

**FISH AND WILDLIFE SERVICE**  
SIERRA NEVADA BIGHORN SHEEP: 2001 POPULATION SURVEY RESULTS  
A REPORT TO THE CALIFORNIA DEPARTMENT OF FISH AND GAME  
UNDER INTERAGENCY AGREEMENT # P9980060

FEB 11 2002

John D. Wehausen, Ph.D.  
White Mountain Research Station  
December 2001

**RECEIVED  
VENTURA, CA**

This report summarizes population information on bighorn sheep herds in the Sierra Nevada developed since the last report produced one year ago. I have attempted to put this information in the context of the recent demographic histories of each group of sheep. In so doing I have attempted to be sufficiently thorough to allow this report to serve as a basic reference document.

This report follows the same general format as previous ones with one exception. Since the previous report was written a draft recovery plan has been developed for these sheep. That plan breaks bighorn sheep in the Sierra Nevada into geographic herd units. I have used the same herd unit designations here. Within some of those herd units there are multiple groups of females that are largely or completely independent demographically. I have referred to such groups here as demes.

My field efforts in the past year have been greatly aided by personnel hired by the Department of Fish and Game program for these sheep. In particular, Tim Taylor, Dennis Jensen, Dave German, and Tom Stephensen have worked in the field with me and independently. Members of the predator-monitoring staff also have provided valuable information on sheep gathered while conducting that monitoring. What I report here is a compilation of all pertinent findings concerning population dynamics of bighorn sheep in the Sierra Nevada during 2001. This past year differed from previous ones in that a helicopter was used on a few days in March to survey essentially every east side drainage in which bighorn sheep might have been found at lower elevations at that time. Snow conditions were optimal at the time of those flights. They allowed us to look for tracks in snow and use such tracks to find the sheep that made them. The primary purpose was to look for sheep in areas where they have not been seen in recent years. This allowed ground effort to be focused in only areas where sheep were present.

Otherwise, monitoring has followed the same approaches used for many years. This has involved attempting to find and classify sheep when and where they are most concentrated, in efforts to count and classify as many different females as possible in each herd unit, with a goal of accounting for all females and associated juveniles. Recognition of individuals by natural markings and a small number carrying collars and/or ear tags are part of that process. Counts of males have been mostly opportunistic. For some herds or demes I provide histories of reconstructed minimum population sizes and composition. Reconstruction occurs when more sheep in some sex/age class are counted at a later date than were accounted during an earlier year. For instance, an extra 2-year old male implies that there was an additional yearling male the previous year and an additional lamb the year before that. As a general rule, I reconstruct what I consider the simplest minimum population history from the existing data. Blank cells simply mean that there are no data available

to create a reasonable minimum figure. In reconstructing the Mount Gibbs herd I relied on early data collected by Les Chow and Peggy Moore.

I define age classes of sheep on the basis of the birthing period. Thus, a lamb is so classified until it reaches 1 year of age, and a yearling until it reaches 2 years of age. Ages are advanced around May 1 each year.

This past winter was similar to the previous one in that the initiation of winter was late. In both years the first significant winter storms did not occur until January (January 10 in 2001). Prior to that first storm there was essentially no snow cover in the mountains. For sheep this means considerable freedom in the choice of habitat and ease in obtaining forage. This past winter differed markedly from the previous one in that it was much colder once the snows arrived. This meant that there was considerably more snow cover at lower elevations -- conditions much more conducive for sheep to use winter ranges. The winter was then followed by a particularly warm spring that melted snow rapidly and provided temperatures conducive for earlier initiation of forage growth at elevations above winter ranges in most years.

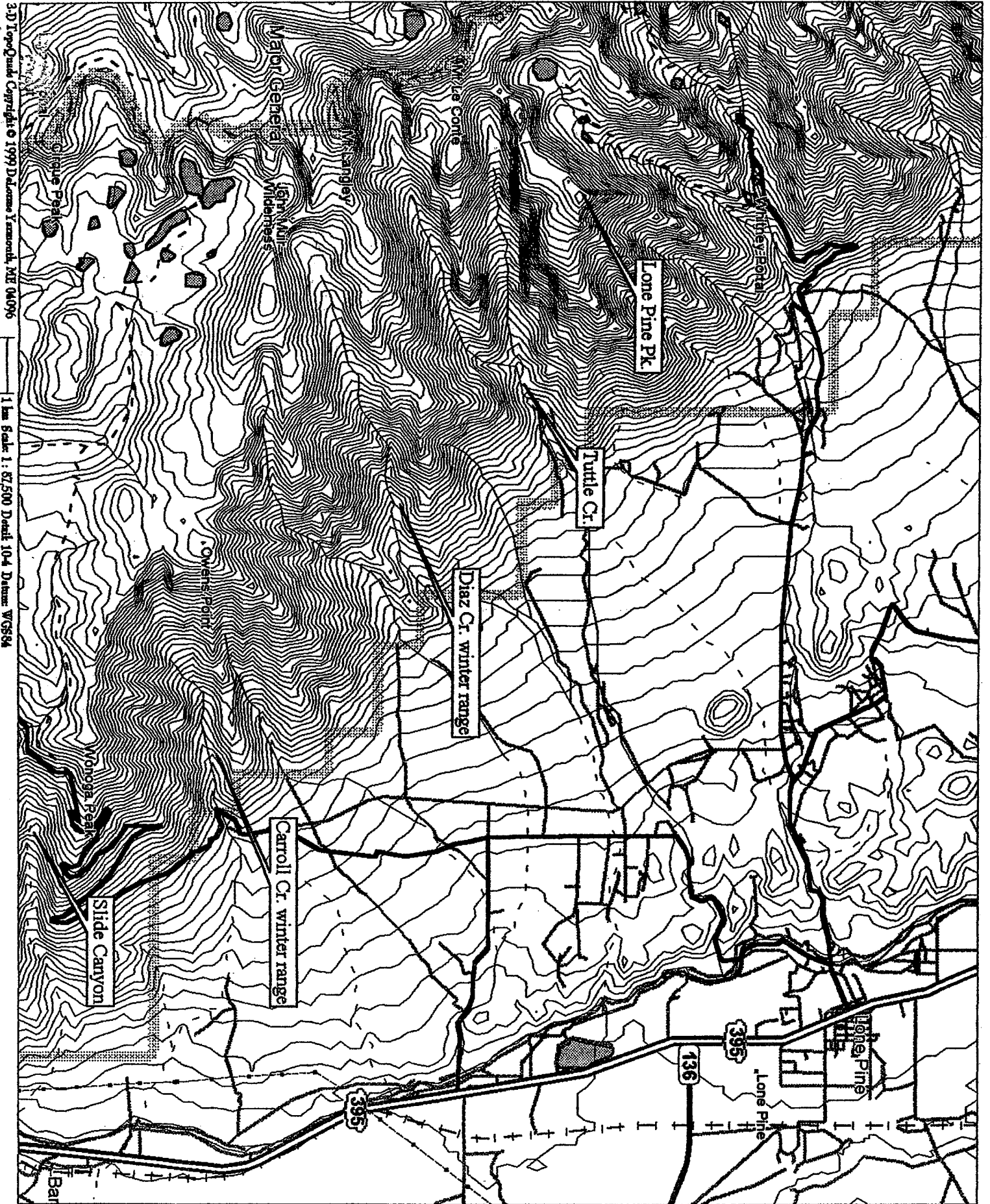
### **I. Mount Langley Herd Unit**

Data collected beginning in 1996 indicated that the reproductive base of the Mount Langley herd dropped to a low of 6 females in 1995. Numbers have increased steadily since then with 9 females and 2 yearling females accounted for in the summer of 2000, accompanied by 9 lambs and 3 yearling males. The number of adult females and yearlings matched what was known the previous year. However, data from both 1999 and 2000 were short 1 female based on what could be accounted in 1998. Evidence of an additional female has emerged in multiple years and only in 1998 were all females in the reconstructed minimum population actually counted. The evidence of the additional female has been one more yearling sheep than the number of lambs counted the previous summer. This implies an additional lamb the previous year and an additional female as the mother of that lamb.

This past winter contrasted notably with the previous winter in terms of winter range use by these sheep. In 2000 no sheep were observed on the Mount Langley winter ranges. The first winter observations of sheep in 2001 were 19 on the Diaz Creek winter range (Fig. 1) on February 23. Eighteen sheep were seen there again on March 2, but the composition had changed. It was evident that there was ingress and egress of sheep from that winter range. A total of 21 different sheep could be accounted for on this winter range (6 adult females, 1 yearling female, 9 lambs, 4 yearling males, and 1 3-year old male). In mid March, after the sheep were no longer evident in Diaz Creek, 2 females and a lamb were recorded on the Carroll Creek winter range (Fig. 1). Sheep again were observed in the Diaz Creek winter range in the second half of April when a Forest Service crew was burning previously-felled pinyon pines as part of habitat improvement for these sheep. Both of these later groups may have included sheep seen earlier in Diaz Creek.

Summer efforts in 2001 began in September and extended into November. A group of 6

Figure 1. Mount Langley herd range with pertinent geographic labels.



4 adult females, 4 yearling females, and 1 yearling male was observed September 13 and 14 west of the crest by the Major General (Fig. 1). Recent tracks, droppings, and beds of a different group containing lambs were evident at that time east of the crest around the top of Diaz Cr.. Efforts were made in September, October, and November to find the additional females and associates, but failed to do so. During those trips, 10 males, including 4 2-year olds and another yearling were observed. Also, in November a group of 8 sheep was found in upper Diaz Creek, but recognition of some of the individuals indicated that these were probably 7 of the sheep seen in September near the Major General accompanied by an older male. Although not yet completed, genotyping from fecal pellets of lambs that were not part of the Major General group indicate that at least 4 additional lambs exist in this herd, for a total of at least 8 lambs.

Data from 2001 have use in reconstructing minimum populations (Table 1). The 4 yearling males observed this past winter add one to what was known the previous summer and similarly increases the minimum number of lambs in 1999 from 5 to 6. That, in turn, is verification that the tenth female still existed in 1999. It is likely that she also existed during the summer of 2000, and that the fourth yearling male accompanied her then; however, it is possible that this yearling male might have accompanied older males, which occurs occasionally. Of the 9 lambs observed in the summer of 2000, the sex could be determined for only 8, which were 3 females and 5 males. The observation of 4 yearling females this summer suggests that the unsexed lamb was a female. Including these 4 yearlings, this herd should now contain 16 females if no mortalities have occurred (Table 1).

During the March helicopter flight we investigated all drainages not known to have sheep at the time, from Tuttle Cr. to Slide Canyon. No additional sheep or evidence of sheep were found.

Year	Adult Females	Yearling Females	Female Lambs	Male Lambs	Yearling Males	Adult Males
1996	6		1	1	1	10
1997	6	1	3	2	1	11
1998	7	3	0	1	2	
1999	10	0	2	4	1	
2000	9 (10?)	2	4	5	4	
2001	12?	4				

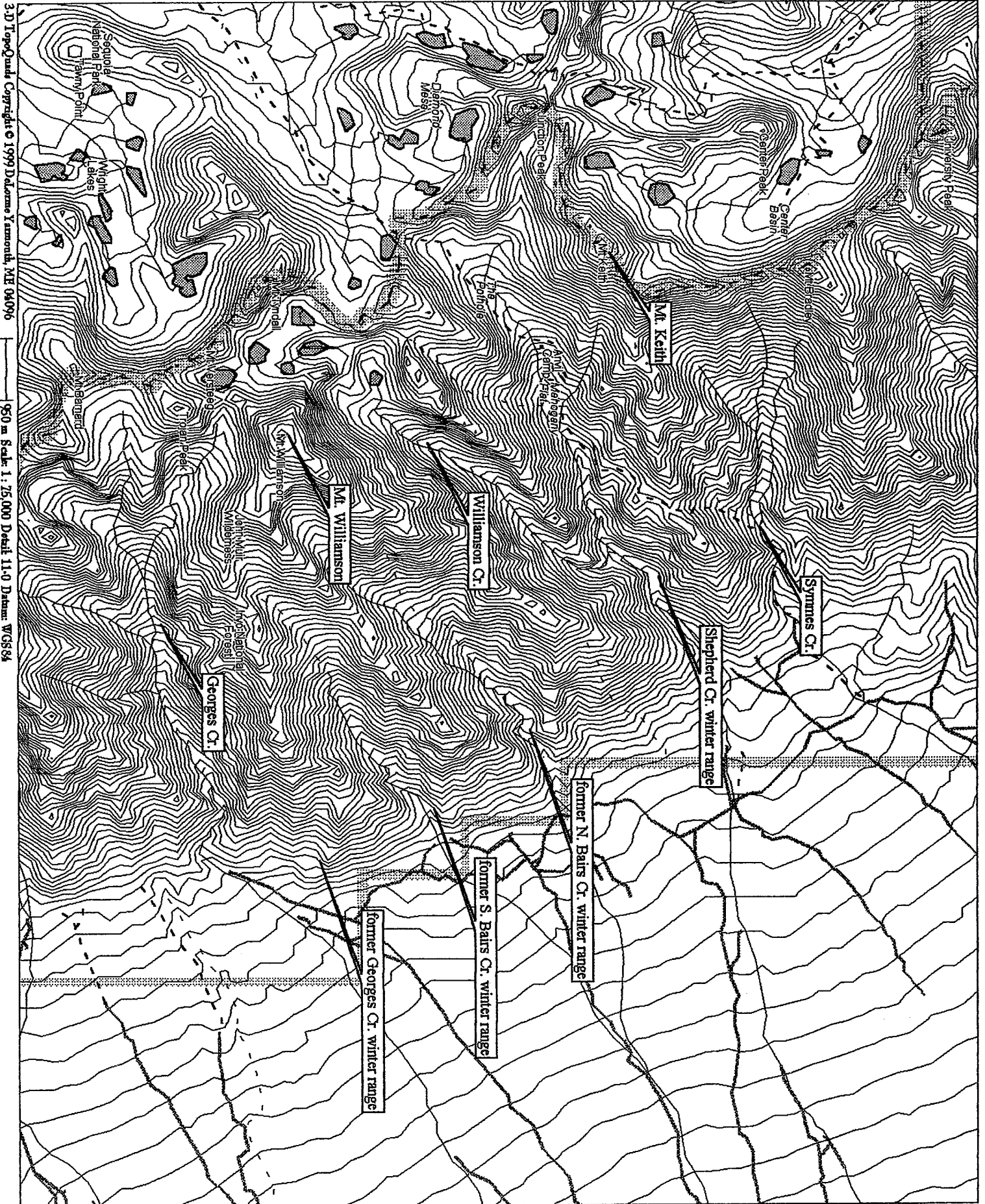
## II. Mount Williamson Herd Unit

Results of field studies and fecal genotyping led to some important results and hypotheses presented in the report prepared one year ago. First was that there were more females than expected in this herd, numbering at least 9; and second was that the center of distribution now appears to be north of Mount Williamson, probably in the Williamson Creek drainage (Fig. 2), in contrast to past years when front country winter ranges were used regularly and summer distribution consistently included the east-side drainages directly above those winter ranges. The lack of use of those front country winter ranges for more than 15 years now is what would cause such a shift in distribution away from those winter ranges and, presumably, toward current areas used in winter.

An investigation of the lower end of the east side of the Williamson Creek drainage in December of 2000 found no clear evidence of bighorn sheep use. However, a small low elevation south-facing bowl of open and rocky habitat that would make good winter range was noted in Shepherd Creek in the area where Williamson Creek joins it (Fig. 2). A check of this habitat on March 14 during a helicopter survey yielded 2 adult females, 1 lamb, and 1 yearling male. These sheep were never seen again during 3 ground checks between March 23 and April 3, except for one of the adult females recognized by her particularly dark pelage that was found dead on March 23. She had been dragged to the base of the slope next to Shepherd Creek and eaten by a bobcat; however, the surrounding evidence, including a broken foreleg, indicated that she had been caught in a snow and rock avalanche that had at least seriously injured her prior to being eaten by the bobcat. These ground surveys turned up only 2 additional sheep on this winter range – one adult (ca. 5 year old) male and one 2-year old male moved to this region from Wheeler Ridge in March of 2001. The latter male crossed high on the east side of Mount Williamson through considerable snow in mid March from his release point at South Bairs Creek to this winter range in Shepherd Creek. His appearance there coincided with the presence of the 5 sheep observed there; however, he was alone when sighted there on one occasion. Subsequently he moved south from there to the range of the Mount Langley herd as spring progressed and has remained there since then. Consequently, this ram has not been an aid in finding Mount Williamson sheep as hoped.

The finding of sheep in this Shepherd Creek winter range suggested the possibility that a new summer range further north in upper Symmes Creek might have developed following abandonment of front country winter ranges since 1985. This possibility might have helped explain the apparent inconsistency among years in the use by sheep of prime summer range on Mount Williamson. This hypothesis was tested in the summer of 2001 by walking from the top of Shepherd Canyon across the steep slopes of Mount Keith to a key pass into upper Symmes Creek (Fig. 2). If sheep were moving north from the Shepherd Creek winter range, they would first ascend the ridge between Shepherd Creek and Symmes Creek until they reached the alpine zone. The area we surveyed would unquestionably have had sign of sheep if this were occurring in recent years. In contrast, we found no evidence of sheep use in this area; nor was any sign of sheep use found higher on Mount Keith the previous summer. This leads to one conclusion – that the Williamson Creek area is the distribution center of these sheep.

Figure 2. Mount Williamson herd range with pertinent geographic labels.





One summer trip was taken in late August 2001 to look for sheep at high elevations on Mount Williamson. During that trip we encountered considerable sign of these sheep, in contrast to the previous summer. Evidence of females and lambs was found from the top of the north ridge of Mount Williamson to its base in upper Williamson Creek. Five lamb fecal samples were collected, and genotyping of these samples produced 4 different genotypes. On the south side of Mount Williamson we found abundant very recent and fresh (still wet pellets) evidence of females and lambs on the east plateau and adjacent slopes above upper Georges Creek and South Bairs Creek (Fig. 2). Genotyping of 4 fecal samples from lambs with these sheep produced 3 different genotypes, all of which were different from the sheep sampled on the north ridge. Thus, 7 different lambs could be accounted for, which is consistent with the herd size suggested by earlier genotyping. Lab work has found that at least 5 of those lambs are males.

### **III. Mount Baxter Herd Unit**

Prior to the period of winter range avoidance that began in 1987 for this herd, groups of females and lambs that used winter range areas south of Sawmill Creek would spread south along the crest in summer as far as Kearsarge Pass (Fig. 3). Following 1987, field observations suggested that this herd had split into two separate groups of females – one that has lived year round at the south end of this range between Oak Creek and Onion Valley (Black Mountain deme; Fig.3) and one that has lived between the north fork of Oak Creek and Sawmill Creek (Mount Baxter deme) and continued to use the winter range south of Sawmill Creek to a limited extent. These subgroups are discussed separately below.

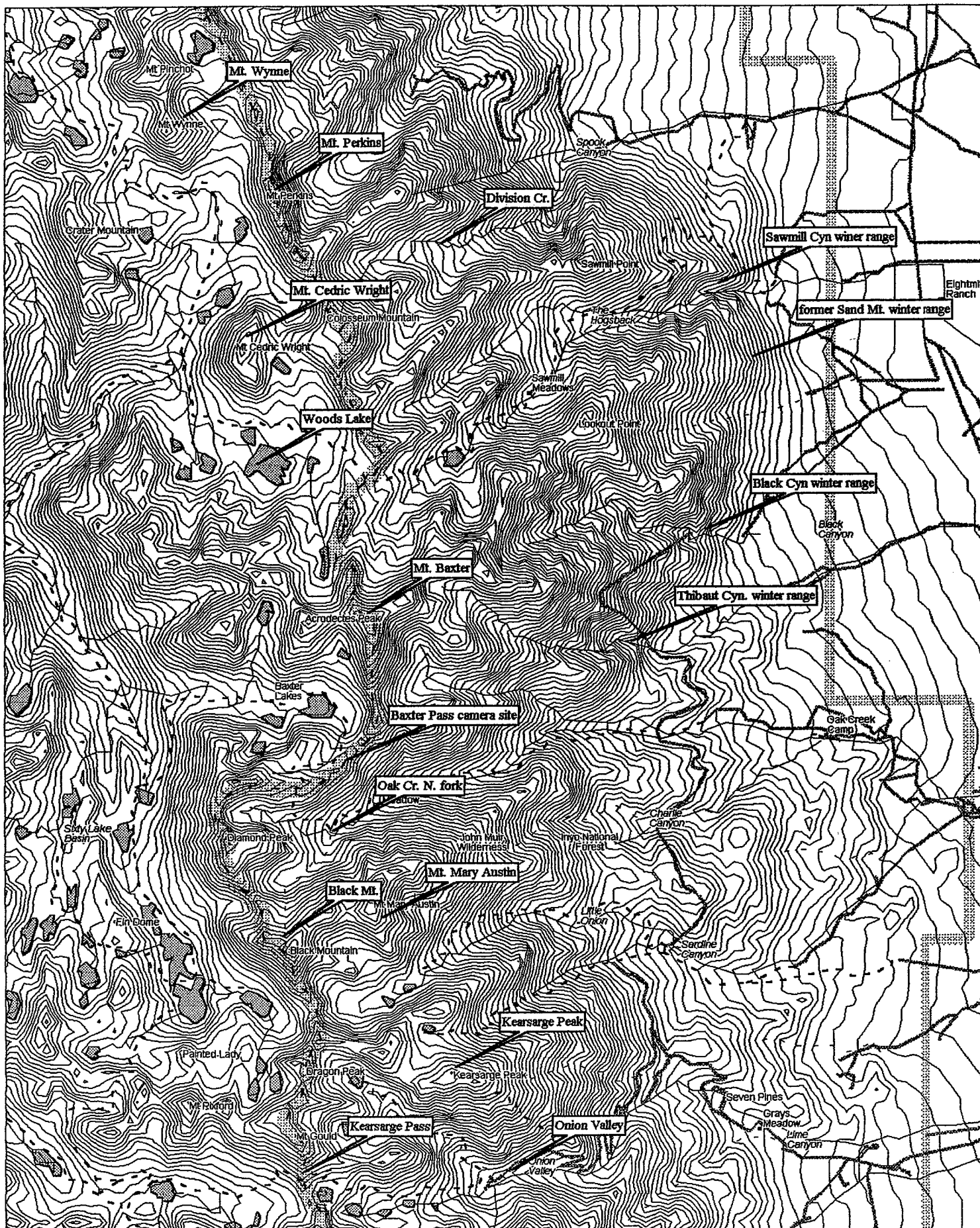
#### **A. Black Mountain Deme**

This female group could be found in the vicinity of Kearsarge Peak, Mount Mary Austin, and Black Mountain (Fig. 3) in summer through much of the 1990s. Some members occasionally were observed on lower slopes of Kearsarge Peak in early spring, and one female was also sighted high on Kearsarge Peak during one winter. None of the naturally marked females from this group have been seen among the sheep that have occasionally visited the traditional Mount Baxter winter range south of Sawmill Creek.

This group had declined to 6 adult females and 3 lambs that could be accounted for during intensive work in the summer of 1995. A data gap then occurred as efforts were focused on developing census data for other herds. When data collection resumed in summer 1998, only 4 adult females and 1 yearling female could be found in this deme, accompanied by no lambs. Additionally, we could find no evidence that these female still used the Kearsarge Peak area. A check of the Kearsarge Peak area in 1999 found evidence of visitation by a group of sheep, but analysis of DNA in the fecal samples determined that they were from males. A check of this area in early August this summer also found evidence of only a single visit by a group a sheep and genetic analyses of the fecal pellets again found them to be from males.

Since the early 1990s it has been usual to find at least one adult male sheep during late winter or early spring in Onion Valley. However, efforts to find sheep in this area this past winter

Figure 3. Mount Baxter and Sawmill Canyon herd ranges with pertinent geographic labels.





produced none. All front country areas were investigated carefully during the helicopter survey, but the only evidence of sheep found were fresh tracks of one sheep in snow on the south side of Kearsarge Peak above the road end at about 10,200 ft. That sheep was never located, despite tracks that appeared fresh.

The small group of females using Black Mountain in summer has been very productive since 1998. In 1999 they were accompanied by 4 lambs. In 2000 they were again accompanied by 4 lambs plus 3 yearlings. This year, 5 females and 5 lambs were observed. We did not find an additional group of yearlings and 2-year old females, but found sign suggesting that such a group of sheep existed.

#### B. Mount Baxter Deme

This group of females has been monitored since 1995 primarily via cameras on the ridge top of a mineral lick slope on Baxter Pass (Fig. 3) coupled with winter range observations. Key winter range areas used by these sheep have been monitored every winter during conditions when sheep would be likely to be there. Individuals recognized from Baxter Pass have been seen on this winter range.

This group of sheep remained at low numbers for most of the 1990s with low reproductive success. Only 5 females could be accounted for and during 1994-97 and only 4 lambs were recorded on the winter range during those four years, none of which were later recorded as yearling females. Reproductive success has since increased. During the winter of 1997-98, 4 ewes and 4 lambs were recorded on the winter range and the following summer one yearling female was recorded on video footage on Baxter Pass -- the first known yearling female since 1993. The following winter (1998-99) had low winter range use with only a single group of 4 sheep seen (the yearling female, 1 adult female, 1 lamb, and 1 2-yr old male). These were recognized as 4 of the 6 sheep seen on video footage from Baxter Pass the previous summer; the other two sheep recorded by the camera were 2 additional adult females. Mechanical failure of the camera on Baxter Pass in 1999 and lack of any sheep observed on winter ranges the following winter produced a 1 year gap in the data. However, camera data from the summer of 2000 documented two yearlings of each sex, indicating that at least 4 lambs were produced in 1999, in addition to 5 lambs born in 2000. Combining the 5 adult females known during 1994-98, the yearling female known in 1998, and 2 more in 2000 yields a potential for at least 8 adult females to exist in the summer of 2001 and 6 adult and 2 yearling females the previous winter. Unknown was whether additional adult females were recruited from the one lamb known to be born in 1998 and others that might have accompanied the additional 2 adult females that were not recorded by the video camera that summer.

Winter range use by the Mount Baxter herd during the past two winters has paralleled that of the Mount Langley herd. In 2000 no sheep were observed, whereas this past winter we recorded 22-23 different sheep during about a two week period in the first half of March. This use was in Black Canyon and Thibaut Canyon. Composition changes suggested some ingress and egress at Black Canyon during this period, where 15-16 different sheep could be accounted for (5 adult

females, 3 yearling females, 4 lambs, 1 yearling male, 1 3-year old male, 1-2 older males). At Thibaut Canyon there were an additional 7 sheep (2 adult females, 2 yearling females, 2 lambs, 1 yearling male). The resulting total was 7 adult females, 5 yearling females, 6 lambs, 2 yearling males, and 2-3 older males. Because these yearlings would have been born in 1999, there must have been at least 7 lambs that year. For population reconstruction, these results indicate that (1) there were 3 more yearlings (all females) than were distinguished in 2000 video footage from Baxter Pass, (2) at least 7 lambs the previous summer, and (3) at least 7 adult females in 1999.

Year	Adult Females	Yearling Females	Lambs
1993-94	5	0	1
1994-95	5	0	2
1995-96	5	0	0
1996-97	5	0	1
1997-98	5	0	4
1998-99	5	1	1
1999-2000	6	1	7
2000-01	7	5	6

During field surveys this summer we recorded two groups of sheep on July 25 that totaled 14 sheep (6 adult females, 3 yearling females, 4 lambs, 1 yearling male). Two automated video cameras stationed on Baxter Pass recorded both of these groups as well. These cameras recorded sheep on 20 different days between June 23 and October 9. Different sheep recorded were at least 9 adult females, 3 yearling females, 2 yearling males, and 7 lambs, but there may have been an additional 2 females and 2 lambs. These summer counts thus failed to document 1 yearling, and 1-3 adult females known from winter. Table 2 gives a possible reconstructed history of the females in this deme.

The division between the Mount Baxter and Black Mountain demes may be breaking down as these groups increase in size. For numerous years we have found no evidence of other than an occasional sheep (probably mostly males during rut) crossing the top of Oak Creek between these areas. Prior to winter range abandonment in the 1980s there was regular evidence of such a connection and no reason to think that the southern part of this range was a separate deme. In July of 2001 we documented a group of 10 females, lambs, and yearlings from the Mount Baxter deme making such a crossing. The sign indicated that they had headed north across the top of Oak Creek the previous afternoon. We tracked them across Baxter Pass and eventually caught up with this group in a canyon on the north side of the Baxter Lake drainage. It is hoped that the development

of such a connection will bring some of the Black Mountain sheep to the Mount Baxter winter range and thereby help build numbers there.

#### **IV. Sawmill Canyon Herd Unit**

This herd unit was once treated as part of the Mount Baxter herd, but has been recognized as a separate group since the late 1970s. Its size clearly has been small since 1995, but there has been some uncertainty regarding exact size due to inadequate allocation of field time to this herd. In the summer of 1995, 7 adult females, 1 lamb, and 1 2-yr. old ram were found in this herd. No sheep from this herd were seen in 1996, but 6 adult females, 3 lambs, and 2 yearling males recorded in the winter of 1996-97 documented at least 3 lambs born in 1996 and a minimum of one more lamb than was seen in 1995 (plus at least one additional female that would have accompanied that lamb). In 1998 only 2 females and a lamb were observed in the winter range and brief summer investigations turned up no sheep and little sign of this herd. In 1999 no sheep were seen in winter, but 6 females, 1 lamb, 1 2-yr. old male, and 1 older male were seen in the summer range. In 2000, again no sheep were seen in the winter range. Summer investigations that year turned up 2 adult females, 2 yearling females, 1 lamb, and 1 2-yr old male south of Woods Lake. Evidence of sheep use from the Woods Lake area to Mt. Wynne (Fig. 3) suggested the possibility of as many as 9 adults and yearlings and 5 lambs utilizing this area in 2000. However, because the sheep habitat south and west of the Woods Lake Basin is utilized by sheep from the Sawmill Canyon and Mount Baxter herds, it is not clear what proportion of those sheep were from the Sawmill Canyon herd. Part of the sheep sign found in 2000 was a set of fecal pellets from an out-of-season (August born) lamb above the Woods Lake Basin. A lamb matching that description was among the sheep seen this past winter in the Black Canyon winter range of the Mount Baxter herd. Thus, the Sawmill Canyon herd could be smaller than what the sign suggested in 2000.

Winter range use by the Sawmill Canyon herd showed a notable spike in 1997, when 12 different sheep were observed there over about a 2 month period (6 females, 3 lambs, 2 yearling males, and 1 2-yr. old male). Since then the use of that range has been sparse, with only 3 seen during the heavy winter of 1997-98 and none the subsequent two winters. This past winter saw some reoccupation of the winter range that began in the middle of February. First was a group containing 2 adult females, 1 yearling female, 1 lamb, and 1 3-year old male that were still there in mid March when it was checked by helicopter. Second was a group of 2 adult males that appeared in April.

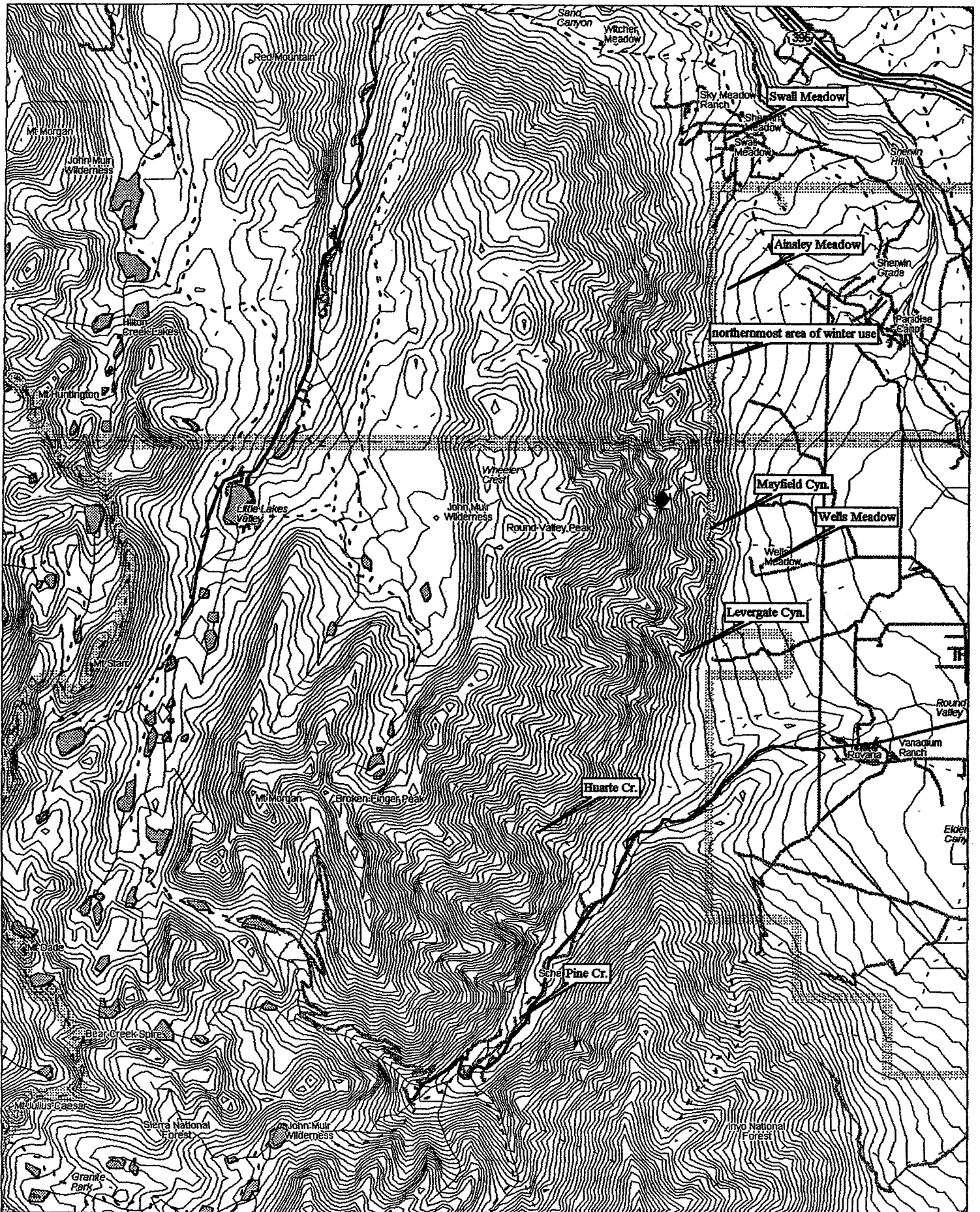
No sheep were seen during one trip into the summer range of these sheep in 2001. However, ample sign of these sheep was found during that trip. Of particular note was fresh (1 day old) sign of a large group of females, lambs, and yearlings found on Mount Cedric Wright and the top of Division Creek (Fig. 3). Fecal pellets of different sizes indicated that this group contained at least 6 different lambs. Recent tracks and fecal samples of 4 adults and 1 lamb also were found at the western base of Mount Perkins (Fig. 3). Although not yet completed, genotyping of 9 fecal samples from these lambs appears to represent 8 different individuals. This suggests that at least that many adult females also exist in this herd.

## V. Wheeler Ridge Herd Unit

Only 7 adult females and 3 female lambs can be accounted for as the surviving reproductive base of the Wheeler Ridge herd following the severe winter of 1994-95. A minimum of 12 sheep are known to have died that winter (all in a single snow avalanche), but other many other deaths may have gone unrecorded. This herd has been tracked closely since then, primarily through winter monitoring. This monitoring took place in Pine Creek (Fig. 4) during 1995-98. Since then it has included front country low elevation winter ranges after sheep showed extensive reoccupation of those ranges beginning in 1999. Population reconstruction for bighorn sheep in the Sierra Nevada has always depended on periodic opportunities for excellent counts. In addition to the 1994-95 winter, 1998-99 was such a year. This occurred in part because the sheep groups spread out across the front country winter range where spatial separation greatly aided counts. Prior to that, we depended on seeing as many sheep as possible at one time in Pine Creek. While all of the females very likely were seen every winter, we could not account for all of them at one time. In contrast, because of smaller numbers and easier recognition of individuals, it is very likely that all lambs were accounted for in every year. In 1999 we counted 13 different adult females in this herd compared with 6 in 1995. Because an old collared female that was moved to Wheeler Ridge from the Mount Baxter herd in 1986 was discovered still alive in 2000, it is necessary to add 1 to each of these figures (Table 3); thus, the herd gained 7 females during those 4 years. The count in 1999 also was important in that 3 2-year old males were counted. They established that 3 of the 5 lambs in 1997 were male. Consequently, the gain of 7 females between 1995 and 1999 equals the number of female lambs known during 1995-97 that would be adult females in 1999 (Table 3).

Year (winter)	Adult Females		Yearling Females		Lambs		Yearling Males		Adult Males	
	O	R	O	R	O	R	O	R	O	R
1994-95	6	7	0	0	3/1	3/1	1	1	4	8
1995-96	8	7	0	3	2/2	2/2	0	2	4	8
1996-97	8	10	1	2	5	2/3	2	2	5	10
1997-98	7	12	0	2	5	4/1	0	3	5	12
1998-99	13	14	4	4	10	5/5	1	1	12	15
1999-2000	16		4		11/3	10/4	5	5	7	16
2000-01	19		8		6/11		4		21	

Figure 4. Wheeler Ridge herd range with pertinent geographic labels.





This suggests 100% survivorship for those female age classes during that period. Since 1999 it is not clear whether such high survivorship has continued. In 1999, 18 females were known to exist, but the sex of all of the 10 lambs present was not determined. On the basis of 5 yearling males recorded the following winter, there may have been as many as 5 females among those lambs, which would have brought the potential number of females to 23. However, only 20 females were recorded in the winter of 1999-2000, of which 4 were classified as yearlings. Thus, 9 of the 10 lambs were documented alive as yearlings and 16 of the 18 females from the previous year. This past winter saw a similar pattern. Of 14 lambs existing in 2000, only 12 were documented as yearlings (8 female and 4 male) and 19 of 20 older females from the previous year were seen (Table 3). In total, the 2001 count was missing 3 females out of 30 expected, or 10%, while the 2000 count was missing 2-3 females out of 22-23, or 9-13%. The question is whether some or all of those uncounted sheep were dead or remained at high elevations where they were not counted.

In the second half of March this year we used a helicopter to assess the completeness of our ground counts. From Huarte Creek north to Swall Meadows (Fig. 4) we investigated canyons where we knew of sheep, as well as ones where we did not. We flew up into the snow looking for tracks of uncounted sheep. In every case the only sheep we could document were the ones that we already knew to exist. Because we did not fly up to the highest possible elevations and did not investigate the side drainages further up Pine Creek, it is still not possible to answer the question of whether the missing sheep were alive. One of the females we did account for this winter and spring was the old one moved there from Mount Baxter in 1986 and first discovered to be still alive in 2000. This year she was not seen until spring (May), when she appeared in Pine Creek with another female. She was clearly in areas where sheep cannot be counted from the ground during winter, and she was similarly not seen from the helicopter. She could be representative of the approximately 10% that have been unaccounted for in the past two winters. Obviously, 100% survivorship cannot be maintained for many years in a herd, but 10% annual mortality may also be an overestimate.

There is another reason to think that at least some of these few missing sheep are alive. During the summer of 2000 this population was sampled on multiple occasions. That sampling produced a consistent lamb:adult ewe ratio of about 76:100, and during one survey documented 4 adult females that did not have lambs. However, winter sampling yielded 17 lambs for 18 adult ewes, or a ratio of 94.4:100. Adding the old transplanted female seen in May (known to have had no lamb with her the previous summer) drops this to 89.5:100. Both of these ratios are well above what was recorded the previous August and September. From sampling the previous summer, at least 21 adult females would have been expected to have accompanied the 17 lambs seen this past winter, and 22 would be necessary to achieve the summer lamb:adult ewe ratio. Thus, our winter-spring count of 19 adult females, including the old collared one was 2-3 short of what was expected, and that number would have had to have died between September and February. This seems like an excessive mortality rate. It is possible instead that a small number of females in this herd are remaining at high elevations above Pine Creek in winter. They are probably not pregnant and therefore do not need the extra nutrients available at lower elevations.

A consistent and interesting social and geographic pattern of group composition in winter

has been observed for this herd the past two years. In the winter of 1999-2000, four groups of females, lambs, yearlings, and occasional older males developed in this herd. One small group of 2 untagged females and a lamb was at the north end of the front country winter range in the southern of a cluster of unnamed drainages south of Ainsley Meadow. It is not known when and by what route they got there. A second group of 15 also included no marked females, but had a yearling male that was eartagged as a lamb the previous year. This group was observed February 1-2 as it headed out of Pine Creek to the front country winter range. This group was not observed again until February 28 when it appeared at Mayfield Canyon just north of Wells Meadow (Fig. 4). The third group contained 3 tagged females (radio frequencies 159.740 and 160.110, and a 2 year old female with just an ear tag). They left Pine Creek about February 20 and took up residence around Levergate Canyon (Fig. 4). The fourth group included the other two radio collars (159.830, 159.870), and remained in Pine Creek most of the winter, but headed out to the south end of the front country winter range on March 16. They never got as far as Levergate Canyon before heading back into Pine Creek Canyon.

In 2001 we again found a small group of sheep in same area south of Ainsley Meadow and recognized one of the 3 females there as matching one seen there in 2000. There was again a group of about 15 sheep that included no marked animals that appeared in Mayfield Canyon on February 27, but we did not see this group leave Pine Creek. The third group this year also matched the one from the previous year. It contained 3 tagged females (159.740, 160.110, and the one with just an eartag). They left Pine Creek on February 4 and again occupied the slopes near Levergate Canyon, but moved a little further north this year as far as the slopes above Wells Meadow. The fourth group this year again contained the remaining two radio collars (159.830, 159.870) and remained mostly in Pine Creek. On March 11, 2 females and a lamb from this group were seen leaving Pine Creek for the front country winter range, but the remaining 6, including the 2 collared females, never left Pine Creek. Notable about these patterns over the past two winters have been the identical associations among tagged females, the similarity in the timings of when the different groups appeared on front country winter ranges, and the consistency in the front country areas that they used. Additional winters will tell if this is a consistent pattern. It is also noteworthy that the same associations of tagged females have not been seen in summer.

This past winter offered much better opportunities to census the male portion of the Wheeler Ridge herd than the previous winters have. Females appear to lead reoccupation of low elevation winter ranges, with males following in subsequent years. This pattern has been apparent at Wheeler Ridge, where male groups have been seen only occasionally on those ranges until the winter of 2000-01. We took advantage of this increase in males and developed a total count of 21 males at least 2 years of age. That count had a cascading effect on reconstructed population data all the way back to 1995. In 1995 we knew of only 1 yearling male, 2 2-yr. old males, and 3 older males that survived the winter, of which one was killed by mountain lion the following December. Previous population reconstructions indicated that there were two additional males in 1995, which brought the total surviving number that year to 17. The new reconstruction using the recent winter count adds yet 2 additional males, for a total of 19. This reconstruction assumes that counts have accounted for all lambs every winter, which is suggested by the strong propensity for that age class

to occupy lower elevations. The alternative to this reconstruction is that these 2 additional males reflect unrecorded recruitment.

Sampling in the summer of 2001 logged a sample of 19 adult females for groups in which complete classifications occurred. With these females were 14 lambs, 2 yearling females, 7 yearling males, and 2 older males. The lamb:adult female ratio of 74:100 is very similar to the ratio in the summer of 2000. The sex ratio of yearlings reflects the unbalanced sex ratio of lambs recorded this past winter (6 females, 11 males). Given the increasing pattern in the number of lambs seen the past 3 winters (10, 14, 17), at least 19-20 lambs should be expected to be counted during the 2001-02 winter.

## **VI. Mount Gibbs Herd Unit**

The only sheep seen in this herd unit in winter since the early 1990s has been a sheep seen once at high elevation from a long distance (Highway 395) through a spotting scope by Karl Chang. All other data have been developed in the summer range. This past year was no exception. In late March of 2001 an attempt was made to find sheep from a helicopter, but winds prevented the entering of Bloody Canyon (Fig. 5). Only the most eastern face of Mt. Gibbs could be surveyed to some extent, and no sign of sheep was seen there.

This herd was formed when 3 females and their 2 lambs emigrated from Lee Vining Canyon in the summer of 1986, about a half year after the first translocation to Lee Vining Canyon from the Mount Baxter herd. No lambs were produced in 1987, presumably because of the lack of any mature males. Two lambs were produced in 1988, apparently sired by one of the founding lambs that was male. In 1988, that male and one of the founding adult females fell victims of mountain lion predation prior to the breeding season, and a female offspring also disappeared from this group that year. This herd produced no further lambs until 1992 after males from the Mount Warren herd apparently found them in 1991. At the time these males appeared, the herd consisted of 3 adult females, all founding members of this group, of which one was a lamb when they moved there from Lee Vining Canyon in 1986. Ages of the two older females in 1991 were, respectively, at least 10 and 13 based on aging at capture in 1986, while the other female was 5 years old. Both founding adults carried radio collars in 1986. Table 4 traces the history of this group since 1991 when males appeared and breeding resumed.

There was an apparent low point in this herd in 1993 when only 1 female and two males were documented. The documented reproductive base remained at only 1 female during 1993-96, and because this sheep carried no collar, it has been presumed to be the 1986 founding female lamb. Also, because no radio collared females have been observed since 1992, it has been presumed that they died during the winter of 1992-93, which was a heavy winter, especially compared with 6 consecutive years of winter drought that preceded it.

Field observations have documented that a male lamb existed in each of 1994 and 1995 and a female lamb in 1996, all of which survived to become yearlings. In 1998, no lambs accompanied

Figure 5. Mount Gibbs and Mount Warren herd ranges with pertinent geographic labels.



the two females seen. In 1999 there was one lamb seen with two females, but genotyping of fecal samples from those three sheep found that one of the females did not match the two female genotypes from the previous year, i.e. was a third female genotype. In the summer of 2000, three different females were documented, of which 2 had dark pelage and one was light in color. There were also 2 lambs seen in 2000, which fecal genotyping found to be one of each sex.

YEAR (summer)	ADULT FEMALES	YEARLING FEMALES	LAMBS	YEARLING MALES	ADULT MALES
1991	3	0	0	0	1
1992	3	0	1	0	2
1993	1	0	1	0	2
1994	0	0	0	0	3
1995	1	0	1	1	3
1996	1	0	1	0	5
1997	1	1	1	0	2
1998	2	0	0	1	3
1999	2	0	1	0	0
2000	3	0	2	1	0
2001	2	1	1	0	6

Our work this past summer documented two different groups of sheep, the first of which was seen twice: (1) 2 adult females, 1 yearling female, and 1 lamb; and (2) 6 adult males, the youngest of which might have been 2 years of age. Groups of the same size and composition also were reported to us by a number of observers hiking or engaged in other data collection in this area. Not accounted for in 2001 have been a third female seen in 2000 and the male lamb from that year.

The 6 adult males observed this year are of interest. In 1996, 5 males at least 2 years of age were seen in this herd (Table 4). In subsequent years, 3 additional male lambs have been recruited in this herd, (1 each born in 1997, 1999, and 2000). These would increase the potential number of males at least 2 years of age in 2001 to 7. We have not been able to account for all of the adult males in any year since 1996. In 1997 only 2 were seen; in 1998, only 3 were seen, plus a yearling; and in 1999 and 2000 no adult males were seen, although a combination of reports and fecal genotyping suggested the existence of 4 adult males and 1 yearling male in 2000. The 6 males seen this year that did not include a yearling, but otherwise account for all but one of the males known



since 1996. Given that the first appearance of males from Mount Warren occurred 10 years ago, it is likely that at least one of those initial immigrants has died.

The origin of the third adult female seen in 2000 and documented genotypically in 1999 remains an interesting question. She cannot be one of the founding females because she carried no radio collar, and because she would have been older than expected life spans. This means that she was either an earlier offspring or an immigrant. Offspring beginning with 1995 lambs have all been accounted for as adults. However, there was 1 lamb seen in each of 1992 and 1993, whose fates are not clearly known (Table 4). One adult female, 1 lamb and 2 adult males were observed in 1993 (Table 4). It is unlikely that a surviving lamb from the previous year would not have accompanied its mother as a yearling. Data collection in 1994 was inadequate in that no females were found. It is possible that the lamb from 1993 was a female that survived. There are two problems with that possibility. First is that it difficult to explain why that female would not have been seen accompanying her mother in subsequent years, given the strong social behavior of bighorn sheep. Second, it is necessary for that 1993 lamb to be male to account for the 5 adult males observed in 1996, unless further immigration of a male had occurred. A remaining possibility is that a female from the Mount Warren herd immigrated to the Mount Gibbs herd. The Mount Warren herd lost a number of females over the winter of 1998-99. I plan to use archived fecal samples from Mount Warren females collected in 1998 to investigate that possibility genotypically.

The drop from 3 to 2 adult females documented in the Mount Gibbs herd between 2000 and 2001 may reflect the death of the founding female lamb that kept this herd from disappearing. She was born in 1986, which would make her 15 years old in 2001, and puts her into the older ages expected for females. Between ages 6 and 11 she apparently produced 6 lambs, of which 5 were male. It is not yet known whether she was the source of lambs born in 1999 and 2000, but this also can be investigated genotypically.

## **VII. Mount Warren Herd Unit**

While some sheep from this herd unit are sometimes seen in winter and spring at lower elevations, the most complete population data primarily have been developed in summer and fall at high elevations. Prior to the initial large collapse of the Mount Warren herd in 1995, females moved readily between Tioga Crest and Mount Warren (Fig. 5). Since then all evidence has suggested that the few females that remain in this area can be separated into two demes and are treated here as such.

### **A. Tioga Crest Deme**

These sheep are found primarily on Mount Scowden at the north end of Tioga Crest during summer, but range south to Tioga Peak during the colder months. They can sometimes be seen on Tioga Peak in spring, but lack a low elevation winter range.

Three females survived the winter of 1995 on Tioga Crest. They produced 4 lambs during

1995-97, of which 2 were recruited (1 of each sex; Table 5). Following the heavy winter of 1997-98, only a single adult female and a 2-year old male could be found. However, the next year (1999) an additional female was present. They have been seen every year since then, including 2001. This year they were accompanied by 2 lambs, 1 yearling male and 1 2-year old male. Of the three lambs they produced during 1999-2000, 2 have been recruited, both male (Table 5).

It is not clear whether the second female found in 1999 was simply missed in 1998 or might have been an immigrant from Mount Warren. This is the same year that an additional female appeared on Mount Gibbs. Genotyping efforts relative to the unknown Mount Gibbs female will also allow the investigation of the origin of the second Tioga Crest female.

YEAR (summer)	ADULT FEMALES	YEARLING FEMALES	LAMBS	YEARLING MALES	ADULT MALES
1995	3	0	1	0	1
1996	3	0	2	0	0
1997	3	1	1	1	0
1998	1	0	0	0	1
1999	2	0	2	0	0
2000	2	0	1	1	0
2001	2	0	2	1	1

#### B. Mount Warren Deme

These sheep have gone through a series of population declines beginning in the winter of 1994-95 reaching a low point of only 1 known adult female and a female lamb remaining in 1999. Neither was seen in 2000, but fecal pellets were found that suggested that both were alive. The Mount Warren area also has been the location where most males in this area resided. However, beginning in 1999 their summer habitat use patterns apparently changed, as few males could be found during summer in 1999 or 2000. Efforts to find new summer ranges of these males failed. The last good count of males occurred in October 1999 when 10 adult males reappeared prior to the rut. There were an additional 2 yearling males with the 1 female and her lamb that year (Table 6).

In contrast to the sheep on Tioga Crest, the Mount Warren sheep have a low elevation winter range in Lee Vining Canyon. In recent years some sheep usually have been recorded there for a short time in early winter (early December) and again in spring. When females used this winter range they often reappeared in early March, while males have not made extensive use of Lee Vining

Canyon until April and May. No females have been seen on this winter range since 1998, and this past winter was no exception.

During the 2000-01 winter this winter range was used occasionally by a few males, and one of these was seen during a helicopter survey on March 24. During April the number of males using this winter range increased to 8 and they remained there until mid May.

Summer surveys turned up a group of 3 females and 2 small lambs on the north side of Mount Warren in late June. Numerous repeated efforts during summer and fall failed to find these sheep again. This group contained 1 more female than expected. These sheep were not classified carefully by the observers involved, thus left the question of whether one might have been a yearling male instead of a female. This question was prompted by the finding of yearling-sized fecal pellets at the site where these sheep were observed that DNA analysis found to be from a male.

This summer the adult males in this deme resumed their old pattern of summer habitat use. They were seen repeatedly south of Mount Warren and totaled 10. This was 2 fewer than the last good count in 1999 (Table 6).

YEAR (summer)	ADULT FEMALES	YEARLING FEMALES	LAMBS	YEARLING MALES	ADULT MALES
1995	11	0	3	1	13
1996	12	1	11	2	13
1997	9(-12)	3(-?) *	6-8	0(-?) *	12-13
1998	6	0	3	0	9
1999	1	0	1	2	10
2000	0	0	0	0	7
2001	3 **	0	2	0	10

\* 3-6 yearlings (sexes not known for all). \*\* not well classified; 1 yearling male possible.

### VIII. Population Size Trend Throughout the Range

As is usual, there are a number of gaps in the data for 2001 that prevent the establishment of a solid figure on the number of bighorn sheep now existing in the Sierra Nevada. First, data on males is quite incomplete because they have not been the focus of survey efforts. This leaves open the option to attempt to develop a figure for the number of females. However, there are data uncertainties involving females also. At Mount Langley we failed to find about half of the females

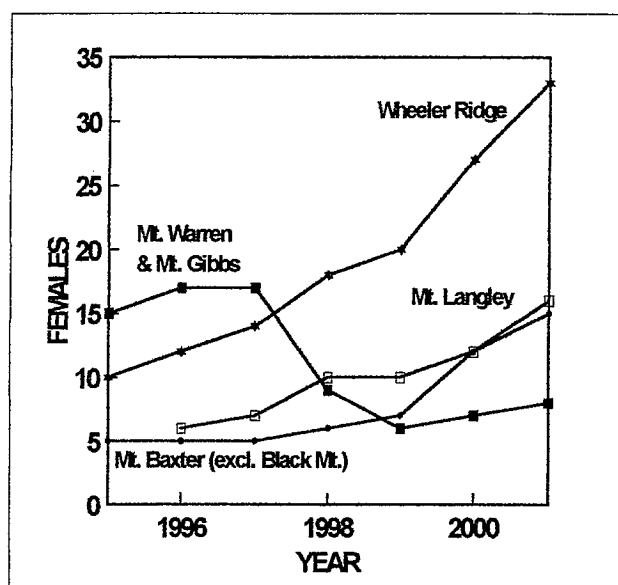
this summer, thus can only project how many are likely to be there based on data from last year and the number of yearling females seen. On Mount Williamson it would be necessary to rely on genotyping data from a year ago until additional genotyping data are available for adults. For the Black Mountain herd we did not locate a group containing females recruited the past two years. This number also can be obtained from fecal genotyping, but those data are not yet available. The same can be said for the Sawmill Canyon herd, where past data suggest that there should be at least 6 females, but genotyping of lambs this year suggest so far that this should be increased to 8 or more. Data for Wheeler Ridge will not be available until counts are completed this next winter (2001-02).

It is because of such data gaps that population figures for these sheep have been established at later dates as reconstructed populations. It is nevertheless possible to project a likely total number of females currently existing, with the appropriate accompanying assumptions. I will make the following assumptions in so doing: (1) there has been no adult mortality at Mount Langley, resulting in 16 females alive; (2) the number of females at Mount Williamson is the 9 different genotypes detected in 2000; (3) 4 females 1-2-years old exist in the Black Mountain deme in addition to the 5 adults seen; (4) the Mount Baxter deme has all 12 females known during winter plus the 3 yearlings from summer, for a total of 15; (5) 8 females exist in the Sawmill Canyon herd where genotyping data suggest that 8 lambs may be present; (6) there are 33 females at Wheeler Ridge; and (7) Mount Gibbs, Tioga Crest, and Mount Warren total the 8 females counted. This produces a total of 98 females at least a year of age. Given that some of these are likely to be slight undercounts, as discussed earlier, a round figure of about 100 females is reasonable for the summer of 2001.

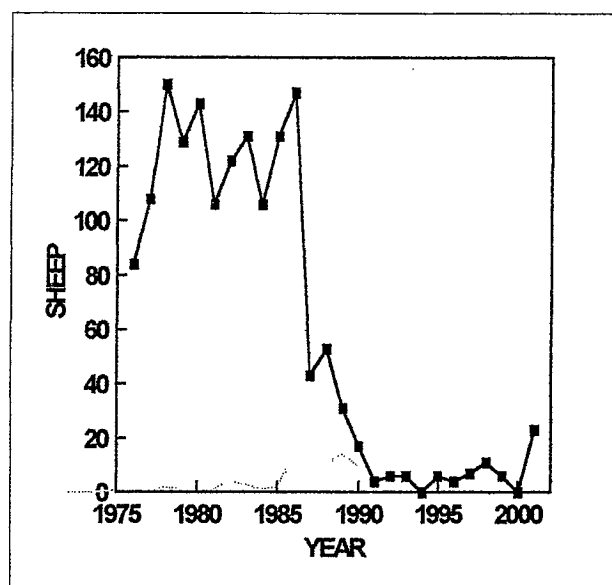
What is clear from population data collected during the past year is that the strong population gains seen in the past couple of years continued in 2001, with most of the lambs from 2000 alive as yearlings. The number of lambs produced also appears to have increased. Excluding Mount Williamson, where population data were lacking, about 40 lambs existed in the summer of 2000. For the same herds, the 2001 figure is 30% higher at 52, using the projection for Wheeler Ridge discussed above. This is similar to the rate of increase in the number of lambs from 1999 to 2000. The lambs on Mount Williamson increase the 2001 total by 7 to 59 total.

My synthesis of herd size data in 1999 suggested that the number of adult sheep in the Sierra Nevada was, conservatively, about 125. Fecal DNA results from Mount Williamson have since indicated that about 10 additional sheep should be added there, bringing that total to 135 adults. In 2000 the number of adults increased by about 25%. Similar increases this year should put the total number of adults near or exceeding 200. Adding the 2001 lamb crop puts the total number of sheep in the Sierra Nevada conservatively at about 250. That is what existed in the late 1970s (including lambs) when I first developed solid population data for the herds that existed then. This is a remarkable increase considering that in 1995 only about 100 bighorn persisted in the Sierra Nevada.

Figure 6 illustrates the trajectories of the number of females in the herds or demes for which the numbers are best known. Three of these show continual increases since 1995, especially in the



**Figure 6.** Reconstructed numbers of females for herd units having the most complete data.



**Figure 7.** Different sheep seen on the Mount Baxter herd unit winter range, 1976-2001.

past two years. The sheep in the Mono Basin (Mount Gibbs and Mount Warren herd units) show a very different pattern involving an overall decline. The pattern for those sheep has been driven by two of the demes there – Tioga Crest and Mount Warren; Mount Gibbs has not seen any decline during that time period. Of all the groups of females in the Sierra Nevada, the sheep in that area remain most vulnerable to extirpation of female groups. However, they are currently showing an increasing trend.

This past winter saw a major change in winter range use in 3 southern herd units. This is well illustrated by the Mount Baxter herd sheep that use the winter range south of Sawmill Creek (Fig. 7). In total, close to 130 different sheep in the Sierra Nevada were observed using winter ranges in 2001. One of the concerns expressed in the draft recovery plan for bighorn sheep in the Sierra Nevada has been the effect of very small sizes of demes on potential group sizes. This concern has centered on whether sufficient group sizes could occur that would provide the sheep the psychological comfort needed to make adequate use of winter ranges, and thereby obtain nutrients that will optimize reproductive output. The recent rapid gains in herd sizes among the herds in the Owens Valley region suggest that this problem resolving on its own. This has occurred despite the fact that there was essentially no use of winter ranges south of the Wheeler Ridge herd in 2000. What has occurred in the past few winters have been climatic conditions optimal for sheep that do not make much use of winter ranges. Among the factors has been the late initiation of winter snowstorms. This has allowed sheep to feed in safe habitats unimpacted by snow as much as 2.5 months longer than in winters that begin early.

While use of winter ranges showed a major jump in 2001, this use is still very limited geographically and temporally in some herds compared with what was seen in the past. Winter



range reuse by the Wheeler Ridge herd preceded by 2-3 years what was observed this past winter at Mount Langley, Mount Baxter, and Sawmill Canyon. At Wheeler Ridge we have observed continuing and expanded use of winter ranges; extensive use by males only began in 2001. If this same pattern holds for the southern herds, this bodes well for their future. In particular, it will substantially remove concerns about stochastic effects of winter severity on the sheep in that winter severity becomes a positive rather than a negative factor when winter ranges are used extensively. This is because severe winters that begin early can provide the best nutrition on winter ranges and extra snow pack can extend the alpine growing season and thereby improve diet quality of the sheep later in the year.

### **IX. Future Monitoring**

Prior to the period of winter range avoidance that began largely in the second half of the 1980s, census data for the Mount Baxter, Sawmill Canyon, and Mount Williamson herds units were derived from counts on winter ranges. For these herds the development of high country census methods occurred only beginning around 1995 after deme sizes had dropped to low levels that allowed these counts to be made. These counts have depended on persistence and a degree on luck in finding different female groups within a short time period. With small herd sizes, counts have often entailed finding just a single group when all or most of the females were aggregated.

With increasing herd sizes these high country counts are becoming more difficult, as illustrated by the Mount Langley herd this year. Additional methods will probably be necessary to continue this monitoring. The simplest will be winter range counts. If winter range use continues to increase, this will be a natural transition. However, it is important to note that in the past, when winter ranges received high use by these sheep, winter range counts also frequently were less than complete except in certain winters. This was because all sheep either did not use the winter range, or were not in the winter range at one time. The apparent exceptions were years of heavy snowfall, and data from winters providing more complete counts were used to reconstruct populations from early years, just as they are used currently. This means that the best data often will lag 1-4 years behind the year in question.

Another potential method that also will have a similar time lag will involve attempting to genotype all the lambs each year from fecal samples. This will be possible if genotypes of all the females are already known. If lambs can be genotyped each year and assigned with reasonable confidence to individual mothers, this will allow an assessment of how many females are producing lambs. As female lambs are recruited, they will be added to the known pool of potential mothers. A female that is producing lambs on a regular basis can be expected to be identified as alive by this method, even if a year is skipped occasionally. If a female is present and not producing lambs, she has little or no value from a conservation or evolutionary perspective, so is not important if not detected by this method. Somewhat more difficult to detect will be females near the end of their reproductive periods if they skip multiple years between lambs.

The advantage of this method is that by knowing the habitat use patterns of the females

possible to develop an adequate sampling of fecal samples in a relatively short period of time. However, lab time may be considerable if herds grow to large sizes. This is probably a method most appropriate for small and intermediate herd sizes. It is clearly the best current method for the Mount Williamson herd, which has so far continually defeated attempts at direct counts since 1996.

The use of a helicopter to supplement winter ground counts proved useful this past winter to focus ground efforts. The helicopter should be limited to the extent possible to finding unknown sheep rather than attempting to develop complete sex and age classifications. An attempt to classify sheep at Thibaut Canyon this winter demonstrated a major limitation of this tool. A group classified from the air as 3 females and 4 lambs proved to be 2 females, 2 yearling females, 2 lambs, and 1 yearling male when classified accurately from the ground. Caution should also be exercised when using a helicopter not to discourage sheep from using winter ranges.

Attempts should be made to expand helicopter use to see if sheep at high elevations can be found. Because of the elevations involved, this will take ideal weather conditions. The upper elevations of Pine Creek would be one place to try this. Another might be to see if any of the Black Mountain sheep can be found during winter. Below are some recommendations relative to specific herds.

#### Mount Williamson

Investigations the past few years now point only to Williamson Creek as the center of distribution of this herd. Two different attempts should be made to develop direct counts in that drainage. First would be to use a helicopter in March when snow should allow sheep to be found via tracks. Second, there is a major cliff wall on the west side of Williamson Creek from the top of which the entire drainage is visible. It is very likely that females bear their lambs on the west facing slope of the canyon and remain there for a considerable period before moving to other areas on Mount Williamson. In the late 1970s I once camped high in Williamson Creek in the second half of June and watched females with lambs dropping to feed daily at the base of the slopes on that side of the canyon. I recommend that an attempt be made to spend multiple days on the top of the cliffs on the west side of the canyon in June glassing the west-facing slope of this drainage.

#### Wheeler Ridge

Efforts to sample sheep in this herd during the past two summers have been educational as to the extreme difficulty this presents. Monitoring of the signals from the 4 radio collars during the past summer suggested that early in summer the females were concentrated on the high front slopes between Huarte Creek and Levergate Canyon. This should be monitored this coming June and taken advantage of. A small amount of effort when sheep are so concentrated early in the year may be able to produce a large sample for lamb:ewe and yearling:ewe ratios in a short amount of time that will take a much larger effort once they disperse further west.

There have been reports of males from this herd in the Humphries Basin in recent years. It

would be desirable to make a survey there to investigate this.

Mount Baxter and Sawmill Canyon Herd Units.

Keeping track of the three demes involved in these herd units will require more time than has been available in recent years. One reason is that increased size of the Black Mountain deme means that it cannot be seen in a single group any longer. Finding all these sheep will take coordinated work of perhaps two teams on the ground in summer and additional time allocation.

The rapid increase in the use of the Baxter Pass mineral lick makes this an ideal place to sample the Mount Baxter deme. Two cameras were used in 2001. A third camera is available but needs repairs. It is recommended that this third camera be deployed in 2002. Each of these cameras can video only a limited area relative to what the sheep use. They have been set along the ridge top because the sheep tend to use this area for bedding. A third camera will in effect monitor an additional bedding area.

The Sawmill Canyon herd simply needs more time allocated to it to develop data via direct observations in summer. This could be a herd allocated to monitoring via fecal genotyping if field time is insufficient for direct monitoring.