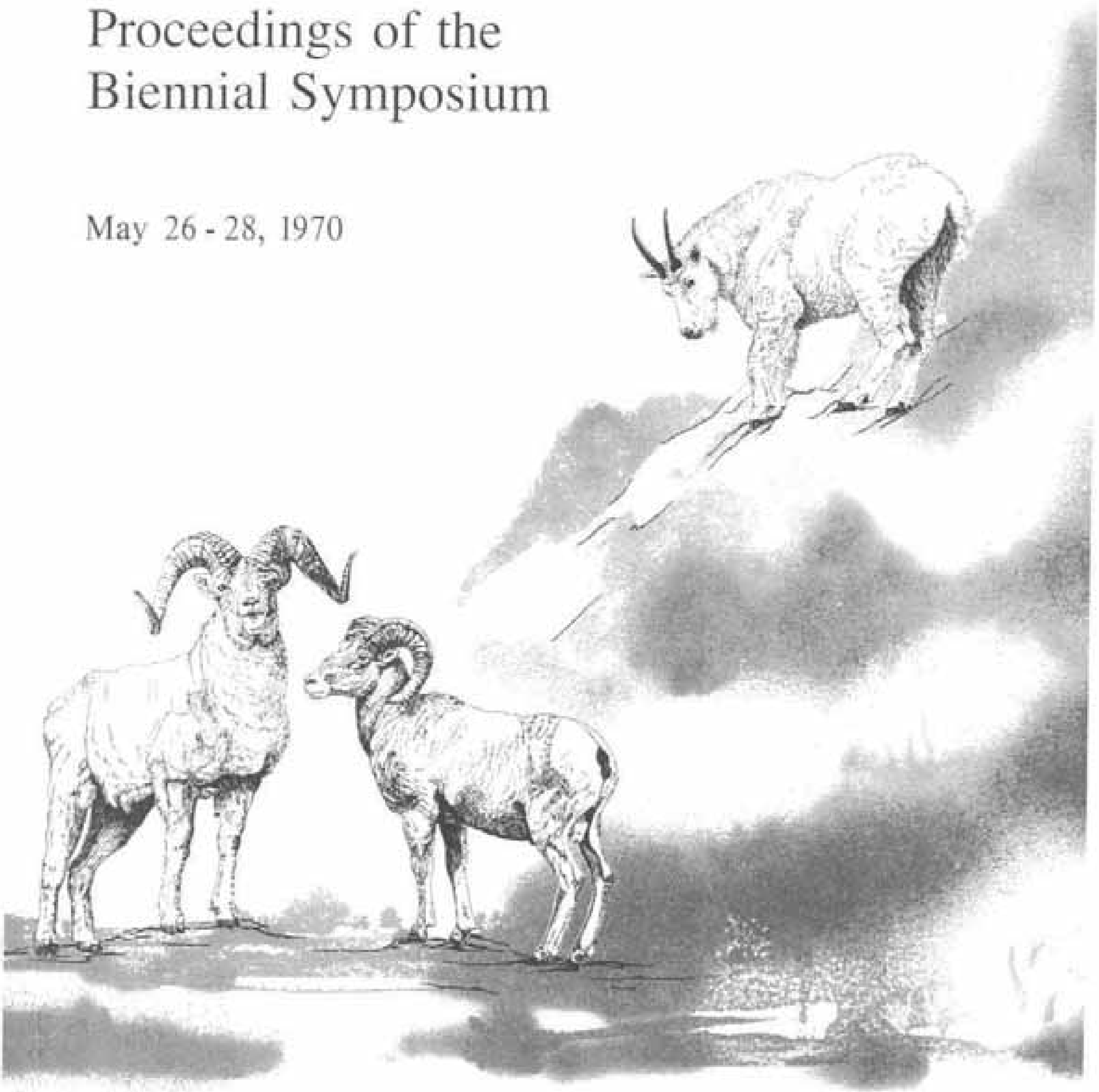
Northern Wild Sheep and Goat Council

(formerly Northern Wild Sheep Council)

Proceedings of the Biennial Symposium

May 26 - 28, 1970



TRANSACTIONS OF THE
NORTHERN WILD SHEEP COUNCIL

May 26-28, 1970

Williams Lake

WILDLIFE MANAGEMENT BRANCH

British Columbia Fish and Wildlife Branch

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IN MEMORY

JAMES A. ERICKSON, 1943-1970

James A. Erickson, Dall Sheep biologist for the Alaska Department of Fish and Game, was killed July 27, 1970 when the light aircraft in which he was a passenger crashed in Alaska's Brooks Range. The accident occurred in the course of an aerial Dall sheep survey in the Arctic North Wildlife Refuge.

Jim was born in Jamestown, New York, on January 25, 1943 and grew up in that general agricultural area. He graduated from Bemus Point Central High School in 1961 and in the summer of that year drove north to begin his life in Alaska. Jim attending Wildlife Management School at the University of Alaska and obtained his degree in 1965. While in school Jim was recognized as an exceptional student and well earned the Outstanding Athlete Scholar award.

In the fall of 1965 Jim began a Masters degree program at Colorado State University. His thesis problem concerned age determination techniques applicable to mule deer. After completing degree requirements, Jim began permanent employment with the Alaska Department of Fish and Game in May 1967. He was assigned to Anchorage and worked on the Dall sheep research project. Jim was transferred to Fairbanks in February 1969 and assumed leadership of the sheep studies in the Interior and Arctic regions of Alaska. For the past three years Jim has been leading a capture, marking, and movement study of sheep in the Alaska Range, south of Fairbanks. Jim was also involved with a horn growth study and all other aspects of sheep management in Alaska.

His work was characterized by a thorough, common sense approach intended to yield a maximum of practical information. His integrity, enthusiasm, conscientious attitude, and never ending drive will have a lasting influence on those of us that knew Jim.

In addition to his professional involvement with the management of renewable resources, Jim was personally dedicated to preserving the values which he felt were important in his adopted home, the rugged piece of real estate which is Alaska. He belonged to the Alaska Conservation Society, was interested in kids and worked with him through the local 4-H program.

Jim was an experienced canoeist on Alaska's wilderness waterways, a hunter, a skater, a cross country skier, and in the winter enjoyed nothing more than working his team of malemute freight dogs.

Jim is survived by his widow, Sandra, a daughter, Jane 3, and a son, Reed 1.

A scholarhship fund for his two children has been started for those wishing to contribute. Tony Smith, Box 5-963, College, Alaska, will forward donations to Sandra.

THE PARADOX OF THE BIGHORN SHEEP

by

P. J. Bandy

The decline of the bighorn sheep in western North America is largely attributable to the usurpation of much of the pristine range by agriculture, particularly grazing. However, it is also symptomatic of our past ecological ignorance, and our present impotence as wildlife managers and custodians of natural environmental quality.

The historical decline of the bighorn sheep, in the face of increasing pressures from the plow and the cow, is understandable. So also, is our failure to halt the further die-offs, when our knowledge of causal factors was inadequate and we accepted parasites and diseases, ipso facto, as benign agents limiting populations in order to prevent annihilation from some other cause. But, it is not understandable why wildlife managers have ignored, for more than a decade, the mass of evidence, summarized by Buechner (1960), incriminating man and his treatment of bighorn ranges, as the precursors of disaster. Furthermore, it seems incredible that wildlife management agencies should ignore the recommendations of their own wildlife managers until die-offs, such as occurred recently in south-eastern British Columbia, create public pressures that cannot be ignored. Under these conditions, it seems paradoxical that the bighorn sheep survives, giving us yet another chance to establish a suitable management program.

In the Endangered Species Protection Act of the United States, passed in 1966, bighorn sheep were not listed, in spite of the fact that only 1% of their pristine numbers have survived 100 years of "progress" in North America. Furthermore, a recent publication, entitled "Endangered Wildlife in Canada" includes the bighorn between its covers, but states that it is "not entirely endangered" because "sufficient populations exist in American and Canadian National Parks". Such statements, following the loss of 74% of the populations wintering at low elevations in south-eastern British Columbia, including 76% of the Kootenay National park population, are difficult to comprehend. How much further must bighorn sheep decline before they are considered endangered?

Buechner (1961) and others have suggested that surviving bighorn populations now occupy habitat which can only be considered marginal when compared with extensive pristine ranges. Certainly, populations occupying seral ranges, must be considered marginal in terms of their transitory nature and the lack of effective habitat management programs. Also, climax ranges, where they are still occupied by bighorns, must be considered marginal in terms of their transitory nature and the lack of effective habitat management programs. Also, climax ranges, where they are still occupied by bighorns, must be considered marginal, if only on the basis of restricted size. Moreover, most ranges, whether seral or climax, whether inside or outside national parks, are shared by other species such as cattle, elk or domestic burros, and are generally in various stages of degeneration as a result of excessive grazing.

Almost all populations, showing the stresses of marginal existence, are heavily parasitized with a variety of nemotodes, cestodes and coccidia. Moreover, they passively carry disease producing organisms which seem to require only mildly increased physiological stresses to flourish and to succumb with their hosts.

To say the least, bighorn sheep are endangered, and perhaps, if sufficient protection and managerial skills are not applied, we may witness still further declines and the eventual extinction of yet another native mammal. Bighorn sheep are fragile, both in the wild state and in captivity, but, hopefully, they can respond to good management based upon sound and detailed knowledge gained through research.

Prerequisite to the management of bighorn, is the exclusive ownership of the habitat within which they live, and particularly, the winter ranges. Lawson Sugden (1961), in reference to California bighorns of British Columbia, stated: - "Protection of bighorn ranges from excessive human influence, and use by domestic livestock, must become a major part of California bighorn management.....All other management considerations are secondary to this, for without suitable habitat no amount of legal protection can benefit any animal."

Buechner, in his monograph considered that the key to the future of bighorn sheep lies in the improvement of forage conditions through reductions in interspecific competition from wild and domestic animals, particularly elk, cows and horses. Furthermore, he pointed out, as early as 1961, that we have sufficient background knowledge to serve as a basis for effective conservation. Research provided this knowledge and we need only to put this knowledge into practice to make a good start in the conservation of bighorns.

It is essential, that we acquire the title and grazing rights of all significant bighorn winter ranges and decicate them in perpetuity, to the conservation of sheep. Having done so, we must then apply currently known principles of ecology and management to increase and maintain vigorous populations. In other words, the immediate future of bighorn sheep and a withdrawal from disaster, lies in the hands of wildlife managers and the administrators of the wildlife resource.

However, to increase our competence and, needless to say, our confidence, that we, as wildlife mangers, can ensure the continued existence of bighorn sheep, and perhaps continue to provide moderate consumptive use of some populations, we must enormously increase our biological and ecological knowledge. To husband this fragile animal, we need to know much more about the relationship between sheep populations and habitat quality, seasonal range requirements, energy flows, nutrient recycling, specific nutritional requirements and the effects of all these on vigour and reproductive performance. We must learn more about the parasites and disease agents affecting bighorns, their life cycles, effects upon the hosts, susceptibility to control, density interactions between host and parasite, the factors influencing pneumonia, methods of treatment, and much more.

We also need to obtain accurate populations statistics and a thorough understanding of population dynamics in various environmental circumstances, and at different density levels. We need to know potential and actual growth patterns, reproductive rates, mortality rates, the causal factors of mortality, age structures of populations in various habitats, the role of predation, and many other aspects of the biology and ecology of bighorn sheep.

In short, we really know very little about the specifics of bighorns and it is essential, while we still have sufficient numbers of animals to work with, that we intensify both our managerial and our research efforts.

As wildlife managers, we must develop a suitable philosophy in regard to bighorn sheep. Having done so, we can then prescribe policies appropriate for the future and can translate these into cooperative management and research activities. Without such a philosophy, without policies, without vigorous and decisive management and without intensified research effort, there can be little doubt that the bighorn sheep of western North America will eventually reach the end of its road to extinction, or will become nothing more than a curiosity in parks and other outdoor museums.

The future of bighorn sheep is the yardstick by which we can measure our competence as wildlife managers. For positive results, we need more than pious hopes that someone else will do something before it's too late.

PROGRESS AND PROBLEMS - MARKING AND COUNTING DALL SHEEP IN THE MACKENZIE MOUNTAINS, NORTHWEST TERRITORIES

by

Norman M. Simmons and James R. Robertson

Abstract

In early 1968, work was started on the design of a management plan for big game in the Mackenzie Mountains, Northwest Territories. A phase of this project involves the development of a method of surveying Dall sheep populations. Experiments are being conducted in a small block of mountains to determine the usefulness of aerial surveys and to develop techniques for conducting them. Trial surveys to date have pointed out that major errors may occur in aerial counts of Dall sheep. Those errors, plus the high cost of the surveys have led the authors to question the practicality of the counts. Essential to the aerial survey program is a knowledge of the seasonal movements of Dall sheep. Dall have been successfully trapped with simple, inexpensive, portable traps, and marked with ear tags and streamers, horn notches and screws, and paint, but no traps have been located in areas suitable for aerial surveys. Furthermore, trapping is slow and expensive. Experiments are now being conducted on a flexible and relatively inexpensive method of applying dye to groups of Dall sheep from the air to supplement the trapping and tagging program.

Introduction

The hunting of big game animals by non-residents in the vast Mackenzie Mountains wilderness was first permitted by the Government of the Northwest Territories in 1965. The greatest non-resident hunting pressure has been applied to Dall sheep (*Ovis dalli*). Hunter success continues to be high (75-95%), however, and 60% or more of the rams killed have been over eight years of age and have had full curl horns.

In March 1968, Project Leader Norman Simmons began working toward the design of a management plan for big game in the Mackenzie Mountains. The plan is to be presented to the

Territorial Game Management Service for implementation. Since then, he has received the assistance of Territorial Game Management Officers with several phases of the study. During the summer and fall of 1969, Park Warden Jim Robertson conducted a program of trapping and marking sheep in the Mackenzie Mountains as a part of the project.

Aerial Dall sheep surveys

Because of the importance of Dall sheep to non-resident hunters, a major portion of the project has been devoted to that species. A basic step toward Dall sheep management is the development of a population survey technique. Aerial surveys with fixed-wing aircraft seemed to be the logical solution to the problem so we began developing and testing techniques in a small block of mountains near the Keele River.

Goals and assumptions. The specific purpose of our experiments with aerial Dall sheep surveys in the Mackenzie Mountains is to determine our ability to identify legal rams and count all adult rams from an aircraft, count total numbers and plot the distribution of sheep on their summer and winter ranges, and find the boundaries of summer and winter sheep ranges.

Several assumptions were made regarding sheep behavior and movements:

1. Except with rare and insignificant exceptions, summer and winter sheep ranges are above timberline,
2. During the late winter (February through April) and early summer (July) the population in the survey area is relatively static with no significant recruitment or loss of sheep to the area,
3. The sheep will not hide from the aircraft as do mountain goats, but instead will flush and facilitate aerial observations,
4. We can depend on tracks in snow to lead us to groups of sheep; where there is snow cover and no tracks, we will assume there are no sheep and act accordingly,
5. And, of course, all the sheep have an equal probability of being counted.

At least for the study, area, we tried for a census, a total count of the Dall sheep occupying the terrain above timberline. Dall sheep seemed to lend themselves to a census, at least in the winter, because of their limited range and habit of congregating in flocks. The extrapolation of population numbers from random sample counts is not practical because of the highly "clumped" distribution of sheep bands.

Study area 6h. For ease of planning and identification, the mountainous area hunted by non-residents was divided into 20 major areas that appeared easily defined by wide river or stream valleys and/or dense timber stands. These were in turn divided into 173 subdivisions also bounded by timber and drainage valleys. Each subdivision appeared small enough to be thoroughly searched by aircraft in 10 hours or less. The major divisions were identified by numbers and the subdivisions by letters (Fig. 1).

For experiments with aerial survey techniques, area 6h was chosen because of its small size, clearly defined boundaries, and relatively large population of regularly hunted sheep. The numbers of sheep killed there each year are known. Unfortunately, no mineral licks suitable for trapping were found in 6h.

Area 6h is located at about 64° 35' N latitude and 127° 55' W longitude, between the Keele River and the headwaters of the North Redstone River. Relatively gentle slopes of alluvium form the base of the mountain block from about 3000 feet elevation to about 5000 feet. The upper limit of the white spruce cover is at about 4500 feet. Alpine tundra vegetation, which the sheep prefer to occupy most of the year, covers the rest of the area. The southern half of area 6h is made up of rugged, unstable slopes which are largely unoccupied by sheep in the winter. The highest point there is 7812 feet above sea level. The northern half of 6h is characterized by gentler terrain and long, flat-topped ridges. This northern area is preferred by sheep for winter range (Fig. 2).

There are roughly 80 to 100 sheep in area 6h. During the winter there may be 20 or more moose and several hundred woodland caribou on the timbered slopes fringing 6h. Grizzly bears and wolves have occasionally been seen in the area.

Marking sheep. A plan to mark sheep was included in the survey design program so that the seasonal movements of sheep could be related to counts in each sample area. At first the use of syringe-firing weapons at mineral licks to capture Dall was tried, but that method proved slow and costly. Then traps were set up at easily accessible mineral licks in areas 4f and 4g. Dall sheep in these traps have been

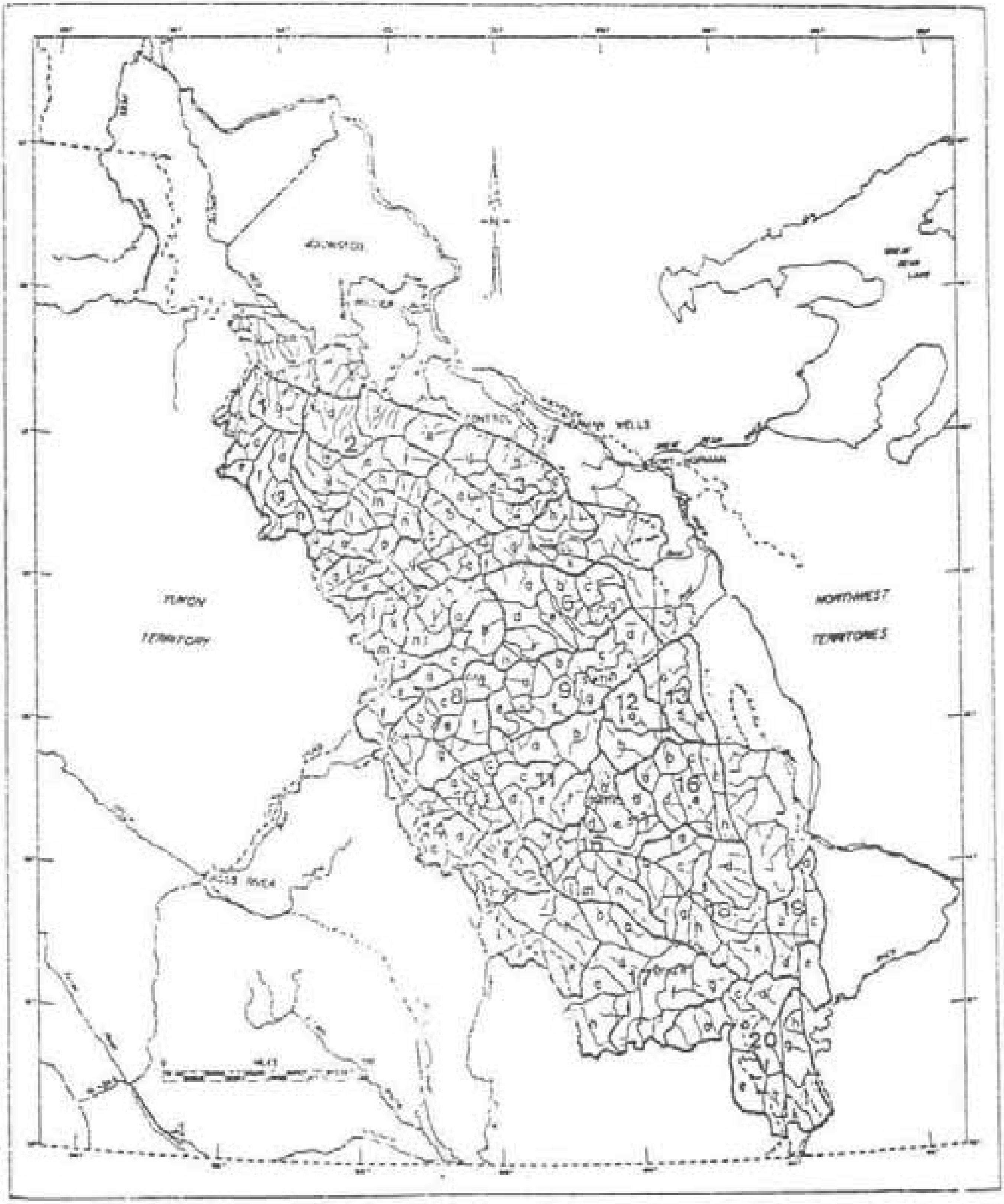

Fig. 1 -- Divisions and subdivisions of Game Management Zone 1 into sample areas for aerial surveys.

Fig. 2 -- Topographic map of area 6h. (Geological Survey of Canada. Scale 1:250,000.)

marked and released and their movements occasionally plotted since September, 1969.

Progress

Development of an aerial survey technique.

Considerable time was spent testing various types of aircraft and flying techniques before work could begin on identifying sources of error and evaluating survey results. Thought he first flights in search of Dall sheep in the Mackenzie Mountains were made by N. Simmons in 1966, the choice of the equipment and general technique currently used was not made until early 1968.

Choice of equipment. The Piper Super Cub and the Helio Courier were chosen as the best available fixed-wing aircraft for Dall sheep surveys in the Mackenzie Mountains. Helicopters were considered, but the expense of ferrying them to the survey areas and holding them through periods of poor weather was prohibitive.

Of the two aircraft chosen, the Helio Courier was preferred. It offered the most ideal combination of comfort, load-carrying capacity, safety, and manoeuverability in the Mackenzies. Though it won't climb quite as rapidly, it will turn about as sharply as a Super Cub. It won't stall and spin like most other aircraft. Lateral control is maintained at any speed, through its rate of descent at 30 mph may cause the observer to blanch. The 260 to 300 hp engine is relatively quiet, especially in the recent models. The Courier will carry more of a load than aircraft with similar STOL capabilities, which means kegs of fuel can be hauled to survey areas and then deposited on river ice or sand bars before surveys are started. The plane is also comfortable and can be adequately heated in the winter. Observer comfort and peace of mind are highly significant ingredients of a successful aerial survey.

To further observer comfort and reduce fatigue, noise abating ear muffs were worn during surveys. Records were kept on a battery-operated tape recorder, backed up by standard observation forms and 1:250,000 scale topographic maps.

Observation techniques. The most effective method found to survey 6h consisted of flying over the entire area in overlapping contour strips at approximately 20 foot intervals of elevation. Each pass overlapped the previous one so that "blind spots" obscured by the fuselage or wing were covered. The length of the strips flown and their elevational sequence varied according to the topography and to principles of fuel economy. The pilot acted as navigator and plotted our course and locations of wildlife sightings on maps. The area viewed was nearly always on the passenger side of the aircraft.

The ground-to-aircraft distance varied according to season and topography. In the winter, sheep tracks in snow could be seen from 500 yards or more in bright sunlight, but sheep were harder to see. After sheep tracks were seen the pilot would approach the slope to within 500 feet or less and remain at that distance until the sheep were found. Slopes blown nearly free of snow were searched from elevations closer to the ground than were snow covered slopes because of their speckled appearance. During summer months, white sheep above timberline could usually be spotted with ease from a considerable distance, except in steep-walled, rugged canyons. The latter were searched carefully closer to the ground.

Attempts were made to determine the accuracy of counts from a fixed-wing aircraft by searching 6h with a Bell Jet Ranger helicopter. Those efforts were repeatedly foiled by bad weather. This winter we planned to check on our precision by searching 6h several times in a 30-day period with the Helio Courier. Again, because of bad weather, we failed to complete more than one survey.

Weather had to be nearly ideal before it was worthwhile to conduct aerial surveys. Ideal weather would be calm air, clear skies, and five hours of good sunlight bathing the survey area. Deep shadows of early morning and late afternoon precluded surveys during December and January, even though large parts of the survey area would be brightly illuminated.

Positive results. Three late-winter surveys have been flown in area 6h. During those intensive surveys, we were able to identify adult rams and legal rams with confidence. Their dark horns showed clearly against their white coats and the background of snow. We were also able to delineate at least the late winter range of the Dall in 6h, and we suspect that this same range is used from December through April.

Sheep tracks in snow were a boon to the surveys. Rarely did we search along sheep tracks and not find the animals that made them. This gave us some confidence in the validity of our counts, especially when fresh snow blanketed the entire sample area.

Dall sheep show up beautifully against alpine tundra in 6h in the summer. This fact also led us to believe that a total count of Dall sheep is feasible.

Development of trapping and marking techniques

Requirements. In the Mackenzie Mountains we are faced with problems of economics and transportation peculiar to a large roadless wilderness. We need a method whereby two to four men could mark a significant number of sheep in a short field season. Trapping seemed to be the answer. However, we needed a trap that was fairly inexpensive, was transportable in available STOL aircraft and small boats, was simple to erect and easy to operate either automatically or by an observer in a blind. The trap had to be readily and economically accessible daily, even in inclement weather. It had to be capable of holding sheep without serious injury for at least 24 hours.

The material used to mark sheep had to be long-lasting and readily visible from a fixed-wing aircraft. The material had to lend itself to coding so that individual sheep could be identified, at least as members of a group, from the air.

The trap. The Canadian Wildlife Service purchased 10-foot wide cargo net made of 3/16 inch polypropelene rope in a 4-inch mesh from False Creek Industries in Vancouver, B.C., for the traps we planned to use to capture Dall sheep. The netting costs about $0.30 per square foot, assembled. It is light weight and portable, strong enough to hold a panicky moose (as we later proved), and withstands the harsh northern environment well. It is slightly elastic and will not seriously injure captive animals.

After some experimenting, J. Robertson designed a box-like sheep trap made of the cargo netting stretched around a frame of spruce logs. He made two of the traps, both approximately 14 feet wide, 16 feet long, and 6 feet high. Single gates measuring about 2 feet by 2 1/2 feet were hung on rope hinges on each trap so that they opened from the bottom. The gates were held open by simple nail and screw-eye triggers which were attached to trip cords (Fig. 3). Other gates, hinged like normal doors, were placed opposite each trap-gate to permit sheep to pass easily through the trap when it is tied open and to permit the trappers easy access to captured sheep.

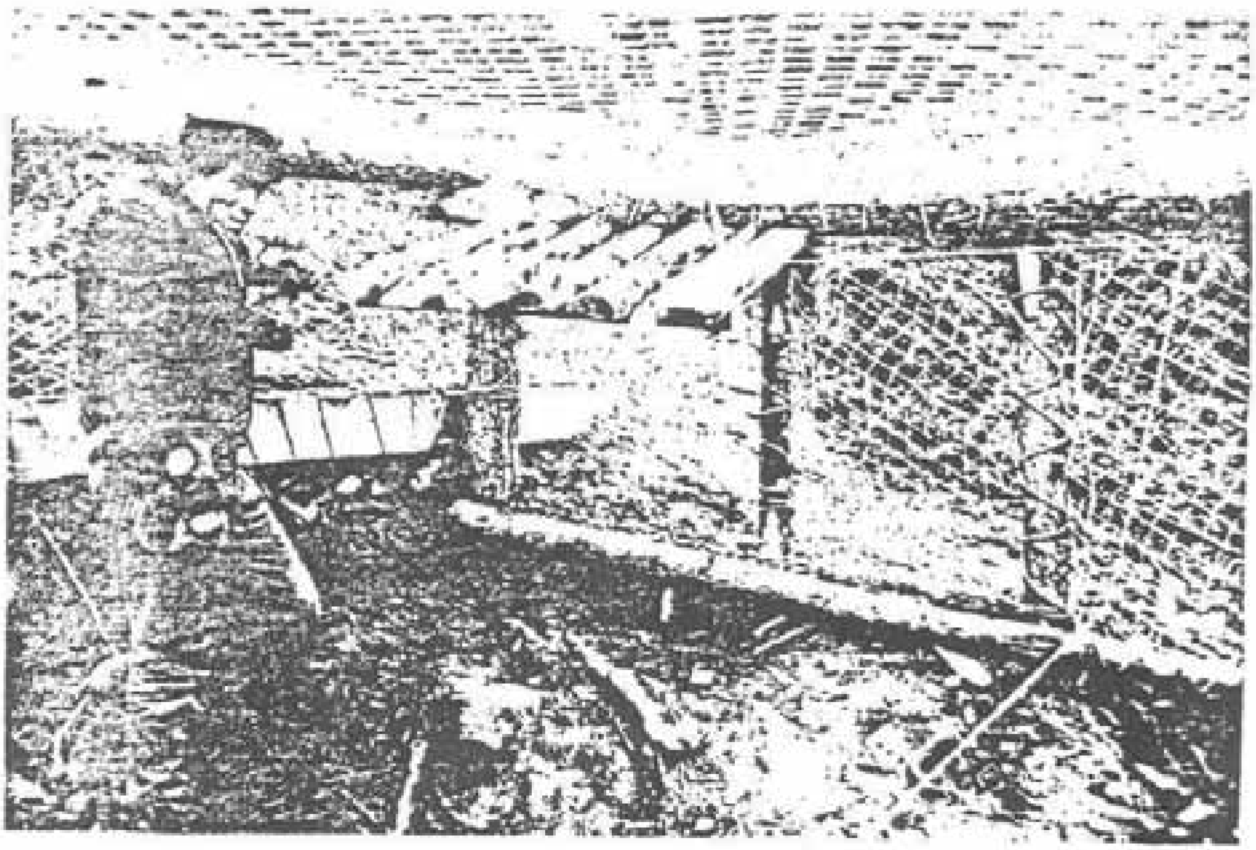

FIG. 3 -- TRAP FOR DALL SHEEP USED ON THE
KEELE RIVER, MACKENZIE MOUNTAINS,
NWT. DETAILS OF THE SIMPLE
AUTOMATIC TREGGIER ARE SHOWN.
(PHOTO: W. SIMMONS, CANADIAN
WILDLIFE SERVICE)

Each trap can be constructed by two men in less than a normal work day. It can be stripped of its netting in an hour or less, and the net may then be transported by pack frame, canoe, or small plane to another trap frame. The traps are simple and nearly maintenance-free, Unless you catch a grizzly bear. In that unfortunate case, you merely sew the netting together again.

Fifty-pound salt blocks were placed in each trap to bait the sheep into the trap. Such salt blocks had been at the natural mineral licks for two years preceding trap construction, and the sheep sought them out in preference to the mineral-laden soil.

The traps were located at natural mineral licks on the shore of the Keele River. One trap is about 13 miles upstream from our base camp, and the other is only about 4 1/2 miles upstream (Fig. 4). The traps can be checked daily by boat or aircraft.

Marking sheep. We used both NASCO (Fort Atkinson, Wisconsin) Jumbo Rototags and Perfect ear tags, and Day-Glo Saflag 3/4 by 18 inch strips (The Safety Flag Co. of America, Pawtucket, Rhode Island) in various color and number combinations to mark the ears of captured sheep. Such markers are in common use and will not be discussed in detail here.

Robertson developed a simple identification code using notches filed in the trailing edge of horns and small brass screws imbedded in horns. This system should enable a sheep to be identified when "in-hand", either alive or as a skeleton.

The captured sheep were also spray-painted in such a manner that they could be recognized as individuals from the air until the painted hair wore off or was shed.

Positive results. Eighteen sheep were caught between 30 August and 21 September, 1969. One died of unknown causes while it was being tagged.

The traps themselves worked very well. The trip cord was placed near the rear half of the trap so that several sheep could enter before springing the trap as they jostled one another around the centrally-located salt block. The trapped sheep were caught one at a time by hand, sometimes with the aid of a lariat, and carried outside through the access door for weighing, measuring, and marking.

Fig. 4 -- Map showing mineral licks used for tapping sheep and the Canadian Wildlife Service base camp on the Keele River, Mackenzie Mountains (Carcajou Cany on Sheet 96D; scale 1:250,000).

Six marked sheep were seen in September, 1969, by pilots flying within a 10-mile radius of the traps. The pilots were only casual observers and were not looking for the marked sheep. The readily saw the paint on the white coats of the sheep, and they saw the ear streamers on closer inspection.

Four marked sheep were seen from the air by Simmons and pilot Perry Linton in March, 1970, during about 8 hours of searching. Some paint remained on three of the sheep. This made spotting much easier. However, the ear streamers were visible from the aircraft at first sighting. All of the marked sheep seen in September, 1969, and march, 1970, were identifiable as individuals were recognized by their paint pattern. The color code of the ear tags and streamers could not be discerned from the air.

Problems and Proposed Solutions

Aerial survey technique

Aerial surveys conducted to gather information about Dall sheep are useful and perhaps even necessary in wilderness areas like the Mackenzie Mountains. However, when the information gathered includes total counts of Dall, the survey may be weakened in value by inherent observer-caused errors and the high cost of conducting the survey for a questionable return. Sources of error are numerous and some are well hidden, but only a few major ones will be discussed here.

Sources of error. When we saw how well Dall sheep stand out on alpine tundra in the summer and how clearly their tracks show up in bright sunlight in the winter, we became confident of our ability to make a total count of the sheep in a small, well-defined area. However, after comparing aerial surveys conducted under similar conditions for two or more years, we became confused by the variability in our figures. Where might we have gone astray?

In February and March, 1970, all or most of are 6h was searched three times by fixed-wing aircraft and several sources of error came to light. In the first place the basic assumptions made prior to the surveys did not all hold true:

1. We found quite a few sheep below timberline. A group of six were found in the forest on the

bank of the Keele River, nearly two miles from timberline. Sheep in timber are hard to see and no doubt are a major cause of variability.

2. There is a possibility that sheep may cower and hug rock outcrops when they hear an airplane, and thus become hard to see, especially in rugged areas swept nearly bare of snow in the winter. We noticed that after our third search of 6h this past winter, the sheep were frightened more easily by our plane than they were during the first search.

Several other potential sources of variability in counts of Dall sheep are fairly well known and require little discussion. Observer fatigue and subsequent inattention to the demanding task of searching for sheep can be caused by turbulence, engine noise, infrequent rest periods, and uncomfortable aircraft. Variability in the skills and techniques of both pilot and observer directly affects the accuracy of the count. Variability in the amount of sunlight and shadows covering the survey area is a very important factor. Like shadows, uneven snow cover in the winter can mask the presence of sheep that may leave no tracks and that blend well with their mottled habitat.

Of the above factors, poor weather was the most vexing. For example, even after repeated tries we have been unable to complete a single aerial survey of 6h during summer months because of unsuitable weather.

Expense. The minimum cost for conducting an aerial survey of 6h with a Helio Courier is about $1000. This includes the cost of positioning fuel for the survey and aircraft ferry charges. Often you can add to that amount the cost of holding the aircraft until weather improves and the cost of aborted attempts to survey the area. The latter expense may be considerable, especially when you nearly complete your area and are forced by deteriorating weather to quit and start over again later. With our normal luck the cost of surveying 6h could easily be $2000.

Area 6h is a relatively small mountain block that takes about five hours to search thoroughly. Other sample areas in the Mackenzie Mountains take 10 hours or more to survey.

Until we know the validity of survey results, we cannot decide whether the results merit the high cost of aerial surveys. If the results do not justify the expense, we may have to rely on only indirect indicators of population status such as hunter kill statistics.

Further work needed. More work in 6h, with both fixed-wing and rotary-wing aircraft, is needed before we can determine the magnitude of errors indirectly caused by movements of sheep to and from timbered areas and by hidden sheep. Until then, we cannot suggest solutions to the dilemma. Observer fatigue, pilot and observer skill problems, and inadequate lighting problems have been solved for the current experiment. However, these problems may be practically insoluble when different pilots, observers, and aircraft are used by the Game Management Service. The magnitude of errors caused by these factors could be estimated once the validity of aerial surveys conducted under ideal conditions has been determined.

Marking sheep

Trapping and tagging - problems and solutions. The trapping and tagging program itself has a few recognized "bugs", but they may be easily remedied. The main problem with the present traps is in the handling of captured sheep. The sheep become quite excited when a trapper enters the trap to catch each sheep. We propose to build dark rooms into which the sheep can be coaxed before they are handled. The sheep may bed down in these rooms and may not become excited even when men enter the rooms. This technique has been used successfully with bighorn sheep (O. canadensis).

We noticed that the sheep become very thirsty if allowed to remain in the trap a day. We will build wooden watering troughs in each trap to solve this problem. This will also help in our effort to minimize physiological stress and increase chances that our marked sheep will survive.

Two major problems with our trapping and tagging program are: 1) It is slow and costly in man-hours and 2) we have been unable to locate traps in sample areas that can be surveyed from the air in 10 hours or less. We are now experimenting with a method of dyeing sheep from an aircraft. If this proves feasible, it will be less costly than the trapping and tagging program, and we will be able to study the movements of marked sheep in any area we choose. Even if it is successful, however, this technique will only supplement our trapping and tagging program. The latter will be expanded to include at least two more traps.

Conclusions

When we identify major sources of error in conducting aerial counts of Dall sheep in the Mackenzie Mountains, work out correction factors and requirements that will minimize the effects of these errors, and weigh the cost of the surveys against the results, we may conclude that aerial counts are impractical. In that case we will have to recommend less costly, indirect indicators of population health. In any case, we believe that periodic aerial surveys, less intense than the aerial counts, will be valuable in determining Dall sheep distribution, relative abundance, seasonal range boundaries, a minimum number of rams available for harvest in heavily hunted areas, and lamb:ewe ratios in the early summer (July).

The success of our aerial survey program will depend partly on our ability to learn the seasonal movements of marked Dall in each area surveyed. The trapping and tagging program will provide us with valuable information about sheep movements, especially after we increase the number of tagged sheep each year. However, we are also hoping for the success of our aerial dye-spraying program, for this technique may be a key to the success of the entire Dall sheep project.

USE OF DROP NET AND COLLARS IN STUDY OF DALL SHEEP

by

James A. Erickson

A drop net similar to that used by Glazener, et al. (J. Wildl. Mgmt. 28: 280-287, 1964) to capture turkeys (*Meleagris gallopavo*), and by Ramsey (J. Wildl. Mgmt., 32:187-190, 1968) on deer (*Odocoileus*), has been used to capture Dall sheep in Alaska. Twenty drops of a 60 x 60-foot, 3.5-inch-square mesh net of No. 72 knotless nylon dyed black ($420 from Nichols Net & Twine, East St. Louis, Ill.) caught 68 sheep at a natural mineral lick in 8 days, 30 May - 7 June 1969.

The 200-pound net was hung from 13-foot corner poles of 2-inch pipe and propped up in the center with a 15-foot post of 1-inch pipe. Boat winches on the corner posts were used to raise the net. Blasting caps were inserted in the 3/4 inch polypropylene supporting ropes at each corner and the center, and were connected in parallel with No. 18 copper wire to a 12-volt lantern battery about 100 meters away in a blind. A push-button switch was used to close the circuit.

Sheep usually fell and could not get up again when the net dropped on their backs. Most sheep struggled for about one minute, and then lay still. Violent struggling was rare. Rapid heart beats, audible several meters away, were characteristic of captured sheep. Despite the lack of continual struggling, sheep were fatigued when released. They appeared to recover rapidly. Only 1 of 75 sheep caught to date was injured seriously, the femur of a 6-year old ram was broken, probably from falling against a sharp rock in the trap zone. The mean time required to reset the net, including measuring, collaring, and ear tagging sheep, was 77.8 minutes for the 19 resets in 1969. Two men have dropped and reset the net four times in one day. Trapping activities did not appear to disrupt the sheep's mineral lick use patterns and trapping success remained high throughout the operation.

Collars of 6-inch wide "aurora pink" "Saflag" (Safety Flag Company of America, Pawtucket, R.I.) backed with canvas and numbered in three locations with 4-inch black "Saflag" numerals were placed on captured sheep. The numerals were sewed to the collars. Cost of materials and labor was about $4.50 per collar. The collar ends were fastened together with two metal clips through grommets arranged to allow 23-inch maximum neck girth for females and 25-inch for males. Most males and some females had sufficient head and horn size at 12 months of age for collars to stay on. Apparently most collars were still functional after one year on the sheep. After 10 months of use at least one numeral and one metal clip were known to be missing. The collars do not appear to cause any lasting change in behavior of other sheep toward collared sheep.

The collars were visible to an unaided eye about one mile away. The numbers could be read at that distance with a 48X telescope. Larger numerals and stiffer backing materials should improve the readability from aircraft. Several factors, including folded collars, smallness of numbers, the evasiveness of sheep, and pilot's lack of skill in mountain flying have prevented the positive identification of 64 of 106 (60%) numbers seen from a PA-18-150 aircraft. A modified collar design, using 6-inch numerals, backed with vinyl stiffening material (about $8.00 each) will be tried in 1970. The success in reading collar numbers from the air depends to a great extent on the survey pilot's ability.

MONITORING DISEASE IN THE ROCKY MOUNTAIN BIGHORN

by

Bob Hudson

Abstract

Management of disease in big game populations requires an adequate assessment of the condition of free-ranging animals. Many of the basic blood parameters are not specific for disease processes and reflect only general physiological adaptation to stress. The seromucoid proteins were evaluated as more specific correlates of inflamatory reactions to parasitism. These proteins were useful in detecting changes in parasite activity, however, they did not reflect the size or number of inactive lesions. Reactiviation of lungworms during the vernal rise of larval output resulted in the stimulation of an inflammatory reaction mediated by an antibody similar to that causing hay fever or food allergies in man. In areas where trapping operations are conducted, seromucoid analysis may be a useful tool in studying the host response to parasitism.

WHITE MUSCLE DISEASE IN GOATS AND SHEEP

by

Daryll Hebert

Abstract

Mountain goats (Oreamnos americanus), from which blood samples were being taken in an effort to determine serum sodium values, were trapped during the summers of 1965, 1966, 1967. During the first two summers three animals died, two adult females and a kid, following symptoms approximating those of white muscle disease, as described by Muth (1963). This led to further studies on three animals in the summer of 1967, to ascertain whether or not white muscle disease was present. S-GOT values were determined and a histological evaluation was made of the muscle tissue.

Even where presumed white muscle disease was occurring in mountain goats, mountain sheep (Ovis canadensis) inhabiting the same general region were not affected. Evidence was accumulated explaining some factors influencing the susceptibility of mountain sheep and goats to white muscle disease.

POPULATION CHARACTERISTICS AND HARVEST OF BIGHORN SHEEP IN SUN RIVER AREA, MONTANA

by

Allen Schallenberger

Abstract

One of the largest herds of bighorn sheep in the United Sates ranges in the Sun River area of west-central Montana. History and physiography of the area are given. Forage utilization on winter ranges and condition of the ranges are briefly mentioned. History of the harvest through hunting and removal by trapping and transplanting are given. Population characteristics and the apparent effects of harvest are discussed. Results are contrasted with those found for bighorn sheep in Nevada.

AERIAL INVENTORY AND CLASSIFICATION OF DALL SHEEP IN ALASKA

by

Lyman Nichols

Because they are white in color and inhabit almost exclusively the treeless alpine, Dall sheep are one of the best suited of all species to aerial census. In Alaska, they have been counted by air for a number of years by investigators working for the Alaska Department of Fish and Game, the U. S. Fish and Wildlife Service, and the U. S. National Park Service. Jones (1963), Nichols and Erickson (1968), Scott (1949), Sumner (1948) and others have reported on the use of aerial surveys in attempting to count and classify Dall sheep.

Workers in the past, myself included, fell into the trap of believing that these animals could be counted accurately and rapidly because they appear so obvious on the green, summer alpine range. However, the more we worked with the technique in attempting to determine population status, the more it became apparent that much more flight time and effort was required to get adquate area coverage and count accuracy than was spent in the past. Even though the sheep are white, they can blend with the landscape under certain conditions of light and terrain. Unless every alpine meadow, canyon and cliff is carefully searched, sheep will be missed. Animals will bunch when approached closely, making accurate counting very difficult. A few peaks covered with clouds may mean large groups missed. Worst of all, we found that it is nearly impossible to identify all age classes at any one time of year form the air and so obtain a true picture of herd composition.

Attempts to examine and compare herds by observed percentages of sex and age classes as done in the past also proved useless, partly because of improper animal identification and partly because comparison by percentages is relatively meaningless. Since the percentage in the herd of a particular class is dependent upon the abundance of the other age or sex classes, it is not an adequate means of examining and comparing the status of the class in question. For example, in a herd containing 75 rams, 100 ewes, 25 yearlings and 50 lambs, the percentage of lambs is 20 percent. In a herd of 25 rams, 100 ewes, 5 yearlings and 50 lambs, the lamb segment represents 28 percent of the herd, apparently indicating higher production. Actually, the best indicator of production is the lamb:ewe ratio, which in this case is identical at 50:100 showing equal production in each herd. Therefore it became obvious that we would have to expend more effort to obtain complete area coverage and accurate classification, and to interpret the data by means of valid comparisons. Further complicating the problem was our inability to accurately classify a herd from the air at any given season. During the common summer surveys, sufficient effort makes it possible to enumerate a high percentage of the total sheep present and to classify new lambs with very good accuracy. However, some rams invariably seem to be missed due to their often solitary habits and the exceptionally rough terrain they seek. Yearling females (between 12 and 15 months of age) and most yearling males are extremely difficult to differentiate from young adult ewes and so are usually classified as "ewes". Horn tips are hard to see against the dark green or brown summer background making it difficult to separate rams into size classes where this is of interest.

Classification counts conducted in the spring, preferably in April, make it possible to classify the past summer's lambs, thus enabling the determination of lamb survival through their first winter and, as will be explained later, the determination with reasonable accuracy of the proportion of adult ewes in the herd. Since the sheep are still more or less concentrated on their spring ranges, with the rams still occupying the same ranges as the ewes, an accurate determination of the proportion of rams to ewes may also be obtained at this time. Snow conditions are frequently spotty at this season, and it is easy to miss substantial numbers of sheep against the broken background, making an estimate of the total herd size impractical. For the same reason, classification of many rams by horn size is still difficult.

The best time for classifying rams has been found to be during midwinter. They are randomly distributed among the ewe bands during and shortly after the rut and horns show up very well against the snow background. A good estimation of the proportion of rams to ewes may be obtained, and classification by horn size is relatively easy. Ewe:lamb ratios during the winter may also be readily obtained. The disadvantages of midwinter surveys include the difficulty of obtaining adequate sample sizes due to the short hours of sufficient daylight, the difficulty in locating all groups of animals, making herd-size estimates impractical, and the usual problems of cold weather airplane and people operation, particularly in remote areas.

To make three detailed classification surveys each year of large sections of sheep habitat is beyond our budgetary and manpower means. Therefore, we have tentatively settled on two types of sheep count to determine the status of various herds.

The general inventory survey is a relatively simple one, designed to give an estimate of total population size and distribution. Such surveys are flown during the summer after most of the snow has melted off the sheep mountains and after the termination of lambing season. Relatively large blocks of habitat are covered, limited each year by manpower and budget. No systematic attempt is made to classify sheep during these counts because of the reasons previously given; however, lambs and adult rams are frequently tallied to give at least an impression of production and available animals for harvest.

The technique used is to pre-select a block of mountains of a size that experience dictates can be covered with desired accuracy within time and financial limits. Boundaries should be picked which limit sheep movement to and from uncounted neighboring areas which may be surveyed in future years. Although the flying is not nearly so critical as in classification surveys, it still requires a suitable aircraft and a pilot experienced in mountain flying. Turbine-powered helicopters would be well suited for this job but are too expensive, at least for our budget. The best aircraft found for the job so far, and the only one really suitable for it, is the Piper PA-18-150 Supercub, a two-place, tandem-seated airplane in which both pilot and observer have excellent visibility from both sides of the plane.

One of the most helpful devices we use in sheep census is an intercom set which allows pilot and observer to communicate freely without shouting. Our set is completely self-contained so it can be used in any plane and is built into a pair of military-type crash helmets. Built-in boom microphones and earphones, and a continually "on" circuit, enable the carrying on of normal conversation without interference in flying or writing. The crash helmets provide an obvious safety device but are expensive. A similar unit can be built with much cheaper earphone-boom microphone sets. Being able to talk freely and easily enables the pilot and observer to cooperate readily in locating and classifying animals and increases of the work.

It is the pilot's job to help locate sheep, to put the observer in position to count them, and to keep him in contact with a given group until he feels it is completely enumerated. The pilot must also remain constantly oriented to prevent duplicate counting or missing of groups. The observer does the actual counting, plotting, recording and navigating. He is equipped with a suitable topographic map of the area, usually 1:250,000 scale although in some cases a:63,360 maps may be used where they do not cause inconvenience in the small cockpit. The observer plots the actual route of the count directly on the map during flight. This makes it possible to continually check the route for missed areas as well as to maintain orientation for observation plotting. Each sheep or group of sheep is plotted on the map by means of a consecutive index number, only, to avoid confusion. Forms are also carried by the observer which enable him to readily record each animal by sex or age class if desired, or at least by group size in the case of a rough inventory survey. Each observation is then recorded in desired detail on the form, using the same index number as given for that observation on the map. Each may thus be referred to by location, number, and/or composition. Distribution is then adequately portrayed and may be readily compared in future counts for detailed changes.

Results of each survey are later listed on a simple summary form for ease in reporting or quick reference. Original flight maps, observation and summary forms are filed together for reference.

The second type of survey used is the detailed classification count, conducted three times each year as previously described on selected sample or study areas. These are designed to supply data on herd-size trends, production, lamb survival, seasonal movements, abundance of harvestable rams, and sex ratios.

The sample areas chosen should lend themselves to aerial counting, contain a reasonable sample of sheep, be representative of the area and herd sampled, have boundaries as finite and impassable to sheep ingress or egress as possible, and require no more than four or five hours of flying time for a complete survey. If more time is required, they may not be completely surveyed in one, or at most two short winter days, making it possible for weather changes to interrupt the counting.

Weather, aircraft performance, and pilot technique and experience are much more critical than for inventory surveys. To obtain accurate data, it is necessary to get complete area coverage in the case of a total-herd count, and to classify all animals as accurately as possible. The pilot must be able to take the observer by the sheep in such a manner as to enable him to determine sex and age class of each animal. This requires low, slow passes, sometimes many of them so that compact, shifting groups may be sorted out. In some cases, groups bunch and shift so badly that they cannot be counted. Then it is necessary to split them up or make them move out into countable form by "buzzing" them with the plane. The observer must be willing to stay with each group until he is satisfied with his classification and counting. Needless to say, this takes time, skill and conscientious effort.

These counts should not be undertaken unless the weather is good. Strong winds are especially to be avoided since they cause turbulence that not only makes counting difficult and unpleasant, but creates a definite hazard in the form of severe downdrafts. Light winds may cause minor turbulence but should be no problem to a pilot experienced in mountain flying. Sometimes they can actually be of assistance, since by flying upwind past a group of sheep, groundspeed is reduced, giving the observer longer observation time.

When counting a number of sheep scattered on a broken slope, we have found that it is easier to keep track of animals by subdividing the slope into smaller units bounded by avalanche chutes, ridges, etc. Then the counting is started with the uppermost animals and the work progressed downwards until the segment is completed. Sheep usually tend to move directly up steep, broken mountainsides when "worked" by a plane. When the count is started at the bottom, tallied animals working upwards mingle with those as yet uncounted, creating confusion for the observer.

After the data have been gathered from the various counts, it is necessary to interpret them into useful form. As stated previously, herd composition cannot readily be determined from the results of any one survey. Therefore, it is necessary to mathematically construct a population from

The data which will represent the actual composition and size at any one time. The following example illustrates the method I use to arrive at an approximation of the herd status during the summer after lambing and prior to hunting. Although results are far from absolute, they represent the true composition of the sample herd better than results from one summer count.

To obtain the ewe-yearling-lamb segment of the population, we use the pre-lambing (April) and post-lambing (July) surveys. Yearlings and ewes (always including a few unidentified young rams as "ewes") may be directly classified in the early count, while lambs may be readily identified in the later count but ewes and yearlings are not easily distinguished and so must be lumped. For the moment, the ram segment may be ignored. Assume a count as follows:

Count Date	Rams	Ewes	Ewes+ Yearlings	Yearlings	Lambs	Total
April	60	150	(180)	30	--	270
July	70	?	(240)	?	80	390

The yearling:ewe ratio may be used as observed in April and is 30:150 or 20:100. Since sample sizes are different in the two counts, the yearling:ewe ratio (assumed to remain the same) must be extrapolated to determine the number of ewes and yearlings in the summer population. The difference between the 240 ewes+yearlings observed in July and the 180 observed in April is 60 ewes+yearlings assumed missed in the April survey. At the ratio of 20:100, these represent 10 yearlings and 50 ewes which must be added to the observed 30 yearlings and 150 ewes in April to give the summer composition, or 40 yearlings and 200 ewes. Thus, the computed ewe and yearling and observed lamb composition of the herd is as follows:

	Ewes	Yearlings	Lambs
Computed July Population	200	40	80

The next step is to determine the ram segment of the sample herd by using the classifications obtained in the various surveys as follows:

Count Date	Unclas. Rams	Young Rams	Legal Rams	All Rams	Ewes
April	25	30	5	60	150
July	20	40	10	70	200*
January	--	24	5	29	100

Several factors regarding the counts are apparent: the greatest number of animals was counted in July, the best time for a "total" count. The April and January counts were for the purpose of obtaining ratios and were sample counts, only. A number of rams were unclassified as to size in the April and July counts when horn tips were hard to see. (A "legal" ram in Alaska is one with a horn curl of 270° or greater: a 3/4-curl ram). All rams were classified in January when visibility was best.

The highest ram:ewe ratio was observed in the April count at 60:150 or 40:100. Ram:ewe ratios obtained in the January count could only be used in computing the following summer's population unless the past fall's harvest is known. The highest observed ram:ewe ratio is used for computations under the assumption that young rams may sometimes be classified as "ewes", but rarely are ewes classified as "rams". Therefore, the highest ram:ewe ratio seen is probably the most accurate.

By applying the ram:ewe ratio of 40:100 to the computed 200 ewes in the July population, a total of 80 rams should have been present in the herd at that time. Ten rams were assumed to have been missed during the summer survey.

The January survey data are used to determine the classification of rams in the past July's population, and the number of rams harvested during the hunting season which fell between the July and the January censuses. A known harvest would make it possible to check the accuracy of the computations.

The observed ratio of 29 rams to 100 ewes in January cannot be used in direct comparison with the July figures since in January, the 100 "ewes" include unidentified yearlings. At the computed July ratio of 40 yearlings to

*Computed

240 yearlings+ewes, 17 yearlings and 83 ewes should make up the 100 ewes+yearlings in the January count. Thus, the observed ram:ewe ratio should be 29:83. Extrapolating this to the computed 200 ewes which should still be in the herd, there would be 70 rams altogether in the January population. Subtracting the 70 computed for January from the 80 computed for July would leave 10, presumably legal rams removed by hunting.

At the observed ratio of legal rams to all rams of 5:29, or 17:100, there should be 12 legal rams in the computed January ram population of 70. The remaining 58 young rams may be presumed to have been present in the July population as well as in that of January.

The hypothetical July population can now be reconstructed as follows:

Young Rams	Legal Rams	All Rams	Ewes	Yearlings	Lambs	Total
58	22	80	200	40	80	400

Ratios obtained from the foregoing computations for this population are:

Rams:Ewes	=	40:100
Legal Rams:Ewes	=	11:100
Yearlings:Ewes	=	20:100
Lambs:Ewes	=	40:100

These ratios should give a more accurate indication of herd sex and age composition, production, and survival than direct counts during any survey, and may be compared directly and meaningfully with similar ratios from other herds or from year to year.

Although this method is probably more useful already than direct count data, several refinements are necessary to improve its accuracy. More must be learned about adult mortality by season and about ram horn growth between count periods. The method at present cannot take into consideration mortality or changes in status between "young" and "legal" rams from count to count. Two-year-old ewes (22-24 months of age) can be identified from the air in the spring by horn and body size, but I am not yet sure of the identification of rams of the same age class. If animals of this age class are sexually mature by their second breeding season at approximately 18 months of age, they can logically be included with the "adult" ewe and ram segments in computations. However, if they are not, they will have to be classified separately in order to accurately determine production, survival, etc. as ratios to 100 adult ewes. Most of this needed information should be provided within the next few years by present and projected sheep studies in Alaska.

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AN ANALYSIS OF THE EFFECTS OF TEN YEARS OPEN SEASON HUNTING ON BIGHORN SHEEP POPULATIONS IN IDAHO

by

James K. Morgan

Abstract

Hunter questionnaires were sent to every Idaho bighorn sheep hunter in 1960 and 1968. Better than 90% return was obtained. A comparison of average number bighorns observed, average number legal rams observed, tag sales trend and harvest trend is made for the period encompassed by the two questionnaires. The point of diminishing returns on open season ram hunting is reflected in the data. Average number of bighorns observed per hunter declined 52% between 1960 and 1968. Average number of legal rams observed per hunter declined 85% for the same period. Open season hunting in the face of extremely low recruitment rates is postulated as the reason for the 33% greater decrease in the ram component. The possibility that reducing the ram component below some specified level may interfere with reproduction through behavioral mechanisms is examined. Management alternatives to regulate the harvest of mature rams are suggested.

SEASONAL GROWTH PATTERNS OF BIGHORNS CORRELATED WITH RANGE CONDITIONS AND ENDOPARASITE LOADS

by

John G. Stelfox and Joe McGillis

Data obtained from bighorn sheep winter ranges in Jasper, Banff, Waterton Lakes and Kootenay National parks for the period 1966-69 indicate a direct correlation among forage production, ungulate stocking rates, endoparasite loads and overwinter weight losses. Table 1 compares data from two winter ranges in each of Jasper, Banff, and Waterton Lakes parks. parasite data are from Bandy (1968) and Uhazy (1969).

Table 1. Forage production, stocking rates (days-use/acre), lungworm loads and overwinter weight losses from two bighorn sheep winter ranges in each of Jasper, Banff and Waterton Lakes parks, 1967-69.

Park	lbs. Forage Per Acre	Animal (Days-Use Per Acre)	Lungworm Per Gram of Feces	% Samples** Heavy load Parasites	Ave. Ewe Wts.(lbs) (lbs)		Winter*** Wt. loss
					Fall	Spring	
Jasper	133	71	2,375	48	169^{16}*	133^{11}	20
Banff	205	75	626	17	158^{8}	141^{6}	11
Waterton	428	29	594	0	166^{3}	144^{16}	13

* Sample size.
**% fecal samples with 1,200+ lungworm larvae per gram fecal material
***Winter weight loss as a percent of fall weight.

The above table indicates that although fall weights are similar in Jasper and Waterton, that mature ewes in Jasper sustain a 20 percent overwinter weight loss while foraging on an unproductive range (133 lbs. forage/acre), under a high stocking rate (71 days-use/acre) and while supporting a high lungworm load (2,375 larvae/gram of feces). Conversely, in Waterton where the range is over three times as productive, the stocking rate only 41 percent as heavy, and the lungworm load only 25 percent as great, mature ewes lost only 13 percent of their fall weight. In Banff where forage production is somewhat greater than in Jasper but where the stocking rate is similar, ewes lost only 11 percent of their fall weight. The greater weight loss in Jasper seems due in part to the lungworm load being four times greater than that in Banff.

Table 1 shows that 48 percent of the fecal samples from six herds in Jasper continued heavy lungworm loads (1200 + larvae/gram of feces), compared with 17 percent from four herds sampled in Banff, and 0 percent from two herds sampled in Waterton during 1967-69.

The influence of total endoparasite loads on bighorn sheep lamb weights is presented in Table 2.

Table 2. Relationship of body weight to endoparasite loads of five female bighorn sheep lambs in Jasper and Banff National Parks; 1966-69 (Uhazy 1969).

	0.8 Yr. 56 lbs.	0.9 Yr. 44 lbs.	0.5 Yr. 76 lbs.	0.6 Yr. 65 lbs.	0.7 Yr. 48 lbs.
NEMATODES	No. 1	No. 2	No. 3	No. 4	No. 5
Protostr. stilesi	heavy	mod.	light	light	
Protostr. rushi	0	4	0	0	0
Marshallagia marsh.	1270	962	21	32	0
Other *Marsh.*, *Ostert.*, & *Teladorsagia* spp.	1961	1943	61	44	0
Nematodirus spp.	4806	4022	200	19	831
Trichuris ovis	303	371	108	21	25
CESTODES					
Moniezia expansa	3	1	40	0	0
Totals	8345	7303	430	116	856

Table 2 shows that the three weekend ewe lambs (nos. 1, 2, 5) averaged only 49 lbs. during the winter and had an average endoparasite load (excluding lungworms) of 5,501 compared with an average weight of 70 pounds and a parasite load of 273 for the two normal lambs.

Bandy (1968) found an average of 550 Eimeria (coccidia) per gram of feces in the Stoddard Creek and Columbia Lake herds south of Kootenay Park during January-March 1966 six months prior to the 75 percent die-off of these herds, and an average of only 115 Eimeria during January-March 1967, immediately after the die-off. He also reported an average of 660 Eimeria per gram of feces for the Graveyard and Vermilion Lakes herds in Jasper and Banff respectively during January-March 1967 where populations were high but where no die-off was occurring. He also found Nemacodirus and Marshallagia spp. higher (199) prior to the die-off than after the die-off (110). Cowan (1951) reported heavy parasitism by Ostertagia and Nematodirus in three confined bighorns that were in a moribund condition.

Fall Weights and Condition

ram lambs averaged 70.3 pounds and ewe lambs 65.3 pounds during the falls of 1966 to 1969 in Jasper and Banff. Ram lambs gained an average of 6.4 pounds over winter compared with 4.4 pounds for ewe lambs.

Rams increased in weight until at least six years of age when they averaged 274 pounds in the fall. The heaviest ram weighed was a 10 year old at Jasper which weighed 301 pounds on November 14, 1968. At this time the rut had been in progress for two weeks. Mature rams in Jasper lost 50 to 70 pounds during the 60 day rutting period of November and December. One eight-year old ram lost 35 pounds during 32 days of rutting (1.1 lbs./day) between November 15 and December 17. Full curl rams averaged 297.5 pounds in mid November and 235.0 pounds in January and February after the rut.

Spring Weights and Condition

The average spring weight of eight rams (6 yrs.+) in Jasper was 230 pounds, a decrease of 22.7 percent from their fall weight. Mature ewes (3 yrs.+) had only a 20.0 percent overwinter weight loss in Jasper compared with 13.0 percent in Waterton. In summary, there appears to be no significant difference between fall weights in Jasper and Waterton, indicating that summer ranges in both parks are adequate to permit bighorns to attain the prime condition of 165 to 170 pounds for mature ewes and 290 to 310 pounds for full curl rams in late October. Lungworm loads up to 1000 larvae per gram of feces have little effect in increasing winter weight losses above that due to range, climate and rutting stresses. However, an average lungworm load of 2,375 larvae per gram of feces was associated with a 20 percent weight loss in ewes compared to an 11 percent weight loss where the lungworm load was only 626 larvae per gram of feces but where stocking rates and forage production were quite similar. Non of the lungworm loads were heavy (1200 + larvae per gram of feces) where the forage production was 428 pounds per acre and the stocking rate only 29 animal days-use per acre. With a stocking rate of 75 animal days-use per acre on a winter range producing only 205 pounds forage per acre, 17 percent of the fecal samples were heavily parasitized with lungworms. When forage production decreased to 133 pounds per acre and the stocking rate remained high (71 animal days-use per acre) the fecal samples averaged 2,375 lungworm larvae per gram of feces.

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BIGHORN SHEEP AND OVERGRAZING IN THE LOWER CHILCOTIN RIVER REGION, BRITISH COLUMBIA

by

Dennis A. Demarchi

The Lower Chilcotin River region of British Columbia supports populations of California bighorn sheep (Ovis canadensis californiana Douglas) and domestic cattle. The earliest records about the bighorn on this range referred to them as a "nice little band of sheep", Williams (1926) or "a small band (of bighorn)", Cowan (1940). Cowan even went as far as to omit this area from his distribution map of native bighorn in recent historical times.

The earliest recording of bighorn here was by Simon Fraser in 1808 (Lamb, 1960). Fraser was the first white man to explore this portion of the Fraser River. At a narrow constriction of the Fraser River approximately three miles upstream from the mouth of the Chilcotin River he noted a "horn of the Sasyan or Rocky Mountain Ram".

There were no estimates at the numbers or distribution of the bighorn until approximately 1917. However, most of the records are subject to bias until Sugden studied this area in the mid - 50's. Sugden (1961) speculated that the bighorn in this region had fluctuated over the years with a major low about 1915.

The bighorn in this area were observed from the ground or in fixed-wing aircraft until 1961. I had reason to believe that the earlier estimates of the population were grossly in error and under estimates.

In 1961, H. B. Mitchell counted 401 sheep on this range. In 1962, C/O J. Lesowski estimated 300 plus bighorn on one portion of the range. In May 1964, H. Mitchell and J. Lesowski classified 313 sheep. And so the counts go until 1968 when I conducted the research for my Master's degree on this range. Harold Mitchell conducted several classified counts at the same time as I was studying the range conditions. Of the four counts from August 1968 to August 1969 the highest total animals seen was on August 2nd, 1968, when 358 animals were classified.

The ratio of rams to 100 ewes classified fluctuated slightly being 37, 52 and 34 rams per 100 ewes on August 2nd, November 22 and March 13 respectively (Table 1). But the proportion of lambs to 100 ewes showed a rapid decline, being 41, 23, 25 lambs per 100 ewes in August, November and March. At the same time the number of animals classified dropped from 358 to 284 to 231 (Table 2).

The snow conditions during the 1968-69 winter were very adverse, as this was one of the first winters in recent times when the snow did not blow off the slopes. However, this does not explain the drop in lambs and the total count between November and August. It is rather significant that the count of lambs dropped from 81 to 38 during this period, but from November to March did not vary.

I did not include any data from my ground counts during the spring and summer of 1968. I had confined myself to a limited portion of the range, and access was difficult so that I did not observe many of the sheep. Perhaps though I should say that on June 7, I observed 109 ewes and 68 lambs and then on July 21, I observed 124 ewes and 62 lambs, which is a drop of 12 lambs per 100 ewes in this period. Incidentally, my count on July 21 is the same as the helicopter count on August 2nd for the same area.

The bighorn sheep occupy mainly the Agropyron/Poa habitat type. Overgrazing of the Agropyron/Poa association by livestock has greatly reduced the climax dominant grass species, Agropyron spicatum. Stipa comata increased as overgrazing began and it continued to increase until overgrazing was severer, then it too decreased. Weedy forbs such as Antennaria rosea, Opuntia fragilis, Chenopodium album and Lepidium densiflorum invaded the overgrazed community and became well established as the severity of grazing increased.

Grazing decreased the density and weight of Agropyron spicatum plants. At the same time the relative amount of crude protein in this species was increased. Grazing did not appear to affect the chemical composition of Stipa comata. There was more protein per square meter in Stipa comata from fair condition sites than in Agropyron spicatum from excellent condition sites. Stipa comata from poor condition sites produced as much crude protein per square meter as did Agropyron spicatum from excellent condition sites.

The phenological development Agropyron spicatum and Stipa comata affected their chemical composition. Crude protein, phosphorous and moisture percentages were highest in the leaf stage and lowest in the cured and weathered stages. Total ash and calcium percentages were highest in the cured and weathered stages and lowest in the seed-ripe stage. Crude fiber was lowest in the flowering stage and highest in the cured and weathered stages.

Increased stocking rates and poor livestock distribution are believed to be responsible for the degradation of the Agropyron/Poa climax community on this range. Close cropping of Agropyron spicatum resulted in a relative increase in forage quality, but almost eliminated this species.

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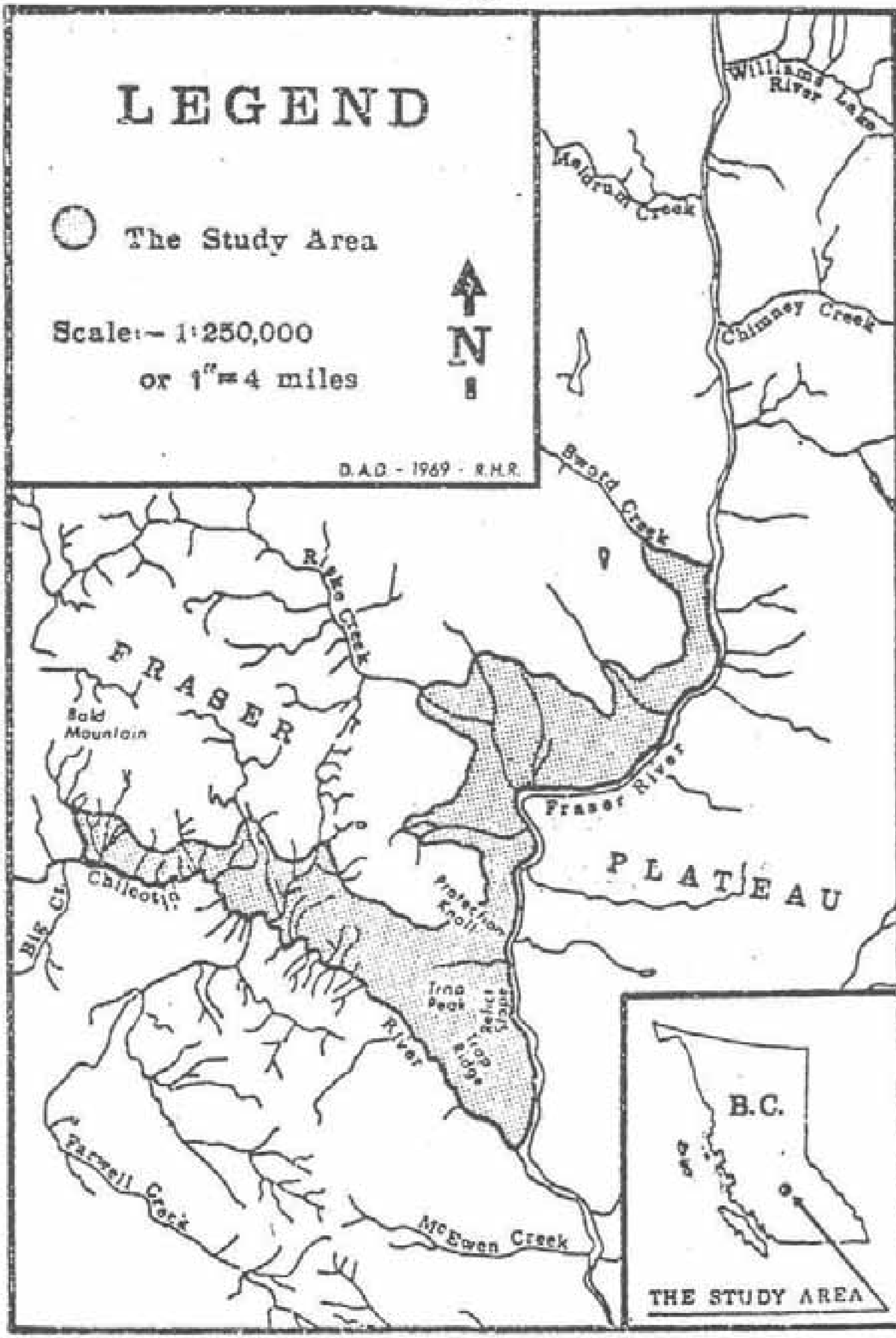
LEGEND
The Study Area
Scale:- 1:250,000
or 1" = 4 miles
N
D.A.G. - 1969 - R.H.R.
Williams River
Lake
Chimney Creek
Sword Creek
Riske Creek
FRASER
PLATEAU
Fraser River
Bald Mountain
Chilcotin
Chilcotin River
Big Cr.
Farwell Creek
McEwen Creek
Irna Peak
B.C.
THE STUDY AREA


SCALE
1:126,720 or 1" = 2 miles
D.A.D. - 1969 - R.H.R.
Fraser R.
Chilcotin R.
N
LEGEND
Open Grassland
Forest
Sagebrush
Sand Banks and Rock Cliffs
Cultivated Fields
Ponds

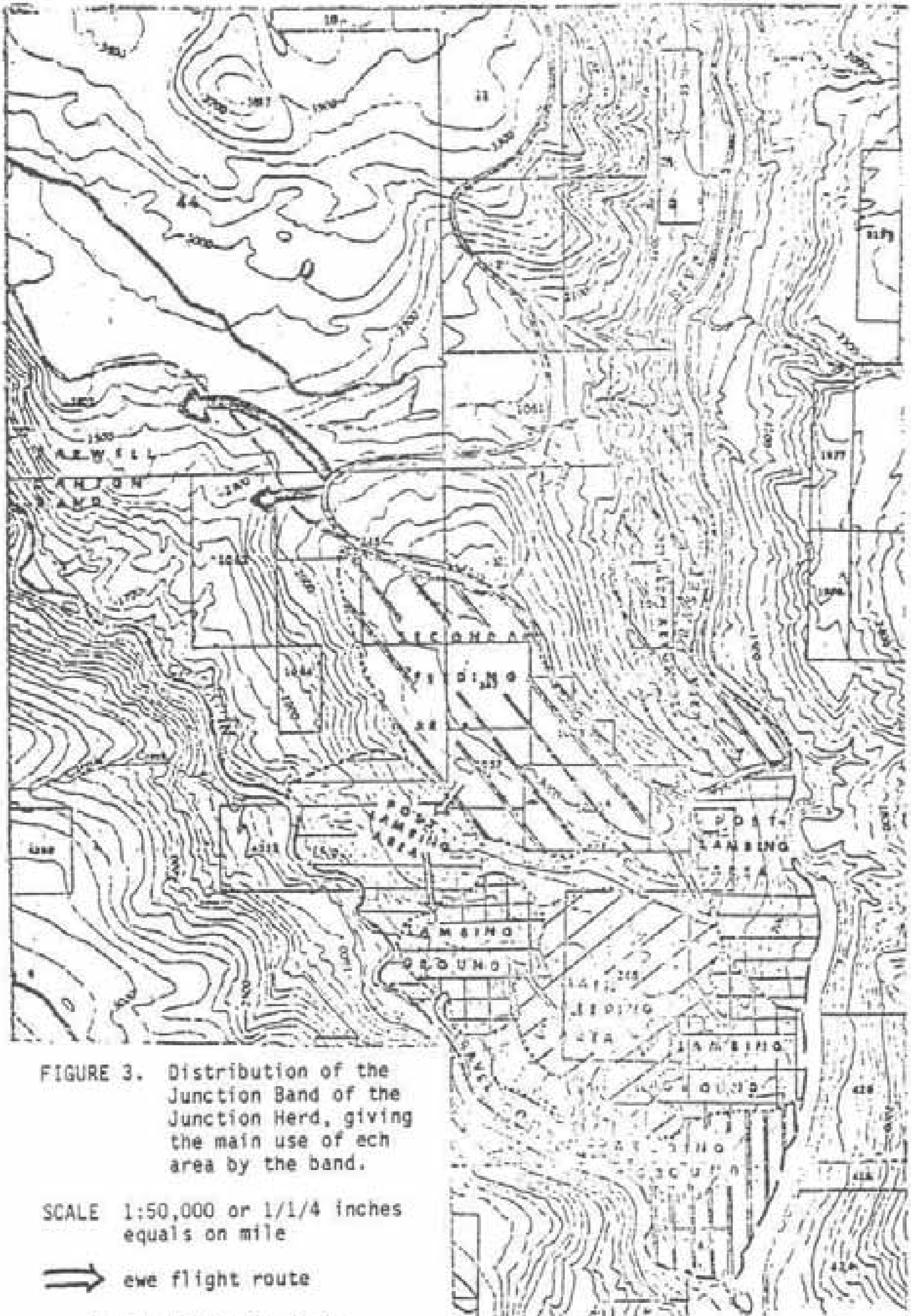

FIGURE 3. Distribution of the Junction Band of the Junction Herd, giving the main use of ech area by the band.

SCALE 1:50,000 or 1/1/4 inches equals on mile

ewe flight route

ram migration route during rutting period

Summary of Classified Counts of Bighorn on the
Chilcotin River Range

May, 1970

Dennis A. Demarchi
B. C. Fish and Wildlife Branch

Ratio of Rams: 100 Ewes:Lambs

Date	Rams:100 Ewes: Lambs	Observer
June 7, 1968	-:100:62	Demarchi*
July 21, 1968	-:100:50	Demarchi*
August 2, 1968	37:100:41	Mitchell & Demarchi**
November 22, 1968	42:100:23	Mitchell & Lesowski**
March 13, 1969	34:100:25	Mitchell & Stringer**

* Ground count on a restricted portion of the range

** Helicopter count over all the range

Classified Counts of Bighorn

	Rams	Ewes	Lambs	U/C	Total	Observer
May 22, 1964	38	126	94	55	313	Mitchell & Lesowski
August 2, 1968	74	199	81	-	358	Mitchell & Demarchi
November 22, 1968	84	162	38	-	284	Mitchell & Lesowski
March 13, 1969	49	145	37	-	231	Mitchell & Stringer

SHEEP MANAGEMENT DILEMMAS

by

V. Geist

Regrettably, the paper I am writing on sheep management is not yet finished, but what appears below will be part of it. Most biologists at the meeting will be interested in how to manage sheep for public hunting, and only this objective will be considered here, although there are other management goals of equal or greater importance.

There are a number of attributes of sheep biology which run contrary to general principles as taught and expounded in American wildlife schools. These attributes can be disregarded only at the biologist's and mountain sheep's peril.

1. Sheep produce no harvestable surplus of young adults as do quail, rabbits, deer, or moose. The input of young adults (yearlings) into the sheep population equals on the average the mortality of adults, which in stable, unhunted populations appear to be about 10-11 percent. The sheep population biology is geared to long-lived adults, minimum reproduction, and retention of young adults within the population. This is quite different from the population biology of rabbits or deer, in which reprooduction and dispersal of young adults is maximized. The population dynamics of mountain sheep appear to be quite similar to that of musk-oxen and caribou which are also highly gregarious ruminants, exploiting climax plant communities.

2. Hunting mortality for sheep is largely additive, not compensatory. Whereas there exists a sound, logical basis for hunting, compensating for natural mortality, in such species as grouse, quail, rabbits and squirrels, and to quite an extent also white-tailed deer and moose, there is no factual basis whatsoever for hunting compensating fro natural mortality in rams. One can state quite exactly how much hunting "compensates" for the natural mortality of rams. Assuming a stable population it will be about 4 percent or less for rams younger than eight years. That is, from 100 rams shot of that age class, at least 96 would have continued to live. For rams older than eight years, the picture changes only a little. Given an average maximum mortality of 23 percent, as is apparently the case for the bighorns I am studying now, 77 out of 100 rams of that age class shot by hunters would have continued living. One cannot, for instance, argue in front of sportsmen that the full curl unharvested in fall will die next winter; the cahnces of being proven a liar are 77 out of 100.

The implications of this second major point are quite important. Rams which survive the hunting season can be expected to die <u>at least</u> at the same rate as those of the same age class in an <u>unhunted</u> population, and <u>not</u> at a reduced rate as would be expected for pheasant, quail, squirrels or rabbits. What this means we can show by a little calculation: we start hunting a previously unhunted population, harvesting <u>by permit full curls</u> only (8 years old or older). There are about 30 percent of the rams full curls and 70 percent rams seven years old or less including long-yearlings. Let us assume we have 100 rams. Of the young rams, 4 percent (i.e. 2.8 or 3 rams) will die; of the full curls, 23 percent (i.e. 6.9 or 7 rams) will die. Total deaths expected equals 10 rams or 10 percent. Assuming 7 percent of the rams, all full curls, are killed by hunters, then 23 full curls are left. The total mortality of full curls will then be not 7, but 7 + 23/100 = 7 + 3.29, which is approximately 10 rams. Total ram mortality will now be not 10 percent, but 13 percent of the pre-hunting population. That is quite an inroad, since only 10 long-yearling rams are added on the average to the population. If the objectives is to maintain the trophy-quality of the pre-hunting population, it cannot be achieved. The mortality of the full curls will always by $N_{\text{full curls left}} = N_{\text{f.c. pre-hunting}}(1-m_1) \times (1-m_2)$, where m_1 = hunting mortality and m_2 natural mortality expressed in decimals. The number of full curls will shrink progressively to stabilize at about $\frac{7}{7 + 70} \times 100 = 11$ percent, <u>assuming no other complications</u>. These full curls will all be those that just became eight years old, and hence carry horns typical of their age. The number of huntable full curls cannot be increased by removing full curls, but by increasing the number of young rams produced by the females. That is a separate problem.

3. Beahviourally, sheep cannot be equated with small game or even deer. Their home-range patterns are entirely different from those of deer; they are highly gregarious and maintain tradition; and they adjust their response to humans on the basis of past experience with them, and do not have an "innate" response to humans. From personal experience I can attest to the excellent memory of sheep. Thus, sheep running from humans act no more "natural" than those ignoring them or even running to them looking for hand-outs. This adaptability will cause trouble and complications unless respected, as I will indicate later.

In addition, shooting selectively for various sex-age classes will affect the biology of the unhunted sex-age classes as well.

What can one expect to happen if full curls are hunted during a long hunting season with many hunters participating?

1. Rams will withdraw from most of their accustomed areas and desert them in favour of rugged, secluded terrain--if such is available. If no secluded localities are present, (that is hunters are stalking everywhere the rams turn) desertion of favoured feeding areas is unlikely. If secluded terrain is available, the rams begin to act ecologically atypical, and begin to derive their sustenance from probably second-or third-rate range. This alone would cause trophy-quality and body size of rams to decline.

2. Psychic stress can be expected to appear for the first time. This is enormously costly in food-energy and is highly detrimental to the normal physiological functioning of the animal's body. It takes surprisingly little stress to produce, as agricultural and psychological experiments on sheep and goats have shown. For the present, however, it can only be said that it will be most likely severe only in relatively small, relic populations, while sheep in high quality populations travelling in large bands, are likely to be more forgiving.

3. Hunting will select in favour of nervous, jittery rams that spook at the slightest chance of trouble. This point was raised and argued convincingly by Dr. Chuck Hanson at the Desert Bighorn Council. It implies that nervous, jittery sheep, that easily desert ranges and are inefficient food converters, will be selected for on the whole. In the long run this means a smaller female population, decreased reproduction, and fewer trophy rams for harvest.

4. Removal of full curl rams must affect younger rams in several ways. (a) Normally, full curls guard estrous females and prevent younger rams from guarding. This means, in the presence of full curls, young rams feed and rest, and do not waste energy by guarding non-estrous females. If the full curls are removed, the field is open for the highly active six- and seven-year-olds, which now are permitted to lose their fat resources. Secondly, the overall reduction in rams, coupled with the more intense guarding by the six- and seven-year-old rams, allows young rams to guard non-estrous females. That is grim. For such young rams virtually stop feeding. We can hence expect an increased winter mortality of four- to seven-year-old rams, and a considerably reduced growth of the survivors, (b) Removal of full curls should lead to an over-exploitation of the winter-ranges of females. Normally, full curls move right after the rutting season to different wintering areas from those of the females. They are

accompanied by a segment of the young ram population, while the remainder stays with the ewes at least until mid-March, and then searches out the older rams. Removal of full curls should lead to more young rams remaining with the females, which, in the long run, will lead to smaller female populations and a smaller output of rams, (c) If there are more young rams with the females, particularly in spring, expect an increased harassment of the females. Young rams are more prone to court throughout the year, and are far more rough with the females than old rams. Although I do not know how extensive this would influence the birth weight and hence neonatal survival of the lambs, I would not laugh it off.

There are a few other complications, but these will suffice as examples. The foregoing does read like gloom and doom, but it should not. One can counteract these problems, but not by looking at how it is done with quail, squirrels or deer, which, after all, is what texts on North American game management are based upon.

BIGHORN SHEEP--WHAT IS OPTIMUM HARVEST?

by

William H. Rutherford

The basic assumption which we are making here is that bighorns can be managed for hunting, and that the man who puts up the money is entitled to a program which will produce harvestable bighorns. We know that bighorns can also be mismanaged for hunting, and here we are getting into things which other participants in the meeting have covered. In making the assumption that every herd either has or can have harvestable animals, the management program which finally evolves has to consider everything which influences the actual production of harvestable animals. Everything is so interrelated that it is a bit difficult to take one aspect of management out of context, examine it, and put it back in. I may not succeed in my attempt. Nevertheless, I have chosen to look at the aspect of administrative expediency and its relationship to bighorn herd management.

At one time or another, in one way or another, every wildlife management agency has the problem of reconciling the management needs of species with expediency of formulating and enforcing regulations. As biologists, we are all familiar with the deferences which sometimes have to be made to administrative demands. Furthermore, we are all familiar with the experience of pushing for the administrative acceptance of a particular management approach, only to find that the public will not buy it. My purpose here is not to perpetuate any rifts between biologists and administrators, or between game managers and the general public, but to explore some of the problems in bighorn sheep management which administrative or public attitudes might create.

Our primary commitment should be to strive for the greatest number of recreational hunting opportunities in bighorn sheep management. Put in other terms, the greater the number of surplus harvestable sheep which can be produced, the greater the number of permits which can be issued, and in turn, the greater the number of hunters who can be in the field. All of this, of course, is based on an assumed optimum success rate. Certainly, we can put more hunters in the field if we can convince them that an expected lower success rate should be acceptable. But if we are to be in the position of offering a reasonable chance that a sheep hunter can be successful, the only way to accommodate more hunters is to make better use of the harvestable animals which are produced.

This is the basis for the position which I am presenting here; that traditional and set management philosophies by both wildlife administrators and the public are not conducive to getting the best use of the harvestable sheep which exist in any herd.

Every herd is different. We know that bighorns have close ties to familiar range, that the pioneering instinct is weak, and that separate herds might exist in relatively close proximity without ever making contact. We know that every sheep and every herd is a product of the habitat it occupies, as well as being a product of the particular gene pool from which it came. The physical, ecological, and genetic factors which produce sheep in one herd are not the same as those which produce sheep in another herd. Each herd is an entity in itself, and its entire composition, sex and age structure, mortality rate and replacement rate are all determined by these same physical, ecological and genetic factors.

The modern concept of the game animal potential of bighorn sheep is almost entirely as a trophy animal. Quality rather than quantity is stressed. Basically this is a good philosophy, because quantity in the same sense as that of deer, elk, or even antelope, is not attainable in bighorn sheep populations. The sheep hunter sees himself as one of the elite, and a whole series of traditional beliefs and attitudes concerning the relationship of the hunter to the animal, and vice versa, has evolved. One of these traditions has to do with the inflexible line of demarcation between what is and what is not a trophy animal. Almost invariably, this boundary is placed at the 3/4 curl mark.

Is this reasonable? In many cases, it is. Restricting the harvest to animals having 3/4 curl or larger horns, mutually agreed upon by the hunting public and the wildlife management agency, usually means that rams less than five years of age will not be taken. If harvest of the older age classes of rams fits in with the management requirements of a particular herd, the trophy philosophy can be accepted on its own merits and conflicts do not arise.

However, it is my contention that hidebound attitudes toward the sanctity of the trophy ram and toward the convenience of having one statewide set of regulations to enforce, can, in some cases, frustrate good management. There is no more justification for restricting the harvest to 3/4 curl rams in <u>all</u> herds, just because it is a proper procedure in some herds, than there would be for going to the other extreme and opening all hunting area to hunters-choice harvest.

My entire point here is to emphasize the necessity for tailoring harvest regulations to the requirements of each individual bighorn herd.

This approach has to be based on complete or nearly complete knowledge of the population dynamics of any herd to be considered for liberal harvest regulations. We are not talking about liberalization for its own sake, and if information for any herd is sketchy or imperfectly known, there is no alternative but to continue the conservative approach.

Let us take a hypothetical herd in which it is determined beyond a reasonable doubt that of each ten rams which enter the yearling age class only one will survive to become a trophy animal. This is very inefficient production of the end product, and the cost of the trophy animal which is produced is really exhorbitant when one considers what was lost along the way. Absolute documentation of this pattern of population dynamics makes this herd a prime candidate for relaxation of harvest regulations.

Let us take another hypothetical herd in which it is determined beyond a reasonable doubt that recruitment and replacement are at such a low level that the herd is barely holding its own. This herd, of course, is in trouble, and its ability to survive is dependent on many things which we are not considering at this point. The thing which we are considering is that the herd cannot spare any of its prime breeding rams because they will not be replaced from younger age classes. Here is a situation which, strictly from the harvest viewpoint, would seem to indicate that a continued closed season would be in order. This is correct, as long as the rams are in the prime breeding age class, but even herds as precarious as this one is, can offer some hunting. Harvest of the past-prime ram which will soon pass out of the picture is entirely justifiable, and can offer a real challenge to a trophy hunter.

Let us take another hypothetical herd in which all of the classic symptoms of boom-and-bust are beginning to appear. Rate of population increase has been sharply upward for a period of several years, and habitat deterioration is imminent. Without going into conjectures about what is going to cause the bust (here we are thinking about the disease-parasite-nutrition-competition complex), let us simply say that, based on past experience, this herd is becoming ripe for a crash. In such a situation, it could even be entirely justifiable to hold hunters'-choice seasons for as long as it would take to alter the pattern of population dynamics.

These examples are intended to show that each separate herd has its own level of optimum harvest potential. In order for management to arrive at this optimum level for each herd, the old standards of what constitutes an acceptable end product are going to have to be discarded. I doubt that we will ever reach a point where an ewe will be an acceptable trophy, but within reasonable limits a bighorn sheep trophy should be any animal which is harvestable, from the management standpoint. Modern management concepts and philosophies demand that harvestable sheep be made available for harvest. Administrative and public acceptance of these concepts is necessary in formulating management programs. There is no room for regulations based on conformity, expediency, and ease of enforcement, nor is there room for an inflexible definition of "trophy".

ARTIFICIALITY IN MOUNTAIN SHEEP MANAGEMENT

by

Ray Demarchi

"The value of a recreational experience is inversely proportional to the artificiality of its origin." Aldo Leopold.

Although Leopold was speaking about "put and take" fisheries his quotation is applicable to the mountain sheep resource.

Before I go any further, I will give you my idea of artificiality. Man creates artificiality. At the extreme, an artificial resource (i.e. a wildlife population) is one which would disappear in the absence of the effort of man. The opposite is a natural or wild, self sustaining resource.

It appears and unfortunately so, that something that is never known is seldom missed. In our quest for an increased Gross National Product and a higher standard of living, people come to accept lower quality or deteriorated environments.

Mountain sheep are very much a part of a quality environment throughout the mountainous western states and provinces. In fact, the loss of mountain sheep throughout much of its former range evidences deteriorated and deteriorating environment.

We, as ecological generalists and mountain sheep specialists have a responsibility to protect the wild sheep of North America. We must establish our objectives and develop a conceptual framework which will ensure the protection of our wild mountain sheep.

Over the past two days we have heard a diversity of presentations varying from parisitological and immunilogical studies through tagging and marking and population dynamic studies to habitat research and manipulation. At both ends of this list lies the potential imposition of artificiality.

The animal researchers are leading us toward the goals of being able to monitor and control diseases through a veterinarian approach while the habitat manipulators would improve nutrition and thus increase survival through an agricultural approach. Off to one side we have those who do their "biologist thing" by catching the sheep-critters and mutilating them through branding, marking, painting, spraying and tagging.

We do all of these things in the name of mountain sheep management and mountain sheep research. Personally, I think most, if not all of the research being conducted will lead us ultimately to a better understanding of how we can best protect and perpetuate and perhaps even restore the mountain sheep resource.

I would suggest, however, that we begin to question and to discuss in greater depth the values of highly artificial and closely managed sheep populations as opposed to those populations that are truly wild.

At this stage of our technological expertise we could raise bighorn in barns for "put and take" management if we chose to do so. However, I am certain that none of us would promote this approach.

In most areas, except those very few areas which are as yet not influenced by man and are inviolate to such influences, the option of leaving "hands-off" have been taken away. It is obvious, then, that some managerial interference is necessary.

My suggestion is that when we are making decision or promoting our management programs that we apply only the minimum amount of artificality that will insure the protection and perpetuation of the population. Only in this way will we maintain the highest quality recreational values possible from our wild mountain sheep.

WHEN AND WHY IT IS GOOD MANAGEMENT TO SHOOT BIGHORN EWES AND LAMBS

by

William Wishart

When to shoot ewes and lambs is when your neighbouring province or state has a major die-off of bighorns due to the same mismanagement principles that you have been using; i.e., males only seasons on overstocked bighorn pastures.

In 1966, Alberta was able to capitalize on the bighorn die-off in British Columbia by introducing a long advocated permit season on "ewes". Since that time, the average provincial "ewe" or non-trophy kill has been 125 animals in 23 management units. Our first two non-trophy seasons allowed the shooting of any bighorn with horns 12 inches in length or less. In 1967, it became apparent that hunters were starting to select yearling rams. That year, yearling rams comprised over 20% of the kill.

In 1968, the non-trophy regulations were changed to legalize the shooting of ewes and lambs only. Lambs presently comprise about 15% to 20% of the total kill. A few problems have developed from harvesting ewes and lambs and these will be discussed later.

The question of why it is good management to shoot ewes and lambs is based on the very simple but difficult to define concept of carrying capacity. Game populations are like bacteria on agar. Their populations quickly reflect the suitability of the medium that they are raised on. One does not have to search the big game literature very far to discover that the survival of game, particularly the young in the northern and mountain climates is dependent on winter carrying capacity. The direct correlation of winter conditions on the mother and survival of the young has been well documented in several studies, particularly in deer (Severinghaus, 1951, Verme, 1962, Ransom, 1964). Malnutrition in pregnant femals is synonymous with resorbtion, abortion, stillborn and early mortality of the young. Even for the surviving young the battle is not over. Other studies on caribou, antelope, and bighorns have shown that survival of young during the winter is influenced by the rank heirarchy at feeding sties (Henshaw, 1969, Bruns, 1969, Geist, 1969). Under severe winter conditions, the young are invariably displaced from feeding craters or bedding areas by older animals with larger antlers or horns. It follows then, that the number of young surviving the northern and mountain game herds becomes the indicator of carrying capacity. In the case of bighorns, the number of yearlings surviving is a good indicator of population response to carrying capacity (Buechner, 1960). Thus, mountain sheep managers should strive continuously to maintain high production of young in their herds.

Let us suppose that we have three areas, each with a winter carrying capacity of 100 bighorns, and we are faced with having to maintain each herd at that number under the following separate conditions;

(1) maximum sustained yield,
(2) 3/4 curl law,
(3) Boone and Crockett standards.

Using a simple hypothetical age structure with no mortality other than hunting each case will develop as indicated in Table 1.

Table 1. Three bighorn management conditions using a hypothetical age structure with no natural mortality (--indicates annual removal necessary to maintain a winter herd of 100 animals)

	AGE	RAMS	EWES	LAMBS
Condition I (maximum	1	20	20	
sustained yeild)	2		20	
	3		20	20
	4		20	20
Wintering *Biomass = 5 tons				
Annual Biomass Removed = 2 3/4 tons				
Condition II	1	10	10	
	2	10	10	
(3/4 curl law)	3	10	10	10
	4	10	10	10
	5	10	10	10
Wintering Biomass = 6 1/2 tons				
Annual Biomass Removed = 2 1/4 tons				

* Biomass determined from weights given in Blood et al, 1970

	AGE	RAMS	EWES	LAMBS
Condition III	1	5	5	
	2	5	5	
(Boone & Crockett	3	5	5	5
standards)	4	5	5	5
	5	5	5	5
	6	5	5	5
	7	5	5	5
	8	5	5	5
	9	5	5	5
	10	5	5	5
Wintering Biomass = 8 tons				
Annual Biomass Removed = 2 tons				

Condition I is very similar to a situation that existed in the Sheep River herd in Alberta prior to the 3/4 curl law; i.e. high hunting mortality of yearling rams and some hunting mortality of ewes due to mistaken identify (Wishart, 1958). Lamb production and their survival to yearlings was also very high.

Not that under this condition that it is not necessary to remove any lambs to maintain the herd. Assuming that yearling rams are sexually mature at eighteen months, their removal would have to take place after the rut. Condition I is probably the least desirable form of management at the present time because of the trophy fixation of mountain sheep hunters.

Condition II approximates an optimum situation where 30" to 35" bighorn rams are harvested equally along with adult ewes and lambs each year to maintain a stable population. At present, bighorn management in Alberta is generally tending towards this end.

Condition III is a luxurious form of sheep management where a few very large rams can be produced at a cost of removing most of the very young. This latter condition no doubt existed naturally in wild sheep under pristine conditions without competition from other ungulates. Sheep numbers would have waxed and waned with winter conditions always tending towards stability and equilibrium with their environment. Management of this type would certainly provide record-book rams.

At this point it should be noted that the wintering bighorn biomass in condition III is 60% greater than the wintering biomass in condition I. Conversely, a 35% greater biomass can be annually removed in condition I compared to condition III.

From the standpoint of maintaining a bighorn herd at a fixed population the three examples demonstrate two facts clearly:

(1) As the number of rams harvested is reduced the number of lambs harvested must be increased.

(2) As the age of the herd is increased the amount of range required must be increased.

Thus, a range with a winter carrying capacity of eight tons of mountain sheep could theoretically produce harvestable sheep over a period of ten years as follows.

RAMS	EWES	LAMBS
320 yearlings	320	0
or 125 five-year-olds	125	125
or 50 ten-year olds	50	300

Therein lies a sheep management dilemma.

As mentioned earlier, the choice in Alberta has been towards the middle of the road; e.g., Condition II. As a result, the immediate problems that developed were local burn-outs of accessible herds. Also it became apparent that we lacked precise information on population numbers, distribution and age structure. We are now asking ourselves about the survival rate of orphaned lambs and the importance of barren ewes that "babysit" yearlings. In other words, more dilemmas.

But more important and overriding all of the foregoing is the insidious decline of mountain sheep ranges due to (1) mis-management of wild and domestic ungulates, (2) destruction from mining and exploration and (3) the loss of grassland to forest succession from many years of fire protection. It becomes obvious that unless the resource base is secure, "ewe" seasons are of little significance in the management of mountain sheep.

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NORTHERN WILD SHEEP COUNCIL MEETING
BUSINESS MEETING
May 26-28, 1970

Williams Lake

Business Session

Decisions

1. The meetings will be formal. The executive will be from the State or Province hosting the next meeting.

Vote - unanimous

2. The council will meet every two years alternating if possible with a combined meeting of the Desert Bighorn Council and the Northern Wild Sheep Council.

Vote - 28 yes, 8 no

3. The next meeting of the Northern Wild Sheep Council will be in Alberta in 1972. The chairman is E. Scheffler, Department of Lands and Forests, Fish and Wildlife Division, Natural Resources Building, Edmonton, Alberta.

4. No meeting is scheduled for 1971 as the Department of Fishery and Wildlife Biology at Colorado State University and the Colorado Division of Game, Fish and Parks are planning to hold a North American Bighorn Sheep Conference in April, 1971. Tentative dates will either be April 13 & 14 or 27 & 28.

5. The following telegram was sent to the director, Idaho Fish and Game Department; Commissioner, Idaho Fish and Game Department; Governor of Idaho and State Director, Bureau of Land Management:

"The Northern Wild Sheep Council, an international group of 54 professional wildlife biologists from Alaska, Northwest Territories, British Columbia, Alberta, Montana, Colorado, Wyoming, California, wishes to affirm support for Mr. Jim Morgan and the Idaho Department of Fish and Game in their efforts to preserve the mountain sheep in that state, as outlined in Life Magazine (May 22, 1970).

The decline of the wild sheep of Idaho parallels similar declines occurring in every other herd of sheep in competition with domestic livestock, and it is becoming increasingly apparent that corrective action must be undertaken now if the declines are to cease.

The suggestions advanced by Mr. Morgan represent the only corrective action that is likely to be successful in saving the sheep, and we concur with them. It is our hope that the Bureau of Land Management will see fit to follow these suggestions and thus protect these rare and endangered animals before habitat conditions deteriorate further."