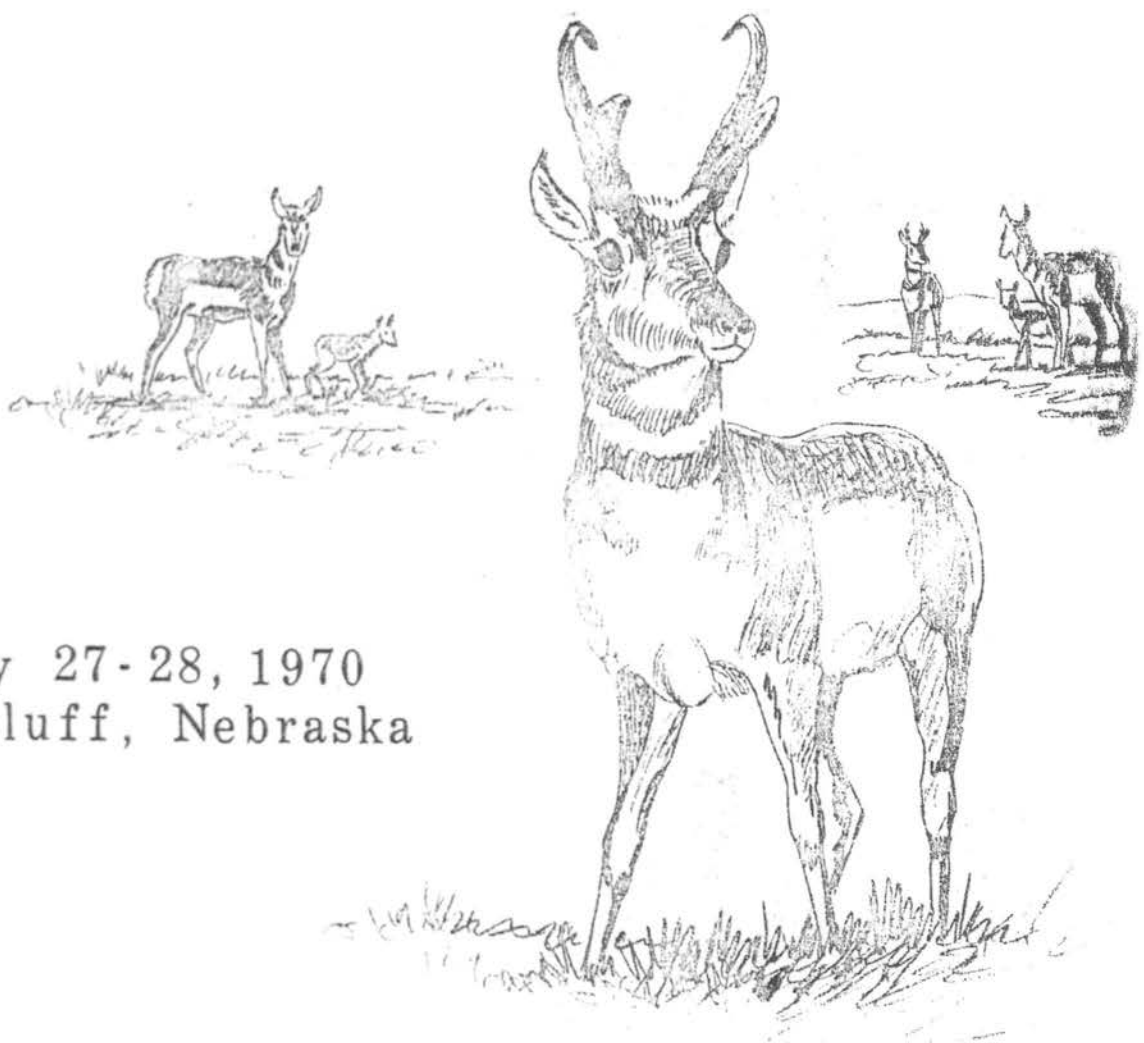
PROCEEDINGS of the
FOURTH

ANTELOPE STATES WORKSHOP



January 27-28, 1970
Scottsbluff, Nebraska

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INTRODUCTION

The fourth Antelope States Workshop was held at the Quality Courts Motel, Scottsbluff, Nebraska on January 27 and 28, 1970. Eighty-five persons registered for the meeting, representing four universities and four federal, two provincial and ten state agencies.

Discussion leaders for the sessions were Jim Yoakum, George Bear and Don Beale. Their excellent work is attested to by the considerable volume of discussion which is included with these papers.

Because of a tight schedule, Bill Wishart's paper was presented as part of an evening session, and time was insufficient to include Bart O'Gara's paper on food habits.

Duane Pyrah, in behalf of the Montana Fish and Game Department, volunteered to host the next workshop in 1972.

ANTELOPE STATES WORKSHOPS

Date	Meeting Place	Chairman
April 14-15, 1965	Santa Fe, New Mexico	William S. Huey
February 16-17, 1966	Denver, Colorado	George D. Bear
February 5-6, 1968	Casper, Wyoming	John L. Newman
January 27-28, 1970	Scottsbluff, Nebraska	Karl E. Menzel

REGISTER

Avey, Richard	Chadron State College, Chadron, Nebr.
Autenrieth, Robert	Idaho Fish & Game, Jerome
Bailey, William	Nebr. Game & Parks, Lincoln
Baker, Calvin	U.S. Forest Service, Chadron, Nebr.
Banks, Don	Nebr. Game & Parks, Bassett
Beale, Don	Utah Fish & Game, Logan
Bear, George	Colo. Game, Fish & Parks, Ft. Collins
Bradshaw, Bill	U.S. Forest Service, Laramie, Wyo.
Brownlee, Sam	Texas Parks & Wildlife, Alpine
Bussinger, Marvin	Nebr. Game & Parks, Alliance
Call, Mayo W.	Bur. of Land Mgt., Bountiful, Utah
Carter, Pete	U.S. Fish & Wildlife Service, Lakeview, Oregon
Compton, Buck	Mont. Fish & Game, Miles City
Corsi, Rex	Wyo. Game & Fish, Cheyenne
Craig, Bob	Nebr. Game & Parks, Alliance
Cruse, Jim	U.S. Forest Service, Denver
Deatrich, Frank	Nebr. Game & Parks, North Platte
Ehlers, Frank	Nebr. Game & Parks, Crawford
Eichhorn, Larry	Bur. of Land Mgt., Lewistown
Ellis, Jim	Zool. Dept., Univ. of Calif., Davis
Fowler, Ronald	S. Dak. Game, Fish & Parks, Aberdeen
Frandsen, Raymond	Nebr. Game & Parks, Sidney
Fuller, Doug	U.S. Forest Service, Douglas, Wyo.
Furley, Richard	Nebr. Game & Parks, Alliance
Geiger, George	U.S. Forest Service, Hot Springs, S.D.
Hardman, Bill	U.S. Forest Service, Wall, S.D.
Heinz, Dan	U.S. Forest Service, Halsey, Nebr.
Hepworth, Bill	Wyo. Game & Fish, Laramie
Hepworth, Leland	Chadron State College, Chadron, Nebr.
Hlavachick, Bill	Kansas Fish & Game, Hays
Hnatiuk, Joseph	Dept. of Nat. Res., Saskatoon, Sask.
Hockley, Marvin	Wyo. Game & Fish, Sheridan
Houston, Jim	Colo. Game, Fish & Parks, Craig
Hunt, Donald	Nebr. Game & Parks, Oshkosh
Hurt, Jim	Nebr. Game & Parks, Alliance
Jacobsen, Bob	Bur. of Land Mgt., Craig, Colo.
Johnson, Ken	Nebr. Game & Parks, Lincoln
Kampbell, Marvin	Nebr. Game & Parks, Rushville
Kerr, Dick	Bur. of Land Mgt., Fairfax, Va.
Larsen, Parry	N. Mex. Game & Fish, Albuquerque
Lemmon, Lon	Nebr. Game & Parks, Crawford
Lock, Ross	Nebr. Game & Parks, Alliance
Lovaas, Al	Nat'l Park Service, Hot Springs, S.D.
Mapston, Ray	Bur. of Land Mgt., Casper, Wyo.
McCole, Jim	Nebr. Game & Parks, Scottsbluff
McGowan, Terry	Bur. of Land Mgt., Denver, Colo.
McIntosh, Don	Bur. of Land Mgt., Billings, Mont.
McKenzie, James	N. Dak. Game & Fish, Mandan
McMahan, Bill	Bur. of Land Mgt., Rawlins, Wyo.
McMeekin, Gary	Chadron State College, Chadron, Nebr.
Menzel, Karl	Nebr. Game & Parks, Bassett
Minnich, Don	Colo. Game, Fish & Parks, Colorado Springs

Morton, Allen	U.S. Forest Service, Laramie, Wyo.
Munger, Bob	Lincoln Journal, Lincoln, Nebr.
Nason, George	Nebr. Game & Parks, North Platte
Norman, Richard	Colo. Game, Fish & Parks, Fort Collins
O'Gara, Bart	Coop. Wildl. Res. Unit, Missoula, Mont.
Pate, Larry	Wyo. Game & Fish, Casper
Perkuchin, Don	U.S. Fish & Wildlife Service, Ellsworth, Nebr.
Peterson, Jack	Nebr. Game & Parks, Alliance
Pogorelz, John	Colo. Game, Fish & Parks, Fort Collins
Pyrah, Duane	Mont. Fish & Game, Lewistown
Radtkey, William	Bur. of Land Mgt., Miles City, Mont.
Robertson, Ken	Nebr. Game & Parks, Bassett
Roby, Garvice	Wyo. Game & Fish, Sundance
Samuelson, Jack	N. Dak. Game & Fish, Mott
Schlichtemeier, Garv	Nebr. Game & Parks, Alliance
Schwarzkopb, Bill	Chadron State College, Chadron, Nebr.
Sheeter, Guy	Bur. of Land Mgt., Grand Junction, Colo.
Smith, Arthur	Utah State Univ., Logan
Suetsugu, Harvey	Nebr. Game & Parks, Alliance
Sundstrom, Chuck	Wyo. Game & Fish, Rawlins
Timm, Dan	Nebr. Game & Parks, North Platte
Vance, Lloyd	Nebr. Game & Parks, Lincoln
Van Velson, Rod	Nebr. Game & Parks, Alliance
Wentland, Harold	Mont. Fish & Game, Glendive
West, Douglas	S. Dak. Game, Fish & Parks. Lemmon
Weyers, Ken	U.S. Forest Service, Chadron, Nebr.
Wills, Dale	U.S. Forest Service, Fort Collins, Colo.
Winter, Ken	Wyo. Game & Fish, Powell
Wishart, Bill	Dept. of Lands & Forests, Edmonton, Alta.
Witt, Larry	Nebr. Game & Parks, Lincoln
Wood, Bob	Nebr. Game & Parks, Bassett
Woody, Monty	Bur. of Land Mgt., Albuquerque, N.M.
Yoakum, Jim	Colo. State Univ., Fort Collins

A BRIEF DESCRIPTION OF ANTELOPE RANGE AND DISTRIBUTION IN NEBRASKA

by
Harvey Y. Suetsugu
Nebraska Game and Parks Commission
Alliance, Nebraska

Historically the pronghorn antelope ranged throughout most of the Great Plains. As civilization advanced westward the native prairie gave way to agriculture. At the same time antelope declined. Several factors or combinations of factors were responsible for the overall decline. Some believed that the buffalo extirpation had a great influence on the survival of the pronghorn since both were found in direct relationship with each other. Certainly, changes in habitat and land use, and the lack of harvest restrictions, had great influence on antelope numbers. Whatever the cause for the decline, by 1900 only remnant herds remained throughout pockets of the western ranges.

In 1873 the Nebraska legislature passed a law making it unlawful to kill, ensnare, or trap any deer, antelope, or elk between the dates of January 1 and September 1. It was further restricted from January 1 to November 1 in 1897. Finally in 1907, the season was closed for the taking of elk, deer, antelope and beaver. The season on antelope remained closed until 1953, a period of 47 years.

A 1925 publication (Nelson, E. W. 1925. Status of the pronghorn antelope 1922-25. U.S.D.A. Bull. #1346) stated that 10 small bands of 187 animals remained from thousands of antelope which once roamed the Nebraska plains.

Recovery of the species in Nebraska was slow. However by 1955 the estimated population in western Nebraska was approximately 3,500 antelope. Hunting seasons have been held every year since 1953, with the exception of 1958. A total of 16,720 permittees have harvested 13,623 antelope for a hunter success of 81.5 per cent. Archery seasons have been held annually since 1964.

The major antelope range is traversed by three escarpments and several rivers and creeks in an east-west direction. The Pierre Hills, commonly referred to as the badlands in Nebraska, extends south from the South Dakota State line in the northwest part of the state. The Pierre Hills then rise abruptly to meet the Pine Ridge escarpment which slopes gently southward to the Box Butte tableland and on to the North Platte Valley. South of the river, the Wildcat Hills escarpment drops into the Pumpkin Creek Valley and confronts the Cheyenne escarpment and its tableland.

The climate is mild, but as is typical of the High Plains region, much fluctuation of temperature occurs. Occasionally severe winter storms sweep through the state. Normal annual precipitation in the antelope range varies from 15 inches in the west to 23 inches in the east with most of it occurring from April to June.

The shortgrass rangeland of the Pierre Hills and Box Butte Table support the highest density of antelope numbers in the state (2.7 and 1.3 antelope per square mile respectively). Aerial surveys, conducted during the summer of 1969, show an overall index of 0.8 antelope per square mile and 37:100:59

buck:doe:kid ratio in the Panhandle compared to 0.2 per square mile and 38:100:33 buck:doe:kid ratio in select areas of the Sandhills.

Pierre Hills:

The Pierre Hills, designated as the North Sioux antelope management unit, supports the highest density in the state with 2.7 antelope per square mile. The area is a rolling plain developed on soft clayey shales. The low hills are round-topped and the valleys are broad swales. Pockets of small badly eroded areas of badlands are found in the area. Vegetative cover is thin with sparse stands of native grasses, principally western wheatgrass, needle-and-thread, blue grama, hairy grama, and buffalo grass. Prickly pear cactus is quite abundant. Willow, cottonwood, green ash, and elm grow along the watercourses. Small pockets of big sage exist in the grassland. The land is used primarily for cattle and sheep ranching. Livestock water has been provided by small run-off dams in the past but today a vast network of piped water from central wells provides better distribution of stock on the rangeland.

Box Butte Table:

The Box Butte Table and Sandhills habitat types make up the Box Butte antelope management unit. The topography of the Box Butte Table is generally flat to rolling. The east half of the tableland is predominately cropland (corn, wheat, sugar beets, potatoes), while the west half is rangeland. Soils vary from silty loam to sandy loam. Short and mid-grasses such as buffalo grass, blue grama, little bluestem, sideoats grama, and threadleaf sedge are dominant. Shrubs and trees are mostly limited to shelterbelt plantings.

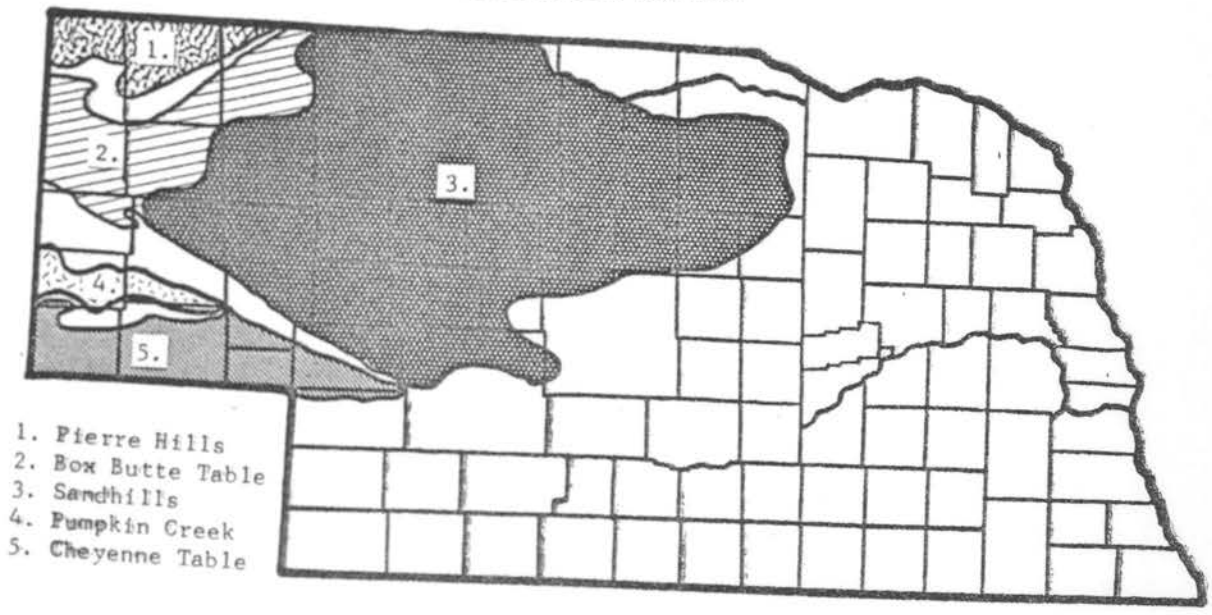
Sandhills:

The Sandhills is the largest continuous habitat type constituting about 20,000 out of 77,000 square miles in the state. A portion of the Sandhills is located in the south and east portion of the Box Butte management unit. The Sandhills habitat also includes the Garden, Dismal, Cherry, Brown and Rock management units. Antelope density, based on the 1969 aerial surveys, is 0.2 antelope per square mile in select areas. The Sandhills are characterized by the loose sandy soil of the valleys and dunes which are shaped by the erosive wind. There is little surface run-off but there are many exposed groundwater lakes and marshes. Because of wind, little soil formation has occurred. The dry meadows have accumulated a few inches of organic matter, however where tall grasses grow in the wet meadows there is considerable organic matter. Vegetation is sparse. More than 200 species of plants occur throughout the area.

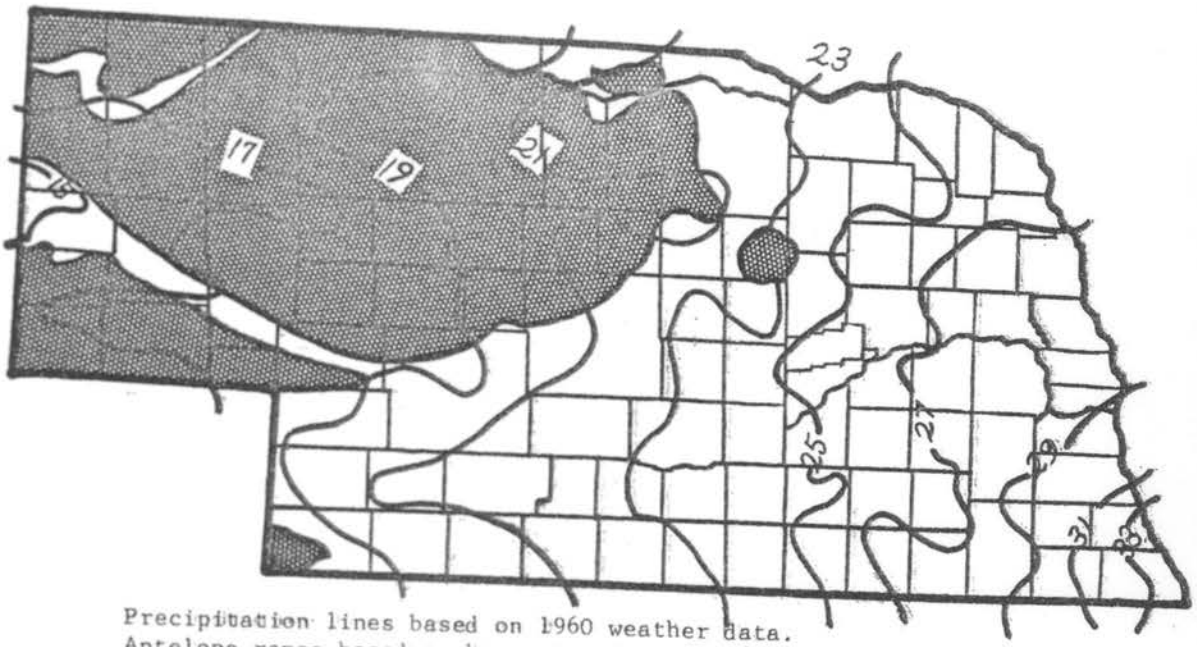
Dominant grasses in the hills include prairie sandreed, little bluestem, sand bluestem, needle-and-thread, and gramas. The meadows have plant species such as prairie cordgrass, big bluestem, switch grass, and sedge. The more common woody plants are wild rose, American plum, western sandcherry, snowberry, cottonwood and willow. Common forbs are lead plant, goldenrod, coneflower, sunflower and common lupine.

The Sandhills are used primarily for grazing since the loose sandy soil with poor moisture holding property permits only limited farming. Extensive haying is done around the meadows throughout the area.

TOPOGRAPHIC REGIONS



PRECIPITATION AND ANTELOPE RANGE



Precipitation lines based on 1960 weather data.
Antelope range based on harvest and observation data.

Pumpkin Creek Valley:

The Pumpkin Creek Valley, with an elevation in certain areas of nearly 1,000 feet below that of the surrounding tableland, is a remnant of the ancient High Plains created by water erosion. Vegetative growth in the valley is restricted due to the low precipitation (14.4 inches of average annual precipitation) and the poor moisture holding property of the soil (mixture of sand, gravel and silt of the Brule Clay Formation). Vegetative type is classified as shortgrass complex with species of introduced grasses. Grass species include blue grama, buffalo grass, needle-and-thread grass, crested wheatgrass, western wheatgrass, and downy brome. Some of the more common forbs are sweet clovers, sunflower, ragweed and lambsquarters. Crop production is as important as livestock production in this area.

Cheyenne Table:

The Cheyenne tableland is a broad ancient plain whose surface formation is made up of sediments brought down from the Rocky Mountain region. Stream channels become established and their valleys widened. Topography is flat to rolling and soil drainage is good as loose porous soil and subsoil allow rapid percolation. A high percentage of the arable land is in wheat production. Livestock production is on the rough, broken land adjacent to the draws and drainages and makes up about 30 per cent of the area. Vegetation is primarily native plants of the shortgrass community. Dominant species are blue grama, buffalo grass, needle-and-thread grass, crested wheatgrass, western wheatgrass, and downy brome. Some of the more common forbs are fireweed, Russian thistle, sweet clovers, sunflower, ragweed, lambsquarters, and horseweed.

SUMMARY

The Nebraska antelope range is primarily in the shortgrass and mixed grass prairies of the Great Plains. Vegetative range types are Sandhill, mixed-grass and shortgrass prairies. Despite the limited supply of winter browse species, antelope fare well in the state. With as many as 1,825 firearm permits authorized for a single season and with the applications exceeding the number of available permits, the pronghorn antelope is highly prized as a game and trophy animal in Nebraska.

Discussion

Ellis: Do you have much of a winter die-off problem here - severe winters?

Suetsugu: Not that we're aware of. The only mortality we had was in a study herd.

Larsen: Generally, why do you feel that the Sandhill antelope densities are lower than your better habitat, and also, how does the productivity in the Sandhills compare to your good herd?

Suetsugu: In the past couple of years, we have found only small numbers in the Sandhills and our productivity is low. Index in 1969 was 100 does to 33 young in the Sandhills and our western range had 100/57.

Larsen: When you talk about .2 per square mile compared to over one per square mile, or something like that in your tight lands, do you have some evaluation of why your Sandhills aren't as good range as the other.

Suetsugu: Well, I think some of us have our theories on this. For instance, despite the fact that historical records show that we had antelope all through that range(Sandhills), some of us aren't sure that these records weren't following the various drainages into the Sandhills.

Larsen: They never were particularly good antelope habitat?

Suetsugu: This is what, I personally feel it is. We do have another problem. Antelope in our state as well as other states, congregate in the winter-time, and whether the landowner could tolerate a number such as 100 or 200 antelope on one area, and I certainly believe that in the Sandhills you would have this problem where alfalfa is raised.

Larsen: Could you tell us generally what effect predation might have on these low density antelope herds?

Suetsugu: We don't have any information to say one way or the other on it.

Larsen: Do you seem to have fairly high coyote populations across your antelope ranges here?

Suetsugu: Coyote population densities are relative and I can't say for sure, but in the past 10 years I would say our coyote population is increasing to the point that I think we should be concerned, especially southeast of Alliance, in Garden County, in a portion of the Sandhills. I think the coyote population has increased to the point where maybe we should be concerned, but overall, it's not a problem.

Compton: Grossly, at least, what is the sagebrush density between the Sandhills and your better populated range? Do you have any in say the Panhandle?

Suetsugu: Yes, we have big sage in the Pierre hills but generally speaking, we don't have big sage, and I think when you talk about sage you're talking about big sage, browse type. We do have herbaceous sage, and we do have quite a bit of what I call sand sage in western Nebraska.

Yoakum: Do you have any information on how the browse plant composition of the Sandhills may have changed in the last 50 to 100 years?

Suetsugu: No.

WINTER WHEAT UTILIZATION BY PRONGHORN ANTELOPE IN NORTHWESTERN NEBRASKA

by
J. Leland Hepworth
Chadron State College, Chadron, Nebraska

Abstract: Pronghorn antelope were observed in a winter wheat growing area of northwestern Nebraska. Three separate herds were studied from 1 December 1968 to 4 April 1969. It was found that during this period of snow cover and paucity of other succulent forages such as sagebrush, the pronghorn grazed on winter wheat very extensively.

The problems of big game animals on private lands are persistent. Discussion of the problem of pronghorn antelope (Antilocapra americana) utilization of winter wheat with ranchers, wildlife and range management people helped bring about this study.

Hjersman and Yoakum (1959) suggest a need for more information on the food habits of pronghorn by seasons of the year. Since pronghorn stomachs are more feasibly obtained during hunting seasons, data from the critical cold and snowy periods are not so abundant. Food habit studies indicate a minimum usage of winter wheat (Triticum aestivum), by pronghorn. This is perhaps due to: the availability of preferred foods; the weather of the season and the location of the study area.

Grazing and browsing preferences of pronghorn for various species of plants and in different communities at different times of the year were studied by Severson and May (1967). Why pronghorn have these preferences is difficult to establish, but general observations point to succulency as a key to preference.

Early snow cover and unseasonably cold temperatures, combined with earlier luxuriant growth and marked stooling of the winter wheat, made study conditions quite ideal.

During the period of the study, from 1 December 1968 to 4 April 1969 I have relied primarily on personal observations, combining and comparing with those of G. J. McMeekin.

The Betts and Snook pronghorn herds combined numbered 27 at the onset of the study; reaching a maximum number of 50 on 4 February 1969. Numbers remained quite constant until 15 March 1969. From that time the herd members gradually left. By 4 April 1969 they had abandoned the winter wheat fields.

The McConaughey herd numbered 23 on 2 December 1968. They were harassed considerably by human activities and numbered 17 prior to taking leave of the area.

STUDY AREA

Observations were limited to the northern part of Dawes County, in northwestern

Nebraska. Three separate ranch areas were used, namely: Betts, consisting of five dryland sections; McConaughey, consisting of three dryland sections; and Snook, consisting of seven dryland sections. The winter wheat of the Betts and Snook areas was of the strip farming summer fallow rotation type. The McConaughey winter wheat is an approximately 300-acre field that is summer fallowed. All of the wheat growing areas are surrounded by short grass prairie, except for some poor stands of alfalfa (Medicago sativa).

The terrain is rolling and rather eroded. There are some well-defined ridges and gullies that feed into the White River system.

Wheat yield of the study areas is highly variable, depending largely on precipitation. Growers indicated a production range of from 10-50 bu/acre.

METHODS

The pronghorn were observed from 4-wheel drive vehicles. Binoculars were used to locate the animals and to observe their foraging. Snow cover was quite continuous. Much of the area was covered on foot, both to observe the animals and to follow their tracks to see where and upon what they had fed. A similar technique was used by Rouse (1941).

Bed grounds were located at all three areas. A preferred travel route between the wheat fields of the Betts area and the Snook area was located and traverse of the pronghorn was noticed.

A total of 75 observations of foraging pronghorn was made. Eleven were made in the forenoon, and the remaining 64 during the afternoon.

RESULTS

The McConaughey pronghorn bedded on a bare knoll in the winter wheat field and at a sheltered depression in the prairie about 1/2 mile southeast of the wheat field.

They were seen foraging on the winter wheat fields 13 times. Twice they were seen pawing and foraging on an overgrazed alfalfa field. Both of these occasions were early in the study. The pronghorn left the study area on 2 January 1969 and did not return.

The Betts and Snook bands generally bedded on leeward sides of ridges, rarely farther than a mile from a wheat field. During blizzards they sheltered in gullies. They often moved rapidly from the nearer bed grounds directly to the wheat fields. Between the Betts and Snook areas they had a well-established trail. Here they moved along a gentle ridge for about four miles, avoiding man-made structures.

Foraging observations of the Betts and Snook bands are treated together. In order of ascendancy they were: winter wheat and winter wheat stubble — three sightings, alfalfa —three sightings, winter wheat stubble — 10 sightings, short grass prairie — 16 sightings and winter wheat — 28 sightings. In the short grass prairie they foraged prickly pear (Opuntia spp.) considerably.

The pronghorn did not overgraze the green winter wheat, except for one wheat

land of the Snook area. There the wheat was cropped close during very inclement weather and some wheat plants were pulled up. Of interest were the pronghorn grazing directly and continuously along drill rows of wheat.

DISCUSSION

Pronghorn food habit studies such as Buck (1947) and Yoakum (1958) show that browse and forbs are their preferred foods. However, Brown (1946) does report a 10% grass content in pronghorn stomachs taken during December, January and February in an area where browse species were abundant.

Succulent foods are preferred by pronghorn according to Bridge (1942). This study is in agreement as green winter wheat was grazed when unharvested wheat and wheat stubble were readily available. The only other observable green vegetation utilized was the cactus. Pronghorn out of necessity utilized the winter wheat until such time as tender forbs and browse became available in the nearby short grass prairies. Couey (1946) found that grass was fourth in volume and second in occurrence in fall and early winter pronghorn stomach samples.

The wheat stubble was snow filled during most of this study. Conversely, the green winter wheat fields tended to be kept more free of snow.

There is no sagebrush in the area and other browse is very scarce during the critical winter months. These observations suggest that during a critical period winter wheat may be an important food for pronghorn. This thesis finds support in the report of Cole (1957).

Relative to the management and public relations aspect of pronghorn foraging extensively on winter wheat during severe winter weather, these are my conclusions. First, pronghorn do not greatly impair the following wheat yield. It is a common practice in this area to allow limited grazing of winter wheat by cattle. Second, when most ranchers are given the consideration that their crops do make a contribution to the welfare of the pronghorn and society generally, they disallow the depredations pronghorn may commit.

LITERATURE CITED

Bridge, M. 1942. Notes on the pronghorn. Wyoming Wildl. 7(11):20-23.

Brown, R. O. 1946. Antelope surveys and investigations. Colo. State Fish and Game Depart., Denver. P-R Quarterly Progress Report 4-R, July 4 p.

Buck, P. D. 1947. The biology of the antelope (Antilocapra americana) in Montana. M. S. thesis, Montana State College, Bozeman, Montana. 70 p.

Cole, G. F. 1957. A preliminary report on antelope range relationships in central Montana. Montana Depart. Fish and Game, Helena, Mont. 10 p.

Couey, F. M. 1946. Antelope foods in southeastern Montana. J. Wildl. Mgmt. 10(4):367.

Hjersman, H. A. and J. D. Yoakum. 1959. The pronghorn as a range animal. Inter. Antelope Confer. Trans. 10:76:83.

Rouse, C. H. 1941. Notes on winter foraging habits of antelopes in Oklahoma. J. Mammal. 22(1):57-60.

Severson, K. E., and M. May. 1967. Food preferences of antelope and domestic sheep in Wyoming's red desert. J. Range Mgmt. 20(1):21-25.

Yoakum, J. 1958. Seasonal food habits of the Oregon pronghorn antelope, (Antilocapra americana oregona Bailey), Inter. Antelope Confer. Trans. 9:47-59.

Discussion

Hlavachick: You say they pulled up the root system of the wheat. Was this a particularly dry fall?

Hepworth: Our fall was not dry. We've had very extensive rainfall and we've had very fine germination, very extensive stooling of the winter wheat, but during the December weather - we started December out with a lot of snow and very, very cold weather - the soil where the wheat was growing had actually desiccated or dehydrated due to freezing, and it became more frangible and loose, and when the pronghorn browsed the area then they did pull up some of the roots along with the upper part of the stooled wheat plant.

Pyrah: I wondered if you did any feeding site examinations or other food habits' work on native upland sites that were used?

Hepworth: No, I didn't, although Mr. McMeekin helped a great deal with this study and he has just completed a year-long study, and it's a shame that this study wasn't completed soon enough that he could give a paper at this meeting, but he did study other areas at other seasons of the year. However, I didn't.

Houston: Has Nebraska paid any damage claims on winter wheat?

Hepworth: Well, I would have to toss this ball, and turn this over to Harvey or Jim or someone else. I'm not knowledgeable in this area at all.

Suetsugu: We don't have any provisions for any compensation for damages to crops.

Autenrieth: Did you feel the pronghorns were maintaining their body conditions when utilizing primarily winter wheat?

Hepworth: I don't think they suffered a great deal in relationship to overall body weight while they were on this winter wheat. How long they might have been able to do this and not suffer, I wouldn't be prepared to say. We had a real break in the weather the latter part of March, and our cold weather stopped. They were able to leave almost overnight and go out and start foraging on forbs starting to come up in short grass prairie and on buds on woody vegetation. I would personally be a little suspicious of them running into difficulty if they had to feed on this winter wheat for an elongated period of time.

Compton: What has been the fawn production in this area?

Suetsugu: It's quite high - fluctuates from year to year - the North Sioux ran 100/89.

SUCCESS AND FAILURE OF ANTELOPE TRANSPLANTS IN KANSAS[1]

by
Bill D. Hlavachick
Kansas Forestry, Fish and Game Commission
Hays, Kansas

ABSTRACT

The first introduction of pronghorn antelope (Antilocapra americana) into Kansas was made in 1964 when 75 head were released at two sites in western Kansas. These antelope were obtained from the National Bison Range in northwest Montana.

In 1965, sixty-one antelope obtained in a trade with the Colorado Game, Fish and Parks Department were released at two sites in south-central Kansas.

Eighty-five antelope obtained from the Sioux Army Depot in Nebraska in 1967 were transplanted into two sites in central and west-central Kansas.

No additional antelope have been obtained from out-of-state sources since the Nebraska transplant. No future introductions are planned.

The northwest Kansas herd has grown to about 250 animals since the introduction of the Montana antelope. The Colorato pronghorns have increased slowly and have extended their range to the south and west of the original release sites. Approximately 85 antelope are present in these herds. The semi-wild Nebraska antelope have dispersed so critically since their release that only 12 to 15 head are known to have survived and remained in or near the transplant sites. Several individual and small band movements of 3 to 90 miles have been recorded. It is concluded that semi-wild antelope are not suitable for transplant stock.

INTRODUCTION

During 1962, summer surveys of the only occupied antelope range in Kansas indicated a total of 12 males, 30 females and 14 fawns residing in Wallace County in extreme western Kansas. It was felt that as scattered as these few antelope were they were in danger of extirpation. This precipitated an antelope transplant program and negotiations were begun that year with South Dakota and Montana to obtain transplant stock. Open winters and abortive trapping efforts resulted in no antelope being obtained until November, 1964. During the interim, cooperative transplant agreements were entered into with several landowners throughout the occupied range and in other areas in south-central and central Kansas.

OBJECTIVES

The ultimate objective of this program is to add another member of the wildlife community to the growing list of huntable species in Kansas. Although admitting that antelope will never provide more than a token utilization benefit to the hunter, it is nevertheless practical to provide this species for the benefit of the nonhunter as well.

1/ A contribution from Kansas Federal Aid Project W-23-R.

Secondarily, the antelope will provide a reservoir of animals for future in-state transplants.

RESULTS AND DISCUSSION

Seventy-five antelope obtained from the National Bison Range near Moise, Montana, during November, 1964, were released at two sites in Wallace County (Figure 1, Site A). The shipment consisted of 16 adult males, 16 juvenile males, 30 adult females and 13 juvenile females.

Summer surveys in this area since the release have shown annual increases of 17 per cent, resulting in a 1969 population estimate of 250 head. This herd will serve as a nucleus from which future transplant stock will be obtained. Limited permit antelope hunting will probably be initiated in this region first with other areas to follow when it is determined that huntable populations are present. We consider this release to be quite successful.

In January, 1966, the Colorado Game, Fish and Parks Department shipped 50 antelope to Kansas for release in Barber County in the south-central portion of the state. One of these was dead-on-arrival and eight were transferred to the Maxwell Game Refuge near Canton (Figure 1, Site B). On January 20, twenty-three more antelope were received from Colorado. One doe was dispatched due to a broken rear leg, and another was found dead shortly after the release. A total of 62 animals was released in Barber County (Figure 1, Site C). The buck:doe:fawn ratio was 142:100:275. It is apparent that the release was "heavy" to young animals. The agreement with the Colorado Department was in the form of a trade; antelope for lesser prairie chickens (Tympanuchus pallidicinctus). Follow-up investigations have shown that the antelope have dispersed gradually into nearby Comanche County on the west, and to some degree, south to the vicinity of the Oklahoma border.

The success of this transplant is indeterminate. Aerial censuses appear to be of little value due to the expanse of the area and the relatively small number of antelope involved. Ground counts and personal communications with local ranchers indicate moderate reproductive success. A large coyote (Canis latrans) population coupled with free-ranging coyote chase-dogs (greyhounds) may be a limiting factor in keeping herd growth at a low level. Local coyote hunters all have chase-dogs and antelope are harassed by these packs several times during the winter.

The third, and last, out-of-state effort to obtain antelope transplant stock was undertaken with Nebraska. During January, 1967, Kansas contracted with the Nebraska Game, Forestation and Parks Commission for the major portion of the Sioux Army Depot antelope herd located near Sidney. After several abortive "drives" on the Depot, 85 antelope were trapped, loaded and sent to Kansas. Two release sites were selected. One site was in Ellsworth County in central Kansas (Figure 1, Site D), and another was in Edwards County south of the Arkansas River in the southwest part of the state (Figure 1, Site E). Fifty antelope were released at the Ellsworth County site: 10 adult males and 8 females, 4 yearling males and 6 females, 2 male fawns and 7 females, and 13 of unknown sex and age. The buck:doe:fawn ratio was 100:100:64. The remaining 33 antelope were released at the Edwards County site (1 buck and 1 fawn were dead-on-arrival at the Edwards County release site). Dispersal away from these two sites has been detrimental to the success of this release. Numerous road-kills occurred near both release site areas. Extremes of dispersal distances varied from 3 to 90 miles and almost

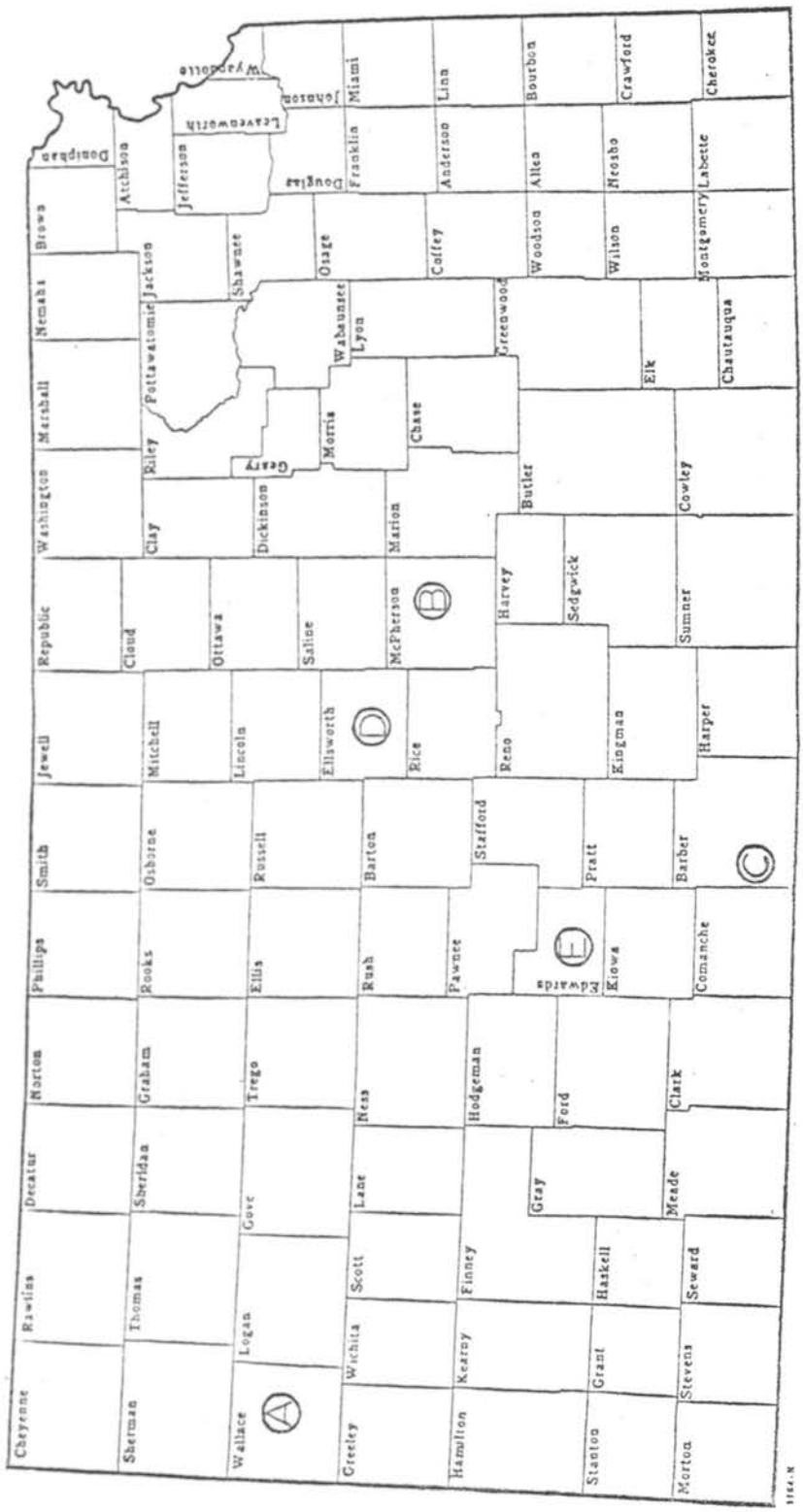


Figure 1. Antelope release sites in Kansas, 1964-1966.

all ranges in between. The movement of 90 miles was accomplished by 2 adult does, moving northwest when last seen.

By 1969, no antelope remained at the Edwards County release site. The last 4 antelope reported were located in Ford County in 1968, about 40 miles southwest of the original release area. Only 15 head remain from the original 50 released at the Ellsworth County site. These were observed during the summer of 1969. Reports indicated that at least 2 fawns were produced by this small band.

We have concluded that the severe dispersal and subsequent deterioration of these latter releases was caused by the inability of the semi-tame Nebraska antelope to adjust to a severe change in their former habits. These antelope had enjoyed a semi-tame, strictly confined way of life at the Depot and had become overly adjusted to man and his activities. Roadway and railroad rights-of-way were part of their regular haunts on the Depot. This fact led many of them to their deaths by way of collisions with automobiles and trains after their release in Kansas. We feel that their natural instinct of "herding up" during the winter had become so changed after years of confinement that this instinct had deteriorated. This has resulted in, to some degree, abandonment of the gregariousness for which pronghorns are noted. Needless to say, we do not feel that the last two releases were successful. Rather, they can be termed dismal failures. As a result of the Edwards County-Ellsworth County releases, we will no longer use anything less than wild stock for transplant purposes.

CONCLUSIONS

Of the four releases, one has been very successful, one moderately successful and two have been failures.

The failures were not due to any apparent lack of habitat availability or quality, but rather to inferior transplant stock. In view of the original objectives, our stocking program has been a success. We have reintroduced the pronghorn into historic range in Kansas and are building up a herd from which transplant stock may be obtained. We are not hunting the animal; we could on a limited basis. Our preference is to use the herd as a source of transplant stock.

Discussion

West: Have you noticed any problem in that higher rainfall belt with stomach worms, round worms, intestinal parasites?

Hlavachick: We have never done any study on external or internal parasites. For the most part, we just haven't had the animals to work with.

Pogorelz: How does your state handle the damage claims? Do you have any provisions?

Hlavachick: No, we don't pay damage at all. We never have. What we'll do is rent a plane and try to run them off, try to get them back to the middle of the pastures, harass them enough that they'll stay off the winter wheat. Normally what they'll do is go back on somebody that doesn't mind, and there are a few of those. Most of the people enjoy seeing the animals around. There's a few who mind.

Yoakum: You said you thought you had a problem with the burning - what is your problem?

Hlavachick: I can't envision antelope staying when there is a wall of fire coming out from all directions. When you get rain down there, about everybody get it and those farmers know within just a little bit of what it takes to burn the ground. They get out and that day you'll see them light up and the whole country will be on fire just after one little rain. They know when it's ready; they're not going to hurt the ground.

Yoakum: What little I've seen in references to burns, the antelope move right in and really help the plant succession for the betterment of the antelope and I believe there is a range management technique here for the bettering of the range, but then the rotation - the burning I imagine would be much more beneficial.

Hlavachick: Kansas State University always has recommended rotational burning for years and nobody has complied.

ANTELOPE HERD RANGES IN CENTRAL MONTANA 1/

by
Duane Pyrah
Research Biologist, Montana Fish and Game Department

Bayless (1969) and Wentland (1968) reported on individual home ranges of marked antelope during winter and summer. This report continues, along slightly different lines, their work on antelope in the Yellow Water Triangle in central Montana. This study relates marked antelope to specific herd units throughout the year. This study will continue. I reached the hypotheses in this report from data gathered mostly between September 1967 and December 1968.

The Yellow Water Triangle contains 271 square miles near the geographical center of Montana. It is near 23 miles on each side and lies south of a line between Grass Range and Winnett. The Yellow Water Triangle is split into two topographic types: eastern flats and western hills. The eastern flats are a series of low, east-west ridges covered by sagebrush-grass vegetation. The ridges are separated by shallow valleys of greasewood-sagebrush and greasewood vegetation types. Cultivated lands lie along larger streams and hay is the principal crop. The western hills are drainage heads with modified (probably burned) grassland vegetation on ridges and benches with better soil. Acreages of sagebrush-grass and greasewood-sagebrush types are minor in the western hills. Prior to this study, our knowledge of antelope using the study areas was not sufficiently detailed to plan sagebrush control experimental treatments on areas which were important to antelope. The conclusions of this study will be used to select, for experimental treatments, areas which are important to antelope during different seasons.

HERD RANGES

Stable social orders are recognized behavior conditions of many animal communities. No other study of marked antelope is known which shows continuing social associations between individual antelope throughout the year. Gregg (1955), Cole (1956), Fichter and Nielson (1962), and Prenzlow, et al (1968) studied behavior of individual antelope more than the interactions of herds.

The concept of stable arrangement of social groups in antelope herds, therefore, is new. Etkin (1964), referred to by Knight (1967), "defines a social group as one whose members stay together as a result of their social responses to each other rather than any other factor in the environment. Groups which owe their existence to attractive factors in the environment rather than social responses are called aggregations." These social responses are based upon recognition of individual antelope in the herd and to some knowledge of their place in the herd structure.

Our thesis of stability of herd associations is based upon reobservations of antelope marked with neck bands and radios over a three-year period. Three marked antelope for three years and many others for two years have remained with the same herd, which shows they have strong social bonds. Knight (1967) evaluated sociability of marked elk by "coefficient of association"

1/ A contribution from Montana Federal Aid Project W-105-R.

calculations (Cole, 1949) and concluded for elk, "With few exceptions no two individuals other than a cow and her current calf were closely associated for more than several days."

Our observations show very few movements of antelope to the outside of the highway boundaries of the Yellow Water Triangle. Summer herd ranges lap outside of the Triangle at three points, but winter ranges are all within the Triangle.

There are at least three types of social interaction in antelope herds. First, the doe and her offspring form a unit of special communal behavior; second, most summer herds are larger associations of doe-fawn groups; and third, winter herds are groups of summer herds.

Does are the stable element of antelope herds and maintain the traditions which perpetuate summer herds, and possibly winter herds also. Often does lead the herd. Their leadership might be due to their better knowledge of the herd range and the traditions they have learned.

Bucks confine their activity to the vicinity of does as much as possible. Bachelor buck herds have a special type of sociability. Bachelor buck herds have high coefficients of association during early summer, but they are short-lived.

Winter Herds

I define "winter herd" as: a group or groups of antelope on a common winter range where they often assemble into one herd. Winter herds are mixed sex and age classes; and it is my opinion, they are distinct populations in central Montana. The "herd range" I define as the entire area used by all of the antelope in a winter herd.

Few antelope with neck bands moved from one herd range to another. Antelope which left one herd range either temporarily or permanently did so as displacement or investigation, partly during the "spring shuffle."

"Spring shuffle" has not been used for antelope before; therefore, it is defined for this paper as: the investigational movements of groups of young antelope, called "shuffle herds," which occur when summer herds break away from winter herds and return to summer ranges. Antelope not attached to a stable social unit are involved in these shuffle movements. Does eventually join other doe-fawn summer herds and bucks form bachelor buck herds. But, sometimes these shuffle herds leave the herd range and take up residence in another herd range.

In an unusual situation, one adult doe wintered in one herd range and summered seven miles away in an adjacent herd range. One yearling doe moved permanently from one herd range to another. One adult doe changed temporarily to another herd range. One radio-marked yearling doe displaced after trapping to another herd range for winter but returned to former summer range the following spring.

Bucks, more often than does, switched herd ranges. Young bucks we would expect to move around more than older ones, and this usually happens as bachelor buck herds break up at the onset of the rut. Four marked bucks, which permanently left herd ranges where they were born, did so as yearlings. One buck displaced to a third herd range as a two year old. Two bucks set up in successive summers "non-breeding territories" in adjacent herd ranges. A "non-breeding territory"

is defined as an area defended by a buck antelope, usually two or three years old, but where no doe-fawn summer herds are present, seemingly because food conditions of that habitat niche are too poor. These non-breeding territories, like bachelor buck herds, last only until the rut in the fall when the bucks move closer to doe-fawn summer herds. Most banded bucks have been observed through two years in the same herd range.

Preferred winter habitat included topography which had south facing slopes where much warmer microclimates prevailed. On these sites antelope over-used sagebrush and rabbitbrush, sometimes leaving almost untouched adjacent sagebrush stands on flatlands. Six of seven winter ranges are in the eastern flats part of the Yellow Water Triangle, mostly on public land.

We observed that antelope abandoned winter pastures used by cattle and sheep. In many cases, cattle and sheep used sagebrush heavily during very cold weather.

The average size of the seven herd ranges was 24,800 acres and they ranged in size from 10,240 to 59,670 acres. The seven herds averaged 79 antelope in 1968 and 99 antelope in 1969. There was a direct correlation between size of herd range and number of antelope in the winter herd, larger winter herds occupied larger herd ranges. However, higher densities of antelope were on smaller herd ranges.

Summer Herds

I define "summer herds" as doe-fawn groups which are more or less stable throughout the summer. A "summer herd range" is the area used by a doe-fawn group. High association coefficients among members of a doe-fawn group and low association coefficients of animals from different groups indicate they are sociable toward each other in the group and to some degree antisocial to others in adjacent groups. It appears then that they recognize each other as well as the areas each group uses. These summer herd ranges appear to be a form of territory; however, we have not studied behavior to see if they are defended or what behavior patterns separate summer herds. When these summer herds mix, they almost invariably separate into the same original herds, thus individual antelope follow the ones which they recognize.

Bucks are accessories to doe-fawn herds. I have observed more than one territorial buck in a summer herd range, as did Cole (1956). Non-breeding territories have been mentioned already. Bachelor buck herds possibly show a sibling association. Without knowing which herds they were born into, we are only surmising an explanation for the differences of their association coefficients. One such herd contained seven marked bucks. High coefficients of association indicated four bucks might have been from the same doe-fawn herd; lower coefficients of association indicated the other three might have been from other adjacent summer herds.

Bachelor buck herds occupied poor habitat as was shown by Wentland (1968). However, they stayed in proximity to doe herds as nearly as territorial bucks would permit them. The bachelor bucks were around three of four doe-fawn summer herds in one herd range; the other doe herd was quite isolated.

Summer herds in the Yellow Water Triangle were invariably located where they had access to areas not grazed or lightly grazed by livestock during summer. Cole (1956) noted that antelope used alfalfa fields most where fields enclosed

additionally large areas of native rangeland. It is my opinion that the ungrazed native rangeland was the primary attractant and if the alfalfa fields were used secondarily when food plants were used up or became dried out on the upland sites. The prevalence of winter pastures for cattle and sheep appears to be an important summer habitat feature for antelope of the Yellow Water Triangle.

Average summer herd ranges covered 4,145 acres or about 6.5 square miles. Key summer areas much like key winter areas were small and the large size of the area was necessary for suitable escape distance.

FUTURE PLANS

In the near future we will investigate more closely: (1) the role of sagebrush in fawning sites, (2) distribution of vegetation types on summer and winter ranges, (3) relationship of livestock to antelope use of rangeland, and (4) movements of antelope on critical areas which are sprayed to kill sagebrush.

ACKNOWLEDGMENTS

Harold Wentland worked on this project during early spring 1968. I would also like to acknowledge the contributions of finances and supporting services by the Bureau of Land Management.

LITERATURE CITED

Bayless, Stephen R. 1969. Winter food habits, range use, and home range of antelope in Montana. J. Wildl. Mgmt. 33 (3):538-551.

Cole, G. F. 1956. The pronghorn antelope--Its range use and food habits in central Montana with special reference to alfalfa. Montana Fish and Game Department and Montana State College Agr. Expt. Sta. Tech. Bull. 516. 63 pp.

Etkin, W. 1964. Cooperation and competition in social behavior. Social Behavior and Organization Among Vertebrates. Wm. Etkin, ed. Univ. of Chicago Press. 307 pp.

Fichter, E., and A. E. Nielson. 1962. Study of pronghorn population. Idaho Fish and Game Dept., Job Compl. Rept., Federal Aid Project W-85-R, 16 pp.

Gregg, P. A. 1955. Summer habits of Wyoming antelope. Ph.D. thesis. Cornell Univ., Ithaca. 185 pp. (Dissertation abstr. 15:2374).

Knight, Richard R. 1967. Elk population trends, food habits, and range relationships in the Sun River area. Montana Fish and Game Dept., Job Complt. Rept., Federal Aid Project W-98-R-6 & 7. 237 pp.

Prenzlow, E. J., D. L. Gilbert, and F. A. Glover. 1968. Some behavior patterns of the pronghorn. Special Report No. 17, Colorado Dept. of Game, Fish and Parks. 16 pp.

Wentland, Harold J. 1968. Summer range habits of the pronghorn antelope in central Montana with special reference to proposed sagebrush control study plots. Montana Fish and Game Dept., Job. Compl. Rept., Federal Aid Project W-105-R. 65 pp.

Discussion

Ellis: These shuffle herds that you're talking about - is there any evidence that they occupy less desirable habitat or anything of that nature, than your more permanent adult herds?

Pyrah: Yes, this occurs usually at the time of year when they are making the most use of grass. As vegetation greens up in the spring, this makes available really a wider spectrum of habitat than was available earlier, and their duration might be shorter if there wasn't a change in vegetation in the spring.

Suetsugu: That sagebrush grassland area in the study area in the east that you had, is that just continuous sagebrush without any topography break and what was the scale from one end of the study area to the other?

Pyrah: It was about 23 miles on each side and the topography on the east side is flat, and the hills are on the west side.

Suetsugu: Then there is no reason in the sagebrush grassland for the animals not to travel?

Pyrah: They leave the hills, which do not have sagebrush, on the west to winter on the sagebrush on the flats.

ANTELOPE MANAGEMENT AND BLM's WILDLIFE HABITAT MANAGEMENT PLANNING SYSTEM

by
Terry A. McGowan, Wildlife Management Biologist
Bureau of Land Management, Denver, Colorado

ABSTRACT

The Bureau of Land Management has developed and initiated, on a Bureau-wide basis, a new wildlife habitat management system. This system, when fully implemented, should have a beneficial impact on antelope habitat as well as habitat of other wildlife species on the Public Domain.

This wildlife habitat management system is designed to attain predetermined objectives through a four phase system: Habitat inventory and analysis, habitat management plan, management implementation, and management evaluation. The system provides for coordination and cooperation with state fish and game agencies as well as other state and Federal agencies.

Priorities based on wildlife needs and manpower limitations will determine the rate of progress but the goal is to eventually have all important Public Domain habitat areas for both game and non-game species under this system.

INTRODUCTION

During the 1968 Antelope States Workshop, Jim Yoakum [1/] described the decline of pronghorn antelope (Antilocapra americana) numbers in the United States from about 35,000,000 in 1805 to a population low of about 20,000 animals in 1900 and the subsequent recovery to an estimated 365,000 in 1964. According to Public Land Statistics 1968 [2/] approximately 170,000 antelope presently inhabit the public lands. Recognizing these statistics as no more than rough estimates, we still can conclude that about one half of the present U. S. antelope population inhabit public lands administered by the Bureau of Land Management. These Federal lands will likely determine the abundance and distribution of our future antelope populations. Antelope populations on private lands will probably decline with the expected increase in intensity of land uses. At best, antelope and their habitat will be a secondary consideration on private lands. The public lands will be the only significant areas where the public will have guaranteed access and where preservation and management of antelope habitat will be a primary management goal. We can conclude this exercise in statistics by generalizing--so goes BLM lands goes the pronghorn.

1/ Yoakum, Jim, A Review of the Distribution and Abundance of American Pronghorn Antelope, Proceedings of 3rd Biennial Antelope States Workshop, Feb. 5-6, 1968, Casper, Wyoming.

2/ Public Land Statistics 1968, Bureau of Land Management, U.S.D.I., U. S. Government Printing Office.

The management system the Bureau will use to meet the great challenge and responsibility of perpetuating antelope on the Public Domain is the subject of this paper.

WILDLIFE HABITAT MANAGEMENT SYSTEM

The wildlife habitat management system provides a framework for wildlife habitat management on the public lands through a four-phase system: habitat inventory and analysis, habitat management plan, management implementation and and management evaluation. The system includes a recognition of the life histories and habitat requirements of both game and non-game wildlife species on the planning area.

The major components of the management system are:

I Extensive Habitat Inventory and Analysis

II Intensive Inventory and Analysis

III Habitat Management Plan which includes provisions for management evaluation.

Throughout all phases of the system, coordination with the state fish and wildlife agency is mandatory and coordination and cooperation with other state and Federal agencies is emphasized. In most instances a significant part of the inventory data will come from the state fish and wildlife agencies. The objectives of the resulting habitat plan must also reflect the goals of the state fish and game agency for management of the game animals dependent on the habitat. The system incorporates the traditional division of responsibility between state fish and wildlife agencies and BLM, that is, the state responsibility for habitat on public lands.

I want to stress the fact that our management plan objectives are not limited to game species. On the contrary, some of our first planning efforts under this system have been to manage habitat to benefit rare or endangered non-game species. Now we will discuss each of the major categories of the system.

EXTENSIVE INVENTORY AND ANALYSIS

The purposes of the Extensive Inventory and Analysis are:

(1) Identify and describe habitat and its components for all important terrestrial and aquatic species. This is done on a district-wide basis.

(2) To set up wildlife habitat areas for intensive study or management. These wildlife habitat areas are either terrestrial or aquatic and become the working unit or area of the system. These wildlife habitat areas are based on biological units such as herd ranges, winter ranges, reservoirs, spawning areas, etc.

(3) To determine the relative habitat management needs among the various wildlife habitat areas and establishment of priorities for work on these areas.

INTENSIVE INVENTORY AND ANALYSIS

This category of the habitat system provides guidelines and standard procedures for identifying habitat (and habitat related) problems and developing management recommendations. At this stage we are working on a specific wildlife habitat area which was set up using methods described in the Extensive Inventory and Analysis.

The Intensive Inventory and Analysis has the following three basic objectives:

(1) Identification and documentation of habitat and habitat related problems through collection and analysis of detailed information related to specific wildlife population needs for food, cover, water and living space.

This is actually the inventory phase and includes the following types of data.

(a) Habitat condition

1. Present condition of food, water, cover, etc. for each important habitat component.

2. Capability of the habitat for improvement of the components listed above.

(b) Population condition

1. Present numbers (when appropriate), density, production, etc.

2. Potential carrying capacity and production.

(c) Utilization of wildlife

1. Present sport harvest, commercial harvest, and non-consumptive use.

2. Potential for satisfying increased demands.

(d) Evaluation of existing data and provision for establishing basic surveys to collect essential data when existing data is not adequate.

(2) The second major objective of the Intensive Inventory and Analysis is to devise and analyze management alternatives which will solve problems which are identified. This involves the following major steps:

(a) Problem identification into two categories

1. Limiting factor (biological) related problems - food, water, cover, etc.

2. Utilization related problems such as under-harvest, over-harvest, lack of access, etc.

(b) Problem causes and where causes are not identified, basic surveys are planned for gathering this information.

(c) Problem solutions - listing all possible solutions, limited only by the present and potential capability of the habitat and wildlife species. At this state, considerations are not made for other land uses.

(3) Development of management recommendations for use in the final habitat plan. These management recommendations will include:

(a) Objectives expressed in quantitive terms of specific habitat needs. The objectives can be to maintain habitat conditions as they presently exist if satisfactory.

(b) Management methods which best solve the problem, including but not limited to changes in livestock grazing, timber management, habitat development, access development, land acquisition, classification and withdrawal.

(c) Implementation sequence and cost estimates

(d) Evaluation of management based on a program needed to assess progress and accomplishments. To permit evaluation, the objectives under (a) above must be specific and measurable.

The Intensive Inventory and Analysis portion of the planning systems requires the greatest manpower input and makes final development of the habitat management plan a fairly simple task. All steps are written out, particularly the analysis steps: problem identification, causes, solutions and alternative management methods. Writing out these steps not only helps in a logical development of alternative methods, but also provides a valuable record. New BLM personnel will be able to review the recorded problem-solution process and will be in a better position to evaluate why specific management methods were recommended.

HABITAT MANAGEMENT PLAN

Prior to preparation of the plan, the management recommendations (the end product of the Intensive Inventory and Analysis) must be coordinated with other resources by the Bureau's Management Framework System or by the District Manager. The plan is then written, using management recommendations as approved or modified by the decision-making processes.

The components of the plan include:

(1) A brief introduction to orient the reader and a map of the wildlife habitat area.

(2) Management objectives stated in specific terms that can be measured for evaluation of progress and accomplishment.

(3) Management methods stated and described in detail sufficient for implementation. These include restrictions on other uses and relate to attainment of objectives.

(4) Management evaluation includes studies designed to measure progress in reaching objectives (2).

(5) Implementation schedule and cost estimates in terms of time, dollars, and manpower.

(6) Provisions for review and updating.

I have given a brief outline of the BLM's wildlife habitat management planning system. The procedures are actually more detailed than I have presented. The system includes no new or revolutionary techniques, but does provide a systematic approach for insuring proper consideration and long term management direction for wildlife habitat on the public lands.

Discussion

Larsen: At what stage in this planning and development of priorities and plans, etc. do the recommendations of the District Grazing Board come in?

McGowan: The other resources are going to follow pretty much the same thing. Their methods are going to be different - the way they gather their information, etc., but the coordination in their recommendations are going to all hit at the same time, and we've got a really beautiful system, I think, this Management Framework system, in providing overlays, where all this information, for the first time is put on one piece of land. One of the problems, of course, is each resource has some different interests in the area that they consider; for instance, our watershed people are concerned on watershed boundaries; livestock interests, the range resource, are primarily interested on allotment basis, so we're going to have a little bit of problem relating to this unit of land. For instance, we may have a planning unit under consideration in the district that involves two habitat areas, but in developing this methodology here, we couldn't possibly see any way to manage wildlife without dealing with biological units, so regardless of where we put this information all together, we have to work with wildlife units, because we've got these various components of habitat, and we've got to consider the big picture. Our habitat area may overlap, and include a piece of the Forest Service, for instance, that may be the summer range. This may frequently be the case. On paper, at least, we would consider this. We'd have to know something about what is going on up there to adequately manage our lands. We'd have to put and take from the Forest Service to give us the big picture, but once we get to this piece of land that's going to be considered - it's a planning unit - the Bureau has standard planning units, they are fairly large units of land - at least after we've gone through this information, we know the relative values of various parts of that planning unit - whether it is our entire unit or not doesn't really matter. Then these various overlays which are prepared are put down, and I think it's going to resolve things like we've been faced with in the past - spray

project operations. We'll have our antelope habitat pretty well identified. Fencing, water development, changes of vegetative types, timber harvest - all of these things are going to be brought to bear at the same time, and their effect on wildlife hopefully will certainly be known better than it ever has been in the past. Now, as far as how these things are resolved, this is really going to be a gut-buster, it's not going to be anything new, it's not going to solve the problems for the people that make the decisions on what action is taking place on a unit of public land. The thing that it's going to do - it's going to give them more information than they've ever had before. They are going to have to document their decisions, which to my knowledge, hasn't been done before, so I think this is really going to give a careful consideration to future actions. What stage we're at now may be our next question. Our system was developed maybe about two years ago. This is the first year that the state and district offices have had a chance to try this thing out. We are starting to get quite a few plans now into the service center for review and we have seen a few areas where we want to make minor changes at this stage in our system, but we think it's pretty sound. It is just a logical step-by-step procedure. Next year, if we still have the men available, there will be an increased effort at putting out these plans.

Johnson: Do you have any timetable set up on the development of the plans for the areas?

McGowan: Only in terms of these priorities that we've established here. Of course, our manpower will determine how fast we go. Our basic Bureau objective is to cover all lands in the Bureau, hitting the hot spots first and going down, but eventually we want to include all habitat. Another thing I didn't mention, is that we may draw this herd boundary of a deer herd, an elk herd, or some fairly substantial unit of land. Now, we have other priorities in terms of just the areas that we are going to consider. After we go through this system for the major species, we want to include all species including dickey birds - the whole gamut of wildlife, and this will be our second step of priority after we have developed plans, then we will go back, and as best we can, include beneficial treatments for other species. One thing that we have to really consider, in the very early stage here when we developed these recommendations is for instance, we may be recommending that a certain treatment be applied to a piece of land to benefit big game. We have to be awfully careful that what we are recommending might not have an adverse effect on other wildlife species, but we are trying to include, to some extent, all of the wildlife species living on the area. The intensity of this will of course vary, depending on how much money and time we have got, and the amounts of information that is available. Certainly, there may be conflicts between antelope management and sage grouse, for instance, so we want to certainly consider the impact on other wildlife. In this portion down here, no other considerations except the practicality of any operation. We are not going to worry about what happens to the range, or we are not going to worry too much about watershed problems and all until we get down here to coordinate activities.

Bill Hepworth: . . . coordination level, and you're working out your district plan, quite often we have herd units that are overlapped by as many as three different Bureau of Land Management districts. What coordination do you have among districts before decisions are made relative to a particular problem?

McGowan: There is no exact procedure because it varies. Our state directors, our state setup are pretty much autonomous units to the point of view of managing their lands, so it will involve a cooperative effort. In some

instances I've seen, one district may relinquish their perogatives to manage to another district that may be better equipped to handle the job so that you're only dealing with one district, but it's still up to the districts or the state office involved. Of course, I know that some of the points you're bringing out here - this is quite a problem - in some of our areas where two or three states coincide, the boundaries and the biological unit overlaps all three. Of course our management is going to have to be coordinated, not only with other agencies, but within our own Bureau. Our objectives are going to have to be coordinated throughout this area, but there is no standard precedure. It still depends on how the involved states will react to this. One problem I see is that the priorities might be different within the units and this could be quite a problem.

Bill Hepworth: Differences will occur, therefore there must be some way for special review of the over-lapping areas.

Yoakum: Let me cite you an example. There are two district and two state offices in Nevada and California, and they didn't resolve it, so we're calling in Washington, and they are coming out and we are going to get it resolved. There is a built in system. It's being refined right now. This is certainly being considered because we see so many areas where this is going to occur. Right now the Washington office is making a review of this, and of course when it gets to a deadlock it can go right on up to the various administrative levels within the Bureau, but we are trying to get a smoother system.

TRES PIEDRAS ANTELOPE HERD-HABITAT DEVELOPMENT & MANAGEMENT

by
Montford H. Woody, Wildlife Biologist
Bureau of Land Management, Albuquerque, New Mexico

ABSTRACT

In 1965, the New Mexico Department of Game & Fish became concerned about the effect the net wire fencing program, being carried out by the Bureau of Land Management and livestock operators in the Tres Piedras area in northern New Mexico, would have on antelope. As a result of a joint field tour and additional meetings held in 1965, both agencies agreed on the following:

The present net wire fences should be modified wherever possible.
Any new fence construction should be designed to permit antelope movement.
Before any new net wire fence construction, the BLM would request NMG&F recommendations and concurrence.
Additional big game forage was needed around the base of San Antonio Mountain.
Big game water units constructed in the eastern portion of herd unit would increase the amount of available antelope habitat.

The BLM and NMG&F realized the competing uses and demands on this antelope habitat was creating an undesirable situation and the two agencies were willing to commit the money and manpower needed to improve conditions. The results indicate that the cooperative effort was successful. During the five-year period of development and management the antelope herd increased from approximately 250 to approximately 1,200. Hunter pressure increased from 83 hunters and 46 animals harvested in 1965 to 169 hunters and 151 animals harvested in 1969.

DESCRIPTION OF AREA AND RESOURCE INFORMATION

The Tres Piedras herd unit is situated on a high volcanic plateau located in north-central New Mexico. The eastern and southern boundaries are the Rio Grande Gorge; the Western boundary is lower elevations of the San Juan Mountain range; the northern boundary is the New Mexico-Colorado State Line. Two large volcanic mountains, San Antonio and Pot Mountain, are located in the herd unit. The elevation ranges from 11,000 to 9,500 feet on the two mountains, down to 7,500 feet on the plateau. Annual precipitation ranges from about 20 inches on top of the mountains to about 10 inches on the plateau. The spring and fall seasons are generally dry. July and August rains account for about 50% of the moisture with the remainder being in the form of sleet or snow. The vegetation types in the management unit range from mountain grass and shrubs at the summit of San Antonio Mountain down through conifers and pinon-juniper stands on the slopes to sagebrush, grasses and winter fat at the lower elevations on the plateau.

Herd Use Patterns

The antelope herd uses the top and slopes of San Antonio Mountain as spring and summer ranges and generally moves to the lower slopes and on to the plateau during late summer, fall and winter. A ten-mile sheep fence apparently divides the unit into two separate habitat areas. Approximately 70% of the antelope

herd is concentrated in the San Antonio Mountain area, west of the sheep fence, and about 30% of the herd is scattered east of the fence. This fence runs parallel to U. S. 285 about 3 miles east of the highway. Some antelope movement across this fence has been observed, but generally very little movement occurs.

Habitat Use and Demands

San Antonio Mountain provides forage for elk, deer, antelope, domestic sheep and cattle. The demand for forage by these species varies by season: Elk, winter use; deer, yearlong use; antelope, spring-summer use generally. But during mild winters the antelope use is yearlong. Livestock grazing occurs during the summer. Over 250 miles of allotment boundary and pasture division fences have been constructed by the BLM and livestock operators. Prior to 1965, most fence construction was sheep-type 36" net wire with two to three strands of barbed wire above the net wire for a total height of 48 to 56 inches. This fence construction, along with the grazing demand on San Antonio Mountain, created undesirable habitat conditions. The BLM, the agency responsible for the habitat management on public domain lands, and the NMG&F, the agency responsible for managing wildlife on all lands, private, State and Federal, met in the field in 1965 to discuss the matter. After the field tour and numerous office contacts and meetings, the two agencies agreed to work together to improve habitat conditions. The NMG&F committed $10,000 to be used on a 50% basis with the BLM for 2,000 acres of land treatment and seeding around the base of San Antonio Mountain. All other wildlife projects such as fencing, antelope pass devices and big game water units were to be accomplished by the BLM. The wildlife development projects, units and costs are shown in Table 1. All BLM construction and development was located on public domain land. The land status on the Tres Piedras management unit is estimated to be 55% BLM, 15% USFS, 15% State and 15% private.

Evaluation of Development Work

Seedings - 2,317 acres. One limiting factor was the lack of big game forage. Therefore, the objective of the land treatment was to increase the amount of big game forage around the base of San Antonio Mountain. All increases in forage as a direct result of the project would be reserved for elk, antelope and deer - no increase in domestic livestock use would be permitted. A totally successful land treatment project seldom occurs. In reviewing and evaluating these four seeding projects, we have attempted to state why the project failed or was successful. We did not attempt in this paper to list all possible factors that might have influenced the results.

The Martinez and Salazar seedings were completed in 1966. We used a Marden and Fleeco brushcutter to control undesirable brush species and to prepare a seed bed. A seed box mounted over the rear cutter of the Marden brushcutter broadcast three pounds of crested wheatgrass per acre. A stand of crested wheatgrass was not established. However, the native forbs and grasses did increase and the amount of antelope use increased. The Marden brushcutter did not provide adequate brush control or seed bed preparation. Also, a seeding rate of more than three pounds per acre should have been used.

We tried different land treatments and seeding methods on the 1967 Clark and Atencio Projects. A Towner offset disc prepared the seed bed and we drilled the seed with a rangeland drill. The seeding mixture was 9 lbs. per acre. We added yellow sweet clover and Nomad alfalfa at 1 lb. each per acre with 7 lbs. of grass. There was major change in the procedure of the treatment on the two projects.

TABLE 1 - WILDLIFE HABITAT IMPROVEMENT PROJECTS

COMPLETE TO DATE

PROJECT NAME	FY YR	DIRECT PROJECT COST*	QUANTITY	UNIT	UNIT PRICE
Salazar Elk Seeding	66	$5,761 BLM 1,290 NMG&F	840	ac	$ 8.39
Salazar Protection Fence	66	4,138	3.4	mi	1,217.00
Martinez Elk Seeding	66	3,710 NMG&F 599 BLM	509	ac	7.50
Martinez Protection Fence	66	4,930	3.9	mi	1,264.00
Antelope Ramps	66	2,308	7	ea	341.00
Antelope 4-Ft Guards	66	2,169	16	ea	135.00
Atencio Wildlife Seeding	67	3,050 BLM 2,500 NMG&F	505	ac	11.00
Moeller Wildlife Seeding	69	3,100	310	ac	10.00
Atencio Protection Fence	67	4,138	2.4	mi	1,359.00
Clark Wildlife Seeding	67	1,311 BLM 2,500 NMG&F	290	ac	13.14
Clark Protection Fence	67	2,526	2	mi	1,263.00
Antelope Guzzlers	67	9,100	7	ea	1,300.00
Antelope 8-Ft Guards	67	2,506	10	ea	250.00
Antelope Fence Panels	67	392	7	ea	56.00
Inverted Tanks	68	4,020	3	ea	1,340.00
San Antone Inverted Tank	69	1,550	1	ea	1,550.00
Pot Mt. Antelope Panels	70	450	8	ea	56.00

SUMMARY

Seedings:	2,317 acres
Fencing:	11.7 miles
Antelope Pass Devices:	58 units
Big Game Waters:	11 units

EXPENDITURES TO DATE:

NMG&F	$10,000
BLM	52,048
TOTAL	$62,048

*Planning & evaluation costs are not included

We pulled the rangeland drill as we plowed Atencio Seeding, whereas on the Clark Project we plowed and then waited 90 days and drilled. An excellent stand of introduced seeded grasses and forbs was established on the Clark Project. The results on the Atencio Project were not as favorable with only scattered establishment of new plants. Why the difference between the two projects? When one pulls the rangeland drill directly behind the towner offset disc, the tendency is for the seed to be planted at a depth of 2 inches or more. If one drills the treatment area after waiting 60 to 90 days, there is an excellent chance that the depth of the seed will be about ½ inch.

Antelope use was heavy on the Clark Seeding during the spring and summer of 1968. On six different occasions, over 100 head of antelope were observed using the 290 acres seeded. The estimated fawn crop on the four seeding areas was 100% for 1967 and 1968.

Antelope Pass Devices

A total of 58 antelope pass devices have been installed to aid antelope in crossing woven wire fences. We have tried four different types of pass devices, "antelope fence panels", 4-foot wide antelope guards, 8-foot wide, light duty cattleguards, and earthen ramps. The ramps were constructed by building a wooden barrier on each side of the fence. The barriers were 12 feet long and 3 to 4 feet high. A dozer was used to push dirt up to the barriers. The total jump distance from one barrier across the fence to the adjacent barrier varied from four to eight feet, one was 4 feet, one was 6 feet, and five were 8 feet. The antelope guards were installed in the same manner as a regular cattleguard. The jump distance across both the 4 and 8-foot guards is six feet. Mature antelope have jumped the 4-foot wide guards, 8-foot wide guards, and 30 inch combination barbed and net wire fence. Antelope did not jump the 4-foot guards until approximately 13 months after installation. Antelope jumped the 8-foot guard within 3 months after installation. It appears that antelope will adjust to and utilize the 8-foot guards faster than the 4-foot guards, 8-foot guards, 8-foot ramps, or the 30 inch fences. To date, no data is available to indicate that any antelope have jumped the 8-foot ramps. No information is available to indicate that antelope fawns (3 months or less) have used any of the pass devices. Both sheep and antelope have jumped the 4-foot earth ramp.

Recently, 12 allotments in this management unit were changed from sheep use to cattle use. On the allotments converted to cattle use, 1/8 mile of old woven wire was removed and replaced with a 4-strand barbed wire fence. The wire spacings were 16", 8", 8", and 10 inches. The bottom strand wire was smooth. Usually this type of fence modification (we call it "Antelope Fence Panels") is placed in the corners of the allotment. Almost immediate antelope use was made of the panels. The panel cost is low and they allow antelope to move freely between allotments. These "Antelope Fence Panels" have proven to be very satisfactory. We hope to install 15 panels and ten 8-foot guards in 1971 and 1972.

In summary, it appears that the 8-foot guards, the 30-inch fence and the "Antelope Fence Panels" offer the highest potential to aid the movement of antelope across the fences.

Water Units

During FY 1967-68, artificial watering units were installed. Six of these units were "antelope guzzlers" and five were the "inverted umbrella tanks". The guzzlers were installed to benefit antelope and the inverted tanks were to benefit the deer

and antelope.

A guzzler consists of one 1000 gallon fiberglass tank, 3/16 inch thick with a non-skid texture ramp designed to support a 1,500 pound animal and one 14 x 32 foot cathment apron. The apron is a corrugated galvanized iron sheet built on a timber base.

The inverted tank is a 2,300 gallon galvanized iron storage tank with a galvanized iron inverted umbrella catchment apron attached to the top of the storage tank. The apron is a circular iron sheet with a 16-foot diameter. Water is piped 40 - 100 feet to a float box and drinking basin.

A 200 x 400-foot exclosure fence was constructed around each unit. In sheep allotments, a 26-inch woven wire with one strand of barbed wire 4 inches above net wire was installed. In cattle allotments the standard BLM 4-strand barbed wire fence was constructed. These exclosure fences prohibit sheep and cattle from using the water units.

Antelope have been observed using both types of water units. Additional habitat that was unavailable in the past due to lack fo sufficient water supply is now available for antelope use. A water supply for antelope from these artificial water units does not mean complete success in the enlargement of the antelope herd. But we believe that it was one of the limiting factors. If antelope numbers increase to 1,500 - 2,000 head using the eastern one-half of the unit, we feel the water units will be successful.

Habitat and Game Management

As stated previously, the New Mexico Game & Fish Department is responsible for all game management activity including all population manipulation while the BLM is responsible for land management, including habitat management, on public domain lands. The two agencies have met in the field every summer since 1965. During these tours and additional office meetings, information about the work and activities of each agency is exchanged. This allows the two agencies to identify problems and decide what action is needed.

Proper range management and control must be obtained if one hopes to achieve a successful wildlife program. An allotment management (AMPS) plan is one tool we use to achieve better range management. A grazing allotment is evaluated resulting in a grazing system for the allotment. Most systems we have used allow one or more pastures to be rested during the growing season. The AMPS are designed to incorporate wildlife planning and provide for wildlife needs.

Let's review what has occurred in range management since 1965. Twelve operators have changed from sheep use to cattle use. Seven allotments have approved allotment management plans in effect. Two of the AMP's allotments, Atencio and Martinez, are located at the base of San Antonio Mountain. The remaining five are located on or north of Pot Mountain.

The antelope harvest and related management activities are shown in Tables II and III.

The low harvest compared to survey results is due to the management objective of increasing the antelope herd. The 1969 season was the first either sex hunt conducted. The principle reasons were to reduce the number of antelope around

TABLE II - ANTELOPE POPULATION DATA AERIAL SURVEY NMG&F SURVEYS

YEAR	BUCKS	DOES	FAWNS	TOTAL	TYPE OF SURVEY	FAWN CROP
1961	63	96	72	231	100%	75%
1962	43	119	76	238	100%	64%
1963	No survey					
1964	No survey					
1965	57	105	95	257	100%	90%
1966*	44	143	128	315	70%	89%
1967**	22	109	101	232	40%	93%
1968	117	336	299	752	100%	82%
1969	93	248	146	487	33%	58%

* BLM Ground survey
** BLM aerial survey

TABLE III - ANTELOPE HARVEST DATA

YEAR	HUNTERS	HUNTER DAYS	ANTELOPE KILL	HUNTER SUCCESS	TYPE OF HUNT
1962	83	126	46	55.4	1½ days - buck only
1963	52	78	27	51.9	" " " "
1964	83	126	46	55.4	" " " "
1965	67	101	47	70.1	" " " "
1966	117	176	50	42.7	" " " "
1967	126	189	72	57.2	" " " "
1968	123	246	85	69.0	2 " " "
1969	169	278	151	89.3	2 " " "

the base of San Antonio Mountain, to attempt to increase the rate of production and to obtain age ratio data on the herd.

CONCLUSIONS

The conclusions the BLM has reached are based on field observations and general knowledge of the area.

The placement of antelope pass devices has permitted mature antelope and 4-months old fawns movement through sheep-type fences. Game water units have increased the amount of habitat available to the antelope herd and the seeding projects primarily designed to benefit elk have produced additional spring and summer forage for antelope.

The herd has greatly increased in numbers since 1965. Why the increase on this management unit? The ability of one portion of the habitat, San Antonio Mountain, to produce early spring and summer forage in the form of cool season native grasses and forbs and the establishment of cool season seeded grasses and forbs on San Antonio Mountain have very likely influenced the reproduction rate of this herd.

Aerial and ground surveys conducted during the past five years show the doe-fawn ratio to be higher on San Antonio Mountain than on the adjacent plateau area. A reasonable estimate would be 95% to 100% on San Antonio Mountain survey compared to 30% to 50% on the adjacent plateau habitat. The native grass and forbs, along with seeded species and the small amount of sheep fencing on San Antonio Mountain are believed to be the major reasons for the difference.

Can Pot Mountain, a habitat area similar to San Antonio Mountain, be developed and managed to produce the same results? Yes, we think it can. Hopefully, some member of the BLM or NMG&F in the future may present a paper on the results accomplished on Pot Mountain and the plateau north of the mountain.

Discussion

Perkuchin: Do you have areas where you need reduction in your domestic livestock use, and has any of this been instituted, and is it possible to do this?

Woody: Yes, we did. When we seed an area, we get two years non-use agreement signed by the grazing operator. He can't use it, and this allows us to develop an allotment-manager plan which usually calls for some sort of reduction and our best selling point to date has been, would you take say a 10 or 20% suspended non-use. In other words, your qualification on paper will remain the same, but if we can talk them into taking 30% we do. As far as going to a reduction hearing, we didn't have to in this particular area.

Jacobsen: What is your opinion as to what is best accepted by the antelope - pass structures or a lowered fence?

Woody: Well, I think a lower fence. I'll have to qualify that. Around our game water units, in one area we installed a guzzler, and put in a 8 foot guard and a 30 inch fence both just to make sure that they could get in it, but they kept jumping the fence and didn't use the guard, so we took the guard out and installed it in an area where we thought we might need it over the existing fence.

Wentland: Did anyone do any studies to indicate whether the antelope actually were eating this grass in the seeded areas?

Woody: No, there was no intensive study done, it was just a general field observation. When I went into the park seeding I saw numerous tracks and I thought we had trespass sheep in here, and I started looking at the tracks and I got my field glasses out and it was antelope. I would watch them and would walk over to them to try to figure out exactly what they were eating. It looked to me like we were getting considerable use on the crested wheat grass seed that was coming up along with alfalfa and there wasn't any livestock in there so I assumed that it was antelope.

Burch: Do you expect them to continue to use this grass as these crested wheat plants get large?

Woody: Well, I think that a lot of it will depend on your livestock grazing. If you go in there on a rotation system and graze it hard one year and rest it the following year, and get the heavy utilization, then I think that they will come back and use it, but if it becomes a mature plant, I don't think they will.

Kerr: I just wanted to say that inspections I made of the Clark seeding, at times every crested wheat plant had been grazed by antelope.

Woody: We'd like to point out that the seedings were primarily designed to produce additional forage for elk. I should have brought this out in the paper. I have it written, but I didn't say it, but on the particular area that we seeded 2,000 acres - for three straight years our field counts indicated that the fawn crop was over 100%, and we include this, that they must like that cool season grasses and forbs. At least it appears that way to us.

TWO "KILLER WINTERS", 1964-1965 and 1968-1969, IN NORTH DAKOTA

by
James V. McKenzie, Big Game Biologist
North Dakota Game and Fish Department

In North Dakota, we have four seasons of the year - winter, spring, summer and fall. Some may dispute this statement but it is fact. Why I distinctly remember that last spring was on Sunday because I went fishing. I mention this because there may be people here today that have only heard of our winters with the often publicized temperature readings of 20, 30 or even 40 below zero. These are also fact, but we like our winters - they keep out the riff-raff. The bare-foot lads of the great, unwashed, psychodelic cult are not unheard of in North Dakota but in our state, after they are done complaining about their chilblains, they have forgotten what they were protesting in the first place. Yes, winters are an integral part of the North Dakota experience - so much so that winter hardiness is of paramount importance when a new species of perennial plant or animal is considered for introduction into our state.

Along this vein, even native species such as the American Pronghorn are tested periodically, to reaffirm this inherent quality. This, in essence, is what will be considered during the next few minutes.

First, I believe, a brief history of the American Pronghorn in North Dakota is in order.

The 1926 publication, A Biological Survey of North Dakota by Vernon Bailey, notes that this magnificant game mammal was well known to the plains Indians. The Mandans called him "Koka"; Dakotas referred to him as "Totakana"; he was "Uchi" to the Hidatsas; and "Chka" to the Arikaras. Early settlers spoke of him as the pronghorn and found him plentiful in nearly all sections of what is now North Dakota.

As section after section of his historic range disappeared under the plow and as a rapidly increasing human population exerted unrestricted pressure on his numbers, this animal was crowded, ever westward, into the more inaccessible portions of his former range. Perhaps there, predators, disease, severe winters and continued harassment from an advancing civilization resulted in the continued herd decimation until E. W. Nelson noted in his bulletin, Status of the Pronghorn Antelope, 1922-1924, ... "Antelope have almost disappeared from North Dakota. The remaining herds now number only five and aggregate about 225 animals."

This apparently was the low ebb in the population of "Totakana" in North Dakota because each subsequent record showed an increase, for instance William T. McKean, Biologist for the North Dakota Game and Fish Department, reported in his paper, Results of the 1950 Antelope Census, ... "For all areas censused a total summer population of approximately 2,492 is indicated."

A corresponding census in 1951 by Mr. McKean showed a population of at least 3,878 animals and this data provided the basis that year for the first open season on pronghorns in North Dakota in well over fifty years.

The population trend spiraled upward through the remaining 1950's and early 1960's until it "peaked out" at more than 14,000 animals in 1964. During this period (1951 through October, 1964), 13 hunting seasons were held; a total of nearly 27,000 permits was issued; and a harvest of about 25,000 animals was realized. I have chopped this historical account off at the end of October, 1964 for a very good reason. The following month, November, 1964, the snows came.

The winter of 1964-1965 will long be remembered for its severity with its frequent blizzards; deep, crusted snow; low temperatures over prolonged periods; and with the effects of a combination of these factors upon both domestic and wildlife stock in North Dakota.

That winter may best be characterized by its impact on the primary pronghorn antelope range because that is where the most devastating conditions developed.

I have averaged the climatological data from seven reporting stations in the southwestern portion of North Dakota as a basis for my attempt to describe conditions as they existed from November 15, 1964 through March 31, 1965.

During that 137 day period there were 75 days when the minimum temperature was 0°F or colder; also, there were 10 days when the maximum temperature was never above 0°F and an additional 93 days when the maximum was below 32°F.

It is well to emphasize the fact that there were 34 days during this period when the maximum temperature did rise above 32°F. These days of thawing trends were fairly evenly distributed through seven distinct periods of the winter. In other words, seven times during the winter thawing "peaks" did occur but in each instance, they were followed by severe "troughs" of extremely cold temperatures extending over several days. (These are "crusting" conditions and will be discussed later.) The average temperature for the winter of 1964-1965 was 8.3° below the seasonal normal of 18.7 degrees and it varied from 14.2°F below normal in December to 2.9°F below normal in February. Significantly, the average temperature for March was 12.4° below normal. As we say in North Dakota, 'we had a cold snap'.

Precipitation-wise only an average amount of snow or 2.45 inches of precipitation fell during the winter of 1964-1965. (The normal for this period of the year is 2.46 inches of precipitation.) By computing one inch of precipitation into an average of 10 inches of snow, the total snow fall approximated the normal of about 25 inches for the period in question. However, the precipitation by month showed November, December and January to be above normal and February and March to be below normal. This fact, coupled with the below normal temperatures, resulted in a situation where much of the snow that fell on our pronghorn range staying on the ground for most of the entire 137 day period. The reported snow depth at the reporting stations bears out this contention as the average snow depth on November 27 was 6 inches and it was still 6 inches on March 30. It never dropped below 4 inches and it ranged up to 17 inches in depth, in fact, during 65 days of the winter, the average snow depth was 10 inches or more for this portion of North Dakota. Keep in mind that this snow had thawed and then froze into seven distinct crusts or strata. There was literally an impenetrable layer of ice over much of the pronghorn range in North Dakota.

Finally, there is one climatological ingredient that isn't recorded other than

in a general sort of way - it is wind velocity. When the wind-chill factor is considered, wind velocity assumes major importance in a discussion of this nature. For instance, with the temperature at -20°F and a wind speed of 25 mph, the wind chill is the same as when the temperature is -65°F and the wind speed is 5 mph. To a pronghorn attempting to winter on an exposed hillside in North Dakota, the seriousness of the wind-chill factor is hardly a moot possibility.

So much for this (undoubtedly dry) climatological information. How did all of this effect pronghorn antelope in our portion of the northern plains?

Previously mentioned was the fact that the July, 1964 population estimate was in excess of 14,000 animals. The July, 1965 survey revealed that this figure had been reduced to 6,151 animals on the same areas censused a year previously, a reduction of 56.8%.

Included in this reduction was the poorest reproduction recorded in North Dakota since this data was first collected in 1951. It was down to an average of 62 kids per 100 does and was as low as 39 kids per 100 does in much of that area bordering Montana. So not only did a large number of animals die directly but an additional indirect loss occurred due to the effects of the severe winter on pronghorn reproduction.

There is little doubt that the direct loss of animals during the winter was the result of starvation and malnutrition and these conditions probably developed in three ways. First, with the deep, crusted snow covering much of their normal food, the pronghorns had to eat what ever was available; next, the snow restricted their normal movement in search of food; and finally, the prolonged periods of below normal temperatures coupled with frequent high winds placed additional food requirements on the animals just to keep the fire burning - so to speak.

An interesting observation was made during a collection trip near Belfield, North Dakota in January, 1965. Eight animals were collected from a group of about 35 pronghorns marooned in a farm area and who were attempting to survive in or adjacent to a field of stunted corn. Several other animals were already dead in the field. The viscera of each animal was removed in its entirety and placed in separate plastic bags for subsequent analysis at our field laboratory near Jamestown, North Dakota. Later these viscera were opened and analyzed. Not surprisingly, paunch samples showed about 99% by volume was corn stalks, leaves and some grain. Also, antelope hair was found in all paunches - this would not have been so surprising in itself had one sample not been 5% by volume antelope flesh. Obviously this animal had fed on one of the already dead pronghorn antelope.

Another indication of malnutrition was recorded on May 11, 1965 near Beach, North Dakota. At that time, forty dead pronghorns were picked up on one ½ section field. The bone marrow of these animals indicated severe malnutrition and they had died with paunches full of nothing but volunteer wheat and wheat straw.

There were numerous other examples but it will suffice to say that in areas of little or no woody browse, the pronghorns died and in other areas where woody browse was available, they survived.

With malnutrition and starvation stalking the remaining animals, it is little

wonder that reproduction was to suffer. The added stress of pregnancy likely pushed many of the older aged females off the deep end. This contention is born out by the fact that the sex ratio of animals one year old or older was tilted toward males during the 1965 population survey and only males were represented in the 5½ year age class obtained through a field check of animals harvested during the 1965 pronghorn season. (Incidently, only 3 animals fell into this age class out of slightly more than 100 checked and these were all males.) In fact, very few kid, yearling and 4½ year age classes were noted during this field check.

In retrospect, it appears that the very young and the very old were effectively culled from the pronghorn population in North Dakota during the winter of 1964-1965. The importance of this culling action will be pointed out later.

The period from 1965 through October, 1968 was one of herd rebuilding. Annual seasons were held on a much restricted basis with an additional 7,132 permits being issued which resulted in the harvest of 6,025 pronghorns during these intervening four years. The 1968 pronghorn antelope population was established at about 8,250 animals and it appeared that "Totakana" was well on his way to recoup his losses suffered during the "killer winter" of 1964-1965. Then last winter (1968-1969) descended on North Dakota and in some ways, it was a replay of events as far as American Pronghorn in our state was concerned.

Again, the pronghorn range was hard hit with below normal temperatures, above normal precipitation and deep snow that continued to accumulate over most of the corresponding 137 days mentioned earlier in this paper.

The average temperature from the seven reporting stations was only 4.1 degrees below the seasonal normal for this period, however, after above normal temperatures (14.8 degrees above normal) in November, temperatures plummeted in early December and remained 10 to 14 degrees below normal until the fore-part of February. Then they moderated to temperatures of 1 to 6 degrees below normal for the remainder of the period under consideration.

There were 60 days when the minimum temperature and 14 days when the maximum temperature was 0°F or colder, in addition, there were 83 days when the maximum temperature was below 32°F.

The remaining 40 days had maximum temperatures of above 32°F. It is well to point out that 16 of these days occurred in November and 13 others occurred in the last half of March. There were only two brief periods (in the first part of January and the middle of February) when thawing conditions moved any amount of snow prior to the spring thaw which began the last part of March. Again, with the exception of warm periods at the beginning and the end, North Dakota experienced another cold winter.

The precipitation was above normal as 3.86 inches fell during the 137 day period. This is 1.41 inches above the 2.45 inch normal for this period and most of it fell in the form of snow during the period when below normal temperatures prevailed. In fact, November was only slightly (.07 inch) above normal and both February and March were below normal. A computed total of 23 inches of snow fell during December and January (1 inch of precipation = 10 inches of snow).

The average snow depth was never below 10 inches from December 25, 1968

through March 18, 1969, a total of 97 days. During this period, the snow depths averaged 15 inches or more for 37 days and the deepest accumulations averaged 18 inches in early March.

One oddity of last winter was the fact that not one blizzard was experienced in the southwestern part of North Dakota. Comparatively light and variable winds sifted the snow around a little but for the most part, the snow accumulated where it fell. This situation likely took the place of the severe "crusting" conditions that could have developed.

This reduced wind velocity condition was viewed with mixed emotions. On one hand, the wind-chill factor was much reduced but on the other, few areas were blown free of snow which adversely effected the antelope's ability to find food.

This fact coupled with the below normal temperatures and above normal snowfall over an extended period of time resulted in another major winter-kill of pronghorns in North Dakota. The July, 1969 antelope census showed a 23% reduction from the previous year to 6,320 animals. This loss undoubtedly would have been greater had production not remained quite good (91 kids/100 does) in 1969.

This brings up an interesting possibility. I feel that because of the natural culling effect of the 1964-1965 winter-kill, we went into last winter with a healthier, more vigorous breeding population and even though mortality occurred the over-all production remained near normal possibly due to this culling. This may or may not be true.

Looking back, the two winters are comparable in several ways and if I were asked what conditions would contribute to some future winter-kill of American Pronghorns in North Dakota, I would include these general criterion - below normal temperatures, above normal snowfall, and either very little wind or frequent periods of "crusting" for from 60 to 100 days; and large pronghorn concentrations on inadequate or browse-depleted winter ranges.

Now South Dakota has some rough winters too - with deep snow and cold weather. In fact on the way down here to Scottsbluff, I drove through that state and it was cold. It was so cold in fact that just south of Lemmon, South Dakota, Doug West's duty station, we saw a white-tail jackrabbit pushing a cottontail - trying to get it started - Doug will take it from there.

EFFECTS OF PROLONGED DEEP SNOW AND COLD WINTERS ON PRONGHORN MORTALITY AND REPRODUCTION IN SOUTH DAKOTA

by
Douglas R. West
Department of Game, Fish and Parks
Lemmon, South Dakota

INTRODUCTION

Antelope mortality during severe winters with prolonged deep snow cover and below normal temperatures has been documented by Martinka (1967) and Bever (1949, 1950, 1952), and in Pittman-Robertson reports from other states.

Little benefit can be derived from reviewing this past history unless new knowledge is brought to light; or conclusions can be drawn and recommendations put forth on needed research work or management programs.

RECENT SEVERE WINTERS IN SOUTH DAKOTA

Evidence of reduced antelope populations following hard winters in South Dakota can be noted by the absence of pronghorn hunting seasons in 1945 and 1949. In both cases the previous winters were of the type to be considered severe.

Bever (1949) states that it had been customary to conduct the antelope census in late May and early June and to use only one plane. In 1949, two planes were used and the census was delayed until July 1 in order to be able to present the most timely report to the Commission when they met to consider the advisability of an antelope season.

The census showed a decrease in Harding, Butte, and Meade Counties. The 1949 spring breeding population was 60 per cent below the calculated 1948 post hunting season population. From 1948 to 1949, the total antelope population, including the 1949 kid crop, dropped 48 per cent.

Field checks made after the January blizzards indicated starvation, rather than choking or freezing; was the principal cause of death.

The 1949 spring and summer population data were analyzed by Wendell Bever (1949) for changes in ratios and he concluded the kid mortality during the preceding winter was only moderately above normal.

Another indicator of winter losses is the variation in losses between geographically (to antelope) separated areas. For example, winter conditions were more severe in Meade County than in Harding and northern Butte Counties, yet the losses in Harding and Butte were greater than in Meade. Normally we would expect the reverse if inclement weather were the principal cause of winter loss.

Bever's last indicator of the degree of winter loss due to weather lies in an antelope mortality study conducted in southeastern Montana adjacent to the South Dakota line. Aerial surveys conducted by the Pittman-Robertson staff in Montana showed an estimated winter loss of 32 per cent of the total population. This is approximately half as great as that occurring just across the line in South Dakota.

This Montana P-R report adds credence to the theory that much of South Dakota's loss may have been due to population shifts. This report indicated that possibly 30 per cent of the antelope censused in Carter County, Montana may have been South Dakota antelope.

Many Harding County residents report that a local pilot noticed the sudden disappearance of antelope in early 1949. He followed their movements by their conspicuous trail. The antelope were reported to have moved about 200 miles from the point of general origin to the Powder River breaks in Montana.

Bever (1950) found in the 1950 spring antelope census that there was an increase of 1,342 antelope in Harding County since 1949. The fact that there were more adult antelope in Harding County in 1950 than the total antelope population in 1949 indicates some movement into the county took place.

In the three counties cited above, doe:kid ratios in 1949 were found to average 100:91, with a low of 100:85 in Meade County. The 1948 average was nearly identical to 1949, while in 1950 the average was 100:100.

The winter of 1951-52 was a hard winter with snow accumulations of up to four feet on the level being reported. Little information can be found in the files and the census data do not clearly indicate any significant mortality to adults or reduced kid crop.

After a 15 year interval, the next hard winter occurred in 1964-65. A three day blizzard began on December 16, 1964. By any standards it was severe. Temperature records from a number of U. S. Weather Bureau reporting stations showed minimum temperatures on December 16 of -16°F. to -30°F. The maximum low reported was -42°F. Four to seven inches of snow lay on the ground when the storm hit. Strong winds gusted throughout the three days and nights with velocities averaging 20 to 40 mph. The wind chill factor ranged from -50°F. to -70°F. or lower.

Livestock losses were greatest to sheep and the bulk of these losses occurred in northern Harding County. Big game losses were feared but few substantiated reports were attributed to the initial storm.

Pheasant losses were estimated to be from 90 to 100 per cent. Small birds such as English sparrows and horned larks were wiped out. Sparrows that had sought shelter inside buildings suffered the same fate.

A BSF&W Predator and Rodent Control Trapper stationed in Buffalo, South Dakota reported sage grouse were quick frozen in their roosting forms.

The most severely hit area in South Dakota was adjacent to the North Dakota line south to the South Fork of the Grand River and from Lemmon west to the Montana line. This area had the greatest snow accumulation on the ground prior to the blizzard.

The remainder of the winter was characterized by repeated light snowfalls and frequent drifting and ground blizzards. Temperature records did not show a great deal of variation between reporting stations. Weather records were not available to show snow accumulation on the ground as the winter progressed, except in the more southerly areas of lesser accumulations. North Dakota records may give a more true indication of snow accumulation. Wind velocity and duration records are not maintained by reporting stations. The importance of this stress factor cannot be evaluated.

By early January, antelope movements to the south were evident by the large concentrations. These were in historical wintering areas that had not had heavy winter use in the past decade.

Reports of antelope losses were small. Carcasses checked indicated starvation. Most reports did not start to trickle in until after the snow had melted. One report concerned a small band of antelope that had perished in a fence corner. They were standing on top of sheep that had died in a storm a month earlier.

It is this writer's opinion that losses would be generally restricted to the northernmost portions of the state and would be minimal due to movement. A more noticeable effect was anticipated in the reproductive success of the coming summer and was so stated in the Proceedings of the First Antelope States Workshop held in Santa Fe, New Mexico in April, 1965.

The 1965 spring aerial survey in the four northwest counties was done by two planes between May 20 and June 1, on a 33 per cent sample basis. Very little change in population numbers was found in Harding and Perkins Counties and an increase was noted in Butte County. Based on 1949 information, it was recognized that we may still have had Montana and North Dakota antelope that had not yet returned home.

The doe:kid aerial check on reproduction was flown between June 26 to 30th. A sample from northeastern Harding County showed a ratio of 100:48 or less than half of normal. In the southeastern portion of that county where snow accumulation was considerably less, the ratio was normal with 100:100. The county wide average based on a sample of 170 does checked was 100:87. In Butte County, a sample of 136 does showed a ratio of 100:86.

With the pre-hunt population at carrying capacity in Harding County, a 32 per cent harvest was taken and a 25 per cent harvest was taken in Butte County.

The big blow fell in 1966 when spring counts were made. The adult breeding population was down 1,000 head in Harding County and 1,200 head in Butte County, from the calculated 1965 post hunting season population. A lesser decrease was noted from Perkins County.

The 1966 summer population, adults and kids combined, was down 74 per cent in Harding and down 54 per cent in Butte. The compounded shortage from the expected 1966 pre-hunt population was about 5,000 head.

Doe:kid ratios in the summer of 1966 were normal and are as follow:

Harding County	- 100 does:	121 kids	
Butte County	- 100 " :	112 "	
Perkins County	- 100 " :	110 "	
Meade County	- 100 " :	101 "	
Corson County	- 100 " :	138 "	* (This is abnormally high.)

Lack of continuity in the data is unexplained. When the shortage was found in 1966, Butte and Harding Counties were reflown with the same results. Mortality between mid 1965 and early 1966 did not seem feasible as carcasses would have been reported by ranchers. Ranchers believed the loss took place during the early 1965 winter. If this were true, the 1965 spring flight may

have tallied antelope from North Dakota and Montana that had not returned to home territory. North Dakota and Montana surveys are started in early July, a full month later than in South Dakota.

The high doe:kid ratios in 1966 are within the normal range. This high ratio would have been unlikely if sampling in 1965 had overestimated the true population and a resulting fall harvest of 43 per cent had occurred instead of the expected 33 per cent. The 1965 hunting season kill data indicated a normal sex and age composition based on hunter report cards.

A leptospirosis scare developed among the ranchers in the fall of 1965. Blood, kidney, and urine samples were collected. Additional blood samples were collected during the 1966 hunting season, West (1968). No positive samples were found in South Dakota antelope.

Severe storms occurred in March 1966 and on May 1, 1967. These were either outside of the main antelope range or a rapid snow melt followed and there was no noticeable effect on antelope populations.

The next severe winter was in 1968-69. By December 20, 1968 the snow cover had increased to six inches. Snowfall accumulation charts do not show several periods of mist and sleet that crusted the snow. Repeated light snowfall, between the wet precipitation, resulted in at least two layers of ice in the snow cover. One was in late December and another in early January. The ice made pawing for food a nearly futile task.

Depth of accumulated snow varied greatly. At Belle Fourche, the snow lasted about two weeks and was gone by January 6th. This station remained relatively snow free for the balance of the winter.

Redig, South Dakota which was quite open in 1964-65, was hit in 1968-69 with one to two feet of snow cover for most of the winter. Northern Perkins County had similar snow depth and temperature conditions except snow depth scarcely exceeded one and one-half feet in late February and early March.

Snow accumulation records were not available from northwestern Harding County where ranchers reported three feet of snow on the ground.

Snow on the ground was deeper and occurred over a much larger area in 1969 than in 1965. With the 12 to 20 inch snow depth, very little browse was available. The six to ten inch high big sage, which occurs only in Butte and Harding Counties, heavily used and low in vigor, was buried under the snow and ice. Silver sage was available in some areas.

Lack of available browse was shown by the unusually large winter movements of sage grouse. No large movements had been noted between early 1952 and early 1969. Large flocks gradually worked southward and by the time the snow melted in mid-March the sage grouse were on the south slopes of the Two-Top divide in central Butte County.

The 1969 spring aerial survey was conducted between May 12 and June 11 in the northwestern counties. A doe:kid check on reproduction was flown in late June and sampled a minimum of 10 per cent of the adult does. During the first flight northern Perkins and northeastern Harding Counties were flown 100 per cent in an attempt to locate carcasses of dead antelope and deer. This was abandoned as unsuccessful and the balance of the area flown on a 33 per cent sample basis.

Adult antelope increased 250 head in Harding and 400 head in Butte. Reduced numbers were noted in Perkins and Corson Counties. This agrees with North Dakota's information on the center of the winter severity.

Lower than normal doe:kid ratios were found in western and northern Harding, northern Perkins and Corson Counties. Figures 1, 2, and 3 show zones of average doe:kid ratios compared to ratios found in 1965 and 1969.

Weather records were gleaned for information that might provide correlations with antelope productivity. The following problems were encountered:

1. Weather stations recording snowfall on the ground were few in number and widely scattered.

2. Wind velocity records are unavailable.

Maximum and minimum daily temperatures were plotted and found to be fairly uniform during the December to mid-March period when snow accumulations existed. Relatively few conclusions could be drawn. It was noted that northcentral Meade County had similar temperatures but less snow accumulation than northern Perkins County. Normal doe:kid ratios of 100:109 were found in Meade and an abnormally low ratio of 100:73 in northern Perkins County.

Comparison between the two recent severe winters was impossible due to the above mentioned paucity of weather data. Productivity comparisons in the accompanying maps indicate the wind-temperature stress in 1964-65 had a greater effect on productivity than the relatively wind-less winter of 1968-69, if other factors were equal.

SUMMARY

The 1948-49 data strongly indicate winter movement out of deep snow areas to more protected or windswept areas. Shorter moves were noted in early 1965. Information on time lapse or rate of return to former home range is lacking. It may be pertinent to note that in early 1949 movement was unhindered by cross fencing as it is today.

Adult mortality was observed in the winters of 1948-49, 1964-65, and 1968-69. Starvation or malnutrition was the obvious cause of death in observed animals. No large scale die-offs were observed due to winter weather. (An exception may exist in the 1964-66 period when this writer misplaced 2,200 head of antelope and has not gotten the books back in order.)

Reduced productivity as expressed in doe:kid ratios may have occurred in Meade County in 1949. It definitely was noted in 1965 in Harding, Butte, Meade, Perkins, and Corson Counties, and in 1969 in Harding, Perkins, and Corson Counties.

Cold temperatures without deep snow cover to reduce available browse had no apparent effect on the spring population or doe:kid ratio in Meade County in 1969.

High productivity shown by the 1950 and 1966 doe:kid ratios indicates antelope does are able to regain body condition and successfully conceive following a severe winter.

CONCLUSIONS

1. We do not know the energy requirements of antelope under different degrees of stress and different types of stress by cold and wind. Therefore, with our limited present knowledge, weather records cannot be accurately used to interpret stress on pronghorns.

2. Stress has been more apparent in reduced kid crops than in adult mortality.

3. When adequate winter food is unavailable, antelope will die.

4. Lack of adequate available browse is a critical factor for antelope in western South Dakota in any winter when the snow depth exceeds 18 inches for a prolonged period of time.

LITERATURE CITED

Bever, Wendell 1949. The 1949 Antelope Census in South Dakota. Quarterly Progress Report, P-R Project W-12-R-7. So. Dak. Dept. Game, Fish, and Parks, Pierre, 9 pp. mimeo.

_____, 1950. The 1950 Antelope Census in South Dakota. Quarterly Progress Report, P-R Project W-12-R-7. So. Dak. Dept. Game, Fish, and Parks, Pierre, 4 pp. mimeo.

_____, 1952. The 1952 Antelope Census in South Dakota. Quarterly Progress Report, P-R Project W-12-R-9, So. Dak. Dept. Game, Fish, and Parks, Pierre, 5 pp. mimeo.

Martinka, C.J. 1967. Mortality of Northern Montana Pronghorns in a Severe Winter. J. Wildl. Mgmt. 31(1):159-164.

U.S. Weather Bureau, 1964. Climatological Data, South Dakota Vol.69(12) Ashville, No. Carolina.

_____, 1965. Climatological Data, South Dakota. Vol. 70 (1-3), Ashville, N.C.

_____, 1968. Climatological Data, South Dakota. Vol. 73 (12), Ashville, N.C.

_____, 1969. Climatological Data, South Dakota. Vol. 74 (1-3), Ashville, N.C.

West, Douglas R. 1965. Antelope Management in South Dakota. Proceedings of First Antelope States Workshop, Santa Fe, New Mexico, April 14-15, 1965.

_____, 1968. Locker and Field Checks of Antelope and Analysis of Hunter Report Card Data, 1966-67. Progress Report, P-R Project W-95-R-1, So. Dak. Dept. Game, Fish, and Parks, Pierre, 8 pp. mimeo.

Figure 1. Approximate Zones of Antelope Productivity Variation as Shown by Ten Years of Doe:Kid Ratios.

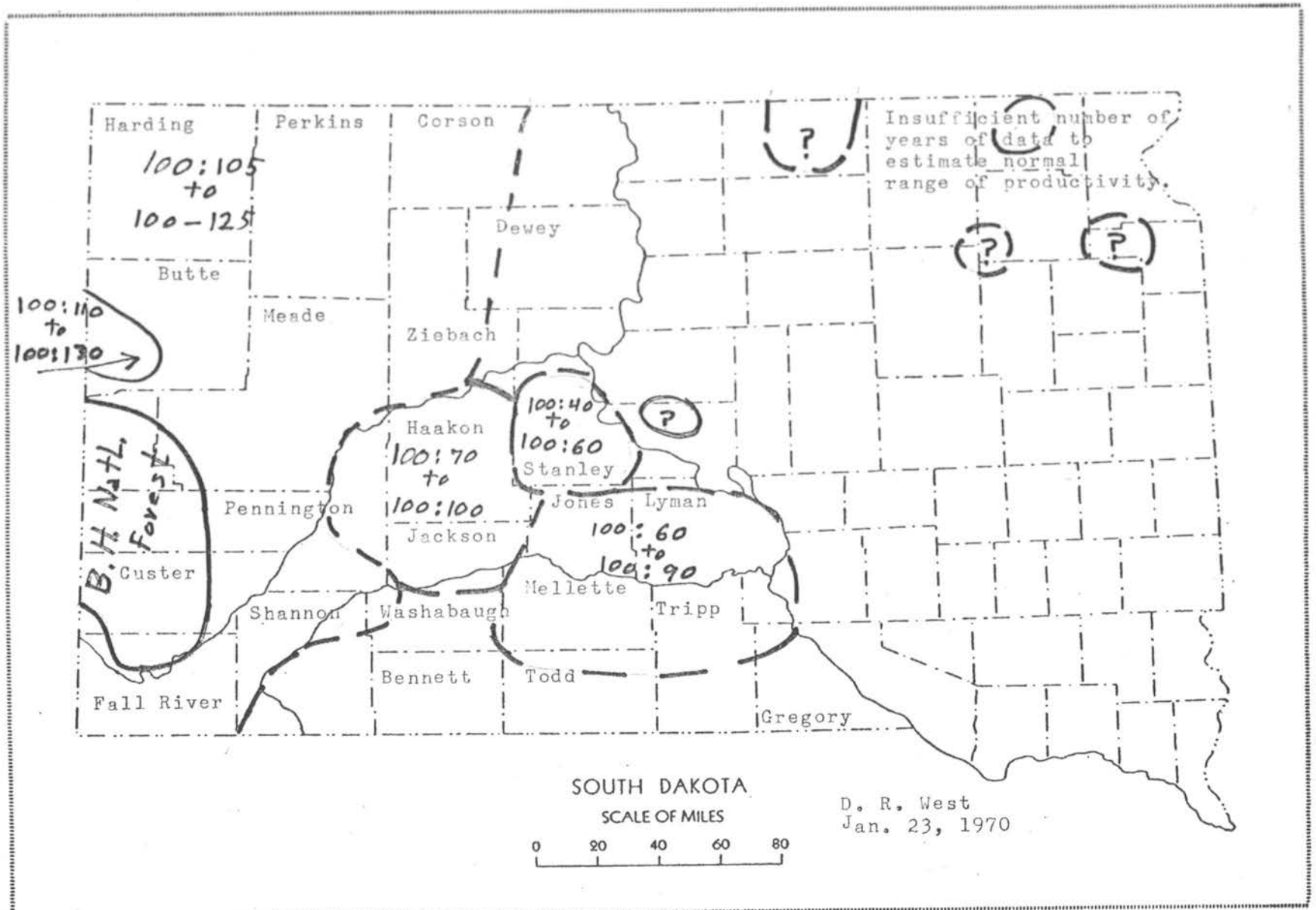


Figure 2. Observed Boe:Kid ratios in 1965.

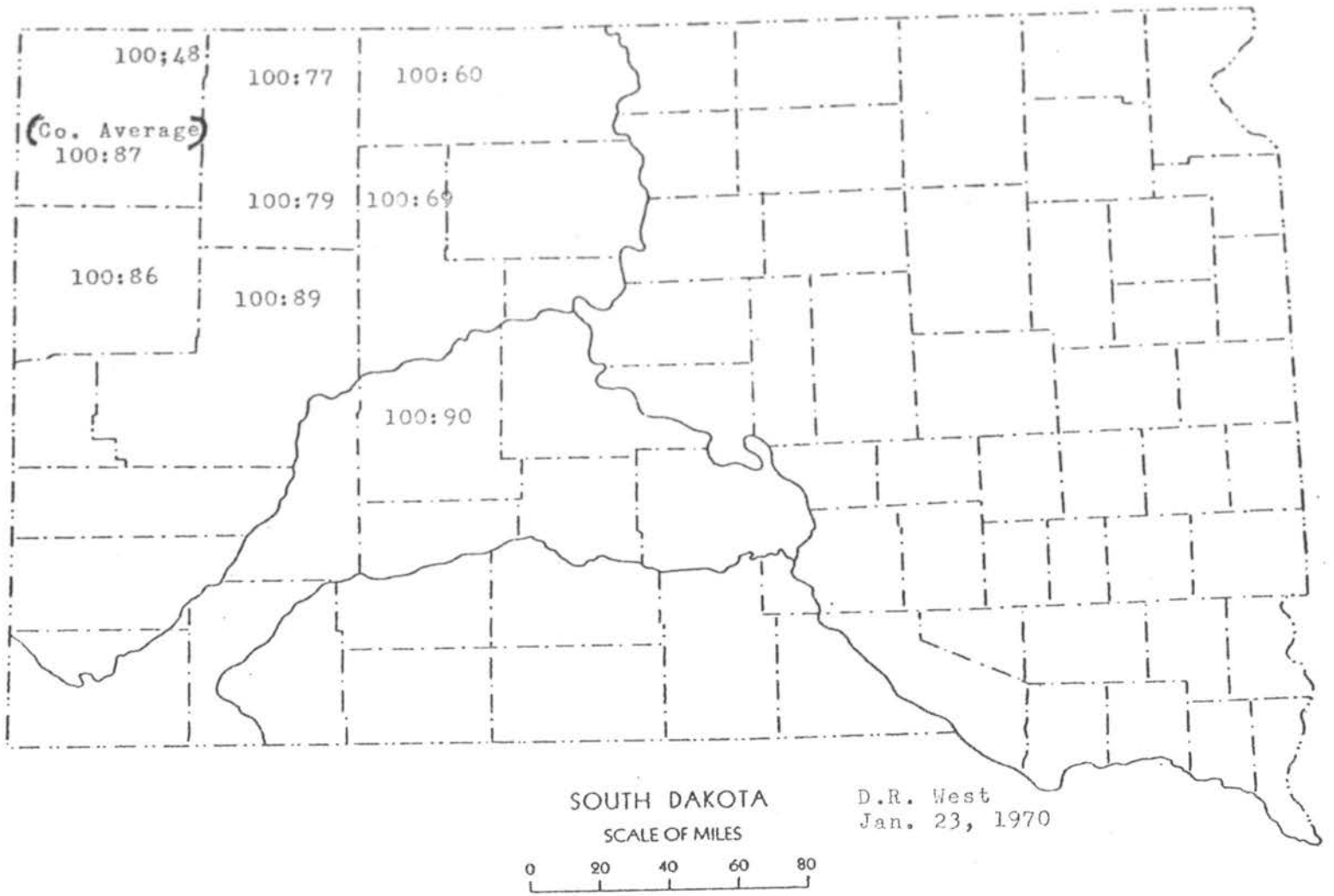
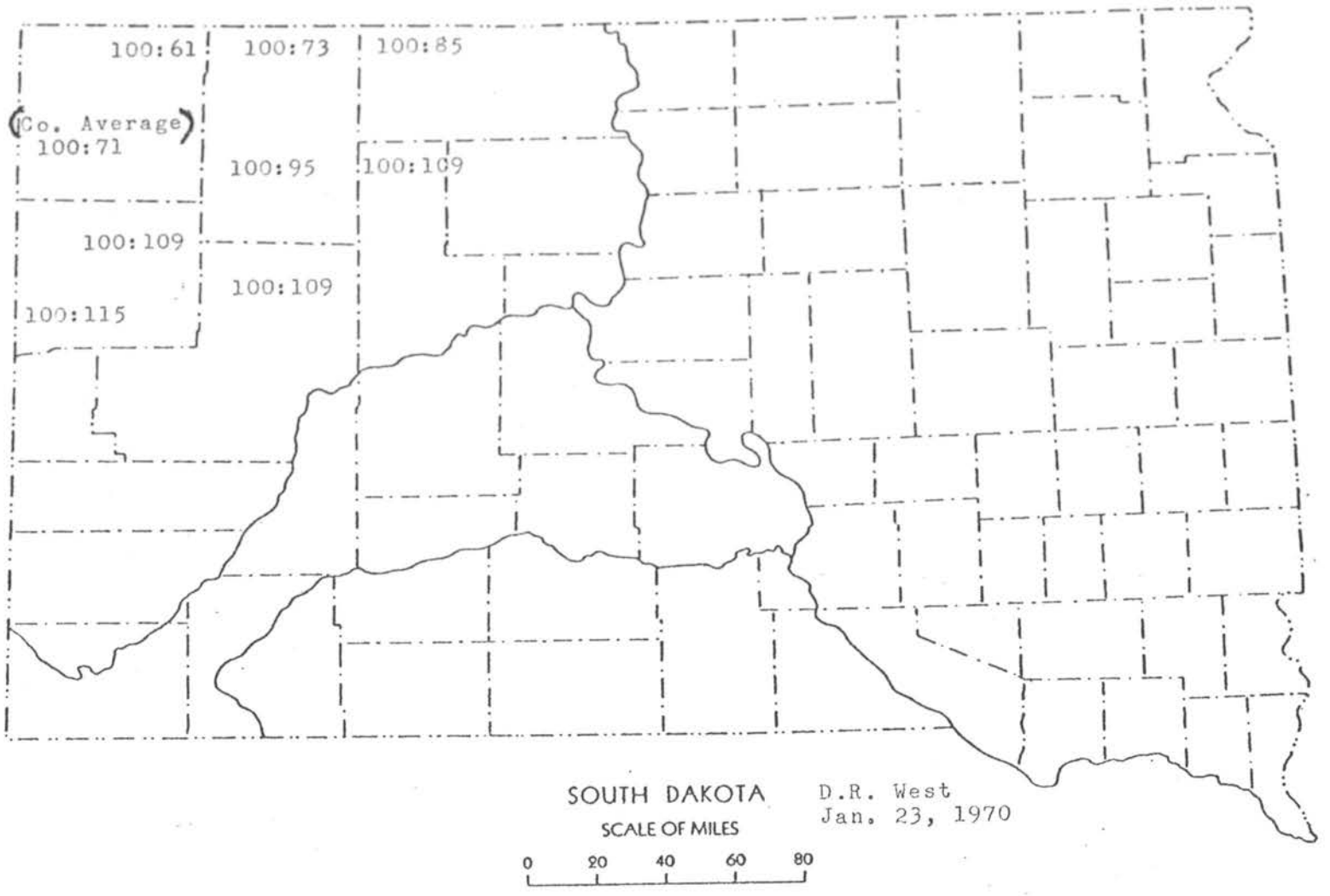


Figure 3. Observed Doe:Kid Ratios in South Dakota in 1969.



SOUTHEASTERN MONTANA ANTELOPE POPULATION TRENDS IN RELATION TO SEVERE WINTERS

by
H. O. Compton

The effect of severe winter weather on antelope has been the concern of wildlife workers for many years in the northern antelope states. Several investigations have been documented in Montana. Biersgard (1949) reported on a mortality survey following the severe winter of 1948-1949. Antelope carcasses varied from 0.3 to 4 per square mile in Carter County. He estimated a winter loss of 32% of the herd. Fawns made up 50% of the carcasses aged and 82% of the carcasses had full or nearly full stomachs when investigated. In 1950, Brown reporting on the same area found a 38% herd reduction from the 1947-48 winter counts. He estimated there were 500 fewer antelope in the Carter Unit than in 1949 and 1,500 less than in 1948. Martinka (1966) did an intensive study in north central Montana during the winter of 1964-1965. He found 500 antelope that had died from natural causes plus several hundred more killed by trains and other unnatural means. Fawns comprised 28% and mature males 33% of the dead antelope aged. Gelatinous bone marrow was found in 97%. There were 62% fewer antelope in the herd the following summer.

This report will deal exclusively with the antelope herds in southeastern Montana. This area is Montana Fish and Game Department Administrative District or Region #7 and is comprised of the 10 southeastern counties, a land area of approximately 30,000 square miles. The physiography of the region varies from badlands to open stand-ponderosa pine forests. The majority of the land mass is a gently to severely rolling grassland with varying densities of shrubby growth, predominately big and silver sagebrush.

The region is the most important antelope producing area in Montana. Antelope densities have been increasing steadily since the 1930's. An estimate of between 40 and 45 thousand antelope was made in 1964. The annual harvest in the region has averaged 6,800 for the last ten year period with the largest harvest being 12,200 in 1964. The 1964 figure represents 1/2 the antelope killed in Montana that year.

Two of the last five winters have been abnormally severe in southeastern Montana (1964-65 and 1968-69). Snowfall from November, 1964 through April, 1965 totaled 49.5 inches, twice the normal for this period. Snow in depths from 15 inches to 5 feet was on the ground from November through February. Temperatures averaged +21°F during the six month period with 52 days showing 0°F. and lower readings. High winds and freezing conditions caused snow cover to be hard and crusted. Antelope were very obviously grouped into large herds during this time. Groups from 4 to 5 hundred were commonly seen on the move and some extensive shifts in range were noted. In one case, antelope moved from northern Montana and crossed the ice on Fort Peck Reservoir. The following spring, over a thousand head were recorded on the south shore of the lake looking north across several miles of water. In another case, several hundred animals were stranded south of the Interstate Highway fence between Glendive and Wibaux.

Antelope numbers were found to be reduced region-wide by 40% the following year. This decrease ranged from little change to an 80% reduction in some units. Fawn production was drastically reduced as indicated on the charts by fawns per 100

Table 1. Weather Data From Miles City Airport, 1964-1965.

Month		Snowfall Inches		+ - Normal	Precip. Inches	+ - Normal	Temp. (° F)	+ - Normal
		Total	Max.	Total				
Nov.	1964	14.4	8	+ 10.5	1.33	+ .90	25.6	- 7.0
Dec.	1964	7.3	13	+ 3.0	.62	+ .25	7.6	- 15.6
Jan.	1965	13.4	14	+ 7.5	.96	+ .52	13.5	- 3.0
Feb.	1965	3.5	15	- 2.0	.53	+ .16	18.2	- 2.1
March	1965	6.9	7	+ 1.9	.75	+ .10	17.3	- 13.6
Apr.	1965	4.0	3	+ 1.4	2.12	+ 1.06	44.6	- 1.1
Total Average		49.5		+ 3.7	6.31	+ 2.99	21.2	- 7.1

Table 2. Weather Data From Miles City Airport, 1968 - 1969.

Month		Snowfall Inches		+ - Normal	Precip. Inches	+ - Normal	Temp. (° F)	+ - Normal
		Total	Max.					
Nov.	1968	4.0	2.2	+ 0.1	.72	+ .29	34.5	+ 1.9
Dec.	1968	18.0	13.0	+ 13.7	1.78	+ 1.41	12.3	- 10.9
Jan.	1969	6.9	13.0	+ 1.0	.70	+ .26	- 0.7	- 17.2
Feb.	1969	2.4	12.0	- 3.1	.24	- .13	16.5	- 3.8
March	1969	6.0	9.0	+ 1.0	.73	+ .08	25.5	- 5.4
Apr.	1969	10.0	1.0	+ 7.4	2.83	+ 1.76	51.0	+ 5.3
Total Average		47.3		+ 3.4	7.00	+ 3.67	23.2	- 5.0

Table 3. Antelope production and density, 1960 - 1969.

	YEAR									
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
F/100 D.	99	95	92	94	77	70	95	92	99	93
% Fawns	38	39	36	35	32	30	41	37	39	37
% Does	38	41	39	37	42	43	42	40	39	39
Density (1)	1.28	1.68	1.78	1.46	1.54	0.92	0.56	0.72	0.99	1.11

(1) Antelope per square miles.

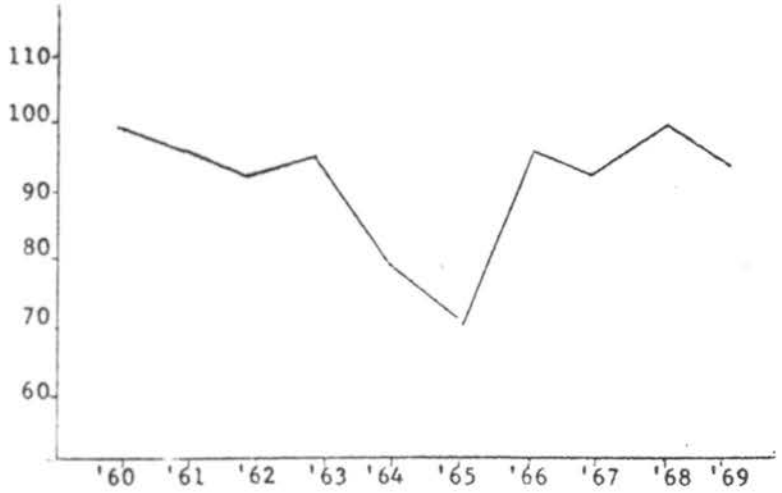


Figure 1. Fawns per 100 does.

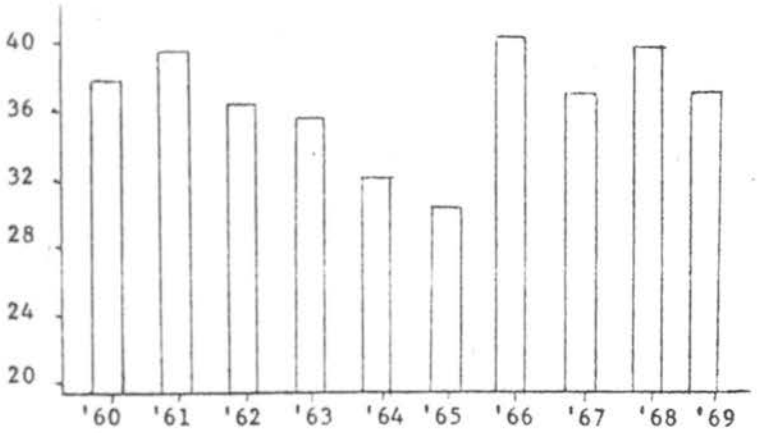


Figure 2. Per cent fawns in population.

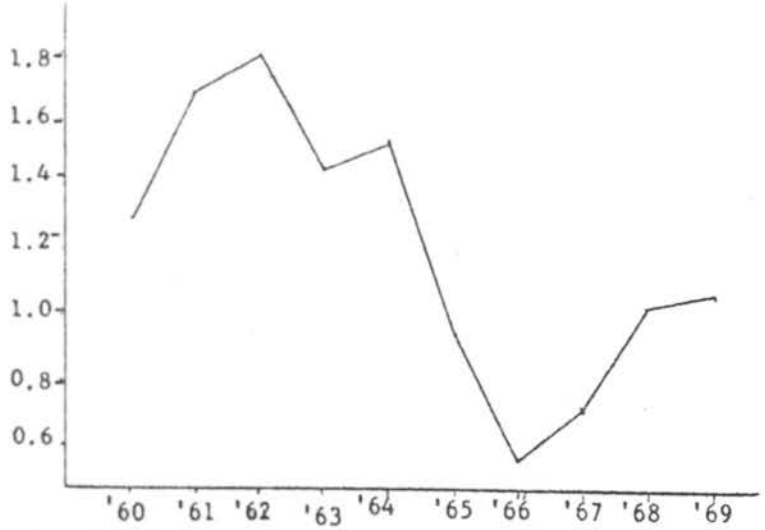


Figure 3. Antelope per square mile.

does and per cent fawns in the population.

A further look at the charts shows that fawn production and density had started a downward trend even before 1965, in fact about 1960, 5 years before the tough winter. Had some other factors contributed toward herd reduction besides severe winter weather?

Last winter (1968-69) was another severe winter. Very little game damage or mortality was reported. I really didn't know how bad it was until I started looking at the weather data. Total snow fall was 48.3 inches, depth varied from 13 inches to 4 - 5 feet. There were 46 days of below zero temperatures, 25 of these being in January. A comparison will show that last winter was almost as bad as in 1964-65. What happened to our antelope populations? Another look at the charts will demonstrate. Keep in mind that the antelope density going into this winter was about 2/3 of what it was in 1964 (1.46 in 1964 and 0.99 in 1968). The 1969 fawn:doe ratio decreased slightly from a very high 99F/100 D in 1968 to 93 per 100 and the fawn segment of the herd decreased from 40% in 1968 to 37%. The large fawn recruitment to the herd in 1968 would contribute an abnormal proportion of non-breeding females to the 1969 herd and would probably reflect in the fawn:doe ratios. Some direct mortality no doubt did occur, particularly along the North Dakota line on the eastern edge of the region. Bone marrows were checked on several animals killed by a train near Baker. Analysis indicated they were in poor winter condition. Of most importance, 1969 production remained high and was about at the same level as in the early 1960's. The total number of antelope in 1969 actually increased in density (0.99 in 1968 and 1.11 in 1969).

Some of the eastern hunting units near the North Dakota line showed depressed fawn crops in 1969. These extreme eastern hunting units were also the ones which showed the greatest reduction following the 1964-65 winter. The major difference between these units and those in the rest of the region is the composition of sagebrush. Some of the eastern units are farmed heavily and the grassland complex has much less sagebrush. The antelope killed by the train near Baker had predominately big sage in their paunches along with some dried compositae heads and other forbs. They had to be seeking out the sage under several inches of snow.

What conclusions can be drawn? Antelope densities had increased to the point, by the early '60's, where they were becoming an agricultural nuisance. Forage supplies were in poor condition through over-use and drought. Hunting pressure had been progressively increased to the saturation point. Hunters were annually harvesting 25% of a herd that had an annual increment of 35%. Antelope production began to go down. Along came the 1964-1965 winter. The severe winter accelerated the downward trend which was brought about by an unbalanced antelope-range association.

The herds were smaller going into the 1968-1969 winters and range conditions had improved considerably.

Mortality was much less than in 1965 and the 1969 summer densities had actually increased over 1968.

Literature Cited

Bayless, S. 1967. Winter Range use of pronghorn antelope in Central Montana. Montana Fish and Game Department. P-R Completion Report. W-98-R-7, B-15. 65P.

Bergerson and Thompson 1946. Aerial census of Montana's pronghorn antelope population. Montana Fish and Game Department, Wildlife Restoration Division. Typewritten report.

Brown, D. 1949. Carter Unit Aerial Antelope Survey. Montana Fish and Game Department. P-R Quarterly Report - January - February, 1949.

Brown, L. 1950. 1950 Antelope Census. Carter - Powder River Units. Montana Fish and Game Department. P-R Quarterly Report. April - June, 1950: 13-16.

Compton, H. O. 1964. Big Game Surveys and Investigations. Montana Fish and Game Department Completion Report. W-77-R-9, A-1.

_____, 1965. Big Game Surveys and Investigations. Montana Fish and Game Department. P-R Completion Report, W-77-R-10, A-1.

_____, 1968. The Antelope picture in Southeastern Montana. Montana, Outdoors, Vol. III, No. 9.

Martinka, C. 1966. The International Antelope Herd. Montana Wildlife, July: 28-30.

Riersgard, K. 1949. A survey of 1949 winter loss of antelope, Carter Unit. Montana Fish and Game Department. P-R Quarterly Report. April - June: 1949 13-23.

Salinas, Gerald. 1948. Carter County Antelope Study, Summer, 1947. Montana Fish and Game Department, Wildlife Restoration Division, 47P.

Discussion

Pyrah: I wanted to ask Doug West whether his low spring fawn production following severe winters was attributed to the winter conditions or to a perpetuating poorer range condition during summer?

West: In my opinion, I believe it is the effect of the immediate winter causing stress on the doe. In normal winters in that area the normal kid crop should be 100/100, 100/115 or 100/120. In the mild winters we have no problem. We have seeds of Artemisia frigida (silver sage). In an open winter I don't think it proves a problem. We don't get the deep snow. The low kid crops seem to occur where we have had the deep snow and stress.

Pyrah: It looked like it was consistently low, so I wondered if it had something to do with another problem.

West: I'm sorry. I probably should have brought some other years' data to show the difference. The four counties in the northwest corner ordinarily will average 100 does per 100 kid or higher. It does grade down to the east excessively as we get out of the sagebrush and browse plants in general. The low would be on the Missouri River by Ft. Pierre, where it runs to 40 to 60 kids per 100 does.

Wishart: Did you notice any difference in the horn growth of the bucks following a tough winter?

West: No, but I wish we would have.

Wishart: We found a significant difference.

Hnatiuk: I was wondering whether you found any differences in the types of mortality. In other words, the year classed as 1968-69. I think Jim would be the one to answer that.

McKenzie: What data we have, and it is of a very limited nature, was collected during the season in 1965, and at that time there was very definitely a difference in not only the sex groups but age classifications too. It seemed like your 2½ - 3½ year age group were predominant, in the harvest anyway.

Hnatiuk: Well, may I add something here. In our amount of observations last winter we had a few isolated populations that had a fair amount of mortality, and I found that the females survived the best, and then there were the fawn bucks and 3½-year old bucks that were found most frequently.

West: Back in 1965, these 40 animals I mentioned were picked up in the one half-section. This was just the entire herd - everything died, and one point I failed to mention in my paper. This particular area, as would apply to what I termed the marginal range east of U.S. Highway 85, can be characterized by alternate strips of wheat stubble and summer fallow interspersed with over-grazed pastures. That's about that simple, and this past winter out in that area - that was probably the severist winter conditions - we suffered the greatest winter loss out there. In fact, as Buck mentioned, we actually had some increase in that border area with mortality.

Kerr: Either Buck or Doug was talking about antelope that died in the corner standing over dead sheep. Was it inferred that they died there because they couldn't get over the fence, or this was just a last refuge for them?

Compton: I believe, probably in a blizzard like that, they don't tend to jump fences too well, either. They will pile up in a fence corner and just stay there without attempting to go through when you think they should be able to jump over it. Whether it's visibility or what it is, I don't know.

Larsen: I have a question I'd like to direct to Buck, on his comment on the population increasing here, due to range conditions. Would you explain a little bit more what you mean about range conditions. Was it availability, or was it actual condition of the vegetation, or density of plant species, or what do you mean in terms of range condition?

Compton: Comparing 1964-65 versus 1968-69. Well, the period of 59, 60 and through 61 was a very dry, drouthy condition in that part of the country, and range conditions, as we speak of them, in quotes, there just wasn't any range condition, and it started raining, and things improved considerably. What I'm referring to is both grass cover and condition of the shrubby growth. In 1968 and 69 it was much better condition as far as availability and composition.

Leland Hepworth: I would like to direct a question to the panel members. Did you find any relationship between the very, very cold temperatures and death when your wind chill index was very high, your temperatures very low, were these the times when the animals actually died, or was it just a progressive wearing down of the animals over an extended period of coldness?

McKenzie: We did, in 64 and 65 have animals that apparently they get to a certain point, and apparently, there is just no recovery. We had animals dropping off the 3rd of June. This direct loss was noted, similar to what Doug mentioned, where they were actual storm mortalities, but then apparently as a combination of the severe conditions and the deteriorating body conditions, they just kept going downhill. A few would drop off, until as I mentioned, clear into June they were dying. We have one of biologists from North Dakota here, and he was watching a herd near Mott this past winter. I wonder if you'd care to expound on that a little bit, Sam.

Samuelson: There was a herd of about 60 head right north of town. It was real handy, so I just kind of watched them. At the end of the winter there were only about 20 left. In other words, they just dropped off as the winter wore on. The winter of 64-65 there was a blizzard condition. This past winter there was just severe cold - no storms or anything - well, progressively all through the winter they just kept dropping off. You'd go out there one day and there would be 3 or 4 piled up, you'd go out the next day and there'd be another half dozen, so it was down by the end of the winter to about 20 head left. Fellows around there even tried to feed them cake and alfalfa and everything else, and it just did no good at all. I'm sure their condition was down so far they they were just gone.

FACTORS INFLUENCING SUCCESS OF PRONGHORN HUNTERS

by
Ronald M. Fowler[1]
Colorado Cooperative Wildlife Research Unit
Colorado State University
Fort Collins, Colorado

Success of pronghorn hunters is a major concern of game managers since harvest is the main tool used to manipulate pronghorn populations toward a desired density. Therefore, factors which influence hunter success are also of interest to game managers, especially factors which cause success ratios to be lower than desired.

Little research has been conducted on factors that influence hunter success. The lack of research may be due to interrelationships and combinations of factors that make recognition and evaluation of individual factors difficult or impossible. Also, factors influencing success cannot be recognized and evaluated with certainty until after the hunting season. By then nothing can be done to correct conditions which affected success adversely.

However, some conditions which lead to fluctuations in hunter success are more evident than others. Game managers are concerned primarily with foreseeing conditions which will have an adverse effect on success. The sooner the potentially adverse effects can be evaluated, the more can be done to try to remedy the situation prior to hunting season.

One condition which has been of concern to game managers in the Colorado Game, Fish and Parks Division is the effect privately owned land closed to hunting has on the success of pronghorn hunters. Since the extent of closed land can usually be determined prior to hunting season, knowledge of the effect of closed land on hunter success could be used in the future as a basis for comparison in determining the potential effect of a certain amount of closed land.

The purpose of this study then, was first, to determine the effect of private land closed to hunting on success of hunters in Colorado during 1967 and 1968, and secondly, to determine the effect on hunter success of conditions more directly related to hunters and management practices. The possible effects of weather, terrain, and vegetation were not considered.

DESCRIPTION OF STUDY AREA

This study was conducted in Colorado on all pronghorn management areas located east of Interstate Highway 25, plus the adjoining northern one-half of Larimer County as shown in Fig. 1. There were 34 pronghorn management areas in 1967, and 38 in 1968. These areas covered about three-fourths of the plains region of the eastern one-third of Colorado.

The predominantly privately-owned plains region of eastern Colorado has become an increasingly significant pronghorn range during the past several years. Both

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1 Present Address: South Dakota Department of Game, Fish & Parks, Aberdeen, South Dakota 57401

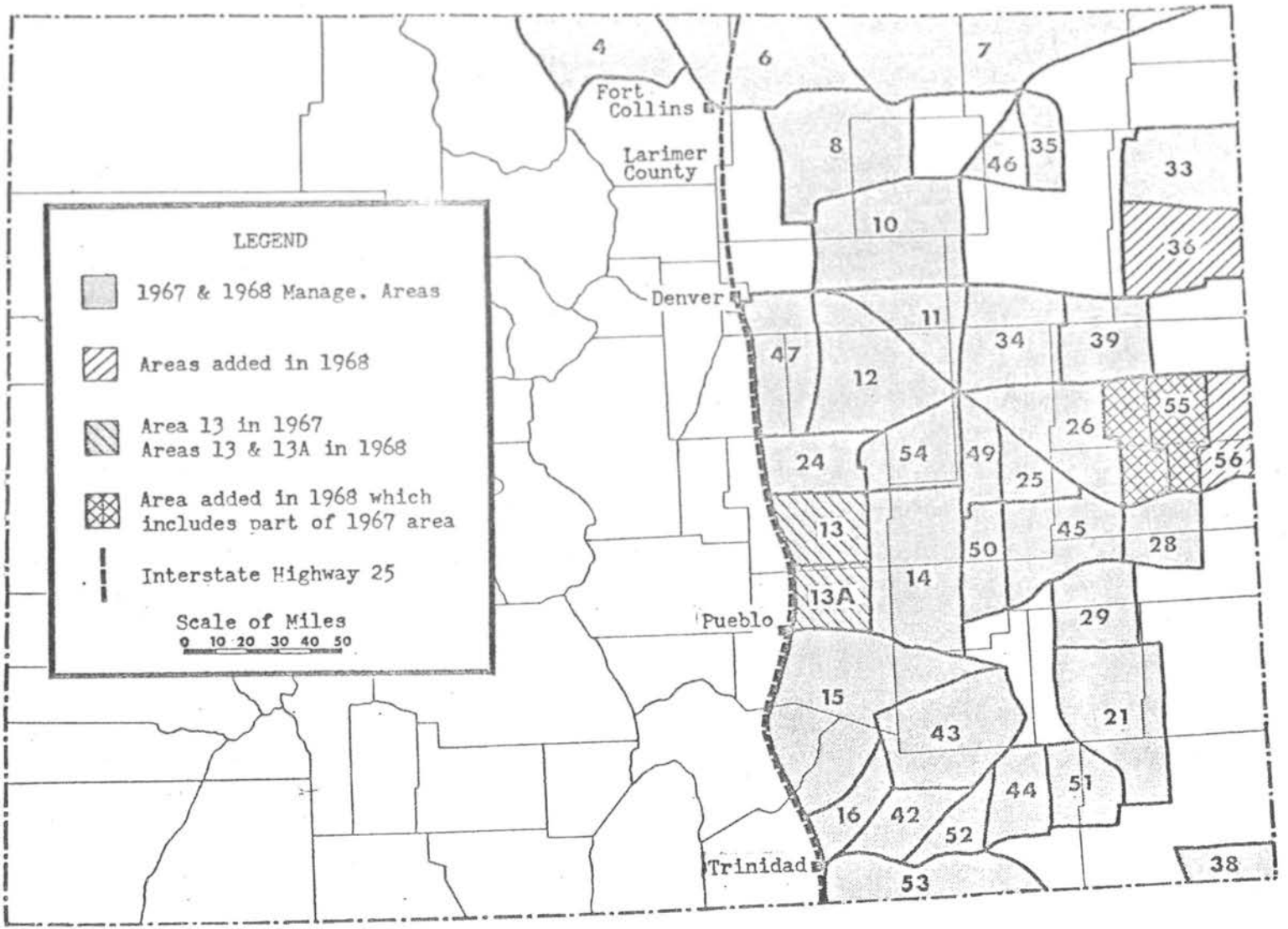


Fig. 1. Location of study area.

the number of pronghorn and the percentage of pronghorn in Colorado that are located in eastern Colorado have increased. According to the Colorado Game, Fish and Parks Division, the number of hunting permits allowed, which is based mainly on the pronghorn population, increased in the plains region from 825 in 1960, to 6140 in 1967. The percentage of the total number of hunting permits allowed in Colorado that were sold in the plains region increased from 45 per cent in 1960, to 84 per cent in 1967.

DATA COLLECTION

Determination of the extent and location of land closed to pronghorn hunters was made possible through the cooperation of Colorado Game, Fish and Parks Division Wildlife Conservation Officers. A survey of 20 landowners who closed their land was taken to determine how much land was closed, and if pronghorn were on the closed land during the hunting season.

To obtain information on factors related to hunters which might influence the hunter's chances of killing a pronghorn, a questionnaire was developed and a survey of 1250 hunters was taken during the two months immediately following the 1967 and 1968 pronghorn hunting season. Three different methods of contacting hunters were used in the 1967 survey: (1) interviewing hunters as they stopped at a Colorado Game, Fish and Parks Division check station; (2) handing out questionnaires to hunters by way of Colorado Game, Fish and Parks Division field men, with instructions to complete the questionnaires and return them by mail; and (3) obtaining names and addresses of hunters from Colorado Game, Fish and Parks Division files and interviewing these persons by telephone. All hunters surveyed in 1968 were interviewed by telephone.

Information concerning sizes of management areas, number of hunters per management area, and number of pronghorn per management area was obtained from the Colorado Game, Fish and Parks Division.

RESULTS AND DISCUSSION

Effect of Closed Land

The study showed that pronghorn were present on land closed to hunting in 10 of 34 management areas during the 1967 hunting season, and in 9 of 38 areas during the 1968 season. The amount of closed land varied from about 5 per cent to about 37 per cent of a management area. Of the approximately 9800 square miles of study area, a maximum of 1520 square miles, or about 16 per cent, was closed.

Closed land reduced hunter success as indicated by the significant relation between the success ratio of hunters and whether or not management areas contained closed land (Table 1). Also indicating the adverse effect of closed land on hunter success is the significant difference between the average success ratio in areas containing closed land and areas completely open (Table 2).

However, the data indicated the correlation between percentage of management area closed and success of hunters in the area was insignificant. Thus, the factor influencing success in an area was apparently the number of pronghorn on closed land and not closed land as such. Since the number of hunting permits is usually based on total pronghorn population of a management area and

not on the huntable-pronghorn population, the huntable-pronghorn:hunter ratio was probably below the average pronghorn:hunter ratio determined necessary by the game managers to obtain the desired harvest and yet allow an average success ratio. The number of pronghorn available to hunters possibly decreased even more during the hunting season due to pronghorn accumulating on closed land when escaping hunters.

Table 1.--Relation between closure of land and success of hunters.

Mgmt. Areas Containing:	No. of Hunters	% of Total	% Succ.	X^2_c	d.f.	P
Closed Land	2,915	25.3	76.6	61.143	1	<0.01
No Closed Land	8,621	74.7	83.1			
TOTAL	11,536	100.0	81.5			

Table 2.--Comparison between average of hunter success percentages of areas containing closed land and average of hunter success percentages of areas not containing closed land.

Mgmt. Areas Containing:	No. of Areas	Avg. % Succ.	t	d.f.	P
Closed Land	19	76.4	3.201	69	<0.01
No Closed Land	52	83.3			

Effect of Hunter Related Factors

A total of 1250 pronghorn hunters was contacted during 1967 and 1968. Of these hunters, 1049 were interviewed by telephone, 110 were interviewed in person, and 91 completed questionnaires themselves. These 1250 hunters that were contacted represent 12 per cent of all hunters on the study area in 1967, plus 10 per cent of all hunters in 1968.

Due to the type of questions that was asked the hunters, answers to some of the questions may not be completely accurate or reliable. This has to be kept in mind during analyses of the data.

Day of Season Hunted. Hunter success apparently was influenced by the day of the season on which hunting was done since the daily success ratio of hunters in the field decreased with each successive day of the three-day seasons (Table 3).

Due to increased exposure to hunters, the pronghorn probably became more wary as the seasons progressed and thus were harder to find and shoot. Also, as the seasons progressed, it is plausible a larger percentage of the remaining hunters were those unable to find and shoot what was considered a suitable pronghorn. The fact that nearly 76 per cent of the successful hunters killed their pronghorn the first day of the season may also indicate the relative unwariness of pronghorn early in the hunting season.

Table 3.--Relation between day of season hunted and success of hunters.

Day of Season	No. of Hunters	Number Successful	% of Total	% Succ.	X^2	d.f.	P
1st	1187	725	75.6	61.1			
2nd	416	203	21.2	48.8	24.060	2	<0.01
3rd	70	31	3.2	44.3			

Pronghorn Observed Per Hour. The daily decrease in number of pronghorn observed per hour of hunting by both successful and unsuccessful hunters (Table 4) again points out that pronghorn were less easily found as the seasons progressed. Even though the difference in average number observed per hour between successful and unsuccessful hunters was not statistically significant, there is again an indication that the hunters who eventually shot a pronghorn were able to find more pronghorn per unit time than hunters who were unsuccessful. The lack of a significant difference between the averages for successful and unsuccessful hunters was due to the high variation in number of pronghorn observed per hour by individual hunters (Table 4).

Table 4.--Comparison of average number of pronghorn observed per hour each day of a three-day season, between successful and unsuccessful hunters.

Day of Season	Pronghorn Obs. per Hour by Succ. Hunter	Pronghorn Obs. per Hour by Unsucc. Hunter	t	d.f.	P
1st	6.1	2.7			
2nd	4.0	2.3			
3rd	2.6	1.4			
Season	5.6 ±66.9*	2.4 ±42.7*	0.922	1652	<0.20

*Average ±SD of number of pronghorn observed per hour by each hunter.

Distance From Home. The average "cross-country" distance (not necessarily the distance traveled) between the hometown and the approximate hunt location was not significantly different between successful and unsuccessful hunters (Table 5). Apparently hunters who traveled further from human population centers did not encounter sufficiently more pronghorn to increase hunter success. On the other hand, neither were the hunters who hunted closer to home enough more familiar with the area and location of pronghorn to increase chances of success.

Table 5.--Comparisons of factors involving average distance from area hunted to home and average number of persons in hunting party, between successful and unsuccessful hunters.

Factor	Average per Succ. Hunter ±SD	Average per Unsucc. Hunter ±SD	t	d.f	P
Miles From Home	66.3 ± 44.6	62.5 ± 44.4	1.215	1226	<0.15
No. in Hunt Party	3.1 ± 1.6	3.2 ± 1.5	0.803	1226	<0.25

Number in Hunting Party. There was no difference in average number of persons comprising hunting parties of successful and unsuccessful hunters (Table 5). The number of persons in a hunting party was originally considered as a possible factor influencing success because of theories that (1) the more people in the party the better the chances of someone seeing a pronghorn, (2) there would be more help in stalking pronghorn, and/or (3) possibly more people would keep shooting until all permits in the party were filled.

Use of Rifle Scopes. Telescopic sights on rifles increased success of hunters who used them (Table 6). Use of a scope probably increases shooting accuracy and thus chances of success. However, there might exist more of a tendency for hunters using scopes to shoot at pronghorn which are out of range. The actual benefit of scopes might therefore be less than the potential benefit. Hunters realize the beneficial effect of scopes, as indicated by the relatively large percentage who used them in 1967 and 1968 (Table 6).

Table 6.--Relation between use of rifle scopes and success of hunters.

Usage	No. of Hunters	% of Total	% Succ.	X_c^2	d.f.	P
Scope	981	79.9	80.4	7.791	1	<0.01
No Scope	247	20.1	72.1			
TOTAL	1228	100.0	78.7			

Method of Hunting. Hunters used three methods in trying to locate pronghorn: (1) riding in a vehicle, (2) walking, and (3) sitting or "still" hunting (Table 7). Although there was no relation between success of hunters and method of hunting in either 1967 or 1968, the higher percentage success of the comparatively few "still" hunters in 1968 may have meaning. Possibly pronghorn approach nearer to sedentary hunters than to moving hunters, either because the nonmoving hunters are not noticed as quickly, or because the persons are viewed as inanimate objects. Even though there was no significant difference in percentage success between methods, the best method may have depended locally on the type of terrain and/or density of antelope. For example, locating pronghorn from a vehicle may have been the best method of hunting where the terrain was flat and where there were few antelope.

Reasons Hunters Walked. Approximately one-half of all hunters interviewed walked when trying to find pronghorn (Table 7). The reason for walking was considered a plausible factor influencing success. If a hunter were forced to walk, due to landowner desire or land being inaccessible by vehicles, his attitude and thus his actions might change and affect his chances of success. Less time might be spent hunting and/or less area covered. As Indicated in Table 8, the probability is less than 10 per cent that there is no relation between reasons hunters walked and success of hunters. However, the relation is not considered significant because the relatively high success of hunters who walked due to land being inaccessible by vehicles (100.0 compared to 77.8 and 79.8) was for too small a sample of hunters (20 compared to 504 and 114, respectively).

Table 7.--Relation between method of hunting and success of hunters.

Year	Method	No. of Hunters	% of Total	% Succ.	X^2	d.f.	P
1967	Walking	398	56.5	79.1	0.047	1	>0.10
	Riding	307	43.5	78.2			
	Still	---*	-----	----			
1968	Walking	240	46.1	78.3			
	Riding	259	49.7	79.2	0.779	2	>0.30
	Still	22	4.2	86.4			

*Not determined in 1967.

Table 8.--Relation between reasons hunters walked and success of hunters.

Reason	No. of Hunters	% of Total	% Succ.	X^2	d.f.	P
Own Desire	504	79.0	77.8			
Landowner Desire	114	17.9	79.8	5.774	2	<0.10
Vehicle Inaccessibility	20	3.1	100.0			
TOTAL	638	100.0	78.8			

Means of Transportation. The type of transportation used by hunters who rode while looking for pronghorn had no influence on success of hunters interviewed (Table 9). Apparently terrain and other traveling conditions did not make traversing the area difficult enough to give one type of vehicle an advantage over another. If certain means of transportation had an advantage, more area could have been covered more effectively by hunters using these means and therefore more pronghorn might have been found sooner. In turn, the chances of success would have probably been increased.

Table 9.--Relation between means of transportation used while hunting and success of hunters.

Means of Transportation	No. of Hunters	% of Total	% Succ.	X^2	d.f.	P
2 Wh. Dr. Pickup	271	47.9	77.9			
Jeep	171	30.2	79.5			
Car	69	12.2	76.8	1.038	5	>0.05
4 Wh. Dr. Pickup	46	8.1	82.6			
Horse	7	1.2	71.4			
Motorbike	2	0.4	100.0			
TOTAL	566	100.0	78.6			

Goal of Hunters. The goal of each hunter interviewed, whether it was to shoot a "trophy" buck or just "anything", had no significant influence on the success of the hunter (Table 10). However, it is not known whether the goal described by a hunter was the goal at the start of the hunt or the goal at the end of the hunt, or if the original and final goals were the same. Thus, the effect of any change in goal on success also is not known.

If the goal was such that the hunter was selective and thus passed up opportunities to shoot pronghorn other than what was desired, the remaining number of chances to shoot a pronghorn would have been decreased. On the other hand, the more selective hunters may have tended to be the better hunters. Assuming the goals described were the original goals, hunters either were able to find and shoot what they were looking for or else they soon changed their goals to something requiring less selectivity.

Table 10.--Relation between goals of hunters and success of hunters.

Goal	No. of Hunters	% of Total	% Succ.	X^2	d.f.	P
Meat	350	28.5	81.1			
"Trophy" Buck	315	25.7	79.0	3.506	3	<0.40
Buck	307	25.0	79.2			
Anything	256	20.8	74.6			
TOTAL	1228	100.0	78.7			

Location of Lodging. The relation between location of lodging during the hunting season and success of hunters was significant at the 0.10 probability level (Table 11). The hunters who stayed overnight at home tended to be less successful than hunters who lodged someplace closer to the area hunted, such as at a friend or relative's home, a motel or a camp. Possibly hunters who lodged at home did not start hunting as early in the day as hunters who lodged elsewhere, due to the longer drive to the area hunted. Thus, the persons lodging at home probably found the pronghorn more wary than did the other hunters. As was indicated by Table 4, the daily, and therefore possibly the hourly, average number of pronghorn found per hour by hunters decreased as the hunting season progressed.

Table 11.--Relation between location of lodging during hunting season and success of hunters.

Lodging Location	No. of Hunters	% of Total	% Succ.	X^2_c	d.f.	P
Home	801	65.2	77.2	3.223	1	<0.10
Not at Home	427	34.8	81.7			
TOTAL	1228	100.0	78.7			

Experience Hunting Pronghorn. The experience of pronghorn hunters, when categorized according to whether the person (1) had experience but hunted for the first time in the management area, (2) had more than one year of experience hunting in the management area, or (3) had never hunted pronghorn before, was not related to success of hunters (Table 12). Hence, familiarity with the management area and/or pronghorn hunting apparently did not influence hunter success.

Table 12.--Relation between experience of pronghorn hunters and success of hunters.

Category of Experience	No. of Hunters	% of Total	% Succ.	X^2	d.f.	P
Exp. in Mgmt. Area	604	49.2	77.2			
Inexperienced	405	33.0	81.5	2.784	2	<0.30
Exp. but 1st Year in Area	219	17.8	78.1			
TOTAL	1228	100.0	78.7			

When experience was considered in terms of the number of years a person had previously hunted pronghorn, there was no significant difference in average total amount of experience between successful and unsuccessful hunters (Table 13). However, the average number of years that persons had previously hunted in the management area was significantly different between successful and unsuccessful hunters; the successful hunters being the less experienced (Table 13). Implied is that hunters who were more experienced in the management area were not as intent, or able, to kill a pronghorn as were less experienced hunters. The reason for this lower success ratio is not known. The more experienced hunters may have tended to be more selective but the degree of selectivity was not shown to be a factor which decreased success of hunters interviewed (Table 10).

Table 13.--Comparison of average number of years experience hunting pronghorn, between successful and unsuccessful hunters.

Category	Successful		Unsuccessful		P
	No. of Hunters	Avg. ±SD	No. of Hunters	Avg. ±SD	
Total Yrs. Exp.	967	3.2 ±4.6	261	3.2 ±4/3	0.01*
Yrs. Exp. in Mgmt. Area	967	1.5 ±2.7	261	1.9 ±3.3	0.05**

*t = 0.038, d.f. = 1226
**t = 1.716, d.f. = 1226

Hunters' Reasons For No Success. Nearly one-half of the unsuccessful hunters said they were unable to kill a pronghorn because they missed shots (Table 14). Closed land was a minor problem according to hunters, since only 1.8 per cent of the unsuccessful hunters gave "lack of permission to hunt" as the major reason they were not able to shoot a pronghorn. However, it is not known how many hunters had to spend extra time during the hunting season locating land that was not closed, and therefore spent less time hunting than persons who had no trouble obtaining permission to hunt. Thus, closed land may have had more of an influence on success than was indicated by hunters in the interview because many hunters affected by closed land may have given another reason for their lack of success.

Table 14.--Frequency of hunters' reasons for being unsuccessful.

Reason	No. of Hunters	% of Total
Shots Missed	136	48.2
Pronghorn Too Distant	91	32.3
Did Not Hunt	21	7.4
No Pronghorn Observed	19	6.7
No "Trophy" Found	9	3.2
No Permission To Hunt	5	1.8
No Buck Found	1	0.4
TOTAL	282	100.0

Pronghorn Per Hunter. There was no correlation between number of pronghorn per hunter and success of hunters in individual management areas. The potential number of pronghorn per hunter is revealed, but the degree of pronghorn availability is not. As has been stated, pronghorn were on closed land in about 10, or nearly one-fourth, of the management areas each year. Also, hunter distribution possibly did not correspond with pronghorn distribution in some management areas.

MANAGEMENT IMPLICATIONS

Of the factors which were found to influence hunter success, closed land was probably the one which could be investigated most thoroughly prior to hunting season. Field men generally are familiar with policies of land owners in their respective districts and could determine location and extent of closed land. The most important aspect influencing success of hunters in areas containing closed land however, is apparently the number of pronghorn on this closed land. This number can be estimated prior to hunting season by observation and/or from talking with the landowners. The number of hunting permits allowed in a management area can then be based on the number of huntable-pronghorn rather than on total number of pronghorn. One problem that might be encountered is the movement of pronghorn onto closed land during the hunting season.

The study results indicated there was a significant decrease in success ratio of hunters each successive day of the three-day season in 1967 and 1968. Approximately 75 per cent of the pronghorn killed were shot the first day. Thus, a season longer than three days would probably not increase hunter success enough to be warranted. On the other hand, a longer season would probably improve the quality of hunting because it would allow hunters to spend more time hunting and be more selective.

Hunters who were able to locate the most pronghorn were the most successful. Game managers could probably use this finding to develop better public relations between hunters and landowners. Hunters could be reminded that obtaining prior permission to hunt from the landowners, as well as learning where pronghorn tended to stay, would increase their chances of finding and shooting a pronghorn during the season. Hunters should be encouraged to make a greater effort to obtain permission to hunt. Such an approach would be appreciated by landowners. Hunters also need to be encouraged to use scopes for greater success and fewer wounded pronghorn.

SUMMARY AND CONCLUSIONS

Factors related to hunters, landowners, and management methods which were found to decrease success of pronghorn hunters in Colorado during the 1967 and 1968 hunting seasons are: (1) closed land, (2) hunting done late in the season, (3) inability of hunters to find pronghorn, (4) nonuse of telescopic rifle sights, and (5) experience hunting pronghorn in the management area.

This study indicates what factors have influenced hunter success in general and what some of the management implications are. However, the major reason(s) for a relatively low success ratio (below about .80 in Colorado) in specific management areas may often differ from area to area and from time to time. Thus, in each situation it is up to the game manager to determine (1) what factors or conditions are present that have a potential effect on success, (2) the extent of these conditions, (3) the degree of influence the conditions may have, and (4) the feasibility and practicality of trying to remedy or counteract the conditions prior to hunting season. The results of this study can be used to provide a better idea of what factors or conditions to look for in the future which may influence hunter success.

Discussion

West: You made one observation of the possible benefit of a longer season. I figured that out about 3 years ago. The hunters had hunted in mid-week - we ordinarily have a 9-day season. As near as I could determine, about 10 per cent of the hunters hunted only during mid-week, or after the opening weekend crowd had gone. That 10% accounts for at least 25% of the total man days of recreation.

Fowler: And they were what you consider trophy hunting?

West: I don't know.

Johnson: Were there any questions that you asked on your interview survey that were also included on the regular Hunter Success Survey, and were there any differences, or what were the similarities between the responses given by the telephone survey as compared to the regular Hunter Success questionnaire?

Fowler: I did not look at the questionnaire that was sent out by the Game and Fish Department. In fact, there is a hunter report card involved, I believe, with the hunters but I don't know what questions were involved on the questionnaire. I was relating characteristics of hunters to success of those hunters and I don't know how this compared with the total hunters.

Johnson: It didn't look like there were many questions that would probably have been included, but ---

Bear: No, our regular survey is on the back of the hunter's license that he sends in. Ron's survey is much more intensive and I think we covered it pretty well, the same questions.

Fowler: I did sample all management areas and this 1,250 hunters that I interviewed, I imagine is approximately 11% of all hunters in 1967-68. There was no random selection of names in the interviewing process and there wasn't a random sample or anything of this nature.

AN EXPERIMENT IN PROMOTING QUALITY ANTELOPE HUNTING

by
W. D. "Pete" Carter, Refuge Manager
Sheldon-Hart Mountain National Antelope Refuges
Lakeview, Oregon

ABSTRACT

In 1967 the Bureau of Sport Fisheries and Wildlife initiated an experimental trophy antelope hunt on the Charles Sheldon National Antelope Range. A similar hunt began on the Hart Mountain National Antelope Refuge in 1968.

The objectives of these hunts were: to promote the qualitative aspects of antelope hunting, to determine if hunters were interested in trophy hunting and to determine if potential antelope hunters could be taught to recognize trophy antelope in the field.

A mandatory pre-hunt orientation session was used to present life history data and mounted heads were used to instruct hunters in techniques of choosing trophy heads. This session has proven popular with the hunter and adds considerably to his appreciation of some of the finer traditions of antelope hunting.

AN EXPERIMENT IN PROMOTING QUALITY ANTELOPE HUNTING

The Bureau of Sport Fisheries and Wildlife and many state fish and game departments have become increasingly concerned with the qualitative aspect of todays hunting and fishing experience.

There are many examples along our streams and lakes, in waterfowl marshes and big game ranges which demonstrate our neglect of quality for the sake of quantity. The demand for us to provide more fish and game for the growing number of outdoor enthusiasts has been such that in many instances we have overlooked quality. I consider this a serious oversight. With the risk of using a trite phrase I would also say I consider this discrimination.

We are discriminating against that veteran trout fisherman with the patched boots, well worn creel and ancient hat adorned with his own fly creations that caught trout and not fishermen. We are discriminating against that fellow we used to see poling in off the marsh in his duck boat loaded with hand made decoys and the black lab. We are discriminating against those two leather faced fellows we used to see riding out of the "back country" with monster buck antelope behind their saddles.

It's no mystery why many of the sensitive and truly appreciative outdoorsmen are no longer in the field. The trout fisherman couldn't understand why someone built an all weather road three miles up the stream to his favorite hole. The duck hunter couldn't understand the airboat crowd that could get to his favorite canvasback point in 20 minutes while it took him over 90. The two antelope hunters abandoned the "back country" the year after they found their old haunts crisscrossed with new trails and the number of four wheel drive vehicles outnumbered the antelope.

Perhaps an outdoor experience as they knew it is destined for a fate similar to that of the buffalo. I certainly hope not and believe it doesn't have to be that way. Wildlife administrators, managers, biologists, hunters and fishermen have an obligation to preserve the finer traditions and ethics of hunting and fishing.

In recognition of this obligation and the need for promoting quality the Bureau of Sport Fisheries and Wildlife in 1966 began exploring the possibility of "quality" antelope hunts on its two national antelope areas. The Charles Sheldon Antelope Range and the Hart Mountain National Antelope Refuge were ideal for this purpose.

The Charles Sheldon Antelope Range, in northwest Nevada, was established by Executive Order in 1936 to provide for the preservation, study, and management of antelope (Antilocapra americana), sage grouse (Centrocercus urophasianus), and other indigenous wildlife. The Range encompasses about 544,000 acres of withdrawn public domain and purchased land. It is traditional year around antelope habitat with elevations from 4200 to 7300 feet. The area is managed by the Bureau of Sport Fisheries and Wildlife and the Bureau of Land Management.

The Hart Mountain National Antelope Refuge in southeast Oregon was also established in 1936 with objectives similar to that of the Sheldon Range. The refuge includes about 240,000 acres of withdrawn public domain and purchased land. It is traditional summer-fall habitat for antelope with elevations from 4500 feet to 8000 feet. Hart Mountain antelope usually winter on the Sheldon Range 22 miles to the south. The Hart Mountain area is administered by the Bureau of Sport Fisheries and Wildlife.

Antelope populations on these two areas have varied considerably. In general there was a population decline from 1942 to 1955. Since that time populations have been more or less static. In recent years the summer-fall population on Hart Mountain has been around 400 head while there are about 750 on the Sheldon Range. Both areas were closed to antelope hunting after they were established.

METHODS

During the initial stages of the project the concurrence and cooperation of the Nevada and Oregon Fish and Game Departments was sought and enthusiastically offerred.

Rather than attempt two hunts the first year, the Sheldon Range was chosen as the site for the first trial in August 1967. It was agreed at the beginning that the emphasis of the hunt would be on that nebulous term called "quality." With this as a guide the following objectives were developed:

1. To provide an opportunity for a limited number of hunters to participate in a trophy antelope hunt which emphasized the qualitative features of antelope hunting.

2. To collect biological data from harvested animals such as: rumen sample, weight and condition, age - horn development relationship, evidence of disease, etc.

3. To determine if hunters can be taught to distinguish trophy antelope

heads in the field during a two hour pre-hunt indoctrination.

4. To determine if hunters were interested in trophy hunting and how much time and effort they were willing to spend pursuing this interest.

5. To determine the prevalence of trophy antelope heads in the population and the degree of difficulty in bagging such a trophy.

6. To determine what individual hunters considered as "quality" hunting and a "quality" outdoor experience.

For the purposes of the above objectives a trophy antelope was defined as one which would score the minimum points necessary for annual Boone and Crockett competition. The present minimum score is 82 points.

The Bureau and the two states involved had already had some experience in the management of controlled hunts for bighorn sheep, (Ovis canadensis nelsoni) in Nevada and (Ovis canadensis californiana) in Oregon. The procedures developed for the antelope hunts were similar and an arbitrary number of 10 hunters was chosen for the first hunt.

Antelope hunting regulations for the respective states prevailed. In addition, special regulations were as follows:

1. Hunters were required to attend a 2½ hour pre-hunt indoctrination session on the afternoon preceding the antelope season.

2. Camping was permitted at designated areas only.

3. The use of motor vehicles was restricted to established roads and trails.

4. Buck antelope were the only legal game. All other animals were protected.

5. Shooting at antelope from a point within 50 yards of a motor vehicle was prohibited. (Included in Oregon State Regulations)

6. Hunters were required to bring all field dressed animals to a central check station.

Pre-Hunt Indoctrination

The pre-hunt indoctrination session was scheduled from 2:00 P.M. - 4:30 P.M. the day before the antelope season opened. The session was held at a centrally located check station in the field.

The indoctrination discussion, led by federal and state personnel, presented information on antelope life history and management, deterioration of hunting values in recent times, early traditions and skills of hunting, Boone and Crockett scoring, choosing a trophy, fair chase, hunting tips, and rules of the hunt.

Several exhibits were displayed to assist the hunter in distinguishing trophy type heads in the field. A photograph display showed 8"x10" glossy prints of eight different mounted antelope heads. Attached Boone and Crockett score sheets illustrated the respective scores of each size head. Perhaps the most

valuable exhibit was a life size antelope silhouette upon which mounted heads could be attached. The silhouette was placed at 100, 200 and 300 yard intervals and small, average and large mounted heads were attached. The small heads would score 55 to 65 B&C points, the average heads scored 65 - 75 points while the large heads scored 75 or better.

Hunters were given an opportunity to examine these heads with binoculars, rifle scopes and spotting scopes. Their skill in estimating the Boone and Crockett score was informally tested.

RESULTS

As previously mentioned the first hunt was held on the Sheldon Range in 1967 when 10 permits were issued. In 1968 the program was expanded to include 10 permits on the Hart Mountain area. In 1969 two groups of ten hunted Sheldon while one group of 16 hunted Hart Mountain.

A total of 66 permits has been authorized and that many hunters have participated in these special hunts.

Only two hunters (3%) have been unsuccessful in killing an antelope. One of these was due to illness. The other was a novice lady hunter.

Boone and Crockett scores of the 64 animals taken were as follows: 3 heads (5%) scored in the 80's, 42 heads (64%) scored in the 70's, 18 heads (27%) scored in the 60's and one (2%) scored in the 40's.

The 64 successful hunters hunted about 108 days. Thirty-eight hunters (59%) shot their antelope on the first day of the season while 16 hunters (25%) killed their animal on the second day. Five hunters (8%) hunted 3 days, three hunters (5%) hunted four days, one hunter (2%) hunted five days and one hunter (2%) hunted six days.

In addition to a rumen sample the following information was obtained from each hunter: number of buck antelope considered before shooting, length of stalk, number of shots fired, number and location of hits, was animal as big as he thought it would be, did he plan to have the head mounted and hunter comments evaluating the hunt.

DISCUSSION

Most wildlife workers agree there is a need to place more emphasis on the quality of hunting and fishing, as well as other outdoor activities. Just how this greater emphasis may best be accomplished is not known but it seems as if there is a place for special areas or events which are dedicated to this purpose. Some National Wildlife Refuges are well suited for this. Many of these areas can make important contributions toward the preservation of our hunting and fishing heritage by emphasizing the qualitative feature of these activities.

An evaluation of this experiment in promoting quality antelope hunting shows many interesting and worthwhile areas for discussion and investigation.

First, it was probably a mistake to call the project an experiment in promoting quality antelope hunting for we have done very little promoting. Most of our efforts have been toward development and management of the hunt. The hunters who participated had a great experience and many called it a "one in a lifetime hunt." Strangely enough, many hunters were more impressed with the opportunity to hunt without competition than they were with the abundance of game.

Some of the most interesting information was obtained during our discussions with hunters about "quality." Many recognized the importance of a high standard of conduct plus a respect and appreciation for the animal being hunted. Sometime in their past they had acquired this sensitivity we were attempting to develop. For others, it was something new. The idea of crawling on your stomach in the rocks for two or three days for a chance to shoot an old patriarch seemed somewhat foreign, especially when they could shoot a young buck next to the road and be home before dark.

After three years of conducting this hunt we believe it is possible to train novice antelope hunters to distinguish trophy antelope in the field. Some have demonstrated the interest and ability to do this within accuracy limits of five Boone and Crockett points. All have indicated a major contribution to their enjoyment of the hunt was the indoctrination session.

About 90% of the participating hunters said they were interested in trophy hunting prior to the hunt but less than 15% spent more than two days hunting for an outstanding animal. Some hunters were reluctant to spend more than two days hunting trophy antelope because they needed their vacation time for deer, elk, or bird seasons.

A cursory examination of the biological data gathered shows there were no diseased animals taken. Averaged field dressed weight was 102 pounds for all three years and the data indicate animal weights may vary as much as 15 pounds from one year to another.

We anticipate these hunts will continue on an annual basis with some refinements in data gathering. Perhaps we will not only improve our knowledge of the antelope but of the antelope hunter also.

Discussion

Pate: Were the antelope aged and was there a correlation between the horn length or size of horns and age?

Carter: We didn't start aging until last year. We haven't looked at this too closely, but I'll admit that we were surprised when we were running onto 2½ and 3½ year old antelope that had quite large horns. A 2½ year old antelope that would score into the 70's, sort of surprised us. We're talking about horns 15 or 16 inches in length.

SOME POSSIBLE PREDATOR-PREY RELATIONSHIPS BETWEEN BOBCATS AND PRONGHORN ANTELOPE ON DESERT RANGES

by
Donald M. Beale, Utah Division of Fish and Game,
and Utah State University, Logan

Studies conducted with pronghorn antelope in western Utah on 10,000 acres of fenced range have indicated high fawn production but also high fawn mortality during the summer months. Production rate with an experimental herd over an eight-year period ranged from a high of 181 fawns per 100 does to a low of 100 fawns per 100 does. During this same period, summer mortality of fawns ranged from a low of 15 per cent to a high of 79 per cent. Excluding 1969, which was a year of exceptionally high survival, fawn mortality for the season averaged 50 per cent from June 1 to early November. Most of this loss occurred in July and August. Some mortality was attributed directly or indirectly to forage condition but a large portion of the loss was unexplained prior to 1968.

Although efforts had been made to use radio tracking, not until 1967 was a technique perfected for using radio telemetry to determine causes of fawn mortality. During the summers of 1968 and 1969, 38 2-or 3-day old fawns were equipped with radio transmitters. These fawns were located and observed daily for about 16 weeks in order to determine their physical condition and movements throughout the study area. Data obtained by radio telemetry during two seasons revealed bobcat kills of 35 per cent of the fawns on the study area in 1968 and 12 per cent in 1969.

The fawns were apparently killed during the night when they were bedded down. This is supported by the fresh condition of the carcasses when found in the morning. Signs at the kill site indicate that bobcats approached the antelope probably by smell, sneaked to within range and jumped on the fawns before they got up. With this type of hunting behavior by one class of predators, the number of antelope groups, the proportion of fawns in each group, the terrain occupied by the antelope, and the size of fawns may all be factors in predation. Probably these factors are in some way indirectly related to forage conditions. Our observations indicate that during good forage years antelope tend to gather in fewer but larger groups than in poor forage years. When antelope are in fewer groups, predators depending on smell for locating their prey would have less chance of coming in contact with an antelope. Also, larger groups collectively may be more alert than small groups. Usually in comparatively dry (low precipitation) years most of the antelope feeding activity is along washes where the palatable browse plants are more abundant. When feeding in these areas, antelope frequently bed down near by where approach by bobcats is made easier. Moreover, other research in Utah indicates that bobcats feed extensively on jack-rabbits. Therefore, bobcats are probably more prevalent along washes because of the higher jackrabbit density there. During poor forage years the growth rate of fawns was markedly lower than in good forage years. This, in turn, extends the period that the fawns are more vulnerable to predation.

Predation by bobcats during the summer of 1969, comparatively speaking, was

not as high as would be expected if the above assumed relationships are correct, other factors being equal. Forage conditions in 1969 were not as good as in 1968, either in quality or quantity of feed, and yet predation by bobcats was lower in 1969 than in 1968. This discrepancy in part may have occurred as a result of removal of bobcats on the range adjacent to the study area. A private trapper captured 14 bobcats in the winter of 1968-69 on range centered approximately 5 miles from the study area, and this may have reduced bobcat numbers on the study area as well. There is no knowledge of similar trapping in previous years. Also, fawn survival in 1969 was much higher than that of any other year during the study and tends to support the thought that some factor was involved which had changed over previous years.

Discussion

Perkuchin: Did you have information on the density of coyotes and did you have any mortality you could attribute to coyotes?

Beale: Actually, not these two years. Since we've been out there for 8 or 9 years, we've got one confirmed loss by a coyote, and this was when they were 2 or 3 days of age, the coyote came through on the fawning grounds. Probably the coyote population is above bobcats, I don't know. You see many more of them, but they're a different type of animal - different behavior. It's anybody's guess.

McKenzie: I was wondering on the life of those batteries on your transmitter, is that a commercial source for that particular radio, or is it one that you fellows devised?

Beale: This is essentially the same circuit design that's been published in the Wildlife Journal in 1964 or 65, I guess, with some modification, but really quite similar just in the size of your transistors and the type of transmitter used, type of crystal used, and this sort of thing, and the amount of power output you want, the rate you want to beep the signal - all of these determine how much longevity you're going to get out of it. It carries so much weight and has so much energy there, it just depends on how you use it.

Bill Hepworth: Aside from the fact that cats quite frequently tend to cover the carcass and you may occasionally find the tracks at the site of the kill, how do you distinguish between a cat kill and a coyote kill? If there are no tracks in the dirt, is there a characteristic way in which the two species differ in their approach to the animal?

Beale: I don't think that coyotes would take them by the neck like these have all been done, but other than that, I couldn't say. You find the very same pattern of attack to the neck and throat, claw marks on the back where they rode the animal, and this is all fresh - you're just an hour or two behind and you can just see what's happened.

Bill Hepworth: I thought I'd just comment on this. On this desert study that Chuck Sundstrom is working on we found a number of animals taken by the neck, but they're on hard ground and there are no tracks observed, there's no scratch marks and in only one case have we found a carcass partly covered, which I thought at the time was probably a cat because this is a characteristic. But I'm at a loss to say whether it's coyotes or bobcats with no tracks. We suspect a coyote in most cases because we've driven a coyote off on occasion, but still the bite marks in the neck amount to about four bite marks. Sometimes the jugular is punctured and sometimes it isn't. The animal's held down so it either dies of shock or suffocation and so I'm really wondering how one might establish without

tracks, whether it was a cat or a coyote.

Larsen: Just an answer to Bill Hepworth's question. Other than the attack on the neck is about the only thing we can go by. You're going to have to be right close behind it if you are going to determine anything as far as a predator kill goes.

Compton: Would you care to theorize on the difference between this situation you're working with, with finding these results, and other areas where we have antelope populations, you don't get this sort of thing. Are there any studies to demonstrate the other way?

Beale: As far as predation, you mean? The extent that we can apply our results outside, I don't know. I would hope to find more in another year or two. I see absolutely no reason to think that our losses in 68 and 69 (in this enclosure) should have been caused by anything different in previous years, but again, how much we can apply this to outside, I don't know.

Larsen: Could you speculate why most of your mortality seems to be on fawns of say 2 or 3 months of age rather than infant fawns - the first week or two? Do you have any mortality of infants, say the first week or two of life?

Beale: Very, very little. In this coyote kill that I mentioned, of course, this appeared at that age, but generally speaking, throughout the study we've had relatively no mortality until several weeks of age. As far as any relation to bobcat kill would just be after the fawn is 5 or 6 weeks of age, its scent glands are being developed, and there might be some relationship here. As far as moving around, they would be more vulnerable at their earlier age than they are at the age they are taken.

Fowler: Would the mother be more protective at the younger age?

Beale: I don't think so. I think as far as protection of the mother goes, it's insignificant. Protection is derived from their behavior characteristics, that of speed, that of evesight. I mean at night the fawn is bedded down, and the doe is bedded down, and she's not going to be providing physical protection for a fawn.

Kerr: You said that you lost 12 to 35% of your fawns. When you've had this kill of 12 to 35%, what was your surviving doe-fawn ratio at about 6 months?

Beale: About 40 or 50 fawns to 100 does. As far as our desert count, all doe/fawn ratios seldom got below 40 fawns to 100 does. This is probably a 75% fawn loss.

Kerr: How many does were you counting in this - what was the population you were working with?

Beale: It varied from year to year. Last year it was 16 mature does and 29 fawns - 13 pair of twins and two singles. That's the size of our mature doe herd - it's been about 15 or 16 does.

West: Is this study being continued?

Beale: Yes.

West: I've raised about 30 kids. Some years when it isn't too wet you can pick them up without taking any precautions with gloves because I'm going to take them home. They seem to have a waxy, oily substance on them - the newborn. I often wonder if we should clip some hair and have it checked out to see if there isn't something there that would mask the odor. It's a little hard to believe that anything living doesn't give off odor, but there must be a reason.

DEVELOPMENT OF A TECHNIQUE FOR NIGHT-TRAPPING ANTELOPE FAWNS 1/

by
Sam Brownlee and Tommy L. Hailey
Texas Parks and Wildlife Department

INTRODUCTION

The study to determine seasonal movements and total range of antelope herds in the Trans-Pecos region of Texas was initiated in 1965. To accomplish the stated goals, it was necessary to mark a large number of antelope. It was soon determined that capturing and marking fawns would be a more feasible procedure than trying to take adults for the purpose. The fawn approach also could furnish known-age animals for developing an aging technique.

First, personnel examined literature for capture techniques which had been developed in other states. It was ascertained that techniques so far developed would not fit our need. After perusal of literature on the subjects, it was decided that a daylight-hoop-net-capture technique could be modified to fit our needs. The primary modification was in procedure, that is, to net the antelope fawns at night instead of by day. A spotlight was found to be adequate to locate them.

MATERIALS AND METHODS

After experimentation, it was determined that the following list of items was needed to obtain best capture results.

(a) One ½-ton pickup or similar vehicle.
(b) Two 7½-inch hand-held spotlights (Aircraft wing landing lights).
(c) Two nylon capture nets of 2½-inch mesh with hoops 36 inches in diameter and handles 10 feet long.
(d) A capture team consisting of a minimum of 3 or a maximum of 4 people.
(e) One pair of 7 by 35 binoculars.

Prior to capture operations, personnel conducted a ground and/or aerial survey of pastures during late evening to determine the location of bedding sites and approximate number of fawns available. Observations showed that the fawns would stay bedded in selected spots during the late evening hours until they reached the age where they followed the does. These sites selected were usually low rolling hills adjacent to broad flats, and ordinarily had ground cover up to 24 inches in height. Both the crests and the slopes were utilized as bedding sites.

The actual capture operation was conducted at night and consisted of the following procedures: a capture team of from three to four people, one to drive the vehicle and two or three to work the spotlights and nets. The pursue and capture was begun by driving strips, approximately 200 yards apart, through the bedding site. During this time personnel standing in the bed of the pickup worked the spotlights over the terrain along the route. (Personnel using the spotlights must be positioned high enough so that the lights can be used above the vehicle cab to enable them to see down through the vegetation). The fawns were located by light reflecting

1/ Contribution of Federal Aid Project W-57-R.

from their eyes. When the eyes were spotted, binoculars were used to correctly identify the animal. If it proved to be an antelope fawn, the vehicle headlights were turned out and one spotlight beam was kept focused on the animal. Two men, equipped with nets, were immediately stationed on the ground on either side of the vehicle adjacent to the front fender and out of the glare of the spotlight. (On a 3-man team, the driver handled both the vehicle and the spotlight.) The vehicle was then driven toward the fawn while keeping the spotlight beam directly on it.

Experience showed that the approach was one of the more critical phases of the operation. If the fawn saw the men with the nets or heard the noise made by the walking men, it became alarmed and usually escaped. However, it was found that if the pickup engine was revved up to a high speed during the approach, this tended to drown out the noise made by the walking men and focused the fawn's attention directly on the vehicle. Under these conditions the approach could usually be made without alarming the fawn. When close enough, one of the men placed the hoop net over the fawn. The net pouch was of a size that would not pin the animal to the ground, but, at the same time, it was not able to stand upright either. (Experience showed that there is less chance of injury with this size net pouch than with one that is larger or smaller.) The second man then removed the fawn from the net, and it was then weighed and tagged.

RESULTS

In the 4 years of developing and using this technique in the Trans-Pecos region, 210 antelope fawns out of 237 observed were captured for a success rate of 88.6 per cent. The first year, 1966, was a year of experimentation. Only 39 antelope fawns were observed, but, of these, 32 were captured. However, 210 man-hours were expended in the operation.

In 1967, after some modification in the basic technique, 80 antelope fawns were captured out of 88 observed. Project personnel expended 215 man-hours which resulted in a capture rate of one fawn per 2.69 man-hours of effort.

In 1968, only 95 man-hours were utilized in this effort and 27 antelope fawns were captured out of 33 observed. Due to other commitments, a limited amount of time was directed to the fawn-marking program.

In 1969, project personnel expended 195 man-hours and captured 71 fawns out of 77 observed.

Ninety per cent of the fawns observed but not captured were large enough to run with the does. Several attempts were made to capture these larger animals, but they proved futile. This size fawn was wary and could not be approached. In the 4 years of marking in this area, the smallest fawn captured weighed 3 pounds. The largest fawn captured weighed 20 pounds. The average weight of the captured and tagged fawns was 10.23 pounds.

DISCUSSION

It was found that if personnel made a thorough ground or aerial reconnaissance

prior to attempting to capture the fawns, more could be located at the bedding site level and a greater number taken. The use of an airplane in locating the bedding sites during late evening was a great advantage. Arrangement for use of the airplane was facilitated by the fact that the Department's plane was generally in this area conducting the annual antelope census at the height of the fawning season. During the late evening, the pilot would fly the plane at low elevation over the area scheduled to be worked and would systematically mark the areas on a map and record the number of fawns located.

One disadvantage of this technique was in having sufficient personnel available to conduct the aerial survey and the capture operations at the same time. However, for our area and purpose, this technique worked very well. Possibly the hoop-net method of capturing antelope fawns would need to be modified to fit other areas, but I believe it could be modified to work well in any site location.

Discussion

Hnatiuk: How large an area did you work in?

Brownlee: Normally we worked it on a ranch in a section - the ranches varied from 10,000 acres all the way up to about 70,000. Fortunately, we have maps made of each area and when we conducted this reconnaissance we marked the location within the section and this made it a lot easier.

West: You said the average weight was about 10 lbs. That surprised me. You said you were dealing with animals that were 3 weeks and on up?

Brownlee: Right. We're dealing with animals from a few hours old up to about 3 weeks.

West: Was there any difference - you mentioned 24-inch vegetation they were bedded in - from the older fawns?

Brownlee: No. It seemed to be the prime requirement for the bedding site was the type of the vegetation. If the vegetation was short, the does did not utilize the area.

West: It's kind of surprising. Most of the fawn observations I've made of real young ones would be in mowed hay land, even summer fallowed fields, the shorter the better.

Brownlee: Normally, this area we're talking about - the primary vegetation was bluegrass, sideoats grama, some chino and black grass, and the higher the vegetation the more success we had in the areas for the numbers seen.

Autenrieth: You mentioned you could fly the areas in the evening and see a downed fawn?

Brownlee: No. These does usually suckle the fawns in about the last hour of the daylight and the fawns were up, and normally where you spot the fawns from there in that time you can usually find them within a 50-yard radius of that area that night.

Larsen: Do you know anything yet about the retention of those tags?

Brownlee: Of course this has been in four years. This last harvest we collected 6 antelope that still had the tag and the ribbon. The green faded pretty well. You had to be fairly close to the animal to be able to identify the color. They seemed to retain the tags pretty well. We did have two instances where the tag had evidently been removed by some means.

Hlavachick: When you let those little devils loose, how far did they run and did you think that might have increased their susceptibility to mortality?

Brownlee: Surprisingly, they run approximately 150 to 300 feet from where we released them. After leaving an area and working another area, we'd come back to see how many we could locate and normally they were in the immediate vicinity of where we released them.

Leland Hepworth: Did you find a preferred time of the night in relationship to your success? Is it better to work this capture when it's very dark, or early in the night, or what about say 2:30 or 3:00 o'clock in the morning?

Brownlee: The best time or the nights that we found we had the best capture success were nights when it was fairly dark, or very little moon and very little wind. Wind seemed to make the fawns more nervous and normally as we approached them they would not run, but they would get up. They still did not attempt to run unless they heard the men on either side. We captured the fawns from about 9 o'clock in the evening all the way up to 7 o'clock in the morning.

Leland Hepworth: Less in the morning?

Brownlee: Normally, in the early hours after 4 o'clock, they would become restless, probably due to the fact that probably the does would come back to feed the fawn but I don't think that time as such makes much difference for its capture. I think the primary consideration for the capture is the ability of the spotters to locate after 6 or 7 hours on the back of a pickup.

Beale: Did you have any problems at all with abandonment?

Brownlee: As far as we could tell, we had no problems at all. We did not take any special precautions in keeping the scent away from the fawn, and you would fly the ranch or make a ground reconnaissance a day or two later and you would see the fawns with the does, and in some instances we found as high as every fawn we captured a previous night in that area, so I feel that as far as fawn abandonment, it's not a problem in our area.

Beale: If the fawns remains in the same area the doe will continue to return to it for several days after tagging so you'd have to be checking back a week later.

Brownlee: Right. Now we encountered on one range as high as 70 tagged antelope on one ranch and one factor I might mention, that the farthest movement has been about five miles.

Autenrieth: What was the upper age limit of successful capture?

Brownlee: As far as that goes there was very little problem as long as the fawn was by itself or with another fawn. We could have a reasonably good chance of capturing the fawn. If it was with a doe or if the doe would come through there and pick the fawn up, we had no chance then.

Autenrieth: What was the oldest one that you did capture?

Brownlee: Oh, I would probably say 3 or 3½ weeks. And something else we found out, once the fawn gets up and starts moving or running, a man can't catch it.

INTRAUTERINE MORTALITY IN THE PRONGHORN 1/

by
Bart W. O'Gara, Assistant Leader
Cooperative Wildlife Research Unit 2/
University of Montana, Missoula

ABSTRACT

The reproductive tracts of 78 pregnant pronghorns (Antilocapra americana), collected in Montana and Yellowstone National Park, were examined to determine the cause for disparities in numbers of corpora lutea and fetuses in utero. Investigation revealed that the 3 - 7 corpora lutea commonly found in this species resulted from a similar number of ova which were ovulated, fertilized and developed into spherical blastocysts. During the "thread stage" the trophoblastic walls of the blastocysts reshaped themselves from spherical vesicles to long tubular threads and some of the embryos were killed due to knotting and tangling of the "threads." When more than one embryo per uterine horn survived the thread stage, the one distal to the corpus uteri was displaced or its membranes were pierced by the necrotic tip of the proximal embryo. Thus excess blastocysts and embryos were eliminated during the thread stage or at the time of implantation.

INTRODUCTION

The anatomy and embryology of the pronghorn have not been studied as extensively as those of the other common families of artiodactyls. German biologists made detailed studies of many of the cervids and bovids between 1850 and 1900. Antilocaprids presumably were not available to the Germans, and even researchers in the universities of the United States found it difficult to secure specimens because the numbers of pronghorns decreased dramatically as the prairies were settled.

Wislocki and Fawcett (1949) were the first investigators to publish an extensive paper on the placentation of the pronghorn. They had only four, poorly-preserved reproductive tracts of mid-pregnancy, but they noted the presence of more corpora lutea than fetuses in utero. During the last 10 years, several biologists have described high corpus luteum:fetus ratios. Other

1/ This research was financed by a National Defense and Education Act Fellowship granted to the Department of Zoology at the University of Montana.

2/ Bureau of Sport Fisheries and Wildlife, Montana Fish and Game Commission, University of Montana, and the Wildlife Management Institute cooperating.

mammals also have more corpora lutea than fetuses. The elk (Cervus canadensis) acquires "extra" corpora lutea by postconception ovulation (Halazon and Buechner, 1956). In the mare accessory corpora lutea are formed during pregnancy as a result of stimulation of the ovaries by the uterine gonadotrophin contained in pregnant mare serum (Nalbandov, 1958). In the porcupine (Erethizon dorsatum) atretic follicles luteinize at the same time as the corpus luteum of pregnancy (Mossman and Judas, 1949). Mitchell (1965) correctly diagnosed the source of "extra" corpora lutea in the pronghorn as multiple ovulation followed by fertilization and development of excess embryos. Four was the maximum number of embryos in utero after the thread stage in this collection. However, Mitchell (pers. comm.) found as many as seven embryos in utero which had survived the thread stage, but he did not describe the stage of development or manner in which ova and embryos were lost.

The ruminant placenta consisting of caruncles from the uterine mucosa and cotyledons from the chorion was described by Strahl (1906) who also used the term placentome for the union of the two mentioned parts. Strahl's terminology is used in this article.

The stage of development in the pig in which the trophoblastic wall reshapes itself from a spherical vesicle to a long tube was called a thread by Heuser and Streeter (1929); this stage in the pronghorn will be referred to as threads or the thread stage in this paper.

METHODS AND MATERIALS

During this study, 78 gravid does were collected by shooting on the National Bison Range, Moiese, Montana, and in Yellowstone National Park; 66 were taken during 1965-66 and 12 during 1967. During 1965-66, uteri were removed from the peritoneal cavity and fixed immediately in AFA. Ova and blastocysts were recovered from fixed uteri by opening and pinning each horn flat under alcohol, and the endometrium was inspected with a dissecting microscope while the fluid was agitated gently with a medicine dropper. Prior to implantation, a large amount of embryotroph is present making ova and small blastocysts difficult to locate (Bischoff, 1854). Blastocysts often shattered when the uteri were opened because the AFA coagulated the embryotroph and "glued" the conceptuses to the sides of adjacent caruncles.

If the ova could not be seen, the endometrium was flushed with a rubber bulb on a glass tube, and the flushing fluid was placed in a separatory funnel for 10 minutes to allow the ova to sink. A few cc of alcohol were withdrawn into a 4-inch watch glass; if the ova could not be found, the alcohol in the watch glass was reduced from 70% to 30%. Three drops of Harris' hematoxylin were mixed into the alcohol by shaking the watch glass, and the mixture was allowed to stand until the solid material was stained purple.

The excess alcohol was removed with a pipette and replaced by 30% acid alcohol which rapidly bleached most of the embryotroph and other debris. When the color disappeared from the debris, the acid alcohol was removed and replaced with 30% basic alcohol. Five minutes later, the basic alcohol was upgraded to 50% and then replaced with 70%. The ova with their now blue nuclei were easier to locate.

The uteri of 12 does which were collected in the autumn of 1967 were either flushed with physiological saline to retrieve conceptuses or one side was flushed and, so that ova or embryos could be observed in situ, the other side was cleared in hydrogen peroxide and benzyl benzoate (Orsini, 1962). Oviducts and uterine horns which were to be cleared in toto were dissected from their connective tissues in the field and suspended inside 18-inch, 30 mm glass tubes filled with AFA.

RESULTS

After the autumn 1965 collection, whole blastocysts were recovered from four uteri in numbers corresponding to the number of corpora lutea. One doe had 5 corpora lutea and 5 blastocysts, and three does had 4 corpora lutea and 4 blastocysts each. Conceptuses were not recovered from some of the preserved uteri, but fragmented ovular tubes were often found. Of the 12 does collected in the autumn of 1967, the first doe had not ovulated; the last two had implanted embryos. Six tracts which were either flushed or cleared during early pregnancy revealed 28 corpora lutea and 28 ova or blastocysts, indicating a 1:1 ratio of corpora lutea to blastocysts prior to the thread stage.

During the thread stage, the blastocysts elongate to as much as 12 cm and entangle with one another (Fig. 2). In contrast Assheton (1906) maintained that in sheep the length of a blastocyst was determined by the size of the uterus and the number of embryos which never overlap. During the thread stage, the blastocysts are very fragile, and it is difficult to determine how many are present. While untangling the threads of an animal collected on 11 October 1967, two knots were found. In one embryo an overhand knot was pulled tight; in the other case, two embryos formed a tight granny knot. At this time, sections of trophoblast "budded-off" the ends of tubes which were separated from the inner cell masses by knots and became free vesicles (Fig. 3). The greatest number of trophoblastic vesicles found in one uterus was 23. Trophoblastic vesicles were found in all uteri containing thread stage blastocysts. Widakowich (1922) examined the reproductive tracts of several thousand pregnant cows and found three "membranes ovularires sans ebauche embryonnaire" (ovular membranes without embryonic knobs) in one uterine horn of a cow whose ovaries contained a single corpus luteum. Widakowich (op. cit.) hypothesized that one of the first two blastomeres of triplets had been suppressed and the remaining one contained

the primordia of the trophoblast. Tarkowski and Wroblewska (1967) succeeded in producing 12-cell trophoblastic vesicles from single blastomeres in vitro; this indicates that a four blastomere ova could have disaggregated into individual blastomeres of which three developed into vesicles. The fact that the vesicles found by Widakowich were large (2, 3.8, and 6.8 cm long) indicates that they were remnants of a thread stage embryo such as those found in the pronghorn.

A search of the literature failed to locate any other reference to trophoblastic vesicles in other species, but Dr. Elizabeth M. Ramsey (pers. comm.) of the Carnegie Institute stated that she occasionally receives trophoblastic vesicles which have been passed spontaneously by women or which have been obtained by curettage. If such vesicles in women are the result of some genetic defect in or damage to the inner cell mass, they would be homologous to the pronghorn vesicles created from sections of trophoblast isolated by knotting from the control of the inner cell mass.

From the thread stage on, no more than two embryos were found in a uterine horn. However, Mitchell (pers. comm.) found as many as seven embryos in utero after the thread stage in his collection. The numbers of post-thread stage embryos, young enough for embryos being crowded out to be identified, indicated that some mortality took place during the thread stage. Ten out of 15 pronghorns collected at this time had fewer surviving embryos in their tracts than corpora lutea in their ovaries. These pronghorns had an average of 4.47 corpora lutea and 3.07 embryos.

Each uterine horn has an expansion of the lumen about 1/3 of the way from the corpus uteri to the oviduct (proximal chamber) with a rich blood supply to the mesometrial side of the uterine wall. Another expansion of the lumen, about 3/4 of the way from the corpus uteri to the oviduct (distal chamber), does not have a greater concentration of blood vessels than the other areas of the uterus (Fig. 4). Embryos with expanded chorionic and allantoic vesicles were commonly found in the proximal and distal chambers on both sides; thus quadruplets often survived the thread stage.

During the growth of the chorio-allantois, a necrotic tip forms on the oviducal end and eventually reaches the utero-tubal junction. Before the membranes of the embryos in a horn expanded enough to touch one another, the membranes in the proximal chamber began to implant and became 3 - 4 times the size of those of the embryo in the distal chamber (Fig. 5). The allantois of both embryos now pushed against the ends of their chorions, and necrotic tips began to form on the ends of the membranes oriented toward the oviduct.

When a proximal embryo's necrotic tip reached the membranes of a distal embryo, the tip would usually pierce the distal chorion, fold in most of the length of the distal allantois, and carry the distal membranes and embryo

to the utero-tubal junction (Figs. 6 and 7). In one case the distal embryo was enfolded and mummified in the chorion of the proximal embryo. In some cases the necrotic tip of the proximal embryo pierced all of the extra embryonic membranes of the distal embryo, but more often only the chorion was pierced and the allantois folded in as stated above. The path of least resistance was apparently through the lumen of the allantois because the invading necrotic tip usually terminated at the oviducal end of the distal allantois. Traction on the necrotic tip of the distal embryo and the chorion of the proximal one would pull the invading necrotic tip out of the chorio-allantois of the distal embryo while its membranes rolled off of the necrotic tip like a stocking rolled off of a leg. In late pregnancy, necrotic wads of embryonic membranes were often found in the utero-tubal junction or sometimes a wad of necrotic material was present on the leader to the necrotic tip 1 - 2 inches from the utero-tubal junction with the tip touching the junction.

During the spring of 1966, Bromley (pers. comm.) observed a doe giving birth to twins on the National Bison Range. After the doe had eaten the fetal membranes, Bromley caught and tagged the two newborn fawns. Where the ground was wet from amniotic fluid, he found a teratoma with hair on one end; after freezing it weighed 172 g and was 112 mm long by 90 mm at the widest point. The teratoma appeared very similar to acardiac monsters which are occasionally born with normal babies. It consisted principally of a membranous bag which was filled with bloody fluid. One end was solid, covered with hair, and contained teeth. Possibly this was one of the crowded or pierced embryos which was able to survive as a parasite on the fetal membranes of a normal fetus, even though grossly deformed, until parturition. The smallest fawn weighed by Bromley--5 lbs--was in utero with this monster.

The above observations, in addition to the fact that no more than two embryos per doe were present in the 43 animals collected from 4 November 1965 to parturition time in the spring of 1966, indicated that intrauterine mortality took place at two periods in the early development of the pronghorn--during the thread stage and at the time of implantation.

Triplets have been reported in about 0.5% of the pregnancies of adult pronghorns (Hepworth and Blunt, 1966). Hoover et al. (1959) reported an apparent instance of quadruplets in Colorado.

Asdell (1964) does not list any of the present day wild ruminants, with the exception of the Chinese water deer (Hydropotes), as commonly giving birth to more than two young at a time, but I believe that the pronghorn may have had "litters" of young in the past. Possibly, in comparatively recent times, predation or other factors have made two precocious young of greater survival value than several smaller and less well-developed young.

In summary, there appear to be three unique phenomena associated with the early embryology of the pronghorn.

(1) The common occurrence of trophoblastic vesicles, budded-off from thread stage blastocysts.

(2) About one-third of the thread stage embryos are killed by knotting.

(3) Embryos in excess of two which survive the thread stage perish when the necrotic tips of the rapidly expanding chorio-allantoic vesicles of embryos nearer the corpus uteri pierce their membranes and carry them to the utero-tubal junction.

DIAGRAMS OF A NORMAL SEQUENCE OF EVENTS LEADING TO TWINNING IN THE PRONGHORN

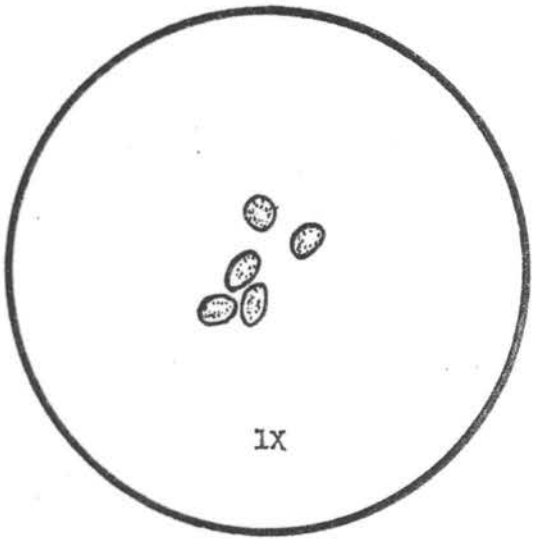


Fig. 1 Ovulation, fertilization and development to 5 spherical blastocysts.

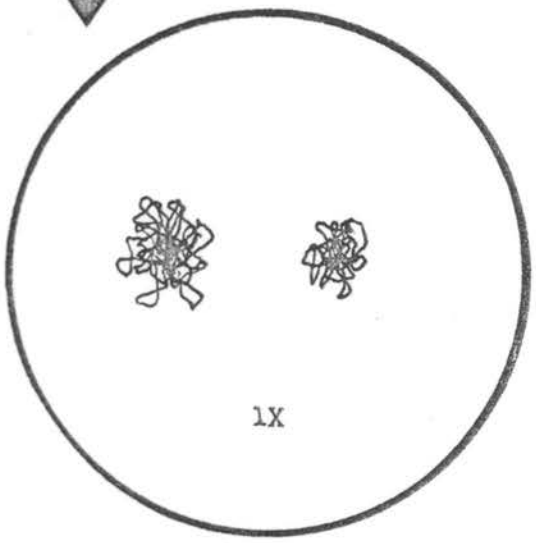


Fig. 2 Spherical blastocysts reshaped into threads which tangle.

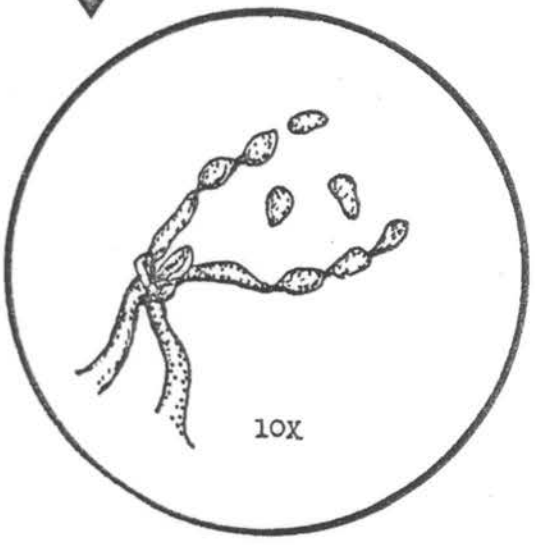
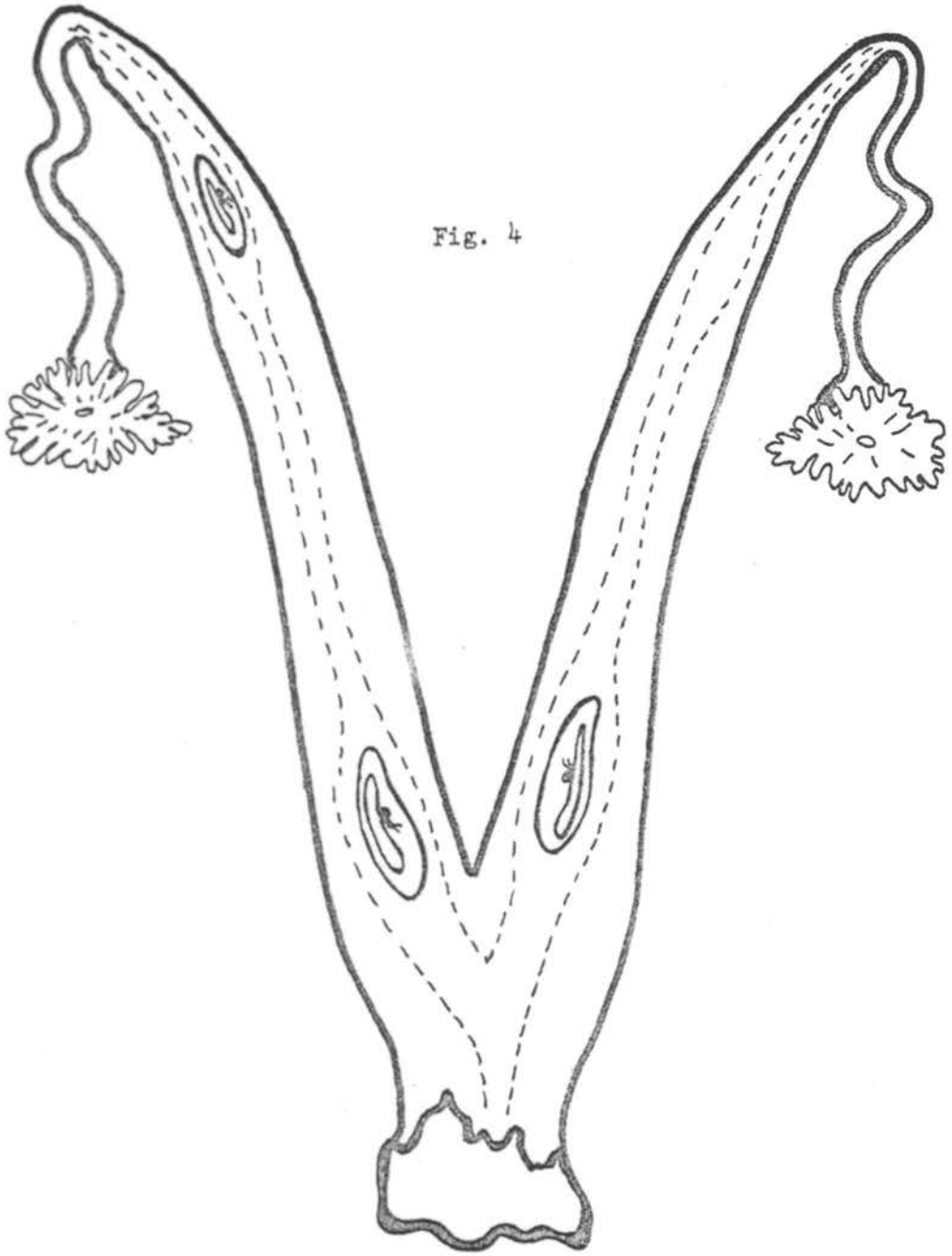


Fig. 3 Some threads knot and bud-off trophoblastic vesicles.

Fig. 4



Three embryos survive the thread stage and position themselves in the uterus as the chorion expands and the allantois begins to grow. Dotted lines show the approximate size of the lumen of the uterus.

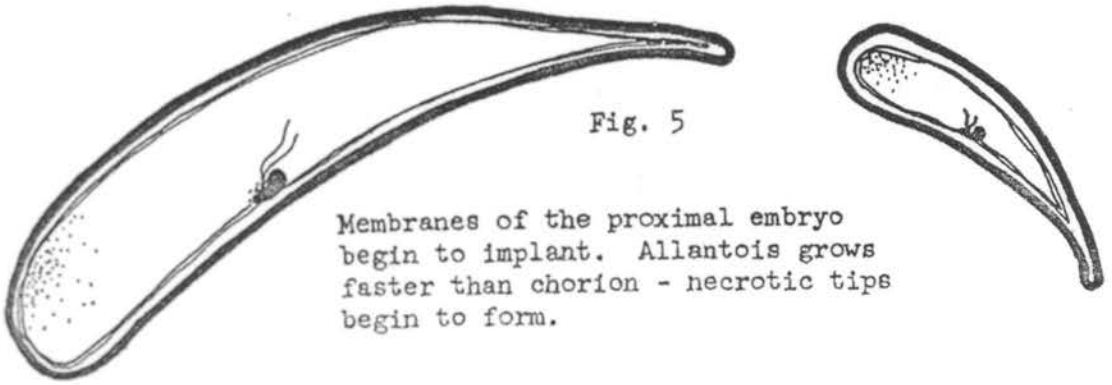


Fig. 5

Membranes of the proximal embryo begin to implant. Allantois grows faster than chorion - necrotic tips begin to form.

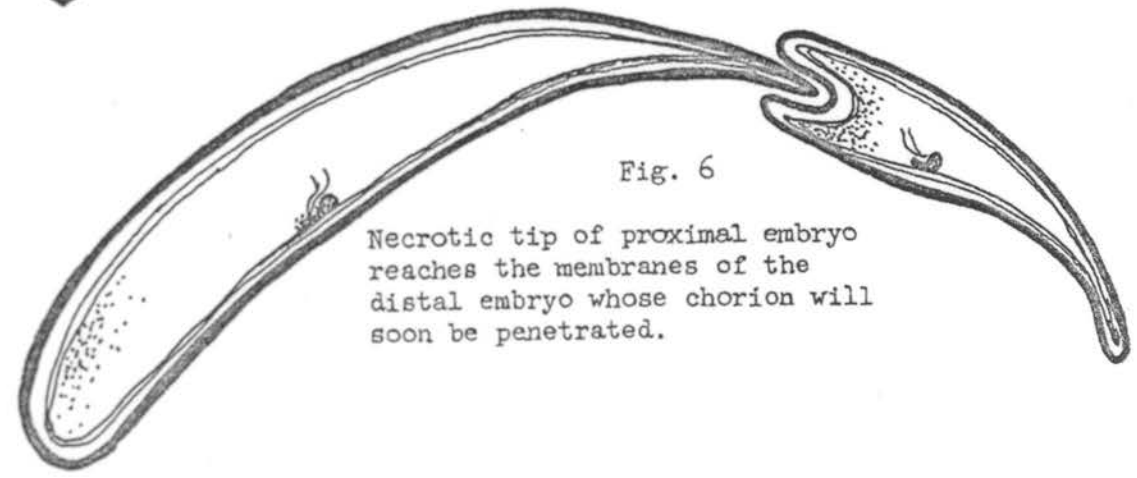


Fig. 6

Necrotic tip of proximal embryo reaches the membranes of the distal embryo whose chorion will soon be penetrated.

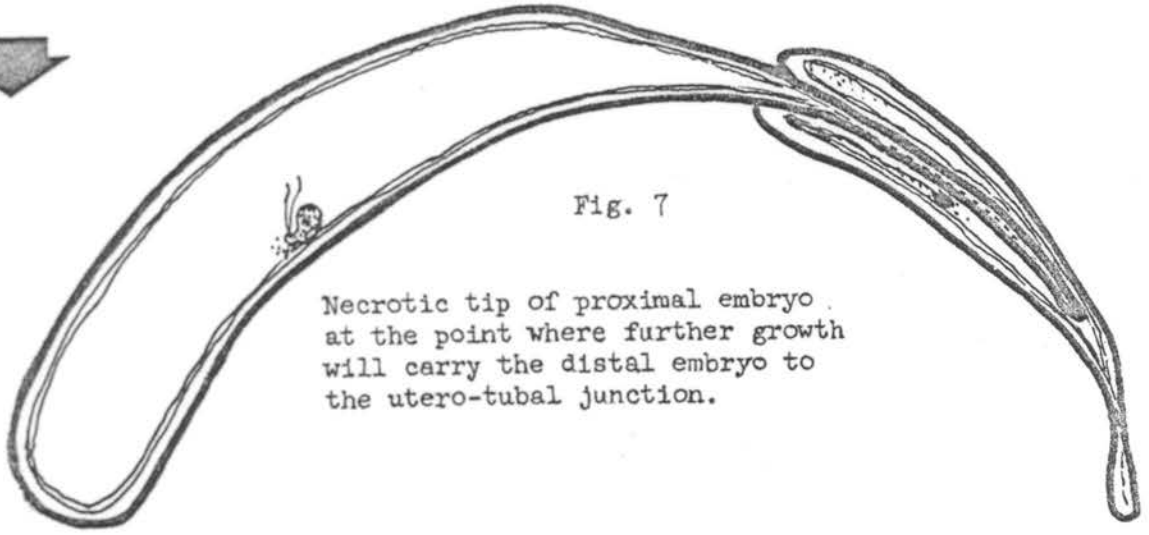


Fig. 7

Necrotic tip of proximal embryo at the point where further growth will carry the distal embryo to the utero-tubal junction.

Chorion

Allantois

Literature Cited

Asdell, S. A. 1964. Patterns of mammalian reproduction. 2nd ed. Cornell Univ. Press, Ithaca, New York. 815 pp.

Assheton, R. 1906. The morphology of the ungulate placenta, particularly the development of that organ in the sheep, and notes upon the placenta of the elephant and hyrax. Phil. Trans. Royal Soc., B-Vol., 198:144-215.

Bischoff, T. L. W. 1854. Entwicklungsgeschichte des Rehes. Giessen, J. Ricker'sche Buchhandlung. 44 pp.

Halazon, G. C. and H. K. Buechner. 1956. Postconception ovulation in elk. N. Amer. Wildl. Conf. Trans., 22:545-555.

Hepworth, W. and F. Blunt. 1966. Research findings on Wyoming antelope. Wyo. Wildl. Spec. Antelope Issue. Wyo. Wildl., 30(6):24-29.

Heuser, C. H. and G. L. Streeter. 1929. Early stages in the development of pig embryos, from the period of initial cleavage to the time of the appearance of limb-buds. Contributions to Embryology, No. 109. Carnegie Inst. of Washington, Publ. no. 394:1-29.

Hoover, R. L., E. E. Till, and S. Ogilvie. 1959. The antelope of Colorado. Colo. Game and Fish Tech. Bull. 4. 110 pp.

Mitchell, G. J. 1965. Natality, mortality and related phenomena in two populations of pronghorned antelope in Alberta, Canada. Ph.D. thesis, Wash. State Univ., Pullman. 111 pp.

Mossman, H. W. and I. Judas. 1949. Accessory corpora lutea, lutein cell origin, and ovarian cycle in the Canadian porcupine. Amer. J. Anat., 85(1):1-28.

Nalbandov, A. V. 1958. Reproductive physiology. W. H. Freeman and Co., San Francisco. 271 pp.

Orisini, M. W. 1962. Technique of preparation, study and photography of benzyl-benzoate cleared material for embryological studies. J. Reprod. Fertil., 3:283-287.

Strahl, H. 1906. Die Embryonalhullen der Sauger und die Placenta; in O. Hertwigs Handbuch der vergleichenden und experimentellen Entwicklungslehre der Wirbeltiere, Jena., 1:2-8.

Tarkowski, A. K. and J. Wroblewska. 1967. Development of blastomeres of mouse eggs isolated at the 4- and 8-cell stage. J. Embryol. and Exp. Morphol., 18(1):155-180.

Widakowich, V. 1922. Developpement des membranes ovulaires, sans 'ebauche embryonnaire, chez des trijumeaux de vache. C. R. Soc. Biol., Paris, 87:1043-44.

Wislocki, G. V. and D. W. Fawcett. 1949. The placentation of the prong-horned antelope (Antilocapra americana). Bull. Museum of Comp. Zool., Harvard College, 101(5):548-558.

Discussion

Beale: Can you formulate any hypothesis in your study here on how nutrition prior to breeding might effect the implantation of these embryos?

O'Gara: I don't think that nutrition prior to breeding would have the effect in the pronghorn that it would in something like the sheep because you've got this great excess of potential fetuses. If, in fact, nutrition would reduce the rate of ovulation, it could cut it from 5 to 2 and I think you'd still have the same number of embryos available for implantation. Sure, if you got the doe starved to death, or something, but I mean under normal range conditions.

Beale: This would fall in line with some of the work in New Mexico, wouldn't it Parry?

Larsen: We have a little something on that - not nearly as scientific.

O'Gara: Is it in the later stages than this?

Larsen: Yes. Generally, about four months or something like that, but it was a special collection because of very, very poor body condition during the breeding season, and this was a supplemental thing that I'll talk about a little bit, but we didn't notice a reduction because these females and males both were in emaciated condition during breeding season so we made some winter collections to see how this apparently may have reduced the success of the breeding season, and it apparently didn't do so. Mortality might come later because of starvation.

Wishart: What are your theories on the super numerary corpora?

O'Gara: Well, I showed where they came from but if you're asking why, then this gets into anybodys guess. I really feel that the pronghorn had litters of young in fairly recent times. Now as you all know, there were lots of kinds of pronghorns in North America in fairly recent times, geologically speaking, and most of them simply didn't make it in competition with the bovids and cervids that came in from the Old World. Now this one long-legged prairie runner really didn't get any competition in from the Old World. There were no small grassland or prairie animals that came in. I really feel that if gazelles, saiga antelope, something like this had made it across, we probably wouldn't have pronghorns today, but this may have been a time also when predation and other stresses were put on these animals, and all of a sudden precocious young, ready to get up and run (that would outrun a man in a day or two) we're talking about here, had a great survival value and this is very short term evolution. This probably came about in just a few thousand years instead of a few million years, and this may be the route the pronghorn took to go to a precocious young. This is off the top of my head.

Larsen: Do you have any information on the endocrinology of these corpora lutea? Do they seem to persist and have an endocrine function, or only perhaps comparing to the two fetuses?

O'Gara: They all persist and you can't tell a bit of difference in them. Of course, there is no way - it isn't something like the elk where you have a post-conception ovulation, so this one corpora is really younger than another one. These are the same age, ovulate at the same time, they're sustained by hormones from the uterus, and they are identical. There is no way of telling which is the corpus luteum of pregnancy, or anything like this and I think in the pronghorn the corpora lutea are important right up to parturition. Now you go to almost all of the farm animals and cervids and corpora lutea tend to develop very rapidly and plateau and sometimes regress a little before parturition. The pronghorn grow right to the day the fawns are born, according to my collection.

I had an increase in size and a very rapid regression after parturition.

Larsen: Did you find it necessary to section, or can you count corpora lutea do you think, by external count?

O'Gara: Well, I usually slice these with a razor blade. I just took a fixed ovary and sliced them in about 1 mm. thick slices, so you could open them like a book and using the ovarium as the back of the book. Now this is for rough work, but I mean you can tell almost everything you can by microscopic sectioning.

Bill Hepworth: Bart, I just wanted to ask you to give your thoughts on whether you think this selective adaptation that occurs here in the positioning of the embryos appears as a chance thing, or you've indicated that ovulation takes place approximately at the same time. Is there any adaptation that you think is important in this respect or is this whole thing chance?

O'Gara: I doubt it very much, Bill, and for this reason. As I said they ovulate at one time. I've taken 3 or 4 does now that bucks are chasing - they're just ready to breed (the bucks aren't very happy about it), but they have just ovulated. They're bleeding. You've got a nice little stream of blood from each stigma. There's no doubt about these things ovulating simultaneously. At this time, with all of these big mature Graafian follicles I think the estrogen levels are very high in these does, and I don't know if any of you have ever done it, but you knock a doe down, and if you've got her uterus exposed within 5 minutes it's pumping and moving and you've got peristaltic and anti peristaltic actions really pumping around. This is reduced by the end of the thread stage, but there is still quite a bit of action there and I think the uterus pumps these things around and distributes them. I don't think there is any reason that one embryo in utero is in any better condition than another. I think they 're positioned by the tract. Now, this again is thinking. I'm not guaranteeing it.

Hnatiuk: You've never experienced two sets of corpora lutea - in other words, large and small, perhaps indicating two ovulations in one rut?

O'Gara: Once. I had told the fellows on the Bison Range I wanted to get a doe right after a fray. I really wanted to shoot one right out from under the buck, but could never quite do it. One night one of the fellows called me and he said that evening just at dark he had seen a doe and this doe and buck were over on the opposite side of the Refuge from where the pronghorns usually are so that we shouldn't get them mixed with any others. She acted like she was just ready to breed. She'd let the buck mount and just about the time he was ready to penetrate she would step out a step or two - she was ready. So we rushed up there just at sunup the next morning and there were the buck and doe looking real contented by the pond, shot the doe, and when I opened her up she had five bloody ovulations inside. Three on one side - I flushed the oviduct on that side and got the three uncleaved ova. I sectioned the other side and found two ova. I sectioned the utero-tubule junction - there was no sperm there, but I sectioned a little piece of the cervix and there was sperm there. It was pretty obvious she was bred the night before, and she also had four fairly well-developed corpora lutea. These looked like about two to three weeks corpora lutea. There was quite a bit of connective tissue in them. I think they were beginning to regress, but for some reason this animal had apparently ovulated some two or three weeks before and not become pregnant. Now I flushed that uterus - I really worked it over, I strained all the flushings, put them through separatory funnels and dyed them and everything else and there was just nothing there, so it

was kind of odd. They'd just trapped - I think most of those does went to Kansas - and then I'd just collected about 24 does and we had about a 2 to 1 ratio bucks to does on the range in just a small place. I find it hard to believe that that doe could have gotten through a regular estrus-cycle without being bred, but if the cycle of the previous ovulation was two to three weeks earlier, it would have put it that much earlier than the normal breeding time, so it may have been a silent ovulation like cattle undergo. Physiological without psychological.

Hnatiuk: I was just wondering, because I think I've noticed this in two or three females that we've caught during the late October season. I sort of suspected this type of thing.

O'Gara: Well, I would think in a hunted herd or a dispersed herd or something, there would be a chance of a doe getting through without getting bred and then you'd have this condition.

A SIX YEAR STUDY OF ANTELOPE PRODUCTIVITY AND SURVIVAL IN SOUTHERN NEW MEXICO

by
Parry Larsen, Game Biologist
New Mexico Department of Game and Fish

New Mexico has antelope herds scattered statewide but the most important continuous populations inhabit the short grass plains of the eastern one-third of the state. In the southeastern corner of the state we have a series of sandhill areas characterized by vegetative types such as mesquite, shin-oak, sand sage, and mixed grasses. These intergrading habitat types occupy approximately 6,000 square miles, and at least portions of the sandhills formerly supported thriving pronghorn herds.

During recent years these sandhill antelope herds have been raising fawns to weaning age at a rate consistently much lower than antelope in other sections of the state. July aerial survey data pooled from all sandhill areas, for the five years preceding 1963 show an average fawn:doe ratio of 27 per cent. Survey data from antelope herds on adjacent upland short grass plains in southeastern New Mexico, for the same period, show an average fawn:doe ratio of 79 per cent. Obviously, we have year to year fluctuations in pronghorn rates of increase in all our herds, but a comparison of these longterm averages for the two basic habitat types, seems clearly to indicate a chronic net productivity problem in our sandhill herds. These general reproductive failures have resulted in deteriorating populations, which furnish only occasional light hunting. A study was begun in July 1963 to isolate and measure the relative importance of various factors responsible for the decline in net productivity. In this paper, I will summarize some of these investigations and findings. I should point out that I have not been working personally on these studies for the last three years, and only recently inherited the reporting responsibility, so I am lacking much of the empirical knowledge of the latter phases of this project.

I have a few color slides which will give you an aspect of the general topography and vegetative types, as well as familiarize you with the three study areas we will be talking about.

NARRATIVE OUTLINE

Slide No.		Extent of Type:
1.	Location of sandhills type, LE,Mesa, PAC study areas.	6,000 Sq.Mi.
2.	Mesquite dominant on unstable sand, blown out to barren hard pan. Only gets transient antelope use.	20%
3.	Mesquite on stable sand, co-dominant with sand sage, or shin-oak. Forbs may be seasonally abundant, and these sites get considerable antelope use.	20%
4.	Oak dominant, with some sand sage, also a good forb producing type, except during drought.	10%
5.	Oak, on semi-stable dunes. Good dropseed cover.	25%
6.	Dropseed dominant on semi-stable dunes.	20%

7. Same as 5 and 6, but on these large deep sand areas, where ranch water is less available, we built a few of these watering units about 15 years ago. Also good lesser prairie chicken range.

8. Tobosa swales, large low flats, few forbs except after rains. Antelope do use these considerably as loafing areas, etc. 5%

9. Tobosa swale, flooded. Form several large playa lakes following run-off, long lasting. 5%

10. Antelope examination for reproductive physiology, disease, and parasites.

11. Coyote food habits examination.

The early stages of our project were designed to reveal possible physiological deficiencies of the sandhill antelope. As a primary study area we selected the LE Ranch, a private land ranch of approximately 200 sections. In order to make comparative studies on an antelope herd reproducing at a satisfactory rate, we set up the Mesa Control Area, about 40 miles to the northwest in the rolling short grass plains.

Our initial efforts were directed at closely observing the September breeding season on both areas. We distinguished breeding herd size, buck:doe ratios, intensity of rut activity, and other general behavior characteristics. No significant differences between areas were apparent. Subsequent examination of female reproductive tracts verified our observations that the breeding season was seemingly normal and highly successful.

To obtain these basic reproductive rates, we held special antelope hunts on both study areas the last weekend in October. At the mandatory check stations, we had the assistance of U.S.D.A. parasitologists and veterinarians. Organ and tissue specimens were collected here and prepared for laboratory examinations. Approximately 80 blood samples were examined in the U.S.D.A. labs for Brucellosis and Leptospirosis. A series of uterine and preputral flushes were tested for the presence of the Trichomonas flagellate. All these tests for possible abortive agents were negative. Bacteriological cultures prepared from uterine smears of 40 does revealed no widespread pathogens of suspected importance. Similarly, detailed parasitological searches revealed nothing of suspected significance in imparing antelope vigor or fecundity.

Our detailed analysis of the reproductive tracts from the 40 breeding age does killed on these hunts was conducted in the Veterinary Medicine laboratories at New Mexico State University. We made corpora lutea counts, fetal counts, weights, and measurements. The LE study area does had a mean fetal rate of 1.89 compared to 1.95 for the Mesa area does. These comparably high rates of conception suggested that there was no basic reproductive deficiency in the sandhill antelope herd, at least during the first month or so of the reproductive cycle. Similar tests scheduled for the second study year were planned for the end of November, to provide information on a stage where the average fetus was entering the third month of gestation. On this second hunt, only six adult females were killed, but their mean fetal rate, 2.00, was again comparatively high.

As a secondary objective, during this period, we had an opportunity to learn something of the reproductive performance of pronghorn under severe nutritional stress. The Mesa area suffered a serious year-long drought during 1964, and the antelope were emaciated during the normal breeding period. We collected nine adult females that winter, conducted our standard examinations, and recorded an average fetal rate of 1.67. The reduction in fetal implantation rate was due solely to the presence of one old permanently barren, abnormal female in the small sample. The other does were carrying twins, apparently well developed at about the average rate, during mid-gestation. This was a most impressive performance, considering the physical condition of the herd during the breeding season. It does agree however, with information in publications on reproductive physiology, which indicates that most abnormal fetal development, due to inadequate maternal nutrition, occurs during the late gestation stages.

Because a similar nutritional deficiency was suspected as a possible factor in our sandhill antelope productivity problem, we had, since the inception of the study, conducted spring and fall vegetation density sampling on both study areas. This seasonal measurement of frequency of occurrence of desirable antelope forage, together with the four rain gauges on each area, we felt gave us an adequate evaluation of range conditions as we suspected they most influenced the reproductive performance of the animals. As the study progressed, we tried juggling lots of data to relate fawning success to various combinations of rainfall and/or range condition estimates. I must confess that we were unable to develop any close correlations which would allow us to accurately predict the level of fawning success, based on our estimates of range condition. Certainly the two are interrelated, and we often blame a bad fawn crop somewhere on a dry spring, etc., and I guess this is justified. But we have not evolved to a point in our understanding of other factors involved, where we can state that an average or better forage year will result in a good fawn crop.

During the first two study years, we attempted to watch closely the fawning period to determine approximately the number of fawns born, their fate, and to hopefully identify some common source of mortality.

This was a pretty big job for one man and these efforts were only partially successful. Combining this information with intensive aerial survey data, however, enabled us to compare actual productivity with the potential indicated by our reproductive tract analysis. These life equations strongly suggested that our major source of loss lie in the period from very late gestation through the first week or so of the fawns life. Experience had taught us that one man could not make sufficient observations during this limited period to isolate the mortality factors, so we decided to try the crew approach. In mid-May of 1966 we moved a large trailer onto the north end of our LE study area, and several of the other game management biologists joined in making daily observations well into June. We lived on the area and tried to stagger our scheduling so that eight men were present on the study area each day. Each operated in a specific zone, and we attempted to individually identify isolated heavy does. As the parturition season progressed we began visually pairing-up the does with their fawns, and watching them for extended periods. We assigned code numbers to these groups and our crew met daily to keep track of movement into other zones, etc. We did not tag or mark any fawns and handled only a very few newborn ones for weighing or pictures, etc. Generally we tried not to interject ourselves into their normal behavior patterns, other than the speculative disturbance to the does of our setting up observation points perhaps 200 yards or more distant.

To greatly simplify and summarize two years studies of this kind, I would have to say that we recorded a large volume of individual behavior information, but nothing of repeated significance which would suggest a common source of fawn loss. We located no weak or abnormal fawns, we knew of a few lost or abandoned ones, and we documented a few positive instances of coyote predation. On the other hand we observed many futile hunting attempts by coyotes, and several successful defenses by doe antelope. Of course, a basic shortcoming of our technique was the absence of night observations, when coyote activity probably is the greatest, so we are not yet truly aware of the nature of this interspecific relationship.

Another adjunct of these observational studies was to transplant to the LE study area over a three year period, about 40 does from areas with generally high fawn crops. We attempted to determine if these black collared does had a fawn survival rate significantly different than the native herd. These efforts had only limited success, as we lost many of the marked females due to emigration, and by the time of the July aerial surveys doe and fawn herds were so mixed that it was usually impossible to attribute fawn survival to individual does. During the ground surveys, we were able to make enough observations of isolated collared does to indicate that their fawning rate was generally about the same as native does. Thus, another possible method of demonstrating an inherent reproductive weakness of the endemic herd failed to suggest any substantial difference.

For a long-term study concerned with antelope fawning, it may seem from my account so far that we virtually ignored the possibility of serious coyote predatory affect. It was not until after two years study assured us that we were getting satisfactory breeding and conception rates and low net productivity rates that we began to examine the coyote influence. Through our entire project no predatory animal control has been carried out on the LE primary study area. We have obviously watched the LE coyote situation with great interest and conducted spring track counts around water to suggest relative population levels. These sandhills support a large rodent and rabbit biomass, and are generally excellent coyote habitat. Our population seemed to vary quite a bit over a five year period, and was estimated from a moderate 3/4 per section to a high of approximately 2 1/2 per section. On the LE area we attempted to be aware of the coyote and buffer species population trends and to record any predatory effect. Our observations as previously described only dealt with a portion of the possible interspecific relationship. As an alternative method of estimating coyote impact we decided to select another similar study area, subject it to intensive coyote control, and perhaps learn by reaction the seriousness of coyote predation upon fawns.

Our PAC area of about 250 sections, lay in the sandhills to the east of the LE study area. It was closer than we liked, and we undoubtedly got some crossover effect, but we tried to minimize this. Our coyote control was carried out from December to April and consisted of about ten 1080 stations, two trappers working intensively who also placed many strychnine drop baits around carrion draw stations. Our estimated removal that first year was 359 coyotes. Both the LE and PAC study areas showed an increase in antelope survival rates that next summer, but there was a 14 percent greater increase on the coyote control area. We tentatively concluded that our manipulations were productive, and looked forward to a second year of more intensive studies. We were thrown a real curve, as a major oil discovery was made on our PAC study area. By the next spring there had been severe human and vehicle disturbance over much of this

area with over 200 test sites and producing wells being developed. We achieved a further reduction in coyotes, but there was also quite a decrease in the antelope population due to emigration. Both study areas had a lower fawn crop this year, but the control area percentage fell below that of the LE's. The third year was characterized by a rapid increase in rabbit and rodent populations, and coyote numbers on both habitats in spite of our continued control efforts on the PAC area. The control area again showed a decreasing total antelope herd due to emigration, but produced a fawn crop 14 per cent greater than the LE area.

At this point we are in the process of evaluating some of these perplexing results, and I suspect many of you have been in similar situations and know it's uncomfortable. In ruminating over our various efforts, and the results, I come up with about as many questions as I do answers. Generally I feel we did a good job of investigating the physiological aspects of the antelope reproductive cycle. By eliminating many possible sources of reproductive failure, we were led to a narrow segment of the yearly cycle. Here I feel we concentrated an adequate amount of manpower, and yet the mortality factors were operating during the same period as our observations, without our being able to identify or measure them. Perhaps our techniques were incomplete, but I am not sure how they could be improved. The second year of the crew surveys, we considered some form of telemetry to determine the rate of individual fawns. This raised the questions of obtaining an adequate sample, and the effect of this substantial intrusion into the normal behavior and survival. One serious shortcoming in our aerial survey methods is the classification of yearling does with breeding age adults. In evaluating our survey results, we try to make some reasonable allowances for an estimated number of yearling females, in converting from the "crude fawn crop" to an "adjusted fawn crop". However, until we can accurately determine the number of yearlings in the doe herd, a detailed analysis of annual net productivity fluctuations will be subject to errors.

Our efforts to determine coyote predatory impact on antelope also suffered from technique limitations. We don't know how to accurately census coyotes, much less determine population changes due to control measures. Coyote predation is a secretive act and probably much of it occurs after dark, and we had little success trying to observe it directly. We tried some indirectly. We tried some indirect methods, also with limited results. We put in ten hours of helicopter time, flying over the sandhills around daylight, hoping to collect coyotes with a shotgun after their nights hunting, and examine their stomachs. This proved futile, and we do not know why. In other habitat types we have been able to successfully hunt coyotes from a chopper, but in these sandhills they either hid or denned up. We examined 215 stomachs taken from coyotes trapped during the winter-spring, and got some fair information on food habits, but of course, this was before the antelope fawns were on the ground. We tried collecting and examining fresh coyote scats during the fawning period, but could not get enough for a representative sample.

Our efforts to greatly reduce the coyote population on the PAC area seemed to be working fairly well, however, even a 250 square mile area was too small an area to treat as a distinct unit. Only scattered coyote control by private ranchers had been practiced surrounding the PAC area, and considerable influx into the sandhills, especially during the denning season seemed to occur. This plus probable natural coyote population fluctuations and extreme changes in buffer species biomass, made it difficult to accurately determine the effects of our coyote control upon antelope survival. The oil field development finally des-

troyed any meaningful evaluation which might have been made of this ecological manipulation.

We have in the course of this study made several other tentative investigations into various aspects of antelope life history and these interspecific relationships, but the ones I have described have been our main efforts. Some of our studies have been quite productive, and others have led into blind alleys. Before we can avoid the latter in future studies, substantial improvement will have to be made in our various census and habitat evaluation techniques.

Discussion

West: In your introduction you mentioned a 27% kid crop and a 79% one. Was this between the A and B?

Larsen: Yes, this was a 5-year average of the 5 years prior to the time that we decided to start our study. We knew that the fawn crop was low in the sandhills so we took five years previous aerial survey data which has the same errors we talked about, but the sandhill productivity was 27% and that tight lands 40 miles away was 79%.

West: Was there noticeable difference on the sandhills during the period of your study?

Larsen: Yes, we got a low of about 13 or 15% and a high of almost 50%, in productivity, and in trying to do something like I mentioned about comparing long-term vegetative and rainfall records with annual productivity rates, we seemed to get a high one year and a low the next year, not necessarily a low of 13 to a high of 51, but we did get a zig-zag effect that seemed to be this yearling (increment) contributing quite a bit to it - at least confusing the true fawn crop, but we did have variations in both and perhaps we may even have had one year where the sandhills - if they went up to 50 or 51% may have been equal to or a little higher than our tight lands. I don't recall that to be the case, but it could have happened. Generally, a poor year on the tight lands was still better than a good year on the sandhills.

Robertson: You commented that you had trouble catching and killing coyotes during the fawning period. Did you ever consider having hound men come in and hunt this area? This is real popular in our portion of the sandhills up there and these guys can catch coyotes.

Larsen: As a matter of fact, this ranch foreman on the L E came from Oklahoma and he'd been a greyhound man and he had chased some prior to the study on the ranch but we didn't consider it as a method to try and greatly reduce a coyote population which may have 300 or 400 coyotes in the sandhill area. Now maybe it would work. You've had experience with that, and we didn't use coyote calls either, because you know you can get some coyotes that way, but do those kind of people give up when the coyote population gets low or cut in half, does it then become unproductive for them, so we didn't consider them. It might have been another thing we could have tried.

Robertson: That wasn't exactly what I had in mind. I mean as far as stomach sample analysis to find out whether your coyotes were actually feeding on antelope.

Larsen: No.

Beale: Did you do any trapping as a means of collecting any stomach samples during the fawning time?

Larsen: No, because we'd been working all winter to reduce the coyotes and we got them as low as we could by three months work - poison, traps and

everything else, and at that time our feet were moved off of the coyote control area and we were doing our daily observations on study areas. We flew the control areas at the same time.

Compton: The coyote control area and your control area were both in the same type as far as antelope country?

Larsen: Yes. They were, like I say, too close together, because if we poisoned some coyotes that belonged on the study area, because if they moved 5 or 10 miles in a night's hunting we got some cross effect or some drift in, but we tried not to place poison stations right on the edge of the control area where it would be within 2 miles of the study area. We tried to keep that kind of work in the interior and maybe just trap right along the edge. As a matter of fact, Mayo's pictures that you saw were in the coyote control area. I would say it was essentially identical to the study area.

Compton: You were working with the same antelope production situation?

Larsen: Yes. That is the main reason we didn't move farther away, because on the east side we got to the cap rock up on top - a couple hundred feet up in the air - is the tight lands, and that's that big horseshoe you saw in the sandhill vegetative types, so we could move farther away. We would have liked to, but we had, as near as it was able to evaluate them, identical conditions on the two areas.

EYE LENS WEIGHT VERSUS JAWS IN AGE DETERMINATION OF ANTELOPE

by
J. M. Hnatiuk, Wildlife Research Branch
Saskatchewan Department of Natural Resources
Saskatoon, Saskatchewan

ABSTRACT

Antelope age determination was done on the basis of jaws and eye lens weights. Specimens of natural populations were obtained at game check stations during the one week late October 1967 and 1968 hunting season. The results obtained by using the two age determination techniques were compared. Results indicated discrepancies between approximately one third of the samples. Possible reasons for the discrepancies are given and suggestions for reduction of these are included.

ACKNOWLEDGEMENTS

I wish to thank all sportsmen who volunteered their time to report at the game check stations with their bagged antelope. To those who assisted in the operation of the game check stations and collection of the antelope specimens, I express my sincere gratitude. I express my appreciation to Syd Barber, a part-time student assistant, for processing all the eye lens. Many thanks are extended to Mr. D. A. Blood, Chief Ecologist, and Mr. G. W. Pepper, fellow worker for critically reviewing the manuscript.

This study is part of the research being done in Southern Saskatchewan on pronghorn antelope by the Wildlife Research Branch, Saskatchewan Department Natural Resources of which I am an employee.

INTRODUCTION

Management of natural populations, such as those of the pronghorn antelope (Antolocapra americana), requires knowledge of population growth rate and subsequent density variations. These are dependent upon natality rate, mortality rate and age structure. To obtain this information it is necessary for the wildlife manager to determine the age of individual animals. Information on age structure in a natural population is extremely difficult to obtain and in spite of much research in this field no flawless age determination has been developed.

This is because age determination criteria must satisfy several requirements if they are to be applicable to members of different populations in different habitats. An age character should not be affected by variables such as temperature and nutrition. If it is subject to wear, the rate of wear should be uniform in different individuals and populations, regardless of habitat. Also, the criteria used should be longlived and must change at a predictable rate throughout the life of the individual. Age-determination criteria which satisfy all of the above requirements are unavailable for big game animals. It is, therefore, necessary for the game manager to select those techniques that best satisfy his needs and the above requirements. He should also continue research and improve the techniques that are already available for each specific situation.

With this in mind the present study was initiated. Its purpose was to apply the eye lens and tooth eruption and wear age-determination techniques to natural populations of pronghorn antelope. A further objective was to evaluate and compare the results and determine what future procedures if any may be necessary for improvement of existing techniques and to offer suggestions for new ones.

Past experience at game check stations showed that lower jaws of adult male animals were frequently unavailable because of trophy values to the hunter. This study was thus initiated to apply the eye lens age-determination technique to pronghorns that were obtained at game checking stations and compare these results with the results obtained from jaws collected at the same time. It was felt that the eye lens technique, if satisfactory, would be adopted by our antelope management program because of the ease of obtaining unbiased samples of killed animals at the check stations.

LITERATURE REVIEW

Dow and Wright (1962) developed a very useful technique when they used the lower jaw of antelope to observe changes in mandibular dentition associated with age. This technique was used by the author in the present study. Severinghaus (1949) used tooth development and wear as criteria of age in whitetailed deer (Odocoileus virginianus). Robinette et. al. (1957) proposed an age determination system based on the relative amount of wear on molars beyond the age of eruption. Similar techniques have been used on whitetailed deer by various workers including Ryel et. al. (1961), on elk (Cervus canadensis) by Quimby and Gaab, (1952), and on moose (Alces alces) by Passmore, Peterson and Cringan (1955) (in Peterson 1955). Similar procedures have now been applied to a wide variety of species of big game.

Presently cementum annuli are being used successfully to determine age in some big game animals. McCutchen (1969) determined the age of pronghorn antelope from cementum annuli by using a stained sagittal section of the first permanent incisor. No information on the application of this technique to unknown age animals is presently available. For determining age, Erickson and Seliger (1969) used stained transverse sections of incisors in mule deer (Odocoileus hemionus) while Gilbert (1966) used annuli in the cementum of the first incisor in whitetailed deer. Keiss (1969) used cementum annuli on stained sections of first incisor roots for age determination in elk, while Sergeant and Pimlott (1959) and Pepper and Runge (personal communication 1968) used sectioned incisor teeth in moose.

The use of eye lens weight, because of its continuous growth throughout life, has been investigated by many workers as a criteria for age determination. Lord (1959, 1961) found that the lens served as a reliable age indicator in cottontail rabbits (Sylvilagus floridanus) and gray fox (Urocyon cinereoargenteus). Kolenosky and Miller (1962) described the rate of growth of the lens of the eye in pronghorns and established an age index based on lens growth and size. Mitchell (1965) determined age of pronghorns by using eye lens weight. He noted that eye lenses increased in weight with advancing age in both males and females but found considerable overlap in lens weight in ages above the 1½ year old classes.

Friend (1965, 1967, 1967a, 1969) has recently contributed valuable information to the eye lens technique. His recent research on variations and variables, the relationship between lens weights and variation in diet in laboratory rats, and bibliography and listing of wildlife eye lens investigations are some contributions to the eye lens technique. His investigations of the relationship between eye-lens

weight and variation in diet indicated that there was no correlation between eye lens weight and body weight for rats of similar age class. A later study of white-tailed deer on nutrition and eye lens weight in New York (Friend and Severinghaus 1967) indicated the eye lens weights were consistently lower from samples obtained from an area with poor food supply. An important difference is pointed out, however, in that rats were placed on a lower level nutrition diet prior to weaning or even during fetal development. Under these circumstances the above investigators felt that lens weight may be useful in developing indices to game range conditions in relation to deer population density when age can be accurately determined by criteria other than lens size. They also noted that the nutritional status of the animals must be taken into account in any attempt to develop an index to age based on growth size of the eye lens.

METHODS AND MATERIALS

The whole eyes and lower jaws were obtained at five antelope check stations during the first two days of the special one week hunting season in the later part of October 1967 and 1968. These stations were located at Saskatchewan Landing, Gull Lake, Maple Creek, Cadillac and Leader Ferry in Southwestern Saskatchewan. Upon removal, eyes were individually identified, placed into separate cotton sacks, and stored in 10% formalin until analysis. The majority of eyes were obtained within 8 hours after the animals death. No specimen was in the formalin solution for more than 4 months before analysis.

The procedure used in removing, drying and weighing the eye lens was similar to that used by Kolenosky and Miller (1962). The weighing and drying methods were as follows. After the lens was removed the wet weight of each lens was obtained on a Fisher Mettler electric scale and placed in a Fisher Isotemp oven, senior model, for 72 hours of drying at 65°C. The dried lenses were then removed and immediately weighed. When both left and right lenses were collected, the average weight for each specimen was used in the final analysis.

Jaws were removed, individually identified, and stored until analyzed. The majority of tissue was removed from each jaw to expose characteristics that were used for determination of age.

RESULTS

The combined 1967 and 1968 data of 303 usable lenses and jaws are presented in Table 1. The table shows the range and mean for each age class for males and females separately and for the two sexes combined. Age classification in Table 1 was based on tooth eruption and wear.

When age was based on tooth eruption and wear, male lens weights showed distinct separation only between the fawn and yearling class. Weights of all other age classes (Figure 2) overlapped considerably between adjacent years.

The female segment of the sample showed similar tendencies except in the 1½ and 2½ year class where no overlap occurred. Combining the males and females resulted in overlap of range of weights in all age groups except the fawn and yearling classes. (Figure 2).

The overlap in eye lens weights which occurred when age was determined from

TABLE 1. Antelope dry lens weights (milligrams) by sex, combined and age class. Age based on the use of lower jaw tooth eruption and wear.

	MALES			FEMALES			COMBINED		
Age	n	$\bar{x}$	Range	n	$\bar{x}$	Range	n	$\bar{x}$	Range
0.5(13)*	48	355.1	320.5-400.0	50	359.4	330.5-418.0	93	357.3	320.5-418.0
1.5(25)	48	539.1	498.0-585.0	37	546.9	505.0-578.0	85	543.3	498.0-578.0
2.5(37)	19	626.8	564.5-672.0	29	630.9	579.5-691.0	48	628.9	564.5-691.0
3.5(49)	11	674.6	607.0-738.0	18	687.8	611.0-768.0	29	681.2	607.0-768.0
4.5(61)	11	689.7	633.5-743.0	18	712.7	628.5-762.0	29	701.2	628.5-762.0
5.5(73)	-	-	-	6	735.8	709.0-755.0	6	735.8	709.0-755.0
6.5(85)	1	730.0	730.0	2	733.3	718.0-748.5	3	731.7	718.0-748.5
7.5(97)	-	-	-	4	774.8	754.0-791.0	4	744.8	754.0-791.0
8.5(109)+	-	-	-	1	859.0	859.0	1	859.0	859.0

* Indicates age in months from conception

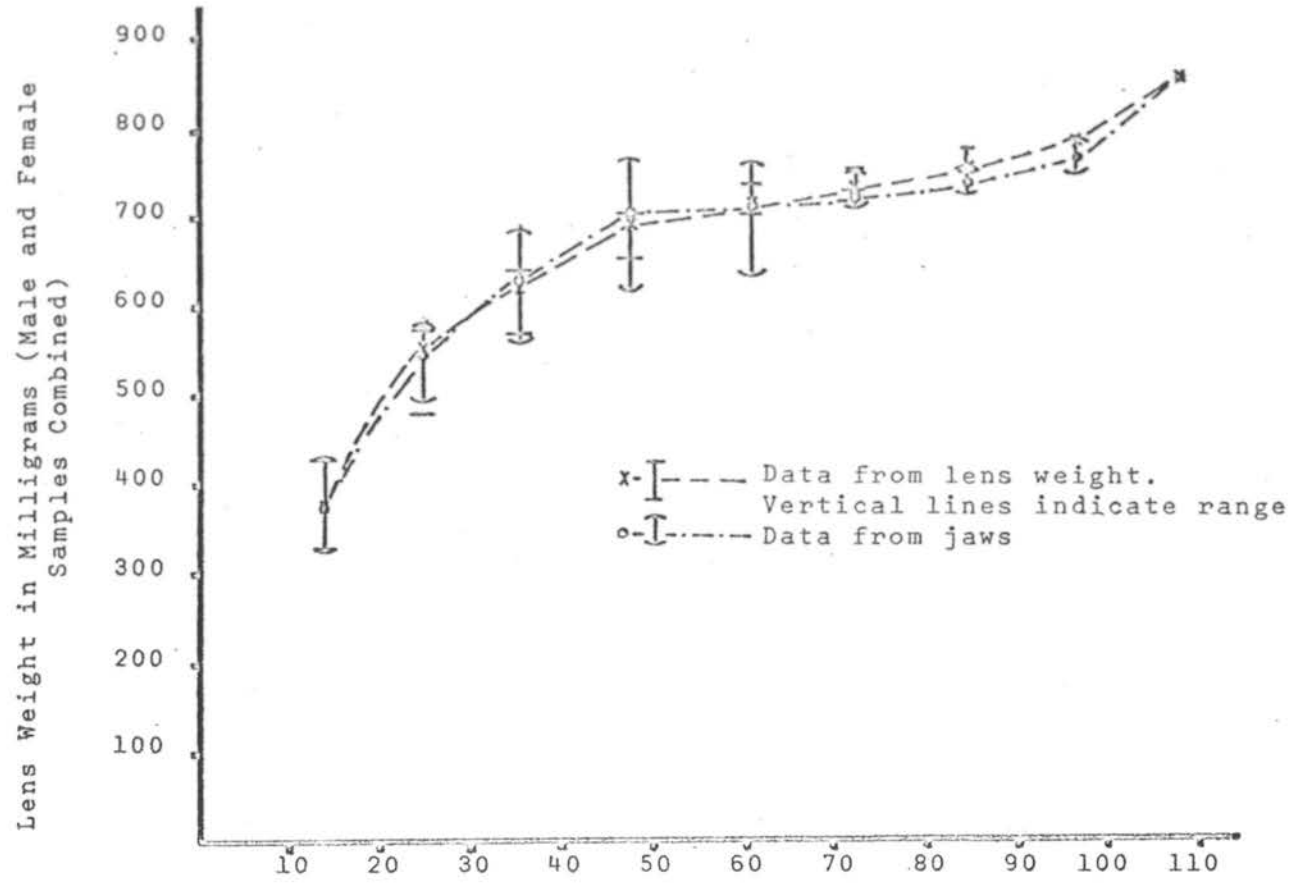


FIGURE 2. Growth curves of the lens of the antelope eye based on mean values for each eye class. The x represents mean eye lens weights as obtained from age determination by lens weights. Darkened circle shows mean eye lens weights as obtained from age determination by jaws, The vertical lines show range of lens weights for each age class.

tooth eruption and wear indicates discrepancies between the two techniques.

Table 2 shows the results when age of animals was based on eye lens weights only. The limits used for all age classes were obtained from Kolenosky and Miller (1962). Eye lens weights without corresponding jaws were included.

Figure 2 gives a graphic representation of the results obtained in Tables 1 and 2.

Table 3 indicates areas of non-conformity between the use of jaws only, and eye lens weight only, in determination of antelope age. It shows that the total per cent difference made in age determination was 29.41. Of this, 5.80 per cent of the males, according to lens weights, should have been one year younger, 4.35 per cent one year older, 2.17 per cent two years younger and 0.17 per cent two years older. Four point two four per cent of the females were classified one year younger and 6.67 per cent were one year older while 1.82 per cent were two years younger and 3.64 per cent were classified two years older.

Additional data in Table 3 show that the 6½ year old class has the highest percentage of discrepancy, but this may be merely a result of small sample size. Age of two of the three 6½ year old animals was determined to be a year older by tooth wear than by eye lenses. The 3½ year class had a discrepancy of 44.83% while the 4½ year class was different 41.38 per cent of the time and 2½ year class was different 31.25 per cent of the time. There were no differences in the fawn and 8½+ year groups. These percentages are based on the number of animals that were in the particular age class and not the entire sample.

The growth curve seen in Figure 1 is of antelope eye lenses as determined by Kolenosky and Miller (1962). They plotted eye lens weights versus age in months. I plotted the combined section of mean eye lens weights indicated in Tables 1 and 2. The figure indicates similar tendencies of the later two growth curves, negative acceleration phase and slower phase discussed by the above authors. It agrees with the concept of the continued growth of eye lens in mammals and shows the later two phases of lens growth. These are the negative acceleration phases from the age of five months to 3½ years and a steady but slower growth rate from 3½ years to death. Samples to indicate the first rapid growth phase, shown by Kolenosky and Miller (1962), from 3 months after conception to 5 months after birth, were unavailable in this study. The lower value in the 6½ year class probably indicates the discrepancy in age determination mentioned previously.

TABLE 2. Antelope dry lens weights (milligrams) by sex, combined and age class as aged by lens weight only. Limits per age class appear at the right as set by Kolenosky and Miller (1962)

Age	MALE			FEMALE			COMBINED			DATA FROM KOLENOSKY		
	n*	$\bar{x}$	Range	n*	$\bar{x}$	Range	n*	$\bar{x}$	Range	n*	$\bar{x}$	Range
0.5(13)#	48	355.1	320.5-400.0	50	359.4	330.5-418.0	98	357.3	320.5-418.0	21	361.6	250-450
1.5(25)	52	538.3	498.0-572.0	40	544.8	481.5-573.5	92	541.6	481.5-573.5	24	551.8	460-575
2.5(37)	25	603.3	578.0-643.5	34	614.5	578.0-643.0	59	608.9	578.0-643.5	15	624.0	575-645
3.5(49)	22	670.2	652.5-686.5	14	673.7	653.5-690.0	36	672.0	652.5-690.0	11	664.4	645-690
4.5(61)	8	706.3	698.5-721.0	27	707.0	690.0-722.5	35	706.7	690.0-722.5	4	712.0	690-725
5.5(73)	9	735.7	726.0-743.0	21	741.2	725.5-755.0	30	738.5	725.5-755.0	3	739.3	725-755
6.5(85)	-	-	-	9	766.5	755.0-784.5	9	766.5	755.0-784.5	2	766.9	755-785
7.5(97)	-	-	-	1	791.0	791.0	1	791.0	791.0	3	794.8	785-815
8.5(109)#	-	-	-	1	859.0	859.0	1	859.0	859.0	1	827.7	815-845

* Includes samples without jaws
\# Indicates age in months from conception.

TABLE 3 Discrepancies when aging by the use of lower jaw and comparing these ages to those obtained by using eye lens weights.

Age	Total classified by jaws		Number and area of discrepancy when classified by using lens weight								Total Males and Females	Percent controversy Males and Females per age class
	Male	Female	Male 1 yr. Below	Male 1 yr. Above	Male 2 yrs. Below	Males 2 yrs. Above	Female 1 yr. Below	Female 1 yr. Above	Female 2 yrs. Below	Female 2 yrs. Above		
0.5(13)*	48	50	0	0	0	0	0	0	0	0	98	0
1.5(25)	48	37	0	0	0	0	0	1	0	0	85	1.18
2.5(37)	19	29	3	6	0	0	0	4	0	2	48	31.25
3.5(49)	11	18	1	0	2	1	3	4	0	2	29	44.83
4.5(61)	11	18	3	0	1	0	2	2	2	2	29	41.38
5.5(73)	0	6	0	0	0	0	1	0	0	0	6	16.67
6.5(85)	1	2	1	0	0	0	0	0	1	0	3	66.67
7.5(97)	0	4	0	0	0	0	1	0	0	0	4	25.00
8.5(109)+	0	1	0	0	0	0	0	0	0	0	1	0
Total	138	165	8	6	3	1	7	11	3	6	Total percent controversy of entire sample	
Type of controversy (percent)			5.80	4.35	2.17	0.72	4.24	6.67	1.82	3.64	29.41	

* Indicates age in months from conception.

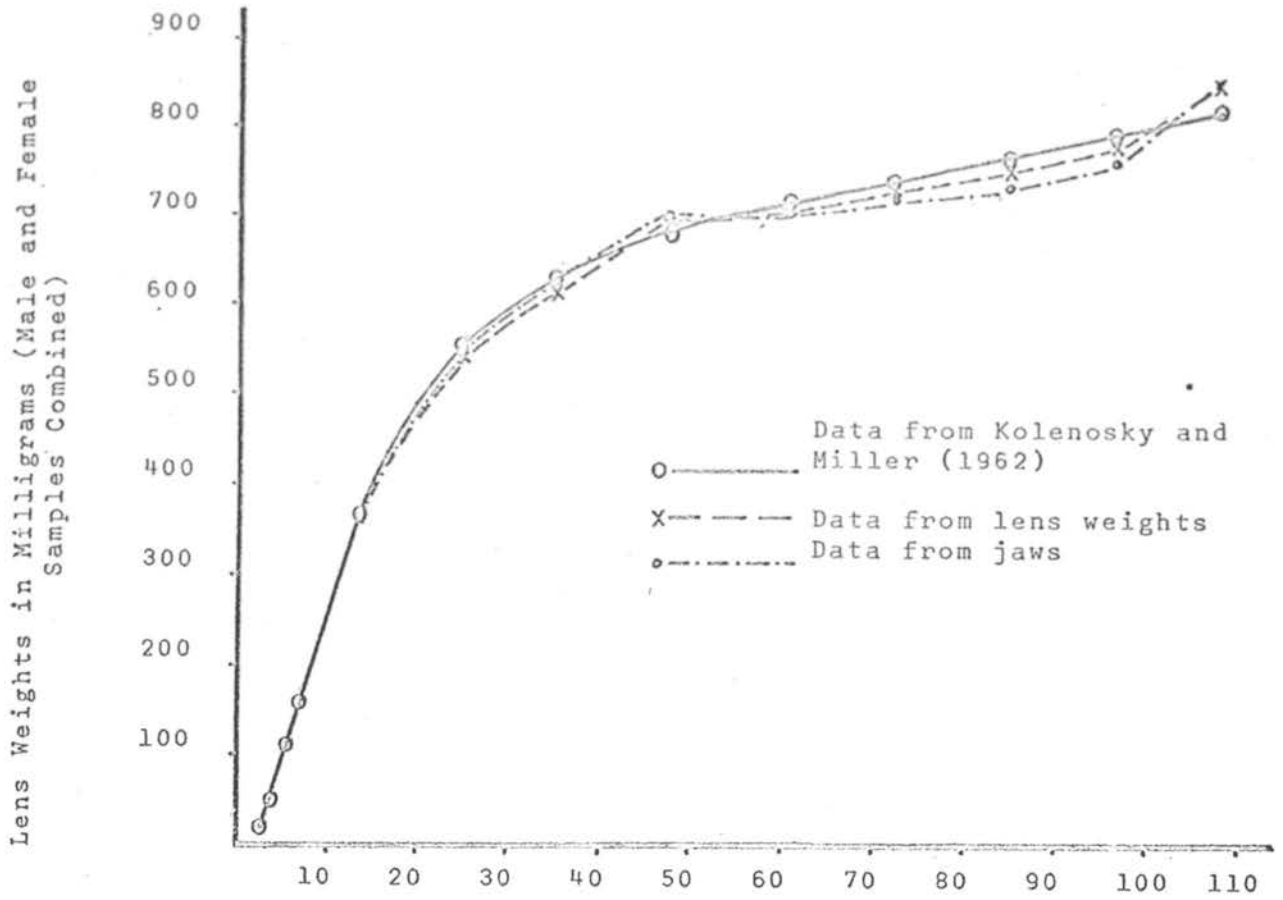


FIGURE 1. The figure indicates the growth curve based on the mean lens weight value for each age class. The solid line is that of Kolenosky and Millar (1962). The broken line represents the growth curve when classification is done by lens weight. The broken line with periods represents the growth curve obtained when classification done with jaws.

DISCUSSION AND CONCLUSION

Data presented in this report indicate discrepancies in age determination of pronghorn antelope by using tooth eruption and wear and eye lens weights. This is not to suggest that both techniques are invalid, but only to point out that variables are present and the need for having known-age animals from specific areas as references.

The author believes that the eye lens technique has potential as an index of age-determination in antelope and could become a useful tool for the game manager. This technique can enable him to obtain more complete information regarding the age structure of natural populations of antelope because of ease of collecting eyes at game check stations would provide a much better sample of older animals than can be done by the use of jaws. Elimination of variables such as irregular eruption of dentition, particularly in the 2½, 2½ and 4½ year age classes. (Dow and Wright) 1962, the abnormal rapid wearing of teeth in animals feeding on sandy soils (Robinette et. al. 1957) and marginal habitat such as is found in the northern limits of their range can be accomplished if the eye lens technique is perfected and a reference collection of known-age animals is obtained.

Dirschl (1963) and personal observations have indicated that antelope in Saskatchewan utilize a much wider range of foods than those in more southern areas. This may be due to the absence of preferred food such as big sagebrush (Artemisia tridentata), (Bayless, 1969) and unavailability of other species such as silver sagebrush (A. cana) when there is excessive snow. The utilization of varied poor quality foods may affect the rate of tooth eruption and wear, and the growth of eye lenses. Consequently, a comparison of data, without a reference collection of known-age animals from the same area may result in controversies as were encountered in this study (Table 3).

Irregular patterns of tooth eruption and wear were also experienced by Dow and Wright (1962). They found that up to 1/3 of 4 1/3 year old hunter-killed animals should have been assigned an age of 3 1/3 years. Similar errors were undoubtedly made in this study.

The use of eye lens weights for pronghorn age determination is not without error and therefore must be done with caution. Friend and Severinghaus (1967) indicated that nutritional deficiencies that adversely affect physical condition of wild deer during the winter, spring, and summer may also retard eye-lens growth in fawns during their fetal period or prior to weaning. They felt that the effect of such deficiencies is heightened where the parent females return to poor winter range year after year.

This may also be a partial explanation of the discrepancies noted in Table 3 in the 2½, 3½ and 4½ year class. During the winter of 1964-65, above average snowfall and below average temperatures persisted for a large part of the winter in Saskatchewan's antelope range. In northern Montana, Martinka (1967) found similar conditions resulting in severe losses of antelope due to starvation. The severity of the conditions in Saskatchewan produced very low fawn crops in the spring of 1965 (fawn:doe ratio of 0.63:1) and 1966 (fawn:doe ratio of 0.72:1) compared to fawn:doe ratios of 0.86:1, 0.91:1, 0.96:1 and 0.87:1, 1961, 1962, 1963 and 1967 respectively (Scheelhaase, 1968). The severe winter in 1964-65 coupled with poor winter range may have had a lasting effect on lens growth in Saskatchewan's pronghorns.

Friend and Severinghaus (1967) conclude by insisting that the nutritional status of the animals must be taken into account in any attempt to develop an index to age based on growth and size of the eye lens. Also, they feel that if nutritional deficiencies retard lens growth then there should be no reason why their weights could not be used as indicators of range conditions when other accurate means of age determination is available.

In conclusion, the author feels that the lens weight technique does have potential for antelope. It is imperative that a series of eye lenses be obtained from a natural population of known-age antelope and their weights be determined. These weights can be used to compare with those of unknown age animals. Similarly, known-age jaws can be obtained and used to compare with those of unknown age.

Presently, an antelope fawn live capture and tagging program is in operation. It is hoped that enough animals will be marked and later collected to provide a series of known-age weights as references. Once this is accomplished both techniques can be evaluated more intensively.

Literature Cited

Bayless, R. S. 1969. Winter Food habits, range use, and home range of antelope in Montana. J. Wildl. Mgmt. 33(3):538-552.

Dirschl, H. J. 1963. Food habits and range of the pronghorn antelope in Saskatchewan. J. Wildl. Mgmt., 27(1):81-93.

Dow, Sumner A. and Philip L. Wright. 1962. Changes in mandibular dentition associated with age in pronghorn antelope. J. Wildl. Mgmt. 26(1):1-18.

Erickson, James A. 1969. Efficient sectioning of incisors for estimating ages of mule deer. 33(2):384-388.

Friend, M. 1965. The age lens technique, variations and variables. New York State. Conserv. Dept. Memo.

_____. 1967. Relationship between eye-lens weight and variations in diet. New York Fish and Game Journal. 14(2):122-151.

_____. 1967a. A review of research concerning eye-lens weight as a criterion of age in arrivals. New York Fish and Game Jour. 14(2):152-165.

_____. 1969. The lens technique. Dept. of Cons. Albany, New York, Mimeo.

Friend, M. and C. W. Severinghaus. 1967. Influence of nutrition on eye-lens weight in deer. New York Fish and Game Jour. 14(2):166-175.

Gilbert, F. F. 1966. Aging white-tailed deer by annuli in the cementum of the first incisor. J. Wildl. Mgmt. 30(1):200-202.

Keiss, Robert E. 1969. Comparison of eruption-wear patterns and cementum annuli as age criteria in elk. J. Wildl. Mgmt. 33(1):175-180.

Kolenosky, B. G. and R. S. Miller. 1962. Growth of the lens of the pronghorn antelope. Jour. Wildl. Mgmt. 26(1):112-113.

Lord, R. D., Jr. 1959. The lens as an indicator of age in cottontail rabbits. Jour. Wildl. Mgmt. 23(3):358-360.

_____. 1961. The lens as an indicator of age in the gray fox. Jour. Mamm. 42(1):109-111.

Martinka, C. J. 1967. Mortality of northern Montana pronghorns in a severe winter. Jour. Wildl. Mgmt. 31(1):159 -164.

McCutchen, H. E. 1969. Age determination of pronghorns by the incisor cementum. Jour. Wildl. Mgmt. 33(1):172-175.

Mitchell, J. G. 1965. Natality, Mortality and related phenomena in two populations of pronghorn antelope in Alberta, Canada. Unpubl. Phd. thesis. Washington State Univ. 205p.

Pepper, G. W. 1966. Antelope population trend survey in Saskatchewan. Dept. of Nat. Res. Publ. 8p.

Pepper, G. W. 1969. Aging Moose. Pers. comm., Sask. Dept. Nat. Res.

Peterson, R. L. 1955. North American moose. Univ. of Toronto press, Toronto. 280 p.

Quimby, D. C. and J. E. Gaab. 1952. Preliminary report pm a study of elk dentition as a means of determining age classes. Proc. Ann. Conf. Western Assn. State Game and Fish Comm. 32:225-227.

Robinette, W. L., D. A. Jones, G. Rogers, and J. S. Gashwiler. 1957. Notes on tooth development and wear for Rocky Mountain mule deer. J. Wildl. Mgmt. 21:134-153.

Runge, W. 1969. Aging Moose. Pers. comm., Sask. Dept. Nat. Res.

Ryel, L. A., L. D. Fay, and R. C. Van Etten. 1961. Validity of age determination in Michigan deer. Papers Mich. Acad. Sci. 47:289-316.

Scheelhaase, C. 1968. Antelope population trend survey in Saskatchewan. Dept. of Nat. Res. Publ.

Sergent, D. E. and D. H. Pimlott. 1959. Age determination in moose from sectioned incisor teeth. J. Wildl. Mgmt. 23:315-321.

Severinghaus, C. W. 1949. Tooth development and wear as criteria of age in white-tailed deer. J. Wildl. Mgmt. 13:195-216.

CASPER ANTELOPE PASS STUDIES

by
Raymond D. Mapston
Wildlife Management Biologist
Bureau of Land Management, Casper, Wyoming

ABSTRACT

Since May of 1967 a cooperative study has been conducted near Casper, Wyoming to determine the capability, willingness and learning ability of antelope to locate and cross two "antelope passes" installed in a woven-wire fence. The fence encloses a pasture containing an important watering place for antelope during the dry summer months. The pass structures consist of a 4x6-foot grill mounted on 6-inch timbers over a pit with earth placed against the timbers to provide a ramp on each end of the grill.

Actual use by antelope during this study indicates that horizontal pass structures have value as a means of facilitating antelope movement through fences. It took a while for antelope to learn to leap over the passes but with repeated use they have adjusted to them. Use of passes by young fawns is encouraging and antelope of all age groups from six weeks up are using the passes with little or no reluctance. Mature antelope show an exceptional broad jumping ability while crossing the passes and leaps of 8 feet are common. The jump is usually initiated from a standing position but antelope have been seen crossing passes while running. Fawns over a month old demonstrate a surprising jumping ability. Most young fawns make an oblique jump across the grill and clear it without difficulty. A large number of antelope use the passes regularly during the summer and fall to move to and from a watering place inside the pasture which the fence encloses. A significant number of adult antelope prefer to jump over the fence in which the passes are installed.

INTRODUCTION

Since the 1950's the Bureau of Land Management and the Wyoming Game and Fish Commission have been conducting cooperative studies to learn more about the effects of sheep-tight fences on antelope and the pronghorn's ability to cross various fence types and pass structures. The most comprehensive study, the first controlled research project of its kind, was conducted near Wamsutter, Wyoming

in 1963-1964 (Spillett, 1965). One of the main conclusions of the study was that horizontal barriers, such as regular cattleguards and simulated cattleguard devices, were crossed by a majority of test antelope (Spillett, Low and Sill, 1967). This was no surprise. The pronghorn's exceptional broad-jumping ability has been recognized and they have been seen using this ability to cross cattleguards installed on the range.

Because of the promising possibilities of horizontal barriers and the demonstrated broad-jumping ability of antelope, emphasis on two studies conducted since 1965 in the Worland and Casper BLM Districts has been directed toward development of an inexpensive, easily installed pass structure that will facilitate antelope movement through fences and yet effectively restrain livestock.

During the three-year study on the Worland District various sized passes and different methods of placement were tested. Over 100 antelope were seen crossing test passes during that study including a herd of about 50 antelope that crossed a 6x6-foot pass installed in a corner location (Mapston, 1968). Using the knowledge that was obtained from the Worland study, a similar antelope pass study is being conducted near Casper, Wyoming.

OBJECTIVES

The primary objectives of the study are:

1. To determine the capability, willingness, and learning ability of antelope, particularly fawns, to cross pass structures under normal and stress environmental conditions.

2. To study the fence jumping ability of antelope.

METHODS

In May of 1967 two antelope passes were installed by the Wyoming Game and Fish Commission in a ten-year-old 46-inch woven-wire fence located two miles north of Casper, Wyoming. The fence encloses a pasture containing a large reservoir that is an important watering place for antelope during the dry summer months. The sites chosen for placement of the passes were on well-established trails that antelope had made while crossing the fence to move to water. Both passes consist of a 4x6-foot grill mounted on 6-inch timbers over a pit. Earth placed against the timbers at each end of the grill provides natural approaches. There are about 200 antelope in the area and sheep are grazed north of the fence during the late winter and spring.

Antelope use of the passes was determined by actual observations of antelope crossing the passes and inspection of tracks around the structures during periodic trips to the study area. During the summers of 1968 and 1969 blinds were set up 50 yards from the passes in order to study and photograph at close range antelope behavior while they were locating, inspecting and crossing the passes. Observations were made during the morning, afternoon and early evening. Time spent in the blinds ranged from 2 to 7 hours. A single-lens reflex camera with 600 mm telephoto mounted on a rifle stock was used for antelope photography.

The study is being conducted jointly by the Bureau of Land Management and the Wyoming Game and Fish Commission. Special recognition is due Big Game Biologist Larry Pate of the Wyoming Game and Fish Commission who has devoted much time and effort to this project. His progress report on the study is included in the literature cited.

USE OF PASSES BY ADULTS

Most antelope were visibly wary of and frightened to a certain extent by the structures for several months. However, antelope were seen making cautious but thorough examinations of the passes a few days after they were installed. Within 10 days some antelope, including two fawns, were seen crossing the structures. Once antelope became fully aware of the openings and learned that they could negotiate the structures, use of passes increased markedly.

Let's take a look at antelope behavior while crossing passes.

Antelope show an exceptional broad-jumping ability while crossing the passes. Leaps of 8 feet are common. You can see that these does will land well beyond the end of the grill. Both made leaps of at least 9 feet while crossing the pass. Notice that the eyes of this airborne doe are focused on the landing spot. This was common and many adults seem to select their landing spot before they jump.

The jump is usually initiated from a standing position. The height of the jump is usually not higher than 3 feet, but some antelope make a high vertical takeoff. Some antelope have been observed leaping through passes while running.

A substantial percentage of the adults choose to jump over the full length of the grill, while many jump at an oblique angle.

Some antelope locate the pass openings by trial and error. The common behavior pattern involved walking along the fence a few yards and then stopping to stare through the fence. This process was continued until the pass was located. In most cases the grill is

what attracts their attention. With their curiousity aroused a thorough inspection is usually made resulting in discovery of the pass opening and use of the pass. The inspection often lasts 10 minutes and includes the following behavior:

1. Studying the entire structure from several yards away.

2. Staring intently through the pass opening from several different angles.

3. Examining the grill visually as well as sniffing at and pawing it with their front legs.

On many occasions antelope were seen deliberately walking more than a 1/4 of a mile along the fence without stopping to look for a way through it until they arrived at the pass. The lead antelope involved usually walked directly to the pass and crossed with little or no hesitation. This probably means that antelope are able to remember the location of the passes and return to them in the future.

A significant percentage of the antelope used well established trails that lead to the passes. Antelope approaching along the trail often walked directly to the passes and crossed immediately. This is probably because they have a direct view of the entire pass opening when approaching along the trail.

USE OF PASSES BY FAWNS

Use of passes by young fawns has been encouraging. Fawns over a month old display a surprising jumping ability although their form leaves something to be desired. Two fawns (apparently twins) were seen crossing one of the passes with a doe on July 15th. Based on peak fawning dates in this area they were no more than 6 weeks old. During the last half of July in 1969, when most of the fawns were 6 to 8 weeks old, 25 were observed crossing the passes. Most of the young fawns make a diagonal jump across the grill while a few leap over the full length.

Fawns occasionally tested their jumping ability by leaping over the 4-foot width of the grill and staying on the same side of the fence. After experimenting these same fawns usually crossed the pass within a few minutes.

One fawn was seen walking through the grill. He managed to cross it after considerable stumbling and was conspicuously frightened, but apparently not injured.

Most fawns clear the grill without difficulty. One fawn was seen making a small hop immediately after seeing its mother jump through the pass. The fawn landed on the frame at the edge of the grill but then made another hop to the ground.

By the first of September when the fawns were about 3 months old, some were locating and crossing passes on their own.. This included lone fawns as well as groups up to four.

Based on observations during the study Pate (1969) in his progress report states:

> Antelope of all age groups from six weeks up are using the passes with little or no reluctance.

The extent of use by young fawns and the ease with which passes are located and crossed seem to indicate that fawns over 6 weeks old have a much better mental and physical ability than is usually attributed to them.

EXTENT OF USE

The heavily used trails leading to both passes point out the degree of use by antelope.

During periodic trips to the study area between July 15 - September 15, 1969, a total of 177 antelope were seen crossing the passes to move in and out of the pasture. Sixty-three (36% of total) were fawns and 25 (14% of total) were fawns less than 9 weeks old. Since it was only possible to be in the study area occasionally these figures represent a small portion of the actual use that occurred.

The largest number of antelope seen jumping a pass as a group was 23. Groups of 5 to 10 were often observed leaping through a pass in rapid succession. Several bucks that could be identified by horn characteristics used the passes regularly to move in and out of the pasture. One buck was seen crossing a pass 3 times during a four-hour period.

It is apparent that a large number of antelope are using the passes regularly and that the amount of use has increased substantially from year to year.

Regarding the extent of use Pate (1969) states:

> Both passes have had numerous tracks on their dirt ramps when they were inspected during the project period. This indicates an increased use of the passes over the previous project period. ....During the summer and fall of 1968 there

> were some water sources available to antelope north of the study site; however, the antelope in the vicinity of the passes used them regularly to go to the lagoon for water.

THE STRESS FACTOR

Antelope are nervous and high strung animals. Because of this trait some wildlife biologists have expressed doubts that antelope under stress could maintain the mental ability required to locate and cross passes. During the 1968 and 1969 hunting seasons antelope which were being closely pursued by hunters located and leaped through passes despite signs of severe stress. For example, the young buck shown crossing in this slide jumped through the pass while running about 150 yards in front of a truck that had been chasing him along the fence for a mile. Although obviously spooked this antelope saw and escaped through the pass while on the run.

On eight occasions while driving in the study area antelope which were spooked by my truck ran directly to a pass and leaped through. This included three fawns estimated to be 2-1/2 months old.

LEARNING ABILITY

A previous study has indicated that adjustment and learning through experience and association are important factors in the "long run" effectiveness of antelope passes (Mapston, 1968). Observations during this study substantiate that viewpoint.

During the first several months of the study use of passes was limited. As the study progressed antelope crossed the passes much more readily and with repeated use seemed to adjust to them. Pate (1969) based on his observations states:

> Antelope have apparently become accustomed to the passes and now use them without hesitation.

It is also apparent that antelope learn to cross passes by watching each other. Groups of antelope gathered around passes commonly focused their attention on the animals that were jumping the pass. Several times antelope were seen examining a pass but refused to cross it. However, as soon as the pass was used by their companions these same antelope leaped across the pass with little hesitation. Note how closely this buck and fawn are watching the doe while she leaps through the pass.

FENCE JUMPING ABILITY

In recent years many opinions have been expressed about the pronghorn's ability or lack of ability to jump over fences. This study provided an opportunity to learn more on this subject. In order to study antelope behavior while jumping fences, blinds were set up near several locations in the fence that antelope commonly jumped over to move in and out of the pasture.

A significant number of antelope prefer to jump the fence in which the passes are located. Of the 223 antelope seen moving through the fence last summer, 46 (21% of total) jumped over the fence. The buck shown jumping here leaped over the 46-inch fence at a point about 5 feet from the pass. This was a special case since it was the mating season and the buck was pursuing a doe that had strayed away from his harem and used the pass to move through the fence. He was simply taking the most direct route to head the doe off.

Note the jumping position of this buck and the antelope in the following slides. The front legs are tucked under the body and the hind legs are being trailed. All of the 52 antelope that I saw leaping over fences last summer trailed the hind legs rather than pointing them forward as deer commonly do when jumping fences.

Another consistent behavior pattern observed was that antelope, when not under stress, commonly made an intensive examination of the fence before leaping over. Just before jumping, most of the antelope stared intently at or over the top wire for at least a few seconds with their noses only a few inches from the fence. Apparently this is done to gauge the jump. However, it should be pointed out that not all antelope made this inspection before jumping. Nine antelope jumped over fences while running at moderate speed without pausing to size up the structure.

When not under stress antelope seem to seek out the lowest part of the fence to jump over. Two sections of 75 feet and 10 feet, where the top wire was down, received heavy use by antelope. Both were 40 inches high. On numerous occasions antelope were seen walking up and down the fence obviously looking for a place to cross. In most cases they would return and cross where the fence was lower.

This doe is jumping where a 10-foot section of the fence was 6 inches lower than the rest of the fence. She returned to this location after carefully looking over several hundred yards of the fence.

The 75-foot section of lower fence which was also 40 inches high received much greater use by antelope.

Some antelope still jumped over the fence where it was 46 inches high rather than cross at the lower sections. In almost every case this involved antelope that walked deliberately to the fence and jumped where they encountered it rather than looking for a place to cross.

During the summer of 1969 a total of 46 antelope were observed jumping over the fence in which the passes are installed. Thirty-five jumped over the 40-inch fence while 16 jumped over the 46-inch fence.

Note the well established trail that antelope have made at a place where they commonly jump over the 46-inch fence.

This will give perspective of the height of the 46-inch fence.

Spillett, Low, and Sill (1967) from their studies at Wamsutter concluded that antelope with few exceptions hesitated to jump fences over which they were unable to see and noted that the eye-level height of a mature antelope is about 38 inches. It is interesting to note that a significant number of antelope in the Casper area under natural conditions commonly jump over fences that are 8 inches higher than their eye level.

CONCLUSIONS

Actual use by antelope during this study and reported use of horizontal pass structures in other areas (June, J., 1967; Kerr, 1968; Spillett, 1965, ZoBell, 1968) indicate that "antelope passes" have value as a means of facilitating antelope movement through sheep-tight fences. According to this study antelope over 6 weeks old can leap over the devices with relative ease. The extent of use by young fawns and the ease with which passes are located and crossed seem to indicate that fawns over 6 weeks old have a much better mental and physical ability than is usually attributed to them.

Adjustment and learning through experience and association are considered to be important factors in the "long-run" effectiveness of pass structures. It takes a while for antelope to learn to leap over the passes, but with repeated use they seem to adjust to them much as they have become accustomed to crawling under fences over a period of years.

LITERATURE CITED

June, J. 1967. Guzzlers - man made water holes for wildlife. Wyoming Wildlife 31(7):30-35.

Kerr, R. M. 1968. A discussion of the woven-wire fence antelope situation on BLM lands in New Mexico. Proceedings of the Third Biennial Antelope States Workshop:22-27.

Mapston, R. D. 1968. The use of structures to facilitate antelope movement through sheep-tight fences. Thesis, Univ. of Arizona, Tucson, 79 p.

Pate, L. 1969. Antelope population studies. Work Plan 10, Job 4, Wyoming Game and Fish Commission. 17-19.

Spillett, J. J. 1965. Effects of livestock fencing on pronghorn antelope movements. Thesis, Utah State University, Logan. 138 p.

Spillett, J. J., J. B. Low, and D. Sill. 1967. Livestock fences -- how they influence pronghorn antelope movements. Utah Agric. Exp. Sta. Bull. 470. 79 p.

ZoBell, R. S. 1968. A review of antelope crossing devices field trials of antelope in Buffalo Basin. Proceedings of the Third Biennial Antelope States Workshop: 28-30.

Discussion

McGowan: Did you have any trouble with the livestock crossing these passes?

Mapston: No we don't. I should have incorporated something about that in the study, however I wanted to go primarily to the discussion of antelope behavior. In this particular area, sheep are grazed on one side of the fence during the late winter and early spring months. There is no indication of sheep trying to cross the structures. Now, in a three-year study which we were involved in, we had a definite problem with livestock, and it wasn't so much sheep as it was yearling cattle. Of course, this is typical of yearlings. They seek a way to get out of any pasture. Now because we feel that there may be some potential problems, Larry and I have concluded that we would like to increase this pass width from 4 feet to 5 feet, and then that would eliminate that oblique jump, which would be the way I think that livestock would tend to cross. So maybe in a couple of years we'll have more data and can provide more information. Right now, it looks rather promising from the standpoint of holding livestock.

Lock: Have you made any observations during the wintertime when you had heavy snow cover, of antelope jumping over a grid that was maybe covered with snow?

Mapston: I haven't spent too much time in this area. During our three-year study in another area there was a definite problem with accumulation of snow under the passes. In this particular area we had more of a problem of blowing sand filling up the pits. Now our recommended installation is first of all installed on at least 6-inch timbers and at least over a 15-inch pit. Now with this type of structure, blowing wind tends to clean this out from snow as well as sand. That is why we recommend the elevated structure. I want to qualify that statement by saying that when you elevate this grill on timbers, it's important to provide dirt ramps - natural earth approaches. We feel that the use by antelope is much greater when the earth ramps were provided than when you must have naked timbers exposed.

Suetsugu: You have demonstrated the ability for the animals to learn to negotiate these passes. Does the hunter learn this pattern? Also, in the first slide you show a marked contrast in the condition of the two animals. Was that intended to show the ability of the one to cross the structure and the other not?

Mapston: No. It was simply the best slide I had of a couple of antelope in a fence corner. Frankly speaking, that's the only reason why I used it whatsoever. There was quite a variance there in condition between those two animals.

Suetsugu: You mentioned everything else except does that were real heavy just prior to dropping of the kid.

Mapston: I'd like to introduce to the group Larry Pate. Would you come up here, and I'd like to have you answer that first question of Harvey's and you may have some observations. I haven't had a chance to draw any conclusions regarding the ability of does heavy with the fawn to negotiate the structures. Do you, Larry?

Pate: No. One thing we should state on this is that except for July, August and September, there's very little use of the structure because there's no necessity. As Ray stated, during the summer, when we make these observations, we spend a lot more time on it during those three months than we do when the doe would be heavy. One thing I'd like to point out on this - this fence was built in 1957 by the Standard Oil Company and they built the lagoon just so all their waste from the refinery could be piped to it

instead of dumping in the Platte. They built the fence in 1957, and it wasn't maintained for a period of 10 years until we initiated the study in 1967. We located these passes on established trails at that time. They beat down the fence to 16 inches high at these two locations where we put the passes. This was the main reason for the location of the passes.

Boatsman: Sometime during the natural movement and ranging of the animal, the doe has to cross the structure to either get into the kidding area or to get out.

Mapston: I can make an opinion, based on what we've done during the five years' study of this, and unless they were very close to the process of birth, I don't think there would be any difficulty whatsoever. The reason I say this, once they make up their minds to jump, they jump these structures with very easy motion. There is no difficulty, so in my opinion, there wouldn't be any real problem. In answer to your first question, Harvey, the antelope hunters have learned the location of these pass structures, and the antelope - I should point out that one part of this area is protected from hunting, so the antelope have learned right from the first shot to head right for those pass structures, and the hunters have learned the same thing.

Pate: The lagoon portion itself is closed to all hunting by the Standard Oil Company, and they allowed us to use the area just for this study, with the understanding that we weren't going to open it to hunting. This bunch of antelope are residents in this area on both sides of that fence, so as far as saying that it would apply to antelope further north, I don't know. These have lived with that fence for 13 years now.

Mapston: If I might clarify that a bit - use of pass structures is not limited to this area. There is no question. Larry is certainly right, and it is something I feel very strongly about - that antelope in certain areas are better able to jump fences, and jump even these pass structures because they've become adjusted to them, but this is not the only area where we are receiving substantial use of cattle guards or pass structures.

Woody: This is more in the form of a comment. It appears to me by talking to Ray and by listening to his presentation, that much more man hours are expended by you people in actual observation, so comparing what you said today with what I said yesterday, the group might lean more towards what you said because you've spent more time with it than we have.

Call: You said quite a lot about the antelope actually jumping over the top of fences. What were your observations as far as trying to go between wires or through the fences?

Mapston: Speaking specifically of this summer, I only saw one occasion of yearling antelope, where she tried to lunge between the top wire and the second wire. She just got her head through on a brief lunge and then came right back. That was the only unsuccessful jump by an adult that I saw. In my opinion, fawns don't demonstrate any real encouraging ability to jump these vertical barriers and quite often we would see them make a desperate lunge to try to get through these wires, and occasionally they would make it and sometimes they would not.

Johnson: I was wondering if there was any injury noticed from animals landing in the cattle guard on crossing?

Mapston: I saw two occasions where I thought there might have been at least minor injuries. Number one was a fawn which was playing with another fawn, and one butted the other into the grill and this little fellow stumbled around through the grill and I'm sure he skinned himself up quite a bit. The other one I noticed two times. Occasionally, yearling animals would land on the timber at the end of the grill and they seemed to limp just

for a short distance - probably not a significant injury, but it is conceivable that it could cause a broken leg or something of this nature.

Larsen: If you go to 5-foot wide cattle guards, how does that fit a jeep or dune buggy?

Gate: This is the reason that we started with four-foot, is so that people would have to go - there's two gates into this pasture and they are swinging gates that are chained shut - and this is why we went to four-foot to start with, is to keep people from going back and forth. The trouble with this area is the maintenance of the fence because it is only two miles from Casper, this is straight north of Casper. The closest fence to Casper has places where they've driven cars through the fence.

Larsen: I wasn't really speaking of your study area because you said it's not open to hunting, etc., but if you were incorporated on a large scale, as a matter of fact if the jeep would almost fit you might get some good pictures.

Mapston: These structures are too light to support a vehicle, and our recommendation, based upon this five years of study in these two areas is for a jumping distance on the grill of at least 6 foot, with the width of 5 to 5½ foot, and this should discourage most vehicle use, although I did see a motorcycle jumping over one of these.

Beale: Do you think the 5 foot will reduce your fawn crossing?

Mapston: I don't know. This is something that we haven't - more of the fawns do jump diagonally, but a lot of them do jump the entire 6 foot distance. It might reduce it. I think our observations next year will tell us much more on this and this is one of the things that we are looking at very closely.

Unknown: Couldn't you make your guard five foot wide and still set your posts in about 6 inches on each end, exclude vehicle, and yet still serve the purpose.

Mapston: We have done that with trial installation over the area and that seemed to be a good installation, yes.

Authenrieth: What would you recommend as far as spacing your passes, say on a 5-mile stretch of fencing?

Mapston: We have a great deal to learn about this and what I say would largely be conjecture. First of all, let me say that for most field situations the corner location is the most desirable. The reason is that the merging fences more or less direct the antelope to the pass structures. I'm thinking in terms of areas where there is a definite need for antelope movement, that one for every two miles would be appropriate. This is a situation that is going to be variable with any field situation. At the time, if you're going to build the fence come hell or high water it's going to get built, and you say well we'll take care of the antelope by putting either 2 per mile or 6 per mile, or one every 50 feet. If you don't locate these instead of just going out and haphazardly going out and putting them in the fence, then you might as well save your money and your effort. The reason for this location, as I stressed, in a straight-line fence, but the only reason that we put them in where we did was for the fact that these trails were established where they had beat this fence down, and they were well established trails at the time. Now, if we would have moved them in 100 yards in either direction, I don't think we would have come up with the use.

A BRIEF HISTORIC REVIEW OF THE PRONGHORN ANTELOPE IN ALBERTA

by
William Wishart
Wildlife Research Biologist
Edmonton, Alberta

The northernmost range of the North American antelope is found on the prairies of Alberta. Antelope formerly extended north into the parkland and west to the eastern edge of the foothills. The encroachment of civilization has since reduced that range to approximately 14,000 square miles in the southeastern part of the province. This northern tension zone for antelope is noted for its extreme weather variations. Severe droughts have affected both distribution and production. Severe winters every 15 to 20 years have at times reduced the total population by as much as 60%. Emigration, starvation, losses due to predation and poor kid crops have been the usual result of hard winters. Fortunately, most of the winters in southern Alberta are frequented by warm westerly chinooks that periodically reduce or remove the snow from large tracts of antelope range. In fact, the frequency of chinooks in the south may very well by why we have so long enjoyed the presence of antelope in Alberta.

Estimates of antelope in Alberta since the early 1900's have ranged from 1,100 in 1924 to 30,000 in 1945. In 1955 systematic aerial surveys of antelope were initiated with observers counting animals within one-half mile on either side of the transect flight line. As a rule, surveys have been flown near the end of July. Since 1955, antelope population estimates for the province have ranged from 7,000 (1969) to 25,000 (1964). The estimates include a large unintended antelope reserve of 1,000 square miles that is leased to the Department of National Defense near Suffield. The fall population in the Suffield Reserve in 1969 was approximately 1,200 antelope.

There have been 33 regulated hunting seasons on antelope during the past 63 years. The longest series of consecutive seasons has been nine years (1960-1968) and the longest closure has been 20 years (1914-1933). The legal annual antelope harvest has ranged from 45 in 1908 to 4,300 in 1964. Bag limits have varied from two bucks to two of either sex. Hunting success has varied from 40% (1968) on a bag limit of one buck to 92% (1962) on a bag limit of one of either sex. Non-resident licenses for antelope were sold in the province until 1949. The cost of the license varied from $15.00 to $50.00. At one time resident antelope licenses were free, but at present they cost $7.50.

Antelope management in Alberta developed as a dramatic result of mismanagement in 1949. An over-kill was recorded when an unlimited number of licenses (1,216) were sold for a limited area (2,500 square miles) at the time of a population low. The net result was a six year closure. In 1956 the number of antelope licenses became restricted, but it was not until 1964 that the antelope country was divided into management units. Present legislation based on a draw system permits hunters to hunt in an area of their choice and at the same time allows an increase in total hunter participation.

Two intensive studies have been done on antelope in Alberta. One study was on the Natality and Mortality of Pronghorn Antelope by Dr. George Mitchell in 1965 and the other study was on Behavioral Adaptations of Wintering Pronghorn Antelopes by Eldon Bruns in 1969.

Mitchell's study was conducted between 1955 and 1964 to determine natality and mortality of a hunted herd and an unhunted herd of antelope. He found that the fetal rates of antelope in both study areas were similar suggesting no significant difference in range quality. He also found that females shed between two and nine ova during estrus and exhibit a mean rate of five ovulations per doe. On the basis of corpora lutea of pregnancy counts he found there was a high loss of ova and early stage embryos. As many as seven viable embryos in utero were observed in October, but never more than two embryos were found in utero after early November.

As expected he found that antelope natality increases as mean annual adult mortality increases. However, the unhunted herd with the highest survivorship also showed high natality. He suggested that emigration and mortality to antelope during their first year of life were the major factors involved.

Brun's winter behaviour study of six antelope herds (221 head) was from January (one of the severest on record) to April, 1969. His hypothesis was that pronghorns have other behavioral adaptations for conserving energy in winter besides migrating southward. He found that antelope were opportunistic migrants and they selected microhabitats with lower wind velocities, less snow, softer snow and less dense snow than the average for the area. Pronghorns were found to be adept at pawing away snow cover to reach their food which appeared to be of higher quality than forage available above the snow. A social hierarchy around feeding craters and bedding sites was indicated, with males at the top, followed by adult females and fawns. Conservation of energy and heat was achieved by reduced daily travel in snow, "single file" travel through deep snow, "clumped" bedding patterns during periods of high wind chill as well as downwind orientation of the anterior with the head curled back alongside the body. During periods of snow melt, bedding and travel were restricted to bare ground. In the six herds studied, only 6% (13) were lost by apparently natural causes.

From the foregoing history and studies on antelope, the following goals and objectives for antelope research and management in Alberta were proposed at a biological staff meeting in December, 1969.

1. Annual population and harvest surveys should be continued on a sound statistical basis.
2. An optimum population goal for the province should be 15,000 antelope, after which a maximum sustained harvest may be taken.
3. A lower limit of 1,000 permits or 5,000 antelope was established below which the season should be closed.
4. Lands sufficient to support an optimum wintering population of antelope should be reserved and managed for this purpose.
5. A survey of antelope range available to public hunting should be conducted.
6. Migration patterns within the province as well as inter-provincial and international movements should be established by a marking program.
7. A high quality hunting experience while in pursuit of antelope should be maintained by not exceeding a density of 1 hunter per 4 square miles.
8. A quality animal should be provided by having trophy seasons not later than the last week of October.

LITERATURE CITED

Anonymous. 1907-69. Annual reports of the Alberta Department of Lands and Forests, Fish and Wildlife Division.

Bruns, Eldon H. 1969. A preliminary study of behavioral adaptations of wintering pronghorn antelopes. M.Sc. Thesis. Univ. of Calgary. 60 p.

Mitchell, G. J. 1965. Natality, mortality and related phenomena in two populations of pronghorn antelope in Alberta, Canada. Ph.D. Thesis. Wash. State Univ. 205 p.

FOOD HABITS IN RELATION TO PHYSICAL CONDITION IN TWO POPULATIONS OF PRONGHORNS 1/

by
Bart W. O'Gara, Assistant Leader
Montana Cooperative Wildlife Research Unit 2/
University of Montana, Missoula

and

Kenneth R. Greer, Laboratory Supervisor
Montana Fish and Game Department
Wildlife Investigations Laboratory
Montana State University, Bozeman

ABSTRACT

Analyses of rumen contents from 112 pronghorns (Antilocapra americana), which were collected in Yellowstone National Park and on the National Bison Range, Moiese, Montana, during August 1965 through June 1966, indicated that the diets of the two populations were different. The stomachs of the animals collected in Yellowstone contained 52 percent browse, 44 percent forbs, and 4 percent grass while those from the Bison Range contained 18 percent browse, 67 percent forbs, and 15 percent grass. Browse was available on the Bison Range in limited quantity and variety.

Fat indices of adult females collected during 1965-66 indicated that those from Yellowstone National Park were in better condition than those from the National Bison Range. These data suggest that northern pronghorns cannot winter well without adequate browse.

INTRODUCTION

Pronghorns were transplanted from Yellowstone National Park to the National Bison Range, Moiese, Montana, in 1951 and 1952. After release, the animals were free to roam the 18,541 acre range. The herd reproduced rapidly. Data from National Bison Range Narrative Reports, Yellowstone Park Annual District Animal Census Reports, and personnel observations indicated that there were at least twice as many fawns per doe on

1/ This research was financed by Montana Fish and Game Commission Project W83R.

2/ Bureau of Sport Fisheries and Wildlife, Montana Fish and Game Commission, University of Montana, and the Wildlife Management Institute cooperating.

the National Bison Range as in Yellowstone National Park during the summers of 1965 through 1967.

During August 1965 through June 1966, 25 pronghorns on the National Bison Range and 100 in Yellowstone National Park were collected by shooting in connection with a study of reproduction in the female pronghorn (O'Gara, 1968). Weights, measurements, and fat indices were recorded to compare the physiological condition of the two populations in an effort to determine the cause of low fawn survival in Yellowstone Park. When the collection was completed, the doe:fetus ratios (100:193--Bison Range and 100:200--Yellowstone) indicated that a postnatal factor was operating, at least during 1966, to cause the low doe:fawn ratios in Yellowstone National Park. Circumstantial evidence pointed to coyote predation as the decimating factor.

When the physiological data was analyzed, it appeared that the pronghorns in Yellowstone National Park were in better condition than those on the National Bison Range. This unexpected discovery prompted us to investigate the relationship between physical conditions and food habits of animals from the two populations.

MATERIALS AND METHODS

Rumen samples were collected and preserved in 10 percent formalin. The samples were analyzed by the volumetric-percentage and frequency method at the Montana Fish and Game Department Wildlife Laboratory. Indices of physical condition were calculated in the following ways:

Kidney Fat Index--Kidneys were removed from the abdominal cavity with all of their surrounding fat. Fat was cut off at right angles to the longitudinal axes and flush with the ends of the kidneys. Each pair of kidneys with their remaining fat was weighed to the nearest 5 g. With the fat removed, the kidneys were again weighed to the nearest 5 g. The difference (the weight of the kidney fat) divided by the weight of the kidneys gave a value which was multiplied by 100 to give the kidney fat index (Riney, 1955).

Back Fat Depth--A forward cut of approximately 25 cm was made starting at the base of the tail and at an angle of approximately 45° from the spinal column. The greatest depth of fat along this cut was then measured to the nearest 1 mm. Traces of fat under 1 mm were recorded as 1 mm (Riney *op. cit.*).

Percent Marrow Fat--This percentage was obtained by the ether extraction-gravimetric method at the Chemistry Station Analytical Laboratory, Montana State University, Bozeman, Montana (Horwitze, 1965).

RESULTS AND DISCUSSION

Adult males and young pronghorns were not collected on the National Bison Range, so only adult females were available to compare the physiological condition of animals from the two areas. Table 1 shows fat indices for adult females collected throughout the year from the two areas. All of the indices used during this collection indicated that the animals on the Bison Range and in Yellowstone Park were in the poorest condition in May and the best condition in December - January. Adult females from Yellowstone National Park had greater fat reserves than those from the National Bison Range during all seasons of the year.

Table 1. Comparison of fat indices between adult female pronghorns from the National Bison Range and Yellowstone National Park during 1965-66.

	Nat'l. Bison Range	Yellowstone Park
	( ) = Sample Size	
Kidney Fat Index	(21)	(55)
Annual Mean	68.6	93.0
Back Fat Depth	(21)	(62)
Annual Mean in mm	5.4	9.5
% Marrow Fat	(21)	(60)
Annual Mean	82.3	90.1

There were more non-lactating does in Yellowstone than on the Bison Range, so the data in Table 1 may be biased. The lactating--non-lactating status of does could only be established with certainty during the months of August through October 1965. The figures in Table 2 suggest that lactating does in Yellowstone Park were in somewhat better condition during the summer of 1965 than those on the National Bison Range; however, the sample sizes are too small for firm conclusions.

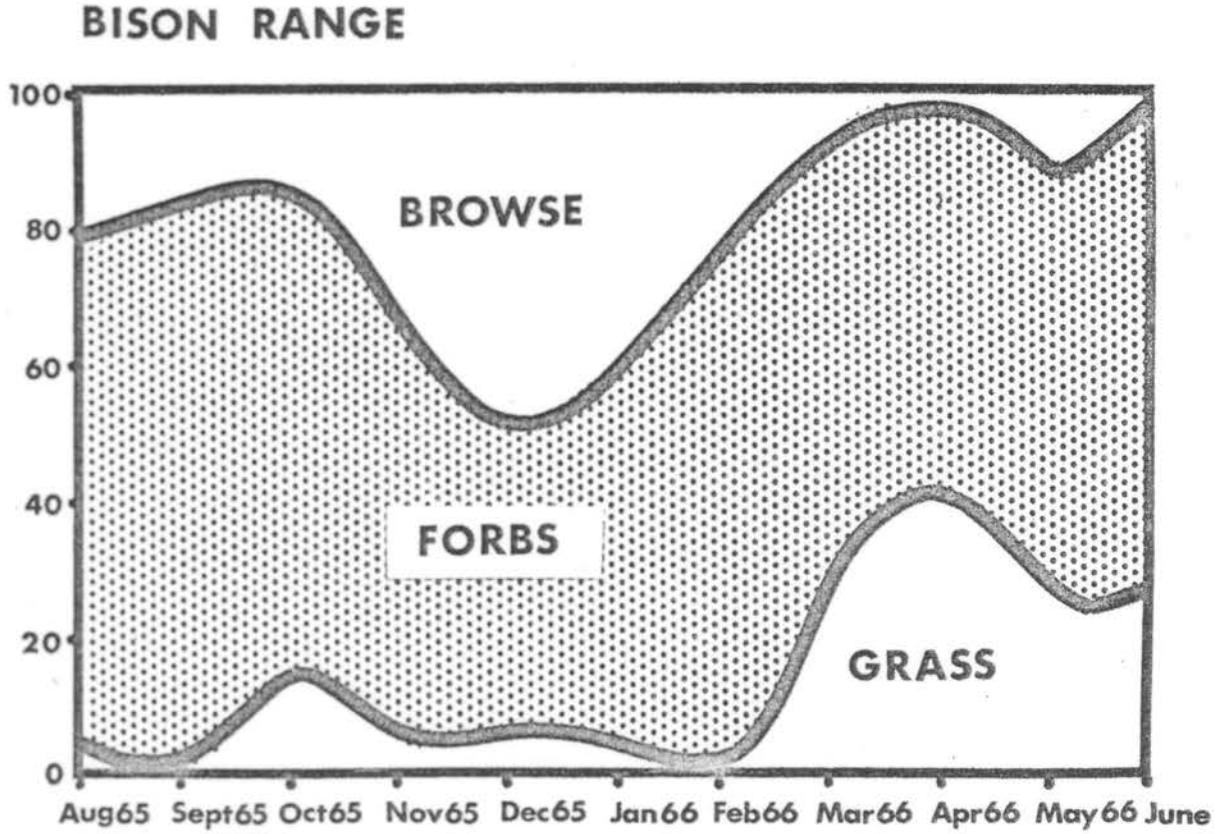
Table 2. Comparison of fat indices between lactating, adult, female pronghorns from the National Bison Range and Yellowstone National Park during 1965.

	Nat'l. Bison Range	Yellowstone Park
	( ) = Sample Size	
Kidney Fat Index	(2)	(4)
August Mean	20.6	64.9
Back Fat Depth	(2)	(4)
August Mean in mm	1.0	6.0
% Marrow Fat	(2)	(4)
August Mean	89.9	91.0
Kidney Fat Index	(2)	(5)
September Mean	49.5	50.3
Back Fat Depth	(2)	(8)
September Mean in mm	1.0	7.0
% Marrow Fat	(2)	(8)
September Mean	90.9	86.4
Kidney Fat Index	(0)	(4)
October Mean	-	38.5
Back Fat Depth	(1)	(5)
October Mean in mm	1.0	7.0
% Marrow Fat	(1)	(5)
October Mean	25.9	90.0

Two of the does collected in Yellowstone Park during September were over 9 years of age. These two animals pulled the indices of does from Yellowstone Park to approximately the same levels as those of the younger does from the National Bison Range. The one adult doe collected on the National Bison Range during October was also over 9 years of age, so it is not comparable to the younger animals collected in Yellowstone National Park during the same month. A review of Refuge Narrative Reports for 1963 revealed other evidence that pronghorns do not winter well on the National Bison Range. The winter of 1962-63 was one of deep snow. When the snow melted in the spring, 11 carcasses (over 10% of the herd) were found and all of the remaining pronghorns were reported to be very thin.

When the stomach samples were analyzed, it was found that both populations depended primarily on forbs in the summer, however the Yellowstone animals consumed more than 80 percent browse in the winter while the Bison Range animals still used as much forbs as browse (Fig. 1, Table 3).

Figure 1. Major forage classes found in the rumens of 24 pronghorns collected at the National Bison Range and 88 collected in Yellowstone National Park.



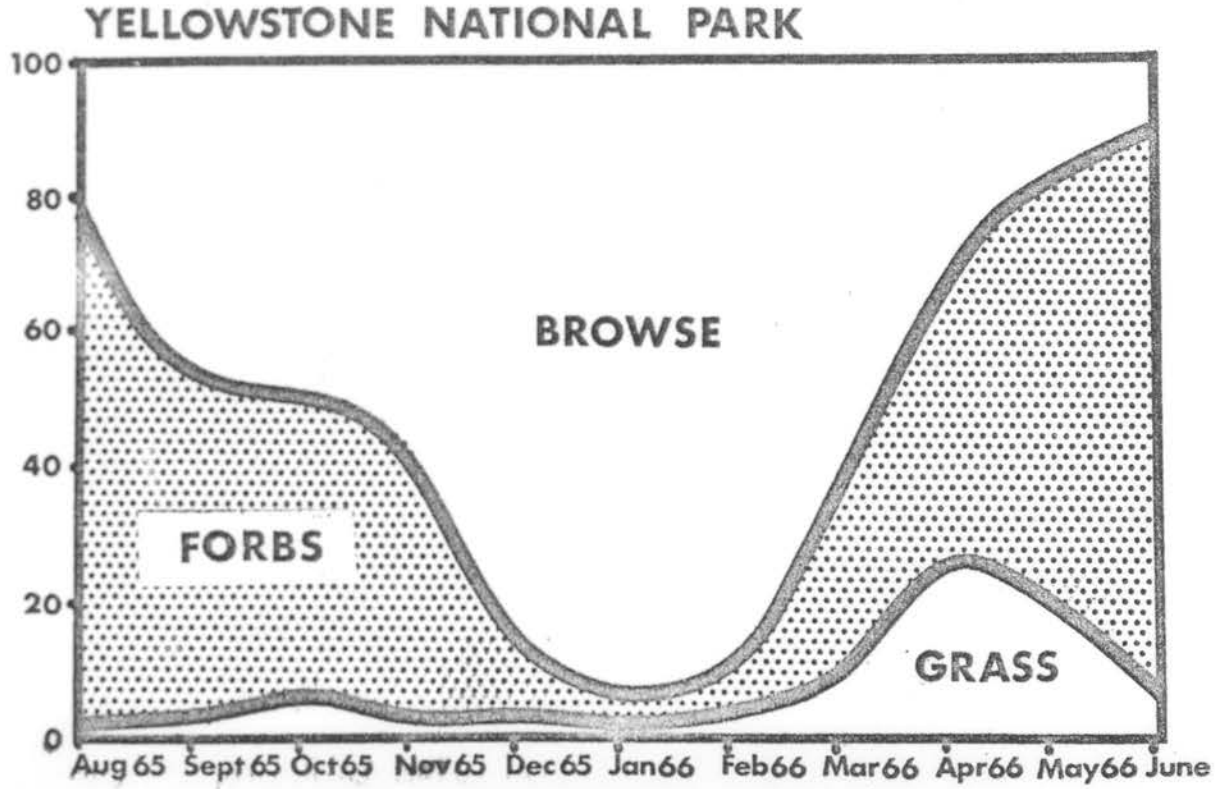


Table 3. Rumen analyses of 112 antelope from Yellowstone National Park (Y) and the National Bison Range (N) during August 1965 through June 1966. Forage class in percent.

	Aug.		Sept.		Oct.		Nov.		Dec.		Jan.		Feb.		Mar.		Apr.		May		June		Total	
Area	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Sample	11	3	23	3	14	2	11	2	9	2	5	-	3	2	7	4	2	2	-	2	3	2	88-24	
Browse	20	24	47	16	47	17	53	32	83	50	97	-	91	21	65	7	31	2	-	12	11	1		
Forb	79	75	52	84	45	68	46	63	14	44	2	-	5	79	28	63	41	56	-	63	82	69		
Grass	1	1	1	Tr	8	15	1	5	3	6	1	-	4	Tr	7	30	28	42	-	25	7	30		
Percent of Major Browse Species:																								
ARFR	16	Tr	19	Tr	35	14	2	32	10	40	51	-	7	15	16	6	1	Tr	-	1	3	-		
ARTR	1	-	6	-	7	-	38	-	55	-	19	-	30	-	15	-	15	-	-	-	3	-		
ATRI2	1	-	Tr	-	Tr	-	-	-	11	-	7	-	-	-	14	-	2	-	-	-	-	-		
BERE	-	-	2	-	-	-	7	-	Tr	-	-	-	-	-	-	-	-	-	-	-	-	-		
CHRY3	1	Tr	4	-	1	-	2	-	Tr	-	1	-	-	-	-	-	-	-	-	-	-	-		
CHNA	Tr	-	Tr	-	Tr	-	Tr	-	2	-	3	-	9	6	3	-	Tr	-	-	-	Tr	-		
EUROT	-	-	-	-	-	-	-	-	-	-	1	-	6	-	Tr	-	-	-	-	-	-	-		
EULA	-	-	Tr	-	1	-	-	-	1	-	4	-	30	-	5	-	Tr	-	-	-	-	-		
POPUL	-	Tr	Tr	-	-	-	1	-	-	-	-	-	Tr	-	-	Tr	-	1	-	-	Tr	-		
PRUNU	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
PRVI	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
RHTR	-	Tr	Tr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
ROSA	Tr	Tr	2	Tr	-	-	Tr	-	-	-	-	-	-	-	-	-	-	1	-	1	Tr	Tr		
SALIX	-	-	1	-	Tr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
SAVE	Tr	-	Tr	-	Tr	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-		
SYMPH	Tr	21	Tr	16	-	3	Tr	Tr	-	-	-	-	-	-	-	Tr	-	Tr	-	Tr	3	-		

Tr = Trace (less than 0.5%).

Code names are listed in Table 4.

Table 4. List of browse plants which were identified in the rumens of pronghorns from the National Bison Range and Yellowstone National Park with code names from Plummer, et al (1966).

Code	Scientific Name	Common Name
ARFR	Artemisia frigida	Fringed sagebrush
ARTR	Artemisia tridentata	Big sagebrush
ATRI2	Atriplex spp.	Saltbush
BERE	Berberis repens	Oregon grape
CHRY3	Chrysothamnus spp.	Rabbitbrush
CHNA	Chrysothamnus nauseosus	Rubber Rabbitbrush
EUROT	Eurotia spp.	Winterfat
EULA	Eurotia lanata	Common Winterfat
POPUL	Populus spp.	Aspen, Cottonwood, Poplar
PRUNU	Prunus spp.	Plum, Cherry
PRVI	Prunus virginiana	Chokecherry
RHTR	Rhus trilobata	Skunkbush
ROSA	Rosa spp.	Rose
SALIX	Salix spp.	Willow
SAVE	Sarcobatus vermiculatus	Black greasewood
SYMPH	Symphoricarpos spp.	Snowberry

On the Bison Range, the monthly use of forbs ranged from 44-84 percent and averaged 67 percent during the period of this study. Large portions of the forb class were fragmented leaves or bare stems and were not readily identified. Yarrow (Achillea spp.) and aster (Aster spp.) appeared to be most frequently used. Grass was eaten in trace amounts during August and September and increased to about 5 percent in the autumn. Maximum utilization of grass, about 30 percent, prevailed from March through June. Some browse was used throughout the year. Both fringed sagebrush (Artemisia frigida) and snowberry (Symphoricarpos spp.) had high rates of occurrence.

In Yellowstone Park, the monthly use of forbs ranged from 5 - 82 percent and averaged 44 percent during the period of the study. No single forb composed more than 4 percent of the rumen contents. Phlox spp. and Russian thistle (Salsola spp.) were the most important species. Grass and grasslike plants composed more than 4 percent of the contents only in early spring when they amounted to 28 percent. Browse composed 17, 48, 82, and 26 percent of the diet in summer, fall, winter, and early spring, respectively. Fringed sagebrush composed from 12 to 20 percent of the diet and had a high frequency of occurrence in summer, fall, and winter. Big sagebrush (Artemisia tridentata) made up 13 - 33 percent of the rumen

volume and had a high frequency of occurrence from fall through spring but was seldom used in summer. Fringed sagebrush and big sagebrush together made up almost 50 percent of the total diet and had 100 percent frequency of occurrence during the critical winter period. Winterfat (Eurotia lanata) and saltbush (Atriplex spp.) made up 12 and 10 percent of the rumen contents respectively with a high frequency of occurrence during the winter; however, they were of minor importance during other seasons (Barmore, 1969).

Many studies concerning the food habits of the pronghorn have shown that this species utilizes sagebrush and other browse extensively during the winter (Baker 1953, Buck 1947, Mason 1952, Yoakum 1958). Thus the Yellowstone antelope were apparently on a more normal diet for the species than the Bison Range animals. The winter of 1965-66 was mild with unusually light snowfall both on the National Bison Range and in Yellowstone National Park. Thus, the rumen analyses should have reflected the winter forage preferences of the pronghorn; but the amount and variety of browse on the Bison Range were limited.

The principal forage species and plant-cover types of the Bison Range were contained in the 5,000-acre area described by Morris and Schwartz (1957). They indicated the plant composition to be about 79 percent grass, 7 percent forbs and 14 percent shrubs. Dominant species were: bearded bluebunch wheatgrass (Agropyron spicatum), cheatgrass brome (Bromus tectorum), balsamroot (Balsamorhiza sagittata), western yarrow (Achillea lanulosa), Lewis mockorange (Philadelphus lewisii), Rocky Mountain maple (Acer glabrum), and fringed sagebrush.

The range of the pronghorn in Yellowstone Park extends southeastward from the northern park boundary near Gardiner, Montana, and includes the Upper Lamar Valley and the Swan Lake Plateau. The range consists of sagebrush and grass. Murie (1940) described this area as a tongue of the Upper Sonoran Life Zone. The pronghorns winter on the lower elevations of this range and many of them spend the entire year there. A high percentage of the big sagebrush plants on the lower elevations are severely hedged and decadent. Leader use has averaged more than 70 percent in recent years. Despite this fact, fringed sagebrush and big sage were the most important year-long food plants. Levels of big sagebrush utilization were generally higher than for other browse species on the same sites during the winter of 1965-66. Sagebrush utilization also appeared to be higher where it was judged to be uncommon rather than common (Barmore, 1969).

Martinka (1967) found that pronghorns which could not reach browse during a severe winter in northeastern Montana perished, while those in sagebrush survived. Data gathered during this study also suggest that the well-being of northern pronghorns is closely linked to the availability of browse, especially sagebrush, on the winter range.

Literature Cited

Baker, T. 1953. Food habit study of game animals (antelope). Wyo. Wildl. 17(11):24-26.

Barmore, W. J. 1969. Pronghorn - mule deer range relationships on the Northern Yellowstone winter range. Annual progress report, YELL-N-17, Yellowstone National Park, Mammouth, Wyo. 18 pp.

Buck, P. D. 1947. The biology of the antelope (Antilocapra americana) in Montana. M.S. thesis, Mont. State College, Bozeman. 70 pp.

Horwitze, W. 1965. Official methods of analyses of the association of official agricultural chemists. 10th Ed. Assoc. Official Agricultural Chemists (Publ.) Wash., D.C. 957 pp.

Martinka, C. 1967. Mortality of Northern Montana pronghorns in a severe winter. J. Wildl. Mgmt. 31(1):159-164.

Mason, E. 1952. Food habits and measurements of Hart Mountain antelope. J. Wildl. Mgmt. 16(3):387-389.

Morris, M. S., and J. E. Schwartz. 1957. Mule deer and elk food habits on the National Bison Range. J. Wildl. Mgmt. 21(2):189-193.

Murie, A. 1940. Ecology of the coyote in the Yellowstone. U. S. Printing Office, Wash., D.C. Fauna of the Natl. Parks Bull. 4. 206 pp.

O'Gara, B. W. 1968. A study of the reproductive cycle of the female pronghorn (Antilocapra americana Ord). PhD thesis, Univ. Mont., Missoula. 161 pp.

Riney, T. 1955. Evaluating condition of free-ranging red deer with special reference to New Zealand. New Zealand J. Sci. and Technology 36(B):429-463.

Plummer, P. A., S. B. Monsen, and D. R. Christensen. 1966. Intermountain range plant symbols. Intermountain Forest and Range Experiment Station 268XII (79-181); 174(79-181) (083.8) misc. 36. 69 pp.

Yoakum, J. 1958. Seasonal food habits of the Oregon pronghorn antelope (Antilocapra americana oregona Bailey). Inter. Antelope Confer. Trans. 9:47-59.