Chris McDaniel
11-11-01

Bighorn Sheep of Big Creek

The bighorn sheep population of Big Creek has undergone dramatic changes in the last fifteen years. The population reached record numbers in the mid-to-late Eighties but was then devastated through rounds of *Pasturella* die-offs in the late-Eighties and early 90's. These events were remarkably well documented, despite the remote locality of the heard, by many dedicated biologists and researchers in the region. By the late-Nineties however, Idaho Fish and Game pocketbooks were being pinched which resulted in cut-backs on winter-range counts and other bighorn sheep related projects in the drainage. During this time, population data was only sporadically collected. In 2001 however, thanks to help from FNAWS, the University of Idaho, and the Idaho Department of Fish and Game (IDFG) intensive monitoring of the Big Creek herd was resumed for the critical lambing and summer range migration periods.

The Big Creek drainage is approximately 40 miles long, flows east-west, and is located almost directly in the center of the 2.3 million acre Frank Church- River of No Return Wilderness. This tributary of the Middle Fork of the Salmon River is home to many species of large mammals and incorporates a large amount of critical winter habitat for mule deer, elk, moose, wolves, cougars, and bighorn sheep.

Bighorn sheep have been a part of Central Idaho, and specifically the Big Creek drainage, since before there was recorded history. Sheepeater Indians wintered in lower Big Creek and relied on the plentiful bighorns to get them through the inhospitable Idaho winters. Early miners and settlers also utilized the sheep for the critical sustenance needed to eek out an existence in the harsh surroundings. Later, people from all over the country and world came, and still come, to Big Creek for the opportunity to hunt bighorn sheep with outfitters such as Jess Taylor or one of the many other renowned sheep guides that have guided in the drainage.

The Idaho Department of Fish and Game began flying annual population surveys of the Big Creek winter range in 1973. These surveys showed a steady population growth from about 60 individuals in 1973 to nearly 200 in 1989. These high numbers may have had a part in the devastating die-off from 1988-90 that drastically affected the herd well into the next century. Jim and Holly Akenson, managers of the University of Idaho's Taylor Ranch, located on the Big Creek winter range, took advantage of their proximity to the animals, and their interest in bighorn sheep stemming from Holly's masters thesis, initiated in 1985, looking at the "Spatial relationships and behavior of bighorn sheep sharing a winter range with mule deer and elk in central Idaho", to determine the processes and initial effects of the die-off on the sheep herd. By placing radio-collars on several sheep they were able to monitor the herd throughout the year and were able to determine lamb survival and recruitment. They found that even though initial birth-rates were high, averaging 76 lambs per 100 ewes, by the end of the summer lamb survival was only averaging 7 lambs per 100 ewes. *Pasturella* bacteria was successfully isolated from all of the tissue samples that were collected and analyzed suggesting that the mortality was occuring as a result of *Paturella* related pneumonia. Additionally, the Akensons located the primary lambing areas and documented the migration patterns of the Big Creek sheep herd.

Idaho Fish and Game budget crunches through the mid-nineties meant a reduction in aerial surveys and an overall lack of funding for major monitoring of the Big Creek sheep population. However, with the help of FNAWS and IDFG, Mrs. Becky Frey, working on her graduate research in the springs of 1999 and 2000, came into Big Creek to evaluate *Pasturella* virulence factors and predisposing factors for pneumonia in the Big Creek herd. Twelve of the fourteen sheep tested came up positive for a biovariant of the *Pasturella* species. This meant that even ten years after the initial die-off, almost 90% of the sheep in the population still carried a form of the bacteria. From this information Mrs. Frey suggested that the population is likely at risk for another die-off in the event of a high stress event such as a hard winter or viral infection.

During the summer of 2000 nearly XXXXX acres of the Frank Church-River of No Return Wilderness went up in smoke including a large portion of the Big Creek winter range. In addition to being interested in how the Big Creek population was doing ten years after the major die-offs and the benefits of long-term monitoring associated with such a study, it seemed to me to be a great opportunity to look at how, and if, the stress factors related to the fire would affect the sheep population during the first year. Again, with the help of FNAWS, IDFG and private research funding through the University of Idaho, I was able to monitor the Big Creek herd through the late spring and summer of 2001. Following protocols set up

during the Akenson's study in the late eighties, five radio-collared ewes were monitored every other week from the air. Time in-between flights was spent monitoring the collared sheep and searching for other bighorn groups from the ground. A combined total of 102 ewes, 76 lambs, 30 yearlings and 19 rams were observed in the three distinct lambing areas used by the Big Creek population, between May 20, 2001 and August 10, 2001. This represents multiple observations of some individuals on several occasions including the five radio-collard ewes. When the summer is split into the three time periods relating to critical occasions in lamb development (birthing, weaning, and post-wean), the results are quite amazing especially when compared with similar data from 1988-89. The "birthing" period, meant to capture the initial birthing rate of the ewes, showed over 90% of observed ewes gave birth to a lamb. This is similar to the average of 85% during the die-off years. Were the numbers start to dramatically differ is during the "weaning" period, that time from birth, during which the lambs heavily nurse, until the lambs are around 6 weeks old. The summer 2001 data shows a lamb:ewe ratio averaging 88:100 during this time period compared to an average of only 25:100 from 1988-89. The "post-wean" period is the time after which the lambs are no longer relying on their mothers milk for nutrition and in aiding in immune response, and are thus more likely to succumb to disease. During this time the Big Creek population showed only a slight decline in lamb numbers during 2001, with an average of 82% of ewes still having a lamb accompanying them by the end of the study. When this is compared to an average of less than 15% during the die-off years, it becomes apparent how well the current Big Creek population did last summer. It should also be noted that all five of the collared ewes successfully reared a lamb through the completion of the 2001 study, compared to only 1 out of 5 in 1988 and 0 out of 10 in 1989.

While these are only primary results, it is obvious that this population did quite well last summer and it will be exciting to see how they fare over the next year(s). Obviously, the Big Creek population has not had, nor could support, many years with 80+% recruitment. Lamb mortality is occurring sometime else besides the summer as late-winter counts still show the herd maintaining a lamb:ewe ratio somewhere around 30:100. This data does show that summer, *Pasturell-* related mortality is not a factor in the Big Creek bighorn sheep population at this time. While the data also does not show any significant affect from fire stress, there are several possible explanations for this including: an easy previous winter or a slight lag in population response to environmental factors. The potential knowledge to be gained, not only on the long-term affects of *Pasturella* die-offs, but also, on the effects of large-scale stressors promoting *Pasturella* out-breaks, has tremendous implications in bighorn sheep biology and future management.

Lamb Production and Survival in Lambing Areas and Summer Ranges of a Bighorn Sheep Population Wintering on Big Creek in Central Idaho

Author:
Christopher S. McDaniel
330 S. Asbury #2
Moscow, ID 83611.
(208) 882-7447

Undergraduate
University of Idaho
College of Natural Resources
Dept. of: Conservation Biology

January 1, 2002

Lamb Production and Survival in Lambing Areas and Summer Ranges of a Bighorn Sheep Population Wintering on Big Creek in Central Idaho

Christopher S. McDaniel, Undergraduate, Conservation Biology, University of Idaho. 330 S. Asbury #2. Moscow ID, 83843. E-mail: wldtrky1@hotmail.com

Abstract:

Long-term monitoring of wilderness populations allows biologists to establish baseline data that can be compared against extensively managed populations. Long-term monitoring allows for data analysis over long time periods and allows biologists to establish predictive management strategies. The Rocky Mountain bighorn sheep (Ovis Canadensis) population in the Big Creek drainage of the Frank Church-River of No Return Wilderness in Central Idaho experienced a sudden and dramatic population decline from 1988 to 1990 as a result of a *Pasteurella* spp. related die-off. Extensive monitoring of the population during that period provided information on lamb production and survival during the die-off phase of a *Pasturella* die-off. After ten years of minimal monitoring a survey of lamb production and survival was conducted on the Big Creek population during the summer of 2001 to assess the recovery stage of the die-off. Average number of lambs:100 ewes was established for three different lambing areas across three different time periods. These were compared to similar data collected during the summers of 1989 and 1990. Chi-square analysis of the data showed significant differences between total die-off and 2001 ratios ($p < .001$) but not between lambing areas in each of the die-off and 2001 periods ($p \geq 1$, $p \geq 1$, respectively). Results show a high survival ratio through the beginning of August, 2001(avg. 86:100) compared with a significantly lower ratio in August, 1989 (avg. 19:100) and August, 1990 (avg. 12:100)

INTRODUCTION AND JUSTIFICATION

Wilderness areas provide wildlife managers with a natural laboratory to accumulate data for baseline models of population dynamics with which to compare intensively managed herds (Hendee et al.1990). The Big Creek bighorn sheep (*Ovis canadensis*) population, located in the Frank Church Wilderness of Central Idaho, offers a unique opportunity for biologists to collect information on the natural history and population dynamics of wildlife living in a "pristine" environment where predation and mortality rates are similar to those experienced throughout the sheep's evolutionary history. Smith (1954) states "it is essential that management objectives for a species as scarce as mountain sheep provide for the continuing collection and interpretation of basic data against a possible time when all our knowledge and ingenuity may be required to maintain the species." Further observation of natural history and long term ecological monitoring is necessary for scientists to develop a more complete understanding of bighorn sheep population dynamics.

Central Idaho bighorn sheep populations experienced dramatic and sudden population losses in several major herds between 1988 and 1990 caused by outbreaks of various serotypes of the *Pasturella* bacteria (Frey 2001, Drew et al. 2000). *Pasturella* related mortality significantly affected the Big Creek sheep population, located on the Big Creek drainage of the Middle Fork of the Salmon River (Drew et al.2000). Sheep densities were at a peak prior to the outbreak (~ 200 individuals with a 43:100 average lamb:ewe ratio between 1973 and 1982), however, aerial and ground sightings in 1989 showed only 130 individuals with a 14:100 lambs:ewe ratio (Akenson and Akenson 1991, 1992).

During the springs of 1989 and 1990, Jim and Holly Akenson, managers of Taylor Ranch on Big Creek, along with the Idaho Department of Fish and Game, placed collars on 12 bighorn ewes on the Big Creek winter range (Akenson pers. comm. 2001). Through radio telemetry monitoring, the Akensons located lambing areas utilized by the Big Creek population and assessed lamb production and survival (Akenson and Akenson 1992). Sheep movements were monitored over two lambing seasons and lamb numbers, birth dates and locations were recorded. Recruitment was monitored throughout the early spring and summer. Results showed high initial birth rate and survival (76:100) but low post weaning survival (7:100) (Akenson and Akenson 1991). This suggested that early summer mortality was the cause of low spring lamb:ewe ratios as opposed to low lamb production. Tissue samples from dead ewes and lambs tested positive for several strains of hemolytic *Pasteurella* bacteria in this population, indicating early summer lamb mortality was likely a result of lambs succumbing to pneumonia as a caused by a *Pasturella* infection (Akenson and Akenson 1992). Akenson and Akenson (1991) suggested that factors, such as stress related to overutilization of habitat, interspecific and intraspecific competition, and weather, could lead to an increased susceptibility to *Pasturella* related pneumonia outbreaks, and result in increased mortality.

Currently, central Idaho sheep populations are still recovering from the die-off, despite a 50% reduction in sheep densities over most of the range and favorable weather conditions throughout the 1990's (Drew et al. 2000). Sightability flights of the Big Creek winter range have been sporadic through the 90's and bighorn sheep population dynamics are only speculative during that period. However, flights in the spring of 2000 estimated the Big Creek sheep population at 130 individuals, below the estimated 200 in 1989 (Drew et al. 2000, Akenson and Akenson, 1991). Aerial counts also indicated a lamb:ewe ratio of 23:100 which is consistent with ratios noted by winter field crews at the Taylor Ranch from 1998 to 2001 (Drew et al. 2000, Akenson et al. 2001). These ratios are still

below estimated heard maintenance level of 30 lambs per 100 ewes, and below the historic ratios noted from 1973 to 1982 (Drew et al. 2000, Akenson and Akenson 1992).

During the summers of 1999 and 2000, interns at the Taylor Ranch monitored the Cliff Creek lambing area both visually, and with radio telemetry. No ewes or lambs were located nor was evidence of bighorn sheep use found.

Study Area

For this study, the same population of sheep that were studied by Akenson and Akenson from 1989-90 was monitored. Study areas were located within the 920,000 ha Frank Church River of No Return Wilderness Area, situated in central Idaho. This population is primarily located in Idaho game management unit 26 and congregates yearly on the winter range in the lower 20km of the Big Creek drainage, a tributary of the Middle Fork of the Salmon River. The Big Creek herd used three distinct lambing areas that included several natal areas within each. The Big Creek lambing area was made up of the Cliff Creek drainage, the Big Creek Gorge and West Lobar Basin areas. The Red Ridge lambing area consisted of Dynamite Creek and Big Cottonwood Creek in the Marble Creek Drainage. In the West Fork of Monumental Creek lambing area, sheep lambed the Snowslide and West Fork of Monumental Creek drainages (see appendix 1 for map). Although all sites vary in elevation (from 1,300 m to 1,900 m for sites in the Big Cr. area, and between 2050 m to 2450 m for sites in the Red Ridge and Monumental areas.) and size (from 50 acres to 300 acres), all the sites are physically similar with open, steep, rocky terrain with southern aspects and large cliff structures. All sites are sparsely vegetated featuring Mountain Mahogany (*Carcocarpus ledifolius)* and commonly contain one or more of the following: Bluebunch Wheatgrass (*Agropyron spicatum),* Idaho

ratios in year (X) by ratios in year (X + 1). Comparisons of lamb ewe counts between lambing periods and lambing sites were made.

Lamb and ewe counts made during post weaning time periods for all lambing sites were used to compare lamb and ewe counts between study years. A chi-square was used to determine significant difference between comparisons.

Results

2001 Production and Survival

Survival coefficients were determined for the Big Creek bighorn sheep population between lambing periods (Birth, Wean, and Post) and study years (1989, 1990, 2001). These are presented in table1. As initial survival is a result of production, this was used as an indicator of production.

Table 1:Big Creek population bighorn sheep lamb survival derived from average lamb:ewe ratios.

1989	Time Period	AVG.	S.D.	SE I	Survival	SE Sur	CI Sur +	CI Sur -	CI +	CI -
Big Creek	BIRTH	49.30	15.59	11.02	0.00	0.00			71.35	27.25
	WEAN	20.50	10.25	7.25	0.42	25.84	52.10	-51.26	35.00	6.00
	POST	18.50	13.08	9.25	0.90	23.33	47.57	-45.76	37.00	0.00

1990	Time Period	AVG.	S.D.	SE I	Survival	SE Sur	CI Sur +	CI Sur -	CI +	CI -
Big Creek	BIRTH	57.50	21.73	15.37	0.00	0.00			88.24	26.76
	WEAN	19.00	7.18	5.08	0.33	28.91	58.16	-57.50	29.16	8.84
	POST	38.92	38.92	27.52	2.05	46.10	94.25	-90.16	93.96	-16.12
Red Ridge	BIRTH	73.60	32.91	23.27	0.00	0.00			120.15	27.05
	WEAN	33.50	11.84	8.38	0.46	44.76	89.97	-89.06	50.25	16.75
	POST	6.30	3.64	2.57	0.19	15.48	31.15	-30.77	11.44	1.16
Monumental	BIRTH	53.30	30.77	21.76	0.00	0.00			96.82	9.78
	WEAN	42.50	21.25	15.03	0.80	52.02	104.84	-103.25	72.55	12.45
	POST	10.00	7.07	5.00	0.24	28.32	56.88	-56.41	20.00	0.00

2001	Time Period	AVG.	S.D.	SE I	Survival	SE Sur	CI Sur +	CI Sur -	CI +	CI -
Big Creek	BIRTH	50.00	70.71	50.00					150.00	-50.00
	WEAN	100.00	0.00	0.00	2.00	50.00	102.00	-98.00	100.00	100.00
	POST	75.00	0.00	0.00	0.75	0.00	0.75	0.75	75.00	75.00
Red Ridge	BIRTH	16.50	11.67	8.25	0.00	0.00			33.00	0.00
	WEAN	79.30	45.78	32.37	4.81	57.45	119.71	-110.10	144.05	14.55
	POST	93.00	65.76	46.50	1.17	111.54	224.26	-221.92	186.00	0.00
Monumental	BIRTH	0.00	0.00	0.00	0.00	0.00			0.00	0.00
	WEAN	50.00	35.36	25.00		35.36			100.00	0.00
	POST	83.75	41.88	29.61	1.68	77.23	156.14	-152.79	142.97	24.53

Attempts at comparing lamb survival between lambing periods in 2001 ultimately failed as observed average lamb:ewe ratios increased at each lambing period (Appendix 2). An assumption of this study was that observed lamb:ewe ratios were representative of the entire population. However, if this were true, observed ratios would be expected to remain constant or decline during the birth and weaning time periods due to factors such as disease, exposure, and predation, post-parturition. As can be seen in Table 1, survival coefficients are >1 and represent an increasing survival between periods. This could be falsely interpreted as birthing activity occurring throughout the summer. Skewed confidence intervals surrounding the estimates and standard errors suggest that these observations are not precise enough to be useful to this study. There are several possible explanations for the increasing ratio. Ewes with newborn lambs are anti-social and remain secluded for several days to several weeks post-parturition. This can lead to decreased detection rates in aerial and ground based surveys. Smaller overall population size, limited field crew, and limited aerial survey budget in 2001 may have also lead to a decreased detection rate from that in 1989-90. For this data, lamb ratios at the post-wean time period are considered the most

accurate for comparisons between years and are therefore the only ones that were used for data analysis.

2001 vs. 1989-90

The use of chi-square analysis allows the comparison of the two bighorn populations across time. Lamb and ewe counts did not differ significantly between lambing sites for 1990 and 2001 ($p \geq 1$) (Table 2). Chi-square comparisons of lamb and ewe counts between 1989, 1990 and 2001 did not differ for the Big Creek lambing site. However, counts between 1990 and 2001 for the Monumental and Red Ridge lambing sites were significantly different ($p = 0.25$, $p \leq 0.001$ respectively) with a higher relative number of lambs being observed in 2001. The total counts for all areas in 1990 were significantly lower than total area counts in 2001 ($p \leq .001$).

Table 2. Comparison of lamb:ewe counts between study years and lambing sites using Chi-square analysis.

Chi-Square Analysis

	1990		2001	p – value
BC	X	vs	x	≥1
RR	X	vs	x	= .025
MON	X	vs	x	≤ .001
Total	X	vs	x	≤ .001

Chi-square analysis of survival data indicates no significant difference in lamb:ewe ratios among sites in 1990 and 2001. This could be due to physiological and geographical similarities such as: habitat, forage quality and quantity, climatological events, and pathogen exposure, for the population in each year.

Significant differences were detected in lamb survival between the die-off year (1990) and 2001 and across all sites except the Big Creek lambing area. A small sample size in the Big Creek lambing area in 1990 (N= 3ewes, 1lamb) may have skewed the results. When the total average lamb:ewe ratio for 1990 is compared to the average lamb:ewe ratio for 2001 a significant difference was established. This difference helps to reaffirm the conclusion that the 2001 Big Creek population was not experiencing a late summer die-off as was seen in the population in 1989-90.

Collared Sheep

Four of the five ewes that were collared in the springs of 1999 and 2000 gave birth to lambs in the spring of 2001. The fifth ewe's collar went dead within the first two weeks of the study and was not seen for the remainder of the study. Two collared ewes (.038, and .836) stayed in the Big Creek lambing area and lambed in the cliff structure in Cliff Creek between May 24 and June 5. One ewe (.110) gave birth at a newly established site in the Monumental lambing area in Snowslide Creek prior to June 14 . The final ewe (.380) gave birth in the Red Ridge lambing area, in Big Cottonwood Creek, between June 3 and June 9.

All four collared ewes successfully reared their lambs through the conclusion of the study on August 10, 2001. Assuming that these sheep were randomly collared and accurately represent some fraction of the total population, the fact that all four collared sheep successfully reared a lamb through the study period is an good indicator that lamb survival and recruitment were likely to be high during this period. When compared with the survival of only 1 lamb out of 5 born to collared ewes in 1989 and 0 out of 10 in 1990

it becomes apparent that the bighorn sheep in the Big Creek population in 2001 are not experiencing a similar die-off pattern to the population in 1989-90.

As of August 10, 2001 only three of the initial five collared sheep still had functional collars. .390 went dead around June 10, .038 went dead on August 3. As all of these sheep were collared within a year of each other, it is likely that the other collars are likely reaching the end of their functional life as well. This suggests that if future monitoring is to occur, additional ewes will need to be collared/re-collared first.

Usage Shift

Contrary to previous years experience, two of the five collared bighorn ewes and likely at least one other non-collared ewe, utilized the Cliff Creek lambing structures in the Big Creek lambing area during the summer of 2001. The increased observations may be due to more intensive monitoring regimes of the lambing area or the possibility that the ewes did not utilize the lambing area for multiple years due to poor habitat quality, or lack of fertility of ewes staying in the Big Creek lambing area. It would be interesting to start long term monitoring of the forage quality in the different lambing areas utilized by the Big Creek population and correlate this with trends in use of the lambing areas.

Intensive monitoring of the Big Creek Gorge and West Lobar lambing sites in the Big Creek lambing area, throughout the summer, did not reveal lambing activity occurring at either site. However, the habitat around West Lobar basin was extensively used, by the two collared sheep that lambed in the Cliff Creek site, during the mid and late summer. Bighorn sheep habitat around the Big Creek Gorge lambing site was extensively burned during the summer of 2000 and this likely affected the lambing use in

2001. Future monitoring would be useful to determine length of time, if ever, to its reestablishment as a lambing area.

One new lambing site was documented within a previously established lambing area. The new site is in the Snowslide Cr. drainage, approximately four miles from its mouth at Monumental Creek (See Appendix I). The new site is in the cliff structures on the north side of the drainage and matches characteristics typical of the previously described lambing structures utilized by the Big Creek population. The new site is included in the West fork of Monumental lambing area as ewes known to lamb in Snowslide Cr. later grouped with ewes from the North fork of the West fork of Monumental lambing sites and spent the remainder of the summer on the Monumental summer range.

It is interesting to note that two of the four collared ewes stayed in the summer ranges associated with their lambing areas. The two exceptions were the ewes that gave birth in the Big Creek lambing area. The pair did remain on the Big Creek summer range until late July and then made a sudden migration to the Monumental summer range. It is unknown, but a difference in forage quality during the late summer may have played a role in the shift. Also, another previously undocumented herd of bighorn sheep showed up on the Big Creek summer range immediately prior to the migration of the two ewes and their lambs to the Monumental summer range and interspecific competition may have also been a factor in the sudden migration.

The arrival of the undocumented herd toward the end of the summer further aroused suspicion that there is still an unknown lambing area being utilized by individuals in the Big Creek population. Unconfirmed sightings from the air suggest that

there is a possibility lambing activity occurring somewhere on Sheep Mountain near the mouth of Rush Creek (see appendix I).

Mortality

Despite constant, intensive, monitoring efforts, bighorn sheep lamb mortality was not directly observed during the summer of 2001. High lamb:ewe ratios maintained throughout the summer suggest low overall summer lamb mortality which meant that there were fewer carcasses to be detected. However, it is critical to realize that lamb mortality is still occurring in this population. Late-winter counts show the Big Creek population maintaining a lamb:ewe ratio somewhere around 30:100. This research shows only that summer, *Pasteurella* related, mortality does not appear to be a factor in the Big Creek bighorn sheep population at this time. However, mortality must be occurring during a different part of the year. Year-long monitoring is needed to fully address this issue.

CONCLUSION

Monitoring of the Big Creek population of bighorn sheep during the summer of 2001 revealed high late-summer lamb:ewe ratios across the whole population and high survival of known ewes and lambs. Both of these suggest that the population is not suffering from the early-summer, *Pasteurella spp.* related, lamb mortality that occurred during the summers of 1989 and 1990. Using chi-square analysis of the data it was possible to quantify the differences between the two time periods and show that it is significant.

Analysis of the possible usage shift away from lambing areas did not reveal any conclusive trends. Some sites within lambing areas saw an increase in use while others did not. The discovery of one previously undocumented site and the evidence that another site likely exists, reveals that there are still critical gaps in the baseline knowledge of this population that need to be filled before conclusive analysis can be made.

The principal conclusion that was revealed through the monitoring in 2001 is that there was high lamb survival through the summer indicating that the population is doing well, at least during this period. Continued long-term monitoring of this population is needed before the dynamics of this population can truly be understood.

Recommendations

At a minimum, the maintenance of current monitoring practices is necessary for the continued establishment of baseline data. Factors that need to be examined in the future include: Monitoring of sheep throughout the year to determine when lamb mortality is actually occurring and what factors are associated with it. Monitoring of forage quality/quantity differences at each of the lambing areas and summer ranges. Increasing the quantity, and monitoring frequency, of collared sheep in the population to replace dead/dying collars and to help determine definite locations of all lambing sites associated with the Big Creek bighorn sheep population.

Additional areas that warrant further investigation include: Determining effects of environmental stress during the previous winter on lamb recruitment. Determining effects of year-round precipitation on bighorn lamb survival and population trends. Determining effects of time-lags on population response to environmental factors, such as the 2000 fire, and the nutrition and predation factors that may be involved with those responses.

Acknowledgments

This project was financed by: the Idaho Chapter of The Foundation for North American Wild Sheep, the Idaho Department of Fish and Game and the DeVlieg Wilderness research grant through the University of Idaho. I appreciate the University of Idaho for letting me base out of the Taylor Ranch Field Station. Special thanks go to: Jeff Rholman for working hard to find financial support for me; Ray Arnold for making travel and telemetry flights safe and productive; Carol Arnold for keeping Ray on track and taking care of all the little details that keep every thing running smoothly; Taylor Summer Crew 2001: Jeremy Kliensmith, Josh Holloway, Sam Cooney, Dave Speten, Andrea Bristol, and Ken Hobson, for being my eyes when away from the ranch and for giving me physical and mental support in the field; Dr. Jim Peek, and Dr. Janet Rachlow, for technical advising on this project. Dr. Al Ward for tracking down needed supplies; and last but far from least, Jim and Holly Akenson, for planting the seed that became this project, for advising and technical support from the beginning, plus a million other things that I will be forever grateful, but especially for always supporting and believing in me and my abilities despite the obstacles.

Literature Cited

Akenson, H.A., J.J. Akenson, and Var. Taylor Ranch employees. 2001, 2000, 1999, 1998. Wildlife Sightings Diary and Field Notes. Unpublished. On file at the University of Idaho's Taylor Ranch Field Station, Idaho.

Akenson, H.A. 1998. Predicting summer lamb mortality in free ranging bighorn sheep. Bienn. Symp. Northern Wild Sheep and Goat Counc. 11: 70-76

Akenson, H.A. and J. J. Akenson. 1992. Bighorn sheep movements and summer lamb mortality in central Idaho. Bienn. Symp. Northern Wild Sheep and Goat Counc. 8:14-27

Akenson, H. A. and J.J. Akenson.1991. Herd Composition and Movements in lambing areas and summer ranges of Big Creek sheep in central Idaho. Report to Idaho Department of Fish and Game. 28pp.

Drew, M.L., J.J. England, L. Kuck, M.D. Scott, D. Toweill, A. Ward. 2000. Distribution and prevalence of Disease agents in central Idaho bighorn sheep and their relationship to lamb recruitment. Caine Veterinary Teaching Center/ Idaho Department of Fish and Game Project proposal. 12pp.

Frey, B. 2001. Heard Health and Habitat Quality in Relationships to *Pasturella* species Induced Pneumonia in Rocky Mountain Bighorn Sheep. M.S. Thesis. University of Idaho.

Geist,V. 1971. Mountain Sheep; a Study in Behavior and Evolution. Chicago: University of Chicago Press. 383pp.

Hindee, J.C., G.H. Stankey, R.C. Lucas. 1990. Wilderness Management. Golden: North American Press. 546pp.

Smith, D.R. 1954. The bighorn sheep in Idaho: its status, life history and management. Wildlife Bulletin No.1. published by the State of Idaho.154pp.

Fescue (*Festuca idahoensis),*Cheatgrass (*Bromus tectorum),* Big Sagebrush (*Artemisia tridentata),* scrub Juniper (*Juniperus communis),* Douglas-Fir (*Pseudotsuga menziesii),* and Ponderosa Pine (*Pinus ponderosa*). A variety of hardy, xeric forb species are also found on these sites such as Western Yarrow (*Achillea millifolium*) and Arrowleaf Balsamroot (*Balsamorhiza sagitata*).

Summer ranges have been identified for each of the distinct herds. The sheep from the lower Big Creek sites have summer ranges located within or adjacent to the Cliff Creek winter range. Sheep in the Red Ridge lambing areas move to high alpine basins (3000 m) at the heads of Big Cottonwood Cr.,and Dynamite Cr. Sheep in the West Fork of Monumental Cr., and Snowslide Cr. lambing areas, summer in the high elevation basins where the heads of the two drainages meet near the Catherine Lakes. It should be noted that movement between summer ranges is known to occur.

OBJECTIVES

The objectives of this study were to: 1) Determine the 2001production and survival among the lambing areas and summer ranges of the bighorn sheep population that use the Big Creek winter range near Cliff Creek. 2) To compare 2001 survival and production rates to die-off (1989-90) survival and production rates. 3) To determine the time of lamb mortality and the probable cause of that mortality. 4) To assess the possible usage shift away from previously determined lambing areas.

METHODS

Access to the Taylor Ranch was gained by the use a fixed wing airplane (Cessna 185). Access to Big Creek drainage study sites was accomplished by foot or stock and was initiated from the Taylor Ranch. Access to the Red Ridge and Monumental study

sites was gained by the use of a fixed wing airplane to travel to Cascade ID, then the use of a four-wheel-drive vehicle to travel from Cascade to Monumental Summit area, approximately 25 km east of the town of Yellowpine and approximately 115 km northeast of Cascade. The remainder of the journey to the Red Ridge and Monumental study sites took place on foot.

Using triangulation techniques, the locations of five collared bighorn ewes from the Big Creek population were monitored from the ground using a hand held receiver and antenna (Telonics TR-2, and antenna). Visual and telemetry monitoring of sheep from a fixed wing aircraft was conducted approximately every 10 days and immediately precluded all trips to the higher elevation study areas.

Each population of sheep was monitored according to a strict time schedule that corresponded with similar data collection dates from the Akenson's study to maximize correlation of data between studies. Once a band of sheep was located from either the air or the ground, a vantage point for maximum visibility was obtained, trying to maintain minimum disturbance to the individuals in the group. From this vantage point, with the aid of binoculars and/or spotting scopes, the sheep were intensively observed and notes on composition of the herd including: age and sex of individuals(if determinable), and lamb:ewe ratios were recorded. Also, physiography of location/habitat, new lamb births, general and specific health conditions, habitat utilization and condition and general activities of the group were noted. A pre-established data collection form was filled out containing all of this information. Each location was recorded and transferred to a USGS topographic map for possible future analysis of home ranges. Protocols were established for documentation and recovery of bighorn sheep carcasses. These included: monitoring

for localized activity of scavengers, and looking for signs of maternal or herd stress related to lamb mortality (as outlined in Akenson 1998). Field necropsy/sampling techniques were established, with supplies provided by the Idaho State Veterinarian at the Caine Veterinary Teaching Center, in Caldwell, ID along with an agreement by Dr. Al Ward of Cain to perform analysis of any recovered carcasses. However, these protocols were never implemented as no mortality was encountered.

A detailed, notebook was kept with daily travels, activities and observations recorded. Along with all sheep related data, records were kept of encounters and population dynamics of other animal species such as the Rocky Mountain goat (*Oreamnos americanus),* black bear (*Ursus americanus),* mule deer (*Odocoileus hemionus),* Rocky Mountain elk (*Cervus elaphus)*, mountain lion (*Felis concolor*) and gray wolf (*Canis lupis*), for possible future scientific use. Fresh bighorn sheep fecal samples, for analysis for lungworm loads, were collected for possible future analysis. Vegetation samples from observed feedings, were also collected for possible future diet nutrition analysis.

Research was based out of the University of Idaho's Taylor Ranch Field Station located adjacent to the Big Creek winter range with base camps set up in various locations within the lambing areas. Nights in the field did not exceed 9 and were generally closer to 7. For safety, support, and educational purposes, when available, a minimum of two people were in the field at all times.

Production and survival data was analyzed using Chi-Square to compare lamb survival across lambing areas and between study years. Lamb and ewe counts were categorized according to lambing site and lambing period with respect to weaning (birth, weaning, and post). Counts were made several times per period. The average lamb:ewe ratio per time period was used to calculate lamb survival between lambing periods and among lambing sites. Lamb survival coefficients were obtained by dividing lamb:ewe