

CARDIAC TELEMETRY, NATALITY, AND FOOD HABITS OF  
BIGHORN SHEEP AT BIGHORN CANYON NATIONAL RECREATION AREA

Kevin P. Coates  
and  
Sanford D. Schemnitz  
Department of Fishery and Wildlife Sciences  
New Mexico State University  
Las Cruces

Introduction

Data were collected from May 1988 to May 1989 to aid in the development of a management program for Rocky Mountain bighorn sheep (Ovis canadensis canadensis) at Bighorn Canyon National Recreation Area (BICA). A principle goal of the management program at BICA is to promote the continued expansion of a reintroduced population of bighorn sheep throughout its ancestral habitat (BICA 1984).

In previous research at BICA (Coates and Schemnitz 1988) we identified 3 factors as potentially limiting to herd expansion: visitor and/or vehicular disturbance of bighorns (especially reproductive ewes), competition with horses for a limited supply of grasses, and possible genetic constraints on recruitment (i.e., inbreeding depression) resulting from small founder group size. The purpose of this report is to present findings on the following objectives.

Objectives

1. Analyze the physiological response of bighorns to human disturbance using cardiac telemetry.
2. Analyze population size, natality and age and sex composition of the bighorn population.
3. Analyze seasonal diets and dietary overlap of bighorn sheep and wild horses; analyze fecal nitrogen of seasonal bighorn diets; analyze foraging relationships of bighorn rams and wild horses.
4. Analyze spatial distribution of bighorns and document range expansion.

## Methods

We originally proposed to study the heart-rate response of bighorns to human disturbance using a heart-rate transmitter (EKG-1000, Stuart

Enterprises, Grass Valley, CA) described by Follman et al. (1982). The transmitter had been used in studies with other large mammals, was durable, had long range, and was easily implanted in the field. However, there was insufficient information available in the literature on cardiology of bighorns to conduct the study as we had originally proposed. We obtained the necessary information by performing tests and experimental surgeries on a domestic ewe (Ovis aries) in a pen setting. A 2-lead electrocardiograph (Burdick Co., EK-5A, Milton, WI) was used to obtain stripchart recordings of the QRS waveform at 3 superficial lead attachments: manubrium to xiphoid, manubrium to right foreleg, and xiphoid to right foreleg. Lead placement from manubrium to xiphoid yielded the waveform of highest amplitude, with a peak value of 0.4 mV.

A heart rate transmitter was experimentally implanted in the domestic ewe. After scrubbing the area, a 5 cm incision was made across the sternum 10 cm caudal to the manubrium. A shallow pocket was formed at the incision using blunt dissection. The transmitter was pushed through the layer of loose connective tissue between the subcutaneous fat and muscle, and not anchored to the thorax. The incision was closed with chromic cat-gut suture. The transmitter functioned properly for 2 days until fluids accumulated in a pocket near the cranial electrode. We drained and closed the pocket by suturing through the skin into the subcutaneous tissue at several locations surrounding the transmitter. The transmitter functioned well up to distances > 1 km for 3 weeks before being passively expelled, without complication, due to tissue necrosis. The ewe was in the third trimester of pregnancy and successfully lambed 4 weeks later.

A free-ranging bighorn ewe was chemically immobilized in April 1989 using ketamine/xylazine. Standard precautions were followed to prevent capture myopathy (Jessup et al. 1984) and a cardiac transmitter was implanted along the left side of the ewe's sternum in a vector between the manubrium and xiphoid. Following surgery, yohombine, was administered by intravenous injection to speed recovery time (Hurley 1985). Undisturbed cardiac activity of the ewe associated with foraging and resting was monitored during daylight hours at 5 minute intervals. Behavior was observed using a spotting scope and

binoculars. Observational distance to the animal ranged from 0.5 to > 1 km.

We determined the age and classification of bighorns that were observed during extensive field surveys, and estimated population size and composition based on multiple censuses over a 3 year period. We determined food habits of bighorns and wild horses by fecal analysis (Holechek and Vavra 1981, Holechek 1982) and calculated dietary overlap (Oosting 1956). Protein content of ewe diets was determined using fecal nitrogen analysis and compared it to the known requirements of domestic sheep in similar reproductive condition and season.

Foraging behavior of bighorns was analyzed to investigate the effects of interspecific associations and habitat security on foraging efficiency (Risenhoover and Bailey 1985). We examined differences in plant composition, distance to escape terrain, and vigilance levels at areas used by rams associated with horses versus areas used with conspecifics.

Spatial distribution of the population was analyzed by locating radio-collared animals and by tracking unmarked bighorn. Use of new lambing areas was observed during 1987 and 1988. Changes in spatial distribution of the population involved lands administered by the National Park Service, as well as the Bureau of Land Management, and the Crow Indian Tribe. A map was provided with our Contract Completion Report to BICA which illustrated changes in population distribution from 1986 to 1989, land ownership, and locations of sensitive-use areas such as lambing grounds.

## Results

Cardiac activity of the telemetered bighorn ewe was monitored for over 200 hours before the transmitter was expelled. There were marked differences between heart rates associated with responses to disturbance, and undisturbed resting and foraging. We elicited disturbances and observed cardiac and behavioral responses on 2 occasions by approaching to within 150 m and causing the ewe to flee. After the initial flight response we remained as far away as possible while keeping visual contact with the ewe.

At the onset of both disturbances the ewe was alone and heart rate increased from a resting rate of 55 to 135 beats per minute (b.p.m.) Heart rate continued to climb for 60 minutes following the initial flight response, and reached peaks of over 200 b.p.m. Heart rate remained elevated for 2 hours

after the initial disturbance without overt indications of stress (e.g. animal not fleeing or with alert posture). Heart rates associated with undisturbed foraging and resting activity averaged 55 and 78 b.p.m., respectively. Responses to disturbance averaged 168 b.p.m. (s.d. 26.2) over a 3 hour period.

Harlow et al. (1987) studied cardiac response of bighorns to acute stressors in a pen situation. In their study, average heart rates associated with mild, medium and heavy stress exposure were 139 (+/- 32), 162 (+/- 19), and 190 (+/- 30) b.p.m. , respectively. Harlow et al. (1987) demonstrated a strong relationship between heart-rate responses and cortisol production. There was no reported difference between peak-plasma cortisol levels for mild and medium heart-rate responses.

However, Harlow et al. (1987) reported that if a bighorn experienced a combination of medium or heavy stressors in a single day, the animal would be assessed as being in a state of chronically elevated blood cortisol. It has been suggested that stress-related release of cortisol may inhibit reproductive mechanisms, depress immunosuppression, and account for widely observed epidemics of pneumonia (Forrester 1971, Thorne 1971).

In previous research at BICA (Coates and Schemnitz 1988), we determine that pregnant or lactating ewes routinely foraged near the road and were frequently disturbed by motorists. In the summers of 1986 and 1987, ewes spent > 40% of their time while foraging near the road in alert behavior. Considering the duration of the heart-rate responses we observed without alert behavior during this study, and the amount of time that ewes spent in alert behavior in 1986 and 1987, we believe that roadside disturbance has the potential to cause chronic elevation of blood cortisol. Further, we concluded that the combined effects of density dependent stressors, which occur naturally as a population approaches carrying capacity, and roadside stress will reduce the carrying capacity for bighorn sheep at BICA.

In spite of stress from roadside disturbance, population growth was rapid from 1985 to 1989. Herd size increased from approximately 40 animals in 1985 to 99 animals in 1989. There is additional habitat in the area, and if population growth continues at or near the present rate, herd size may exceed 160 animals in the year 1993. The bighorn population at BICA was founded 15 years ago by a small group believed to number between 2 and 8 animals which had dispersed from a nearby

transplant site in Wyoming. Additional founders may have originated from transplants in Montana. Since 1975 the population has grown at the maximum reproductive rate. Geneticists believe that such populations require >50 'effective' breeding adults. The population at BICA has not yet reached this number of breeders, but high population quality provides an optimistic outlook for the future.

Rapid growth of the bighorn population is linked to the utilization of large quantities of browse in the diet and to adopting an appropriate foraging strategy (Coates and Schemnitz 1988). Browse was important in summer and winter diets (>50% composition). Fecal nitrogen analysis indicated adequate protein content in browse diets consisting of >45% soapweed, mountain mahogany, juniper, and globemallow. Dietary overlap between bighorns and horses occurred primarily on grasses and averaged 68% during 1988. In previous work we determined that 75% of the horse diet is composed of grasses. Grasses comprise only 5% of the vegetative cover. Grasses composed approximately 30% of the bighorn diet. Analysis of foraging relations between bighorn rams and wild horses indicated that rams utilized foraging areas that supported a higher composition of grasses while foraging with horses. These foraging areas were further from escape terrain than areas utilized by rams with conspecifics. Rams may have been able to utilize these insecure habitats due to high vigilance levels of the horses.

#### Literature Cited

Bighorn Canyon National Recreation Area. 1984. Bighorn Sheep Management: Natural Resources Project Statement. BICA N-019. 2 pp.

Coates, K. P. and S. D. Schemnitz. 1988. Habitat utilization, interspecific interactions and status of a recolonized population of bighorn sheep at a wild horse range. University of Wyoming-National Park Service Research Center. Contract Completion Report. 71 pp.

Follman, E. H., A. E. Manning, and J. L. Stuart. 1982. A long range implantable heart rate transmitter for free ranging animals. Biotelemetry and Patient Monitg. 9:205-212.

Forrester, D. J. 1971. Bighorn sheep lungworm pneumonia complex. In: Parasitic Diseases of Wild Mammals. J. W. Davis and R. C. Anderson EDS. Iowa State Univ. Press.

- Harlow, H., E. T. Thorne, E. S. Williams, E. L. Belden, and W. A. Gern. 1987. Adrenal responsiveness in domestic sheep (Ovis aires) to acute and chronic stressors as predicted by remote monitoring of cardiac frequency. *Can. J. Zool.* 65:2021-2027.
- Holechek, J. L. 1982. Sample preparation technique for microhistological analysis. *J. Range Manage.* 35:267-268.
- Holechek, J. L., and M. Vavra. 1981. The effect of slide and frequency observations on the precision of microhistological analysis. *J. Range Manage.* 34:337-338.
- Hurley, K. P. 1985. The Trout Peak bighorn herd, northwest Wyoming. M.S. Thesis, Univ. of Wyoming, Laramie. 123 pp.
- Jessup D. A., W. E. Clark, and R. G. Mohr. 1984. Capture of bighorn sheep: management recommendations. State of California, Dept. of Fish and Game, Wildlife Management Administrative Report. 84-1. 33 pp.
- Oosting, H. J. 1956. *The Study of Plant Communities.* W. H. Freeman and Co., San Francisco, CA. 440 pp.
- Risenhoover, K. L., and J. A. Bailey. 1985. Foraging ecology of mountain sheep: Implications for habitat management. *J. Wildl. Manage.* 49:797-804.
- Thorne, E. T. 1971. A die-off due to pneumonia in a semi-captive herd of Rocky Mountain bighorn sheep. In *Transactions of North American Wild Sheep Conference.* Fort Collins, CO. April 14-15, 1970.