

**Coachella Valley Multiple Species Habitat Conservation Plan
&
Natural Community Conservation Plan**

**Final Report for Local Assistance Grant P1382103:
Monitoring Peninsular Bighorn Sheep
in the Santa Rosa and San Jacinto Mountains**



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**For the Period of March 1, 2014
to March 31, 2016**

PROJECT: Monitoring Peninsular Bighorn Sheep in the Santa Rosa and San Jacinto Mountains

GRANTEE: Coachella Valley Conservation Commission

TERM: March 1, 2014 to March 31, 2016

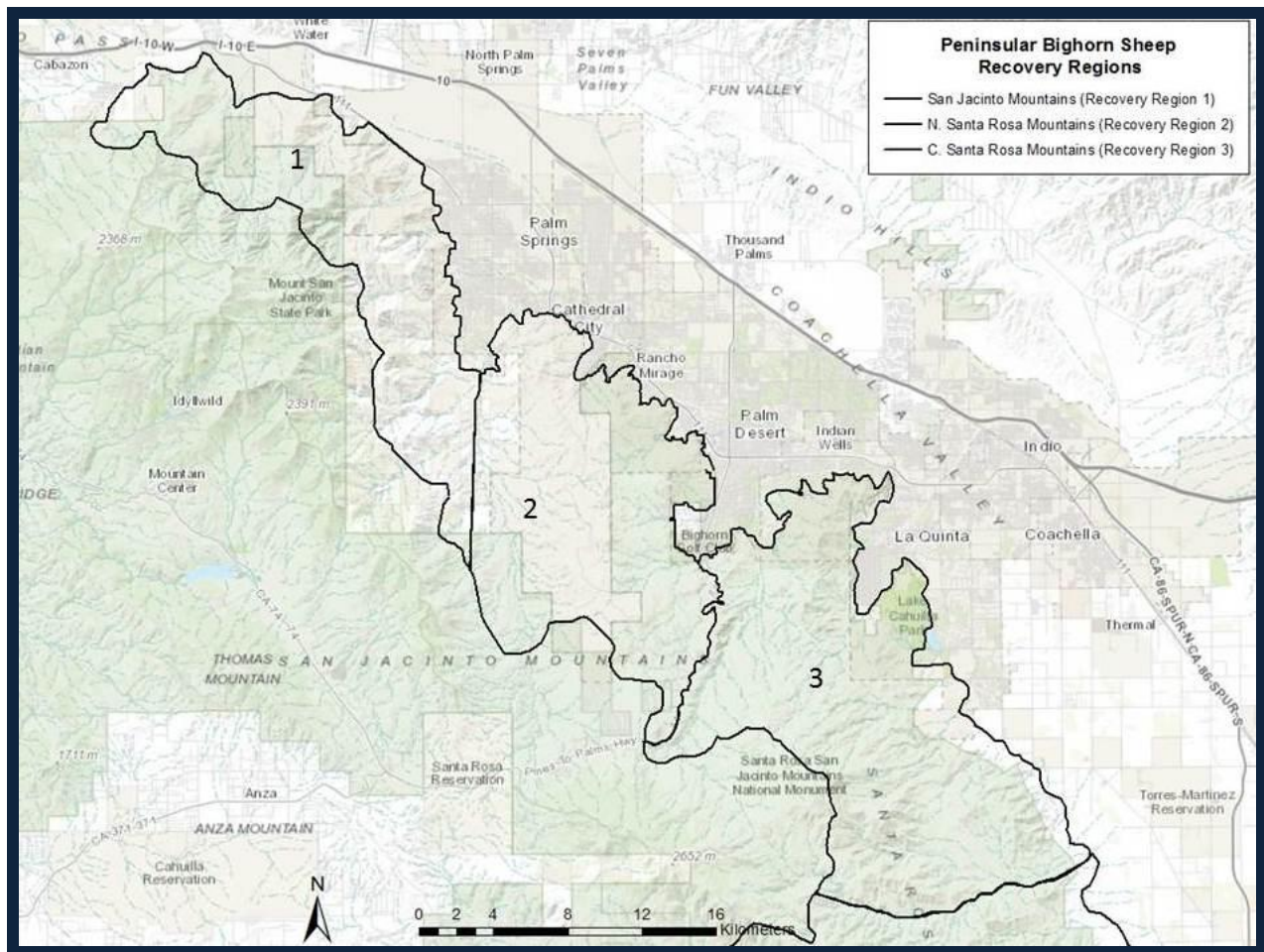
Abstract:

The Coachella Valley Conservation Commission (CVCC) was awarded \$40,000 in funding through a Local Assistance Grant from the California Department of Fish and Wildlife (CDFW). The project "Monitoring Peninsular Bighorn Sheep in the Santa Rosa and San Jacinto Mountains," focused on enhancing baseline monitoring of Peninsular bighorn sheep (PBS) through the use of GPS collars. The goal of the project is to obtain data on sheep movement to more accurately describe the habitat use and adaptive management needs for this species. Through this project we were able to fit 15 bighorn sheep with radio-collars ("collars") and thus increase the accuracy of population estimates. The number of collars was determined in order to ensure that 30% of female bighorn in a given recovery region are marked, as required for statistically valid population estimates. The implementation of this project will enhance the effectiveness of ongoing monitoring of Peninsular bighorn sheep in the Santa Rosa and San Jacinto Mountains to meet recovery goals and adaptive management needs. The CVCC, the implementing agency for the Coachella Valley Multiple Species Habitat Conservation Plan/Natural Community Conservation Plan (CVNCCP), worked with partner agencies including CDFW, USFWS, and BLM to implement this project. Grant agreement P1382103 between the California Department of Fish and Wildlife and the Coachella Valley Conservation Commission was entered into on March 17, 2014. The term of this agreement was March 1, 2014 through March 31, 2016. This report covers the entire term of the project. The project area is within the Santa Rosa and San Jacinto Mountains Conservation Area of the CVNCCP. The project area is also within the Santa Rosa and San Jacinto Mountains National Monument.

Project Summary:

The goal of the project was to acquire data on sheep movement and habitat use to improve baseline monitoring of PBS, one of the covered species under the CVNCCP. When the project began, there were not enough PBS with collars in the Santa Rosa and San Jacinto Mountains to meet the standards necessary for accurate population estimates. The focus of this project was to increase the number of bighorn sheep fitted with collars in this region. The project also made it possible to deploy GPS collars for the first time in this region. The primary objective of this project was completed with the fall 2014 and fall 2015 capture to place collars and ear tags on enough bighorn sheep to provide for mark-resight population estimation. Fitting additional sheep with these collars, funded by the Local Assistance Grant, will now significantly enhance our ability to track sheep movement over time. Through ongoing monitoring, we will be better able to assess population size, describe distribution and habitat use of individual animals, and track mortality factors.

Figure 1. Peninsular bighorn sheep recovery regions in the study area. Map provided by Janene Colby, California Dept. of Fish and Wildlife.



During the initial work on the project, it was determined that there was a more urgent need for information on habitat use patterns in the Central Santa Rosa Mountains, from La Quinta to Palm Desert. This need was in part related to a proposed fence in the La Quinta area to keep bighorn sheep from using golf courses and urban areas as sources of food and water. The original grant agreement identified the Northern Santa Rosa Mountains, from Rancho Mirage to Palm Springs, as the area for sheep capture and placement of collars. Amendment #01 was approved and executed by CVCC and CDFW in November 2014. The amendment changed the focus area for placement of 10 collars from the Northern to the Central Santa Rosa Mountains.

The intent was for placement of all collars to be completed during fall of 2014. Unfortunately, due to weather conditions there was an unexpected delay in the planned capture operation in the San Jacinto Mountains in fall 2014. Capture operations were completed in fall 2014 in the Central Santa Rosa Mountains, in La Quinta. However, due to an increase in wind speed and unpredictable weather during the latter part of the capture operations, the San Jacinto Mountains capture, scheduled for the last day, had to be cancelled. As a result, full deployment of additional collars did not occur until fall 2015. In fall 2015 a sheep capture was coordinated by CDFW and seven collars were deployed on sheep (five females and two males) in the San Jacinto Mountains. Also in 2015, through funding from other CDFW sources, twelve additional collars were placed on females in the Central Santa Rosa Mountains. These collars included

the satellite iridium link that makes it possible for data to be uploaded remotely via computer, not requiring a field visit. However, the delay in full implementation of the collars meant that population estimates by CDFW for the northern Peninsular Ranges could not be completed during the term of this project. This population estimate was completed by CDFW in fall 2016.

The project has had a number of very positive results in addition to the increase in the number of bighorn sheep with collars. During the captures in fall 2014 and 2015, blood and tissue samples were collected from each sheep to be used in disease and genetic analysis. The CVCC is currently working with Oregon State University, USFWS, CDFW, and other scientists on a study of the genetic relationships among bighorn sheep in the Peninsular Range and in the Mojave Desert. The data gathered during this project provided an important set of additional samples to be included in the genetic study. The ability to track sheep movements using data from the GPS transmitters will inform this genetic analysis which aims to evaluate connectivity in this endangered population. The genetic analysis is funded by the U.S. Bureau of Reclamation, CVCC, and the U.S. Fish and Wildlife Service. The results of the genetic study are expected in fall 2017. Associated with the genetic study is a health and disease analysis that will also be completed using samples collected through this project.

Another unanticipated benefit of the project has come from the opportunity to use newer technology to improve ongoing monitoring of bighorn sheep. Monitoring collars with solar GPS pods have not been deployed in the Santa Rosa and San Jacinto Mountains before. These transmitters record detailed location data at two-hour intervals for individual sheep. These data provided through the GPS collars allow monitoring of sheep movements which, over time will allow researchers to quantify and analyze seasonal changes in habitat use, and identify vital lamb-rearing areas. The location based data and ability to track individual animals will greatly enhance our understanding of PBS ecology. Collars with GPS and an iridium satellite link were placed on some of the bighorn sheep during the fall 2015 capture. These collars upload data directly from the collar to a computer or phone; they were funded by CDFW. This newer technology will improve access to data and our ability to evaluate and analyze the data more efficiently.

Project Implementation and Task Summary:

This section of the report provides a summary of the activities involved in project implementation and a review of the individual tasks that were set forth in the grant agreement. Initial work on the project involved coordination between CVCC staff and bighorn sheep biologists from CDFW and USFWS to plan for a bighorn sheep capture and placement of collars on PBS in fall 2014. The California Department of Fish and Wildlife is the lead agency for these capture operations and CDFW staff oversee the entire operation. The capture operation is a very well-planned and executed operation involving a team of biologists and veterinary staff who take every precaution to ensure the safety and successful release of individual bighorn sheep. CVCC staff assisted with project coordination including handling orders for the collars funded by this grant and arrangements for helicopter service to complete the capture operation; the helicopter service was funded in part with other CVCC funds.

The capture and placement of collars on PBS occurred in two phases. On November 5, 2014, nine female sheep were captured, sampled and fitted with collars. The collars used included the VHF unit and a solar GPS pod. In addition, two female and one male sheep were captured, sampled, and ear-tagged. The samples collected from each animal were sent for health analysis through the CDFW Wildlife Investigations Lab. Health analysis and disease profiles will be completed as part of another study, funded by the Bureau of Reclamation, CVCC, and USFWS. Overall, sheep captured in the La Quinta area in November 2014 were in good health but three females had moderate to severe sinusitis; this condition was also noted in sheep captured in the other areas of the range as well. One of the females with severe sinusitis was later reported as

having died. The cause of death was identified as lion predation which occurred well after the capture, but it is possible the severe sinusitis was a contributing factor.

The second phase of the placement of collars on PBS occurred in fall 2015. The original schedule for the project called for all 15 collars to be placed on bighorn sheep during a fall 2014 capture, 10 collars in the Santa Rosa Mountains and five collars in the San Jacinto Mountains. As described in the project summary, an unavoidable delay due to weather conditions resulted in cancellation of the capture of PBS in the San Jacinto Mountains in November 2014. On November 3, 2015 an additional 12 females were captured and fitted with collars in the Central Santa Rosa Mountains recovery region, in the Martinez Canyon, Toro Canyon, and Lake Cahuilla area. In the San Jacinto Mountains, five females and two males were captured and fitted with satellite and GPS collars on November 5, 2015.

Task 1: Obtain Collars for Bighorn Sheep: Accomplishments for this task include coordination with wildlife agencies to plan for the fall 2014 capture of bighorn sheep and placement of monitoring collars on a representative sample of ewes. CVCC staff worked with Randy Botta and Heather Pert of CDFW, and Chris Gregory of USFWS, to determine the number of sheep to be collared. The project called for 10 collars to be placed on females in the Northern Santa Rosa Mountains (later changed to the Central Santa Rosa Mountains) and five collars to be placed on ewes in the San Jacinto Mountains. The collars are VHF collars with a solar GPS pod attached. Fifteen VHF collars were ordered from Telonics, Inc. and 15 GPS pods were ordered from Telemetry Solutions. Preparation of the collars for placement on bighorn sheep was completed by CDFW staff. This task was fully implemented through Local Assistance Grant funding. Figure 2 shows several female Peninsular bighorn sheep that have been fitted with radio-collars. Each collar has a distinctive radio frequency and GPS signature. Unique combinations of radio-collar color and ear tags are used to identify individual animals.



Figure 2. Peninsular bighorn sheep fitted with radio-collars.

Task 2: Capture of Bighorn Sheep: The capture of bighorn sheep to allow placement of monitoring collars was part of a range-wide operation throughout the Peninsular Range, coordinated by CDFW. As described above, the capture of bighorn sheep in the Central Santa Rosa Mountains occurred on November 5, 2014 in the La Quinta Cove area. Nine female sheep were captured and collared; two additional females and one male were captured and ear-tagged. All collared bighorn sheep were fitted with unique combinations of colored collars and ear tags to facilitate individual identification. In addition to placement of collars, blood, fecal and other samples were taken for disease and genetic analysis.

The capture of bighorn sheep was handled by an independent helicopter service, Leading Edge Aviation; CVCC provided funding for the helicopter service. To minimize impacts to bighorn sheep, the capture followed established protocols approved by the Large Mammal Approval Committee. The use of helicopters required coordination with BLM to obtain the appropriate research permits within the Santa Rosa and San Jacinto Mountains National Monument; CVCC and CDFW staff worked with BLM to obtain the necessary approvals.

The intent was to also complete a capture and collar operation in the San Jacinto Mountains. However, due to unexpected weather delays during the range-wide capture, the expected November 2014 capture in the San Jacinto Mountains was cancelled. As a result, five collars planned for deployment in the San Jacinto Mountains were not fitted on bighorn sheep in 2014 and the capture had to be rescheduled to fall 2015. The capture and collar placement ultimately occurred on November 5, 2015 in the San Jacinto Mountains. This change resulted in delays to the monitoring and data gathering tasks for this project. However, the addition of seven collared PBS in the San Jacinto Mountains together with the six bighorn already fitted with collars brings the total to 13 “trackable” bighorn in this recovery region, 33% as required for population estimates. As noted previously, an additional capture also occurred on November 3 in the Central Santa Rosa Mountains, including fitting 12 additional females with radio-collars. As a result the percentage of females with collars in this recovery region was increased to 34%.

Task 3: Field Monitoring Protocol: The focus of this task was on field monitoring of PBS collared in November 2014 and 2015. Field monitoring was carried out primarily by CDFW staff that have the equipment and training to properly retrieve the GPS data. Download of the data from GPS pods requires being within visual contact of a collared bighorn sheep. The biologist completing the monitoring must hike into sheep habitat areas to obtain collar data. For every download of the GPS location data, time consuming work is required to fix location errors and prepare the data for use and analysis. In some cases the number of satellites fixed for a given GPS reading is low and these location data points may be less accurate. Unfortunately the operation of the GPS collars was not without challenges and on some occasions, CDFW biologists were not able to successfully download the data. Data from collars placed in fall 2015 is still being extracted and cleaned up. This work is being completed by CDFW staff.

The first download of data from sheep captured in November was available in January 2015. One of the primary information needs coming out of this project is for data on habitat use by PBS in the La Quinta area. This was in part the reason for the amendment to focus collar placement on bighorn in the Central Santa Rosa Mountains, including La Quinta. A subset of PBS within the Central Santa Rosa Mountains have been using golf courses and urban areas in La Quinta for several years and a fence or other barrier is proposed to limit their access to these areas. The GPS collar data provides a level of information about daily, weekly and monthly sheep movements that has not been available in the past. Maps like those shown in Figure 3a will be extremely beneficial as we develop plans for the proposed fence and evaluate sheep habitat use in this area.

Figures 3a, 3b, and 3c show the data that is downloaded from the GPS collars. Figure 3a is an aerial image of the La Quinta area. The steep and rugged topography in this area is an example of the escape terrain that is an essential element of bighorn sheep habitat. The location is near several golf courses in the City of La Quinta, adjacent to the Central Santa Rosa Mountains. These data and maps were provided by Janene Colby and Randy Botta, CDFW.

Figure 3a: The GPS collars provide continuous monitoring of bighorn sheep movements. This image shows the movement of a single female from November 5, 2014 when she was fitted with a collar to January 14, 2015 when the collar data were downloaded.

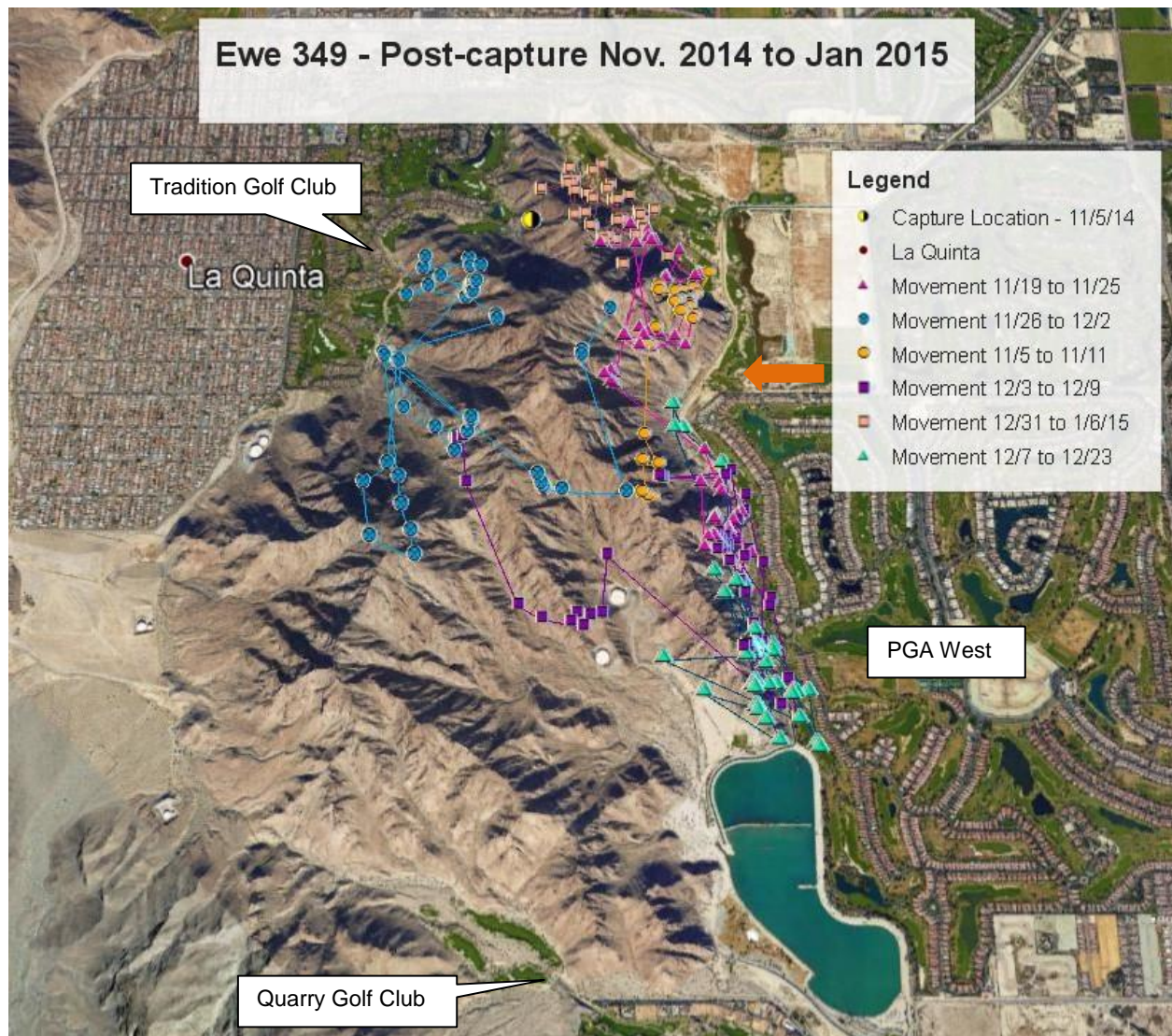
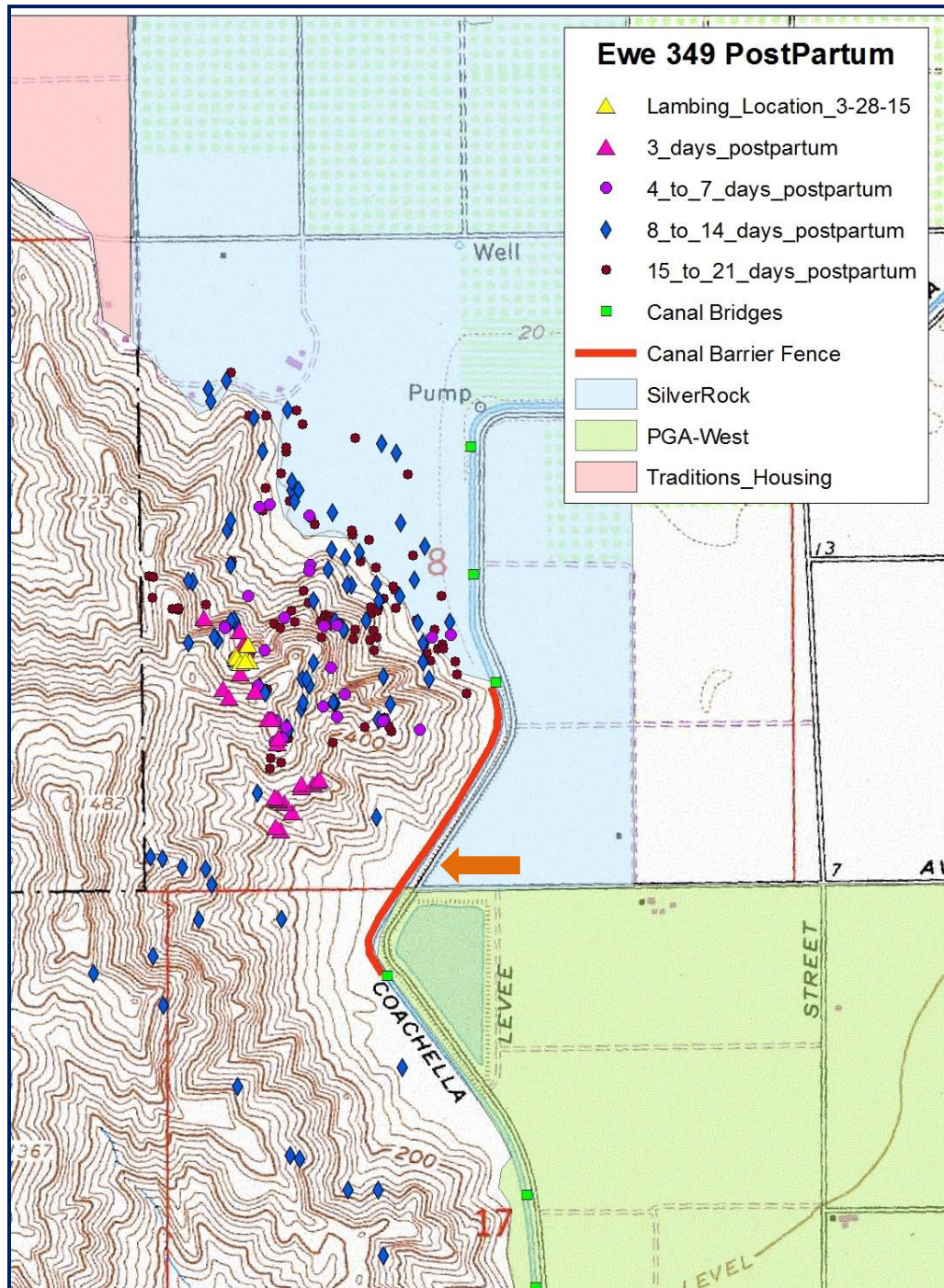
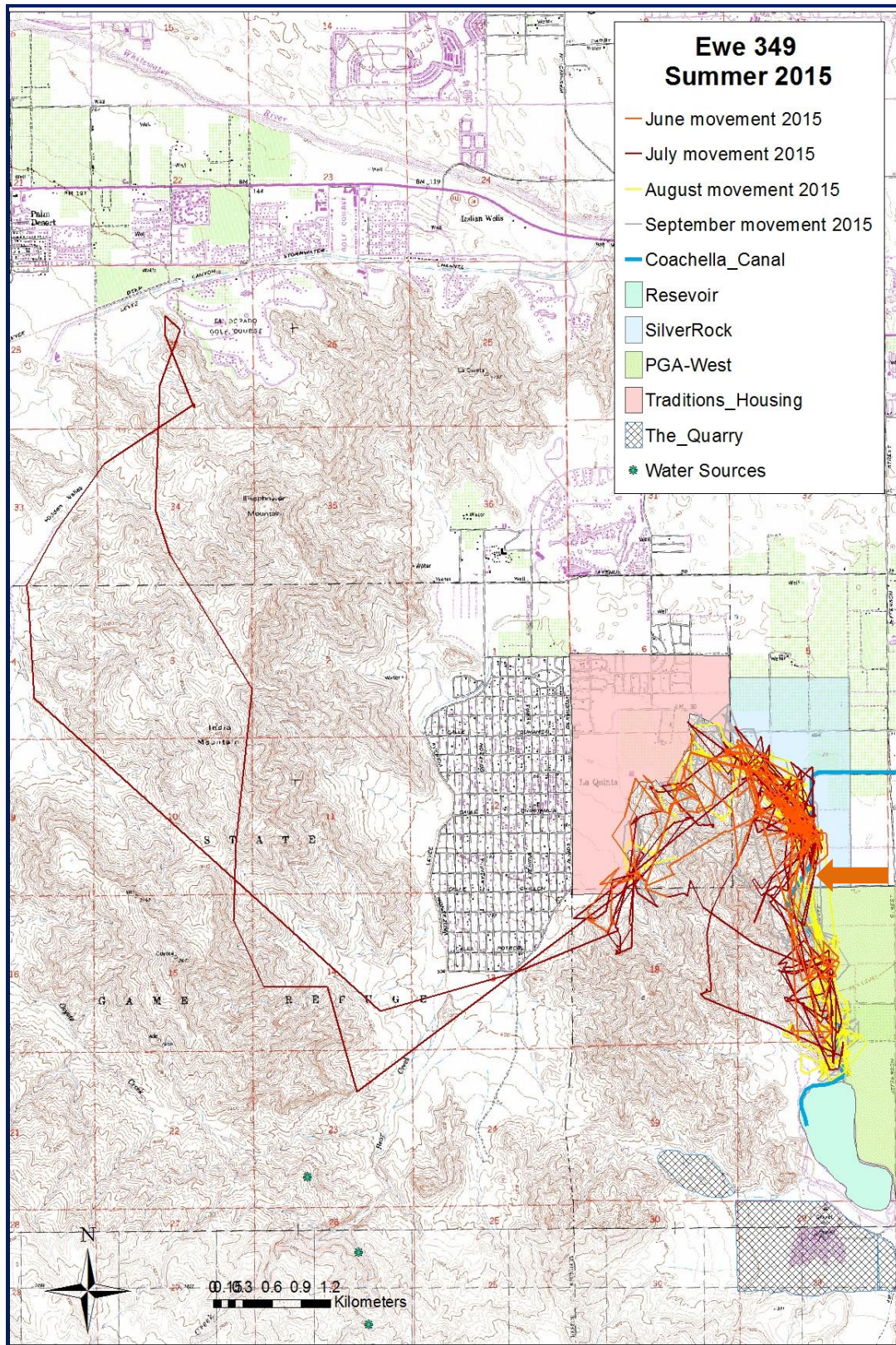


Figure 3b: This map shows ewe 349's movements following the birth of her lamb in March 2015. The orange arrow denotes the same location on both maps.



The GPS data shows the movement of this ewe from the steep slopes above SilverRock golf course down onto the golf course. This occurs within 8 to 21 days postpartum. Bighorn sheep biologists have expressed concern about females bringing their lambs into urban areas at such an early age which may diminish their natural fear and make them more vulnerable to predation.

Figure 3c: This map shows ewe 349's movements in the La Quinta area during the summer months of 2015. The orange arrow denotes the same location on both maps.



The plans to develop a monitoring protocol have been extended. The development of a protocol will be a collaborative effort involving wildlife agencies, other bighorn sheep researchers, CVCC,

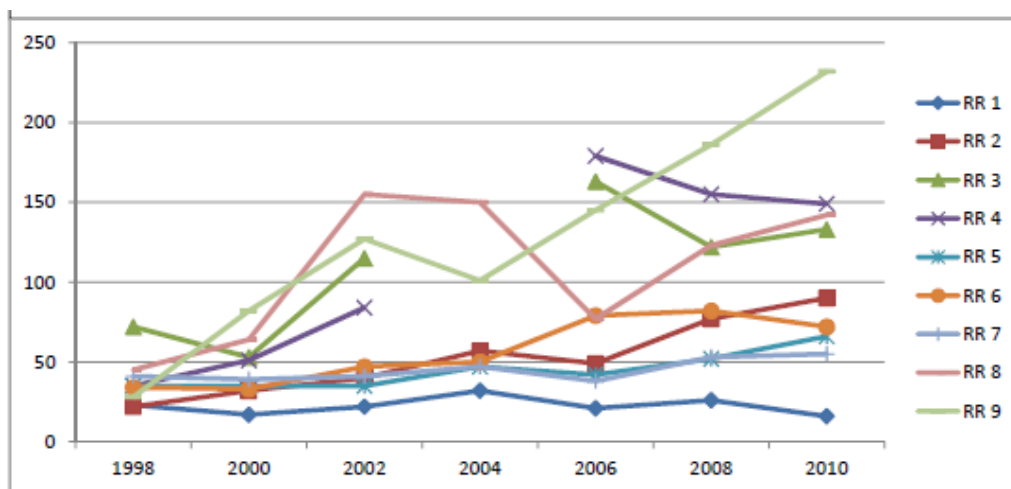
and other partners. Now that additional collars are fully deployed in the project area, data from the collars is still being downloaded and summarized. Getting all the collars deployed took much longer than expected and processing the data is a task which also requires more time. The development of the protocol, though delayed, will benefit significantly from review of these data obtained to date by CDFW in coordination with CVCC, USFWS and BLM. CVCC is also completing work on a vegetation map of PBS habitat in the Santa Rosa and San Jacinto Mountains, also funded through a Local Assistance Grant. This vegetation map will help us to identify habitat variables for bighorn sheep and more accurately quantify factors such as available forage. In partnership with BLM and CVCC, a single census of water resources in the Santa Rosa and San Jacinto Mountains National Monument was completed in 2014. This census identified the status of selected water sources used by PBS in the CVMSHCP area.

Through the course of this project implementation, efforts have been underway to identify options for ongoing monitoring of PBS populations. Additional In our grant agreement, CVCC identified \$21,000 in funding for a biologist to carry out ongoing monitoring. We are currently working with our partners to identify options and other potential funding sources to establish a part-time monitoring biologist position for Peninsular bighorn sheep. CVCC will hold the funds in reserve to be used for monitoring to supplement what is being done by CDFW.

Task 4: Develop Population Estimates and Habitat Model: Another goal of this project is enhance the ability of CDFW to develop population estimates for PBS.

To track recovery status of bighorn sheep, CDFW completes range-wide, standardized estimates which require that $\geq 30\%$ of the bighorn sheep are collared. The range-wide helicopter surveys necessary to complete this estimate have not been conducted since 2010 due to lack of a CDFW helicopter contract and capture activities were not conducted in 2011. CDFW is now planning a rangewide helicopter survey for fall 2016. Once it is complete, a 2016 population estimate will be developed by CDFW. Figure 4 is reproduced from the USFWS 5-year review of Peninsular bighorn sheep completed in April 2011. Recovery regions 1, 2 and 3 are within the Santa Rosa and San Jacinto Mountains. The recovery regions include in this project are San Jacinto Mountains (RR 1), Northern Santa Rosa Mountains (RR 2), and Central Santa Rosa Mountains (RR 3). Indications from the 2010 population estimate show a stable to slightly increasing population trend. The 2016 population estimate will provide important insight into the current status of PBS in this region.

Figure 4. Total 2010 estimated population abundance (adult ewes+adult rams+yearlings) for PBS recovery regions (RR) through time (from USFWS PBS 5-Year Review, 4/21/2011, p. 93).



The original intent was to develop a multi-variate model to address habitat use and fluctuations in population related to stressors in the environment as part of this project. However, not all data that would be used for the model has been collected. Due to challenges with the download of data from GPS collars, and limited resources for field biologists to retrieve these data, additional downloads of GPS data need to be completed. Until this fuller data set is available, it has been determined that completion of the model be postponed. It has also been suggested that the existing models done by the Sierra Nevada bighorn sheep group be used in the development of the model; this group has evaluated and refined several models and associated variables and their expertise would benefit this effort. The development of a model will also involve bighorn sheep researchers whose expertise will also inform the process.

The benefits of such a model will be improved by the availability of vegetation mapping of PBS habitat recently completed. Integration of the vegetation map with the data on spatial and temporal habitat use that is becoming available from the GPS collars can provide a powerful tool to address monitoring questions identified in the original proposal for this project. These questions include: 1) How population dynamics relate to variables such as topography, access to alluvial fans, water/forage availability, vegetation, fire history, invasive species; 2) What are the present and future effects of climate change (e.g. shifts in availability of forage and water, cover). Prior models and distribution maps for PBS in this region have been based on point data which may include an observation of one or more animals at any given point. Most of the data have been provided without attributes to identify bighorn sheep sex, age, and other factors. The data being gathered from GPS collars provides this information as well as an in-depth understanding of the habitat use and behavior of individual PBS. These data will be extremely beneficial as we build on conceptual models from the CVNCCP and the PBS Recovery plan.

Budget:

The grant funding for the project was focused on Task 1 with a budget of \$40,000 for purchase of GPS collars. The collars come in two parts: 15 VHF collars were purchased from Telonics, Inc. (Invoice 100955, \$4,669.71) and 15 solar GPS pods were purchased from Telemetry Solutions (\$37,988.75). The total cost exceeded the budgeted amount of grant funding (\$40,000) by \$2,658.46. This additional amount was funded by CVCC. CVCC also provided funding in the amount of \$14,380 for helicopter service on November 5, 2014 by Leading Edge Aviation.

Table 1: Expenditure Summary

Line-Item Budget	Description	CDFW Funds	Grantee Funds*	Total Cost
General Expenses:				
Equipment	15 Solar GPS Pods (@ \$2,339) plus \$2,806.80 tax and \$96.95 shipping; Telemetry Solutions Inv. #2023; 9/24/14 = \$37,988.75	\$ 37,988.75	0	\$ 37,988.75
Equipment	15 VHF Collars (@\$304 each) and frequency crystals (@\$15 each) plus \$21.51 shipping; Telonics, Inc. (Inv. #100955, 10/24/14) = \$4,669.71	\$ 2,011.25	\$ 2,658.46	\$ 4,669.71
Equipment Total		\$ 40,000.00	\$ 2,658.46	\$ 42,658.46

Line-Item Budget	Description	CDFW Funds	Grantee Funds*	Total Cost
Contractual Services:	State approved Helicopter service – helicopter & crew Leading Edge Aviation Inv. #2014-309, 11/13/2014 = \$14,380	0	\$ 14,380.00	\$ 14,380.00
Total Direct Costs:		\$ 40,000.00	\$ 17,038.46	\$ 57,038.46
Indirect Costs (Overhead):	None	-	-	-
Personal Services:	Funds to be held in reserve by CVCC*			
Salary and Wages	Biologist, (\$30/hour), 700 hours	-	\$ 21,000.00	\$ 21,000.00
Grantee funded staff	Develop habitat model (Grantee monitoring program)/Final Report	-	\$ 19,000.00	\$ 19,000.00
TOTAL BUDGETED FUNDS:		\$ 40,000.00	\$ 60,000.00	\$ 100,000.00

* Grantee will provide \$60,000 for ongoing bighorn sheep monitoring and habitat model.

Conclusion:

As a result of this project (and other funding), more collars have been placed on PBS in order to monitor movement and develop statistically valid population estimates. Data collected by these collars, in combination with other environmental data, will allow for the identification of factors that influence the population dynamics of PBS in order to more effectively predict trends and implement adaptive management. The success of the project is based on completion of the following:

1. Placement of 15 collars so that 30% of female bighorn sheep in two different groups are marked.
2. Obtain data from collared sheep to be used by CDFW for population estimates for 2016.

As noted, the availability of data from GPS collars will increase the effectiveness of ongoing monitoring. One task to be completed is the development of a model of spatial and temporal population fluctuations and habitat use. This task was to be funded by CVCC and did not involve any of the grant funds. We will work with CDFW and USFWS to identify potential bighorn sheep researchers who can assist with modeling habitat use.

