Bienn. Symp. North. Wild Sheep
and Goat Counc. 9:51-55.

UTILITY OF SUMMER FIXED-WING AERIAL SURVEYS IN PREDICTING LAMB:EWE RATIOS OBSERVED ON WINTER RANGE

LYNN R. IRBY, Biology Department, Montana State University, Bozeman, MT 59717

Abstract: I investigated the efficacy of using fixed-wing aircraft to survey sheep during the summers of 1984 - 1990 in southwestern Montana. The area surveyed served as summer range for 150-300 sheep which occupied at least 3 distinct winter ranges. Observations on 9 summer surveys were used to calculate lamb:ewe ratios for individual winter ranges and an overall lamb:ewe ratio. These values were compared to lamb:ewe ratios developed from winter ground surveys for individual winter ranges and for all winter ranges combined. Even with moderately detailed information on summer distribution from radio telemetry studies, the information I collected in summer did not adequately predict sheep numbers or lamb:ewe ratios on winter ranges following the summer aerial surveys. The funds I spent on these surveys could have been better spent on other activities.

Managers of bighorn sheep (*Ovis canadensis*) populations traditionally have relied on lamb:ewe ratios to forecast population trends and/or relative herd health (Geist 1971). Jorgenson (1992) and Festa-Bianchet (1992) suggest that lamb:ewe ratios have limited predictive utility, but this index may be the only readily attainable value for assessing the status of some herds. In the northern Rocky Mountains, sheep tend to congregate on predictable wintering areas where the ages and sexes of sheep can be ascertained relatively easily. If lower than "normal" lamb:ewe ratios indicate potential problems, most managers would prefer to know this before winter. In areas with low density sheep herds dispersed over inaccessible terrain, options for summer monitoring are limited to periodic ground sampling, helicopter surveys, or fixed-wing surveys. The fixed-wing survey would be the most desirable of these options from the standpoint of manhours and rental costs if valid estimates of lamb production could be made.

I tested the efficacy of using lamb to ewe ratios derived from sheep classified on fixed-wing summer flights as predictors of winter lamb:ewe ratios for several herds in the upper Yellowstone River Valley of Montana. These herds include sheep wintering along the Yellowstone River at Cinnabar Mountain (CM) and Point of Rocks (PR) and small bands wintering at high (2000-3000 m) elevations in the Gallatin Range above an area known as the Tom Miner Basin (TM). These winter ranges are used by sheep which summer over an area of approximately 400 km^2. The total population within this area differed from approximately 150-300 individuals during 1984-90. The tests involved variants of the null hypothesis of "no relationship between summer and winter lamb:ewe ratios" for bands associated with specific winter ranges and for all winter ranges combined.

Funding for flights was provided by the Boone and Crockett Club and the Montana Department of Fish, Wildlife, and Parks. Ground survey data were collected by a number of people including: K. Alt, S. Geymer, T. Lemke, J. Swenson, and the participants in the annual interagency sheep count. Thank you.

METHODS

Summer movement patterns for ewe bands in the upper Yellowstone area were identified using radio telemetry in 1978-84 (Keating 1982, Irby et al. 1986). From 1984 - 1990, 9 summer flights were made in July or August to classify sheep in summering areas identified via radio telemetry. One flight per summer was scheduled for 5 of the years and 2 flights per year were made in 1985 and 1989. During each flight, a Piper Supercub was flown at the lowest elevations permitted by wind conditions on the day of the flight. The pilot and the observer attempted to classify all sheep sighted (lambs, ewes, males with less than 3/4-curl horns, males with >3/4-curl horns). Sheep that were identified as females and lambs were used to calculate lamb:ewe ratios.

Lamb:ewe ratios for summer areas used by sheep from specific winter ranges were compared to lamb:ewe ratios obtained the following winter using paired t-tests (H_o:no difference between summer and winter lamb:ewe ratios for specific herds and for all herds in the area) and regression analysis (H_o: no predictive relationship between lamb:ewe ratios observed in summer and those observed in winter for specific herds and for all herds). A 2-factor regression analysis (winter lamb:ewe ratios = mean + summer range lamb:ewe ratio effect + the effect of summer sample size [indexed as the minimum number of individual ewes observed in summer divided by the minimum number of individual ewes observed in winter multiplied by 100] + error) was used to determine if predictability was influenced by the sample size used to calculate summer lamb:ewe ratios. Summer ratios frequently were based on smaller sample sizes than those obtained in winter because of the dispersed distribution of sheep in summer. All statistical tests were run on MSUSTAT (Lund 1989).

High variability associated with ratios calculated from small samples can obscure general trends; therefore, I placed lamb:ewe ratios in general productivity classes (0-30% = poor production; 30-50% fair production; >50% = good production) and compared summer and winter classifications.

RESULTS

Nine flights yielded total counts of 31-127 sheep (Table 1). These values included 25-88% of the total number of ewes on which overall winter lamb:ewe ratios were based. The paired flights in 1985 and 1989 were used to develop a combined "best" estimate (including groups missed in one flight but seen in the other) for tests (Fig. 1).

Paired t-tests (using the single "best" estimates for 1985 and 1989) indicated that lamb:ewe ratios in summer tended to be higher than in winter, but no differences were significant at $\underline{P} < 0.05$ (CM: t = 1.79, $\underline{P}$ = 0.13; TM: t = 2.16, $\underline{P}$ = 0.10; PR: t = 0.49, $\underline{P}$ = 0.64; Overall: t = 1.94, $\underline{P}$ = 0.10).

The value of summer lamb:ewe ratios in predicting winter lamb:ewe ratios was low for CM (R^2 = 0.09, $\underline{P}$ = 0.55), TM (R^2 = 0.01, $\underline{P}$ = 0.85), PR (R^2 = 0.16, $\underline{P}$ = 0.37), and overall (R^2 = 0.28, $\underline{P}$ = 0.22). Adjusting the regression for the number of ewes that were used to calculate summer lamb to ewe ratios via a 2-factor regression did not improve the predictive values of models (R^2 range = 0.14 to 0.38; $\underline{P}$ range = 0.38 to 0.80). There was also no predictive relationship between total number of sheep sighted on summer aerial surveys and the minimum population estimates based on ground observations the following winter (R^2 range = 0.03 to 0.19; $\underline{P}$ range = 0.37 to 0.75).

When production based on lamb:ewe ratios was arbitrarily classified as poor, medium, or good, summer classifications agreed with winter classifications in 3 of 6 years for the CM herd, 1 of 5 years for the TM herd, 4 of 7 years for the PR herd, and 4 of 7 years for all herds combined.

DISCUSSION

Low intensity aerial surveys during mid summer using fixed-wing aircraft did not prove to be an accurate means of predicting lamb:ewe ratios during the following winter for bighorn herds in the upper Yellowstone River valley. The failure presumably was due to inadequate sample sizes. Sheep on summer ranges in this area are widely dispersed at low densities and do not hesitate to use timbered habitat types. When these factors are combined with high winds that preclude low elevation searches in many areas, results tend to be poor. Knowledge on distribution of sheep gained from radio telemetry studies helped identify search areas but did not insure consistent sighting of sheep.

Biological uses of the data collected during summer aerial surveys during 1984-90 were limited. The data suggest that poor recruitment in bighorn herds in the upper Yellowstone area was not due to lamb mortality in late summer or early autumn. Winter lamb:ewe ratios tended to be lower than mid summer ratios, but differences were inconsistent and too small to explain the low proportion of adult ewes that brought lambs to winter ranges.

Lamb:ewe ratios on winter ranges in the study area during the 1970's were generally high (Keating 1982) indicating that these sheep ranges were capable of sustaining higher productivity. Several factors that were prevalent in the upper Yellowstone area during the 1980's have been reported in the literature (Woodgerd 1964, Stelfox 1976, Lawson and Johnson 1982, Festa-Bianchet 1988, Dunbar 1992) as explanations for a pattern of low lamb:ewe ratios by mid summer. During the 1980's, the age structure of females became progressively skewed towards old ewes; drought, fires, and high elk (*Cervus elaphus*) numbers could have contributed to nutritional stress; blood and

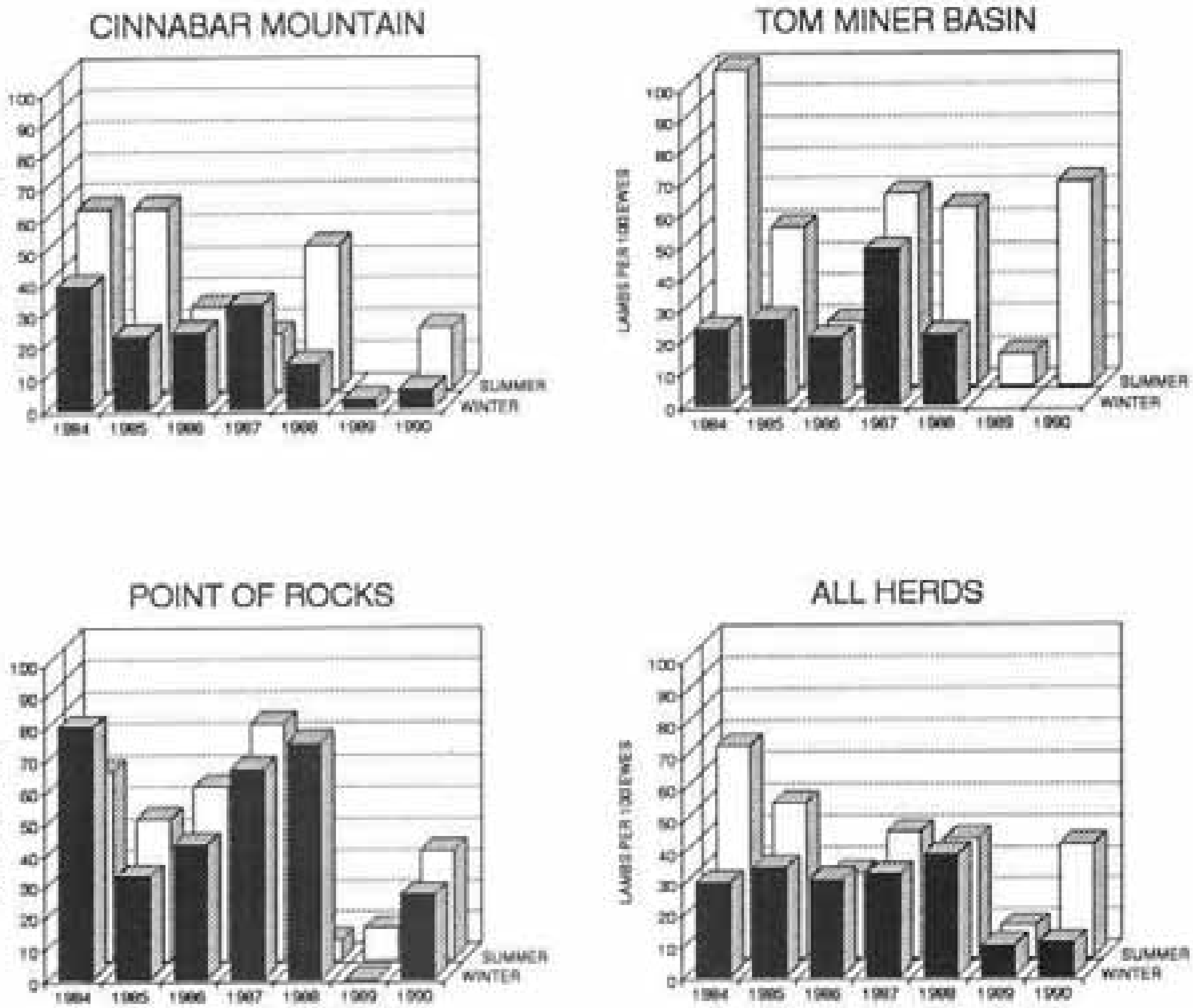

Figure 1. Summer and winter lamb to ewe ratios for Cinnabar Mountain, Tom Miner Basin, Point of Rocks, and all herds combined, 1984 - 1990.

Table 1. Summer and winter counts used to develop lamb:ewe (L:E) ratios.

	Summer				Winter			
Survey Date	Ewe	Lamb	Total	L:E	Ewe	Lamb	Total	L:E
Cinnabar Mountain (CM)								
10 July 84	7	4	13	57	40	8	71	20
19 July 85	7	0	15	0	44	18	83	41
18 August 85	6	4	23	67	44	18	83	41
21 July 86	31	8	39	26	46	15	93	33
28 July 87	23	4	27	17	47	9	80	19
19 July 88	22	10	32	45	44	17	89	39
26 July 89					30	4	47	13
27 July 89					30	4	47	13
15 July 90	16	3	20	19	34	2	60	6
Tom Miner (TM)								
10 July 84	3	3	10	100	21	5	47	24
19 July 85	14	7	26	50	26	7	54	27
18 August 85	0	0	7	0	26	7	54	27
21 July 86	35	7	57	20	28	6	45	21
28 July 87	5	3	12	60	37	18	69	49
19 July 88	23	13	36	56	9	2	15	22
26 July 89	6	0	15	0				
27 July 89	21	2	35	10				
15 July 90	11	7	21	64				
Point of Rocks (PR)								
10 July 84	5	3	14	60	10	8	27	80
19 July 85	0	0	36		15	5	30	33
18 August 85	22	10	32	45	15	5	30	33
21 July 86	11	6	27	55	14	6	32	43
28 July 87	12	9	22	75	3	2	12	67
19 July 88	18	1	19	6	4	3	13	75
26 July 89	10	0	16	0	8	0	18	0
27 July 89	2	1	8	50	8	0	18	0
15 July 90	23	8	31	35	11	3	22	
TOTAL								
10 July 84	15	10	37	67	71	21	145	30
19 July 85	21	7	44	33	85	30	167	35
18 August 85	28	14	62	50	85	30	167	35
21 July 86	77	21	127	27	88	27	170	31
28 July 87	40	16	61	40	87	29	161	33
19 July 88	63	24	87	38	57	22	117	39
26 July 89	16	0	31	0	38	4	65	10
27 July 89	23	3	43	13	38	4	65	10
15 July 90	50	18	74	36	45	5	82	11

fecal samples indicated chronic disease and parasite infections in the population (Worley, D., Montana Department of Fish, Wildlife, and Parks, pers. comm.) and falling prices for coyote (*Canis latrans*) pelts and restrictions on lion (*Felis concolor*) hunting could have resulted in increased predation. The fixed-wing surveys provided no insight into which, if any, of these factors were important.

In summary, unless you are flying for the thrill of low level mountain flying, save your money. Fixed-wing aircraft were not an effective means of sampling dispersed sheep populations in southwest Montana during summer, even when we had much more detailed information on summer distribution than is available for most sheep herds.

LITERATURE CITED

DUNBAR, M. R. 1992. Theoretical concepts of disease versus nutrition as primary factors in population regulation of wild sheep. Bienn. Symp. North. Wild Sheep and Goat Counc. 8:1174-192.

FESTA-BIANCHET, M. 1988. A pneumonia epizootic in bighorn sheep, with comments on preventive management. Bienn. Symp. North. Wild Sheep and Goat Counc. 6:66-76.

____. 1992. Use of age ratios to predict bighorn sheep population dynamics. Bienn. Symp. North. Wild Sheep and Goat Counc. 8:227-236.

GEIST, V. 1971. Mountain sheep: a study in behavior and evolution.Univ. Chicago Press, Chicago. 383pp.

IRBY, L. R., S. T. STEWART, AND J. E. SWENSON. 1986. Management of bighorn sheep to optimize hunter opportunity, trophy production, and availability for non-consumptive uses. Bienn. Symp. North. Wild Sheep and Goat Counc. 5:113-127.

JORGENSON, J. T. 1992. Seasonal changes in lamb:ewe ratios. Bienn. Symp. North. Wild Sheep and Goat Counc. 8:219-226.

KEATING, K. A. 1982. Population ecology of Rocky Mountain bighorn sheep in the upper Yellowstone River Drainage, Montana/Wyoming. M. S. Thesis, Montana State University, Bozeman. 79pp.

LAWSON, B. AND R. JOHNSON. 1982. Mountain sheep. Pages 1036-1055 in J. A. Chapman and G. A Feldhamer, (eds.). Wild mammals of North America: biology, management, and economics. Johns Hopkins University Press, Baltimore.

LUND, R. E. 1989. MSUSTAT statistical analysis package. Montana State University, Bozeman.

STELFOX, J. G. 1976. Range ecology of Rocky Mountain bighorn sheep in Canadian National Parks. Can. Wildl. Rep. Ser. 39. 50pp.

WOODGERD, W. 1964. Population dynamics of bighorn sheep on Wildhorse Island. J. Wildl. Manage. 28:381-391.