

# Annual Report 2009-2010

## Sierra Nevada Bighorn Sheep Recovery Program

### July 2009 - June 2010

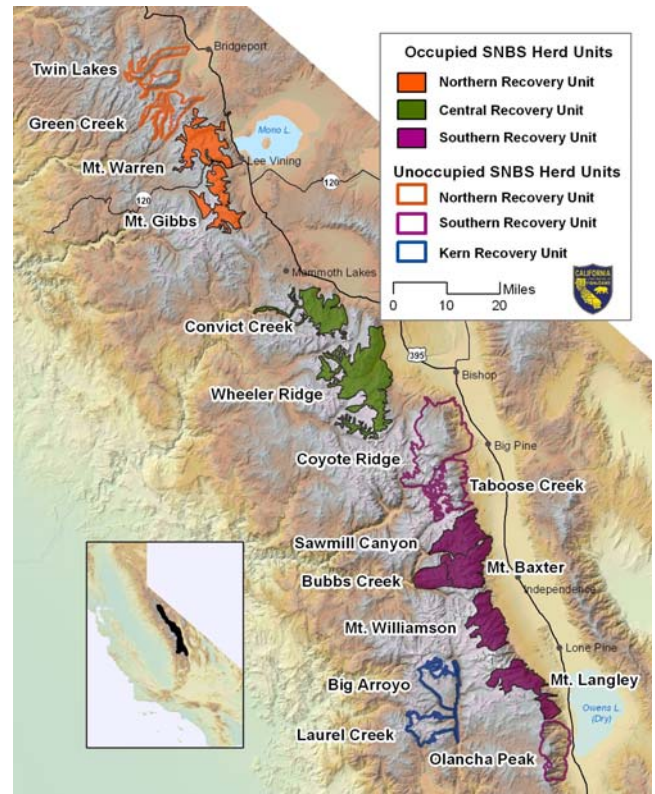
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The goal of the Sierra Nevada Bighorn Sheep Recovery Program is to achieve a population size and geographic distribution of bighorn sheep in the Sierra Nevada that ensures long-term viability of the entire population and warrants its delisting as an endangered species (USFWS 2007). The Recovery Plan for Sierra Nevada bighorn sheep calls for an adaptive management approach in which timely decisions are made based on collected data. To make informed decisions to conserve bighorn, the Recovery Program monitors population estimates, demographic rates, and distribution. The Recovery Program focuses on four major conservation activities: 1) translocating bighorn to augment existing herds or to reintroduce bighorn to areas within their historic range (Figure 1), 2) enhancing habitat through small prescribed burns, 3) reducing the risk of disease in bighorn by limiting exposure to domestic sheep and goats, and 4) managing predation on bighorn by mountain lions (USFWS 2007). This report summarizes conservation activities conducted and demographic data collected during July 1, 2009-June 30, 2010.



**Figure 1.** Locations of 16 historic herd units in 4 Recovery Units. All occupied herd units are required for recovery (USFWS 2007) except Bubbs Creek. Four vacant herd units (Olancha Peak, Laurel Creek, Big Arroyo, and Taboose Creek) must be occupied to meet recovery goals.

## Conservation Activities

### *Translocations*

On April 1<sup>st</sup> 2009, during the previous reporting period, we moved 6 pregnant ewes to Lundy Canyon from the Mount Langley (3) and Wheeler Ridge (3) herds. Five of the lambs born survived through the summer, and all of the translocated ewes survived the year.

### ***Habitat Enhancement***

Forest cover reduces habitat quality for bighorn by decreasing forage availability and increasing predation risk. Removal of pinyon forest on lower-elevation winter ranges in the Mount Williamson herd unit should benefit bighorn by increasing their use of low-elevation winter range, a behavior we have observed more regularly in recent years. In March 2010, the Inyo National Forest implemented a 211-acre prescribed burn on the Shepherd Creek winter range. Unfortunately, humidity was too high and only about 20 acres of the designated area burned completely. Funding and administrative approval will guide efforts to enhance habitat in the future.

### ***Disease Management***

Land management agencies continued to work with permittees that graze domestic sheep to reduce the risk of disease transmission to bighorn sheep. Following the discovery of the group of ewes living in the Convict Creek herd unit (See Range Expansions and Colonizations), DFG worked cooperatively with the Inyo National Forest to inform relevant parties. Subsequently, the permittee voluntarily vacated the nearby Hilton Unit of the Rock Creek Allotment to avoid the potential for contact between bighorn and domestic sheep.

### ***Predator Management***

Predation on bighorn has been a significant source of mortality. Although golden eagles, coyotes, and bobcats are all known to kill bighorn, the primary documented predator of adult bighorn is the mountain lion (USFWS 2007). Mule deer are the major prey source for mountain lions in the Sierra Nevada. In areas where mule deer winter range is adjacent to bighorn winter range, specifically the Mount Baxter, Sawmill Canyon, and Wheeler Ridge herd units, documented predation on bighorn by mountain lions has been significant in some years. In an attempt to monitor mountain lion predation, we place VHF and GPS collars on mountain lions residing near bighorn habitat. In the last year, we collared 7 mountain lions; 5 were newly collared lions and 2 were recaptured. In addition, we marked 2 kittens with pet identification tags (PIT). We use these collars to identify, determine the location of, and investigate mountain lion kills.



Predation by mountain lions was documented in the Mount Baxter, Sawmill Canyon, and Wheeler Ridge herd units. Out of 10 lion kills at Wheeler Ridge in the last 3 years, only 1 was a ewe. Because predation was almost entirely on rams, the effect on adult population dynamics was of less concern; however, little is known about lion predation on lambs because none are radio-collared. In contrast, 18 documented lion kills occurred in the adjacent herd units of Mount Baxter and Sawmill Canyon over the last 3 years (Table 1); 11 of these 18 kills were ewes. The high predation on females is of concern because it will prevent the population growth necessary to reach recovery goals and provide

translocation stock. Because of these losses, any lion considered to be an imminent threat to bighorn was killed. From July 1, 2009 to June 30, 2010, 8 mountain lions were killed. Three lions were killed in the Mount Baxter and Sawmill Canyon herds. Two of the lions removed were documented to kill bighorn and the third was observed repeatedly in habitat occupied by bighorn. Five additional lions were confirmed to have preyed upon bighorn sheep and were killed during this reporting period in herd units other than Mount Baxter and Sawmill Canyon: 2 in the Central Recovery Unit (CRU) and 3 in the Southern Recovery Unit (SRU).

**Table 1.** Documented lion kills of ewes and rams per year in each herd unit. (Annual lion kills are counted between July 1 and June 30 of the following year.)

Year	Mount Langley	Mount Williamson	Mount Baxter	Sawmill Canyon	Wheeler Ridge
07-08	0	0	4	4	5
08-09	2	2	7	0	1
09-10	2	0	3	0	4

## **Population Monitoring and Demographic Trends**

### ***Collaring Efforts***

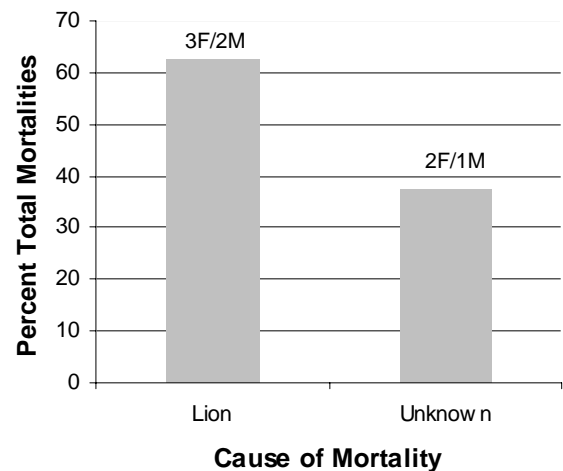
The capture of Sierra Nevada bighorn sheep and deployment of collars are necessary to implement recovery of this federally endangered species (USFWS 2007). Collared animals are needed to assess progress towards recovery goals, examine threats, and evaluate the success of management actions. Helicopter net-gun is the only method feasible for capturing and collaring bighorn sheep throughout most of the Sierra Nevada. Data collected from VHF and GPS collars allows greater understanding of population dynamics and of spatial patterns of habitat use. Spatial information on habitat use has made it possible to document population substructuring (different home range patterns), seasonal migratory patterns, and occasional extreme movements that have brought bighorn close to domestic sheep allotments, increasing the risk of disease. Obtaining population estimates and monitoring demographic parameters such as adult and lamb survival and cause-specific mortality ensures a greater understanding of factors that limit population dynamics, including density-dependence and predation. In addition to gathering data from collars, we determine body condition, health/disease status, and pregnancy status by handling bighorn sheep during captures. We use data obtained from these capture efforts to direct management and species recovery. In the last year, 33 bighorn were captured and collared (Table 2). Five were recaptured and fitted with new collars, and 28 additional collars were added among 8 herds units.

**Table 2.** Distribution of radio collars by herd unit. (Activities occurred between July 1 and June 30 of the following year.)

	<i>Langley</i>		<i>Williamson</i>		<i>Baxter</i>		<i>Sawmill</i>		<i>Bubbs</i>		<i>Wheeler</i>		<i>Gibbs</i>		<i>Warren</i>	
	Ewes	Rams	Ewes	Rams	Ewes	Rams	Ewes	Rams	Ewes	Rams	Ewes	Rams	Ewes	Rams	Ewes	Rams
<b>7/1/2009</b>	<b>9</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>7</b>	<b>1</b>	<b>7</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>16</b>	<b>13</b>	<b>4</b>	<b>2</b>	<b>8</b>	<b>6</b>
additions	6	2	2	0	5	1	1	0	2	0	0	0	1	2	4	2
re-collaring	0	0	0	0	0	0	(2)	0	0	0	(1)	(1)	0	0	0	(1)
translocations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
mortalities	0	0	0	0	-2	0	-1	0	0	0	-1	-3	0	0	-1	-1
censors	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	-1
<b>6/30/2010</b>	<b>15</b>	<b>2</b>	<b>5</b>	<b>2</b>	<b>10</b>	<b>2</b>	<b>7</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>15</b>	<b>10</b>	<b>5</b>	<b>4</b>	<b>11</b>	<b>6</b>

### **Survival and Cause-Specific Mortality Analysis**

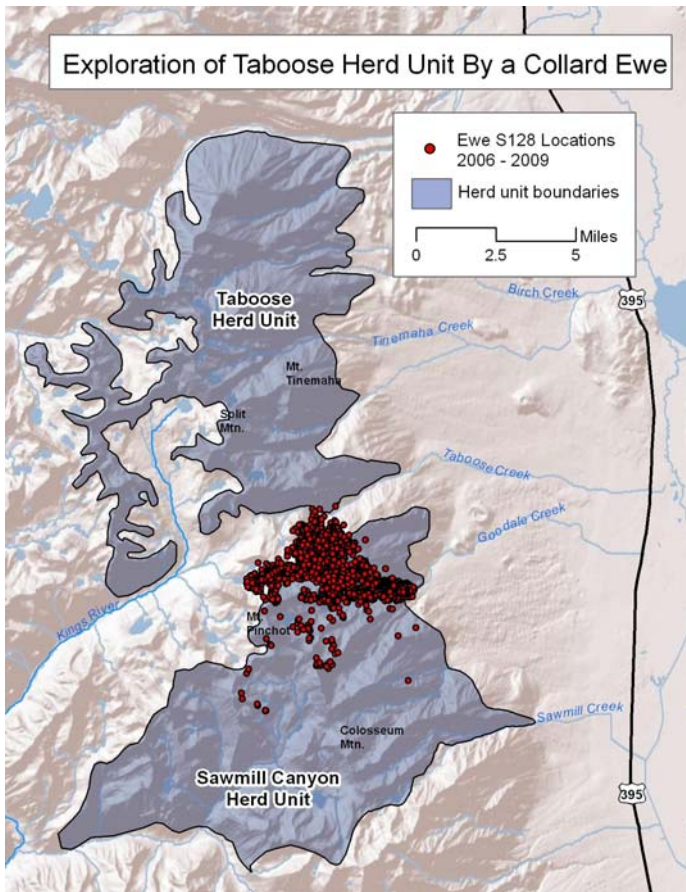
To determine how best to implement recovery actions, it is important to understand the factors affecting adult survival. Survival of adult females is particularly relevant as this has the largest impact on population growth (Johnson et al. 2010). We calculated Kaplan-Meier survival rates by aggregating monthly survival data of radio-collared ewes for each occupied recovery unit (Heisey and Patterson, 2006). The Southern, Central, and Northern Recovery Units had similar survival rates (87.8%, 93.8% and 91.7%, respectively). Using mortality sensors on collars, we investigate new mortalities to determine cause of death. Eight collared bighorn died of natural causes between July 1, 2009 and June 30, 2010, and 1 female died from capture-related injuries. The cause of death was determined for 5 of the 8 naturally-caused deaths (Figure 2). Five bighorn (3 ewes and 2 rams) were killed by mountain lions. Of the mountain lion kills, the 3 ewes died at Mount Baxter, and the 2 males died at Wheeler Ridge. This provides further evidence that mountain lion predation at Wheeler Ridge is focused largely on males.



**Figure 2.** Cause-specific natural mortalities of radio-collared bighorn during July 2009-June 2010.

### **Range Expansions and Colonizations**

The Recovery Plan recognizes that range expansion and colonization may contribute to the recovery effort. Metapopulation dynamics will be important as bighorn populations approach recovery goals. Incipient events, such as the expansion of existing ranges at Wheeler Ridge (during the last reporting period) and Taboose Pass and the colonization of Convict Creek and Coyote Ridge, are supporting recovery.



**Figure 3.** GPS collar locations of a ewe from October 2008 to September 2009 in the Sawmill Canyon herd that demonstrate use within the Taboose Creek herd unit.

In July 2009, California Department of Fish and Game Inyo County wildlife biologist Mike Morrison photographed 2 uncollared bighorn ewes at approximately 9000 feet of elevation in the Coyote Ridge herd unit. Subsequent surveys have not identified further evidence of bighorn sheep. This is the first confirmed observation of bighorn ewes in this area during the last decade.

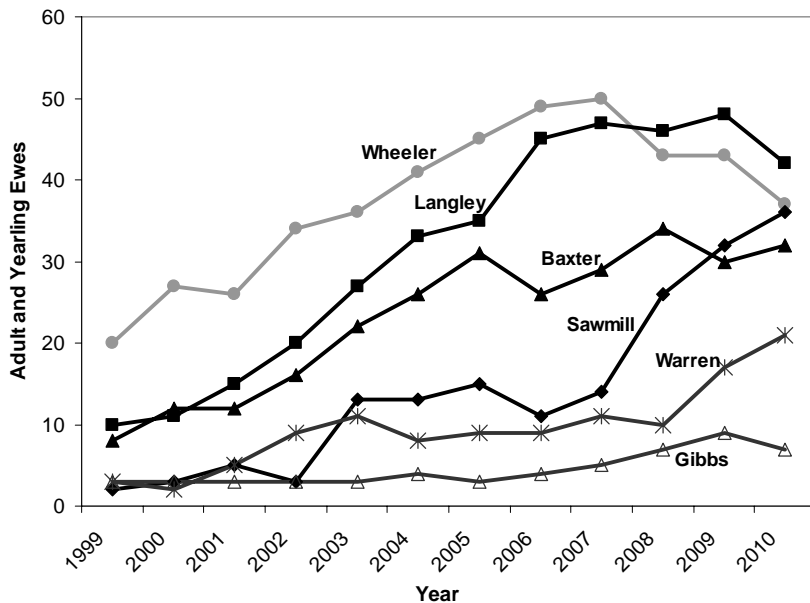
Further evidence of range expansion has been documented in the Taboose Pass herd unit. On multiple occasions in 2009 1 collared ewe from the Sawmill Canyon herd unit moved north across Taboose Pass into the Taboose Creek herd unit, which lies immediately south of Coyote Ridge (Figure 3). Since no ground observations were made, it is unknown how many sheep were in the group that made these excursions. A sighting of a ewe group on July 28, 2009 near the summit of Split Mountain suggests that additional bighorn have made forays into this herd unit.

An August 2009 survey of the Mount Stanford area at the south end of the Convict Creek herd unit yielded fresh bighorn sheep tracks and 3 fecal samples near a timberline meadow between Mount Stanford and Mount Huntington. DNA extracted from those samples proved to be from 3 different bighorn ewes. Photos were taken of a similar group, including an additional yearling male, on Pointless Peak on August 13, 2009 by photographer William Peters. In spring 2010, backcountry skiers reported observing a group of ewes on Esha Peak. This sighting was confirmed in June by program staff. This marks the beginning of occupation of this herd unit. Continued monitoring during coming years will help to verify this occupation.

### ***Demographic Trends***

We attempt annual population surveys of all herd units to obtain population estimates, monitor population growth, and assess progress toward recovery. Minimum counts of bighorn in each herd unit are collected through surveys of occupied habitat and adjacent habitat believed to be vacant. Progress toward recovery is evaluated with reference to these minimum counts (USFWS, 2007). Population surveys focus primarily on ewes, as females are the reproductive base of the population and recovery goals are based on the number of adult and yearling females in a population. Summaries of surveys for the last year are presented for each herd unit from south to north (Table 3).

Minimum counts are often incomplete and represent an underestimate of true population size. To improve our understanding of population dynamics in bighorn herds, we use mortality data and minimum counts from subsequent years to reconstruct more



**Figure 4.** Population trajectories for adult and yearling ewes from 1999-2009 based on a combination of minimum counts, mark-resight estimates, and reconstructed data for 6 herds in the Sierra with annual population estimates. Black trendlines with solid symbols represent herds within the Southern Recovery Unit; the grey trendline represents the herd with long-term data in the Central Recovery Unit; and black trendlines with open symbols represent herds in the Northern Recovery Unit.

complete population estimates. As population size increases, the corresponding range expansion makes it more difficult to obtain minimum counts. In 2 of the larger herds, Mount Langley and Wheeler Ridge, we have invested effort in obtaining mark-resight estimates that may yield more reliable population data as populations continue to increase. Mark-resight estimates are calculated by using the ratio of marked (collared) to unmarked animals observed during a survey. Data from minimum counts, reconstructed estimates, and mark-resight estimates are summarized below (Figure 4 and Table 3).

### Mount Langley

In the summer of 2009, 3 survey attempts in early September were required to achieve a sufficiently complete survey. The most complete count included a total of 33 adult and yearling females and all collared females without the use of telemetry, thus yielding a mark-resight estimate of 48 (95% Confidence Interval (hereafter CI) between 32-71) total females. Overall 29 adult ewes, 4 yearling ewes, 4 yearling rams, 15 lambs, and 15 adult rams were observed for a total of 67 bighorn.

Three females were translocated from this population to Lundy Canyon in March 2009. An additional female died as a result of a capture injury at the same time. Two additional females and 1 adult male are known to have died between the 2008 and 2009 population surveys. Two of these deaths (1 of each sex) were lion predation mortalities at low elevation in winter. Combined, these losses of females exceed documented yearling female recruitment by 2, indicating population decline. Between summer population surveys in 2007 and 2009, minimum losses of females to mortalities and removals for translocation have totaled 11, compared with recruitment of only 7 yearlings. All of the mortalities have been detected because the females carried telemetry collars; therefore we expect additional undetected losses as well. In short, recruitment and mortality data predict

a decline in the number of females in this population between 2007 and 2009. The magnitude of this decline is dependent on the number of unrecorded mortalities.

### **Mount Williamson**

Known marijuana gardens at the base of Mount Williamson in the summer of 2009 prevented the survey of this herd unit by accessing the range directly from below. A considerably longer route including an approach from above was necessary to reach the females in this population. As a result, the sheep detected an observer and fled before any data could be obtained. During the following spring GPS collar locations revealed that bighorn descended as far as the mouth of Shepherd Creek. An attempt to count them documented a minimum of 8 adult females, 2 lambs, and 6 adult males, only about one-half the number counted the previous 2 summers. This count is not considered representative of the true size of this herd unit.

### **Bubbs Creek**

This herd has been surveyed from a helicopter in winter. That survey did not occur in 2010 because helicopter use by the California Department of Fish and Game was suspended following a tragic helicopter accident in January in another region of the state.

### **Mount Baxter**

All collared females in the Mount Baxter herd unit descended to known winter ranges during the 2010 winter-spring period. One of these collared females was in Charlie Canyon at the base of Mount Mary Austin, a noteworthy movement as bighorn had not been detected using this canyon in recent years. A concerted effort to count these sheep resulted in a minimum count of 30 adult and yearling females and the highest count of males in many years. A collared female was killed by a lion at 9000 feet of elevation in October 2009. Of 12 collared females in this herd unit, 5 were killed by lions in a 12 month period. An additional collared female was killed by a lion in April 2010.

### **Sawmill Canyon**

In August 2009, 1 investigator logged a minimum count of 26 adult females, 1 yearling female, 10 lambs, and 1 yearling male in the Sawmill Canyon herd unit. Three collared females not seen in that survey brings the minimum total females to 30. One-half (4) of the collared females in this herd unit were not seen on winter ranges the following winter-spring season, where a minimum of only 16 adult females, 1 yearling female, 8 lambs, and 2 yearling males were counted, but a total of 11 adult males were seen. To these minima can be added 4 collared females and 2 collared males not seen, yielding a minimum total on the winter range of 20 adult females, 1 yearling female, 8 lambs, 2 yearling males, and 13 adult males. Together the summer and winter counts result in a minimum total of 55 bighorn in this herd unit, the highest count for this herd since 1982, when the population was counted at 92 bighorn.

### **Wheeler Ridge**

The Wheeler Ridge herd unit provided poor opportunities to develop good counts of females during the 2009-2010 winter because numerous animals, including 7 collared females, remained at high elevations. In contrast, a brief large concentration of males on the winter range in May yielded the best count for that sex in 4 years. With the addition of 1

collared male not seen during that count, the total came to a minimum of 31 adult and 2 yearling males, with a mark-resight estimate of 35 adult males (CI 29-42). Of the adults, 21 were aged at 5 years and older (i.e. were at least 1 year of age in the winter of 2006 when the last such good count occurred). That 2006 count logged 50 adult and yearling males. The 29 males lost since 2006 suggest a survival rate of less than 90%, although accurate estimates of survival over a period of 4 years without intermediate data are inexact. Because only 12 of those 29 males have been replaced by recruitment, the other 17 unreplaced males result in a 9.9% average annual decline in the number of males in this herd unit.

The number of adult and yearling females that could be accounted for during the 2009-10 winter totaled only 30, compared to 38-42 during the previous 3 years. However, the mark-resight estimate was 43 for the second consecutive year. Although estimated numbers of total females over the past 2 years have been lower than the prior 2 years (49 and 50), the differences are not yet large enough to constitute a statistically-supported trend given the overlap of confidence intervals around estimates.

### **Mount Gibbs**

Based on 3 summer surveys of females and 2 uncollared males observed during an October helicopter capture, the composition of this herd unit in the summer of 2009 was 7 adult females, 1 yearling female, 1 lamb, 1 yearling male, and 5 adult males, for a total of 15 sheep. However, 2 lamb genotypes from DNA extracted from lamb fecal samples collected in August suggest the presence of at least 1 additional ewe group containing at least 1 ewe and her lamb.

### **Mount Warren**

The Mount Warren population included 3 female subgroups in 2009. On Mount Scowden there were 4 adult females, 1 yearling female, and 2 lambs. On the north side of Lundy Canyon there were 6 adult females, 5 lambs and 2 yearling males. Also on the north side of Lundy Canyon were 6 females translocated there in April 2009 from the Mount Langley and Wheeler Ridge herd units with their 5 lambs. In addition, there were 6 adult males, bringing the total to 16 adult females, 1 yearling female, 12 lambs, 2 yearling males, and 6 adult males, for a total of 37. Combined, the Mount Gibbs and Mount Warren herd units contained 25 total females, which is half the goal of the Recovery Plan for the northern recovery unit.

**Table 3.** Summary of population data for all herds of Sierra bighorn for two years.

Herd Unit	Year	Adult Ewes	Yrlg Ewes	Min. Total Ewes	Est. Total Ewes	Lambs	Adult Rams	Yrlg Rams	Min. Total Rams	Est. Total Rams	Min. Total	Total With Ests.
<b>Langley</b>	08-09	35	3	38	46 (33-65)	8	19	5	24		70	<b>76</b>
	09-10	29	4	33	48 (32-71)	15	15	4	19		71	<b>67</b>
<b>Williamson</b>	08-09	11	3	14		4	8	2	10		28	
	09-10	8	0	8		2	6	0	6		16	
<b>Bubbs</b>	08-09	14	3	17		1	4	1	5		23	
	09-10	-	-	-		-	-	-	-		-	
<b>Baxter</b>	08-09	29	5	34	27 (18-40)	13	12	5	17		64	
	09-10	24	6	30	28 (27-36)	20	21	1	22		72	
<b>Sawmill</b>	08-09	22	1	23	29 <sup>1</sup>	9	8	3	11		43	<b>49</b>
	09-10	29	1	30	33 <sup>1</sup>	10	13	2	15		55	
<b>Wheeler</b>	08-09	36	2	38	43 (33-56)	14	20	2	22	33 (21-55)	74	<b>90</b>
	09-10	27	3	30	43 (31-59)	12	31	2	33	35 (29-42)	75	<b>90</b>
<b>Gibbs</b>	08-09	5	2	7		3	3	2	5		15	
	09-10	8	1	9		2	5	1	6		17	
<b>Warren</b>	08-09	6	2	8	10 <sup>1</sup>	5	7	0	7		21	<b>23</b>
	09-10	10 + 6 <sup>2</sup>	1	11 + 6 <sup>2</sup>	11 + 6 <sup>2</sup>	7 + 5 <sup>2</sup>	6	2	8		26/37 <sup>2</sup>	
<b>Totals</b>	<b>08-09</b>	<b>158</b>	<b>21</b>	<b>179</b>		<b>57</b>	<b>81</b>	<b>20</b>	<b>101</b>		<b>338</b>	<b>368</b>
	<b>09-10</b>	<b>155<sup>3</sup></b>	<b>19<sup>3</sup></b>	<b>174<sup>3</sup></b>		<b>73</b>	<b>97</b>	<b>12</b>	<b>109</b>		<b>343</b>	<b>377</b>

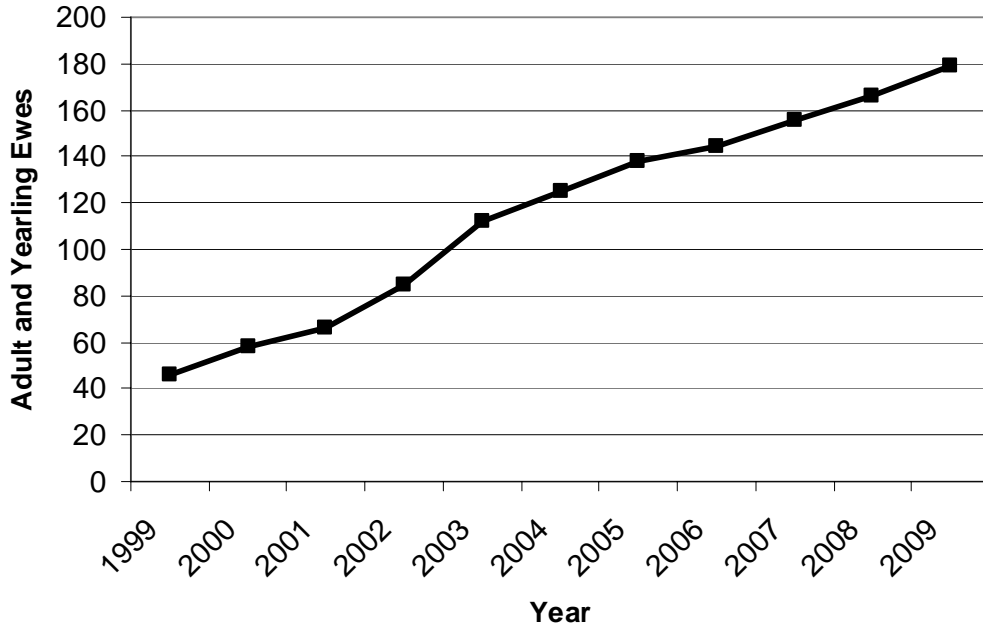
<sup>1</sup> reconstructed population based on additional ewes documented in later years

<sup>2</sup> translocated ewes and the lambs born to them that survived into summer

<sup>3</sup> population counts from 08-09 at Bubbs Creek were substituted for data in 09-10.

## Progress toward Recovery

At present there are an estimated 179 adult and yearling ewes distributed across 7 of the 12 herd units required for recovery. Down-listing requirements will be met when there are 305 adult and yearling ewes. With planned augmentations and reintroductions, predator management, habitat enhancement, and disease mitigation, it is possible that down-listing goals will be met in approximately 10 years.



**Figure 5.** Combined population trajectories for adult and yearling ewes from 1999-2009 based on a combination of minimum counts, mark-resight estimates, and reconstructed data for 6 herds (see Figure 4) in the Sierra Nevada with annual population estimates.

## Summary

Significant progress has been made towards recovery. However, the Mount Baxter and Sawmill Canyon herds have experienced considerable predation during the last 3 years. We have applied increased effort to tracking, collaring, and investigating mountain lion predation in these herds; this effort has resulted in the removal of 3 mountain lions in this area in the last year. Key future recovery actions depend on these populations as a source for translocation stock, which requires that these populations increase. Continued management of mountain lions is necessary to prevent more losses and allow population growth of herds. Collaring efforts continue to provide the higher quality data necessary to implement an adaptive management strategy. At present, 70 ewes are collared, allowing the documentation of range expansions such as those in the Taboose Creek herd unit. Range expansions and natural colonizations are increasing the distribution of Sierra Nevada bighorn sheep, a major goal of the Recovery Plan. In addition, successful translocations like the recent translocation of 6 ewes to Mount Warren bring bighorn closer to recovery.

## **Literature Cited**

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