CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

PENINSULAR BIGHORN SHEEP 2015 ANNUAL REPORT

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

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 for 2015

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South Coast Region

California Department of Fish and Wildlife Peninsular Bighorn Sheep Annual Report 2015

Table of Contents

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EXECUTIVE SUMMARY

Desert bighorn sheep (*Ovis canadensis nelsoni*) inhabit the desert slopes of the Peninsular Ranges of southern California and extend into the mountains of Baja California in Mexico. The population within the Peninsular Ranges was first listed as threatened in 1971 under the California Endangered Species Act. In 1974, the population was estimated at 1,171 (Weaver 1975) but by 1996 the rangewide population estimate had declined to only 276 adult sheep (USFWS 2000). Peninsular bighorn sheep were listed as a federally endangered population segment in 1998 (63 FR 13134) due to: 1) habitat fragmentation, degradation, and loss by urban and commercial development; 2) disease; 3) predation coinciding with low population numbers; 4) response to human disturbance; 5) insufficient lamb recruitment; 6) nonnative toxic plants; and 7) prolonged drought (USFWS 2000). Presently, the population of desert bighorn sheep in the Peninsular Ranges is considered to be stable to increasing based on the most recent 2010 California Department of Fish and Wildlife (CDFW) rangewide survey estimate of 955 bighorn sheep.

In order for CDFW to estimate ewe (female) abundance it is necessary to maintain radio-collars on at least 25% of the ewes within each of the 9 recovery regions within the Peninsular Ranges. At the beginning of 2015, there were a total of 94 active radio-collars throughout the Peninsular Ranges (89 ewes & 5 rams). This represented only 16% of the ewe population rangewide. During the fall 2015 capture an additional 91 active radio-collars (84 ewes & 7 rams) were deployed in the San Jacinto Mountains (SJM), Northern (NSRM), Central (CSRM) and Southern (SSRM) Santa Rosa Mountains, Coyote Canyon (CoC), Northern (NSYM) and Southern (SSYM) San Ysidro Mountains, and Vallecito Mountains (VM) recovery regions. In 2015, there were 13 radio-collared sheep mortalities (11 ewes and 2 rams). Mortalities by recovery region were: NSRM = 1 ewe, CSRM = 1 ewe, CoC = 2 ewes, SSYM = 1 ewe, VM = 2 ewes, and Carrizo Canyon (CC) = 4 ewes & 2 rams. At the close of 2015, 29% of the ewe population was radio-collared with a total of 171 active radio-collars throughout the Peninsular Ranges (161 ewes & 10 rams). A field-based capture is tentatively planned for October 2016 to fill any remaining radio-collared gaps prior to the rangewide population survey in November 2016.

From 1992 to 2016, on average, 12% of all active radio-collared sheep died each year of which 7% was due to predation. In 2015, only 7% of all active radio-collared sheep died of which 3.2% were due to predation, 2.2%

the cause was unknown, and 1.6% was attributed to nonpredation. The average age of radio-collared ewes in 2015 was 7.1 years with a range between 1.5 and 19 years (n = 173). In comparison, the average age of radio-collared ewes that died was 12.0 years with a range between 8 and 16 years (n = 11). In 2015, average rangewide survival of radio-collared ewes was 87%. Over the past 5 years (2011 – 2015), average survival of radio-collared ewes from highest to lowest was SJM (100%), followed by VM (98%), NSRM (93%), NSYM (91%), CC (91%), CSRM (88%), CoC (86%), and SSYM (80%). Survival statistics were not available for the SSRM due to lack of radio-collared sheep.

CDFW has monitored lamb survival (survival to 3 months) and recruitment (survival to 1 year = yearlings) within 2 to 5 recovery regions from 2008 to 2015. The percentage of 2015 lambs that were recruited to yearlings was lowest in CoC (10%), followed by the NSYM (11%), the "urban" ewe group in CSRM (11%), the "wild" ewe group in CSRM (33%), and the IKP ewe group in CC (35%) recovery regions. Typically, lamb survival levels below 30% indicate the presence of lamb respiratory disease within a ewe group. Clinical signs of lamb pneumonia have been documented in all 5 recovery regions; however, rates of lamb survival and recruitment have varied by ewe group, season, and year. For the past 8 years, the average recruitment ratio has been very low (18%) in both CoC and NSYM.

Presently, there is substantial genetic variation and gene flow among bighorn sheep populations within the Peninsular Ranges and across the US-Mexico Border indicating functional connectivity (Buchalski et al. 2015). However, as traffic levels continue to increase connectivity will be lost. The most frequent reports of sheep being killed while attempting to cross roads are on Highways 74 and 78, Interstate 8, and County Roads S22 and S3. Other concerns that may hinder recovery efforts are: disease, the loss of natural water sources, reduction and fragmentation of sheep habitat, habitat modification due to invasive nonnative plants, 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, completion of the US-Mexico border fence, mining, and human activities (border enforcement and off-road vehicles) may alter, discourage, or restrict sheep movement and habitat use of important resources.

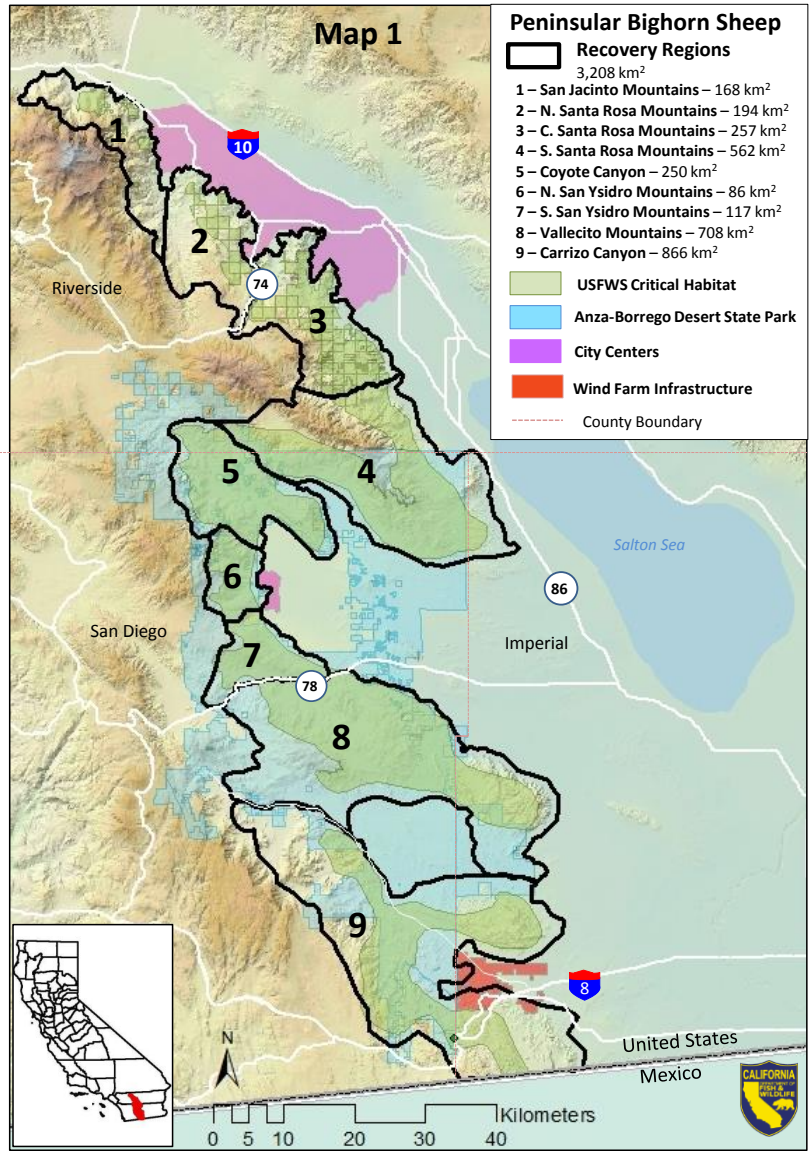
Hopefully, continued efforts by CDFW to monitor sheep health, habitat use, and movements throughout the range will provide federal, state, and local governmental agencies and city planners information to make land and public use decisions that allow for the health and long-term survival of peninsular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


Photo by Jeff Young

BACKGROUND

This annual report highlights capture and radio-collaring, radio-collar monitoring, disease surveillance, cause specific mortality investigation, and lamb survival monitoring undertaken by the California Department of Fish and Wildlife (CDFW) of bighorn sheep in the Peninsular Mountain Ranges of southern California from 1 January 2015 through 31 December 2015.

The Peninsular Mountain Ranges contain 9 designated bighorn sheep recovery regions occupying portions of western Riverside, western Imperial and eastern San Diego Counties (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).

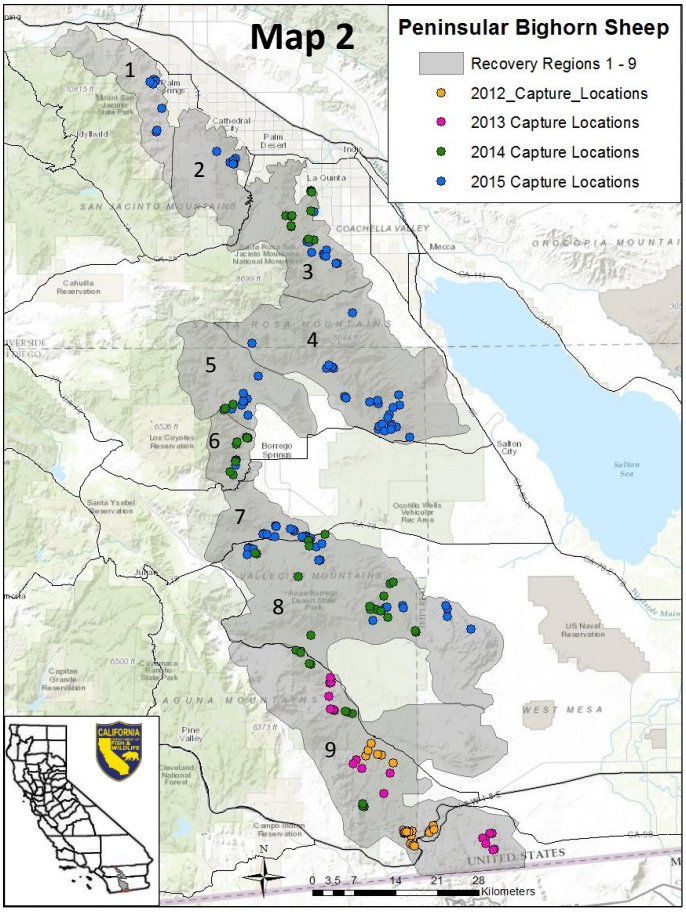


A Cessna 185 fixed-wing aircraft was used to conduct aerial telemetry monitoring at least once a month in all 9 recovery regions. Telemetry flights, however, were not conducted for the first 3 months of 2015 following the retirement of CDFW's southern California Air Services pilot in December 2014. Telemetry flights were recommenced in April 2015 when the vacant pilot position was filled. Flights were used to monitor radio-collared sheep status (alive/dead), obtain location estimates, and download GPS location data.

CDFW conducted ground telemetry monitoring of radio-collared sheep twice a month in all recovery regions except for the SJM and NSRM which were monitored by the Bighorn Institute (BI). Satellite-collared sheep in the SJM, CSRM, SSRM, and VM were monitored every 2 to 5 days with the Iridium Satellite Network that delivers messages and location data via email. 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.

CAPTURE AND RADIO-COLLARING

Capture activities were carried out by CDFW between 27 October and 18 November 2015 on State and Federal Lands throughout the Peninsular Ranges within eastern San Diego, western Imperial and western Riverside counties. Capture of all bighorn sheep was carried out by Leading Edge Aviation under contract with CDFW. Base camp processing of bighorn sheep was carried out by CDFW. Field processing of some bighorn sheep was undertaken by the Leading Edge capture crew. Recovery regions where captures occurred included the SJM, NSRM, CSRM, SSRM, CoC, NSYM, SSYM, and VM (Map 2). Funding for the 2015 Peninsular Ranges bighorn sheep capture was provided by CDFW Big Game Fund, USFWS PR Grant (G1598026), and U.S. Department of Homeland Security, Customs and Border Patrol.



The project objective was to capture and fit Very High Frequency (VHF), Global Positioning System (GPS) store-on-board, and Iridium Satellite radio-collars to a subset of adult ewes (females) and rams (males) to: 1) maintain collars on approximately 25-30% of the ewe population for mark-resight population estimation survey; 2) better define the temporal and spatial movement patterns of bighorn sheep crossing between targeted recovery regions; 3) better define sheep distribution and ewe group organization in the targeted recover regions; and 4) determine causes of mortality.

During 11 days of capture a total of 91 bighorn sheep were captured and fitted with radio-collars (84 ewes & 7 rams). All radio-collared bighorn sheep were fitted with unique combinations of colored radio-collars and ear tags to facilitate individual identification. Of the 84 ewes captured, 28 were deployed with GPS collars, 15 with satellite collars, and 41 with VHF collars. Five rams were fitted with GPS collars and 2 with VHF collars. CDFW conducted regular ground and fixed-wing aerial monitoring of all newly radio-collared bighorn sheep for 1 month post-capture with no mortalities detected.

All sheep were captured using a net-gun fired from a helicopter. Thirty-five sheep were radio-collared in the field and 56 sheep were transported to a base camp for health examinations and radio-collaring. All bighorn sheep arrived in base camp in good condition and appeared normal with respect to disease or injuries with the exception of 1 ram in the VM that had a slight nasal discharge and 1 ram and 1 ewe in the SSRM that had existing eye injuries. Twenty-six percent of the captured sheep showed signs of chronic sinusitis based on horn necrosis. At base camp each bighorn sheep was weighed, examined for injuries, body measurements taken, blood, fecal, and nasal swabs collected for disease testing, and radio-collars attached. The average age of ewes captured was 6.1 years with a range from 1.5 to 11.5 years (n = 50). The average age of rams captured was 6.3 years with a range of 3.5 to 8.5 years (n = 6).

RADIO-COLLAR STATUS

As recommended in the recovery plan for peninsular bighorn sheep (USFWS 2000), CDFW maintains, to the extent possible, active radio-collars on approximately 25-30% of all ewes in each recovery region. Maintaining at least 25% radio-collared (marked) ewes is important for generating reliable mark-resight population estimates based on helicopter surveys. CDFW derives rangewide bighorn sheep population estimates by conducting helicopter surveys in the fall of even numbered years and captures to fit needed radio-collars on sheep during the fall of odd numbered years; however, rangewide helicopter surveys were not conducted in 2012 and 2014 due to lack of a CDFW helicopter contract. A contract has since been executed and a rangewide helicopter survey is planned for fall 2016. Prior to the 2015 capture, only 3 of 9 recovery regions had approximately 25% radio-collared ewes. The objective of the fall 2015 capture was to fill the radio-collared gaps that existed to assure there would be 25% - 30% radio-collared ewes for the 2016 survey. The objective was met in all recovery regions with the exception of the NSRM and CC recovery regions (Table 1). A field-based capture is tentatively planned for fall 2016 to fill the remaining radio-collared gaps prior to the rangewide helicopter population survey.

At the beginning of the 2015 reporting period, the 9 recovery regions contained a total of 94 (89 ewes & 5 rams) active radio-collars. During the fall capture an additional 91 (84 ewes & 7 rams) active radio-collars were deployed in all

recovery regions with the exception of the CC recovery region. Radio-collars were lost through mortality in the NSRM, CSRM, CoC, SSYM, VM, and CC recovery regions while 1 radio-collar became non-functional in the CSRM. At the end of 2015 there were a total of 171 (161 ewes & 10 rams) active radio-collars (Table 1).

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 2015. The recovery regions are: 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, and CC = Carrizo Canyon. The estimated percentage of females radio-collared (% F Collared) at the end of 2015 is based on the ewe abundance estimates from the most recent range-wide helicopter survey in 2010.

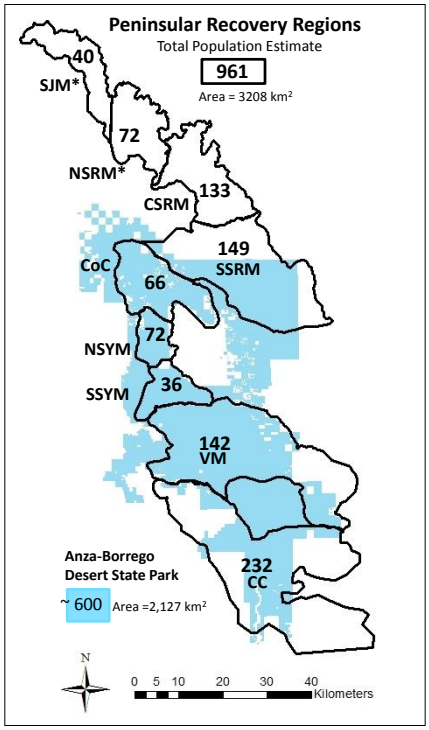
Category	SJM		NSRM		CSRM		SSRM		CoC		NSYM		SSYM		VM		CC		Subtotal		Grand
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	Total
1/1/2015	6	0	5	0	12	0	1	0	6	0	10	0	1	0	20	0	28	5	89	5	94
additions	5	2	6		12		22	2	8		3		14		14	3			84	7	91
mortalities			1		1				2				1		2		3	2	10	2	12
censored					2														2		2
12/31/2015	11	2	10	0	21	0	23	2	12	0	13	0	14	0	32	3	25	3	161	10	171
% F Collared	42%		23%		30%		27%		26%		33%		39%		40%		18%		29%		

POPULATION SIZE AND ESTIMATION

The most recent rangewide estimate of 955 bighorn sheep was conducted by CDFW in 2010 and the population is considered to be stable to increasing (Table 2). 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 (https://www.wildlife.ca.gov/Conservation/Mammals/Bighorn-Sheep/Desert/Peninsular). A rangewide population survey is planned for fall of 2016.

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 Bighorn Institute's 2014 estimates for the San Jacinto and Northern Santa Rosa Mountains. Approximately 66% of the area within the recovery regions lies within ABDSP; and approximately 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



RESPIRATORY DISEASE

Disease epizootics (analogous to disease epidemics in humans) are a major limiting factor in restoring large, healthy, wild sheep populations throughout western North America (Singer et al. 2000). Likewise, disease epizootics were the major contributing factor for declines in peninsular bighorn sheep populations from the 1970s to the mid-1990s (Fredrickson and Mills 2010). Clinical signs of pneumonia (coughing, nasal discharge, droopy ears, lethargy, and weight loss) were first noted in the 1970s in the NSRM and within some areas of Anza-Borrego Desert state park (USFWS 2000). Consequently, a study conducted by the Bighorn Institute from 1981 to 1984 concluded that pneumonia was the major cause of high lamb mortality within the NSRM (DeForge and Scott 1982). Pneumonia-induced mortality in lambs continues to be a problem in many recovery regions throughout the Peninsular Ranges (Colby and Botta 2012). CDFW and collaborators have actively been investigating the causative pathogen or pathogens and the possible factors that drive the timing, duration, and severity of respiratory disease outbreaks within the Peninsular Ranges.

The original pathogens causing respiratory diseases in wild sheep were most likely introduced by domestic sheep (via nose-to-nose contact) as indicated by both empirical and laboratory studies (Lawrence et al. 2010, and Wehausen et al.

2011). Initially, a pneumonia epizootic typically causes an all-age die-off (adults and lambs) followed by up to 12 years of either sporadic or persistent high rates of pneumonia in lambs (Cassirer and Sinclair 2007, Cassirer et al. 2013).

There have likely been multiple independent pathogens responsible for pneumonia epizootics at different times and locations within bighorn sheep habitat including bovine respiratory syncytial virus, parainfluenza-3 virus, and *Pasteurella* and *Mannheimia spp*. (Rudolph et al. 2007, and Besser et al. 2008). Recently, the bacterium *Mycoplasma ovipneumoniae* (hereafter referred to as *M.ovi*) has been identified as the primary pathogen associated with pneumonia in wild sheep populations throughout the western United States (Besser et al. 2008, and Besser et al. 2012). In California, between 2013 and 2015, *M.ovi* was the primary pathogen detected in 11 of 15 cases (73%) of bronchopneumonia in bighorn sheep submitted for post-mortem testing at California Animal Health & Food Safety Laboratory System (CAHFS). In the Peninsular Ranges, results from blood samples collected from wild sheep captured from 1999 to 2015 found that approximately 51% of sheep in each recovery region tested positive for the presence of *M.ovi* (Testing performed by Washington Animal Disease Diagnostic Laboratory at Washington State University).

In the Peninsular Ranges, pneumonia-induced mortality in lambs typically peaks when lambs are between 1 and 3 months of age at a time when ewes and lambs are concentrated within nursery groups. A ewe carrying the pathogen can transmit the infection to her lamb—the lamb can then transmit the pathogen to other lambs within the nursery group. Varying rates (asynchronous) of lamb mortality among ewe groups and years is likely due to differences in the number of infected and pathogen shedding ewes, the virulence and timing of pathogen introduction, and the exposure (contact) rates (Cassirer et al. 2013, and Plowright et al. 2013). Environmental factors may also contribute to asynchronous rates of pneumonia-induced mortality in lambs. In the Peninsular Ranges, the density of ewes and lambs as well as the duration within nursery grounds is dependent on the quality and quantity of vegetation available (J. Colby, CDFW unpubl. data). During drought years, when forage conditions are poor, there is a low density of ewes and lambs for a short duration within nursery grounds which may decrease both the probability of the correct timing of pathogen introduction and the exposure rates to lambs. Reciprocally, during wet years, when forage conditions are good, there is a high density of ewes and lambs for a longer duration within nursery grounds which may increase both the probability of the correct timing of pathogen introduction and exposure rates to lambs. Consistent, high quality forage conditions, such as those provided by golf courses, allow large numbers of ewes and lambs to concentrate within a very small area for prolonged periods of time and thus may facilitate the spread of disease to a larger percentage of the lambs within the nursery group.

A lamb's health status prior to infection may influence the probability of surviving a bout of pneumonia. In the NSYM, lambs observed with diarrhea and weight loss prior to exhibiting signs of pneumonia were less likely to survive than lambs without diarrhea and weight loss (J. Colby, CDFW unpubl. data). The cause of chronic diarrhea is not known; however, lambs and ewes in NSYM readily consume Sahara mustard (*Brassica tournefortii*), a non-native herbaceous annual containing glucosinolates that can be toxic to wildlife (Horn and Vaughan 1983). Diarrhea has also been observed in sick lambs at the golf courses in La Quinta. Sulfate-based fertilizer application to golf course grasses can result in induced copper deficiencies in sheep. Copper deficiencies in sheep can result in diarrhea, weight loss, ataxia (loss of coordination), and decreased resistance to diseases (Scott 2007). Low copper levels have been documented in lambs that have died of pneumonia at the golf courses in La Quinta (refer to section on Lamb Survival and Recruitment).

Outbreaks of infectious disease in wild sheep are difficult if not impossible to manage. Tools used in domestic livestock such as treatment and vaccination are impractical and generally ineffective when applied to wild populations. Geographic separation of domestic sheep and goats from bighorn habitat is the only sure method to reduce the risk of disease outbreaks (Dr. Ben Gonzales, CDFW Senior Wildlife Veterinarian pers. comm.)

CAUSE-SPECIFIC MORTALITY AND SURVIVAL

Because population viability is most sensitive to changes in ewe survival (Ruben et al. 2002), it is important to document survival and mortality statistics within the Peninsular Ranges in order to make cogent management decisions. In 2015, there were 13 (11 ewes and 2 rams) radio-collared sheep mortalities (Table 3). Mortalities by recovery region were: NSRM = 1 ewe; CSRM = 1 ewe; CoC = 2 ewes, SSYM = 1 ewe; VM = 2 ewes; and CC = 4 ewes & 2 rams. From 1992-2015,

on average, 12% of all active radio-collared sheep died each year. During this period of time, lion predation and probable lion predation combined accounted for 7% of the mortalities. In 2015, only 7% of all active radio-collared sheep died. Of this percentage 3.2% were attributed to predation, probable predation, or possible predation combined, 2.2% the cause was unknown, and 1.6% was attributed to nonpredation. Deaths were categorized as nonpredation when the exact cause of death was unknown but predation could be ruled out as a possible cause. The average age of radio-collared ewes in 2015 was 7.1 years with a range between 1.5 and 19 years (n = 173). In comparison, the average age of radio-collared ewes that died was 12.0 years with a range between 8 and 16 years (n = 11). The average age of ewe deaths attributed to predation combined was 12.3 years with a range between 10 and 15 years (n = 4). Age related disease and/or poor health were noted in 3 of the 4 ewe deaths attributed to predation. Ewes that died of nonpredation causes were slightly older with an average age of 12.7 years and a range between 9 and 16 years (n = 3). In all deaths attributed to nonpredation, signs of long-term disease such as chronic sinusitis, low amount of body fat, and/or tooth infections were found during mortality investigations. The average age of sheep deaths categorized as unknown was 11.3 years with a range of 8 to 15 years (n = 4). Age related disease and/ or poor health were noted in 3 of 4 ewe deaths categorized as unknown. Two male radio-collared sheep died due to predation and possible predation. Both 8 year-old rams resided in the CC recovery region and appeared healthy at time of death. However, inferences concerning causes of death and death rates among the ram population cannot be made due to the small number radio-collared rangewide.

Table 3. Cause of death for 13 radio-collared bighorn sheep by recovery region and ewe group within the Peninsular Ranges of Southern California from January 1 to December 31, 2015. Carrizo = Carrizo ewe group, IKP = In-Ko-Pah ewe group, and TB = Tierra Blanca ewe group all within the Carrizo Canyon Recovery Region.

Region(Ewe Group)	Sheep ID	Sex	Age	Month	Cause
NSRM	BI	F	12	May	Possible Lion Predation
CSRM	9000	F	15	March	Unknown
CoC	214	F	8	January	Unknown
CoC	213	F	16	November	Nonpredation
SSYM	208	F	15	January	Probable Lion Predation
Vallecito	210	F	12	February	Possible Lion Predation
Vallecito	325	F	9	May	Nonpredation
Carrizo	191*	F	13	May	Nonpredation
Carrizo	307	F	8	September	Unknown
Carrizo	228	F	14	December	Unknown
Carrizo (IKP)	279	F	10	February	Probable Lion Predation
Carrizo (IKP)	280	M	8	April	Probable Lion Predation
Carrizo (TB)	332	M	8	November	Lion Predation

*Nonfunctioning collar since 2012-Ewe was found by hiker

Table 4. Annual Kaplan-Meir survival rates (modified to allow for staggered entry of new animals) for female bighorn sheep in the Peninsular Ranges of Southern California. Data were collected by CDFW in regions 5 through 9 from 1994 to 2015 and in regions 1 through 3 from 2011 to 2015. In regions 5 – 9: red = lowest survival rate for each region, blue = survival rates below 70%.

Year	1-SJM	2-NSRM	3-CSRM	4-SSRM	5-CoC	6-NSYM	7-SSYM	8-VM	9-CC
1994	*	*	*	*	63%	77%	75%	63%	82%
1995	*	*	*	*	60%	100%	67%	75%	71%
1996	*	*	*	*	67%	80%	100%	100%	60%
1997	*	*	*	*	100%	100%	100%	33%	100%
1998	*	*	*	*	90%	88%	60%	88%	100%
1999	*	*	*	*	75%	86%	50%	80%	100%
2000	*	*	*	*	89%	71%	100%	91%	100%
2001	*	*	*	*	88%	60%	100%	92%	100%
2002	*	*	*	*	78%	75%	83%	91%	91%
2003	*	*	*	*	100%	100%	100%	100%	70%
2004	*	*	*	*	90%	75%	92%	86%	100%
2005	*	*	*	*	100%	100%	82%	90%	75%
2006	*	*	*	*	56%	90%	82%	92%	100%
2007	*	*	*	*	80%	89%	67%	100%	100%
2008	*	*	*	*	90%	91%	75%	92%	92%
2009	*	*	*	*	89%	80%	67%	100%	91%
2010	*	*	*	*	93%	100%	75%	100%	92%
2011	100%	100%	90%	*	100%	85%	83%	100%	100%
2012	100%	100%	89%	*	86%	73%	90%	100%	100%
2013	100%	100%	88%	*	75%	100%	67%	100%	67%
2014	100%	83%	83%	*	100%	100%		100%	100%
2015	100%	80%	92%	*	67%	100%		90%	89%
average	**100%**	**93%**	**88%**	*	**83%**	**87%**	**81%**	**89%**	**90%**

Within the Peninsular Ranges, ewe survival rates can vary by recovery region, year and month. Additionally, the reliability of survival rates is influenced by the percentage of radio-collared sheep within each recovery region at any given point in time. In regions 5 through 9, survival statistics have been collected since 1994 to present and thus serve as a good index of ewe survival within these regions. Survival statistics for regions 1 – 3 were added in 2011 after CDFW South Coast Region assumed responsibility for rangewide monitoring. Presently, survival rates are not available for region 4; however, radio-collars were deployed in 2015 and thus survival data for this region will be available starting in 2016. In 2015, average rangewide survival of

radio-collared ewes was 87%: survival was highest in SJM (100%) and NSYM (100%) and lowest in CoC (67%: Table 4). 2015 survival statistics were not available in the SSRM and SSYM due to lack of radio-collared animals. In regions 5 through 9 from 1993 to 2015, the average survival rate from highest to lowest was CC (90%), followed by VM (89%), NSYM (87%), CoC (83%), and SSYM (81%). Over the past 5 years (2011 – 2015), rangewide average survival of radio-collared ewes from highest to lowest was SJM (100%), followed by VM (98%), NSRM (93%), NSYM (91%), CC (91%), CSRM (88%), CoC (86%), and SSYM (80%). In the SSYM, data were not collected in 2014 and 2015, but the overall low survival rate and trend is of concern within this recovery region. The trend in the CSRM is also of concern, however, up until 2015 there may not have been enough radio-collared ewes to accurately represent the greater CSRM population. Also of concern are low survival rates within CoC in 3 of the past 5 years.

Documentation and mortality investigations of non-collared sheep deaths and/or injuries rely on the willingness and ability of the general public and government agencies to contact either CDFW or BI. Because these mortalities are found by chance alone, they are not necessarily representative of the overall sheep population. In 2015, there were 12 non-collared sheep deaths reported with the majority due to urban related causes (3 ewes, 5 rams, and 4 lambs). Two rams and 1 ewe were killed by vehicles on Highway 74 located between the NSRM and CSRM recovery regions (Map 13). In the CSRM, a young ram was killed on Jefferson Avenue in La Quinta: a distance of almost ¾ of a mile from the nearest mountains (Figure 1). One ram and 1 ewe were killed by vehicles on the east-bound lanes of Interstate 8 in the CC recovery region (Map 15). In September, a yearling ram was killed by a lion along coyote Creek in CoC and in December a pregnant ewe was killed by a lion in Moonlight Canyon within the Tierra Blanca Mountains in the CC recovery region. Details of lamb mortalities are reported in the Lamb Survival and Recruitment section below.

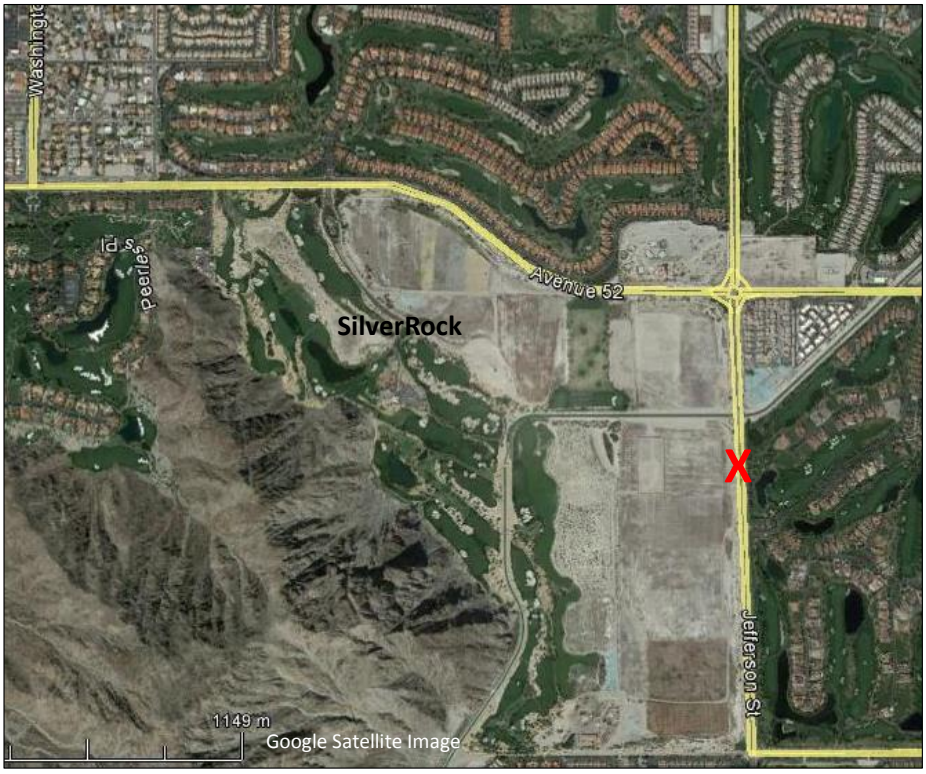


Figure 1. A young ram was struck and killed (red X) by a vehicle while crossing Jefferson Street in La Quinta California on 6/13/2015.

LAMB SURVIVAL AND RECRUITMENT

CDFW has monitored lamb survival (survival to 3 months) and recruitment (survival to 1 year = yearlings) in the CoC, NSYM and SSYM recovery regions since 2008, and in the In-Ko-Pah (IKP) ewe group (within the CC recovery region) since 2010. Details and descriptive statistics concerning lamb production, timing of parturition, lamb survival to 3 months, onset of lamb sickness, and timing of lamb deaths can be found in the CDFW 2012 Annual Report. In 2015, lamb survival and recruitment monitoring in the CSRM was initiated. Lamb:ewe ratios (number of lambs per 100 ewes) and yearling:ewe ratios (number of yearlings per 100 ewes), based on group observations, are used as indices of lamb survival and recruitment. Clinical signs of lamb pneumonia have been documented in all 5 recovery regions; however, rates of lamb survival and recruitment have varied by ewe group, season, and year (Table 5). For the past 8 years, the average recruitment ratio has been very low (18%) in both CoC and NSYM. Typically, lamb survival levels below 30% indicate the presence of lamb respiratory disease within a ewe group. Furthermore, persistently low recruitment levels due to reoccurring pneumonia epizootics in lambs may pose a significant obstacle in population recovery (Cassirer and Sinclair 2007).

Table 5. Index of lamb survival to 3-months-old (Survival) and recruitment of lambs to yearlings (Recruited) from 2008 – 2015 in CoC, NSYM, SSYM, IKP ewe group in CC, Urban ewe group in CSRM and Wild ewe group in CSRM. Three-month lamb survival was calculated from lamb:ewe ratios from group observations obtained from May-June of the year lambs were born and matched with yearling:ewe ratios (recruited) from January - June of the following year. For example in 2015 in NSYM, 19% of lambs survived to 3-months-old (Survival), and 11% survived to yearlings (Recruited) in 2016. [a] Data for recruitment has not yet been calculated for CoC and SSYM.

Year	CoC		NSYM		SSYM		IKP-CC		Urban CSRM		Wild CSRM	
	Survival	Recruited	Survival	Recruited	Survival	Recruited	Survival	Recruited	Survival	Recruited	Survival	Recruited
2008	66%	21%	43%	21%	64%	29%	*	*	*	*	*	*
2009	51%	31%	30%	24%	41%	18%	*	*	*	*	*	*
2010	37%	24%	14%	19%	61%	28%	79%	39%	*	*	*	*
2011	56%	4%	21%	3%	58%	17%	63%	20%	*	*	*	*
2012	36%	7%	13%	13%	63%	38%	70%	45%	*	*	*	*
2013	26%	7%	7%	18%	93%	*	51%	26%	*	*	*	*
2014	25%	22%	38%	34%	*	27%	10%	8%	*	35%	*	38%
2015	21%	a	19%	11%	47%	a	86%	35%	53%	11%	66%	36%
Average	**40%**	**18%**	**23%**	**18%**	**61%**	**25%**	**60%**	**29%**	**53%**	**23%**	**66%**	**36%**

Central Santa Rosa Mountains: Health monitoring of lambs in this recovery region commenced in 2015 after sheep were radio-collared in October 2014. Presently, in the CSRM 4 ewe groups have been identified; 3 of these ewe groups have not been documented foraging at golf courses surrounding the city of La Quinta (hereafter referred to as "wild sheep") while the fourth ewe group regularly forages at golf courses (hereafter referred to as "urban sheep"). Yearling:ewe ratios obtained in 2015 indicated a high rate of lamb recruitment from 2014 for both urban and wild sheep groups in the CSRM (Table 5). In 2015, the peak of parturition occurred in February. Average lamb survival to 3 months was high in both urban (53%) and wild sheep (66%) groups; however, lamb recruitment within the urban group dropped precipitously post-3-months with only 11% of the lambs born in 2015 surviving their first year compared to 36% in the wild group (Table 5). Furthermore, only 1 of the 4 lambs belonging to urban radio-collared ewes survived through 2015. In April, 1 lamb was observed with mild symptoms of respiratory disease within the wild sheep group. In the urban group, a few lambs and several yearlings and ewes, including pregnant collared ewe 349, were observed with diarrhea at SilverRock golf course (Photo 1). Also in April, a sick lamb found at a residence in PGA West golf community was removed by Riverside County Animal Control and taken to their facility. Unfortunately, because wild sheep are extremely susceptible to diseases carried by domestic animals, this lamb could not be treated and returned to its mother. The lamb was taken to the Living Desert Museum and diagnosed and treated for bronchopneumonia: lab results identified the bacterium *M.ovi* as the likely causative agent. By May, all of the lambs at the golf course, including those belonging to four collared ewes were showing mild to severe symptoms of respiratory disease. Mild symptoms of respiratory disease are coughing and nasal discharge but with good body weight and no droopy ears whereas severe symptoms include nasal discharge, droopy ears, lethargy, and weight loss (Photo 2). Also in May, CDFW personnel removed a moribund lamb from the SilverRock Golf Course. The 3-month-old male lamb was taken to the California Animal Health and Food Safety Lab (CAHFS) in San Bernardino where it was humanely euthanized. Necropsy and test results indicated that the lamb had bronchopneumonia with the main bacterial infectious agent identified as *M.ovi*. Additionally, lab results showed the lamb had intestinal coccidiosis, low levels of hepatic copper, and high levels of zinc all of which contributed to a poor immune status and predisposed the lamb to bacterial

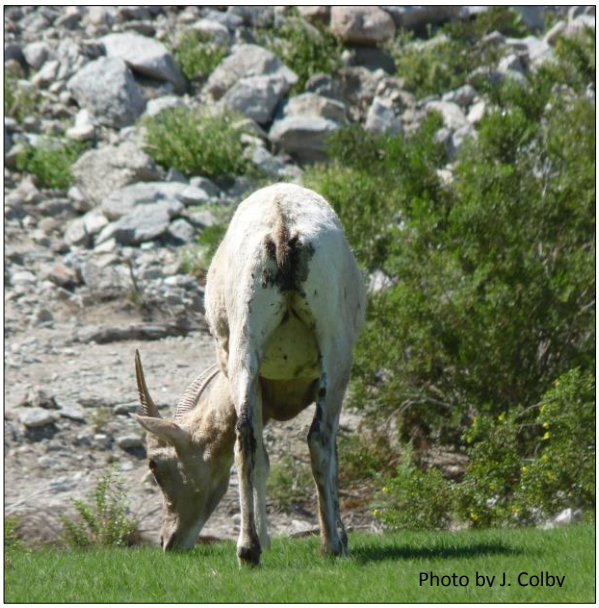


Photo 1. Yearling ewe at SilverRock golf course with diarrhea.

Photo 2. The lamb on the left had pneumonia – droopy ears, nasal discharge, extremely thin, poor coat condition, and lethargic. Typically, when lambs get this sick they no longer cough (mild symptoms are nasal discharge and cough but with no droopy ears and good body weight). In comparison, the lamb in photo B is healthy – head held high, ears up, good body weight (rounded hindquarters), and good coat condition.

infections. In August, a male lamb was found dead in the Coachella Canal terminus at Lake Cahuilla by Coachella Valley Water District personnel. The lamb was retrieved by CDFW personnel and taken to CAHFS for postmortem examination. The cause of death could not be determined due to severe postmortem decomposition but gross and microscopic changes were suggestive of drowning as the possible cause of death. Gross examination of the lungs did not indicate this lamb had pneumonia. Toxicology results indicated a low liver copper concentration which can contribute to ill thrift, decreased resistance to other diseases, diarrhea, ataxia (loss of coordination) and at extremely low levels, death may occur. In 2015, the spread of disease among urban lambs was most likely facilitated by ewes and their lambs concentrated at the golf courses. Furthermore, sick lambs are more vulnerable to predation but because urban lambs have lost their natural wariness they may be at higher risk of predation compared to wild lambs.

Coyote Canyon: The 2015 lamb survival ratio of 21% indicated respiratory disease was once again an issue within this recovery region (recruitment data have yet to be assessed: Table 5). In June, a male lamb was killed by a bobcat near Coyote Creek. Gross necropsy findings indicated the lamb may have been suffering from respiratory disease prior to being killed. Sick lambs will often spend more time near a water source and therefore are more vulnerable to predation.

Northern San Ysidro Mountains: In 2014, lamb survival (38%) and recruitment (34%) was much higher than the previous 6 years (Table 5). Unfortunately, in 2015, lamb survival (19%) and recruitment (11%) were again extremely low. The peak of parturition for this ewe group has shifted from February to January; and in late January 2015, the first symptoms of disease were observed in a 2-week-old lamb with diarrhea and a severe cough. The lambs of 2 radio-collared ewes were also observed with diarrhea, cough, and nasal discharge. Most symptoms of disease were first observed when lambs were between 3 and 7 weeks of age. Of the 20 radio-collared ewes (7 were non-functioning collared ewes) monitored in 2015, 12 ewes (60%) lost their lambs to pneumonia, 2 lambs survived (10%) but had displayed mild symptoms of respiratory disease, 2 ewes did not have lambs (a 16-year-old ewe and a 2 year-old-ewe), and the pregnancy status of 4 ewes was unknown. While most symptoms of respiratory disease were seen in lambs, 5 radio-collared ewes and 3 non-collared sheep also showed mild symptoms of respiratory disease. For example, in February, collared ewe 315 was observed with nasal discharge and another non-collared adult ewe was seen coughing (both were in good body condition). In May, a 2-year-old ram was observed with a dry-hacky cough and another 2-year-old ewe was in poor body condition. In early July, collared ewe 311 was observed coughing several times. In August collared ewes 185, 308, and 316 were observed coughing.

Southern San Ysidro Mountains: There were no radio-collared ewes present in this recovery region until November 2015; therefore, most observations of lambs were opportunistic with little detailed information. Two lambs were seen with symptoms of respiratory disease but both lambs had good body weight and were over 3 months old. During the annual ABDSP 4th of July waterhole count only 8 ewes and 8 rams were counted with no lambs observed during the 3 day count. Based on this information, a CDFW field biologist and volunteer spent 3 days in August near water sources and obtained a lamb:ewe ratio of 47% and a yearling:ewe ratio of 22%. However, average recruitment since 2008 has been below 30% except in 2012 (Table 5). Low lamb recruitment levels in conjunction with a low average annual ewe survival rate (81%: Table 4) may indicate this is a declining recovery region. Hopefully, with the recent addition of radio-collared ewes within the SSYM we will be able to monitor this recovery region more thoroughly in the future.

Carrizo Canyon: There are 4 ewe groups within this recovery region: Tierra Blanca, Carrizo, In-Ko-Pah (IKP), and Jacumba. While group observations were obtained in all 4 ewe groups, lamb survival and recruitment ratios are only reported for the IKP ewe group which has been consistently monitored since 2010. In the past 6 years, average lamb survival (60%) and recruitment (29%) has been good (Table 5). Prior to 2014, each year a few lambs were observed with symptoms of respiratory disease but typically signs were not severe. Starting in 2014 there was an increase in symptoms of severe pneumonia with a subsequent drop in lamb survival (10%) and recruitment (8%). In 2015, lamb survival (86%) and recruitment (35%) ratios rebounded tremendously. Two sets of twins were confirmed within the IKP ewe group in 2015: one set belonged to a non-collared ewe and the other set belonged to collared ewe 233 (Photo 3). Ewe 233 was observed on multiple occasions nursing 2 female lambs at the same time; furthermore, her twins survived through weaning. Of the 9 marked ewes that had lambs in IKP in 2015, only 1 lamb did not survive through the first 4 months. However, if the IKP ewe group is to follow the same pattern seen in other ewe groups where respiratory disease has been introduced, the general pattern will be for decreasing or chronically low lamb survival and recruitment interspersed occasionally with high recruitment levels. The Indication thus far at the writing of this report is for a poor year of lamb survival in 2016. Respiratory disease is also impacting lambs within the Carrizo ewe group. In June, a dead lamb was found by a hiker along the railroad tracks in Carrizo Canyon. A CDFW biologist performed a field necropsy: gross findings were indicative of bronchopneumonia and lab results identified *M.ovi* as the likely causative pathogen. In the Tierra Blanca ewe group, lamb survival through the summer appeared to be high. In August, 13 lambs and 20 ewes were consistently seen in the Agua Caliente County Park campground. While all lambs were active and had good body weight, a few lambs exhibited mild symptoms of respiratory disease. Twins were also confirmed in this ewe group for a total of 3 sets of twins documented in the CC recovery region for 2015.

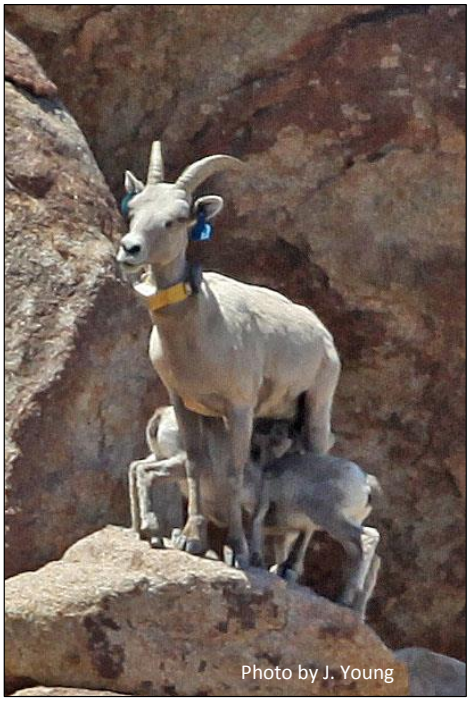
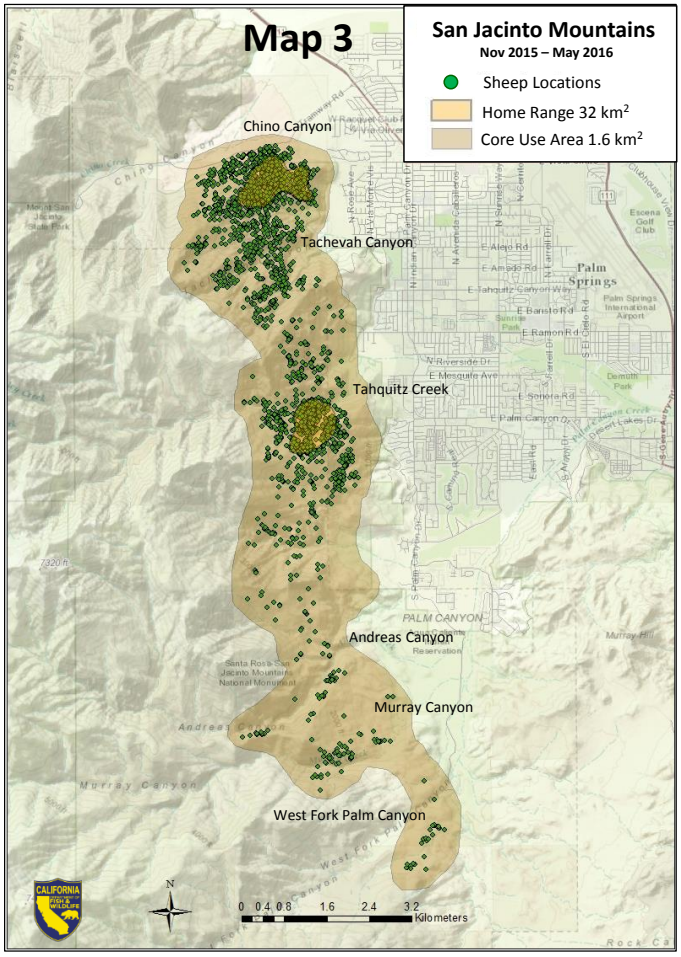


Photo 3. Ewe 233 with two female twins nursing – Spring 2015.

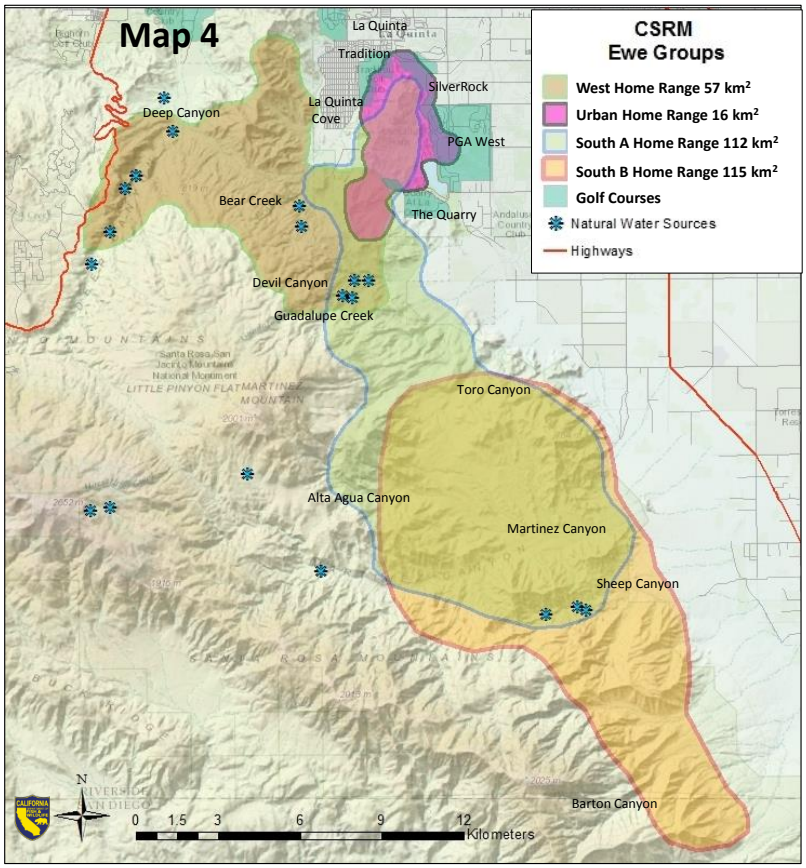
DISTRIBUTION AND MOVEMENT

Presently, remote download and Satellite GPS collars are deployed in the highest numbers with the best representative distribution within each recovery region than at any other time. Population structure and abundance rangewide was last described in 1998 (Rubin et al. 1998); however, the study relied on direct observations for documenting ewe group structure and movement patterns rather than detailed GPS location data. In 2017, CDFW will update and fully describe population structure, movement, and abundance based on current GPS data and the abundance estimate that will be obtained during the fall 2016 rangewide helicopter population survey. Past CDFW annual reports have described habitat use, distribution, and movement patterns in CoC, NSYM, SSYM (2012 Annual Report), and CC recovery regions (2014 Annual Report). This report will describe preliminary results on ewe group structure and movement patterns obtained from location data collected from November 2014 through 2015 in the CSRM and VM recovery regions. We will also briefly describe preliminary location data collected from satellite collars deployed on females within the SJM and SSRM recovery regions.



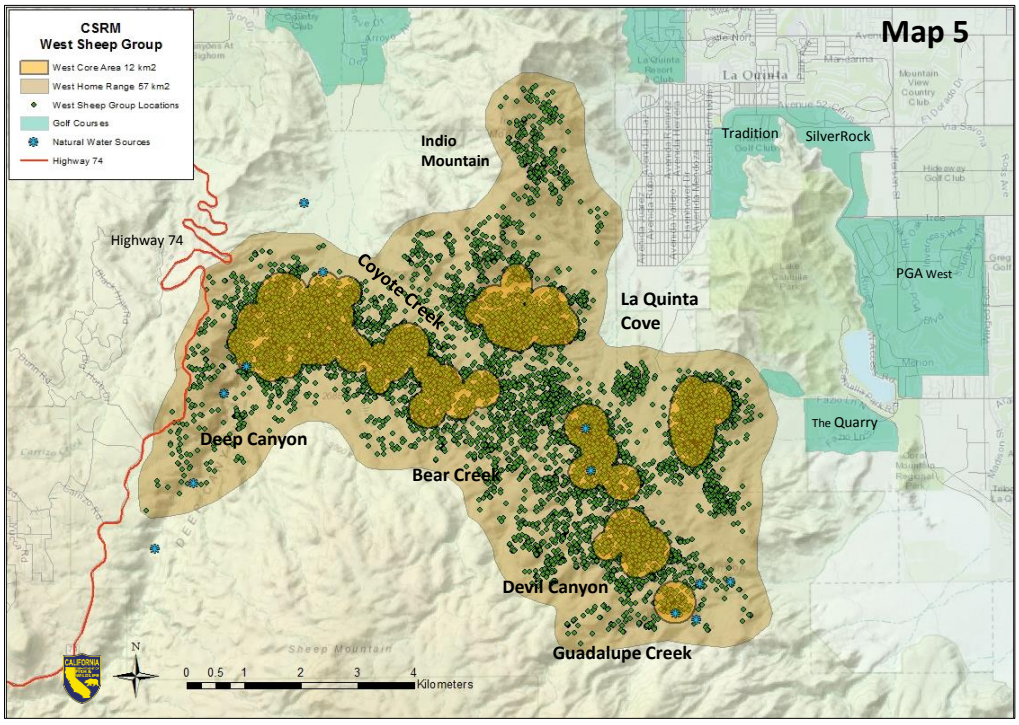
San Jacinto Mountains: The SJM recovery region is approximately 168 square kilometers (km^2) with a density of approximately 0.24 sheep per km^2 (based on 2010 abundance estimate). In November 2015, satellite collars were deployed on 5 ewes and GPS collars were deployed on 2 rams; however, GPS data on the rams is "store-on-board" and has not yet been obtained. Thus far, location data from November 2015 to May 2016 show a home range use of approximately 32 km^2 with core use centered on the south side of Chino Canyon and within Tahquitz Creek Canyon (Map 3). Two collared ewes spent time south of Tahquitz: Ewe 431 spent November and December between Tahquitz and Murray Canyons while ewe 432 spent the month of January south of the West fork of Palm Canyon.

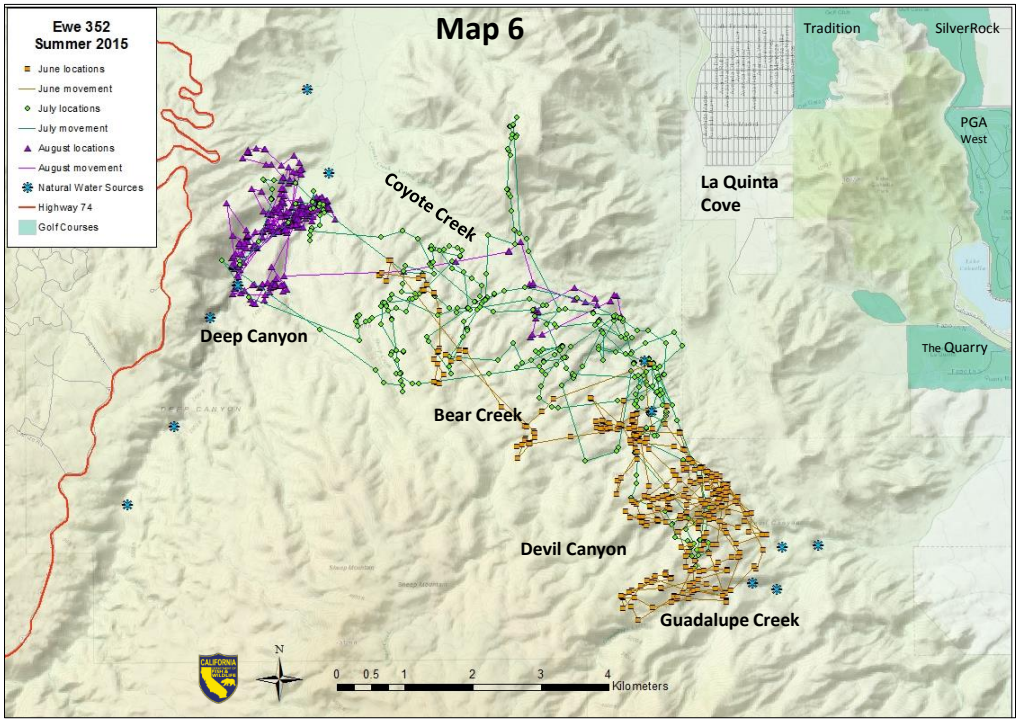
Central Santa Rosa Mountains: The CSRM recovery region is approximately 257 km^2 with a density of approximately 0.52 sheep per km^2 (based on 2010 abundance estimate). Location data reported extends from November 2014 to March 2016 and represents the combined locations of 3 satellite and 10 GPS-collared ewes. Data have not yet been collected on 4 ewes captured in the southern region of CSRM and thus the data reported here do not fully represent all radio-collar movements. To date, data from GPS-collared ewes have identified 4 ewe groups within the CSRM as defined by habitat use patterns (Map 4). Three ewe groups do not use any artificial water and forage resources while the fourth ewe group spends the majority of their time either within or near the golf course communities in La Quinta. We define a ewe group as a group of ewes that share the same 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 but may contribute to the spread of disease as well.



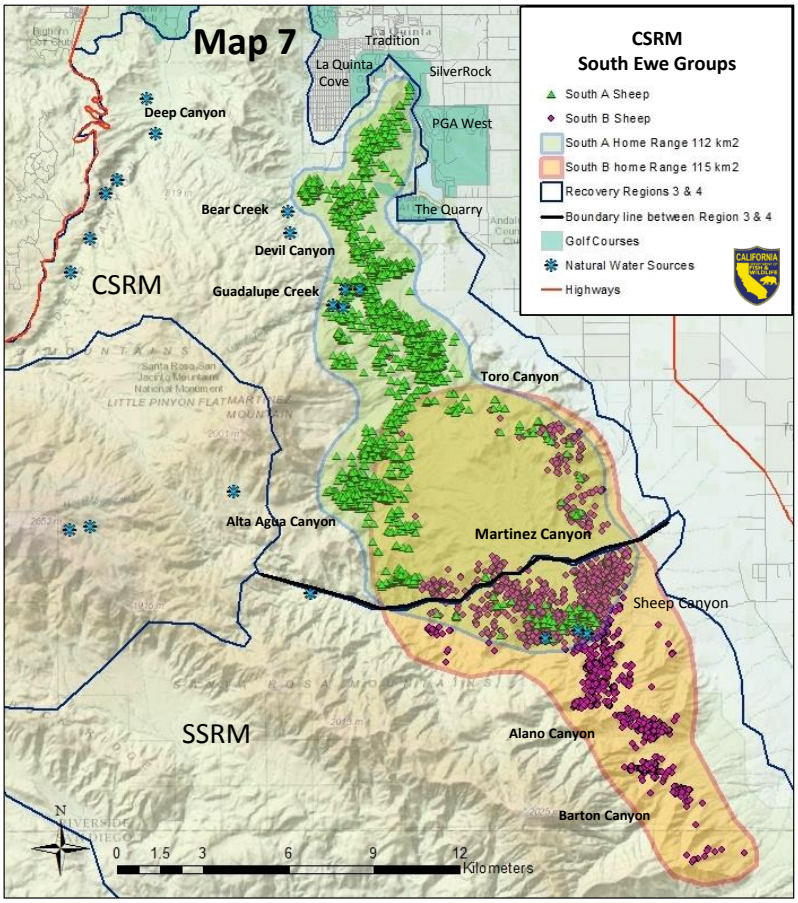
The home range used by the "West" ewe group encompasses approximately 57 km^2 and extends 12 km from east to west and 7 km from north to south (Map 5). The western boundary abuts highway 74 which acts as a barrier to free sheep movement. The eastern boundary ends just west

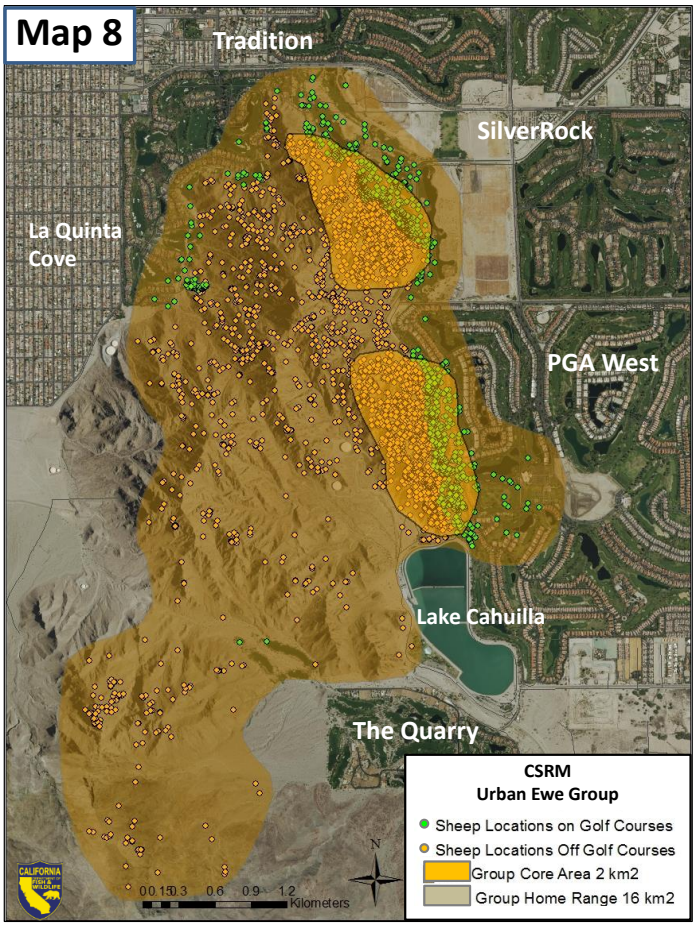
of The Quarry Golf community in La Quinta. The northern boundary surrounds Indio Mountain and the southern boundary ends around Guadalupe Creek. The most heavily used core area is in the lower portion of Deep Canyon and extends into Coyote Creek which is used as a movement corridor into the eastern portion of their range. Lambing habitat has been documented in the areas surrounding Coyote Creek. Summer activity is not centered on a single water source but, instead, ewes move between water sources in Deep Canyon, Bear Creek, and Guadalupe Creek (Map 6). To date, this ewe group has not used any artificial water sources or habitat within the urban environment.





Ewes in the southern portion of the CSRM received radio-collars in November of 2015 and home range definition presented here is preliminary. It is not yet clear whether ewes within this area should be defined as two ewe groups or one ewe group with extensive sub-structuring. The home range used by ewe group "South-A" encompasses 112 km^2 and is approximately 19 km in length and 10 km in width (Map 7). The northern end is on the slopes above the La Quinta golf courses and the southern terminus is just south of Sheep Canyon. Ewe group "South-B" encompasses 115 km^2 and is approximately 19 km in length and 12 km in width. The northern end starts at Toro Canyon and the southern end is just south of Barton Canyon. The official boundary between the CSRM and SSRM recovery regions passes through Martinez Canyon (Map 7); however, these two ewe groups overlap extensively to the north and south of this artificial boundary in the areas surrounding Toro, Alta Agua, Martinez, and Sheep Canyons. Of note is the "donut-like" hole above Martinez Canyon created by the lack of sheep locations within this area. Toro, Alta Agua and Martinez Canyons all drain into this 6 by 4 km valley and is a good example of how sheep prefer to spend the majority of their time on the steep slopes surrounding this valley rather than venturing into it, where the habitat is less safe relative to predators. The true southern boundary for the South-B ewe group may extend farther south than Barton Canyon. Location data from radio-collared ewe 409 (captured in Toro Canyon) have not yet been obtained but in January her VHF signal was detected in the SSRM around Big Wash. This ewe may serve as a bridge between the South ewe groups and the ewe groups within the SSRM.



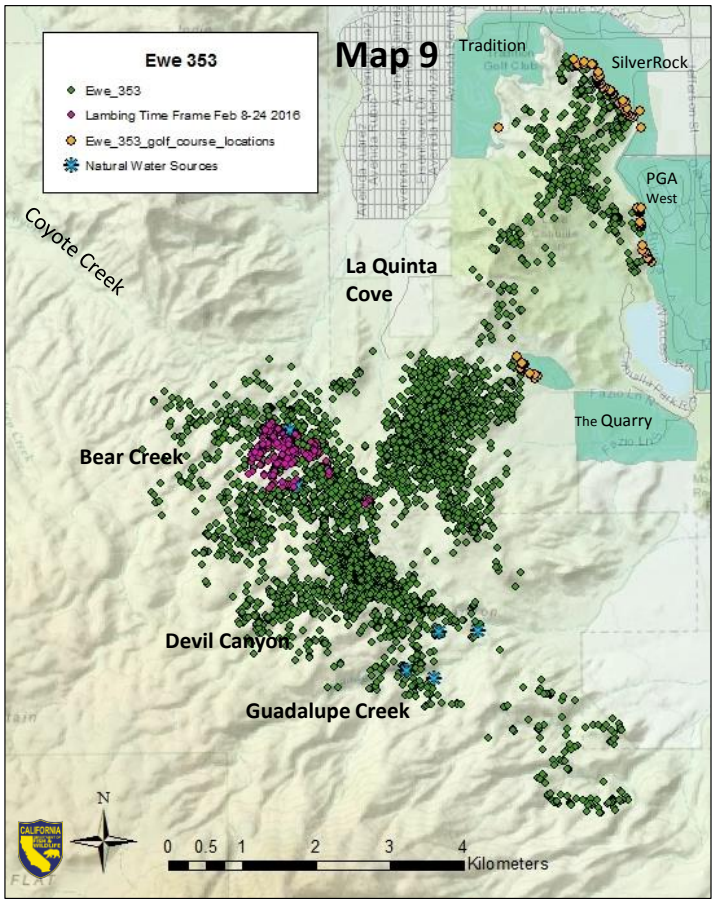


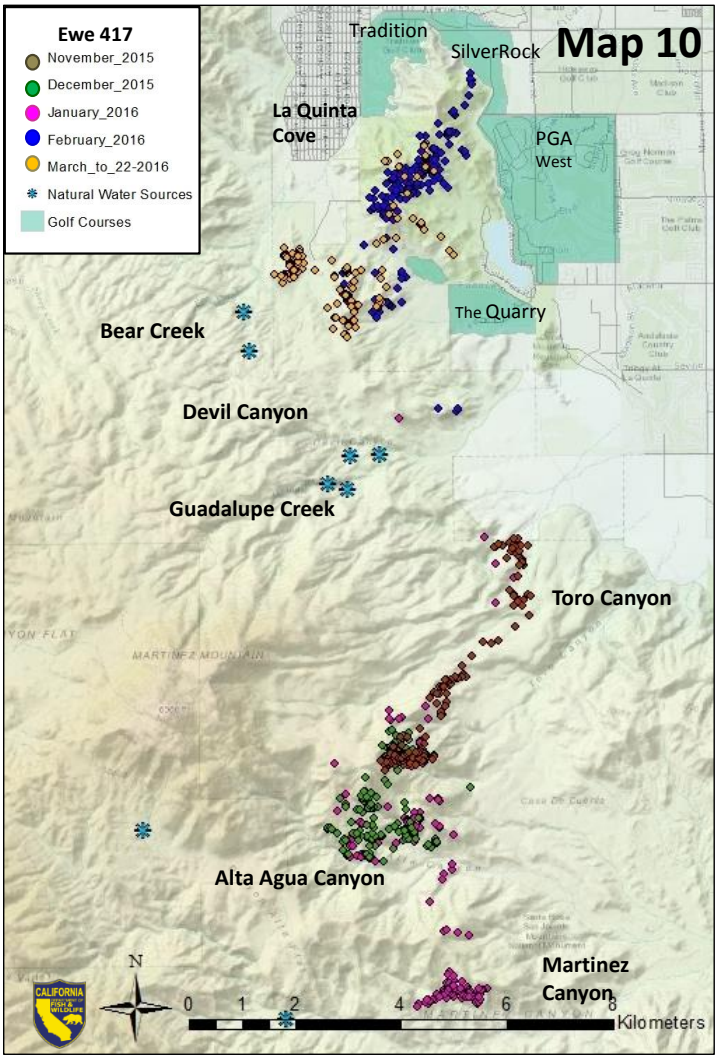
The home range used by the "Urban" ewe group encompasses approximately 16 km^2 and is 3.5 times smaller than the West ewe group home range and 7 times smaller than the South ewe groups home ranges (Map 8). The north boundary is Tradition golf course and the southern boundary is just south of The Quarry golf community. The western boundary is La Quinta Cove and the easternmost boundary is the PGA West golf community. The core use areas are SilverRock and PGA West golf courses and the desert slopes overlooking those courses.

The Urban ewe group is the newest group within the CSRM and most likely formed from ewes that splintered off from the West and South ewe groups. Rams have been documented using the golf courses in La Quinta since 2007 but ewes and lambs did not start using the golf courses regularly until 2012. Ewes and their lambs quickly became habituated to the urban environment and their movement patterns and behaviors contrast strongly with those of their wild neighbors. There is a misperception that due to drought conditions in sheep habitat the ewes and their lambs "need" the water sources and green grasses that are supplied by the golf courses. However, there are 3 other ewe groups in the CSRM that are thriving without artificial food and water sources even during drought conditions (Maps 5, 6, & 7).

Desert bighorn sheep typically have large home ranges because they must move from one area to the next as the quality and quantity of food sources change throughout the seasons. Wild sheep behavior is driven by the constant need to satisfy their nutritional requirements while staying safe from predators. Steep slopes with good visibility afford the safest habitat from predators but riskier habitat such as riparian areas, alluvial fans, and canyon washes can provide the highest quality forage during some seasons. Wild sheep must constantly balance the risks of predation against benefit of higher quality forage. Ewes with young lambs will often choose safer habitat over greener habitat or minimize time within risky habitat while remaining vigilant. Sheep that forage within the urban setting have learned to overcome their innate fear of humans, loud noises, vehicles, and flat open areas far from escape terrain. This "casual" behavior that lacks the natural vigilance and wariness that is innate to wild sheep makes urban sheep more vulnerable to predation, as well as other dangers such as vehicle collisions, consumption of toxic plants, and drowning in pools and canals. Urban sheep no longer behave in a manner that is most conducive to their long term health and survival.

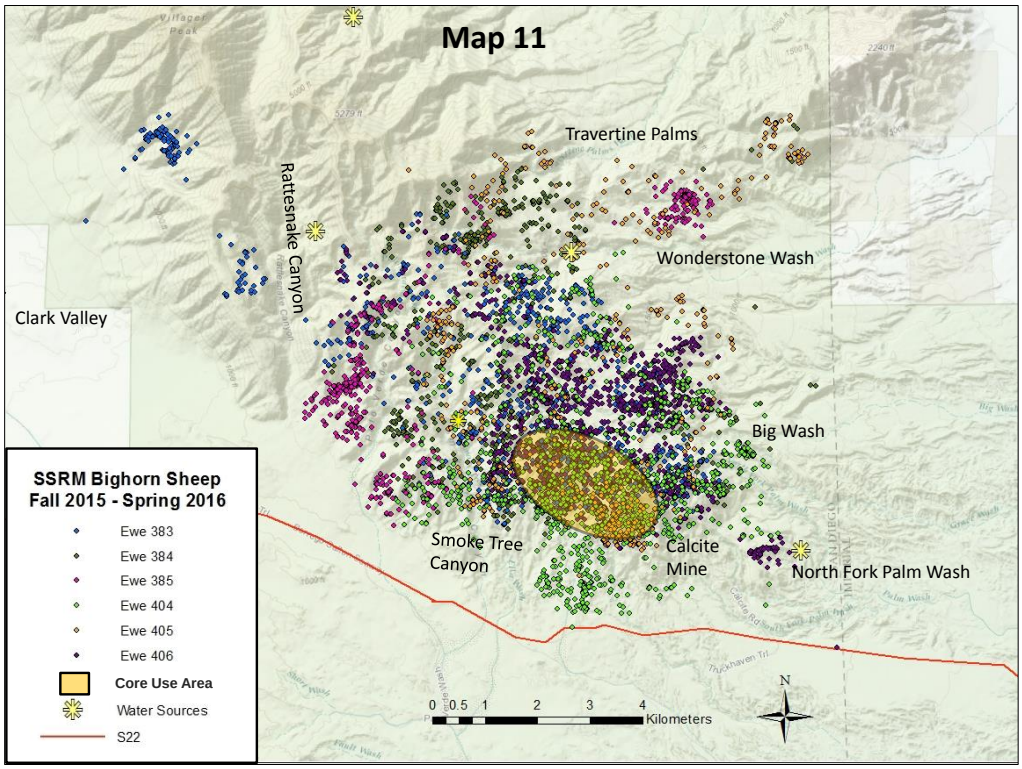
There is also a perception that because the golf courses provide such high quality forage that the urban lambs are thriving and that each year the number of sheep at the golf courses increase. In reality, only 11% of lambs born in 2015 to urban ewes survived through their first year. Most likely, the increase is mainly due to additional wild sheep in surrounding areas joining the Urban ewe group. For example, currently there are 2 radio-collared ewes that appear to be in the process of this transition. Ewe 353, radio-collared in November 2014, does not easily fall within the patterns of any of the CSRM ewe groups but most likely originally belonged to the South-A ewe group (Map 9). In 2015, this ewe spent only 1 day in March and 1 day in August on the SilverRock golf course: then in December, golf course use was increased to 10 days. Most likely, ewe 353 was on the slopes above the golf course and followed "urban" sheep onto the course. Starting in January 2016, ewe 353 used the golf course 21 days out of 31, but returned to safer habitat during lambing season in February. It is possible that in the next few years this ewe will complete the transition to the Urban ewe group. Ewe 417, radio-collared in November 2015, belongs to the South-A ewe group and travels from the steep slopes above SilverRock to Martinez Canyon 19 km south (Map 10). In February, ewe 417 spent time on the steep slopes above the golf courses. No doubt this ewe watched from above as other ewes in the urban group foraged on the golf courses below. Hopefully, a fence should be in place before this ewe, and others, become habituated to the urban environment.

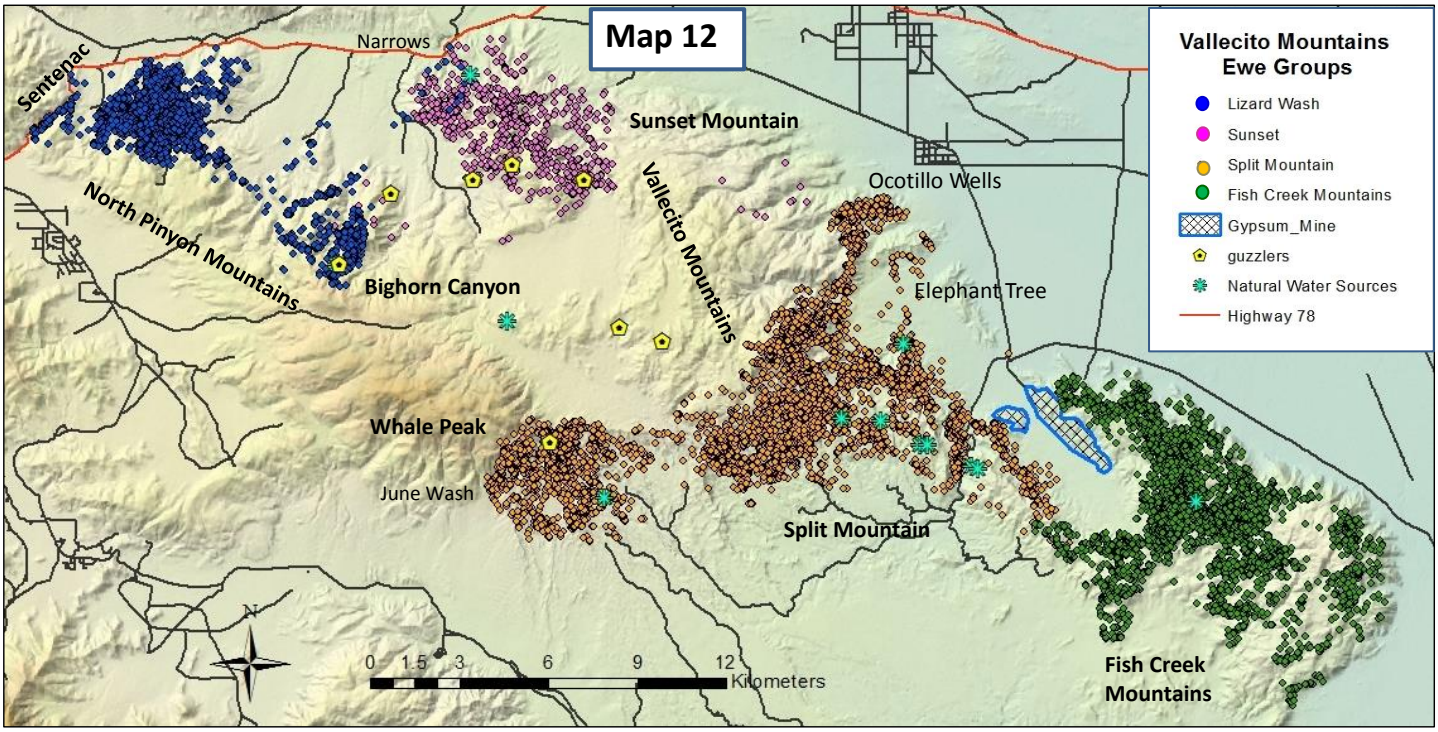




Southern Santa Rosa Mountains: The SSRM recovery region is approximately 562 km^2 with a density of approximately 0.27 sheep per km^2 (based on 2010 abundance estimate). In November 2015, 7 GPS (5 ewes and 2 rams) and 5 satellite collars (5 females) were deployed on sheep. No attempt has been made yet to define home range due to the short time frame of data collection. To date, ewe habitat use has been concentrated in a 10 by 10 km^2 area that extends from just west of Rattlesnake Canyon to the eastern border of ABDSP (Map 11). The most northern boundary is just below Travertine Palms Canyon and the southern boundary is highway S22. Core use area, following the first few months post-deployment, has been located in an unnamed drainage due east of Smoke Tree Canyon and west of Calcite Mine. This core area has a saddle that allows easy access from the south-facing slopes to the north-facing slopes.

Vallecito Mountains: The VM recovery region is approximately 708 km^2 with a density of approximately 0.20 sheep per km^2 (based on 2010 abundance estimate). It is the 2nd largest of all the recovery regions and is one of the most remote and inaccessible areas of the Peninsular Ranges. Due to inaccessibility, it is one of the least studied regions and only recently have we begun to understand ewe group structure and seasonal movements especially within the Fish Creek Mountains. Presently, there are 4 ewe groups that have been identified (Map 12). The "Lizard Wash" ewe group uses an area of approximately 12 x 7 km^2 in the North Pinyon Mountains of the northwestern portion of the recovery region. The northwestern boundary is defined by Highway 78 and the southeastern boundary is Bighorn Canyon. Core use area is centered at Lizard Wash; however, data for several GPS-collared ewes have not yet been obtained. Water sources accessed in summer 2015 were along San Felipe Creek in Sentenac Canyon and at the Blue Spring Guzzler.





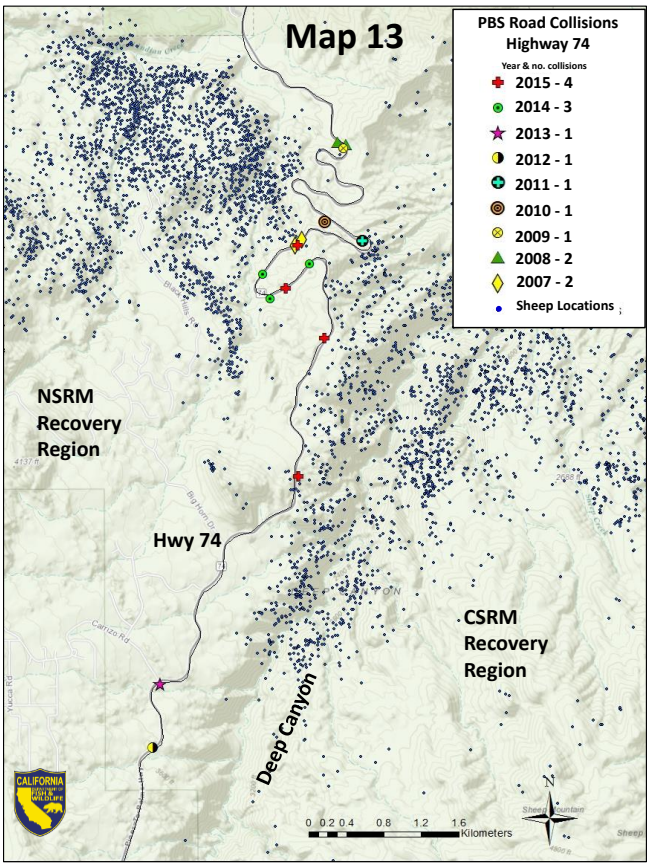
The "Sunset Mountain" ewe group surrounds Sunset Mountain (Map 12). The western boundary is defined roughly by Pinyon Wash and the eastern boundary by Harper Canyon 6 km to the east. The northern boundary abuts Highway 78 through the Narrows while Harper Flats 7 km to the south serves as the southern boundary. Summer water is mainly obtained at the Sunset and Pinyon Wash Guzzlers with less frequent use at the Nolina and Harper Canyon Guzzlers.

The "Split Mountain" ewe group has the largest use area of approximately 17 x 11 km (Map 12). The western boundary is around June Wash on the southern slopes of Whale Peak and the eastern boundary is at the dirt road into Split Mountain. The northern boundary is above Elephant Tree in the Vallecito Mountains and the southern boundary is the lower elevations of the Fish Creek Wash drainage. During the summer months, water was obtained at the Whale Peak Guzzler and at various tinajas (rock basins that collect and store rain water) in Fish, Stone, and Lycium Washes.

The "Fish Creek" ewe group resides within the Fish Creek Mountains and has used an area of approximately 15 x 9 km thus far (Map 12). The northern boundary is to the east of a large Gypsum Mine operation in Imperial County and the southern boundary is north of Carrizo Wash. Thus far, core use area is in a large north/south running drainage on the eastern side of the Fish Creek Mountains. To date, we have data from only 3 of the 5 GPS-collared ewes and summer locations have yet to be obtained.

THREATS TO RECOVERY

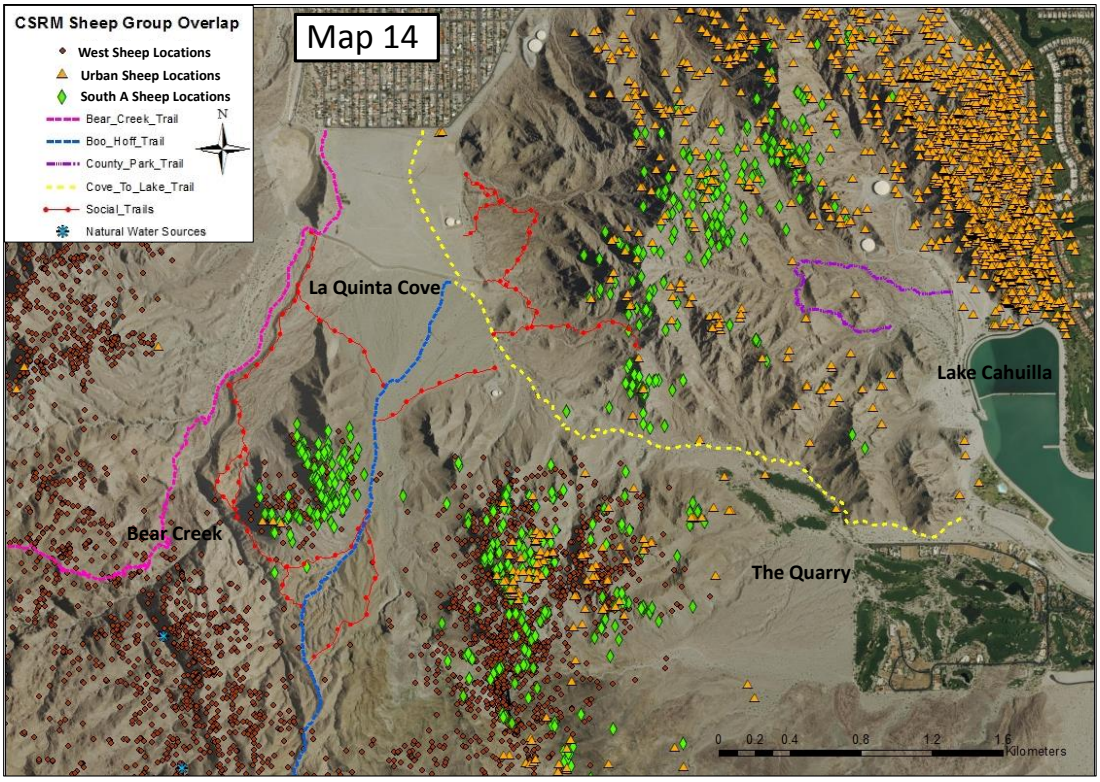
Section D 1.1-1.4 of the Peninsular Ranges bighorn sheep recovery plan describes a series of interim and long-term actions which, if implemented, would eliminate or significantly reduce threats to population recovery. Actions described in the plan address a broad range of known and potential threats to recovery. These threats (generally described) include but may not be limited to: 1) habitat loss and fragmentation; 2) loss of habitat connectivity; 3) loss of habitat quality due to natural (fire) and human causes (introduction of exotic/toxic vegetation); 4) loss, reduction or diversion of water sources; 4) use of the urban interface; 5) livestock grazing; 6) road and highway crossing; and 7) human activities known or found to be directly or indirectly detrimental to sheep. Because bighorn sheep in the Peninsular Ranges reside in a network of state, federal, private, and tribal government lands which lie adjacent to large human urban populations, reaching recovery goals and assuring long-term protections for sheep will require an understanding of and commitment to eliminating threats within and among recovery regions. Identified threats as described in the Peninsular Ranges recovery plan are detailed below by recovery region.



San Jacinto Mountains, and Northern and Central Santa Rosa Mountains - *Threats and concerns – habitat loss and fragmentation, urban use, disease, human disturbance, vehicle collisions, and domestic livestock***:** Urban development within and adjacent to sheep habitat continue to be of concern within these 3 recovery regions. In the SJM recovery region there are several proposed housing developments adjacent to sheep habitat. Currently under construction is the Desert Palisades subdivision on 112 acres within sheep habitat in the Chino Cone area. Connectivity across Chino Canyon is restricted by the Tramway road, fencing, and human activities. In the area surrounding Blaisdell Canyon, domestic sheep and goats that are not properly fenced or are allowed to run loose can potentially spread disease to the wild sheep population.

Connectivity between the CSRM and NSRM recovery regions is impeded by Highway 74 and each year sheep are struck and killed by vehicles while attempting to cross the highway (Map 13). Improved signage and warning devices may prevent accidents that can potentially harm both sheep and humans. Future increases in the traffic load on this stretch of the highway may eventually cut off any movement between the NSRM and CSRM.

Human disturbance in areas identified as lambing and nursery habitat continues to be of concern within these 3 recovery regions. In the CSRM in particular, the West, Urban, and South-A ewe groups' locations overlap in the area just south of La Quinta Cove and thus serve as an important movement corridor between lambing and nursery grounds, foraging habitat, and water sources (Map 14). This vital sheep habitat is also used extensively by recreational users. There are 3 official trails through this area: Bear Creek trail, Boo Hoff Trail, and the Cove to Lake Trail. Signs that clearly state that dogs are not allowed are disregarded by the public especially on the Cove to Lake Trail. There is an extensive system of illegal trails (social trails) that are often used by mountain bikers and hikers in the area around the Boo Hoff trail. This area has been identified as ewe nursery habitat. The social trails that extend into steep sheep habitat off the east side of the Cove to Lake Trail (locally referred to as the "overlook trail") also occur in what has been identified as lambing habitat. Because this is particularly important sheep habitat, we recommend that rules on trails be enforced and unauthorized trails eliminated.



CSRM rams have been documented foraging on golf courses in La Quinta since 2007; and in 2012, ewes and lambs began foraging at golf courses as well. Ewes and their lambs now forage at PGA West, SilverRock, or Tradition on a daily basis. Incidents of sheep walking on the streets and throughout residential neighborhoods in La Quinta continue to increase each year. Sheep use of the urban environment changes their natural foraging patterns and behavior and expose them to a variety of risks such as increased spread of diseases, vehicle strikes, entanglement, drowning, predation, increased parasite loads, and exposure to toxins. Since 2012, 3 rams and 1 lamb have drowned in the Coachella Canal, 1 ram was rescued from the canal, 1 ram died from oleander poisoning, and 1 ram was struck and killed on Jefferson Avenue. Disease is rapidly spread among sheep that concentrate within the golf course communities. In 2015, lambs on the golf course were observed with pneumonia and only 11% of these lambs survived their first year (refer to sections on Respiratory Disease and Lamb Survival and Recruitment for details).

Fencing 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 (USFWS 2000). 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. Other potential actions, such as the capture and removal of sheep from the golf course communities would not be feasible. Ewes teach their lambs where to obtain food and water and once a pattern of use (home range) is established it is maintained from one cohort to the next. Sheep are capable of traveling great distances over a short period of time and would easily find their way back to their original home range. Furthermore, because disease has been identified within the urban ewe group, removal of these sheep to another area would facilitate the spread of disease to other areas of the range.

Southern Santa Rosa Mountains - *Threats and concerns – habitat loss and degradation, depleting water sources, human disturbance (off-road vehicles), disease, and predation:* Gold mine exploration is taking place within sheep habitat in the Wonderstone Wash area in the eastern portion of this recovery region. Sheep habitat within the boundaries of ABDSP does not guarantee protection due to incursions by off-road vehicles in washes that are presently not patrolled by the State Park.

In the past, there have been at least 4 reliable sources of water for sheep in the SSRM: Rattlesnake Springs, Limestone Guzzler, North Palm Wash tinaja, and Natural Rock Tanks tinajas. Recently, some natural springs and tinajas have dried up in the latter portion of the summer. If drought conditions continue these water sources may no longer meet the needs of sheep within this recovery region. A remote camera was placed at Rattlesnake Spring from fall 2011 through summer 2012. No predators, except for an occasional bobcat, were caught on the camera; however, during the late spring and summer sheep were captured on camera in large numbers throughout the day and night. The refill rate of the spring could not keep up with the demand and the spring was often dry by 0900 hours each day. Observations by a CDFW biologist in more accessible areas have demonstrated that sheep with pneumonia will spend increasingly more time near a water source as their disease progresses. This may result in an increased incidence of disease in areas of high sheep concentration. Recently radio-collared sheep within this recovery region and placement of more cameras at springs will help determine whether water enhancement projects may be warranted.

Coyote Canyon - *Threats and concerns – water source 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. However, Coyote Creek is a dynamic system and the area traditionally used by sheep to obtain water at Lower Willows above the closure has filled in with dense vegetation making it difficult for sheep to access water. In the past few years, sheep have been accessing water at or 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 threat (refer to section on Lamb Survival) and CDFW will continue to monitor for possible increases in disease occurrence. Typically, sheep that live within recovery regions with perennial streams and extensive riparian areas (CoC, NSYM, and CC) have higher predation rates than sheep living in areas without perennial streams. Sick lambs will often increase the amount of time they spend near water sources which in turn increases their risk of predation. Furthermore, in past years, CDFW has documented on at least 5 occasions females standing guard over their dead lambs (deaths due to pneumonia) for up to 3 days. In 2 of these cases, it resulted in the adult females being killed by a mountain lion. It is also possible that ravens at the carcass site may key predators to their location: dead lambs are now removed when found near a ewe.

Northern San Ysidro Mountains - *Threats and concerns – urban use, 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 each year at the DeAnza Villas and golf course community. This development poses a threat to the health and survival of sheep in this recovery region due to possible ingestion of poisonous ornamental plants, facilitation of the spread of disease, 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 Villas.

Another major threat to sheep within this recovery region is movement across county road S22. One of the most frequently crossed sections of this road is between mile marker 13 and 14.5 with several past sheep deaths documented at a specific point just below mile marker 14. CDFW is examining the feasibility of placing warning lights and signs at locations along stretches of S22 to reduce this risk.

In August 2015, most water sources within Borrego-Palm Canyon (BPC) dried up and sheep were forced to rely on the pupfish pond adjacent to the trailhead parking lot. If this trend continues, placement of another water source closer to the slopes and away from the trailhead parking lot may allow sheep to access water without being disturbed while still allowing visitors to access the trailhead parking area.

Pneumonia in lambs continued to take a toll on lamb survival in 2015 (refer to section on Lamb Survival and Recruitment). 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 (Photo 4). The BPC trail is not maintained and visitors often become lost and end up off-trail following the dry creek bed where sheep often congregate. 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 and high quality forage alongside the stream. 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, posting signs, and regular trail maintenance to keep people on existing trails may help ensure sick lambs and foraging sheep are not disturbed at this critical time.

Photo 4. Visitors to Borrego-Palm Canyon in Anza-Borrego Desert State Park photograph and admire a ewe (upper left). These visitors all thought that the ewe was curious about the people and looking at them. However, the ewe was looking for her lamb that was on the slopes behind the crowds and was attempting to find a way past the crowds to reach her lamb.

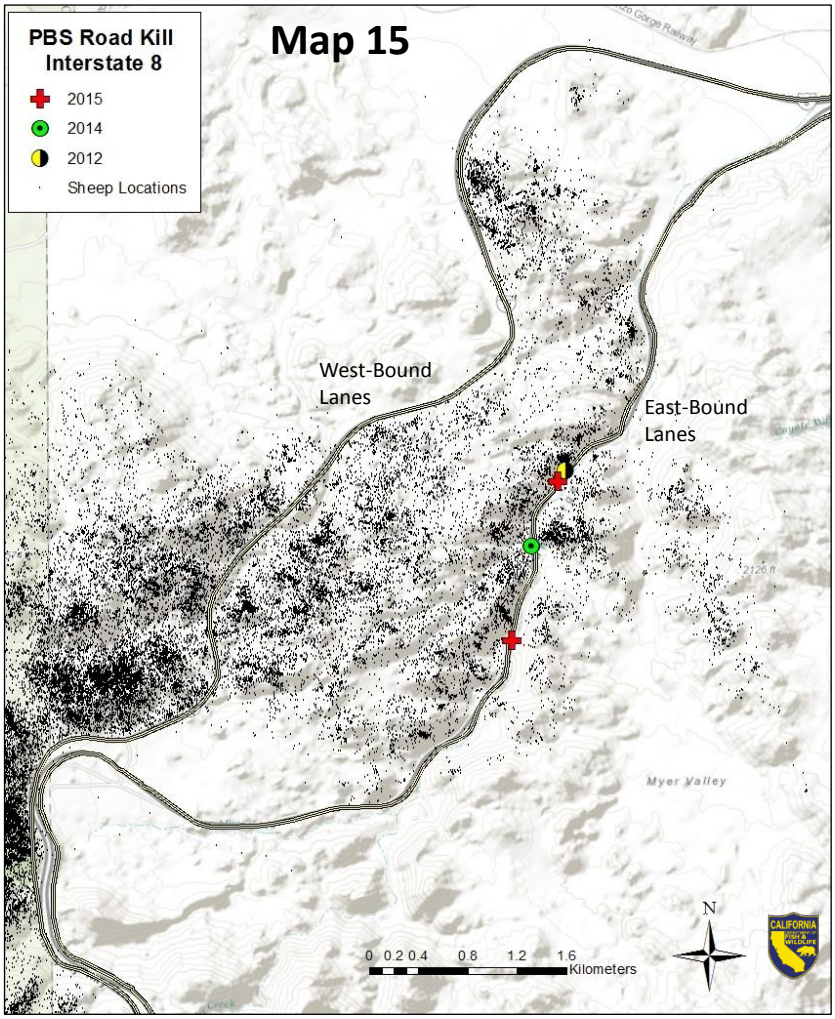
Southern San Ysidro Mountains - *Threats and concerns – vehicle collision, maintaining water sources, disease, and predation:* County road S3 between Pinyon Ridge and Yaqui Ridge bisects the SSYM recovery region and Highway 78 at the Narrows serves as a movement corridor between the SSYM and VM recovery regions. Sheep are most often struck and killed on both sections of these roads during the early spring when ewes are moving between the lambing and nursery grounds. Unfortunately, this coincides with an increase in traffic during the peak of visitation to ABDSP and the Ocotillo Wells Off-Road Recreation Park. Reducing and enforcing the speed limit at common crossing locations on county road 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. Springs farther up the canyon within ABDSP were accessible for a few years following a fire in 2012 but have since filled in with vegetation. Water depletion, accessibility and regular maintenance of guzzlers within this recovery region needs to be addressed by ABDSP in order to ensure future access to water for sheep.

Vallecito Mountains - *Threats and concerns- maintaining water sources, habitat loss, human disturbance, and disease:* The Fish Creek Mountains (FCM) ewe group resides in the eastern portion of this recovery region which is largely outside the protection of BLM wilderness and wilderness areas within ABDSP and thus vulnerable to habitat loss and fragmentation (Map 12). Presently, there is a gypsum mine (with plans for expansion) at the northern portion of the FCM ewe group home range and off-road vehicle use and target shooting is allowed within BLM land on the eastern edge of this ewe group.

For over 30 years, ABDSP has maintained numerous guzzlers within this recovery region and sheep have become dependent upon their use. However, in recent years guzzlers maintenance has been deferred and leaks resulted in several dry guzzlers. In addition, due to drought conditions there has not been enough rain to fill some of the guzzlers. Fortunately, because there are numerous guzzlers, sheep were able to shift their use to functioning guzzlers. Starting in 2015, ABDSP trained volunteers to check the condition of guzzlers; however, a long-term plan and maintenance program/funding needs to be assessed by ABDSP.

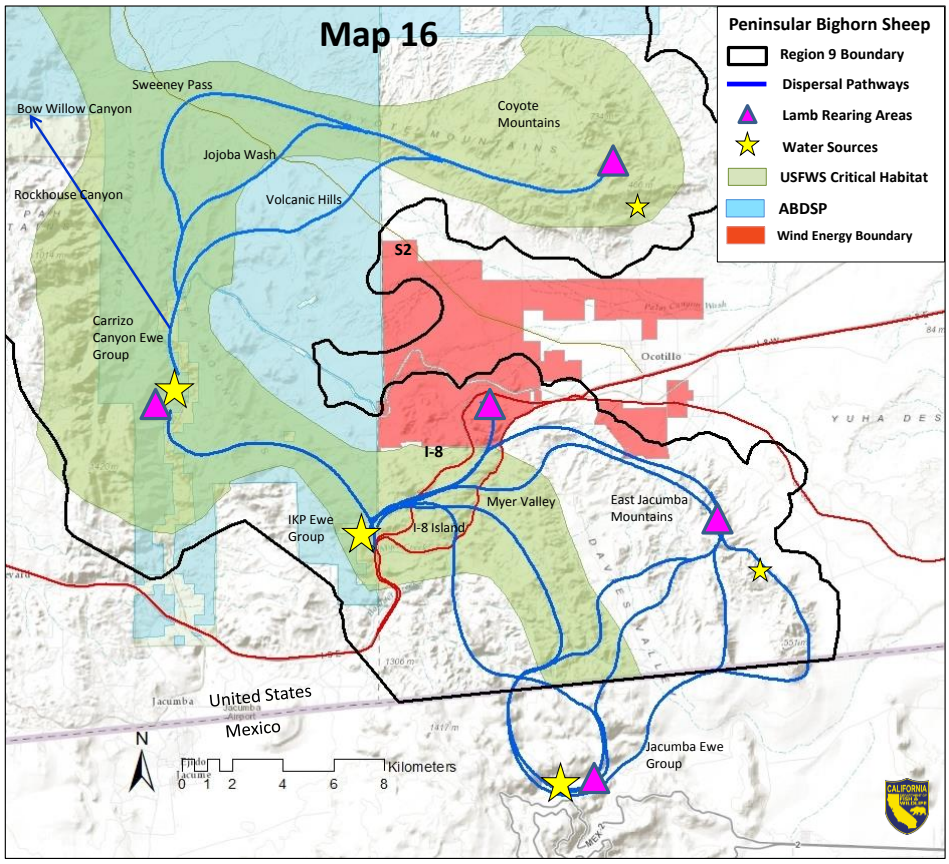
Carrizo Canyon: - *Threats and concerns – vehicle collisions, habitat loss and fragmentation, disease, water accessibility, human disturbance, and domestic livestock:* In the past few years there has been an increase in the number of sick lambs observed in 3 of 4 ewe groups (Tierra Blanca, IKP, and Carrizo). In June of 2015, a dead lamb was found in Carrizo Canyon and lab results identified *Mycoplasma ovipneumoniae* (*M.ovi*) as the likely causative pathogen. CDFW will continue to monitor disease among these ewe groups.



Each year, there are several reports of non-collared sheep being stuck and killed by vehicles while crossing Interstate 8 (Map 15). In March of 2014, the first collared ewe was struck and killed while crossing the east-bound lanes of I-8. In 2015, a non-collared ewe and ram were killed in the same general area of the east-bound lanes. 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 continues to recommend that USFWS and renewable energy project proponents 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 habitat in the CC recovery region. It is hoped that the required off-set measures can be fulfilled in order 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 and directional fencing 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 from the Interstate, the spring can be accessed via a jeep trail from the west. In 2015, there were numerous large jeep events held near the spring: this road needs to be gated to restrict public use in order to protect the watering rights of bighorn sheep. There are numerous small ranches only a few miles to the west and recently a lost horse has been seen using the spring. While horses are not known to spread disease to wild sheep, the presence of a horse indicates property owners may not be properly fencing their livestock. If domestic goats or sheep were to become loose they could potentially spread disease to this ewe group. Farther north, sheep within the Tierra Blanca ewe group are dependent on the water sources at Agua Caliente County Park (ACCP) and Canebrake Canyon. The campground at ACCP 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 (*Nerium oleander*) throughout the campground were removed in 2013; however, the County needs to regularly check and remove any regrowth of oleander within the campground in order to prevent sheep deaths due to oleander poisoning. The water sources along Canebrake Canyon reside on private property. The Canyon is being choked by tamarisk (*Tamarix* spp.) 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 (Jacumba Jim and Black Water) within Carrizo Canyon as well.

Since 2009, GPS data have identified areas within the CC recovery region that are vital sheep habitat and movement corridors (Map 16). 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 activities 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. Border Patrol activities have created a network of roads within the bounds of wilderness areas that also allows unauthorized vehicle access to the general publics. The following areas are considered important sheep movement corridors and habitat within the border region that have been impacted by unauthorized roads: 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 (Map 16) 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

Program activities for 2016 include monitoring radio-collared sheep to detect and investigate mortalities, obtain ground observations to assess group composition, health and disease, lamb:ewe and yearling:ewe ratios, collecting location and movement data, and capture and radio-collaring. A capture is planned for fall 2016 to increase the number of radio-collars in the CC and NSYM recovery regions in order to assure a minimum of 25% marked sheep in all recovery regions prior to a rangewide helicopter survey. Following the fall capture, a rangewide population survey will be conducted to generate an abundance estimate. Additionally, CDFW will update rangewide population structure, distribution, and movement based on GPS data collection. CDFW personnel involved in peninsular sheep recovery will establish department program activities for the next three year period (2017-2020) and will coordinate with federal, state, local and NGO recovery program partners on recovery actions.

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