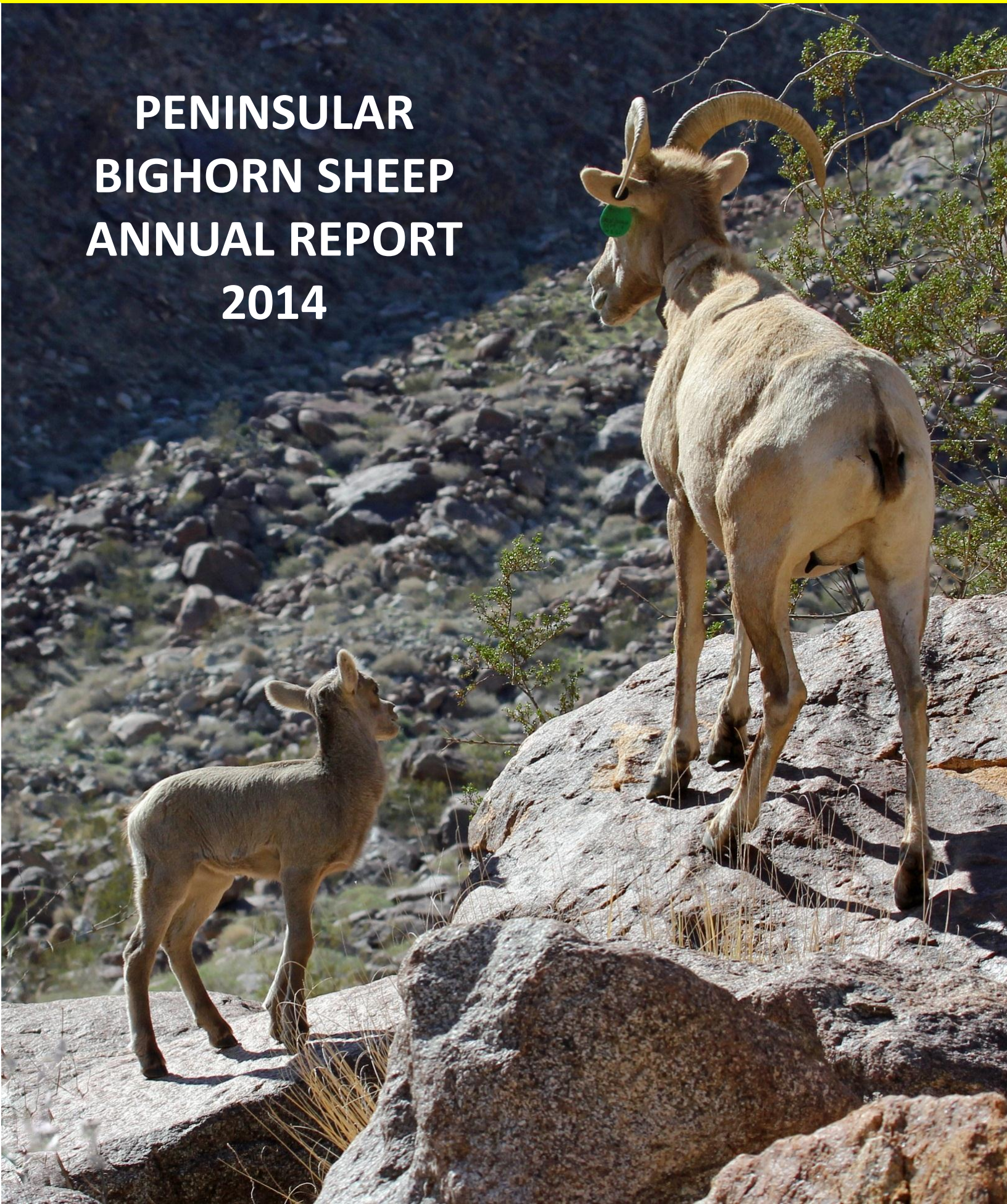
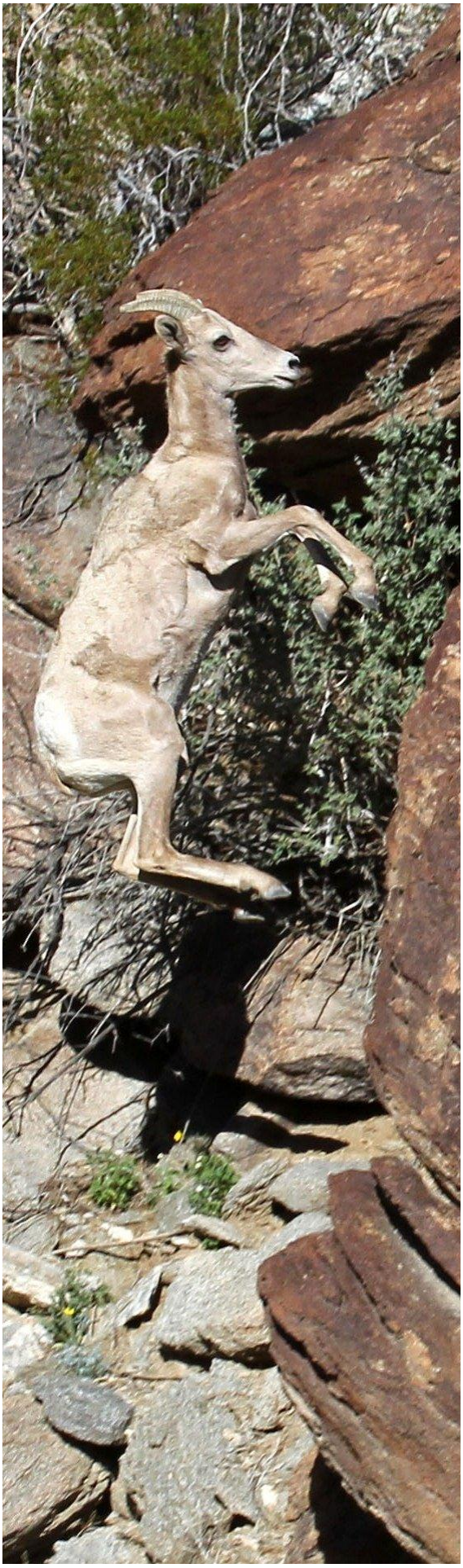
California Department of Fish and Wildlife
South Coast Region

# PENINSULAR BIGHORN SHEEP ANNUAL REPORT 2014





*This report presents information on the status, distribution, and management of peninsular bighorn sheep in eastern San Diego County and portions of Riverside and Imperial Counties*

*A cooperative effort by the California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, and California Department of Parks and Recreation*


*Authors*

*Janene Colby and Randy Botta*

Maps and Graphs produced by
Janene Colby


Suggested background information


U.S. Fish and Wildlife Service (USFWS). 2000. Recovery plan for bighorn sheep in the Peninsular Ranges, California. U.S. Fish and Wildlife Service, Portland, OR. xv +251 pp.

California Department of Fish and Wildlife Peninsular Bighorn Sheep 2012 Annual Report and Recovery Program Review 1993 - 2012

# California Department of Fish and Wildlife
# Peninsular Bighorn Sheep Annual Report 2014
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**California Department of Fish and Wildlife**
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**EXECUTIVE SUMMARY**

Presently, the population of desert bighorn sheep (*Ovis canadensis nelsoni*) in the Peninsular Ranges is considered to be stable to increasing based on the most recent 2010 California Department of Fish and Wildlife (CDFW) range-wide survey estimate of 955 bighorn sheep.

At the beginning of 2014, the 9 recovery regions within the Peninsular Ranges contained a total of 56 (49 ewes & 7 rams) active radio-collared bighorn sheep. In the fall of 2014, an additional 50 bighorn sheep were radio-collared within 5 recovery regions. Throughout the year, there were 9 radio-collared bighorn sheep mortalities range-wide. Mortalities by recovery region were: Northern Santa Rosa Mountains = 2 ewes; Central Santa Rosa Mountains = 1 ewe; Southern Santa Rosa Mountains = 1 ewe; Vallecito Mountains = 1 ewe; and Carrizo Canyon = 4 (1 ewe & 3 rams). The average age of sheep that died was 9-years-old with a range between 5 and 14 years. At the close of 2014, there were a total of 95 (89 ewes & 6 rams) radio-collared bighorn sheep throughout the recovery regions.

Estimating lamb survival range-wide is difficult due to the amount of intensive monitoring necessary. However, lamb survival rates in the recovery regions monitored are typically asynchronous among regions and years and have ranged between 0 and 70% with an average of 30% survival at 6 months. Anza-Borrego Desert State Park (ABDSP) conducts an annual waterhole count each summer in which lamb to ewe ratios are estimated for specific areas of 4 recovery regions; and, in 2014, the estimated lamb survival was 32%. CDFW has monitored lamb survival and recruitment within 2 to 5 recovery regions from 2008 to 2014 and has found varying degrees of pneumonia in all 5 recovery regions. Pneumonia in lambs has been of particular concern in the Northern San Ysidro Mountains; however, in 2014 lamb survival to 6 months was estimated at 45%; a vast improvement compared to the previous 6 years.

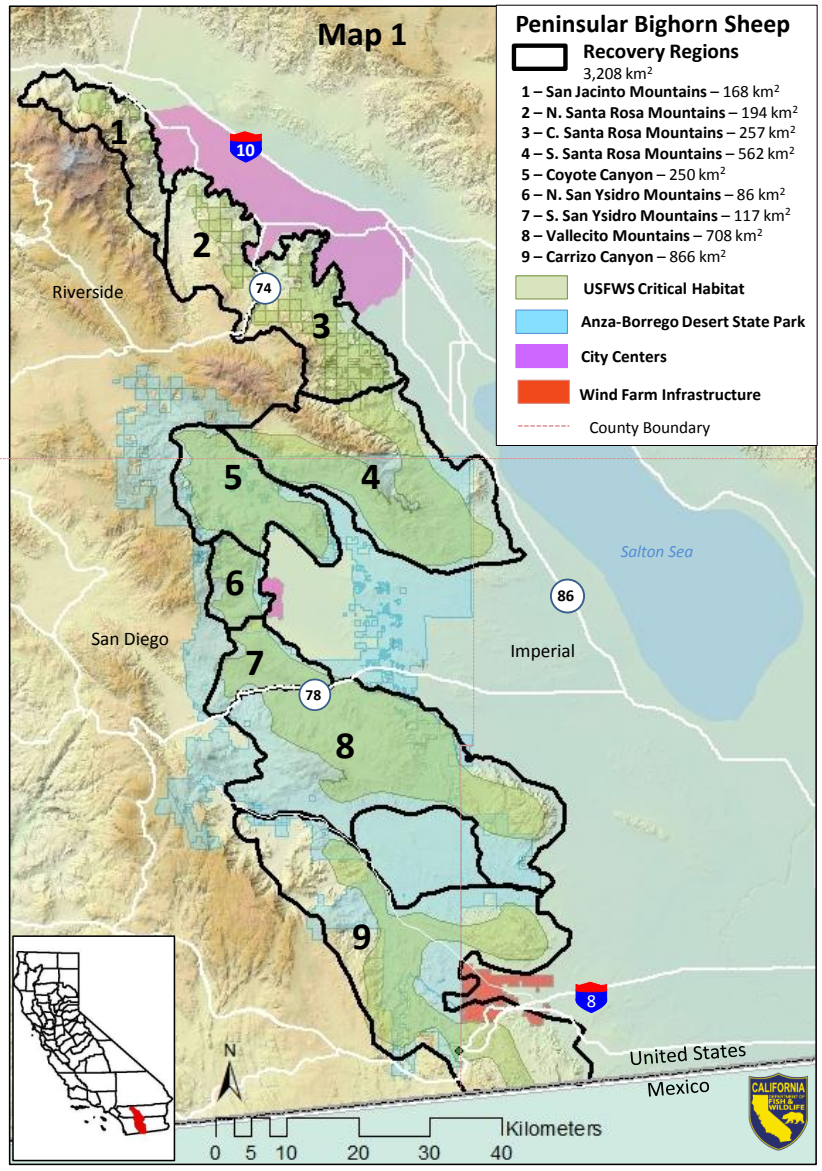
Presently, there is a high degree of bighorn sheep connectivity among ewe groups and recovery regions. However, bighorn sheep continue to be killed by vehicles on the following roads: Highway 74, Highway 78, Interstate 8, County Roads S22, and S3; and as traffic levels increase, connectivity across these roads may be lost. Other concerns that may hinder recovery efforts are: disease, the loss of natural water sources, reduction and fragmentation of sheep habitat, sheep use of urban areas, and human disturbance of essential sheep habitat especially around the urban centers. Yet, even in more remote regions renewable energy projects and border enforcement activities may alter, discourage, or restrict sheep movement and habitat use of important resources.

Hopefully, continued efforts by CDFW to monitor sheep health, habitat use and movements throughout the range will provide federal, state, and local governmental agencies and city planners information to make land use decisions that allow for the health and long-term survival of peninsular bighorn sheep.

## BACKGROUND

This report highlights information collected by CDFW on Peninsular bighorn sheep capture and radio-collaring, cause specific mortality, survival, distribution and movement, and percentage of radio-collared bighorn sheep in the Peninsular Mountain Ranges of southern California from 1 January 2014 through 31 December 2014.

The Peninsular bighorn sheep population contains 9 designated recovery regions occupying portions of western Riverside and Imperial Counties and eastern San Diego County (Map 1). The 9 recovery regions are: 1) San Jacinto Mountains (SJM), 2) Northern Santa Rosa Mountains (NSRM), 3) Central Santa Rosa Mountains (CSRM), 4) Southern Santa Rosa Mountains (SSRM), 5) Coyote Canyon (CoC), 6) Northern San Ysidro Mountains (NSYM), 7) Southern San Ysidro Mountains (SSYM), 8) Vallecito Mountains (VM), and 9) Carrizo Canyon (CC).




CDFW conducted aerial telemetry monitoring activities from a Cessna 185 fixed-winged aircraft in all 9 recovery regions twice a month. Aerial flights were used to monitor radio-collared sheep for activity status (alive/dead), estimate locations, and download GPS location data. Telemetry flight monitoring ceased in December with the retirement of CDFW Warden/Pilot Tom Evans who has yet to be replaced. Telemetry flights are expected to resume in March 2015 once a new pilot is hired.

CDFW conducted ground telemetry monitoring of radio-collared sheep weekly in CoC, NSYM, SSYM, CC, and as time allowed in the VM. CDFW jointly monitored sheep in the CSRM as time allowed with the Bighorn Institute (BI), while the NSRM and SJM were ground monitored solely by BI. Ground monitoring efforts were focused on: 1) mortality investigations, 2) observations of sheep composition, health, and status, and 3) spatial and temporal movements of collared sheep across Interstate 8 and the US-Mexico border.

## PERSONNEL

### *CDFW South Coast Region, Wildlife Management Program*

Mr. Randy Botta, Senior Environmental Scientist (Specialist) for the South Coast Region provided oversight for range-wide population monitoring activities, managed all capture activities, assisted with aerial telemetry flights, and supervised one field position. Ms. Janene Colby, Environmental Scientist with the South Coast Region conducted all field telemetry monitoring, mortality investigations, GIS mapping of sheep locations, data analysis and reporting, and assisted with aerial telemetry flights and capture activities.

***CDFW Resource Management and Air Services Divisions***

Dr. Ben Gonzales, Senior Wildlife Veterinarian with the Department's Resource Management and Policy Division acted as veterinary coordinator on capture operations, managed population health and disease screening and reporting, and coordinated helicopter capture contracting. Mr. Steve Torres, Environmental Program Manager with the Department's Resource Management and Policy Division assisted with development of population monitoring and recovery program funding proposals, monitoring methodologies, and acted as primary Department lead for activities carried out by the Bighorn Institute. Mr. Tom Evans, Warden/Pilot for the Department's Air Services Division piloted all aerial telemetry flights.

**CAPTURE AND RADIO-COLLARING**

As part of the on-going Peninsular Ranges bighorn sheep monitoring and recovery program and U.S. Customs and Border Patrol (CBP) border mitigation monitoring project, CDFW in cooperation with U.S. Fish and Wildlife Service (USFWS), California Department of Parks and Recreation – Anza-Borrego Desert State Park (ABDSP), and Coachella Valley Conservation Commission (CVCC) conducted a bighorn sheep capture during 31 October and 2-5 November 2014. Capture operations were conducted on publicly administered lands in the CSRM (Region 3), CoC (Region 5), NSYM (Region 6), VM (Region 8), and CC (Region 9). Due to time constraints and capture delays, sheep were not captured in the SJM (Region 1). Capture of all bighorn sheep was carried out by Leading Edge Aviation under contract with CDFW, USFWS and the CVCC. Base camp processing of captured bighorn sheep was carried out by personnel from CDFW with assistance from USFWS, ABDSP, Bureau of Land Management (BLM), and BI. The project objective was to capture and fit Very High Frequency (VHF) and Global Positioning System (GPS) radio-collars (hereafter collars) to a subset of adult ewes and rams to: 1) increase the number of collared ewes and add collared rams to identify whether CBP and public use activities modify movement and behavior, 2) maintain collars on approximately 25-30% of the ewe population for mark-resight surveys by collaring new ewes, 3) better define the temporal and spatial movement patterns of bighorn sheep crossing roadways and the US-Mexico border, 4) determine the temporal and spatial movement patterns of bighorn sheep crossing between targeted recovery regions, and 5) better define sheep distribution and ewe group organization in the targeted recover regions.

During the five day operation a total of 54 bighorn sheep (50 ewes & 4 rams) were captured. This included 12 bighorn sheep in the CSRM (11 ewes & 1 ram), 3 bighorn sheep in CoC (2 ewes & 1 ram), 10 ewes in NSYM, 19 ewes in the VM, and 10 bighorn sheep in CC (8 ewes & 2 rams). Of the 54 bighorn sheep captured, 31 ewes were fitted with VHF collars with attached GPS units (hereafter GPS collars), 19 bighorn sheep (17 ewes & 2 rams) were fitted with VHF collars only, and four bighorn sheep (2 ewes & 2 rams) received ear tags only. All collared bighorn sheep were fitted with unique combinations of colored collars and ear tags to facilitate individual identification.

All bighorn sheep arrived in base camp in good condition with only a few minor cuts and abrasions. All bighorn sheep appeared normal with respect to disease or injuries with the exception of 1 ewe in the Vallecito Mountains that had a slight nasal discharge and 3 ewes in the CSRM and 1 ewe in the NSYM that showed signs of chronic sinusitis based on horn necrosis. At base camp each bighorn sheep was weighed, examined, body measurements taken, blood, fecal, and nasal swabs collected, and collars attached. Prophylactic drugs administered included Vitamin E (3 ml) and NuSe (1 ml). All bighorn sheep were aged based on the number of permanent incisor teeth present and horn annuli (for males in particular). The average age of captured ewes was 5.7 years with a range from 1.5 to 15.5 years (n = 50). The average age of captured rams was 5.5 years with a range of 6.5 to 9.5 years (n = 4). For further details, refer to Peninsular Bighorn Sheep Post-Capture Report 2014.

A fixed-wing aerial monitoring flight was conducted two weeks post-capture and ground monitoring of collared bighorn sheep along with visual observation (when possible) was undertaken for three weeks post-capture. No mortalities were detected during this time.

## RADIO-COLLAR STATUS

As recommended in the recovery plan for peninsular bighorn sheep, CDFW maintains, to the extent possible, active VHF collars on approximately 25-30% of all ewes in each recovery region. Maintaining at least 25% collared ewes is important for generating reliable mark-resight population estimates based on helicopter surveys. Since 1993, CDFW has produced the official range-wide bighorn sheep population estimate by conducting helicopter surveys in the fall of even numbered years and captures to fit needed collars on sheep during the fall of odd numbered years; however, range-wide helicopter surveys have not been conducted since 2010 due to lack of a CDFW helicopter contract and capture activities were not conducted in 2011. Contract negotiations are almost complete and a range-wide helicopter survey is being planned for fall 2016. Capture activities have been conducted in 2012, 2013, and 2014 in order to generate a reliable mark-resight population estimate for the 2016 survey. Presently, only 3 of 9 recovery regions have approximately 25% collared ewes (SJM, NSYM & VM: Table 1). The SSRM and the SSYM have only 1 functioning VHF-collared ewe within each region and several other regions fall well below 25% collared ewes (NSRM, CSRM, and CoC). The objective of the fall 2015 capture is to fill the collared gaps that presently exist with the goal being that there will be approximately 25% collared ewes in each recovery region prior to the 2016 survey.

Table 1. Distribution and numbers of active radio-collared female (F) and male (M) bighorn sheep within the 9 recovery regions at the beginning and end of 2014. SJM = San Jacinto Mountains, NSRM = Northern Santa Rosa Mountains, CSRM = Central Santa Rosa Mountains, SSRM = Southern Santa Rosa Mountains, CoC = Coyote Canyon, NSYM = Northern San Ysidro Mountains, SSYM = Southern San Ysidro Mountains, VM = Vallecito Mountains, CC = Carrizo Canyon. The estimated percentage of females radio-collared (% F Collared) at the end of 2014 is based on the ewe abundance estimates from the most recent range-wide helicopter survey in 2010.

| | SJM | | NSRM | | CSRM | | SSRM | | CoC | | NSYM | | SSYM | | VM | | CC | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M |
| 1/1/2014 | 6 | 0 | 7 | 0 | 6 | 0 | 1 | 0 | 4 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 21 | 7 |
| additions | | | | | 9 | | | | 2 | | 10 | | | | 19 | | 8 | 2 |
| mortalities | | | -2 | | -1 | | | | | | | | -1 | | | | -1 | -3 |
| censored | | | | | -2 | | | | | | | | | | -1 | | | |
| 12/31/2014 | 6 | 0 | 5 | 0 | 12 | 0 | 1 | 0 | 6 | 0 | 10 | 0 | 1 | 0 | 20 | 0 | 28 | 6 |
| % F Collared | 26% | | 13% | | 17% | | 1% | | 13% | | 25% | | 3% | | 25% | | 21% | |

At the beginning of the 2014 reporting period, the 9 recovery regions contained a total of 56 (49 ewes & 7 rams) active collars and at the end of 2014 there were a total of 95 (89 ewes & 6 rams) active collars. Collars were lost through mortality in the NSRM, CSRM, SSYM, and CC while collars became non-functional in CSRM and VM. The number of collars fitted to ewes and rams and the percentages of marked ewes in each recovery region at the beginning and end of 2013 are listed in Tables 1.

## POPULATION SIZE AND ESTIMATION

The most recent range-wide estimate of 955 bighorn sheep was conducted by CDFW in 2010. The population is considered to be stable to increasing (Table 2). A range-wide survey is anticipated for fall of 2016. A detailed review of population estimates, ewe abundance, and lamb:ewe ratios from 1993 to 2010 can be found in the CDFW 2012 Annual Report.

Table 2. Peninsular bighorn sheep population estimates for each recovery region for years 2006, 2008 and 2010 based on CDFW helicopter surveys. Map of recovery regions depicts the adjusted population estimate by including the Bighorn Institutes 2014 estimates for the SJM and NSRM. Approximately 66% of the area within the recovery regions lies within ABDSP; and ~ 600 of the estimated 961 bighorn sheep are within the Park.

| Recovery Regions | Year 2006 | 2008 | 2010 |
|---|---|---|---|
| SJM | 21 | 26 | 16 |
| NSRM | 49 | 77 | 90 |
| CSRM | 163 | 122 | 133 |
| SSRM | 179 | 155 | 149 |
| CoC | 42 | 52 | 66 |
| NSYM | 79 | 82 | 72 |
| SSYM | 38 | 53 | 55 |
| VM | 77 | 123 | 142 |
| CC | 145 | 186 | 232 |
| Total | 793 | 876 | 955 |

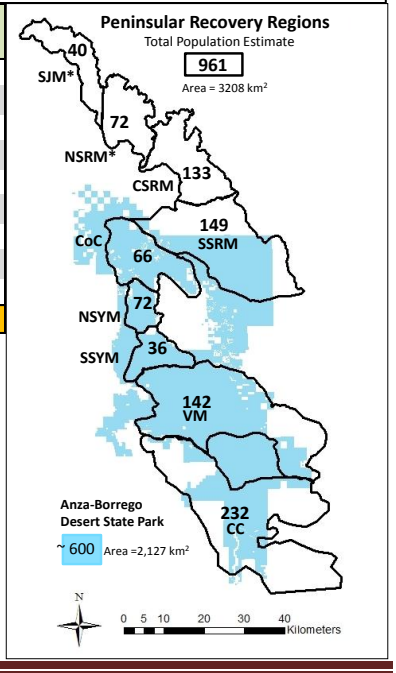


Table 3. ABDSP 4th July water hole count results from 2011 to 2014 in the SSRM, CoC, NSYM, SSYM. Count results are listed as: number of adult females (No. Ewe), number of lambs (No. Lamb), number of yearling males (No. YM), number of yearling females (No. YF), number of adult males (No. Ram), total sheep counted (Total), percent of lambs per 100 ewes (Lamb/Ewe), percent of male and female yearling per 100 ewes (Yrling/Ewe), and percent of rams per 100 ewes (Ram/Ewe).

| Year | Region | No. Ewe | No. Lamb | No. YM | No. YF | No. Ram | Total | Lamb/Ewe | Yrling/Ewe | Ram/Ewe |
|---|---|---|---|---|---|---|---|---|---|---|
| 2011 | SSRM | 39 | 27 | 5 | 4 | 9 | 84 | 69% | 23% | 23% |
| 2012 | SSRM | 24 | 11 | 4 | 1 | 9 | 49 | 46% | 21% | 38% |
| 2013 | SSRM | 23 | 13 | 3 | 1 | 9 | 49 | 57% | 17% | 39% |
| 2014 | SSRM | 36 | 20 | 5 | 11 | 7 | 79 | 56% | 44% | 19% |
| 2011 | CoC | 57 | 14 | 2 | 0 | 24 | 97 | 25% | 4% | 42% |
| 2012 | CoC | 53 | 16 | 6 | 6 | 20 | 101 | 30% | 23% | 38% |
| 2013 | CoC | 58 | 11 | 3 | 3 | 27 | 102 | 19% | 10% | 47% |
| 2014 | CoC | 37 | 9 | 2 | 0 | 19 | 67 | 24% | 5% | 51% |
| 2011 | NSYM | 42 | 3 | 4 | 3 | 18 | 70 | 7% | 17% | 43% |
| 2012 | NSYM | 27 | 10 | 1 | 3 | 23 | 64 | 37% | 15% | 85% |
| 2013 | NSYM | 48 | 5 | 5 | 5 | 35 | 98 | 10% | 21% | 73% |
| 2014 | NSYM | 27 | 11 | 1 | 3 | 19 | 61 | 41% | 15% | 70% |
| 2011 | SSYM | 26 | 12 | 3 | 1 | 34 | 76 | 46% | 15% | 131% |
| 2012 | SSYM | 22 | 8 | 7 | 1 | 16 | 54 | 36% | 36% | 73% |
| 2013 | SSYM | 33 | 13 | 4 | 1 | 24 | 75 | 39% | 15% | 73% |
| 2014 | SSYM | 19 | 0 | 5 | 1 | 32 | 57 | 0% | 32% | 168% |

BI monitored sheep within the SJM and NSRM throughout 2013 (Regions 1 & 2). In the SJM, they estimated there were approximately 40 adult bighorn sheep (23 ewes & 17 rams) with lamb survival at approximately 35%. In the NSRM, they estimated there were approximately 72 adult bighorn sheep (40 ewes & 32 rams) with lamb survival at approximately 25% (Table 2-Map).

ABDSP volunteers conduct an annual 4th of July water hole count in portions of the SSRM, CoC, NSYM, and SSYM (Regions 4-7). The count is not considered an estimate of sheep population within each of these regions or within ABDSP because it does not take place at all available water sources within each of these regions nor does the count cover all regions within ABDSP. However, it is an important indicator of long-term trends and lamb survival to 6-months-of-age within the areas the count is conducted. The waterhole count results from 2011 to 2013 are summarized in Table 3.

## CAUSE-SPECIFIC MORTALITY AND SURVIVAL

There were 9 radio collared mortalities in 2014 range-wide (Table 4). Mortalities by recovery region were NSRM = 2 ewes; CSRM = 1 ewe; SSYM = 1 ewe; VM = 1 ewe; and CC = 4 (1 ewe & 3 rams). The average age of sheep that died was 9-years-old with a range between 5 and 14 years. Only 9% of sheep with collars died this year; well below the yearly average of 12%. Over all years, on average, 7% of all active collared sheep die due to lion predation and probable predation combined whereas non-predation and all other causes combined accounted for only 5%. In contrast, in 2014, only 2% of deaths were due to predation versus 7% due to all other causes combined. Deaths attributed to predation occur most frequently during the cooler months when average temperatures dip below 80 degrees Fahrenheit (Figure 1). 2014 was no exception to this rule, with both deaths attributed to predation occurring in December. Despite the fact that on average a little over half the collared sheep that die each year is due to predation, the sheep population range-wide is stable to increasing. Furthermore, because the majority of sheep killed by lions are older animals, with an average age of 9-years-old (median & mode = 9; n=89); predation, range-wide in general over most years since 1993, is compensatory rather than additive.

Table 4. Cause of death for 9 radio-collared bighorn sheep in the Peninsular Ranges from January 1 to December 31, 2014.

| Sheep ID | Location | Sex | Age (yrs.) | Month | Cause |
|---|---|---|---|---|---|
| 284 | Carrizo | F | 5 | March | Vehicle Collision |
| 295 | Carrizo | M | 7 | May | Unknown nonpredation |
| 296 | Carrizo | M | 9 | July | Unknown nonpredation |
| 304 | Carrizo | M | 9 | September | Capture related[a] |
| 360 | CSRM | F | 10 | December | Probable Lion |
| 160-SAG* | NSRM | F | 5 | July | Fall (Broken neck) |
| 71-ILA* | NSRM | F | 14 | December | Lion |
| 207 | SSYM | F | 13 | March | Unknown |
| 170 | Vallecito | F | 14 | August | Unknown nonpredation[b] |

*Mortality information provided by Bighorn Institute
[a] Ram died 11 months post-capture due to back foot becoming stuck in the radiocollar.
[b] The radiocollar for ewe 170 went nonfunctional in 2011.

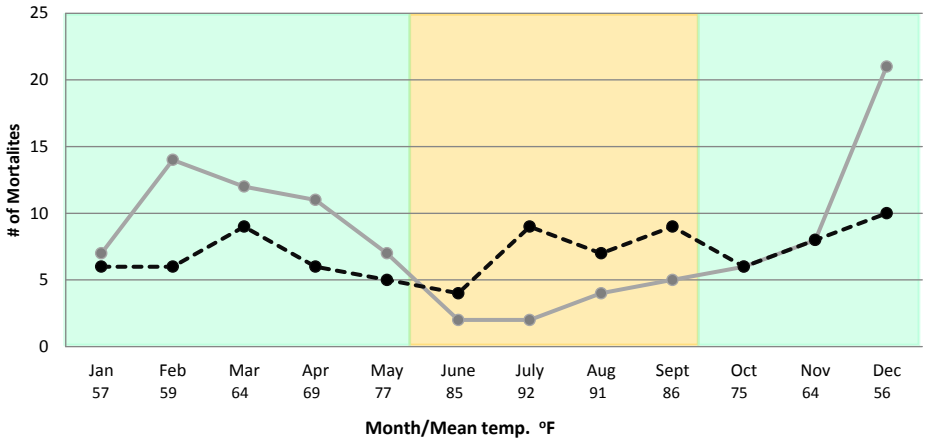



Figure 1. Number of Mortalities by month from 1993 to 2014. Grey solid line = lion and probable lion mortalities combined; Black dashed line = all non-predation mortalities. Average monthly temperatures from 1993 to 2014 listed below each month in degrees Fahrenheit (°F).

**LAMB SURVIVAL AND RECRUITMENT**

Estimating lamb survival range-wide is difficult due to the amount of intensive monitoring necessary. Furthermore, lamb survival rates are typically asynchronous among recovery regions and years (Table 5). However, CDFW monitored lamb survival of collared ewes in the CoC, NSYM and SSYM recovery regions since 2008, and the In-Ko-Pah (IKP) ewe group (within the CC recovery region) since 2010. Lamb pneumonia has been documented in all 4 recovery regions with the lowest rates of survival within the NSYM followed by the CoC from 2008 to 2012. Lamb survival was the highest in the IKP ewe group and second highest in the SSYM ewe group (Details and descriptive statistics concerning lamb production, timing of parturition, lamb survival to 3 months, onset of lamb pneumonia, and timing of lamb deaths can be found in the CDFW 2012 Annual Report). Lamb monitoring did not occur in CoC and SSYM in 2013 or 2014 due to time constraints and the lack of collared ewes; however, group observations were obtained in NSYM and CC recovery regions in order to obtain lamb:ewe and yearling:ewe ratios as an index of lamb survival and recruitment.

Table 5. Index of lamb survival (3M Survival) and recruitment of lambs to yearlings (Recruitment) in CoC, NSYM, SSYM, and CC regions. Three-month lamb survival was calculated from lamb:ewe ratios from group observations obtained from May-June of one year and matched with yearling:ewe ratios (recruitment) from January - June the following year. For example in 2012 in CoC, 36% of lambs survived to 3-months-old (3M Survival), and 7% survived to yearlings (Recruitment) in 2013. *Data has not been obtained. In CC, lamb survival statistics did not begin until 2010.

| Year | | Coyote Canyon | | NSYM | | SSYM | | In-Ko-Pah | |
|---|---|---|---|---|---|---|---|---|---|
| 3M Survival | Recruitment | 3M Survival | Recruitment | 3M Survival | Recruitment | 3M Survival | Recruitment | 3M Survival | Recruitment |
| 2008 | 2009 | 66% | 21% | 43% | 21% | 64% | 29% | | |
| 2009 | 2010 | 51% | 31% | 30% | 24% | 41% | 18% | | |
| 2010 | 2011 | 37% | 24% | 14% | 19% | 61% | 28% | 79% | 39% |
| 2011 | 2012 | 56% | 4% | 21% | 3% | 58% | 17% | 63% | 20% |
| 2012 | 2013 | 36% | 7% | 13% | 13% | 63% | 38% | 70% | 45% |
| 2013 | 2014 | 26% | [a] | 7% | 18% | 93% | [a] | 51% | 26% |
| 2014 | 2015 | [a] | * | 45% | * | [a] | | 10% | |

In 2014, based on group observations, lamb survival was approximately 45% in NSYM; a vast improvement over the previous 6 years (Table 5). NSYM lamb survival in 2013 was originally estimated at only 7%, however, recruitment was estimated at 18% in 2014; therefore, lamb survival in 2013 was originally underestimated. In 2014, lamb survival among NSYM collared ewes was high with 6 of 7 lambs surviving to 6 months: in comparison, only 2 of 7 lambs survived in 2013. In contrast, based on group observations of the IKP ewe group, recruitment of 2013 lambs (26%) and 2014 lamb survival (10%) was much lower than in previous years. Furthermore, lamb survival among IKP collared ewes was low compared to previous years with only 2 of 8 lambs surviving to 6 months.

Estimates of lamb survival to 6 months in 2014, based on data collected by ABDSP during their annual waterhole count were as follows: SSRM = 56%; CoC = 24%; NSYM = 41%; and SSYM = 0% (Table 3). While it is concerning that no lambs were counted within the SSYM, it may be noted that the count does not take place at all available water sources within each region. Furthermore, there have been some changes in water availability within the SSYM that may be reflected in the sheep count numbers (details in section on Recovery Threats and Management Strategies for SSYM). BI estimated lamb survival at 35% in the SJM and 25% in the NSRM.


**Photo 1**

Environmental factors may contribute to differences among recovery regions in rates of lamb mortality due to pneumonia. For example, in the NSYM, between 2008 and 2013, prior to showing signs of pneumonia, lambs were observed with chronic diarrhea and weight loss. In 2014, while lambs were observed with pneumonia it was not preceded by diarrhea. Possibly, chronic diarrhea and weight loss may weaken immune system response resulting in a decreased chance of surviving pneumonia. The cause of chronic diarrhea is not known, however, Sahara mustard (*Brassica tournefortii*), a non-native herbaceous annual, is readily consumed by ewes and lambs within NSYM

(Photo 1): Sahara mustard is slightly toxic to domestic livestock but its effect on wild sheep is not known. The Sahara mustard population exploded in the Borrego Valley (NSYM & CoC) in 2005, and has been a dominant non-native annual each year since, with the exception of 2014 when insufficient rainfall prevented its widespread germination. High lamb mortality was first noticed in NSYM in 2007 and while the correlation between the explosion of this non-native plant species and high rates of chronic diarrhea in lambs is speculative, it is worth consideration and further investigation.

In 2014, 42% of collared ewes had their lambs in January, 50% in February, and 8% in March. According to data collected on parturition of collared ewes in 4 recovery regions from 2008 to 2014 (n = 190: Table 6), 19% of lambs are born in January, 61% in February, 18% in March, and another 3% between April and August. In 2008, peak parturition was in March; however, since 2008, it has shifted between January and February with a trend towards earlier parturition each year. This shift is most dramatic in the NSYM and CoC: two ewe groups that have suffered from high lamb mortality prior to 3 months. Earlier onset of estrus and conception rates may be higher in these ewes because once lactation ceases, they are able to accumulate body fat reserves sooner in the spring compared to ewes that wean their lambs.

**Table 6. Timing of parturition of radio-collared ewes in CoC, NSYM, SSYM, and IKP ewe groups (n = 190) between 2008 and 2014.**

**CoC**

| Year | January | February | March | April | May |
|---|---|---|---|---|---|
| 2008 | | | **100%** | | |
| 2009 | | **78%** | 22% | | |
| 2010 | 40% | **50%** | | | 10% |
| 2011 | | **100%** | | | |
| 2012 | **89%** | 11% | | | |
| Total | 27% | **53%** | 18% | | 2% |

**NSYM**

| Year | January | February | March | April | May |
|---|---|---|---|---|---|
| 2008 | | 44% | **56%** | | |
| 2009 | 10% | **90%** | | | |
| 2010 | 10% | **70%** | | | |
| 2011 | 9% | **91%** | 0% | | |
| 2012 | **75%** | 25% | | | |
| 2013 | 20% | **80%** | | | |
| 2014 | **80%** | 20% | | | |
| Total | 24% | **64%** | 12% | | |

**SSYM**

| Year | January | February | March | April | August |
|---|---|---|---|---|---|
| 2008 | | 14% | **71%** | 14% | |
| 2009 | | **50%** | **50%** | | |
| 2010 | 18% | **64%** | 18% | | |
| 2011 | 14% | **71%** | 7% | 7% | |
| 2012 | 9% | **64%** | 18% | 0% | 9% |
| 2013 | | 50% | 50% | | |
| Total | 9% | **56%** | 30% | 4% | 2% |

**IKP**

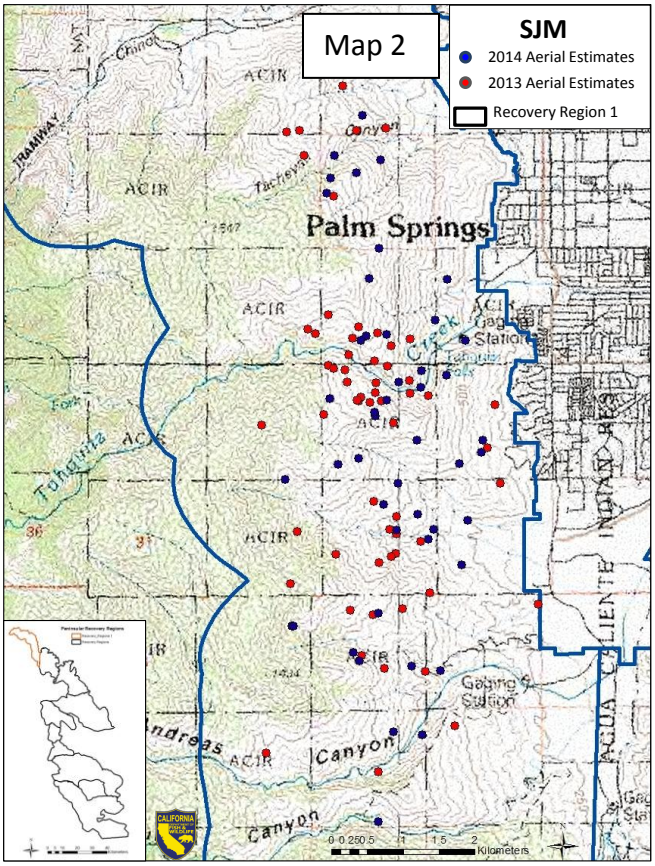
| Year | January | February | March | April | May |
|---|---|---|---|---|---|
| 2010 | 20% | **60%** | 20% | | |
| 2011 | 0% | **100%** | 0% | | |
| 2012 | **60%** | 40% | 0% | | |
| 2013 | | **100%** | | | |
| 2014 | 14% | **71%** | 14% | | |
| Total | 19% | **74%** | 7% | | |

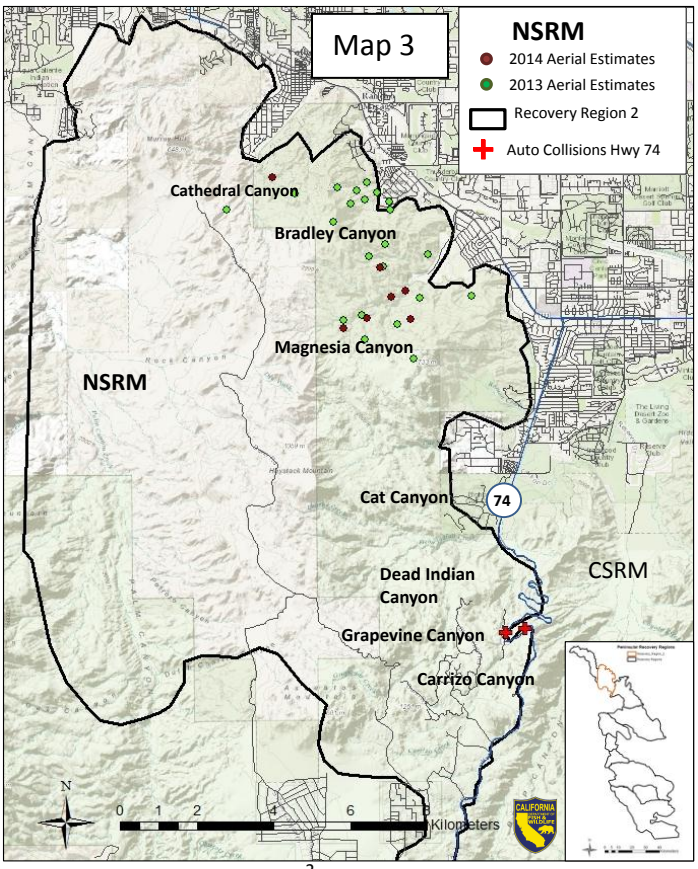
**DISTRIBUTION AND MOVEMENT**

This section summarizes the spatial and temporal patterns of distribution (seasonal use) and movement of ewe groups within each recovery region. The amount of detail in the summary for each region depends on the source of information, the number of collared bighorn sheep within each region, the intensity of field monitoring, as well as the number of GPS-collared sheep within each region. The focus is placed on ewe groups within each region because ewes are the reproductive base of the population. We define a ewe group as a discrete group of ewes that share the same lambing/nursery grounds and the same summer water sources. However, within each ewe group there is some sub-structuring, or subset of ewes, that spend the majority of the year with their adopted ewe group and a small portion of the year with their natal ewe group. We define these individuals or subgroups of ewes as "bridge ewes" since they often bridge the social and physical discontinuities or gaps between ewe groups within a region or across regions. While the seasonal movement patterns of these ewes are atypical, they most likely play an important role in gene flow among populations.

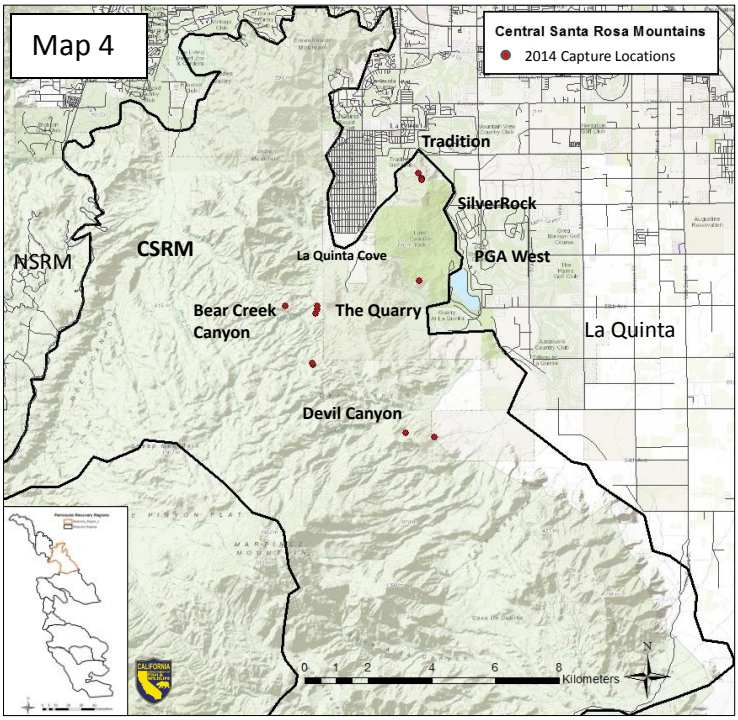
Seasonal use is loosely divided into 3 seasons: prelambing (September/October to December/January), lamb rearing (January/February to April/May), and summer season (May/June to August/September). The seasons were divided in this manner because sheep move to new locations at these junctures or expand or contract their movements as well as change their social behavior, foraging preferences, and group composition during these seasons.

***San Jacinto Mountains:*** The SJM recovery region is approximately 168 square kilometer ($km^2$) with a density of approximately 0.24 sheep per $km^2$. CDFW monitored 6 VHF-collared ewes twice monthly by plane. As time allowed, aerial location estimates were obtained and ranged from Tachevah to Andreas Canyons with the majority of locations focused in the area surrounding Tahquitz Canyon (Map 2). BI conducted daily ground telemetry monitoring and attempted to locate and observe all collared ewes at least twice monthly throughout the year. They documented collared ewes in Chino, Tachevah, Tahquitz, Eagle and Andreas Canyons. All initial sightings of lambs 1-month-old or younger occurred between Andreas and Tachevah Canyons. All 6 collars remained active throughout the year and represents 26% of the ewe population within this recovery region.



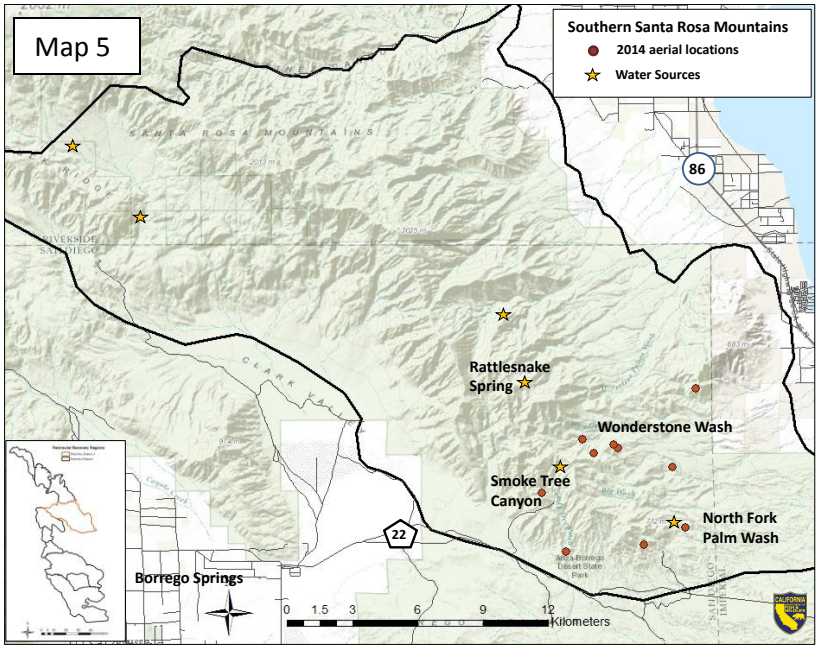




***Northern Santa Rosa Mountains:*** The NSRM recovery region is approximately 194 km$^2$ with a density of approximately 0.37 sheep per km$^2$. CDFW monitored 7 VHF-collared ewes twice monthly by plane. Only a limited number of aerial location estimates were obtained in 2014 with most locations within Cathedral, Bradley and Magnesia Canyons (Map 3). BI conducted daily ground telemetry monitoring and attempted to locate and observe all collared ewes at least twice monthly throughout the year. They have documented two ewe groups within this region: Bradley/Magnesia/Cathedral Canyon (BMC) and Dead Indian Canyon (DI). The BMC sheep were primarily observed within Magnesia and Bradley Canyons with some observations in Cathedral and Cat Canyons. All initial sightings of young lambs were within Magnesia and Bradley Canyons; however, in the fall/winter months a few sheep groups with collared ewes and lambs were observed within Cat Canyon. Presently, there are no functioning collars within the DI group but opportunistic observations were obtained within the areas surrounding Dead Indian, Carrizo, and Grapevine Canyons. Six ewes and their young lambs were observed within Carrizo Canyon. Two radio-collars were lost through mortalities leaving only 5 active collars remaining at the end of the year which represents only 13% of the estimated adult ewe population within this recovery region.



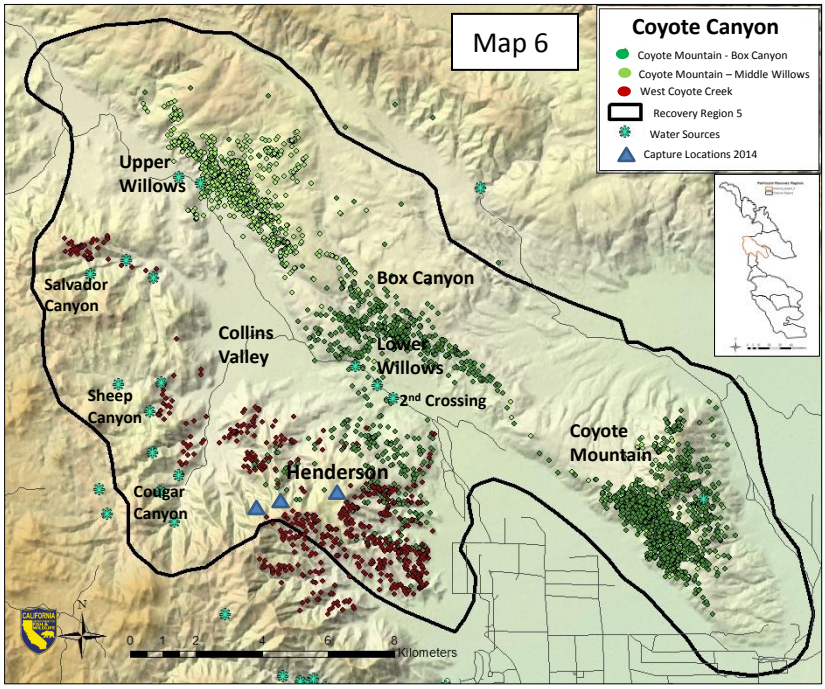

***Central Santa Rosa Mountains:*** The CSRM recovery region is approximately 257 km$^2$ with a density of approximately 0.52 sheep per km$^2$. Throughout the majority of the year, CDFW monitored 6 VHF-collared ewes twice monthly by plane. In November, an additional 9 ewes were captured and deployed with GPS collars and 2 ewes and 1 ram were deployed with

ear tags only. Of the 9 ewes collared, 3 were captured on the slopes above Tradition Golf Course, 1 on the slope above The Quarry Golf Course, 2 between Bear Creek and Devils Canyon, and 1 south of Devils Canyon (Map 4). Of the 3 sheep ear tagged, 1 ewe and 1 ram were captured near Bear Creek Canyon and 1 ewe was captured south of Devils Canyon. Newly collared sheep were monitored via ground and plane for 3 weeks post-capture and no mortalities were detected during this time. Due to the limited amount of location data collected prior to the end of 2014, location and movement data will be reported in 2015. In 2014, 2 collars became nonfunctional and in December, a GPS-collared ewe died, leaving 12 active collars remaining at the close of year. This represents 17% of the estimated adult ewe population within this recovery region.




***Southern Santa Rosa Mountains:*** The SSRM recovery region is approximately 562 km$^2$ with a density of approximately 0.27 sheep per km$^2$. CDFW monitored 1 VHF-collared ewe twice monthly by plane in this recovery region which represents less than 1% of the ewe population. There have been no other collared sheep within this recovery region since 2011. Aerial locations placed this ewe in the area surrounding Wonderstone Wash during lambing season. Summer and fall locations were from Smoke Tree Wash to North Palm Wash (Map 5).

***Coyote Canyon:*** The CoC recovery region is approximately 250 km$^2$ with a density of approximately 0.26 sheep per km$^2$. Throughout the majority of the year CDFW monitored 4 VHF-collared ewes twice monthly by plane. Ground monitoring was conducted as time allowed. During the fall capture, an additional 2 ewes were captured and deployed with collars (1 with GPS & 1 with VHF) in the upper northwest portion of Henderson Canyon. One young ram was captured a few drainages north of Henderson Canyon and deployed with ear tags. Presently, approximately 13% of this ewe population is collared.

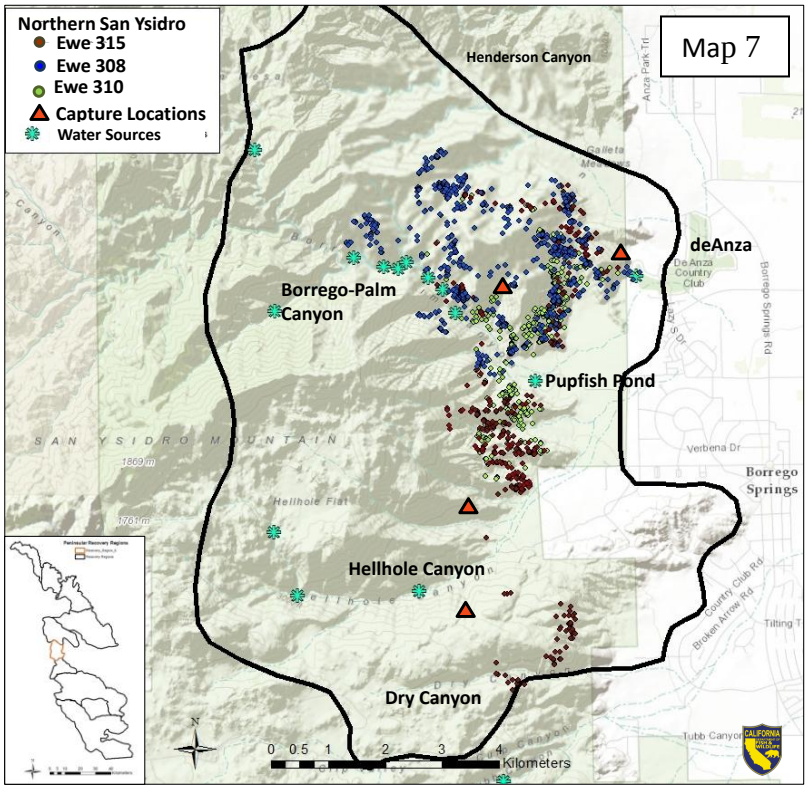



Past observations and GPS data have identified at least 2 ewe groups within this region with a fair amount of ewe group sub-structuring most likely due to the multitude of water sources in numerous canyons throughout the region. The Coyote Mountain ewe group spends the lamb rearing season on Coyote Mountain whereas the West Coyote Creek ewe group utilizes Henderson Canyon and the canyons directly north and west of Coyote Creek during the lamb rearing season (Map 6). Sub-structuring of the Coyote Mountain ewe group occurs during the summer and prelambing season as half of these ewes move to the east side of Coyote Creek near Middle Willows while the other half spend the summer and prelambing season in the areas surrounding Box Canyon and Lower Willows with occasional movement across the creek into Henderson Canyon. The West Coyote Creek ewe group move between the water source at 2$^{nd}$ crossing and available water in Salvador, Sheep,

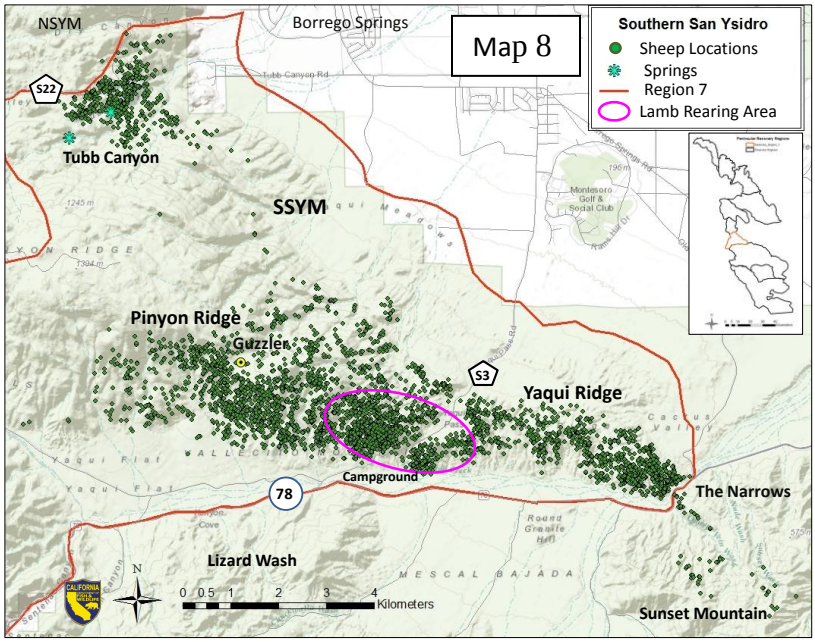
Indian, and Cougar Canyons to the west of Collins Valley during the fall and summer months (details of ewe group structure and movements can be found in the 2012 Annual Report).

Thus far the movement patterns of the newly collared ewes appear to be typical for this region. Soon after capture, the VHF-collared ewe moved to the area surrounding Middle Willows and remained in that area through the end of the year. Six days post-capture, the GPS-collared ewe moved across Coyote Canyon near 2nd crossing to a drainage east of Box Canyon and then moved southeast to Coyote Mountain. In mid-December the ewe moved back across Coyote Canyon just north of Horse Camp via Ocotillo Flats and returned to a drainage north of Henderson Canyon. After 1 week within this drainage, the ewe once again crossed Coyote Canyon using the same approximate crossing location and returned to Coyote Mountain. It is not uncommon for ewes to make multiple short trips (reconnaissance) to the lamb rearing area during the prelambing season.


***Northern San Ysidro Mountains:*** The NSYM recovery region is approximately 86 km$^2$ with a density of approximately 0.84 sheep per km$^2$. Prior to the November 2014 capture, there were no functioning collars remaining within this recovery region. However, 7 VHF-nonfunctioning collared ewes that inhabit the area surrounding Borrego-Palm Canyon (BPC) were frequently observed opportunistically. These ewes were most often observed during lambing season on the south-facing slopes of BPC. Typically, during the summer months, the creek in BPC dries up except at about 5 to 6 locations within the Canyon: also, there is a water source in Hellhole Canyon to the south. In 2014, the area only received 0.43 inches of rain in August (compared to 2.01" in 2013) and as a result there was virtually no standing water within BPC by the end of August. In late August and September, sheep concentrated their use in the area surrounding the pupfish pond (Photo 2) which is located next to the visitor parking lot at the mouth of BPC. Word soon got out that sheep could easily be viewed at the parking lot and people started showing up for photo opportunities. As a result, on 16 September, Ranger Jeri Zemon closed the parking lot for the remainder of the month in order to allow sheep to obtain water without being disturbed by ABDSP visitors. October marked the month sheep shifted their movements to deAnza Country Club which coincides with the month the golf course and lawns were reseeded and watered resulting in a green-up throughout the development. Since 2009, CDFW has documented large numbers of sheep using deAnza Country Club during the fall months. This change in foraging behavior may have been due to the lack of monsoon rains which typically occur in August each year and provide a green up after the long dry summer months. Sheep did not heavily use the golf course in fall 2010 & 2013 when rainfall was adequate to result in a fall green up within the NSYM. In 2014, groups of 6 to 30 sheep (including three 10-month-old ram lambs) used the DeAnza development on a daily basis from October through December. Lambs learn seasonal movement patterns from their dams, and as more ewes bring their lambs to forage at deAnza and become habituated this may become part of their regular fall seasonal movement pattern irrespective of weather conditions.

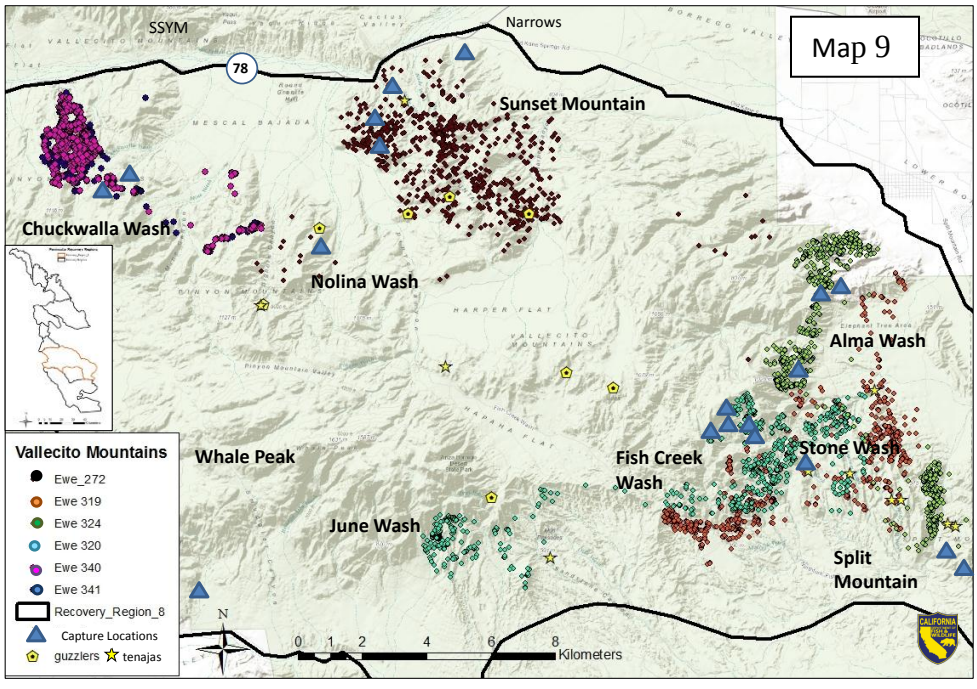


On 31 October, 10 ewes were captured and deployed with collars (4 with GPS & 6 with VHF), which represent approximately 25% of the ewe population within this region. Of the 10 ewes collared, 3 were captured on the slopes above deAnza Country Club, 3 were captured in the first north side drainage of BPC, 2 were captured in a drainage north of Hellhole Canyon, and an additional 2 were captured within Hellhole Canyon (Map 7). According to GPS data for November and December, 3 of the 4 GPS-collared ewes have used the area from BPC to Dry Canyon within the NSYM. Their use is concentrated within the area surrounding BPC and their movements form a circular pattern around the lower slopes of Indian Head. GPS data recorded a small number of visits to deAnza in November and December. The remaining GPS-collared ewe moved to Coyote Mountain soon after capture and GPS data is yet to be obtained.




***Southern San Ysidro Mountains:*** The SSYM recovery region is approximately 117 km$^2$ with a density of approximately 0.31 sheep per km$^2$. CDFW monitored 2 collared ewes twice monthly by plane in this recovery region in 2014. One collared ewe died in March leaving only 1 collared ewe which represents just 3% of the ewe population. As a result, ground observations were very limited in 2014.

Based on past VHF and GPS data the main nursery and lambing grounds are located on the south side of Yaqui Ridge and Pinyon Ridge and is divided by County Road S-3 (Map 8). The road is often crossed by sheep during the peak of lamb rearing season. Highway 78 at the Narrows is also crossed frequently at this time of year. During the summer season, some ewes move northwest to the water sources within Tubb Canyon while others will remain on the south slopes of Pinyon Ridge. In the latter half of the prelambing season, activity moves east out onto Yaqui Ridge. Over the years there have been a number of ewes documented that bridge the gap between the Vallecito and NSYM recovery regions. Each year ewe 270 would move across Highway 78 at the Narrows and give birth on the north side of Sunset Mountain and spend approximately 30 days postpartum with the Sunset Mountain ewe group before rejoining the SSYM ewe group for the remainder of the year. Conversely, Ewe 170 along with several other ewes spent the majority of each year within the Vallecito recovery region in the area surrounding Lizard Wash but crossed highway 78 east of Tamarisk Campground and joined the SSYM ewe group during the lamb rearing season. Ewe 243 would move into the NSYM during lamb rearing season before returning the SSYM ewe group. (Details of ewe group structure and movements can be found in the 2012 Annual Report).

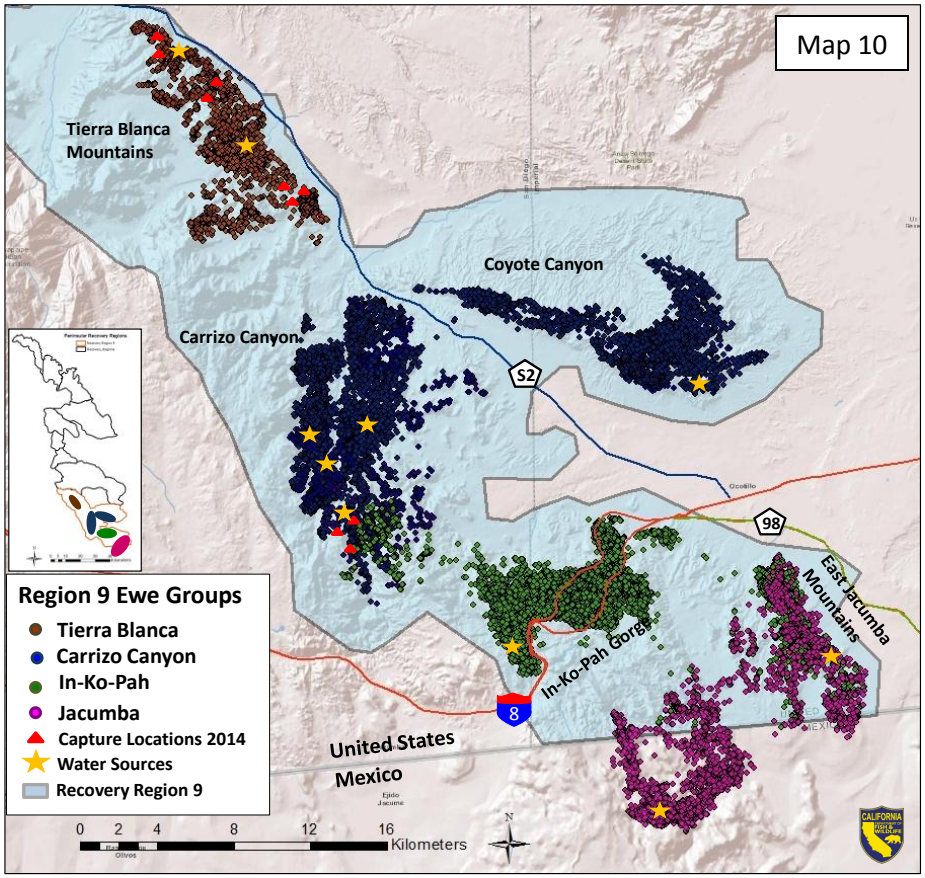



***Vallecito Mountains:*** The VM recovery region is approximately 708 km$^2$ with a density of approximately

0.20 sheep per km$^2$. It is the 2$^{nd}$ largest of all the recovery regions and is one of the most remote, with no paved roads and only a few jeep trails. There are 8 guzzlers and numerous tenajas throughout the region.

Prior to the fall capture, CDFW monitored 2 VHF-collared ewes by plane twice a month; however, soon after the start of the year, 1 collar became nonfunctional. In November, 19 ewes were captured and deployed with collars (10 with GPS & 9 with VHF) which represents approximately 25% of the ewe population. This recovery region represents a vast area with numerous water sources yet presently little is known concerning ewe group structure, lambing and nursery grounds, and seasonal movements (details of ewe group structure and movements can be found in the 2012 Annual Report). Therefore, during the capture great emphasis was placed in capturing ewes throughout the region within the bounds of ABDSP. Of the 19 ewes collared, 4 were captured north of Sunset Mountain, 1 near Nolina Wash, 2 near Chuckwalla Wash, 1 in the alluvial fan south of Whale Peak, 2 north and 1 south of Alma Wash, 5 north of Fish Creek Wash, 1 south of Stone Wash, and 2 were captured east of Split Mountain (Map 9). Prior to the close of the year, GPS data have been collected on 5 of the 10 GPS-collared ewes. The two ewes captured near Chuckwalla Wash continue to use the area north of the wash and west of Lizard Wash, and appear to travel together. Ewe 319, captured near Stone Wash, has moved between the slopes north of Alma Wash to a major drainage just west of North Fish Creek Wash. She often utilizes the lower elevations surrounding Stone, Lycium, and Oyster Shell Washes. This ewe also crosses and forages in the relatively flat expanse of the alluvial fan of Alma Wash rather than contouring across the lower portion of the steep slopes to the west. Ewe 320, captured near North Fish Creek Wash, moves on an east-west access between the lower elevations surrounding June Wash and the Mud Palisades in the west to the lower elevations of North Fish Creek, Stone, and Lycium Washes to the east. In contrast, Ewe 324, captured north of Alma Wash, moves on a north south access which extends from 3 kilometers north of Alma Wash to 7 kilometer south in the Split Mountain area. Unlike ewe 319, this ewe has not used the alluvial fan of Alma Wash thus far.

***Carrizo Canyon:*** CC is the largest recovery region at approximately 866 km$^2$ with a density of approximately 0.27 sheep per km$^2$. CDFW monitored 28 collared bighorn sheep (21 ewes &7 rams) at the onset of 2014 with the addition of 10 new collared bighorn sheep (8 ewes & 2 rams) in November. Unfortunately, 4 collars were lost through mortalities (1 ewe & 3 rams) ending the year with 34 active collars (28 ewes & 6 rams) representing 21% of the ewe population. Monitoring was conducted by plane twice a month and ground monitoring occurred at least 4 times a month in order to record observation on health status, pregnancy status, lambing locations, and movements of all collared sheep, and to remotely download data from sheep deployed with GPS collars.

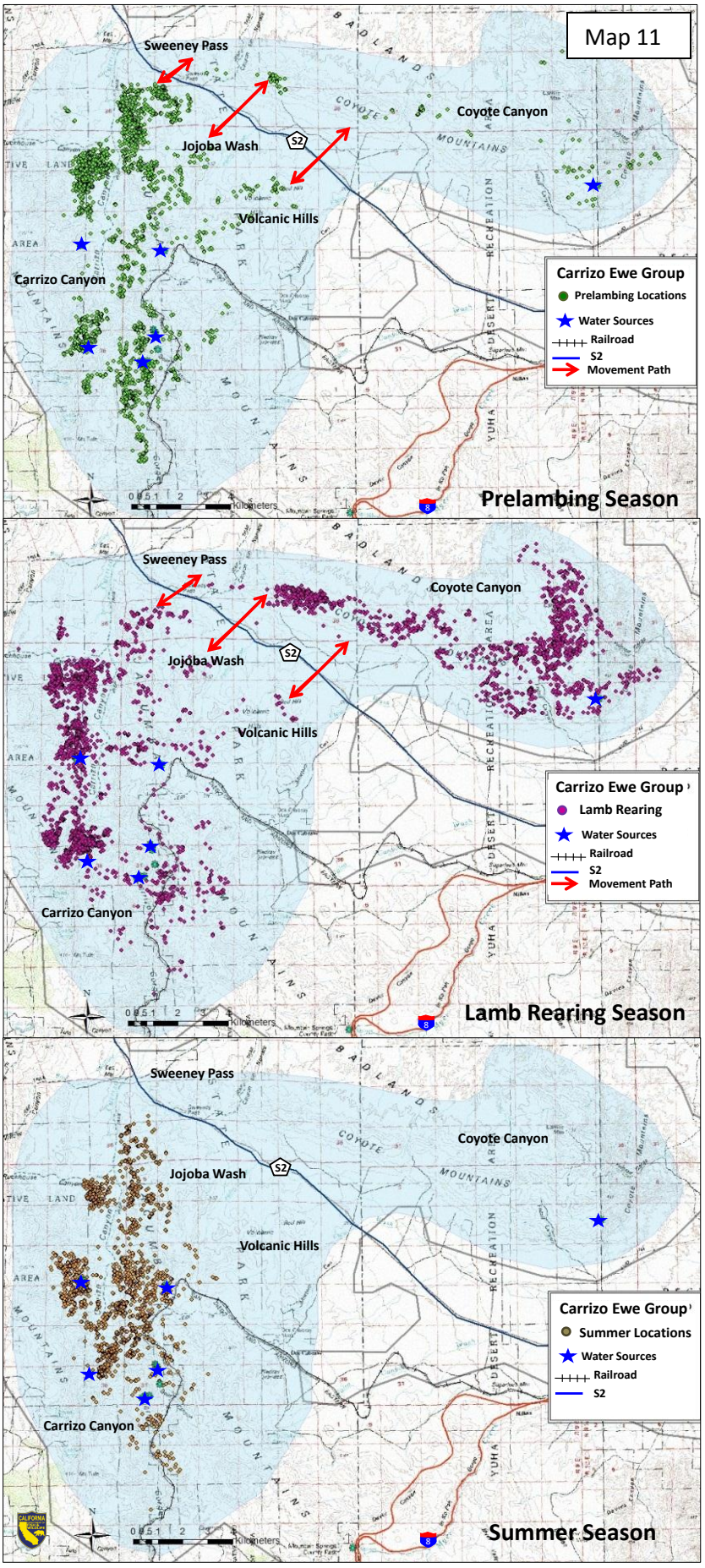


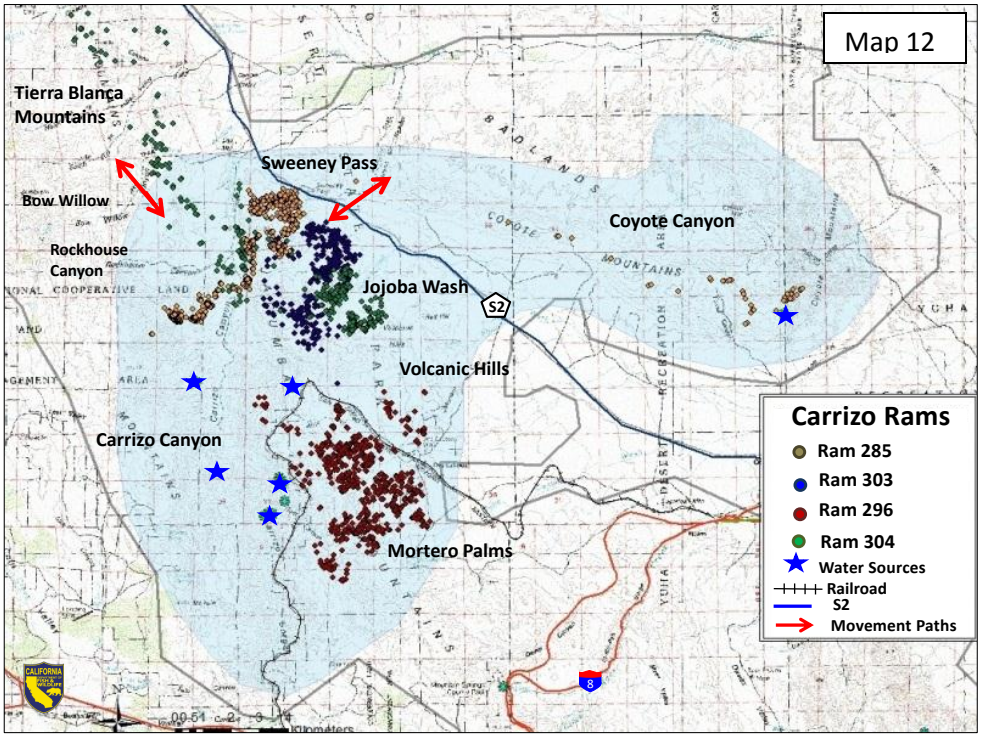

Based on direct observations as well as GPS data there are at least 4 ewe groups within recovery region 9 (Map 10). The Carrizo Canyon and the In-Ko-Pah ewe groups have been well documented based on data collected from GPS-collared sheep since 2009. Two additional ewe groups have been identified based on GPS data collected from sheep captured in November 2013 within the Jacumba Wilderness (Jacumba ewe group) south of Interstate 8 (I-8) and the Tierra Blanca Mountains (Tierra Blanca ewe group) north of Carrizo Canyon.

*Carrizo Canyon Ewe Group:* The Carrizo Canyon ewe group utilizes an area of approximately 296 $km^2$ which is the largest area among the 4 ewe groups in this region (Map 11). It has a number of reliable water sources within Carrizo Canyon and its tributaries. Less reliable water sources in the form of a few tenajas can be found in the Coyote Mountains. County Road S-2 separates Carrizo Canyon from the Coyote Mountains.

At the beginning of 2014 there were 3 ewes and 3 rams with active GPS collars. Two rams died during 2014 leaving only one active GPS-collared ram at the end of the year. An additional 3 ewes captured in the area surrounding Goat Canyon were deployed with GPS collars. Since 2009, GPS data have been collected on 10 ewes within the Carrizo Canyon ewe group. Half of these ewes move a distance of 20 km from Carrizo Canyon to the Coyote Mountains during the lamb rearing season while the other half remain in the area surrounding Carrizo Canyon. We have categorized this as 1 ewe group because both of these sub-groups use Carrizo Canyon during much of the prelambing season and all of the summer season.

The Coyote Mountains sub-group will typically move to the north east portion of Carrizo Canyon during the prelambing season and make 1 or 2 reconnaissance trips to the Coyote Mountains for a few days or a week before finally committing to staying in the Coyote Mountains during the lamb rearing season. The movement corridors identified thus far between Carrizo Canyon and the Coyote Mountains across County Road S2 are at Sweeney Pass, Jojoba Wash, and via the Volcanic Hills between North Mortero Wash and Lava Flow Wash. In recent years, ewes are returning to Carrizo Canyon much earlier in the lamb rearing season possibly due to drier conditions (in 2014 the tenaja east of Fossil Canyon was dry) and lack of good vegetation in the Coyote Mountains in the late spring. Two ewes deployed with GPS collars in fall 2013 have staged in the north east portion of Carrizo Canyon in the prelambing season and made a number of reconnaissance trips out into the Coyote Mountains. Ultimately, they both returned to Carrizo Canyon for parturition and lamb rearing. Risk of predation during lamb rearing season most likely is greater in Carrizo





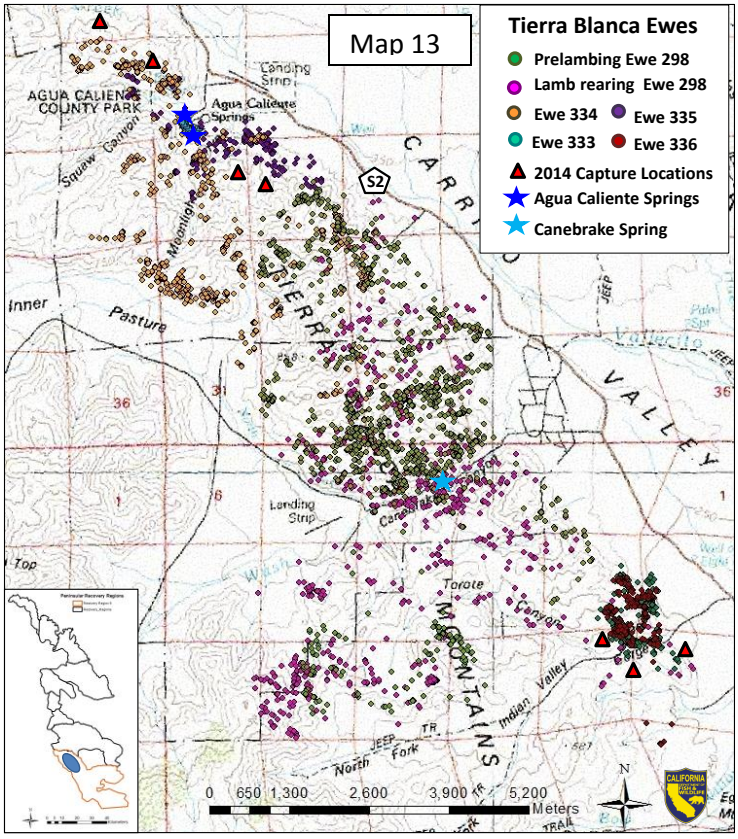

Canyon than in the Coyote Mountains but during drier years the benefits gained by better forage may outweigh the higher predation risk.

The sub-group of ewes that remain in Carrizo Canyon during lamb rearing season use both the west and east sides of the Canyon but appear to concentrate in the areas surrounding Goat Canyon and Black Water. Both sub-groups spend prelambing season on both sides of the canyon but appear to concentrate more within the north end of the canyon yet rarely move north beyond Rockhouse Canyon. During the summer season sheep will move throughout the canyon but may concentrate in areas surrounding Jacumba Jim, Four Frogs, Black Water, Goat Canyon, and Carrizo Palms. Ewes within this ewe group did not appear to move north of Carrizo Canyon into the Tierra Blanca Mountains or south into In-Ko-Pah ewe group.

Presently, there is limited GPS data on ram movements due to problems with GPS collar functionality and mortalities. Thus far most rams appeared to mainly use the east side of Carrizo Canyon between the area surrounding Jojoba Wash, the Volcanic Hills, and Mortero Palms. Ram 304 captured in the Tierra Blanca Mountains moved down into Carrizo Canyon soon after capture and remained there until his death. Ram 285 moved out into the Coyote Mountains in December of 2013 for a short period of time (Map 12).

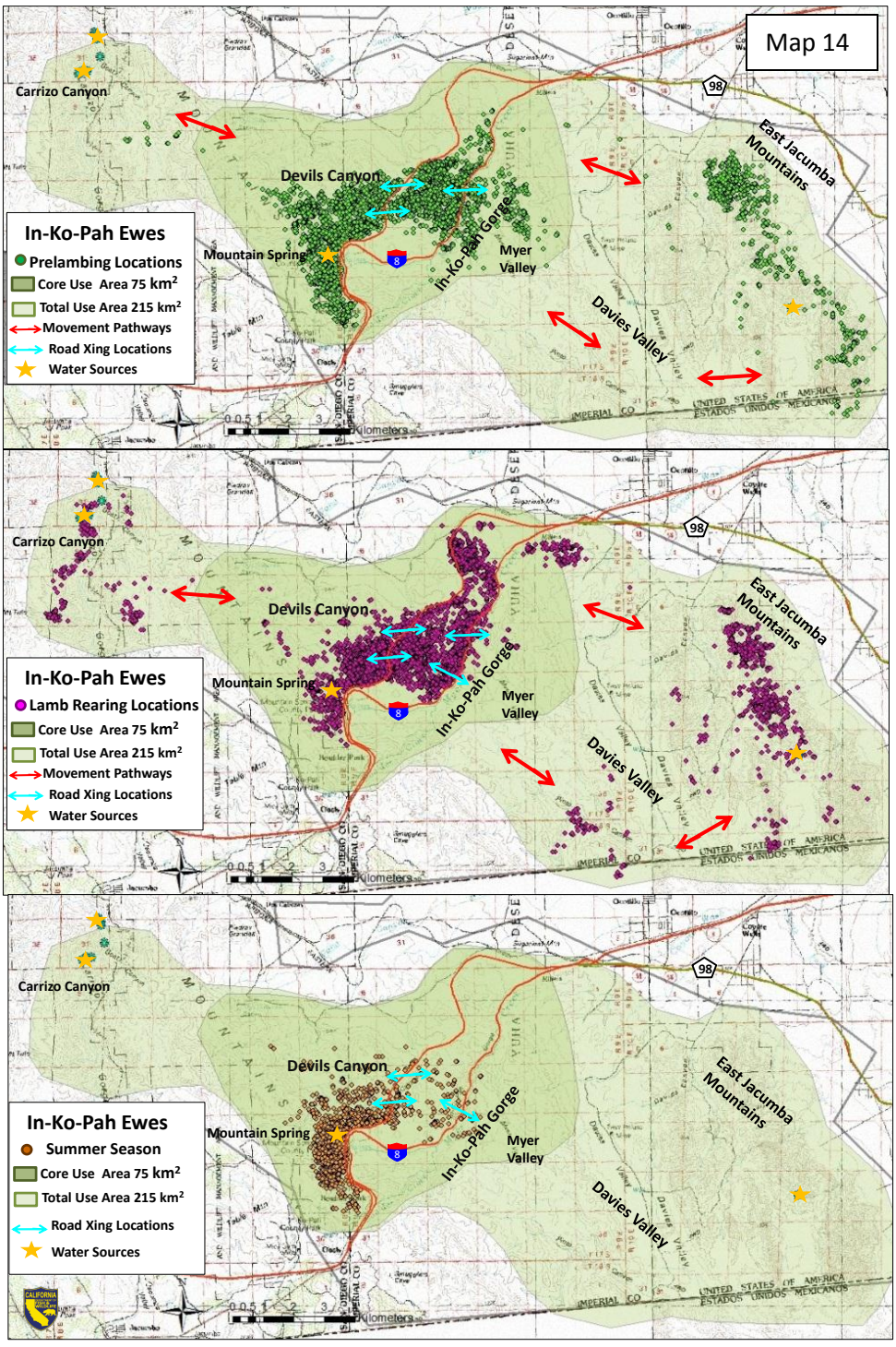
*Tierra Blanca Ewe Group:* The area used by the Tierra Blanca ewe group is approximately 89 km$^2$ and has multiple springs at Aqua Caliente County Park to the north and one water source at Canebrake Canyon to the south. County road S2 is on the east side of the range.

At the beginning of 2014, there was only 1 active GPS-collared ewe. Ewe 298 spent prelambing season in the three canyons just north of Canebrake Canyon, and during the lamb rearing season, the range was expanded to include areas surrounding the North Fork of Indian Canyon and Torote Canyon (Map 13). The summer season was focused around Canebrake Canyon. This ewe never ventured farther north to join the ewes that spend the summer season near the springs at Agua Caliente County Park. The fall capture focused on locating sheep within the north end of the Tierra Blanca Mountains in order to fill the gap in our understanding of this part of the range and to potentially document any movement into the Vallecito Mountains. At the north end, 2 ewes were deployed with GPS collars and 1 ewe and 1 ram were deployed with VHF collars. At the south end, 3



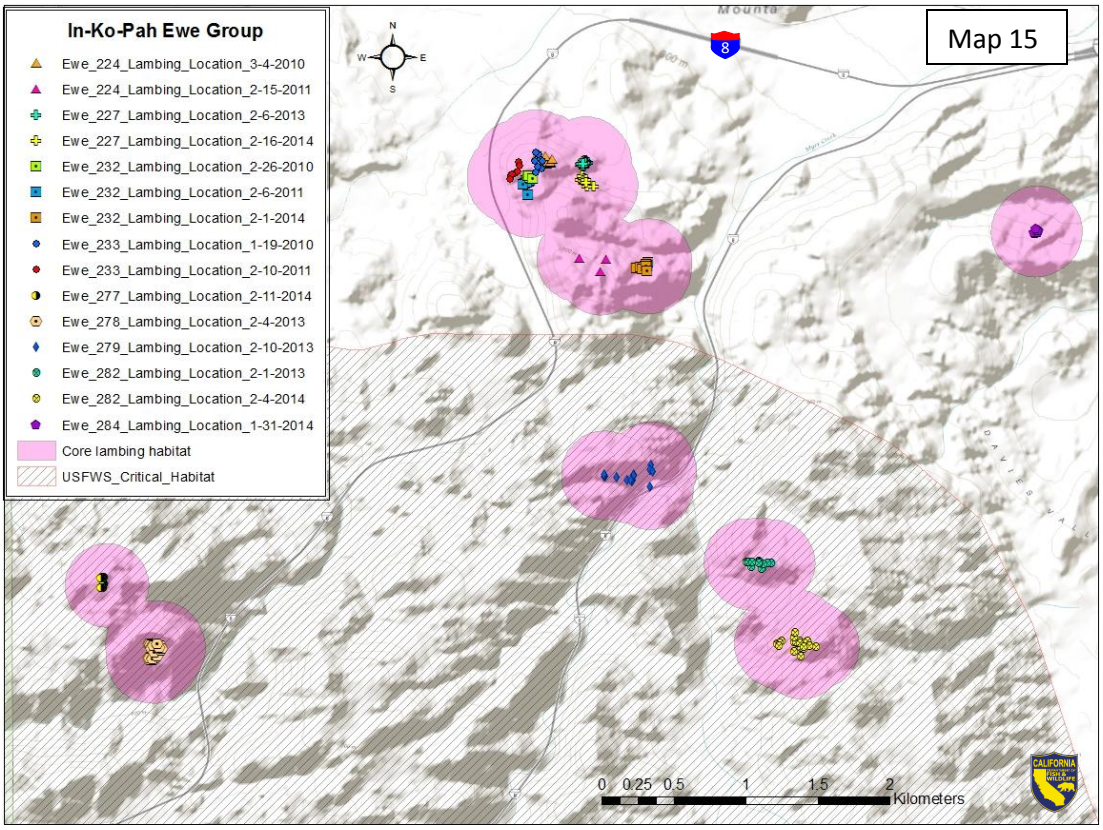
ewes were deployed with GPS collars and 1 ram was deployed with a VHF collar (Map 13). Thus far, the 2 ewes captured in the north range have remained in the north end and move between Squaw Canyon to the north, the Inner Pasture to the west, and just below Moonlight Canyon to the south. The sheep captured in the south end of the Tierra Blanca remained in the area around Indian Canyon. Thus far, preliminary GPS location data has not shown any movement of the Tierra Blanca ewes south into the Carrizo Canyon ewe group.

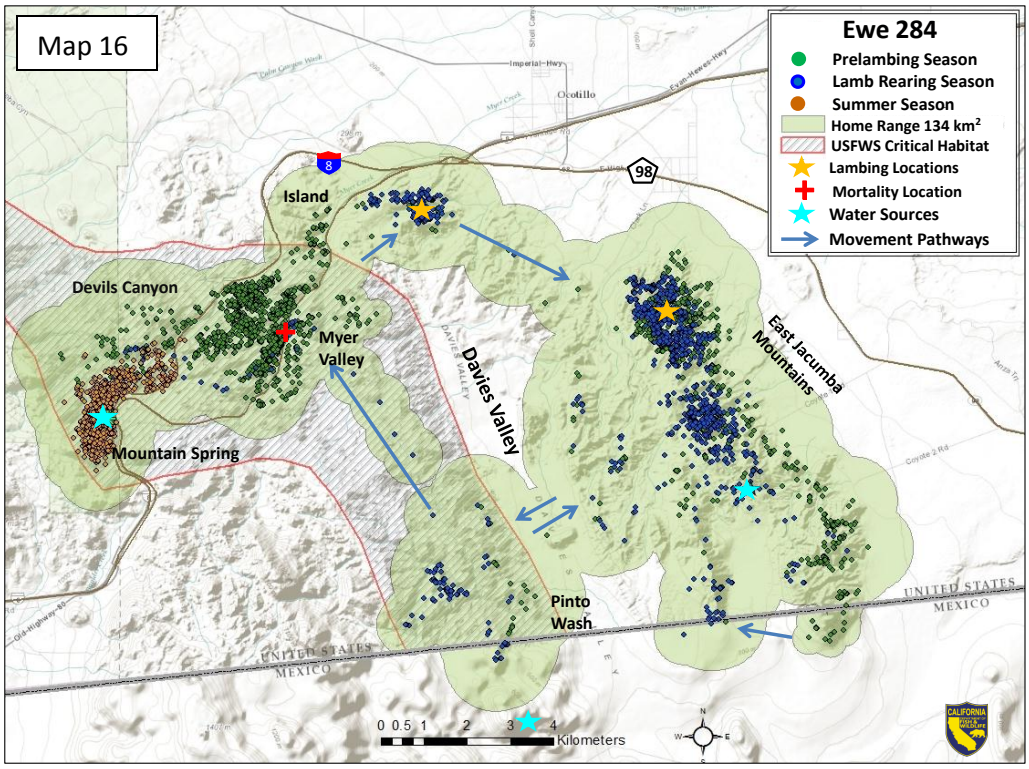
*In-Ko-Pah Ewe Group:* The In-Ko-Pah (IKP) ewe group core use area inhabits approximately 75 km2 in the areas surrounding Mountain Springs, Devils Canyon (west-bound side of I-8), In-Ko-Pah Gorge (east-bound side of I-8), and within the island created by the divergence of the east- and west-bound lanes of I-8 (henceforth referred to as the Island: Map 14). The Island is approximately 8 x 2 km and runs in a northeast to southwest direction. Power lines run through the length of the Island and a wind turbine farm is located at the northwest side of the Interstate and Island. Water sources are located at Mountain Spring and northwest of Boulder Park. There is also radiator water tanks placed all along the west-bound lanes of I-8 that may possibly be use by sheep as well.




GPS data were collected on 7 ewes in 2014. Since 2009, extensive GPS data and direct observation have been collected on 11 ewes and much has been learned about their movements, timing of parturition, lambing locations, lamb rearing grounds, and seasonal use. Typically, during the summer season, sheep congregate at the higher elevations and water sources to the southwest of I-8 (Map 14). During the prelambing season, ewes often moved back and forth across the Interstate near Devils Canyon between the summer use area surrounding Mountain Spring and their lambing and nursery grounds. Lamb rearing season starts in January with the peak in February. Lambing locations have been documented for 10 of the 11 collared ewes: 1 ewe has never been documented with a lamb or has ever been observed pregnant or lactating from 2009 to 2014. Ewes appear to have high site fidelity for lambing locations of which the north end of the Island is favored by the majority of the IKP ewes (Map 15). This important area lies outside of the USFWS designated Critical Sheep habitat but is within the boundaries of Region 9 and recognized by CDFW as essential sheep habitat. Ewe 226 bridges

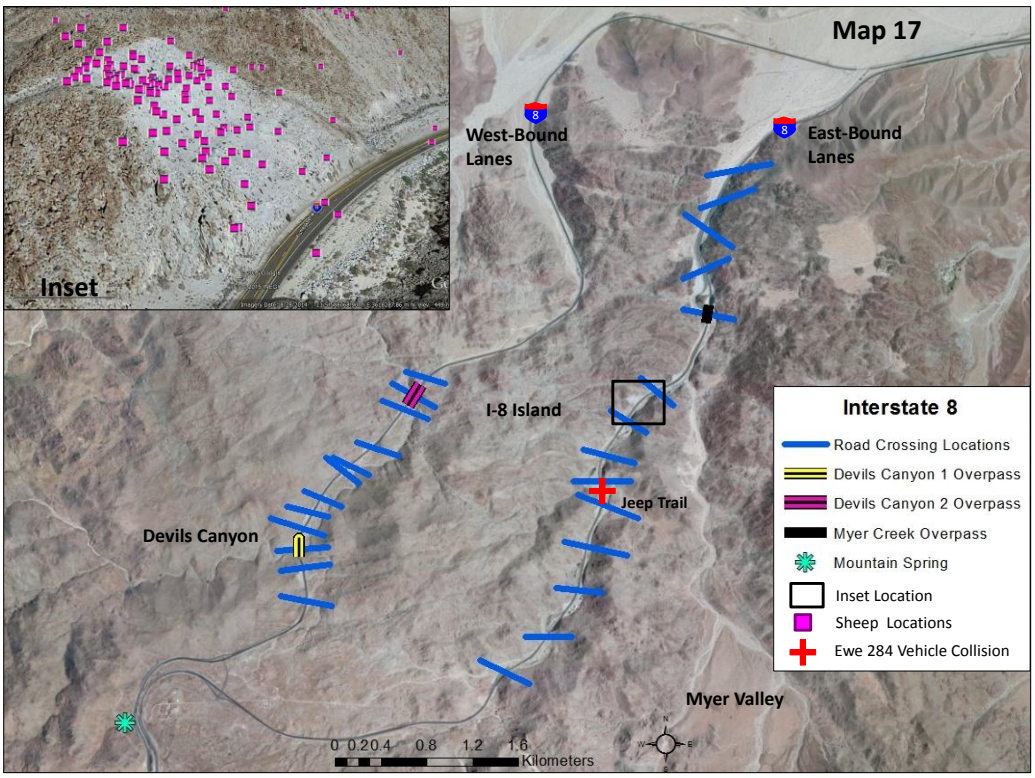
the gap between the IKP and the Carrizo ewe group to the north. This ewe has been documented using the area surrounding Goat Canyon for lambing and for the first few weeks postpartum before returning with her lamb to the IKP ewe group for the remainder of the year. Ewe 284 bridges the gap between the IKP and Jacumba ewe groups (Map 16). This ewe was 3-years-old when captured south of Mountain Springs in 2012. She stayed within the IKP ewe group until December when she crossed the Interstate and quickly moved down to the mountains east of Davies Valley and joined the Jacumba ewe group. In January 2013, she traveled throughout this area and down into Mexico and back. She had her lamb in mid-February and remained in these mountains until the latter part of April when she moved west across Davies Valley to Pinto Wash. At this point and time, the Jacumba ewes often head into Mexico; but instead, this ewe and her lamb turned north and headed up the mountains to the west of Davies Valley and returned to the IKP ewe group. She and her lamb remained in the area around Mountain Spring, Devils canyon, and the Island until December when she once again headed south into the east Jacumba Mountains. In 2014, she repeated the previous year's lamb rearing seasonal pattern and movement corridors. However, in March while attempting to return to the IKP ewe group she was struck and killed by a vehicle while crossing the east-bound lanes of I-8 near Myer Valley. During her short life, she used an area twice as large as the typical IKP ewe and crossed the Interstate at least 19 times and the border at least 6 times. The fate of her 2014 lamb is unknown, but she did recruit her 2013 lamb which may continue to serve as a bridge between these two ewe groups.



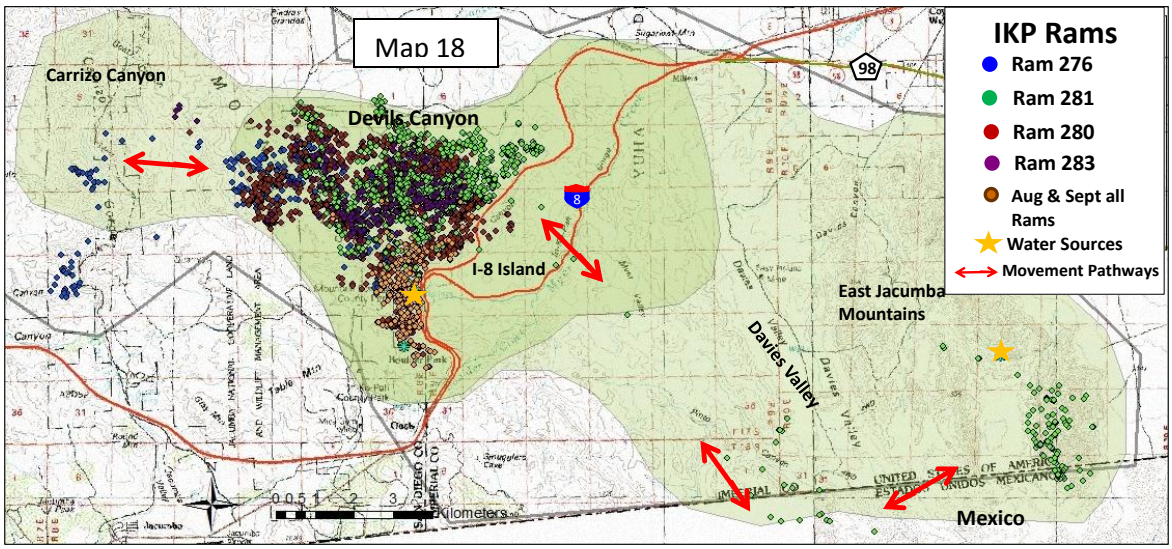




GPS location data indicated freeway crossing events for

ewes occurred most often during the prelambing season October – December and again during lamb rearing season February – April. Sheep crossed the freeway most often between the hours of 0500 and 0900 and 1500 to 1700. From the west, sheep can avoid crossing the surface of the west-bound lanes of I-8 by going through the canyon beneath Devils Canyon overpass #1 and #2 (Map 17); however, they are just as likely to cross the surface of the Interstate anywhere along the road between the two overpasses (based on direct observations and GPS data). Sheep were documented crossing all along the east-bound section of I-8 through the In-Ko-Pah Gorge; however, the most common area was near the entrance to the Jeep Trail which leads to Myer Valley and Davies Valley. This is also the location ewe 284 was struck and killed. GPS sheep locations are heavily clustered on the terraced hillsides along the Interstate. It is believed that the steeply terraced, light-colored, soft dirt gives sheep a comfortable and cool location to rest while providing good visibility for safety (Map 17 inset).



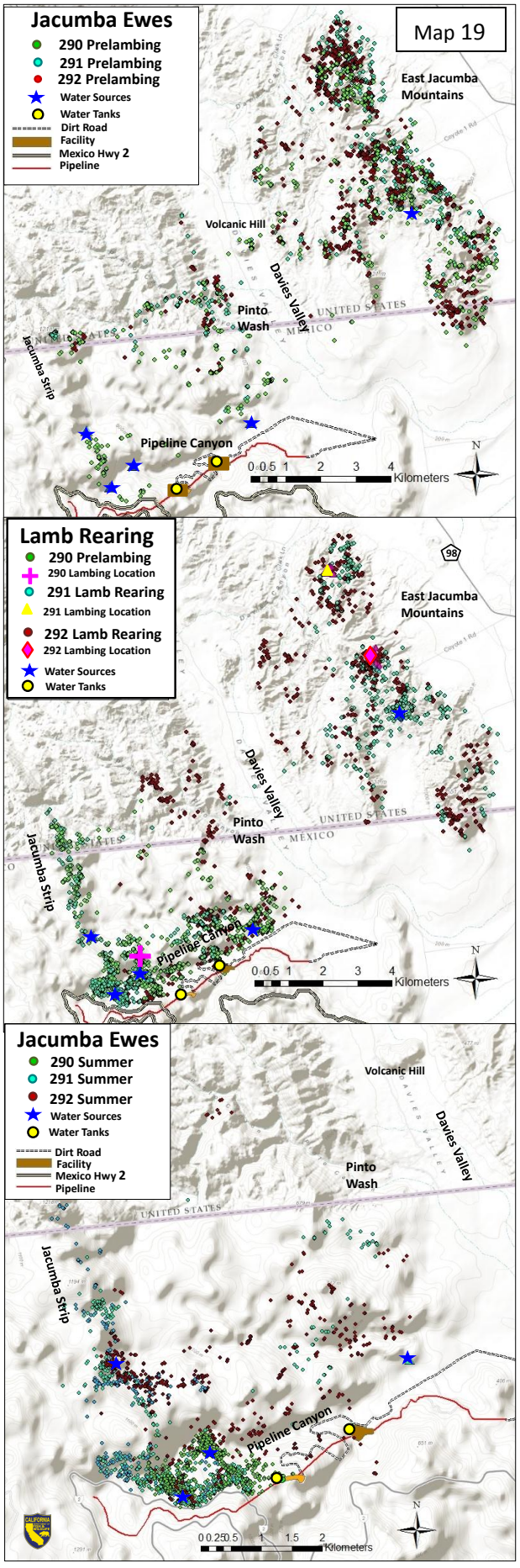

GPS data were collected on 1 ram in 2014; however, since 2012, data and observation have been collected on 4 rams from the ages of 5 and 8 when captured. Rams in this area spend the majority of each year in a very small area surrounding Mountain Spring and Devils Canyon (Map 18). Movements are only slightly altered as they congregate around Mountain Spring in August and September during the rut. Because older rams may already have their dominance status well established, they may not often venture outside the ewe group they live within. Ram 276 (9.5 years-old) briefly moved into the southern portion of Carrizo Canyon during the months of March and April before returning to the Devils Canyon area. Rarely, did these rams cross the Interstate into the Island; however, in 2013 ram 281 (8.5 years-old) crossed the Interstate and within 24 hours was in Mexico where he spent the majority of the month within the Jacumba ewe group. He then moved into the mountains east of Davies Valley in October before returning to Devils Canyon. Because younger rams have not been collared these data may not be representative of all ram movement in this region.



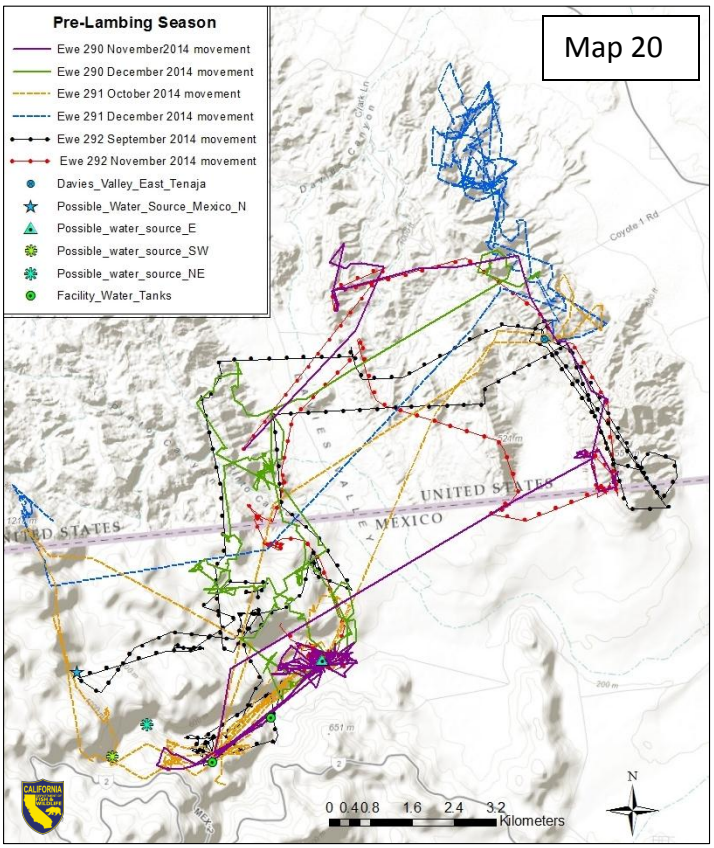
*Jacumba Ewe Group:* During the 2013 capture, 4 ewes and 3 rams were captured in the Jacumba Wilderness and deployed with GPS collars. The Jacumba Wilderness lies between I-8 and the US-Mexico border. Obtaining direct observations and monitoring via fixed-wing plane in 2014 proved to be difficult due to the amount of time these sheep have spent in Mexico. Thus far, GPS data have been collected on 3 ewes and 2 rams, of which 1 ram died in 2014. Lambing locations and lamb rearing habitat is based on patterns inferred from GPS data and has not been verified with direct observations. However, based on IKP ewe group patterns of movement and clustering observed in GPS data that have been verified with direct observation, we feel confident that the interpretation of the GPS data for the Jacumba ewe group is cogent.

Thus far the area used by the Jacumba ewe group is approximately 128 $km^2$ and their home range is bisected from east to west by the US-Mexico border. Fortunately, there is not a fence along this section of the border. The Jacumba Mountains to the west and east are divided by Davies Valley which is approximately 2 km wide and originates in the US and drains 13 km south into Mexico. The home range within the US is BLM wilderness; however, this area has an extensive system of roads used by the CBP. A wind-turbine farm is located along the northeast side of the mountains. In the US portion of the home range there is at least one tenaja (water source) in the eastern portion of the Jacumba Mountains. Based on satellite imagery, and GPS clustering during the summer months, there are a number of potential water sources north of Highway 2 in Mexico. There are two very large above ground pipelines that run in an east-west direction alongside the highway. These two infrastructures combined appear to serve as a semi-permeable boundary to any major movements south by this ewe group.

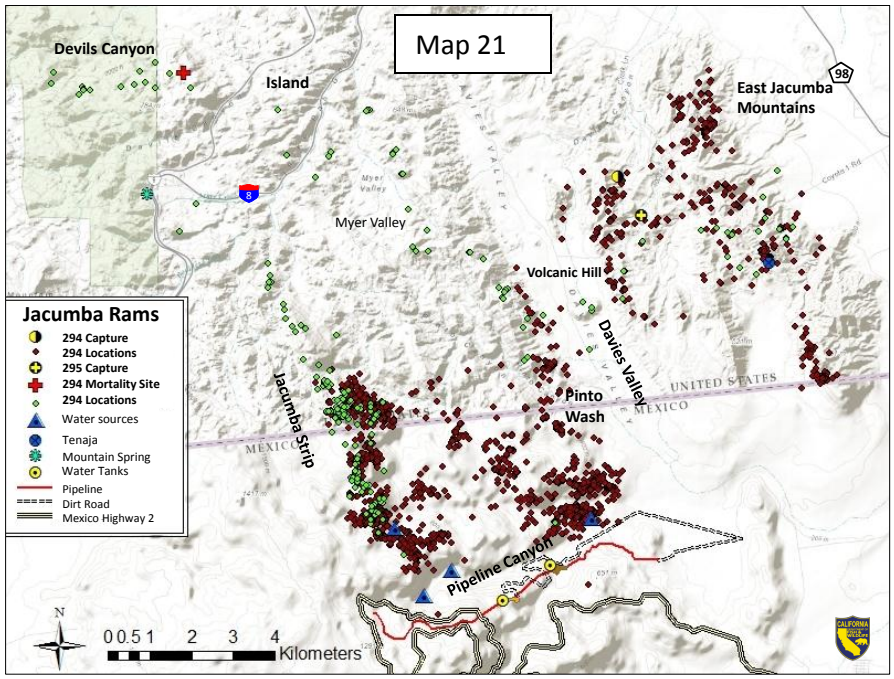
The 3 GPS-collared Jacumba ewes spent the majority of prelambing season 2013-14 within the eastern Jacumba Mountains within the US (Map 19). Ewes 291 and 292 spent the first 2 month of lamb rearing season within the eastern Jacumba Mountains while ewe 290 returned to Mexico in January and most likely had her lamb at the beginning of February. At the end of March both ewes 291 and 292 traveled west across Davies Valley, using a small volcanic mountain as a stepping stone through the valley floor. They entered Mexico and headed for the canyon just north of Mexico highway 2 and the pipeline (hereafter Pipeline Canyon). All three ewes spent the remainder of lamb rearing season in Pipeline Canyon and in the higher elevations of the Jacumba Mountains along a steep narrow strip running north-south across the US-Mexico Border (hereafter the Jacumba Strip). Ewe 292 made several trips across the border to an area within Pinto Wash in the US. The summer season and the early part of prelambing season 2014 were spent on the north-facing slopes of Pipeline Canyon. There are possibly multiple sources of water



within this canyon including possible leaks around the water tanks and pipeline facilities. There are some breaks in the pipeline within the footprint of the facilities which the sheep occasionally cross; however, there was never any documented movement south of the highway. Similar to the reconnaissance trips made by the Carrizo ewe group, the Jacumba ewe group made several reconnaissance trips to their lamb rearing grounds in the east Jacumba Mountains in the US from September to November (Map 20). Finally, in December all three ewes moved back into the east Jacumba Mountains and remained there through the first of the year (2015) when GPS data and visual observations were obtained.




GPS data have been collected on 2 Jacumba rams thus far (Map 21). Data from ram 295 was obtained post-mortem. This ram was captured in the eastern Jacumba Mountains and moved throughout the Jacumba Wilderness with locations focused on the Jacumba Strip. In January, he moved north and crossed the Interstate through the Island and entered the Mountains to the North of Devils Canyon where he died of unknown-nonpredation causes in May 2014. Thus far ram 294 has not moved north of Interstate 8 but has remained within the Jacumba ewe group region. Focal areas used by ram 294 are within the Jacumba strip especially at the north end within the US, the north ridgeline of Pipeline Canyon, and in the eastern Jacumba Mountains. Data on ram 293 has not yet been collected as he has spent the majority of his time in Mexico.




**RECOVERY THREATS and MANAGEMENT STRATEGIES**

Downlisting and delisting goals in the Recovery Plan include: 1) at least 25 ewes must be present in each of the 9 recovery regions for 6 years (downlisting) and 12 years (delisting) without population augmentation, and 2) the range-wide population must average 750 individuals over 12 consecutive years. Currently, 25 or more ewes are present in 8 of 9 recovery regions and the range-wide population has averaged over 750 individuals over the last 8 years. The SJM recovery region currently contains an estimated 23 ewes. Based upon an increasing trend in the number of ewes in this recovery region over the last several years without augmentation, it is possible that greater than 25 ewes will be achieved naturally in the next few years.

**SJM, NSRM & CSRM:** - *Threats and concerns – habitat fragmentation, urban use, and human disturbance:* Urban development within and adjacent to sheep habitat continue to be the main concern within these 3 regions. The BI has documented routine movement of sheep from the CSRM to the NSRM recovery regions across Highway 74 and sheep

continue to be struck and killed on the this highway. Improved signage and warning devices may prevent accidents that can potentially harm both sheep and humans. CSRM rams have been documented foraging on golf courses in La Quinta since 2007: in 2012, both ewes and lambs were documented foraging on golf courses as well. Golf cart bridges across the Coachella Canal allow sheep easy access to grasses and oleander bushes at the golf courses and surrounding homes. In 2014, BI documented an increase in sheep use of urban areas with 12 separate reported incidents of bighorn sheep, including lambs, walking in the streets of La Quinta adjacent to the SilverRock and PGA West golf courses. The use of these areas change natural foraging patterns of sheep and expose them to a variety of risks associated with use of the urban landscape such as increased predation, vehicle strikes, entanglement, drowning, increased parasite loads, and exposure to toxins. Since 2012, three rams have drowned in the Coachella Canal, one ram was rescued, and a fourth ram died from oleander poisoning.

Construction of fences at the urban interface is identified as a site specific recovery action for the Santa Rosa Mountains south of Highway 74 in Section II.D.1.2 of the recovery plan. Construction of fencing to exclude bighorn sheep from golf courses and residential areas in La Quinta would be an important step toward preventing urban related mortalities and enhance efforts toward conservation of sheep in the CSRM. For example, the exclusion fence built in Rancho Mirage in 2002 has completely eliminated urban-related bighorn sheep deaths. On February 28, 2014, CDFW and the USFWS sent a joint notification letter to the Coachella Valley Conservation Commission (CVCC) and the City of La Quinta stating that due to documented sheep use of artificial water and food sources in unfenced existing urban development within the City of La Quinta, and as required under the Coachella Valley Multiple Species Habitat Conservation Plan that installation of an exclusion barrier (i.e., 8-foot high fence) to cure the problem must take place within two years of notification.

**SSRM** - *Threats and concerns – possible disease, depleting water sources, and human disturbance:* Presently, there is little information concerning possible threats for this recovery region due to a lack of collared sheep in past years. There is a concern whether the natural springs and tenajas will be able to continue to meet the needs of sheep within this recovery region. Another possible threat to sheep within this recovery region is illegal off-road vehicle use which has been documented in numerous washes of the easternmost portion of the Santa Rosa Mountains state wilderness area of ABDSP.

**CoC** - *Threats and concerns – water accessibility, disease, predation, and human disturbance*: The jeep road from Lower Willows to Middle Willows is closed by ABDSP Superintendent Order from June 1 through September 30 in order to protect the watering rights of bighorn sheep. In the past few years, sheep have been accessing water along Coyote Creek at or just below the closure gate where it is more open and escape terrain is closer. Moving the closure gate to just below 2nd crossing may help to ensure that sheep can obtain water in a safe location without human disturbance. Disease in this recovery region continues to be a concern and sick sheep are more vulnerable to predation (refer to section on lamb survival). CDFW will continue to monitor for possible increases in disease occurrence within this recovery region.

**NSYM** - *Threats and concerns – urban use, water accessibility, vehicle collision, disease, predation, and human disturbance*: An increase in urban use by sheep within this recovery region continues to be a concern as sheep become more habituated and increase their use of deAnza Country Club golf course and surrounding homes. In December 2012, a ram lamb ~ 10 months-old was the first documented death within the area surrounding deAnza Country Club. While the exact cause of death could not be determined, it was most likely related to use of the urban environment. This development possess a threat to the health and survival of sheep in this recovery region due to possible ingestion of poisonous ornamental plants, increased parasite loads, accidents such as vehicle collisions and drowning in pools or ponds, drinking contaminated water, and increased predation at the urban interface. Presently, CDFW is examining the feasibility of installing barrier fencing along the boundary of ABDSP and deAnza Country Club.

Another major threat to sheep within this recovery region is movement across Highway S22. One of the most frequently crossed sections of this highway is between mile marker (mm) 13 and 14.5 with several past sheep deaths documented at a specific point just below mm14. CDFW is examining the feasibility of placing warning lights and signs at locations along stretches of Highway S22 to reduce this risk.

In August 2014, most water sources within BPC dried up and sheep were forced to rely on the pupfish pond adjacent to the trail-head parking lot. If this trend continues, placement of another pond closer to the slopes and away from the parking lot may allow sheep to access water without being disturbed while still allowing visitors to access the trail-head parking area.

Pneumonia in lambs continues to be a concern despite a recent decrease in deaths in 2014. As lambs become sicker they spend a significant amount of time near the creek in BPC. This occurs at the same time park visitation numbers soar within the canyon. While the sheep in this canyon are habituated, it is not known if constant disturbance in the form of visitors approaching and photographing sick lambs may decrease their chances of survival or impede movement to and from water sources. Increasing the number of Park Docents along known sheep use areas during busy weekends (specifically at the junction of the regular trail and the alternate trail), educating park visitors, and trail maintenance to keep people on existing trails may help ensure sick lambs are not disturbed at this critical time. While dogs are not allowed on the trails within BPC, there are no specific regulations concerning mountain bikes and drones within the Canyon. The CDFW biologist has documented numerous instances of visitors on Mountain bikes and one instance of a drone being flown at dusk in an area used by the BPC sheep: regulations concerning these activities need to be addressed.

**Southern San Ysidro Mountains** - *Threats and concerns – vehicle collision, maintaining water sources, disease, and predation*: Sheep frequently cross Highway S3 between Pinyon and Yaqui Ridge and at the Narrows on Highway 78. Sheep are most often struck and killed on both sections of these highways during the early spring when ewes are moving between the lambing and nursery grounds. Reducing the speed limit at common crossing locations on Highway S3 and through the Narrows on Highway 78 as well as use of warning devices and signage may help reduce sheep deaths.

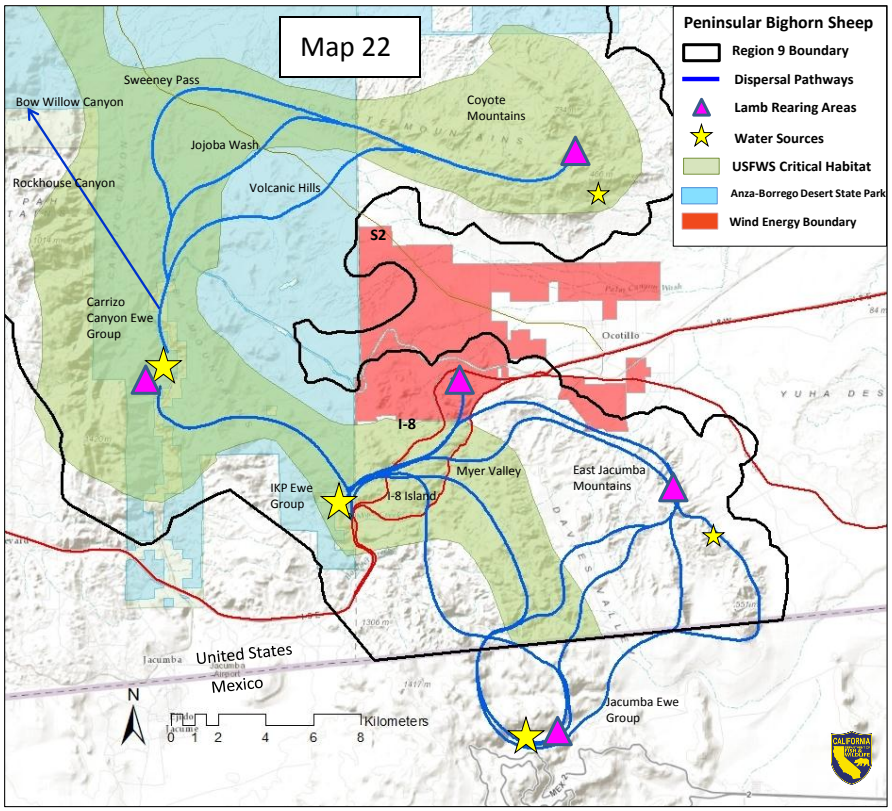
The Tubb Canyon Guzzler which resides on private property has fallen into disrepair and no longer functions. Fortunately, springs farther up the canyon within ABDSP are now accessible to sheep after a fire in 2012 cleared the dense vegetation surrounding the springs. However, vegetation will have to be cleared on a regular basis in order to keep access open as well as decrease risk of predation at the springs.

In past years, sick lambs have been documented within this ewe group (refer to CDFW 2012 Annual report for details). Unfortunately, due to the lack of collared sheep in 2014 lamb disease was not documented.

**Vallecito Mountain** - *Threats and concerns- water availability*: Presently, there is not enough known about sheep within this recovery region due to inaccessibility and the small number of collared sheep prior to the capture in November 2014. There are presently 8 guzzlers within this region; however, they are no longer regularly maintained by ABDSP. CDFW has offered assistance with regular maintenance and repair of these guzzlers. Tenajas and springs within this region have not been checked in recent years and it is unknown how many are still reliable during the summer months.

**Carrizo Canyon** - *Threats and concerns – vehicle collisions, habitat fragmentation and loss, disease, water accessibility, and human disturbance:* While ewe abundance and lamb recruitment have been high in the past, in 2014 only 2 of 8 lambs associated with collared ewes survived their first year. Pneumonia and being struck by vehicles are the two most notable causes. In the past, un-collared rams have been struck and killed crossing Interstate 8, and in March of 2014, the first collared ewe was struck and killed while crossing the east-bound lanes of I-8. This section of the Interstate bisects the seasonal movement pathway of both rams and ewes, and as Interstate traffic continues to increase each year, seasonal movement pathways will eventually be cut off. CDFW staff continued to work with USFWS and renewable energy project proponents to implement vehicle strike hazard reduction (funnel and barrier fencing and signage) and habitat improvement measures required to off-set impacts from energy developments on bighorn sheep in the CC recovery region. It is hoped that the required off-set measures can be fulfilled in a timely manner to reduce strike hazards and improve habitat values for bighorn sheep. However, elimination of vehicle strike hazards will ultimately require the construction of overpass structures along the I-8 In-Ko-Pah Gorge corridor.

Water availability and access to water is a growing concern. Mountain Spring is an important source of water for sheep in the IKP ewe group. Mountain Spring is on San Diego County Park land and is adjacent to the west-bound lanes of Interstate 8. While vehicle access to the spring is restricted, the spring can be accessed via a jeep trail from the west. In 2014, there were numerous large jeep events held near the spring: this road needs to be blocked to public use in order to protect the watering rights of bighorn sheep. Further north, sheep within the Tierra Blanca ewe group are dependent on the water sources at Aqua Caliente County Park and Canebrake Canyon. The campground at Agua Caliente is closed to the public during the summer which allows sheep free access to the multiple springs within the campground. Campground staff should attempt to minimize any construction activities during this time. Oleander bushes throughout the campground were removed in 2013; however, there were numerous resprouts in 2014 which were removed by ABDSP and CDFW staff. The County needs to have a regular maintenance schedule to check and remove any regrowth of oleander within the campground in order to prevent sheep deaths due to oleander poisoning. The water source at Canebrake Canyon resides on private property. The Canyon is being choked by Tamarisk which may eventually prevent access to water and out-compete native plant species that are an important source of forage for sheep during the summer and fall months. Tamarisk continues to be a problem at some water sources within Carrizo Canyon as well.




Since 2009, GPS data have identified areas within region 9 that are vital sheep habitat and movement corridors (Map 22). Sheep within these ewe groups face increasing challenges posed by renewable energy developments, access road construction and maintenance related to border security, and human disturbance. Presently, target shooting is allowed on BLM land within the I-8 Island and is accessed via the Mountain Springs exit; furthermore, jeep activities in Devils Canyon may restrict free movement of sheep to and from their lamb rearing habitat within the Island. Border security activity throughout the recovery region is intensive with regular vehicle patrols, foot patrols, and helicopter flights both night and day within lamb rearing habitat and movement corridors in designated wilderness areas. It is not currently known to what extent these activity may alter, discourage, or restrict sheep movement and use of important resources. There have been several instances, documented by the CDFW biologist, when low flying border security and military helicopters have disrupted normal sheep activities. The following areas are considered important sheep movement corridors and habitat within the border region: Bow Willow Canyon, Rockhouse Canyon, Sweeney Canyon, Jojoba Wash, the Volcanic Hills, Devils Canyon, the jeep road to Mountain Spring, Myer Valley access from east-bound Interstate 8, Davies Canyon and Valley, the eastern Jacumba Mountains with access to canyons at Coyote Roads number one and two, and Pinto Wash.

The Jacumba ewe group is dependent on resources both within the US and Mexico. A fence along the US-Mexico border would prohibit movement to, and use of prelambing and lamb rearing habitat and summer water sources. Furthermore, lamb rearing habitat in the east Jacumba Mountains is not within USFWS designated critical sheep habitat and any further energy projects development within or adjacent to the these areas combined with disturbance by border security activities may have significant adverse effects on this ewe group.

**FUTURE ACTIONS**

Maintaining at least 25% collared ewes within each recovery region is critical in order to obtain accurate data concerning sheep status, trends, distribution, movements, survival, and cause-specific mortality. The lack of radio-collared sheep in several of the recovery regions limits the ability of CDFW to assess current threats to sheep recovery in the Peninsular Ranges. Placement of new radio-collars range-wide to maintain 25% marked ewes in each recovery region is a priority for CDFW. As planned, collars will be fitted to sheep in the SJM, NSRM, CSRM, SSRM, CoC, SSYM, and VM recovery regions during fall 2015.

Management strategies for 2015 include monitoring activities to detect mortalities, ground observations to assess group composition, health, lamb:ewe and yearling:ewe ratios, collecting location and movement data, and capture activities.

**OUTREACH 2014**

Listed below are the formal presentations and informal talks given in 2014 by CDFW South Coast Region Wildlife Management Program staff Randy Botta and Janene Colby:

March – Presentation for AmeriCorps on Bighorn Sheep in the Peninsular Ranges

May – CDFW PBS Monitoring Program and Recovery Region 9 Population Status Presentation for Bi-national Workshop on the Ecology & Conservation of PBS in the California-Baja California Border Region.

June – CDFW PBS Population Monitoring & Recovery Program Presentation for Region 5/6 Senior Staff.

September – CDFW PBS Range-Wide Population Monitoring Program Presentation for Coachella Valley Association of Governments, Coachella Valley Conservation Commission.

October – Informal talk to California Conservation Corps about Bighorn Sheep in Carrizo Canyon

November – Presentation for ABDSP Naturalist Society on Bighorn Sheep within Peninsular Ranges

December – Presentation for ABDSP Visitor Center Staff on Bighorn Sheep in ABDSP

Featured section in the documentary “Becoming California – Environmental Change on America’s Western Edge” www.calegacy.org

**ACKNOWLEDGEMENTS**

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