

THE EFFECTS OF TROPHY HUNTING ON DALL SHEEP RUT BEHAVIOR AND RAM  
SURVIVORSHIP IN ALASKA

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ABSTRACT

We conducted an investigation, 1981-84, into the possibility that the removal of larger-horned rams of Dall sheep (*Ovis dalli*) reduced the survival of younger rams due to their subsequent increased rut participation and also that this resulted in greater harassment of ewes during the rut. We hypothesized that a negative correlation between the numbers of  $\frac{2}{3}$ -curl rams and  $\frac{3}{4}$ -curl rams in a herd would suggest depressed survivorship of young rams from heavy removal of old rams. The sample included 17,657 sheep classified primarily from a helicopter, 1981-84, and 42,208 sheep classified from a Super Cub, 1962-84. The samples included data collected before 1979 when the Alaska curl regulation was  $\frac{2}{3}$  and after 1979 when the regulation became  $\frac{7}{8}$ -curl. There was no correlation between the number of  $\frac{2}{3}$ -curl rams and  $\frac{3}{4}$ -curl rams for the helicopter surveys ( $r = -0.18$ ,  $P = 0.38$ ), however, the relationship was positive but still not significant for the Super Cub surveys conducted where the  $\frac{3}{4}$ - and  $\frac{7}{8}$ -curl regulations applied, respectively ( $r = 0.21$ ,  $P = 0.29$ ;  $r = 0.12$ ,  $P = 0.57$ ). Three hunted mountain count units, however, two of which were in Wrangell-St. Elias National Preserve and Surprise Mountain on the Kenai Peninsula had less  $\frac{3}{4}$ -curl rams than expected (Chi-square = 10.03, d.f. = 1,  $P < 0.001$ ). In another four count units near Anak tuvuk Pass, ewe numbers increased only 2% four years after inclusion of the area into Gates of the Arctic National Park and protection from hunting, but young rams increased 20%, suggesting survival of young rams might have been depressed before protection.

Rut behavior was studied in two un hunted herds in Denali National Park in 1983 and 1984 and in a herd where nearly every  $\frac{7}{8}$ -curl and larger ram was removed every hunting season. Interaction time (interaction behavior per hour of observation) was not influenced by area (hunted versus un hunted), but was greater when an estrus ewe was present ( $F = 37.67$ , d.f. = 1,  $P = 0.0001$ ) and was greater in 1984 than 1983 ( $F = 28.35$ , d.f. = 1,  $P = 0.0001$ , 3-way Analysis of Variance with area, estrus, and year as treatments). Estrus ewes moved further per hour of observation in the hunted herd ( $F = 7.50$ , d.f. = 1,  $P = 0.006$ ). Ewes in the hunted herd moved about 3 times as far from the younger  $\frac{1}{2}$ - and  $\frac{5}{8}$ -curl rams than they did from those horn curl classes in the un hunted herd ( $F = 5.28$ , d.f. = 1,  $P < 0.03$ ). Ewes ran away more from courting rams in the hunted herd (43 run away responses per 100 behavior patterns by ewes in the hunted herd versus 27 in the un hunted herd). However, the increased ewe harassment was slight and no differences in reproductive performance were

detected. Lamb and yearling ratios did not differ during two years of data collection on the Denali National Park unhunted and nearby hunted areas, nor during 15 years on heavily-hunted Surprise Mountain versus the nearby Cooper Landing Closed Area. We propose that removal of older rams results in greater rut participation by young rams, but this participation results in depressed survivorship only in those cases where removal of large-horned rams included all 7/8-curl and most 3/4-curl rams.

## QUESTIONS AND ANSWERS

Jon Jorgenson, Alberta: Did you maybe see differences in the age at first breeding? Did you have any yearlings breeding, and if so, did you notice any difference between young rams and old rams as to what kind of interactions there were?

Francis Singer: yearling ewes breeding?

Jorgenson: yes

Singer: We did not see very much of that at all. We did see a 3/4 curl ram breed a yearling in the Park in the unhunted herd. However, Lyman Nichols had some limited rut observations for a couple of years in his study areas and he never saw it, and that was in the same area that he went in and collected four yearlings, three of them were pregnant. I believe he was doing the rut observation work at that same time. So there's a possibility that even when it happens you're not seeing it much.

Jorgenson: OK, so you're saying that you didn't see very much.

Singer: No, one case and it happened in the Park.

Jorgenson: OK, but what about even though the yearlings it appears didn't breed, was there a lot of behavioral activities directed towards them by the ram groups.

Singer: We did not see a difference in that between the two populations, but the one thing I'll emphasize again is that when we started the study we thought we had a classic hunted study area with no legal rams left. We found out later during both years, that was not the case. We also found no depressed ram survivorship in this hunted herd that we did the rut study in. So in other words these two populations, this hunter population does not fit Wayne's category of a highly disturbed population after all. The presence of just two or three 7/8 curled rams appear to effect things quite a bit. That's our impression. Just a small number of larger horned rams.

MANAGEMENT OF BIGHORN SHEEP TO OPTIMIZE HUNTER OPPORTUNITY,  
TROPHY PRODUCTION, AND AVAILABILITY FOR NONCONSUMPTIVE USES

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ABSTRACT

This paper describes management of Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) to optimize: 1) hunter opportunity, 2) trophy availability/quality, and 3) availability of sheep to nonconsumptive users in a single Montana hunting unit. This system involves hunting with unlimited permits and conservative annual quotas during September - early November and a limited number of permits for trophy hunts on a winter range heavily used by wildlife viewers and photographers. Relocations of 12 marked rams defined seasonal movement patterns for two major population segments within the hunting district. Marked rams from the Cinnabar Mountain segment were in areas accessible to hunters during the general hunting season in 10 percent (3 of 30) of relocations. Rams from the Tom Miner segment were outside Yellowstone National Park in 4 of 22 (18 percent) hunting season relocations and within 2 kilometers of the Park boundary in an additional 77 percent of the relocations. Sixty-six percent of legal (3/4-curl) rams harvested during the general sheep season were taken from the Tom Miner segment. Mean age of legally harvested rams from this segment during 1979-85 was 6.2 years. The mean age of rams harvested in late season hunts on the Cinnabar Mountain segment (1980-85) was 6.7 years. Hunter success was 4 percent and 87 percent in the general and late seasons, respectively. Sheep response to vehicular and foot approaches on winter range after the late season hunts was similar to or less intense than prior to the late hunts. Tolerance to humans of groups with legal rams was similar to or greater than groups without legal rams. Legal rams were apparently not precluded from active participation in the rut by winter range hunts.

## INTRODUCTION

A bighorn sheep population can theoretically be managed to maximize one of three objectives: 1) the number of hunters afforded an opportunity to hunt, 2) the number and quality (within genetic/environmental constraints) of trophy heads available for hunters, and 3) the opportunity for nature study, photography, or aesthetic enjoyment by a recreation-seeking public (Geist 1975). Geist (1971) also maintains that hunting may result in abandonment of areas by rams. In the short term, hunting during the rut could disrupt the mountain sheep social system at a time that is critical to the continued maintenance of population size. In the long term, hunting during the rut might select against breeding by dominant, high quality, older rams and for opportunistic breeding by young rams that may or may not carry "high quality" genetic traits (Martin 1985). Unregulated rutting by young rams could potentially lead to increased energy expenditures by females and less efficient use of sheep habitat (Geist and Petocz 1977, Heimer and Watson 1982).

This paper describes the management system in a Montana hunting district that attempts to incorporate all three of the previously defined objectives through a combination of unrestricted hunter numbers on summer-fall range with harvest limited by quotas and limited entry hunting on a winter range heavily used by photographers and wildlife viewers. The ram distribution patterns and population monitoring methodology which facilitate this system are described. The effects of winter range hunting on sheep behavior and ram access to ewes were monitored during 1982-86, and the preliminary results are presented here.

## STUDY AREA

Montana Department of Fish, Wildlife, and Parks (MDFWP) bighorn hunting district 300 (HD300) was established in 1977 and includes approximately 1,500 square kilometers of suitable mountain sheep habitat. The unit is located in the Gallatin Range of southwestern Montana between the Yellowstone (east boundary) and Gallatin (west boundary) Rivers. Its southern boundary coincides with the northern boundary of Yellowstone National Park (YNP). HD300 contains two major bighorn sheep population segments:

Tom Miner (TM) - This segment includes 100-250 sheep in three or more populations with winter ranges less than 1 to 5 kilometers north of and summer-fall ranges straddling the YNP boundary.

Cinnabar Mountain (CM) - This segment consists of 80-150

sheep with winter range centered on Cinnabar mountain, 10 kilometers north of YNP, and summer range areas in and outside YNP.

Two sheep hunting seasons have been established in HD300. During September - early November an unlimited number of hunters are allowed to compete to fill a quota of legal (3/4 curl) rams throughout HD300. Each successful hunter is required to present the head to a MDFWP biologist or warden within 48 hours of harvest and to provide the date and location of the kill. Rams are aged by horn annuli counts (Geist 1966) at this time. When the quota is reached, the hunting season is closed on 48-hour notice.

From early November through mid December a limited number of permits awarded through drawings are valid for harvest of 3/4-curl rams from the CM population segment. The heads of harvested animals must be presented to a MDFWP official within 48 hours.

#### METHODS

During 1980-84, 12 rams (7 from the CM and 5 from the TM segments) were fitted with radio transmitters (Table 1). Fixedwing aerial and ground relocations of these animals were used to define seasonal movement patterns. Ten of the instrumented animals provided data on distribution during one or more hunting seasons. Ages at capture ranged from 1 1/2 - 5 1/2 years. Sublegal rams were used to define ram distribution during hunting season only if they were observed with ram bands.

Data on harvest in HD300 from 1976-85 were taken from MDFWP files and used to determine numbers and ages of harvested rams from the TM and CM population segments. Numbers of hunting permits sold in the general unlimited hunt and numbers of permits issued for late hunts were also available from MDFWP records.

Minimum population size and minimum number of legal rams after the close of hunting were determined for the CM and TM segments using the highest count per distinguishable age/sex class in a series of winter range surveys (Geist 1966, Stewart 1975). The CM winter range is easily accessible and 4-16 close range ground surveys were made per winter during 1978-86. Population estimates using the Schnabel (1938) method in the 1982-83 through 1985-86 winters indicated maximum counts represented 60-80 percent of the actual population (Irby, Swenson, and Stewart in prep.).

Winter ranges in the TM area are located at higher elevations and are much less accessible than the CM winter range. Minimum population estimates were based on 1-4 ground and/or

Table 1. Capture sites, dates of capture, ages at capture, and last relocation dates for 12 bighorn rams used to define movement patterns for rams in HD300.

| Site | Ram ID | Date of capture | Age (yr) | Last relocation | Fate           |
|------|--------|-----------------|----------|-----------------|----------------|
| CM   | 0411   | Jan 80          | 2 1/2    | May 83          | Unknown        |
|      | 0204   | Mar 80          | 4 1/2    | Feb 83          | Unknown        |
|      | 0212   | Mar 80          | 1 1/2    | Feb 81          | Unknown        |
|      | 4201   | Feb 84          | 2 1/2    | <sup>a</sup>    |                |
|      | 4210   | Feb 84          | 4 1/2    | Oct 84          | Poached        |
|      | 4204   | Feb 84          | 2 1/2    | <sup>a</sup>    |                |
|      | 4306   | Feb 84          | 1 1/2    | Feb 85          | Avalanche kill |
| TM   | 0203   | Mar 80          | 5 1/2    | Apr 83          | Unknown        |
|      | 2201   | Feb 82          | 2 1/2    | Sep 83          | Hunter kill    |
|      | 2210   | Feb 82          | 2 1/2    | Jul 83          | Unknown        |
|      | 2306   | Feb 82          | 1 1/2    | May 82          | Predator kill  |
|      | 2308   | Feb 82          | 5 1/2    | <sup>a</sup>    |                |

<sup>a</sup> Alive in winter 1985-86.

fixed-wing aerial surveys per winter. Limited sightings of marked animals during surveys suggested that minimum population estimates were 25-50% of actual population size.

Data on behavioral responses to humans prior to and after the late hunt on the CM winter range were collected during the 1983-84 through 1985-86 winters. Distance to humans or vehicles, activity of humans, age/sex makeup of sheep bands, and response of sheep to humans (1 = no detectable response; 2 = sheep alert but no movement to avoid disturbance; 3 = slow and/or short distance, less than 25 m, movement to avoid disturbance; 4 = rapid, long distance movement towards escape cover to avoid disturbance) were recorded for incidents in which sheep were within 400 meters of humans or vehicles during winter range surveys. Numbers of legal rams counted during surveys prior to, during, and after late season hunts were used as an index of ram abundance on winter range. Chi-square tests were used to test pre and post hunting season responses (Steel and Torrie 1960).

## RESULTS

Radio relocations for six of seven rams captured on the CM winter range (Figure 1) indicated a general pattern of northward spring expansion from winter range followed by a southerly movement to summer range deep within YNP in May or June. Movement out of YNP varied, with individuals leaving the Park between August and November. The seventh ram, collared as a 2 1/2-yr-old, moved northwest to summer in the TM area. Summer and early autumn relocations of this ram were in YNP, but limited late autumn observations suggest he returned to the CM winter range through lands outside YNP.

Relocations for five rams collared on winter ranges in the TM area (Figure 1) indicated winter - spring range was almost exclusively on lands north of YNP. Summer - fall ranges for four rams followed through these seasons straddled the YNP boundary.

Rams captured on the CM winter range were located outside YNP on 8 of 30 (27 percent) relocations during the general sheep season (Table 2). Most (5 of 8) hunting season locations outside YNP were on a single ranch or on U.S. Forest Service land with access controlled by the ranch. The outfitter controlling hunting on this ranch specialized in elk hunts and seldom guided sheep hunters.

Four of 22 (18 percent) hunting season relocations of males captured on TM winter ranges were outside YNP and an additional 77 percent were within 2 kilometers of the Park boundary (Table 2). TM rams outside the Park were located in areas customarily hunted by the public or on lands with access controlled by outfitters that regularly guided sheep hunters.



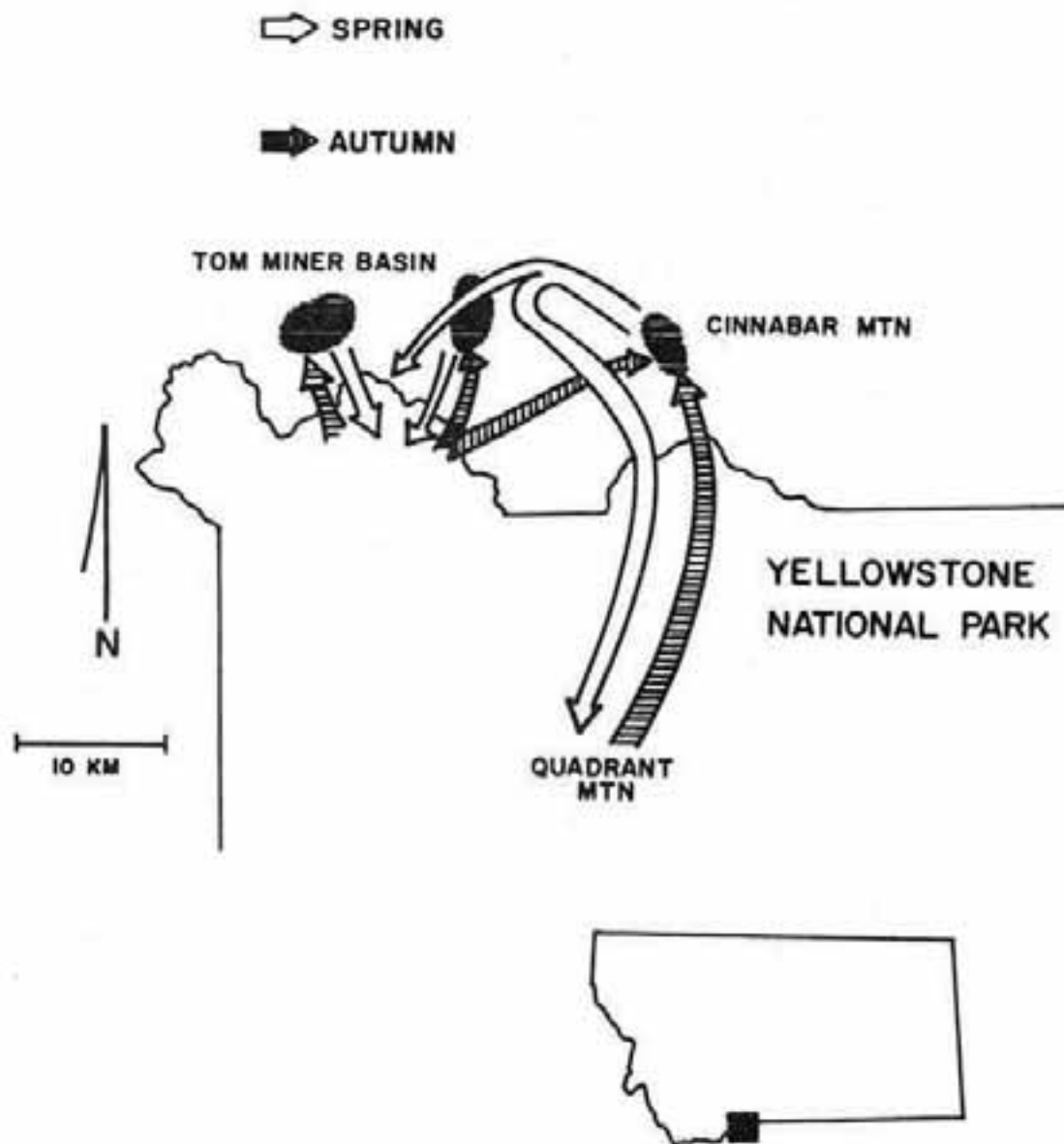


Fig. 1. Map of the study area showing generalized spring and autumn movement patterns for rams in the Cinnabar Mountain and Tom Miner sheep populations. Shaded areas indicate winter ranges.

Table 2. Relocations of radiocollared bighorn rams relative to the Yellowstone National Park (YNP) boundary during the general bighorn hunting season (September - early November) in HD300, 1980-85. The number of rams contributing to relocations are given in parentheses.

| Population segment               | Outside | <2km in | 2-5 km in | >5 km in |
|----------------------------------|---------|---------|-----------|----------|
|                                  | YNP     | YNP     | YNP       | YNP      |
| CM - Quadrant summer range (n=5) | 7       | 4       | 2         | 12       |
| CM - TM summer range (n=1)       | 1       | 3       | 1         |          |
| TM (n=4)                         | 4       | 17      | 1         |          |

Table 3. Number of general season hunters, general season quotas, late season permits, and annual legal (3/4-curl rams) and known illegal (<3/4-curl or 3/4-curl shot after season closure) harvest in the HD300 area, 1974-85.

| Year | General Season |       | Late season permits | Harvest        |         |
|------|----------------|-------|---------------------|----------------|---------|
|      | Hunters        | Quota |                     | Legal          | Illegal |
| 1977 | 62             | 6     |                     | 6              |         |
| 1978 | 102            | 5     |                     | 4              |         |
| 1979 | 116            | 5     |                     | 2              |         |
| 1980 | 72             | 6     | 5                   | 6              |         |
| 1981 | 134            | 5     | 3                   | 9 <sup>a</sup> |         |
| 1982 | 117            | 5     |                     | 4              | 1       |
| 1983 | 105            | 5     | 3                   | 7              | 6       |
| 1984 | 76             | 3     | 2                   | 5              | 1       |
| 1985 | 110            | 3     | 2                   | 5              |         |

<sup>a</sup> One ram was legally killed during the 48-hour grace period after the quota was reached.

From 1977 to 1985 an average of 99 hunters per year participated in the general sheep hunt in HD300 (Table 3). Hunter success rate averaged 4 percent. Quotas were exceeded four times in the past nine years, and the total legal kill during the general season was 86 percent of the total quota. Sublegal rams were known to be killed in three years. Since 1977, 66 percent (23 of 35) of the general season legal harvest was in the TM area, 23 percent in the CM area, and 11 percent from small herds in other portions of HD300 (Table 4).

Mean age of harvested rams in the TM area increased from 4.5 years (standard deviation = 1.5, sample size = 7, range = 3.5-7.5) in 1976-78 to 6.2 years (standard deviation = 1.6, sample size = 20, range = 3.5-10.5) in 1979-85. Mean age of rams harvested in the CM area (1977-85) during the general season was 4.9 years (standard deviation = 1.2, sample size = 8, range = 3.5-5.5). The lower age of rams harvested from the CM area during the general season is presumably due to earlier return to winter range, the only area where rams are accessible to hunters during the general season, by younger rams than by older rams.

The late permit hunt on the CM winter range was initiated in 1980. Fifteen permits were issued between 1980 and 1985 (Table 3) and 13 legal sheep were harvested. Two permit holders elected not to participate in the hunt. Ages of rams harvested ranged from 5.5-9.5 years with a mean of 6.7 years (standard deviation = 1.3, sample size = 13). Older rams (8.5-10.5 years) were available in most years, but hunters selected younger rams with larger horns.

General season quotas in HD 300 have never exceeded the minimum number of legal rams seen on TM winter ranges the previous winter (Table 5). Legal rams as a percentage of the minimum population estimate showed no significant trends during the 1978 to 1986 period for which data were available (CM: correlation coefficient = +0.40, slope = +12.8; TM: correlation coefficient = +0.33, slope = +10.8;  $p > 0.10$ ). Absolute numbers of rams increased and then decreased during this period in the CM unit and evidently decreased in the TM unit. Numbers of legal rams in both areas were positively correlated with minimum population estimates (correlation coefficients: CM = 0.76; TM = 0.67;  $p < 0.10$ ).

The proximity of the CM winter range to a maintained county road and its visibility from a major highway attract large numbers of photographers and wildlife viewers throughout late autumn and winter. Sheep seldom reacted overtly to humans or vehicles at distances of 100 meters or more. Responses of sheep to human and vehicle approaches to within 50 meters on the winter range during the 1983-84 through 1985-86 winters (Figure 2) indicated decreased response levels to vehicles following the

Table 5. Post-hunting minimum estimates of 3/4-curl rams, minimum population size, and legal males as a percentage of the minimum population estimate in the CM and TM population segments of HD300, 1978-86.

| Winter  | CM         |             |                                | TM             |             |                                |
|---------|------------|-------------|--------------------------------|----------------|-------------|--------------------------------|
|         | Legal rams | Total sheep | Legal rams as percent of total | Legal rams     | Total sheep | Legal rams as percent of total |
| 1978-79 | 9          | 66          | 14                             | 14             | 115         | 12                             |
| 1979-80 | 11         | 103         | 11                             | 16             | 112         | 14                             |
| 1980-81 | 10         | 84          | 12                             | 10             | 87          | 11                             |
| 1981-82 | 17         | 91          | 19                             | 8              | 68          | 12                             |
| 1982-83 | 22         | 127         | 17                             | 8              | 114         | 7                              |
| 1983-84 | 14         | 101         | 14                             | 3 <sup>a</sup> | 52          |                                |
| 1984-85 | 13         | 71          | 18                             | 8              | 50          | 16                             |
| 1985-86 | 12         | 83          | 14                             | 8              | 54          | 15                             |

<sup>a</sup> Twenty-three of 39 males sighted could not be reliably classified as legal (3/4-curl) or sublegal (<3/4-curl).

Table 4. Distribution of bighorn ram harvest among population segments in HD300, 1974-85.

| Year | CM             |      | TM             | Other <sup>a</sup> |
|------|----------------|------|----------------|--------------------|
|      | General        | Late |                |                    |
| 1977 | 3              |      | 3              |                    |
| 1978 |                |      | 4              |                    |
| 1979 |                |      | 2              |                    |
| 1980 |                | 4    | 1              | 1                  |
| 1981 | 1              | 3    | 4              | 1                  |
| 1982 | 2 <sup>b</sup> |      |                |                    |
| 1983 | 2              | 2    | 8 <sup>c</sup> | 1                  |
| 1984 | 1 <sup>b</sup> | 2    | 2              | 1                  |
| 1985 | 1              | 2    | 2              |                    |

<sup>a</sup> Rams harvested in one of three minor population segments.

<sup>b</sup> Includes one illegal kill.

<sup>c</sup> Includes six illegal kills.

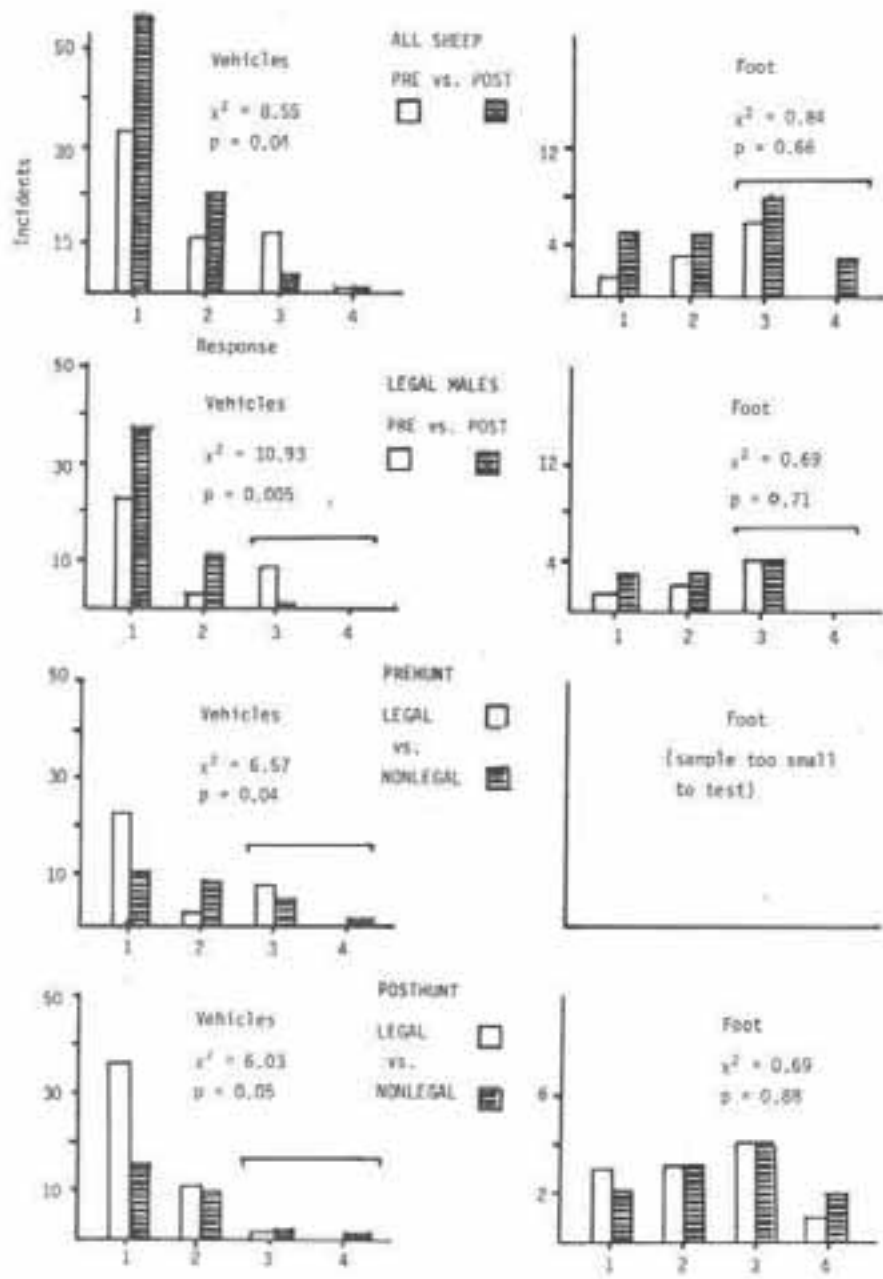


Fig. 1. Histograms contrasting distribution of sheep reactions to humans and vehicles approaching to within 50 m among four response categories (1 = no detectable response, 2 = sheep alert but no movement to avoid disturbance, 3 = slow and/or short distance movement, <25 m, to avoid disturbance, 4 = rapid, long distance movement towards escape cover to avoid disturbance). The disturbance type (human or vehicle), the sheep category (groups with legal rams, groups without legal rams, all sheep), and the timing of the disturbance (pre or post-hunt) are given for each histogram. Chi-square and p values for tests are also shown. Brackets over histograms indicate categories that were merged in tests.

late hunt and no significant difference in response to humans on foot. Groups with legal rams either did not react differently from groups without legal rams or exhibited lower response levels for categories with sufficient sample sizes for testing (Figure 2).

Counts of legal rams during winter range surveys were similar throughout the November - January period during a year without a hunt and in pre and post hunt periods during years with hunts (Table 6). During 1985-86, numbers of rams sighted during the hunt were higher than numbers before and after the hunt.

## DISCUSSION

The available evidence indicates that the management system in HD300 has met its objectives. Approximately 100 hunters per year are afforded an opportunity to hunt in a sheep population complex with fewer than 400 accessible sheep. The mean age of harvested rams in general and late hunts, 6 years, indicates hunters have the opportunity to take mature rams. Low hunter success in the general season is acceptable to most hunters because HD300 is one of the few areas in the contiguous United States where sheep hunting opportunity is not determined by an over-subscribed lottery.

The accessibility of the CM winter range allows hundreds of wildlife viewers and photographers to observe bighorn behavior at distances of 5-100m. Animals visible from the road include an average of 6 3/4-curl rams on any day during the height of the rut.

The late season hunt has not displaced a detectable segment of the older ram population from the winter range, nor has it led to marked decreases in tolerance of sheep to human approaches. Older rams have frequently been observed displaying, fighting, and tending ewes immediately adjacent to the road.

The success of this management system is partially due to unique characteristics of HD300. Unlimited hunting opportunity is feasible because rams have a secure refuge in YNP. Refuge availability combined with minimum horn size requirements for harvest allow a reasonable number of rams to reach the 6 - 10 year age classes where trophy quality is highest. Accessibility to nonconsumptive users is facilitated by the CM population's choice of a winter range bisected by a county road and visible from the main highway that leads to the north entrance to YNP. Colonists established themselves on the range, apparently attracted by low snow cover, convenient escape terrain, and relatively abundant winter forage, in the early 1960's (Keating 1982) and have been exposed to local vehicle traffic and casual observation by humans since establishment.

Table 6. Mean numbers of legal (3/4-curl) rams seen during winter surveys of the CM winter range, 1982-86. Only surveys between 1 November and 31 January are included. No permits were issued in 1982-83, and surveys were divided into pre (1-24 November), during (25 November - 6 December) and post (6 December - 31 January) hunting periods. Hunting periods were too short to include a "during hunt" category except in 1985-86.

| Winter | Prehunt |           | Hunting |           | Posthunt |           |
|--------|---------|-----------|---------|-----------|----------|-----------|
|        | Counts  | Rams (SD) | Counts  | Rams (SD) | Counts   | Rams (SD) |
| 82-83  | 4       | 6 (4)     | 5       | 5 (3)     | 6        | 7 (6)     |
| 83-84  | 8       | 6 (4)     | a       |           | 6        | 6 (3)     |
| 84-85  | 3       | 5 (3)     | b       |           | 7        | 7 (1)     |
| 85-86  | 5       | 6 (2)     | 2       | 8 (1)     | 4        | 5 (2)     |

<sup>a</sup> All animals were harvested on 4 December.

<sup>b</sup> Animals were harvested on 28 November and 2 December.



The minimal response of sheep to a hunt on winter range was not surprising given the situation in the CM winter range. Sheep moving onto this winter range were exposed to deer (Odocoileus hemionus) and elk (Cervus elaphus nelsoni) hunters in November and local traffic and photographers throughout late autumn and winter. Many sheep have been habituated to winter rifle fire during December - February late elk hunts adjacent to and on the winter range. The sheep permit holders add a minute amount to the level of human activity and create a disturbance lasting only a few hours on one to three days. The ease of monitoring sheep population structure on the CM winter range serves as insurance against overharvest since decreases in rams can be detected and the season modified quickly.

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#### LITERATURE CITED

- Geist, V. 1966. Validity of horn segment counts in aging bighorn sheep. *J. Wildl. Manage.* 30:634-635.
- \_\_\_\_\_. 1971. Mountain sheep: a study in behavior and evolution. Univ. Chicago Press, Chicago. 381 pp.
- \_\_\_\_\_. 1975. On the management of mountain sheep: theoretical considerations. Pp. 77-98 in J. B. Trefethen, ed. *The wild sheep in North America*. The Boone and Crockett Club and Winchester Press, New York. 302 pp.
- \_\_\_\_\_. and R. G. Petocz. 1977. Bighorn sheep in winter: Do rams maximize reproductive fitness by spatial and habitat segregation from ewes? *Can. J. Zool.* 55:1802-1810.
- Heimer, W. E. and S. Watson. 1982. Differing reproductive patterns in Dall sheep: population strategy or management artifact. Pp. 330-336 in J. A. Bailey and G. G. Shoenveld, eds. *Proc. Bien. Symp. Northern Wild Sheep Goat Council*. Colorado Division of Wildlife, Ft. Collins.

- 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. 79 pp.
- Martin, S. A. 1985. Ecology of the Rock Creek bighorn sheep herd, Beartooth Mountains, Montana. M.S. Thesis, Montana State University, Bozeman. 109 pp.
- Schnabel, Z. E. 1938. Estimation of the total fish population of a lake. Amer. Math. Monthly 45:348-352.
- Steele, R. C. D. and J. H. Torrie. 1960. Principles and Procedures of Statistics. McGraw - Hill, NY. 481 pp.
- Stewart, S. T. 1975. Ecology of the West Rosebud and Stillwater bighorn sheep herds, Beartooth Mountains, Montana. M.S. Thesis, Montana State University, Bozeman. 130 pp.

#### QUESTIONS AND ANSWERS

Lynn Irby: The question was why weren't they affected by the Chlamydia outbreak in Yellowstone National Park. I don't know what the extent of the ram contact between the populations is but I know there is some. That year, the Cinnabar rams evidently did not come in contact with sheep that had Chlamydia. The two winter ranges are 13 kilometers apart. We were waiting for the other shoe to drop all that winter and nothing ever happened.

Daryll Hebert, BC: Do you have any food habit data on that particular population?

Irby: Yes, in winter 80-81, they ate about 25 percent agropyrons, but we weren't able to distinguish crested wheatgrass from bluebunch, which is a dominant native agropyron there, and about 25 percent sage.

Hebert: Are they taking the crested wheatgrass year round or just in the winter?

Irby: Some stay on the crested wheat grass from October through April unless elk come in and mow it down. I'm not an advocate of crested wheat grass but its really amazing how they go for that stuff. They're still down there now eating this year's greenup and they probably won't leave for 2 to 3 weeks.

Jim Ford, Montana: What do you expect will happen since the reintroduction of domestic sheep into the area?

Irby: That's another shoe waiting to drop. Domestic sheep have been there for four years. There hasn't been any virulent die off, but on the other hand, the population started declining the years after they put the domestic sheep in. Whether there's a relationship or not, I can't say.

Ford: You haven't see any effect so far?

Irby: We haven't seen any dead bighorns that could be definitely attributed to interactions with domestic sheep. Right now, the domestic sheep are not on the core winter range, but the ranch that runs the domestic sheep has spent a lot of time and money replanting hay meadows down river from the core bighorn range and I'm just waiting for the bighorns to discover them. There also is overlapping use of spring range. The spring range that the bighorns are using is a mix of private and Forest Service land. If the ranch owners want to run sheep on their place then I don't know what we can do about it. The Forest Service is going to quite a lot of trouble to make sure there's no contact between domestic sheep and bighorns on their lands, but the bighorns move between public and private lands according to their own schedule. If you brought up Cinnabar as a transplant site, I'm sure it would have been eliminated in the first round, but the sheep pitched up there and seem to be hanging on.