Appendix B – Sierra Nevada Bighorn Sheep Management Activities Conducted by the California Department of Fish and Game

Introduction

As described briefly in the Cumulative Effects section (Chapter 3, section 3.1) of the EA, CDFG has been managing Sierra Nevada bighorn sheep populations since the 1970s. Conservation actions taken by CDFG include: 1) monitoring of SNBS populations, 2) translocations of SNBS for both population re-introductions and augmentations, 3) enhancement of habitat using prescribed fire, 4) monitoring and management of predation by mountain lions, and 5) monitoring the threat of disease transmission between SNBS and domestic sheep and goats. All these activities occurred throughout the range of SNBS, both within and outside Wilderness boundaries. This appendix provides a description of two of the major conservation activities CDFG has been conducting, since the listing of SNBS as an endangered species, monitoring SNBS populations and translocations of SNBS. This appendix references CDFG's *2010-2011 Annual Report of the Sierra Nevada Bighorn Sheep Recovery Program: A Decade in Review* document published in 2012 (Stephenson et al 2012).

SNBS Population and Herd Size Estimates

CDFG has attempted to collect annual demographic data for all occupied herds in an effort to track population trends (Stephenson et al 2012). Population estimates are gathered using ground surveys or helicopter overflights. To determine the size of herds minimum counts and mark-resight methods are used.

Ground Surveys

On-the-ground surveys involve CDFG employees or collaborators hiking into areas SNBS are known to occur based on habitat use patterns during the winter (the eastern base of the Sierra Nevada) or summer months (generally alpine meadows and surrounding escape terrain). Bighorn are then located often with the aid of telemetry equipment (VHF collars) which helps reduce the amount of time needed to find groups of bighorn. Individual bighorn within a group are then classified according to age class and sex. SNBS, particularly females, can be found in larger groups making it easy to

count each individual animal in the herd. Disturbance to SNBS from this survey method is generally low, as it typically involves only one to two people who remain far from the herd and observe through binoculars or spotting scopes.

Helicopter Overflights

Since the introduction of satellite-linked GPS collars, fewer SNBS are monitored with over flights. Helicopter overflights are used infrequently (one day/year) in remote herd units to count SNBS where ground surveys were unsuccessful or not feasible by ground crews.

Minimum Counts

Minimum counts are one of the two methods used to estimate herd size. On-the-ground surveys can be used for minimum counts because of the behavior of SNBS in which focused efforts at the right time can produce relatively complete counts of all females (Stephenson et al 2012). Minimum counts are limited however, in that complete counts of males cannot be obtained due the solitary nature of males during the time minimum counts occur. The use of telemetry collars has increased the frequency of relatively complete minimum counts and the population size at which relatively complete counts can be obtained (Stephenson et al 2012).

Mark-Resight

Mark-resight methods allow CDFG employees to estimate the number of bighorn based on a ratio of the number of marked to unmarked bighorn observed during a survey. Markers include those animals with VHF/GPS collars. CDFG can utilize mark-resight methods to estimate abundance for larger herds (> 45 bighorn) for which this is the most accurate measure of abundance. Mark-resight estimates also include a 95% confidence interval and can be used to evaluate whether minimum counts are complete.

Capturing of SNBS

Since the 1980s, CDFG has been leading conservation efforts to increase the resiliency of SNBS populations. This resiliency includes expanding the range of SNBS throughout suitable habitat in historic ranges. To increase the distribution of SNBS, CDFG began capturing SNBS in 1979 for translocations. For a full description of the translocation efforts, see the Translocation Section further in this document.

CDFG has utilized four capture methods since their capturing efforts began in the late 1970s (1979): drop-nets, drive-nets, darting, and helicopter net-guns (Table 1a). The first two SNBS captured were rams darted in 1979. Darting was used only once again

in 1993. Darting is not the preferred method of conducting captures of SNBS and CDFG would not attempt to capture SNBS by darting for the purposes of monitoring or translocation captures for several reasons. 1) The behavior of SNBS when approached by humans is one of avoidance, they generally move into escape terrain, which is not a safe or feasible location for darting to occur. 2) CDFG veterinarians would not authorize the use of this capture method for monitoring or translocation purposes because it increases the risk of injury or mortality to SNBS. Crews are not able to safely approach and then capture multiple animals at one time, and 3) CDFG is not authorized, under their U.S. Fish and Wildlife Permit to capture using this method unless specific criteria are met.

Drop-nets were also used in 1979, and in 1980 CDFG began using helicopters for assistance with drive-net captures. A net-gun fired from a helicopter (Bell Jet Ranger) was first used in 1987 and then beginning in 2002, used exclusively to capture SNBS. Beginning in 2006, CDFG began contracting to experienced wildlife capture specialists that used a helicopter (Hughes 500) capable of conducting these captures at higher elevations. This allowed CDFG to change the majority of the capture work from late winter/spring on low elevation winter range to high elevations in the fall months. This reduced the impacts to SNBS on low elevation winter ranges, as captures during this time became less frequent. This also allowed CDFG to handle SNBS when they are at their peak condition and collect health data before the winter when body conditions are reduced due to the forage conditions on winter ranges. Drop-net and drive-net captures are dependent upon the presence of very large groups of bighorn in specific geographic locations and which can be easy to bait for drop-net captures (Foster 2005 and Kock et al 1987). In contrast, helicopter net-guns are relatively easy to move to where the SNBS are (in smaller groups) and catch them when needed, even in fairly large numbers.

Since using helicopter net-guns, CDFG has been able to increase the number of captures of previously un-collared SNBS, going from an average of 5 animals annually (1999-2002) to 14 annually from 2003-2006. With the introduction of high elevation captures beginning in 2006 the average number of SNBS captured increased to 30 animals.

The following tables display the different capture methods used by CDFG and how many SNBS were captured using these methods from time periods before and after SNBS were listed. Information is also provided on the location of the capture events and the date in which they occurred either before or after 1999.

Table 1a Location of the Different Capture Methods used by CDFG on SNBS before listing, 1979-1998

Location of Capture	Capture Method	Date of Capture	Number of SNBS Captured
Lee Vining Canyon (Mt. Warren Herd Unit)	Dart	April 20, 1993	1
	Drop-Net	February 17, 1995	2
Sand Mountain (Mt. Baxter Herd Unit)	Dart	March 6, 1979	2
	Drive-Net	March 28, 1980	21
		April 1, 1982	10
		March 5, 1986	32
		March 6, 1986	2
		March 29, 1988	12
	Drop-Net	March 6, 1979	2
		March 27, 1980	10
	Helicopter Net-Gun	March 16, 1987	2
Sawmill Canyon (Sawmill Canyon Herd Unit)	Drive-Net	March 31, 1982	1
	Drop-Net	March 6, 1979	7
Total Number of SNBS Captures			**102**

Table 1b Location of the Different Capture Methods used by CDFG on SNBS during 1999-2012

Location of Capture	Capture Method	Date of Capture	Number of SNBS Captured
Pine Creek Road (Wheeler Ridge Herd Unit)	Drop-Net	March, 1999	7
		March, 2002	2
Scheelite (Wheeler Ridge Herd Unit)	Drive-Net	March, 2003	0
Throughout the Recovery Area	Helicopter net-gun	October through May 2002 to 2012	284
Total Number of SNBS Captures			**293** (216 new captures and 77 recaptures)

CDFG estimated that the drop-net captures conducted in 1999 and 2002 required 42 days (six weeks) to set-up the drop-net stations and at least seven days (one week) for the drive-net stations. Helicopter net-gun captures occurred in 76 days over a 13 year period.

Advances in Capture Methods

Since SNBS were first captured in 1979, 395 captures have occurred by darting, drop-nets, drive-nets, or net-gun. Of these 395 captures only 100 of them used drop-nets, drive-nets, or darting. All but 19 of these 395 captures used a helicopter. For captures that used drop-nets, drive-nets, or darting, helicopters have been used to drop off people or supplies at capture sites, herd animals towards nets, sling animals to processing camps and/or trucks for translocation to other herds units. The use of helicopters to aid in wildlife captures has been a significant advance in the field of wildlife management.

During the 1970's and 1980's multiple large groups containing up to 50 SNBS were using low elevation winter range at Sand Mountain and Sawmill Canyon. Groups of this size are more likely to be captured by drop-net and drive-net than smaller groups. Populations in these areas are now much smaller. Helicopter net-gun is a more efficient method of capture for smaller groups of animals. Darting can also be used to capture animals in smaller groups. However, of the three darting captures that have occurred in the Sierra Nevada, one resulted in the ewe uncontrollably tumbling down a steep hill. Darting is the least efficient capture method, and it poses the greatest danger to SNBS; its very limited use in the Sierra Nevada (Table 1a) reflects this.

Drop-nets and drive-nets have only been used on low elevation winter ranges in the Sierra. Currently only four herd units still offer the potential for these capture methods to occur in low elevation winter range: Wheeler Ridge, Sawmill Canyon, Mt. Baxter, and Mt. Langley. These herd units would also be used for source stock for translocations due to their stable populations and larger numbers of SNBS. Helicopter net-guns allow more flexibility in capturing animals needed for translocation efforts in these herd units, as CDFG can capture the specific animals they have determined most suitable for translocation.

Drop-and drive-net capture methods would not be suitable in four herd units, where SNBS no longer use low elevation winter ranges (Mt. Warren, Mt. Gibbs, Convict Creek, and Mt. Williamson). Helicopter net-gun is the only safe capture method available to capture animals in these herd units (Appendix C). Another advantage of helicopter net-gun captures is that they can occur in October. This allows SNBS to be captured when they are in their best physical condition and less susceptible to capture stress. Capturing in October also avoids repeatedly disturbing SNBS on sensitive winter range, which has been shown to cause winter habitat avoidance if repeated capturing occurs in these areas (EA pages 56-57). Furthermore, of all methods available to capture bighorn sheep helicopter net-gun captures have the lowest risk of capture-related

mortalities (Kock et al. 1987 and Jessup et al. 1988). Helicopter net-gun captures are now the standard capture method in all states capturing significant numbers of bighorn sheep in North America (Foster 2005).

Limitations in Drop-and Drive-net Capture Methods within the Recovery Area

During the 1970s and 1980s, when CDFG was conducting captures of SNBS through the use of drop-nets, SNBS only occupied the Sawmill Canyon, Mt. Baxter, and Mt. Williamson herd units. The Sawmill Canyon and Mt. Baxter herd units were used as source stock for translocations during this time. The population of SNBS within these herd units ranged from 70 to 150 animals, respectively (USFWS 2007 and Stephenson et al 2012). SNBS occurred in large numbers, in specific locations on low elevation winter range. This concentrated use with larger herds allowed for successful captures using drop-nets for several reasons: 1) larger numbers of SNBS would move into capture sites, 2) capture sites were easily accessible to capture crews, and 3) capture site locations would be placed where SNBS naturally occurred using a helicopter to transport equipment and personnel to the capture site.

Beginning in 1983 and 1987, SNBS begin avoiding low elevation winter ranges and populations began to decline rapidly (USFWS 2007 and Stephenson et al 2012). CDFG attributes this avoidance of winter range to increased mountain lion predation (USFWS 2007). Other influences may also have had an effect on habitat use changes, such as changes in forage availability and quality due to competition with large mule deer herds and long-term drought (USFWS 2007). Because of these changes, successful captures of SNBS by drop-nets declined and capture methods had to change, as explained above (i.e. introduction of drive-nets and helicopter net-gun). Smaller herd unit sizes and changes in the areas where SNBS utilize winter range have reduced the potential of capturing large numbers of SNBS and limited the potential of capturing SNBS with drop-and drive-net capture methods. Historic capture sites may no longer be useable for capturing SNBS and smaller groups of SNBS may become capture shy after several captures are attempted.

Captures in Wilderness

CDFG has conducted SNBS capture work both inside and outside of wilderness boundaries. Capture work conducted in the 1970s and 1980s occurred on low elevation winter ranges where higher numbers of SNBS could be captured at one time using drop-nets and drive-nets. Prior to translocation efforts in the 1970's and 1980's, SNBS only occupied the Mt. Baxter, Sawmill Canyon, and Mt. Williamson herd units. These three herd units (using Recovery Herd Unit boundaries and not true historic, occupied

range) included 49,625 acres of the John Muir Wilderness (pre-Omnibus Bill wilderness additions).

After the species was listed as endangered in 1999, CDFG began increasing the number of animals collared with GPS and VHF collars, and helicopter net-gun capturing became the exclusive method of capture beginning in 2002.

Since listing, SNBS now occupy eight herd units on the Inyo NF and 237,510 acres (70%) of their range is within Wilderness areas, this includes the new Wilderness additions implemented by the Omnibus Bill in 2009. Tables 3 and 4 and Figures 1 and 2 displays the number of acres of Wilderness SNBS herd units occupied since the 1970s through today, the percentage of increase in wilderness since the 2009 Omnibus Bill in each herd unit, and the areas in which these increased acres occur in the herd units.

Table 3 Number of acres of Wilderness (Inyo NF only) within SNBS herd units compared between the 1970s through 2012.

Year	Number of Herd Units Occupied	Acres of Wilderness[1]	Percentage of Occupied, Essential Herd Units in Wilderness	Wilderness Areas
1970s *(remnant populations)*	3	49,625	21%	John Muir
1980s *(four re-introductions)*	7	161,880	50%	Ansel Adams Hoover John Muir Golden Trout
2009 *(natural colonization)*	8	195,630	66%	Ansel Adams Hoover John Muir Golden Trout
2012	8	237,510	66%	Ansel Adams Hoover John Muir Golden Trout

[1] Acres are approximate, as herd unit boundaries may represent a larger area than what was occupied at that time (1970s and 1980s).

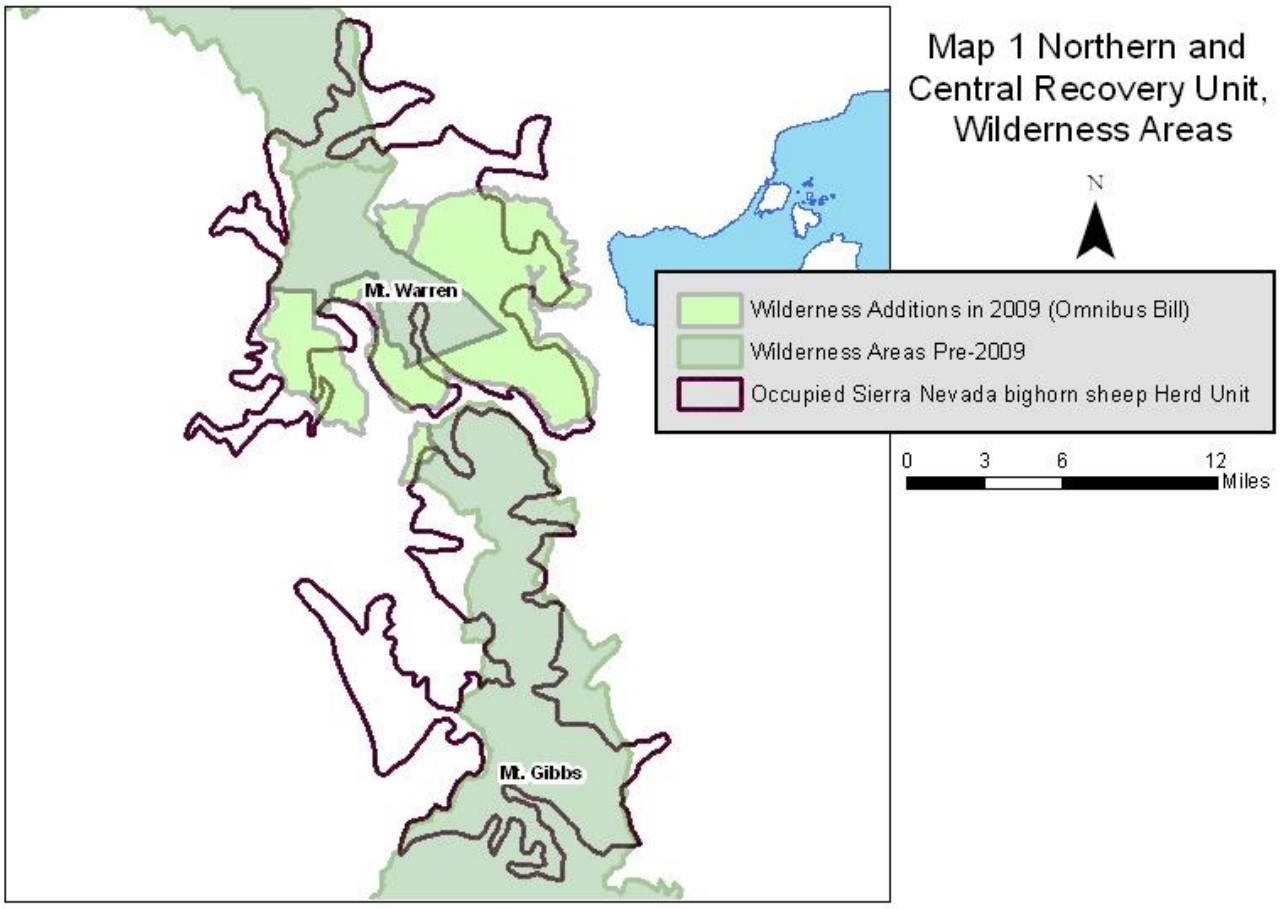
The areas in which captures occurred outside wilderness in the past, are now currently located inside wilderness areas due to the wilderness boundary expansion from the Omnibus Bill in 2009. Table 4 displays the changes in wilderness acres by herd unit from both before and after the Omnibus Bill of 2009.

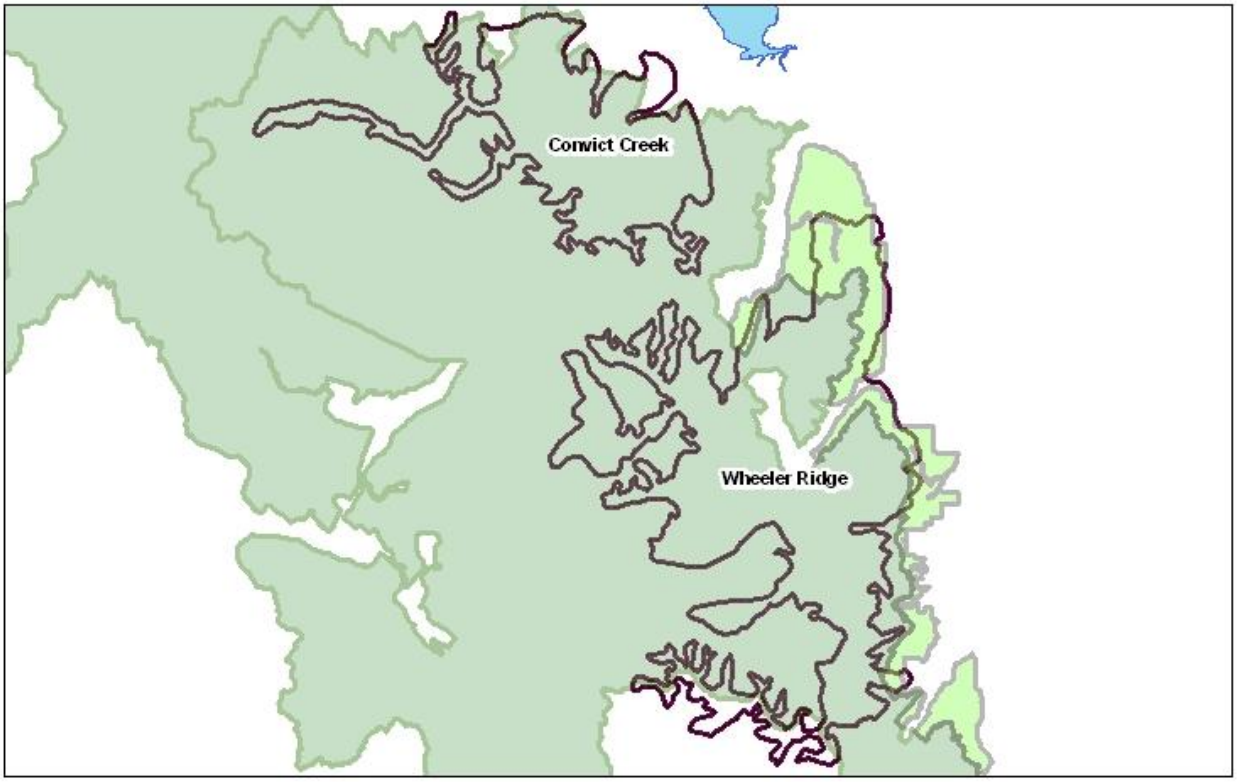
Table 4 Acres of SNBS habitat, by herd unit, within wilderness areas on the Inyo NF.

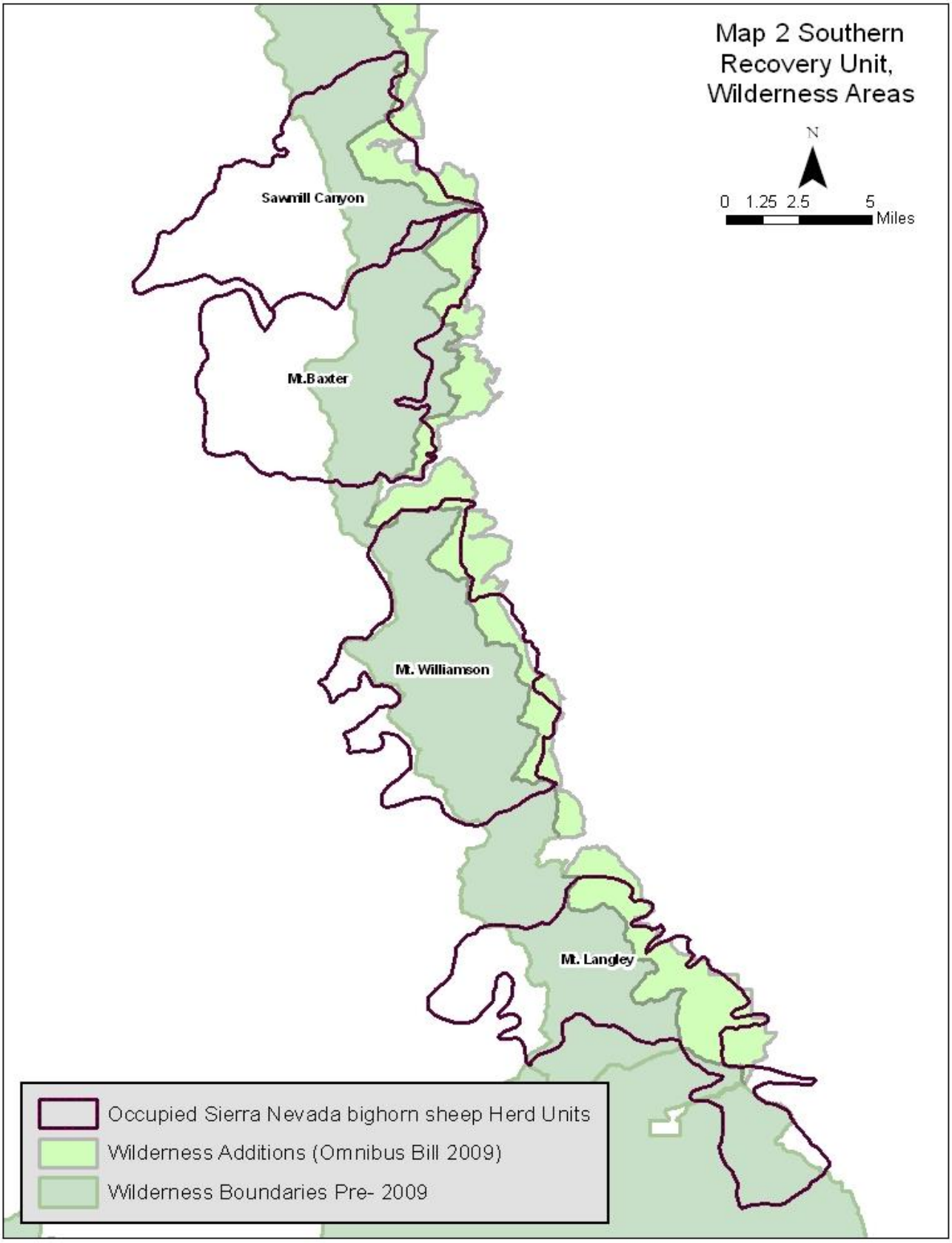
Acres of SNBS habitat, by herd unit, within wilderness areas on the Inyo NF												
	Mt. Warren	Mt. Gibbs	Convict Creek	Wheeler Ridge	Coyote Ridge^^	Taboose Creek^*	Sawmill Canyon	Mt. Baxter	Mt. Williamson	Mt. Langley	Olancha Peak^*	Total
Total Acres of Herd Unit	27,644	21,046	35,006	56,084	64,647	21,666	13,469	18,850	28,445	26,730	30,071	343,658
Acres of wilderness before Omnibus Bill '09	9,093	20,341	32,239	41,780	13,371	15,460	10,274	15,710	23,641	17,321	29,685	228,915
Percentage of herd unit in Wilderness prior to Omnibus Bill '09	32%	96%	92%	75%	20%	71%	76%	83%	83%	65%	98%	66%
Acres added to wilderness under the Omnibus Bill '09	14,394	98	0	9,688	0	5,566	2,753	2,910	4,360	7,673	0	47,442
Total within Wilderness	23,487	20,439	32,239	51,468	13,371	21,026	13,027	18,620	28,001	24,994	29,685	276,357
Percentage of herd unit in Wilderness	85%	97%	92%	92%	20%	97%	97%	98%	98%	94%	99%	80%

As displayed in Table 4, the Mt. Warren, Wheeler Ridge, Taboose Creek, Sawmill Canyon, Mt. Baxter, Mt. Williamson, and Mt. Langley herd units had a 15%, or more, increase in the amount of wilderness acres. The Mt. Warren and Mt. Langley herd units had the most increase in wilderness acreage, with a gain of 53% in the Mt. Warren herd unit and 29% in the Mt. Langley herd unit. Figures 1 and 2 (below) display the wilderness boundaries for both before and after the 2009 Omnibus Bill and demonstrate the increased acreage of wilderness in these herd units.

Figures 1 and 2 Display the portions of the SNBS herd units within wilderness areas (both before and after the Omnibus Bill of 2009) on the Inyo NF.






Map 2 Southern Recovery Unit, Wilderness Areas
N
0 1.25 2.5 5
Miles
Sawmill Canyon
Mt.Baxter
Mt. Williamson
Mt. Langley
Occupied Sierra Nevada bighorn sheep Herd Units
Wilderness Additions (Omnibus Bill 2009)
Wilderness Boundaries Pre- 2009

Monitoring Captures

Monitoring captures are defined as those captures which occur for the purpose of deploying GPS and VHF collars on SNBS and sampling for disease and nutritional health. Individual SNBS are either specifically chosen for capture because their collars are in need of refurbishment or replacement or to deploy additional collars. This decision is based on the herd unit in which the capture is occurring and the objectives CDFG has established for the specific capture event that year.

After listing, CDFG increased the number of captures they conducted in order to accurately monitor demographic trends and distribution as the population grew. In 2002 helicopter net-guns became the exclusive capture method for SNBS. This method allowed for the targeting of specific animals which ensures that demographic trends are being monitored across all population segments. Beginning in 2006, CDFG began contracting to wildlife capture specialists with helicopters capable of conducting captures at higher elevations. High elevation captures occur in the fall when animals are still on alpine ranges. This reduced the impact to SNBS on lower elevation winter ranges and allowed CDFG to capture SNBS prior to the onset of winter when they are in their best physical condition and therefore least likely to suffer physiologically from capture stress.

Data used from GPS and VHF Collars

CDFG has conducted captures of SNBS following the recognition in the Recovery Plan that captures and the deployment of collars are essential for recovery of this species (Stephenson et al 2012 and USDI 2007). In addition to their use for mark-resight population estimates and minimum counts, collars have provided important information relative to a variety of questions:

1. Collars enable CDFG to determine the risk of disease transmission between SNBS and domestic sheep and goats. Movements of collared SNBS are closely monitored while domestic sheep are on grazing allotments near SNBS herd units. This movement data is shared with agencies that manage grazing allotments, and management practices are implemented by these agencies to reduce the risk of disease transmission to SNBS.

2. Collars are used to measure survival rates by sex and herd and to assess cause-specific mortality. These demographic rates are used in Population Viability Analyses that model the effects of possible management actions allowing CDFG to conserve SNBS using adaptive management.

3. Locations recorded on GPS collars are used to generate habitat models. These habitat models are used to identify the best possible sites for reintroductions and augmentations.

4. Capturing of SNBS for monitoring purposes also allow CDFG to gather information used in determining the best animals to select for translocations. Data on body condition, disease status, genetic diversity, winter habitat selection, and reproductive performance all help determine which animals are the most appropriate for translocations. These animals are then specifically selected for capture during translocation capture events.

The deployment of collars has led to documentation of movement between herds, not just by SNBS rams, but also ewes. Range expansion into new habitat by ewes is an essential step in recovery of this species, as it shows an increase in the amount of ewes in specific herd units (USDI 2007). VHF collar data from last winter showed movements by two ewes from the Mt. Baxter herd unit to winter habitat in the Mt. Williamson herd unit (Stephenson et al 2012). Ewe movements in the Wheeler Ridge herd unit were documented using GPS collars and showed a range expansion into the Granite Peak area (Stephenson et al 2012). These range expansions have helped to expand CDFG's understanding of SNBS behavior and habitat. In the future, collared ewes may lead us to additional range expansions and possibly natural colonization which need to be documented to meet criteria for delisting

Information Gathered during Deployment of Collars

The placement of collars relies on the capture of individual SNBS. Deployment of collars has provided an essential opportunity to conduct disease surveillance and determine the nutritional conditions and reproductive status of individuals within populations (Stephenson et al 2012). The following are examples of how this information is used:

1. To determine what was leading to a reduction of births and recruitment in the Wheeler Ridge herd unit from 2000 to 2006, CDFG looked at the average body fat of lactating and non-lactating ewes. Body fat levels showed that nutritional limitations were not the cause of this reduction.

2. Population growth rates in the Mt. Langley and Wheeler Ridge herds showed a decrease over time, suggesting that inadequate conception, births, or survival was the cause of this decline. Pregnancy rates of adult females throughout the

recovery area were between 80 and 90%, indicating that conception rates are not limiting population growth.

Translocations

In the 1970s, only three herd units were occupied by SNBS. Translocation efforts by CDFG between 1979 and 1988 resulted in the establishment of three additional herds. The Recovery Plan requires occupation of 12 herd units across 4 recovery units to provide geographic distribution sufficient to protect this subspecies should one population experience a disease outbreak (Stephenson et al 2012). Natural range expansions have also occurred, resulting in occupation of two other herd units. Eight of 12 herd units and three of four recovery units that are required for delisting are currently occupied. Introductions are required to establish SNBS populations in the remaining four essential herd units that are currently vacant.

The first translocation efforts involved capturing SNBS with drive and drop-nets, as SNBS were located in only three herd units and occupied lower elevation winter ranges where these capture methods are most effective. These captures occurred outside of wilderness areas, but they are inside of current wilderness boundaries that were expanded by the 2009 Omnibus bill.

Once SNBS were moved into the Mt. Warren, Mt. Gibbs, Wheeler Ridge, and Mt. Langley herd units, population augmentations began in 2001. The following table displays when and where augmentations occurred since 2001.

Table 3 Number of SNBS Population Augmentations and where they occurred

Year	Origin	Destination	Number Moved
2001	Wheeler Ridge	Mt. Williamson	1 (ram)
2003	Wheeler Ridge	Mt. Warren	2 (rams)
2005	Wheeler Ridge	Mt. Baxter	5 (pregnant ewes)
2009	Mt. Langley	Mt. Warren	3 (pregnant ewes)
	Wheeler Ridge		3 (pregnant ewes)

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