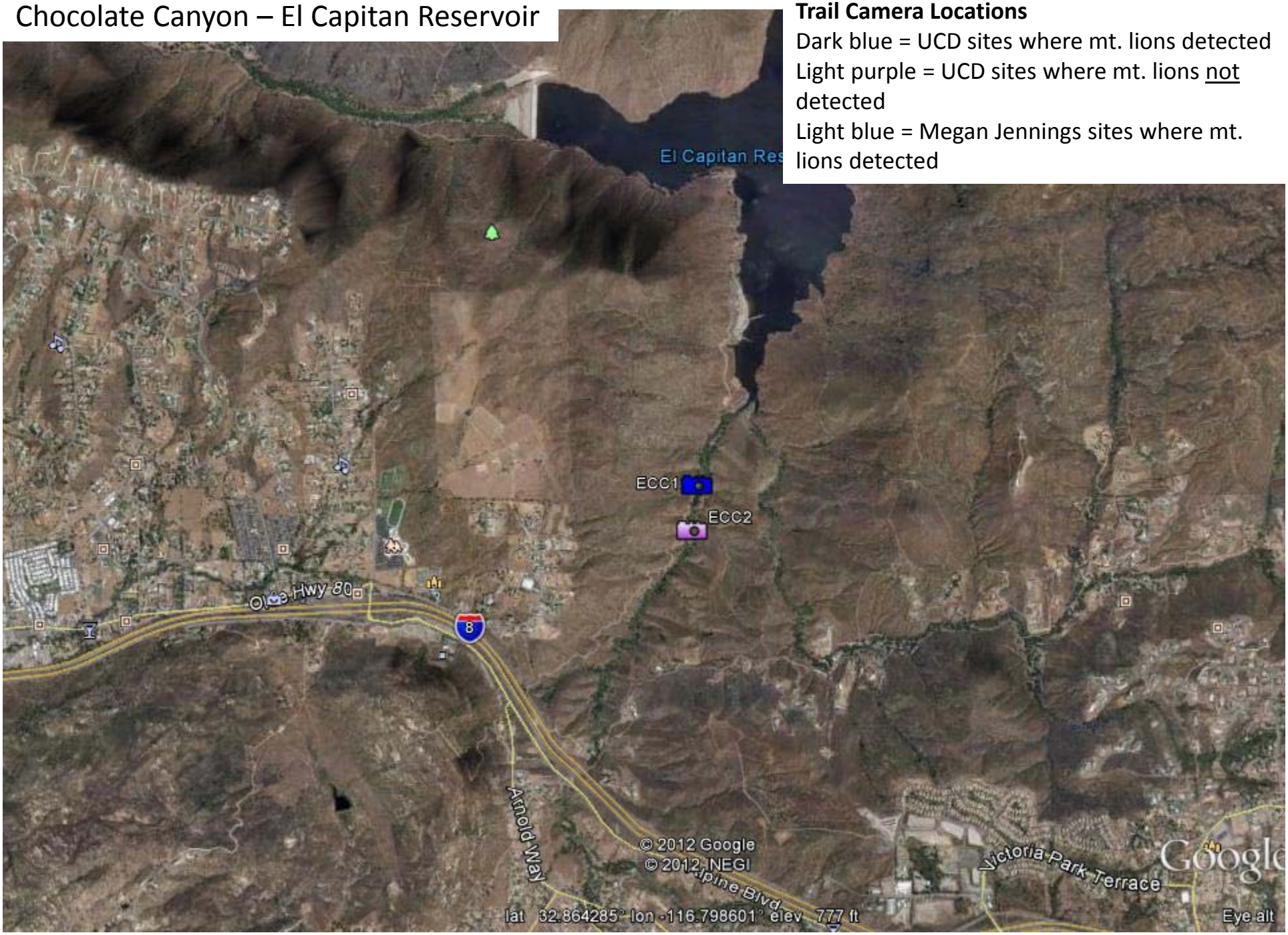
# Chocolate Canyon – El Capitan Reservoir

**Trail Camera Locations**

Dark blue = UCD sites where mt. lions detected

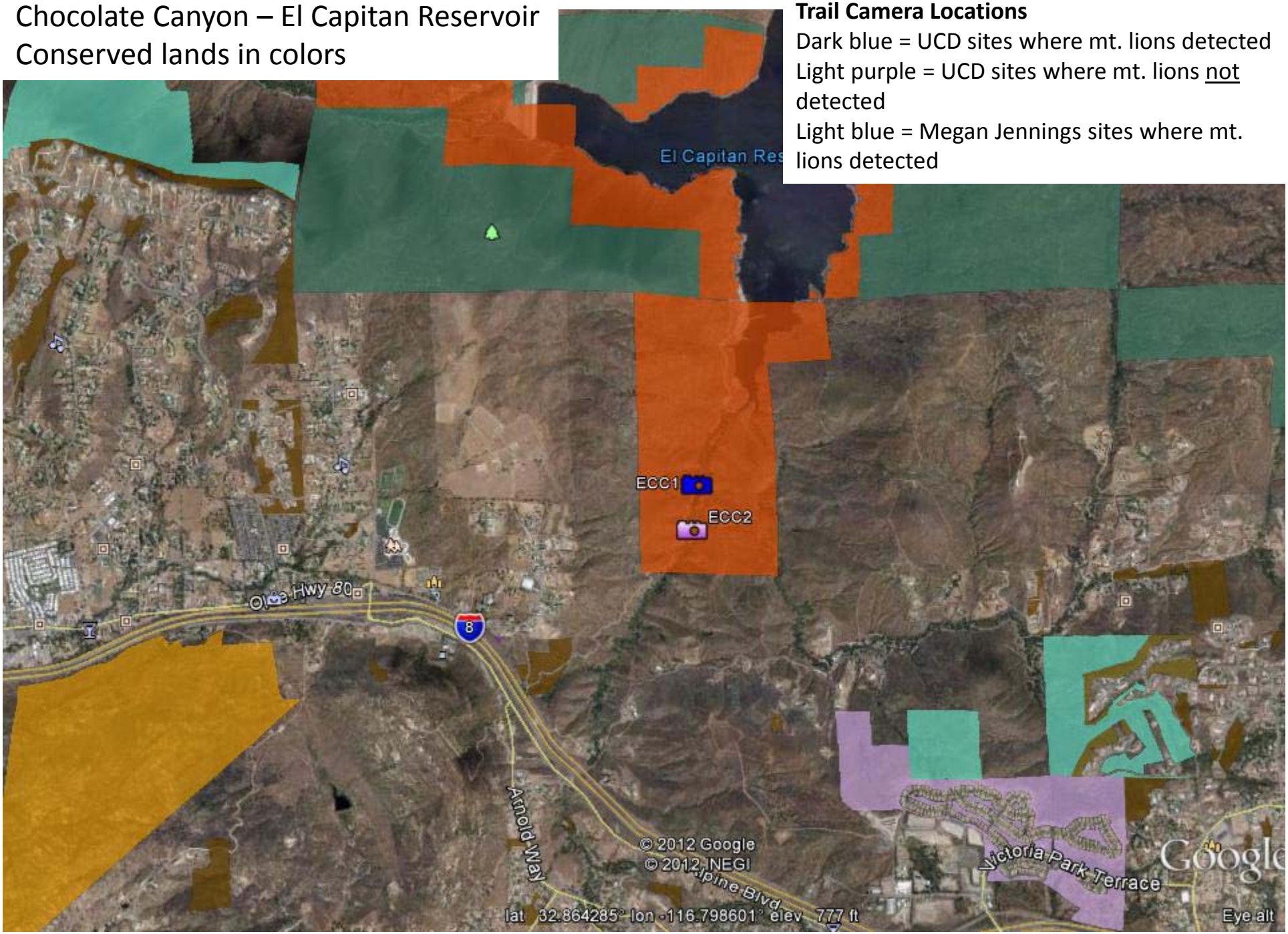
Light purple = UCD sites where mt. lions not detected

Light blue = Megan Jennings sites where mt. lions detected



Chocolate Canyon – El Capitan Reservoir
Conserved lands in colors

**Trail Camera Locations**
Dark blue = UCD sites where mt. lions detected
Light purple = UCD sites where mt. lions not detected
Light blue = Megan Jennings sites where mt. lions detected



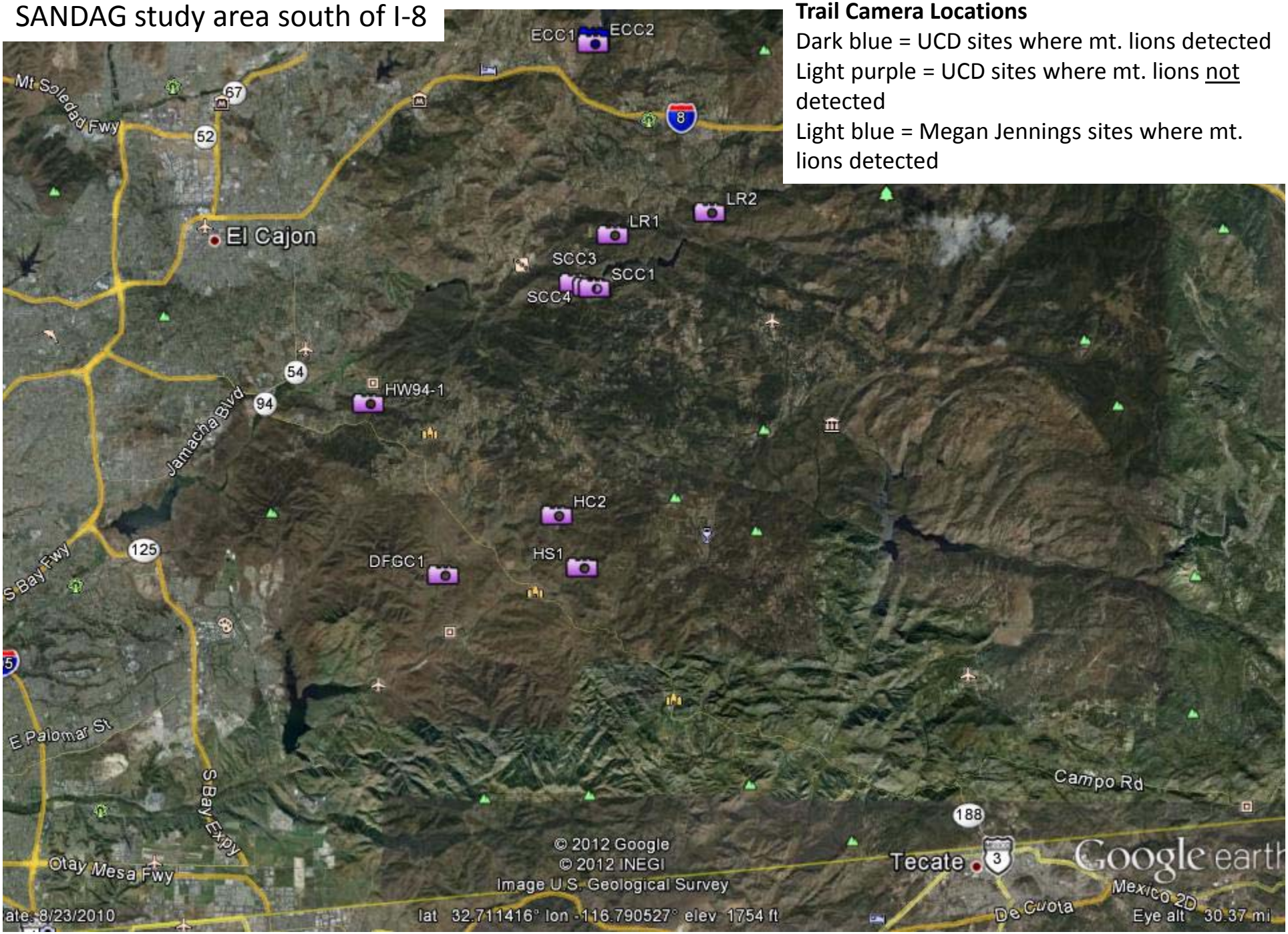
SANDAG study area south of I-8

**Trail Camera Locations**

Dark blue = UCD sites where mt. lions detected

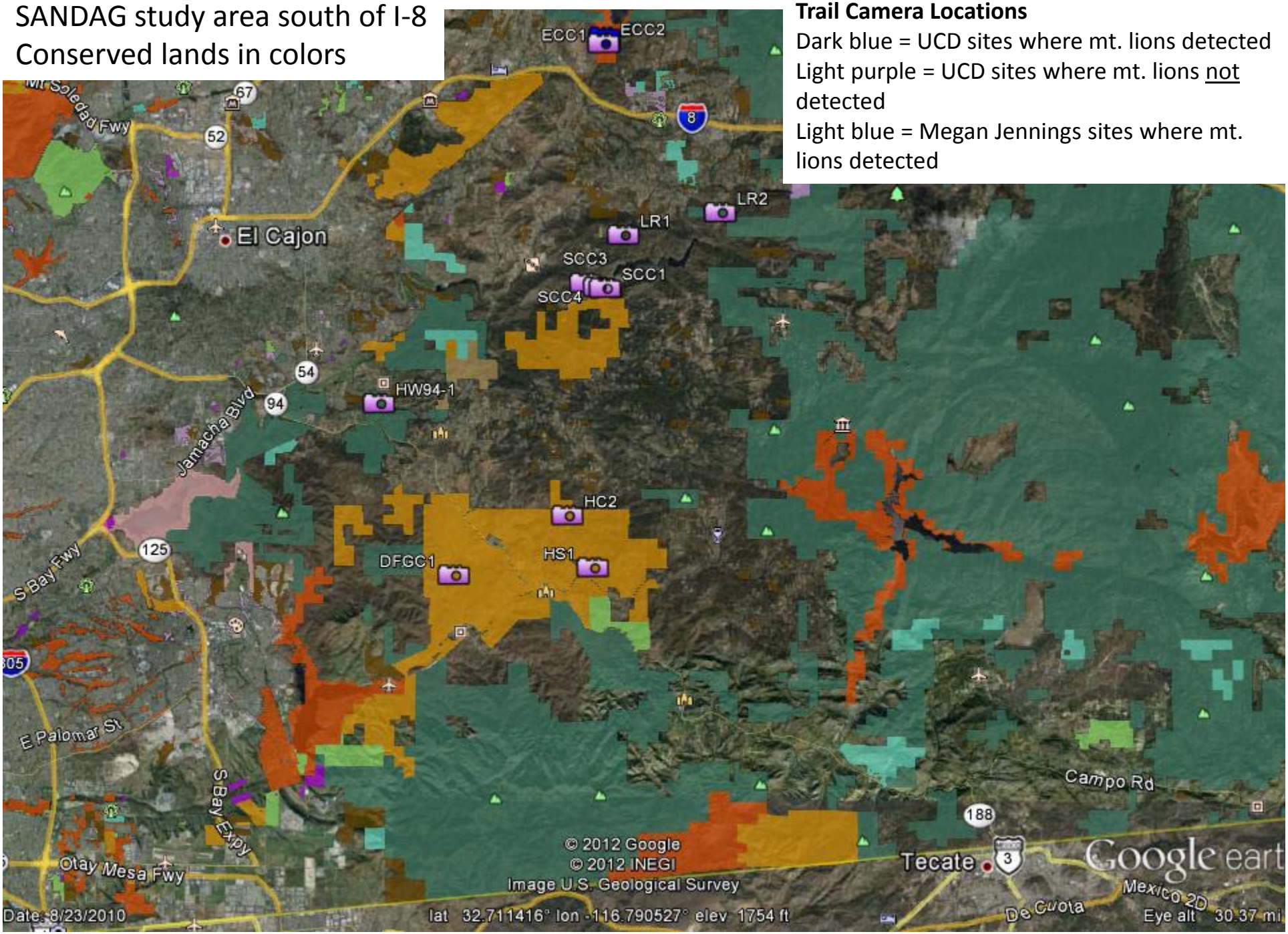
Light purple = UCD sites where mt. lions not detected

Light blue = Megan Jennings sites where mt. lions detected



SANDAG study area south of I-8
Conserved lands in colors

**Trail Camera Locations**
Dark blue = UCD sites where mt. lions detected
Light purple = UCD sites where mt. lions <u>not</u> detected
Light blue = Megan Jennings sites where mt. lions detected



Loveland Reservoir and Sloan Canyon

**Trail Camera Locations**

Dark blue = UCD sites where mt. lions detected

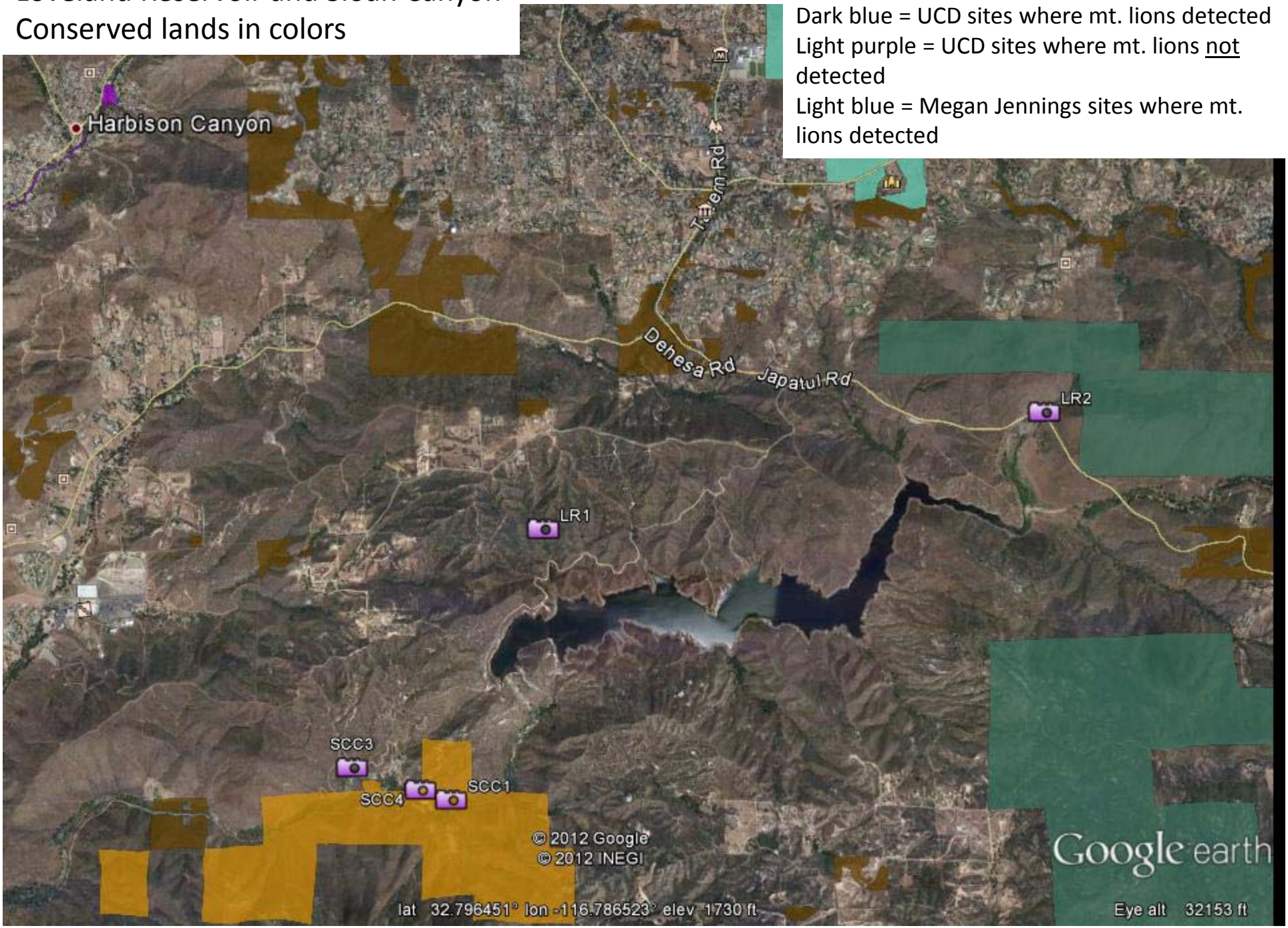
Light purple = UCD sites where mt. lions <u>not</u> detected

Light blue = Megan Jennings sites where mt. lions detected

Loveland Reservoir and Sloan Canyon
Conserved lands in colors

**Trail Camera Locations**

Dark blue = UCD sites where mt. lions detected
Light purple = UCD sites where mt. lions not detected
Light blue = Megan Jennings sites where mt. lions detected



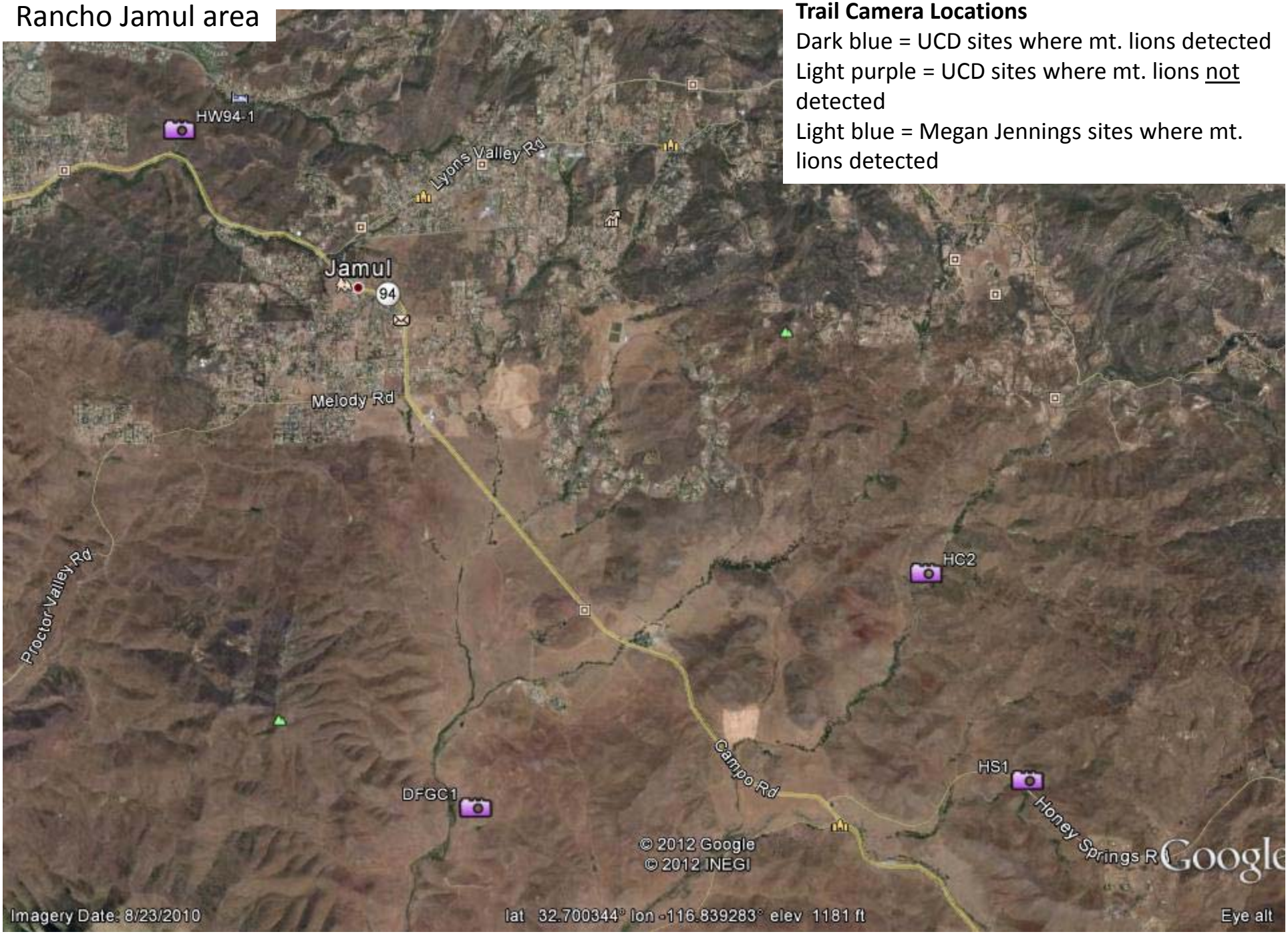
Rancho Jamul area

**Trail Camera Locations**

Dark blue = UCD sites where mt. lions detected

Light purple = UCD sites where mt. lions not detected

Light blue = Megan Jennings sites where mt. lions detected



Rancho Jamul area
Conserved lands in colors

**Trail Camera Locations**
Dark blue = UCD sites where mt. lions detected
Light purple = UCD sites where mt. lions not detected
Light blue = Megan Jennings sites where mt. lions detected