AN ABSTRACT OF THE THESIS OF

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Title Factors Affecting the Mortality of Pronghorn Antelope in Oregon

Abstract approved Signature redacted for privacy. (Major Professor)

A study was undertaken to account for and authenticate all mortality factors affecting pronghorn antelope herds in Oregon. Work commenced in June, 1954, and terminated in July, 1956. Information pertaining to antelope mortality in other states was also collected for comparison with Oregon conditions. Mortality factors investigated and their importance were:

Prenatal and parturition deaths accounted for 14 of 370 carcasses located, or a known incidence of four per cent during the two-year study. Four of 89 carcasses examined manifested signs of old age. The only diseased antelope discovered through post mortem examinations were limited cases of single animals. Clinically diagnosed diseases were: "pinkeye" (Keratitis); "lumpy jaw" (Actinomycosis and/or Actinobacillosis); "Necrotic stomatitis" (Spherophorus necrophorus); "scours" (Diarrhea); pneumonia; and subcutaneous abscesses. The finding of liver flukes, Fasciola hepatica Linnaeus, may have been the first North American record of this parasite in pronghorn antelope. Weather conditions in relation to antelope survival were analyzed and it was believed that no mortality correlation existed between these two factors from 1954 to 1956. Natural accidents such as miring in muddy lakes, drowning, and locking horns were occasionally reported in records previous to 1954, but no records were found for subsequent years. Road kills were the largest known single factor in the category of man-influenced accidents. The problem of predator-antelope relationships was not investigated in detail although several observations were recorded. For 15 years, antelope hunters in Oregon have harvested an annual kill of 3.7 per cent of the estimated annual population, or an average take of 512 animals for an average estimated annual population of 13,854. The illegal or "poaching" kill of antelope was not found to have been a serious problem in southeastern Oregon. "Accidental" killings of does and kids during the hunting seasons were three times greater than poaching losses occurring the remainder of the year.

A total of 370 antelope carcasses was collected. This datum was classified as to sex and age, estimated season of death, and per cent mortality by age group.

Based on present knowledge, no single or combination of decimating agents could be uncovered as limiting factors in holding antelope in Oregon at a static population level. However, indications were noted whereby antelope densities and kid:adult ratios were highest on ranges with a greater vegetation interspersion and edge effect.

FACTORS AFFECTING THE MORTALITY OF PRONGHORN ANTELOPE IN OREGON

By

JAMES DONOVAN YOAKUM

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Photographs were taken by the author unless otherwise credited.

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

FACTORS AFFECTING THE MORTALITY OF PRONGHORN ANTELOPE IN OREGON

INTRODUCTION

A mortality study of the pronghorn antelope, Antilocapra americana oregona Bailey, was initiated in an attempt to account for all authenticated inimical factors affecting pronghorn antelope survival in Oregon. The project commenced in June, 1954, and continued to September, 1956, as an assignment given to the Oregon Cooperative Wildlife Research Unit[1] by the Oregon State Game Commission.

From the project's beginning, the main objective was to determine if there was a marked loss from disease or other causes among antelope kids which affected pronghorn population numbers adversely. Subsequently, the project was expanded to investigate survival factors relative to all age groups. Both past and current antelope losses were subjected to scrutiny during the study. An attempt was undertaken to record and to investigate all possible causative agents of authenticated losses in Oregon.

The need for a study of mortality factors was indicated by a review of previous antelope studies in Oregon. Mace (73, p.14) stated "Periodically, losses occur among antelope because of disease and parasites. Time must be devoted to disease and parasite problems when losses threaten the welfare of antelope herds." Einarsen (50, p.72),

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[1] Oregon State Game Commission, United States Fish and Wildlife Service, Wildlife Management Institute, Agricultural Research Foundation, and Oregon State College cooperating.

in his volume on the pronghorn antelope, wrote "...the difficulty of finding carcasses not out in the open, and the vast distances involved, have made it impossible to learn much more about mortality rates than that they are high. The reason why they are high has so far eluded the studies of range observers."

Then, too, stories by laymen were often encountered relative to high antelope losses. Such a story as the following was told to the writer on his first visit to antelope country: Adult buck antelope kill the young kids of the year by stamping them to death in order to save water during drought years. Similar stories had traveled far and it was desirable to have their validity investigated, substantiated, or discredited for future records of antelope welfare.

Therefore, it became apparent that an investigation and record of all authenticated antelope mortality factors was an immediate need. This paper will attempt to fulfill that requirement, thereby contributing facts to possibly help improve the management of pronghorn antelope.

History of Research Problem

In January, 1953, a research project entitled "A Pronghorn Kid Survival Study in Oregon" was first undertaken by the Oregon Cooperative Wildlife Research Unit. This assignment was a result of an apparent difference between the number of kids born in May and their numbers observed in September. Further analysis of Oregon's pronghorn herds disclosed the following information:

1. Annual inventories indicated that antelope populations were static from 1947 to 1954 (95, p.21).
2. This more or less static condition could be attributed to the loss of antelope kids during early summer (95, 36, 80).
3. Observations by some field agents stated that the cause of antelope kid deaths was apparently "scours", see page 34, but the cause of "scours" was undetermined (33, 78). It was also believed that an unknown disease could have accounted for antelope losses (79).

With the above data on record, investigations were initiated in the spring of 1953. At this time two men, stationed at the Hart Mountain National Wildlife Refuge and Drakes Flat study areas, figure 1, observed antelope herds until the first of October, 1953. The study was resumed in the spring of 1954 with two men at first stationed on Hart Mountain; however, the project procedure was later modified with one man on Hart Mountain and two men on Drakes Flat. Edward Hansen (56) reported the findings of the project up to September, 1954.

One of the 1954 summer study findings revealed that a relatively large number of adult antelope carcasses were found along with kid carcasses. Because of this finding, the project was expanded in the fall of 1954, and one man was assigned the problem of continual surveillance of antelope herds on Hart Mountain and Drakes Flat. Observations were made for winter die-offs since Mason (76,p.5) reported winter kills in 1951 and 1952, but the cause and extent of these

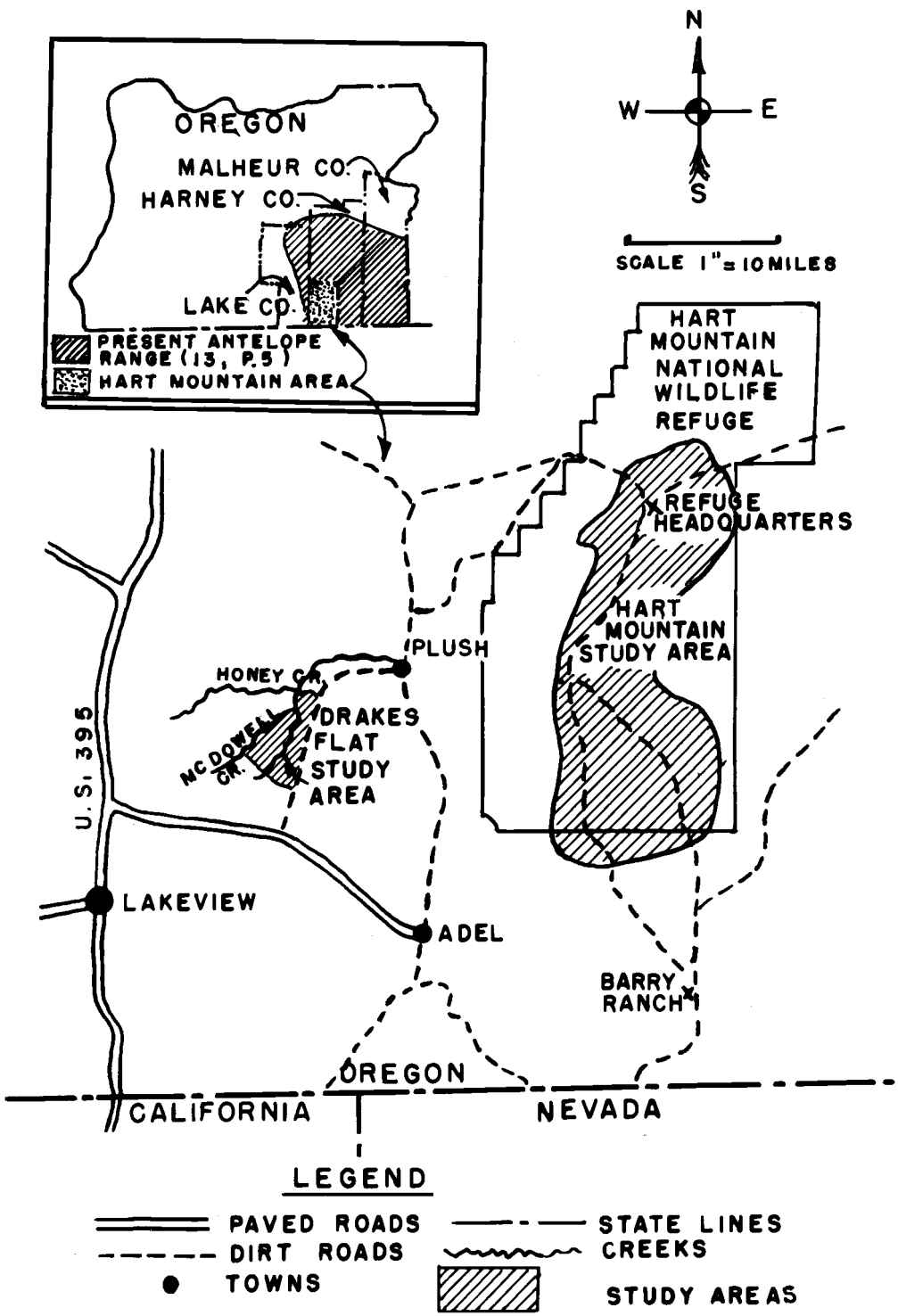


FIGURE 1. MAP OF THE DRAKES FLAT AND HART MOUNTAIN STUDY AREAS, LAKE COUNTY, OREGON.

deaths were unknown.

Further expansion of the program was undertaken when four research men were assigned to the study areas during the summer of 1955; two on Hart Mountain, and two on Drakes Flat. Thereafter, the study was continued on Drakes Flat with two men working steadily until September 1, 1956. Following this date, two new graduate students carried on the project.

Review of Important Studies Relative to Antelope Survival

The following antelope studies are believed to have been the most important investigations undertaken to date in Oregon.

Arthur S. Einarsen (50) in his book "The Pronghorn Antelope", combined years of extensive field observations with laboratory research findings. In the section on "Disease and Mortality", he wrote: "Systematic study of herds has been of such short duration that no actual records of widespread destruction through diseases are available, although there are current reports of mortalities".

During several months in 1940, 1946, and 1948, Dr. R. S. Norton, D. V. M., U. S. Fish and Wildlife Service, was assigned to the Hart Mountain and Sheldon National Wildlife Refuges to investigate possible disease problems affecting wildlife. Dr. Norton's work was interrupted by calls to the armed forces and professional assignments; nevertheless, he made several special reports (88, 87) on diseases and range conditions. This work exemplified the interest shown by the U. S. Fish and Wildlife Service in the health of wildlife on the

National Wildlife Refuges.

In the 1940's, the Oregon State Game Commission assigned technically-trained field agents to make field observations and report conditions of antelope and other game species. These field agents have periodically made special reports on antelope mortality encountered in their districts (35, 68). Such reports were invaluable for later research activities.

A recent study by Hansen (56) recorded 13 known causes of antelope deaths out of 75 carcasses located in 1953 and 1954 on the Hart Mountain and Drakes Flat study areas. Hansen's paper was the first comprehensive report considering each fatality as a separate case.

An annotated list, table 1, of important studies with reference to antelope mortality factors in states other than Oregon was compiled. It was interesting to note from this table that the states with the smaller antelope populations such as California, Arizona, Oregon, Texas, South and North Dakota have published many of the more detailed pronghorn reports, while states with larger antelope populations, namely Wyoming, Montana, and Colorado, published less literature on antelope prior to 1955.

Table 1

An Annotated List of Important North American Pronghorn Antelope Studies with Reference to Mortality Factors

Literature Cited	Date Work Accomplished	Location of Study	Factors Discussed
Ackerly and Regier (1)	1953-1955	California	Predation, Diseases, Poaching, Range
Arrington and Edwards (17)	-1951	Arizona	Predation
Bever (20)	1950	S. Dakota	Diseases and Parasites
Buechner (26)	1946-1947	Texas	Life history, Range
Buechner (27)	-1950	Oklahoma	Range, Climate, Diseases
Einarsen (50)	1936-1946	Oregon	Predators, Disease, Weather, Accidents
Goldsby and Eveleth (52)	1952	N. Dakota	Parasites (mainly internal)
Hansen (56)	1953-1954	Oregon	Disease, Predation, Accidents, Range
Jones (65)	1946-1949	Texas	Predators, Disease, Mgt. practices
Knipe (67)	-1944	Arizona	Range conditions, Predation
Nelson (85)	1922-1924	United States	Predation, Weather, Illegal kills
Rand (100)	1945	Canada	Weather, Predation, Range
Rouse (103)	1951-1954	Montana and Wyoming	Sheep-tight fences, Range
Skinner (111)	-1924	Yellowstone Park, Wyo.	Lists diseases, Internal and external parasites
Udy (122)	1948-1952	Utah	Predator studies, Range

RESEARCH PROCEDURES

Study Areas

Antelope populations are distributed sporadically throughout southeastern Oregon. Consequently, two key areas were designated and investigated intensively for this study: the Hart Mountain area, located on a portion of the Hart Mountain National Wildlife Refuge; and the Drakes Flat area, situated 11 miles west of Plush, Oregon. Both areas were defined ecologically by Hansen (56, p.9-11). Figure 1 illustrates the approximate present range of antelope in Oregon and marks the location of the two study areas.

Field Observations and Collections

There were many different factors affecting the survival of pronghorn antelope in Oregon. Some factors could be studied by observation while others required collections for close examinations; therefore, both methods were employed.

The observational studies included notes on animals in distress, reactions to weather, kid mortalities, and periodic herd counts. Field men were constantly on the alert for antelope in distress. In the few cases that were noted, the morbid animals were transported to a veterinarian for post mortem examination.

During the 1954-55 winter, trips were made throughout the range to investigate herd conditions and verify reports of antelope winter kills. Notes were taken on pronghorn reactions to weather, seasonal movements, feeding habits, preferred habitats, and sex and age ratios.

Kid mortality studies were concentrated in the months of May, June, and July. During the parturition season, kids were ear tagged for possible later identification. At the same time, records were taken on the kids' general health condition. External parasites and blood samples were collected, cultures of diseased tissues obtained, and the frequency of "scours" was investigated. When possible, a veterinarian accompanied the field workers to collect data on the physical condition of the new-born kids. The method of catching antelope kids was essentially the same as described by Hansen (56,p.19) except that the use of horses for rapid transportation was a decided improvement.

Periodic herd counts were taken in an attempt to correlate seasonal populations with specific survival factors. Winter aerial census figures were obtained from the Oregon State Game Commission records. Summer counts were accomplished by the Oregon Cooperative Wildlife Research Unit workers in conjunction with personnel of the U. S. Fish and Wildlife Service on Hart Mountain National Wildlife Refuge and the Oregon State Game Commission on the Drakes Flat Study Area. Generally, workers of the Research Unit conducted ground counts by walking, on horseback, or in automobiles. At times, the Research Unit men were aerial observers in the flight counts conducted by other agencies. Whenever possible, the ground and aerial counts were made on the same dates.

Collections were made of animals in distress, fresh carcasses from road kills and illegal kills, adult does obtained during the

1955 fall and 1956 spring reproductive potential study on Drakes Flat, and hunter kills collected at random throughout the state during antelope seasons. Pertinent information taken from fresh specimens included:

a. Mandible and metacarpal measurements for aging techniques
b. Blood and pathogenic tissues or organ samples for disease examinations
c. Stomach samples for food analyses
d. External and internal parasites
e. Body temperatures
f. Weights and body measurements
g. Reproductive tracts for fetus counts

While each of the above items was probably a complete research project by itself, the limited knowledge gathered regarding their importance was valuable data in trying to determine factors affecting antelope survival. Mandible and metacarpal measurements were determined by methods described by Dow (48) working in Montana during 1951. Although it was not known whether Dow's work was applicable to Oregon herds, no other aging techniques were known; consequently, Dow's methods were employed. Blood samples, as well as parasite and disease collections, were sent to laboratories for further examination.

Information recorded from carcasses found during field checks included habitat, date found, estimated date of death, sex and age, and remarks on the carcasses' condition. The mandible and one metacarpal were retained for subsequent aging. After the recording, a

small stone cairn was constructed on the bones to eliminate the possibility of a recount at a later date. It was evident that workers on horseback were able to locate more carcasses than a person walking. The best procedure for a thorough search was obtained by working the study area in transect lines of 75 foot intervals.

In the course of the field studies, predatory animal scats were collected and recorded by identifying symbols, location, and date. After a year's accumulation, the specimens were shipped to a laboratory for analysis. Stomach samples taken during the investigation were saturated in ten per cent formalin, strained, packaged, and mailed to cooperating research laboratories.

The methods and findings regarding body temperatures, weights, measurements, and reproductive potential studies were undertaken as a separate report to be published elsewhere.

FINDINGS

Mortality may occur throughout the life span of antelope from the fetal period to old age. A high death rate was especially noted during the first three months of the animal's life. The lack of an aging technique prohibited the accurate recording of information on age at death.

Prenatal and Parturition Deaths

In table 2 are listed seven adult does and 14 fetal carcasses located during the study period. Prenatal and parturition deaths recorded therefore accounted for 14 of 370 carcasses located, or a known incidence of four per cent during the two year study. Fetal carcasses were generally found from several months to two years after the time of death. Hansen (56, p.72) suggested complications at birth and abortion as possible causes for six of the 14 fetal carcasses.

Field research workers uncovered the following evidence which indicated that complications at parturition were a possible mortality factor. The first case listed in table 2 is one where the head of a fetus was found between the two sides of the pelvic girdle of a doe carcass. This indicated that the doe died while attempting to give birth. A second fetus remained in the doe's abdomen. The next to the last case listed in table 2 records a doe carcass still containing twin fetuses on June 15, 1955, which was very late for the 1955 kidding season. This may indicate a relationship between the death of the doe and her apparent failure to bear the twins during the normal

kidding season for antelope in Oregon which occurs from May 15 to June 10.

The remains of one lone carcass, located during the summer of 1954 on Drakes Flat, were from a fetus. The animal's metacarpal was 104 mm.; consequently, it was approximately 45 mm. shorter than the minimum size of a new-born kid's metacarpal. Only the legs of the fetus were found.

Recorded data pertaining to prenatal deaths in big game animals appeared to have been meager. Robinette, et al (102, p.128) reported 18 instances of fetal mortality or 1.90 per cent, for 945 mule deer, Odocoileus heminous heminous (Rafinesque), fetuses examined in Utah. Taber(116) relates his findings of four abortive fetuses in a sample of 251, or an incidence of 1.55 per cent among deer, Odocoileus sp., specimens collected in California. Dow (48, p.11)wrote that one kid was born dead in two sets of twins observed during an antelope kidding season studied in Montana. Field biologists from Colorado reported a yearling doe died while in the process of giving birth to a kid (37, p.66).

A combination research project of tagging antelope kids in the wild and raising kids in captivity on Drakes Flat brought forth data pertaining to the occurrence of possible congenital deaths. One case history was recorded from time of parturition to death for a kid that was believed to have died due to a congenital deformity. The kid was observed as it was born, one of a set of twins, at 10:50 a.m., May 28, 1956. Although extremely large at birth, 10½ pounds as compared to an

Table 2

Cases of Antelope Prenatal and Parturition Deaths on Hart Mountain and Drakes Flat, Oregon, from June 1954 to July 1956

Case	Location	Date of Death	Date Found	Remarks
Doe carcass, 2 fetuses	Drakes Flat	1952*	July 1954	Doe probably died while trying to give birth, as fetus found in pelvic girdle
Fetus carcass	Drakes Flat	Spring 1954	June 1954	Determined a fetus by canon bone measurements
Doe carcass, 2 fetuses	Drakes Flat	May-June 1954	July 1954	Fetuses 10 feet from doe. Birds had eaten on carcasses, believe pulled fetuses out of doe.
Doe carcass, one fetus	Drakes Flat	Spring 1955	May 1955	Doe died before giving birth. Believe fetus was about 3/4 developed.
Doe carcass, 2 fetuses	Hart Mountain	1953*	July 1955	Canon bone measurement showed fetuses to be near birth age
Doe carcass, 2 fetuses	Drakes Flat	May-June 1955	July 1955	Fetal carcasses 30 feet from doe. Animals had eaten parts of carcasses
Doe carcass, 2 fetuses	Hart Mountain	June 13-15, 1955	July 1, 1955	Doe carcass seen about 6/15/55, but no fetuses. Fetuses then seen 7/1/55 near doe; believe fetuses pulled out by birds
Doe carcass, 2 fetuses	Drakes Flat	June 1956	June 1956	Animals died in June as area was checked in late May
TOTAL	7 does; 14 fetuses			

*Death was either of this or a previous year.

average kid weight of 7 to 8 pounds, it appeared normal from external appearances. Two and a half hours after birth, the kid was collected and transported to the field quarters where an antelope kid raising program was under way. An attempt was made to raise the animal, but it died 33 hours after birth. Prior to death, the young animal refused to eat, became listless, and remained prostrate. After death, a post mortem examination was made by Dr. V. Hill, veterinarian of Lakeview, Oregon. His autopsy report (145) follows:

> "On immediate autopsy, a minor hernia was found involving about 2 inches of small intestine through the ventro-lateral abdominal muscles, penetrating thru to the skin. It did not involve the inguinal rings. The intestine in this hernia was only beginning to show the effects of strangulation.
>
> "A very large hernia was found involving the entire ansa-spiralis that had shifted to the left side and segments of the small intestine penetrating dorso-laterally thru the left lateral border of the ilio-psoas muscles and dorsally over the lumbar region to the skin.
>
> "Apparently the hernia had obstructed all intestinal circulation of blood within the hernia. It showed the typical characteristics of an early infarction; there was extreme engorgement of blood and discoloration of the intestine.
>
> "Complete obstruction of the lumen was apparent in both hernias.
>
> "The lung was emphysematous, which was considered to have been post mortem change. There was no petechiation found, and other organs were apparently normal.
>
> "My diagnosis was that the kid died of toxemia caused from the strangulating hernias, both of which were probably congenital."

This is believed to be the first authenticated case of a possible congenital death recorded in antelope literature.

The twin of the above antelope also had a short life span. Two days after birth, it was recaptured and appeared healthy. Three days later it was found as a carcass and appeared to have been dead for approximately two days. This set of twins therefore became mortality victims in less than a week after date of birth, figure 2.

Old Age

The extent of old age mortality in Oregon antelope herds is unknown. One reason for this is the absence of an accurate method for aging antelope. Einarsen (50, p.72) believed that old age deaths accounted for many of the adult carcasses found on the range. He based this statement on finding several dead antelope in the following condition: incisors "pegged" or even gone, body emaciated, and pelage rough.

Findings of antelope carcasses with characteristics of old age were also noted during this study. A fresh adult doe carcass, possibly the result of a road kill, was obtained on Drakes Flat in January, 1955. She was very thin and her molars and premolars were worn to the membrane of the mandible. Only one incisor remained and it was "pegged". During the 1955-56 reproductive study, an adult doe was obtained that manifested signs of extreme old age. She possessed one fetus and had only two incisors.

From carcasses collected on Drakes Flat in 1955, notes were taken on 89 jawbones. Four animals in this group were found to have missing or "pegged incisors" and extensively worn molars.

Figure 2. A set of antelope twins that died within one week after parturition on Drakes Flat in May, 1956.

Buechner (26, p.297) listed seven old age deaths out of 84 mortalities located in Texas.

Diseases

For the purpose of this study, Dorland's (47, p.447) definition of a disease was used: in general, any departure from a state of health; an illness, a sickness, or more specifically, a definite morbid process having a characteristic train of symptoms. It may affect the whole body or any parts, and its etiology, pathology, and prognosis may be known or unknown.

Knowledge of diseases affecting antelope in Oregon as of September, 1956, was very limited, possibly because there were so few records of antelope disorders. The diseases credited in the past to antelope have been for the most part clinically examined cases and few were laboratory diagnosed. Even fewer instances were reported of diagnosed cases based on combined clinical and laboratory findings.

Appendix A records an annotated list of diseases afflicting pronghorns in North America. This table indicates that research uncovered only one possible epizootic report in North American antelope herds. The case occurred in the summer of 1873 when an unknown fatal epizootic raged among antelope herds between the Yellowstone and Missouri Rivers. The greatest losses were reported in July when both sexes and all age groups died.

Cases of diseases observed during the current project were limited to a relatively few individual animals, Appendix A, and each

case is discussed in detail under the appropriate disease title in this chapter.

It should be clearly pointed out that it was difficult to diagnose a disease since a normal or healthy condition was not always known in antelope. Our general definition of a disease was defined as any departure from a state of health; therefore, it became apparent that a diagnostician of diseased antelope had to be familiar with healthy pronghorns. This would have been an extensive study in itself. Consequently, the following listed diseases were recorded from observational examinations and were not based on final diagnosis findings, since it was not always possible to receive laboratory confirmation.

Keratitis (Pinkeye)

Symptoms of keratitis in antelope included the following: a watery discharge from the eye, the discharge later becoming purulent, swelling of the eye, cornea becoming opaque in variable degrees, and the diseased animal's inability to travel easily because of partial or complete blindness.

From information tabulated in table 3, keratitis was known to have been reported in Oregon antelope herds since 1937. Of the 11 records listed, nine were reported in winter or spring. A breakdown of six age-known cases presented one kid, three yearlings, and two adults afflicted.

A yearling doe with a severe case of keratitis was caught on

Drakes Flat by two men in March, 1955, figure 2. An account of the episode from field notes taken at the time is related below to acquaint wildlife technicians with symptoms of keratitis observed in a wild animal:

March 4, 1955 -- Friday. Drakes Flat, Lake County, Oregon. 3:00 p.m.

Saw lone antelope walking in harvested hay meadow (Twelvemile Creek).

1. Appeared, and later found to be, a yearling doe.
2. Kept walking around with head low to the ground.
3. Walked in a peculiar manner: walked a little, ran a little, no definite gait.
4. Watched for about a half hour, whereupon it came in contact with a barbed wire fence and followed along same up and over a hill.
5. Followed animal and came within 75 yards, when it bolted into a fence some 50 feet away, backed off, and ran up the hill.
6. A quarter of a mile away, it lay down in a field of short grass.
7. Appeared to look straight at me when I was some 150 feet away, but acted as though it did not see me.
8. Stalked to within 25 feet by approaching from rear;
   a. Could see discharge from both eyes.
   b. Eyes seemed to be closed.
   c. Hair was standing straight up over most of body
9. Suddenly it turned its head towards me, for it must have sensed me, then jumped up and ran straight for a barbed wire fence approximately 100 yards away.
10. Hit fence hard and straight-on, struggled until it went through and continued in a straight path east.
11. Ran into a five foot bitterbrush, Purshia tridentata Pursh, and fell down, up again, and continued running.

Figure 3. A yearling doe totally blind. The diagnosis was keratitis. (Photo by Frank Grogan)

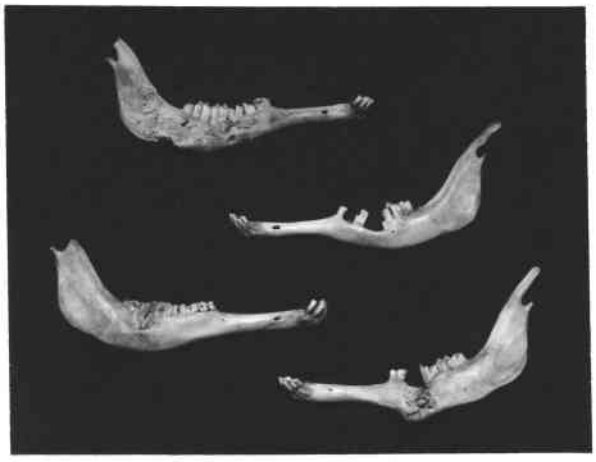


Figure 4. Four antelope mandibles with missing teeth and rarefying ostitis caused by "lumpy jaw".

12. By now apparent that I was not going to catch it, so had dog chase with hopes of altering the antelope's course.

13. The dog overtook the antelope in a chase of about 200 yards, then ran in circles around it. The antelope maintained its original direction, though interfered by fence, brush, and dog.

14. The antelope continued for about four miles when it began to get dark and I lost sight of the animal.

March 5, 1955 -- Saturday. 1:00 p.m.

Arrived in area had seen animal last.

1. Found tracks in fresh snow of a single antelope milling around in circles covering an area of a hundred yards.

2. Located a small pool of blood where animal had lain down.

3. Two piles of fresh fecal droppings and fresh urine were located in snow.

4. Found animal within 200 yards of this area. Believe it did not leave area since last night.

5. Animal was bedded down and had been all the time two men were working around the area.

6. Allowed us to walk within 50 feet.

7. Arose and started running away. Appeared to be more stiff in traveling than yesterday.

8. Ran some 400 yards when it came into an area of large rocks and juniper, Juniperus sp., trees.

9. Stopped often and appeared baffled as to which way to run.

10. Ran straight into a juniper tree.

11. Ran straight into a second juniper tree where it became entangled and was caught.

12. Blatted like a sheep, loud and for several minutes.

13. Did not struggle much after being caught.

14. Pupil of one eye out, bleeding around eye.

15. One shoulder was exposed down to flesh (possibly from running into fence).

16. Photographed animal, see figure 3.

17. Tied feet and loaded into jeep.

18. Animal rode in back of jeep and did not struggle.

19. Transported antelope to Corvallis, Oregon.

The animal was examined the following day at the Oregon State College Veterinary Diagnostic Laboratory. The diagnosis report (8) was keratitis. The autopsy examination also revealed that the specimen had approximately 3,400 intestinal worms and was devoid of adipose tissues.

Eye disorders were reported in two pronghorn cases by Buechner (26, p.317) in Texas. Both were emaciated adult bucks with apparent cases of "pinkeye". Similar cases were reported in Wyoming (61, p.36) and Colorado (40, p.24).

Actinomycosis and Actinobacillosis (Lumpy jaw)

These two diseases will be discussed together for they have similar causative agents when viewed under the microscope and both are infections of the mouth. Actinomycosis is usually a chronic infectious disease chiefly affecting cattle and caused by the bacteria Actinomyces bovis: it generally attacks the bones in the head, causing rarefying ostitis, figure 4. Actinobacillosis is a chronic infectious disease affecting mainly the soft parts of the head of livestock; it is characterized by abscesses and fistula with thick connective tissue walls and is caused by Actinobacillosis

Table 3

Reports of Blinded and Keratitis Diseased
Antelope in Oregon from 1937 to September 1, 1956

Literature Cited	Date of Disease	Sex : Age	Remarks
Meyers (83)	5/23/37	♀ Adult	Eyes discharging, scum over one eye
Jacobs (63, p.1)	3/5/40	♀ Yearling	Left eye ulcerated, scum on right eye
Norton (87)	3/40	one antelope	Totally blind from keratitis
Shaw (107)	2/40	one antelope	Inflammation of the cornea
Branson 23, p.10)	6/12/40	Kid	Completely blind. Believe 36 hours old
Adams 2, p.7)	Winter or spring, 1947	♀	Blinded by some eye affliction
Adams (3)	Winter, 1950	one antelope	One case "pinkeye" in 448 antelope seen
Adams (4, p.5)	2/19/51	one antelope	Evidence of blindness, in large herd
Hansen (56, p.82)	1953	♂ Yearling	Left eye swollen and discharging
Nelson (86)	6/21/54	♂ Adult	Apparently had trouble seeing
Allen (8)	3/5/55	♀ Yearling	Totally blind, heavy load intestinal worms
Einarsen (50, p.74)	develops in spring	cases in herds	Possibly transmitted during winter concentrations
TOTAL			11 individual cases

lignieresi (121, p.587) Laboratory tests were needed to differentiate these two closely allied pathogens.

A complete etiology of these afflictions to antelope was not accomplished since the disorders were noted only through clinical diagnosis. Possible cases of actinomycosis were observed more frequently than instances of actinobacillosis since more bone than soft tissue was examined. Figure 4 depicts four antelope mandibles with varying degrees of suspected actinomycosis. The loss of teeth and the different stages of bone growth abnormalities were symptoms of the disease.

From a total of 293 antelope carcasses, table 4, examined in 1954 and 1955 on the two study areas, possible actinomycosis cases were in evidence seven times and actinobacillosis was believed to have occurred only once. All the diseased mandibles and maxillas were from adult animals having a sex ratio of six females to two males.

Table 4

Records of Possible Actinomycosis and/or Actinobacillosis Occurring in 238 Antelope Carcass Jawbones Collected on Drakes Flat, Oregon, from 1952 to 1955

	Carcasses Classified as to Year of Death							
	1952		1953		1954		1955	
Study Period	Total jaws	% infected	Total jaws	% infected	Total jaws	% infected	Total jaws	% infected
1954*	35	10	33	39	24	20		
1955	(Classified under 1954)				63	9.5	83	2.0

*Hansen (56, p.82)

Skinner(110,p.111) provided one of the first records of "lumpy jaw" in antelope herds of North America. He stated that Yellowstone Park elk, deer, and antelope died from this disease and in the case of antelope, it was particularly virulent. Rush(105,p.105) examined 13 antelope in Montana and noticed that six possessed evidence of ulcers in the mouth. Biologists in South Dakota recently completed work in which they recorded positive identification of the micro-organisms Actinomyces sp. and Actinobacillus sp. in pronghorn antelope (20, p.214) Buechner (26, p.634) reported a thin adult doe found dead with a case of "lumpy jaw" on January 22, 1930 in Oklahoma.

Necrotic stomatitis

Necrophorus stomatitis is a disease characterized by lesions in the mouth and caused by the bacteria Spherophorus necrophorus. The lesions appear as caseous, grayish-yellow areas and may be present on the mucous lining of the mouth and on the dental pad. Sometimes the lesions involve the jawbones and roots of the molar teeth and occasionally pronounced protuberances on the outside cheek are noticed, in which cases wads of feed become impacted in the lesions (61, p.18). This form of lump jaw should not be confused with the "lumpy jaw" condition so susceptible to cattle which is due to an infection by the different bacteria, Actinomyces bovis, page 22.

On June 24, 1955, an adult buck carcass, approximately one day old, was located on Drakes Flat and presented for autopsy. A report of the post mortem examination stated that abscesses were noted at the base of the horns and in the lungs. Bacteriological studies of

infection revealed an isolation of Spherophorus necrophorus organisms (10). It was not known whether this disorder caused the death of the animal.

Diarrhea (Scours)

Diarrhea is the too-rapid passage of intestinal materials and liquids through the bowels. It is apparently a method of discharging bacterial, nutritional, parasitical, or other irritative substances from the intestines.

"Scouring" was observed to affect particularly young kids, although occasionally it was noted to afflict adults. Symptoms were thin, watery, foul-smelling bowel discharges, and adherence of yellow-green, sticky, fecal material to the anal region. In the case of kids, a question was raised as to whether "scouring" was normal or abnormal. Of 51 young antelope examined during the 1955 kidding season, 10 manifested signs of diarrhea and in 1956, two of 29 kids were noted to have "scours". In one case, a kid was caught within a day or two after birth and was noticed to have severe symptoms of "scouring". It was recaptured a week later and only two small flakes of dry fecal material adhering to the tail remained as evidence of the previous condition. In no instance was "scours" noted among depressed animals during the 1955 and 1956 kidding season. Dr. Paul Allen, D. V. M., (93, p.130) stated that the possibility of diarrhea in very young kids could have been brought about by the excretion of the meconium (first fecal material) and/or perhaps the fecal material

after the kid had taken colostrum (first milk suckled by a new-born kid).

A history of "scours" in Oregon antelope reports date back to 1940 (23, p.10) when it was recorded in the Hart Mountain area. Since then the disorder has been repeatedly cited in Oregon State Game Commission district agent's monthly reports (77, 78, 32, 34).

Game management personnel from California (60, p.1) reported that "Scours appear to be fairly common among young kids". A Nevada antelope kid collected in 1954 with a severe case of diarrhea was taken to a laboratory for treatment. The case of diarrhea was diagnosed as a dietary intestinal upset as it cleared away soon after the kid was fed a diet of cow's milk (60, p.1).

Escherichia coli

Escherichi coli is a bacteria commonly found in the intestinal tract of various animals. It frequently assumes marked pathogenicity when it gains entrance to, or is introduced into other parts of the body than the intestinal tract (66, p.274-277).

On September 8, 1956, Frank Grogan of the Oregon State Game Commission, with the aid of an assistant, caught an adult doe antelope on the Hart Mountain National Wildlife Refuge. The animal was found lying in a creek and appeared paralyzed in the hind quarters. Her temperature on the evening of September 8 was 92 degrees Fahrenheit, which was possibly eight to ten degrees below normal. The doe died during the night and a post mortem examination was conducted September 10, 1956.

Dr. Victor Hill, veterinarian of Lakeview, performed the autopsy. His report (59) follows:

> "About 1/3 to 1/2 of the liver was involved in one large purulosanguinous type of abscess; there were numerous small abscesses in the liver; no flukes were found, but the liver was badly deteriorated by this time.
>
> "The left kidney was surrounded by a pocket approximately 4-5 inches in diameter that had fluid in it which appeared to be a mixture of unclotted blood and pus. The fluid was similar in appearance to the material in the big liver abscess except that the latter had a greater concentration of pus.
>
> "Sample was taken from liver and sent to lab."

The sample specimen was mailed to the Diagnostic Laboratory, School of Veterinary Medicine, Colorado A. and M. College, Fort Collins, Colorado. Dr. M. A. Hammarland, pathologist in charge, reported (55) the laboratory diagnosis as Escherichia coli.

Enterotoxemia (Pulpy kidney disease)

Enterotoxemia is usually an acute, often fatal disease found in highly fed, well-nourished livestock. Staggering, convulsions, and sudden death are frequent. The post mortem changes are similar to those of acute indigestion in ruminants (121, p.117).

Enterotoxemia was first reported as a possible disease in antelope herds of Oregon by Hansen (56, p.80). This report followed Dr. Victor Hill's, veterinarian of Lakeview, examination of two antelope kids with symptoms that he strongly suspected as having enterotoxemia, but he was unable to obtain laboratory confirmation.

Brucellosis (Bang's Disease)

Brucellosis is an insidious disease caused by the bacteria, Brucella sp. It affects both livestock and wildlife. When transmitted to man, the disease is called "undulant fever" or brucellosis. The symptoms of brucellosis in livestock are rather inconsistent and indefinite with abortion being the most commonly known evidence of infection; however, a positive diagnosis can apparently be determined only after having made blood-agglutination tests (123, p.505), milk tests, or whey tests.

Although pronghorn herds in Oregon were not suspected of possessing this disease, antelope blood samples were collected and later examined by personnel at the Department of Veterinary Medicine, Oregon State College. Over 50 adult blood samples were tested for brucellosis from 1954 to September 1, 1956, and all were reported negative.

Records could not be found of brucellosis infecting antelope herds of North America. However, it was reported pathogenic to buffalo, Bison sp., and elk, Cervus, sp., in Yellowstone Park, Wyoming, according to Tunnicliff and Marsh (120).

Leptospirosis

Leptospirosis is a disease in which spirochaetes are found in the blood of livestock and wild animals, but the pathogens etiological significance is not at present clearly understood. Consequently,

antelope blood samples checked for brucellosis were also tested for leptospirosis. All samples were reported negative.

Anaplasmosis

Various unauthenticated reports were heard in the field regarding antelope as vectors of anaplasmosis. Mr. L. L. Osteen (90) of the U. S. Department of Agriculture Research Service made the following comment on present knowledge of antelope as possible carriers of anaplasmosis: "We have had no previous experience in testing antelope sera for anaplasmosis and thus we have established no criteria to evaluate and interpret the results of the complement-fixation test for anaplasmosis in antelope".

Pneumonia

An adult buck was observed May 22, 1956, thrashing about while in a prostrate position on Drakes Flat. Two field men approached the animal, whereupon it attempted to escape but was unable to travel because of uncoordinated hind quarters. The animal was collected and an autopsy revealed an abscess in the thoracic cavity near the dorsal aorta which extended up into the spinal canal causing damage to the spinal cord. The post-mortem report (12) also stated that the buck suffered from pneumonia, which in all probability was secondary, caused by the animal's previous prostrate position.

Streptococcus

Streptococcus is a bacterial organism that may produce a variety

of pathogenical conditions (66, p.251).

To date, two known infections of this micro-organism have been reported in antelope of Oregon (11). Both animals were adult does collected during the spring of 1956 on Drakes Flat. The does appeared healthy and normal except for the following autopsy notations:

Antelope #251. Possessed an abscess (24 mm. in diameter) between the right mandible and the mucous membrane. The abscess was full of a purulent, yellowish exudation. The mandible was also involved. A culture was taken and a streptococcus isolated. No Actinomyces present.

Antelope #256. When first collected, the doe was noticed to be passing a discharge from her vagina. A post mortem examination stated: Metritis. Uterus enlarged and walls thickened, filled with muco-purulent exudate---a gram negative rod and a streptococcus isolated from uterus. No fetus.

Doe number 256 might not have given birth to young during the 1956 kidding season since the disease-producing bacteria could have probably killed the fetuses.

Corynebacterium

This is another bacteria micro-organism that appeared three times during antelope post mortem examinations conducted in this project.

On May 24, 1955, a set of twins, approximately two to three days old, were captured and ear-tagged. One kid had a navel infection which resulted in the umbilical cord being swollen approximately one centimeter in diameter and extending into the animal's body approximately 2.2 centimeters. The scab was removed, a sterile sample was obtained and cultured by Miss Marjorie LaSalle, bacteriologist at

at the Oregon State College Veterinary Diagnostic Laboratory. A corynebacterium was later isolated and further work was undertaken to positively identify the suspected pathogen.

After the culture was received from the kid in the field, he was released, for it was thought there was a good chance of the infection walling off and the animal regaining its health. However, the kid was found dead three months later approximately one-half mile from where it was tagged. The cause of death was not determined as the carcass was too decomposed for a post mortem examination and no other evidence was visible.

The mature buck reported on page 31 as being paralyzed and afflicted with pneumonia, also had an abscess from which a corynebacterium-like organism was isolated. Paralysis was due to the abscess and the animal was unable to move its hind quarters. A prognosis of the animal's life duration would possibly be only a few days based on the effects of the two diseases.

A third antelope was collected during this study from which a corynebacterium was isolated. This was an adult doe obtained in May, 1956. One-half of her udder was abscessed and filled with a tenacious yellow purulent exudate from which the corynebacterium was obtained. It was doubtful whether the doe would have raised more than one kid due to a lack of milk (12, p.129).

Subcutaneous abscesses

Diseases of this type were characterized by abscession of the

subcutaneous tissues and possibly were additional cases of corynebacterium. Of the four diseased specimens examined during the study, all the abscesses were located in the head or neck region. The abscesses contained purulent material and appeared as a caseation, while the coloring was from pale green to greyish yellow.

Hansen (56) reported the case history of the first specimen collected on Hart Mountain. The animal was observed with an apparent swollen head, whereupon it was collected and given a post mortem examination. The autopsy report stated that a pathogen was isolated from the facial lesion and classified as a Pasteurella-like organism; but it could not be stated whether this was the primary cause of the lesion or a secondary invader. The diagnosis was diffused subcutaneous necrosis.

A second case of this disease was brought to the field workers' attention when a fresh adult buck carcass was found in January, 1955, by Oscar Deming, Hart Mountain National Wildlife Refuge, and Norman Minnick, Oregon State Game Commission. The carcass was given a post mortem examination by Dr. Paul Allen. His report (7) stated: "Autopsy revealed the entire dorsal and lateral surfaces of the head to be involved in an abscessation of the subcutaneous tissue to the extent that the skin was destroyed or raised--at some points as much as two inches. There was no evidence of any bone involvement whatsoever, and the regional lymph nodes appeared free of the disease. Due to its having been frozen and then thawed, the remainder of the carcass was difficult to evaluate as far as the lesions were

concerned. Cultures of the purulent material resulted in the isolation of a gram negative rod which was very pleomorphic. In all probability, this was not the organism that caused the animal's death."

Two more cases of subcutaneous abscesses were obtained from antelope killed by hunters in 1955. These abscesses were located at the base of the horn and in the neck region. Cultures from one of the abscesses resulted in an isolation of a non-pathogenic micrococcus. This could or could not have been the cause of the abscess (10).

Parasites

The term parasite, as used in this paper, refers to forms of plant or animal life living upon or within another living organism and at whose expense it obtains some advantage without compensation (113, p.1073). Symptoms of parasitism vary with the position of the parasites in the host, and seldom are observed unless they are present in large numbers or when infestations are combined with inadequate nutrition or other diseases. External parasites may cause itching, dry skin, rough coat, or loss of hair. Internal parasites may cause unthriftiness, emaciation, malnutrition, constipation, diarrhea, dizziness, muscular pains, jaundice, anemia, cough, or abscess formations (54, p.477).

Examinations for parasites in Oregon antelope herds were made by the following methods:

1. Post mortem examinations of 36 animals collected in the

field: three were taken alive for autopsy, 25 were collected by shooting, and eight were found as fresh carcasses.

2. Collections of viscera, blood, and abnormalities from 69 antelope during the 1954 and 1955 hunting seasons.
3. Obtaining fresh fecal pellets in the field and microscopically examining them in a saturated solution of sodium chloride.

Post mortem examinations and diagnostic work were conducted by local veterinarians, members of the Oregon State College Veterinary Diagnostic Laboratory, staff from the California Fish and Game's Disease and Food Habits Laboratory, and Oregon Cooperative Wildlife Research Unit field workers.

Tables 5, 6, and 7 list external and internal parasites affecting antelope herds in Oregon, and for comparison, Appendix B lists internal parasites of antelope throughout North America excluding Oregon. Appendix C is a combination listing of external parasites affecting antelope in Oregon and the rest of North America.

A few of the important parasites found infesting antelope are discussed below as a means of emphasizing their scope and significance to the pronghorn's welfare.

Trematodes. Previous to this antelope study there were believed to be no records of liver flukes parasitizing North American antelope.

In December, 1955, an antelope was collected and discovered to

have the common liver fluke, Fasciola hepatica Linnaeus, by P. Rodney Canutt. The animal was an adult doe appearing in good health and carrying twin fetuses. She was collected on Drakes Flat. Seven adult flukes were uncovered from the liver and five fluke eggs were obtained from the gall bladder. The parasites were identified by Dr. Paul Allen, Department of Veterinary Medicine, Oregon State College, and confirmed by Dr. Allen McIntosh, parasitologist, Agricultural Research Center, Beltsville, Maryland. Lesions in the liver were examined by Dr. Paul Allen and reported as apparently not being pathologically significant. Five liver flukes were recovered from another adult doe collected on April 14, 1956, at Drakes Flat (11). This doe also appeared in good physical condition and possessed two fetuses.

Cestodes. Tapeworms are one of the most common representatives of cestodes in ruminants. A tapeworm was obtained from the viscera of an adult antelope buck on Drakes Flat Study Area by P. Rodney Canutt and the writer during the 1955 hunting season. This was believed to have been the first tapeworm record for antelope as host to these cestodes in Oregon. Additional later investigations recorded (11) three antelope with minor infestations of Moniezea expansa (Rudolphi) in 22 animals examined from November, 1955, to May, 1956.

Tapeworms were reported in antelope from Texas (26, p.316), Wyoming (61, p.120), North Dakota (52, p.639), and Colorado (40,

Table 5

Records of Internal Parasites Obtained from Antelope in Oregon

Parasite and Literature Cited	Number of Parasites	Location of Parasites	Host Data	
			Age	Sex
Nematodirus longispciculata antilopcaprae	more than 1,000	abomasum	Yearling	♀
" " (11)				
" " (108, p.6)		intestine		
" " (11)	Less than 100 parasites in 20 different animals		Adults	♀♀
Nematodirus helvetianus (?) (6)	more than 100	abomasum	Adult	♂
" sp. (8)	more than 3,000	small intestine	Yearling	♀
Ostertagia trifurcata (127)	20	abomasum	Adult	♀
" *ostertagia* (127)	20	abomasum	Adult	♀
" sp. (8)	3	abomasum	Adult	♀
" sp. (9)	4	abomasum	Adult	♂
" sp. (11)	less than 100 parasites in 20 different animals		Adult	♀♀
Moniezia sp.	4 segments	intestines	Adult	♂
" *expansa* (11)	3 of 20 animals were afflicted		Adult	♀♀
Fasciola hepatica (11)	7 adults, 5 eggs	liver; gall bladder	Adult	♀
" " (11)	5 adult	liver	Adult	♀
Eimeria zurnii (?) (128)	abnormal amount of ova	from fecal examination		

p.26). Goldsby and Eveleth wrote that seven per cent of 95 animals were infested by these endoparasites in North Dakota (52, p.639).

Nematodes. Nematodes constitute a group of rather slender cylindrical parasitic worms that are more or less attenuated at each end. Their sizes range from a fraction of an inch to about a foot long. They are among the most injurious parasites to domestic stock causing anemia, stunting, emaciation, and many other serious conditions (123, p.133).

Appendix B lists 15 genera and 22 species of nematodes affecting antelope in North America, excluding Oregon. Table 5 lists three genera and four species of nematode parasites obtained from pronghorns in Oregon and adds Ostertagia trifurcata Ransom as a new parasite species to antelope in the United States. The Ostertagia trifurcata Ransom specimen was obtained from the abomasum of an adult doe collected on Drakes Flat in June, 1954.

Most early investigators (50, p.75; 110; 75, p.4; 40, p.22) agreed that antelope were generally free from heavy infestations of parasites with the exceptions being in areas of herd concentrations or where pronghorns share range heavily utilized by domestic stock. This held true for the current study except in the case of yearling animals. A yearling doe collected on Drakes Flat in March, 1955, contained over 1,000 Nematodirus sp. (8). Another yearling doe possessed over 1,000 Nematodirus longispiculata antilocaprae (11).

Twenty adult animals were collected at the same time and location the above yearlings were, but the adults only contained light (1 to 100 parasites) cases of infestation.

Although working with black-tailed deer, Odocoileus heminous columbianus (Richardson), Longhurst (71, p.11) collected data that indicated the susceptibleness of young animals to parasitization. He stated: "...parasites can contribute significantly to losses of fawns during their first winter and to a lesser extent to the losses of yearlings during their second summer. Fewer older deer carry sufficient numbers of worms to be affected. Likewise the magnitude of losses involving parasitism can be increased by severe weather and overstocked conditions.."

Both Wyoming and South Dakota have conducted recent work on parasites of antelope that becomes significant when compared to parasite studies from other states. Bever (20, p.16) wrote: "In South Dakota the antelope kid mortality appears to average between 30 and 60 per cent of the annual crop. Most of these losses are believed to be caused by internal parasites." A similar report was made by biologists from Wyoming (126, p.411) when three antelope kids were examined and found to have heavy parasite infestations. Had the number of stomach worms present in this case been present in an adult sheep, it was believed the sheep would have died in several months. An example was stated where 1,519 nematodes were taken from the small intestines of one antelope kid. Honess and Winters (61, p.175) associated parasites to "scouring" in Wyoming studies and

pointed out that the relationship of heavy parasite infestations was correlated to areas inhabited by domestic sheep.

Beginning in January, 1956, and continuing until July 1, 1956, random samples of antelope fecal droppings were collected from the Drakes Flat Study Area, table 6. Ten pellets from one dropping group constituted a sample. The samples were examined by P. Rodney Canutt for frequency occurrence of endoparasite ova. The droppings were ground in a mortar and allowed to float in a saturated solution of sodium chloride. Microscopic examination disclosed 34.8 per cent of the droppings (23 parasitized of 66 collected) manifested evidence of nematode eggs.

Table 6

Number of Nematode Eggs Found in Antelope Fecal Droppings Collected on Drakes Flat, Oregon, from February 1, 1956 to July 1, 1956

MONTH	Number of Samples	Number Samples Parasitized	Total Eggs Found	Per cent of Samples Parasitized
February	23	9	150	39.1
March	19	5	28	26.4
April	16	7	37	43.7
May	6	2	3	33.3
June	2	0	0	00.0
Total	66	23	218	
Mean per cent of 66 samples parasitized				34.8

Insects. To date, it appeared that only one species of Insecta was a recorded parasite of North American antelope, table 7. This report was the hippoboscid fly, Neolipoptera ferrisi (57, p.16-25) collected from antelope in California. In 1943, one fly was obtained from a hunter's kill while two additional specimens, one from the upper lid and the other from an eyelid, were collected in 1944.

The apparent lack of other insect parasite records points to the conspicuous absence of lice, Mallophaga or Anoplura; and warbles or grubs, Gastrophilidae, Oestridae, Cuterebridae.

Arachnids. Ticks, Dermacentor sp., were the only known species of Acarina recorded to parasitize antelope.

Rush (105), working in Montana, and Buechner (26, p.316) in Texas, recorded ticks on antelope, although neither reported Acarina as serious parasites. Generally speaking, there were very few records of ticks affecting antelope populations in North America, Appendix C.

From the Oregon Cooperative Wildlife Research Unit's studies in the Hart Mountain National Wildlife Refuge region, the occurrence of ticks appeared rarely, table 7, except on young kids from the Drakes Flat herd. The occurrence frequency of these pests on kids was 16 per cent, or 8 kids of 51 examined during 1955. For the 1956 kidding

Table 7

Records of Ticks Parasitizing Antelope on the Drakes Flat Study Area, Lake County, Oregon from May, 1955, to July, 1956

Date Collected	Number of Ticks	Data Pertaining to the Host		
		Sex	Age	Area Tick Found
5/22/55	17	♂	Kid	Base of ear
5/27/55	2	♂	Kid	Base of ear
5/27/55	1	♂	Kid	Hind leg, inside
5/27/55	2	♀	Kid	Neck, ventral
6/ 2/55	1	♀	Kid	Under eye
6/ 4/55	3	♀	Kid	Base of ear
6/13/55	33	♀	Kid	Neck, ventral
6/16/55	6	♂	Kid	Base of ear
1/23/56	1	♀	Adult	Anal region
2/28/56	2	♀	Adult	Anal region
3/24/56	1	♀	Adult	Hind leg, inside
3/25/56	1	♀	Adult	Anal region
4/14/56	7	♀	Adult	Sternum
4/15/56	7	♀	Adult	Sternum and head
4/17/56	8	♀	Adult	Sternum and head
5/ 7/56	1	♀	Adult	Sternum
5/ 7/56	11	♀	Adult	Sternum
5/21/56	3	♂	Kid	Ear, front leg
5/22/56	6	♂	Adult	Sternum
5/23/56	1	♂	Kid	Front leg
5/25/56	1	♀	Kid	Ear
5/28/56	1	♂	Kid	Head
5/30/56	2	♀	Kid	Sternum, neck
5/30/56	5	♀	Kid	Under eye, ear
Total	123	16 ♀♀	14 Kids	
		8 ♂♂	10 Adults	

season, 6 of 29 kids were parasitized by ticks, or an incidence of 21 per cent. An observation in which a kid was infested with 13 ticks located in the head region within 48 hours after being ear-tagged and recaptured, indicates how quickly a week-old kid may obtain these external parasites.

In May, 1956, ticks were collected on Drakes Flat from two adult does that appeared in good health. These ticks were mailed alive to Dr. William Jellison, parasitologist, Rocky Mountain Laboratory, National Institute of Health, Helena, Montana. Jellison (64) had the ticks identified as follows: nine males and one female Rocky Mountain wood tick, Dermacentor andersoni Stiles, and the remaining two were winter ticks, Dermacentor albipictus Packard, females. These findings were believed to add the winter tick as a new parasite species to antelope herds in Oregon.

Nelson (85, p.45) reported two antelope died from the effects of ticks in Oklahoma, but no further data accompanied this statement.

Weather Conditions

Severe Winters

Only one report of a severe winter episode endangering antelope was noted in Oregon during the study. Larry Mitchell, a rancher located at the Rheinhart Ranch along the Owyhee River in Malheur County, reported the following disaster: December, 1951, and January, 1952, were months of heavy snows and the antelope drifted to

lower elevations; however, in late January the weather became much warmer, and the antelope herds moved back to the higher plateaus. Here they were caught in a severe snow storm during February. Between 75 and 100 antelope worked their way down to the Rheinhart Ranch, but even at the ranch the snow was too deep for successful foraging. Consequently, 20 to 25 head died from malnutrition before warmer weather set in. Two other animals became entangled in a four-strand barbed wire fence and succumbed.

Severe winters have been a direct factor on antelope populations as reported by Rand in Canada (100, p.9); Honess and Winters in Wyoming (61, p.266); Jones in Texas (65, p.24); Udy in Utah (122, p.20); and Knipe in Arizona (67, p.29). Causes of death were attributed to freezing storms causing chilling; deep snows affecting speed thereby making pronghorns easy prey for predators, and vulnerability to poaching.

From data presented in figure 12 it can be seen that relatively few antelope died on the project's two study areas during the 1954 and 1955 winters. Although higher than the fall percentage of deaths (12 per cent), the winter total (19 per cent) was less than either the spring (35 per cent) or summer (34 per cent) figures. Causes of known winter losses on the study areas were attributed to road kills (2), disease (1), and old age (1).

Light snows prevailed on the Drakes Flat range and rarely did

they exceed ten inches for more than three to five days during the 1954-55 winter. Antelope were under periodic surveillance and the herds appeared healthy and in good pelage with the exception of one adult doe. She was emaciated and lagged behind the rest of the herd.

Winter conditions were also favorable for antelope during the 1955-1956 season, even though heavier snowfalls forced the Drakes Flat herds to a 1,000 foot lower elevation. Two separate observations were made of kids possessing eye ailments. These eye disorders correspond with similar eye maladies noted during winter months, table 3.

Drought Seasons

Dry years were considered as a contributing lethal factor to antelope herds by Buechner (26, p.219), Jones (65, p.25), and Knipe (67, p.29), but the history of these cases was not described.

In Oregon, Stanley Jewett, biologist, U. S. Fish and Wildlife Service, reported a number of kid deaths (85, p.46) for the 1920's. Jewett believed the cause of these deaths was a sickness in the adults which was possibly a result of extreme drought and the inability of does to nurse their young properly. No further evidence was uncovered indicating drought years as a decimating factor to antelope populations in Oregon.

Natural Accidents

Miring in Mud

Historical records indicate that this was one of nature's early

methods of inflicting mortality to wild animals. Stock (114, p.46) related in his book that antelope were victims of the Rancho La Brea tar pits in California.

A relatively recent occurrence of antelope succumbing through miring took place at Guano Lake, which is located east of the Hart Mountain National Wildlife Refuge, and contained water only during years of heavy rains or snowfalls. At such times the lake raises to one or two feet and the lake bed becomes transformed into a thick muck, thereby creating a hazardous area for antelope migrating from winter ranges to summer range on Hart Mountain.

A total of 15 antelope were reported victims of miring in the lake during the spring of 1938 (15, p.16). One adult doe, heavy with young, was lassoed and pulled out of the lake by local cowboys.

The Hart Mountain National Wildlife Refuge quarterly report for April, May, June, 1939 (22), recorded another similar case. On April 3, 1939, an investigation by Hart Mountain Refuge personnel discovered where 10 does, 7 bucks, and 6 yearlings had perished while attempting to cross Guano Lake during the spring migration. On May 4, another check disclosed four additional carcasses, making a total of 27 deaths for 1939. Seventy-five antelope were reported (22) to have perished in this manner during the spring of 1921.

Precipitation was much less during 1954 and 1955; therefore, the Guano lake bed remained dry throughout the year and no cases of mortality were found.

Drownings

Only one record of an antelope drowning was located in literature pertaining to Oregon pronghorn herds. This was Einarsen's (50, p.51) report of a doe antelope drowning in the midwinter of 1944 while attempting to cross a swollen river. The doe was washed against a clump of willows and was unable again to reach open waters.

Locked Horns

In the Hart Mountain National Wildlife Refuge's narrative report for September and October, 1941 (24), were two separate records of adult buck antelope with horns locked in combat. The first case was at Spanish Lake on September 2. Murial Jacobs, refuge patrolman, witnessed this case and stated that one animal was dead and the other buck died soon after being released. The dead buck had part of its hind quarters eaten by predatory animals. The second case was approximately 12 miles from the first location and occurred on September 30. The two bucks in the latter conflict had evidently locked horns only a short time previous to being located and appeared very active and healthy. Their horns were untangled and they ran away in good stride.

Buechner (26, p.297) reported that two of 84 antelope deaths were caused by bucks fighting in Texas. Murie (84, p.100) cited Marguerite L. Arnold (Yellowstone Nature Notes, January 1936) as witnessing two bucks fighting. The more powerful buck was chased away and the remaining antelope was "...bleeding and almost completely disemboweled."

Man-influenced Accidents

Antelope deaths enhanced by man made constructions (fences) or equipment (cars, trains) were catalogued as man-influenced accidents. Illegal kills are reported on page 69.

Fences

Antelope in Oregon have the behavior of going under fences whenever possible instead of jumping over them like deer. From a mortality standpoint, this "under the fence" maneuver saved many lives. Deer, which characteristically jump barbed wire or netting fences, are quite often trapped when their hind quarters become entangled in the two top wires. This circumstance generally leads to death. No records were found in Oregon of antelope dying from this predicament; however, Ray Erickson, biologist at Malheur National Wildlife Refuge in Oregon, stated that he saw an adult doe trapped temporarily in this manner. Realizing the rarity of the case, he ran to his pick-up for a camera but the antelope had escaped before he returned. Erickson believed the animal had been in the fence for quite some time as the skin on the legs appeared chafed.

Publications by Honess and Winters (61, p.259) from Wyoming and Udy (122, p.42) of Utah, contain pictures of single antelope carcasses entangled in barbed wire fences.

Stories were often heard on rangelands of antelope running into and breaking fences. No authenticated records of this situation were traced for antelope in Oregon.

The mobility of antelope on the range was noticed to have been influenced by sheep-fences. On two separate cases antelope (both adults and kids) were observed fighting and attempting to pass through woven-wire fences. The carcass of a doe pronghorn found in June, 1954, and still in a lactating condition, was located 12 yards from a sheep-tight fence. An autopsy report (25) stated the cause of death was a severed neck vertebra. Although it was not positively determined, the contributing cause of the antelope's death could possibly have resulted from running into a nearby woven-wire fence which other antelope had been seen fighting previously.

Buechner wrote (26, p.318) that hundreds of antelope in Texas were confined by sheep-proof fences and died of malnutrition. He further stated that if it were not for the sheep industry in that area "...the antelope populations could be greatly increased....". Such reports prompted the U. S. Bureau of Land Management to initiate a study of antelope relationships to sheep-tight fences. The preliminary report was submitted by Charles Rouse, biologist, U. S. Fish and Wildlife Service, in January, 1954 (103). Rouse's work was based on two years of extensive field investigations in Montana and Wyoming, and although the study indicated sheep-proof fences were detrimental to antelope welfare, Rouse emphasized that overgrazed ranges were one of the most serious problems confronting antelope populations.

Road Kills

A total of 24 antelope was recorded as killed or seriously injured on public roads in Oregon during the three-year study period, table 8. From this data, which was believed to be fairly representative for antelope habitat, it seemed apparent that road kills were not an important limiting factor to antelope in Oregon.

Special surveillance was maintained on the Plush-Twelvemile road in Lake County, Oregon, for this road was well traveled and transected approximately 14 miles of concentrated antelope habitat. For 1955 and 1956 there were only two annual road accidents which occurred in January and June. An adult buck killed in June, 1956, on Drakes Flat was a trophy animal and would qualify for entry in the Boone and Crockett Big Game Competition, figure 5.

On March 13, 1956, a car ran into a herd of antelope on a highway near Bend, Oregon, resulting in the worst pronghorn antelope-car accident on record. Several animals in the herd of approximately 50 were struck when they suddenly attempted to cross the paved highway in front of the speeding vehicle. Upon seeing the animals, the driver apparently applied his brakes and the car slid sideways into the herd. Eighteen of the animals were either killed immediately or seriously crippled. The injured animals were later shot. The car was only slightly damaged and landed in a nearby roadside borrow pit.

An examination of the killed animals disclosed the following sex and age information: two adult bucks, four yearling bucks, ten adult does, and two yearling does. In addition, the ten adult does were carrying 18 fetuses; therefore, 36 animals were lost because of this

Figure 5. An adult trophy buck antelope that was struck by a vehicle on Drakes Flat in June, 1956.

Table 8

Reports of Antelope Road Accident Victims
in Oregon from 1954 to July 1, 1956

Date	Area	Road Type	No.	Sex	Age	Observation Notes
June, 1954	Harney County	Dirt	1		Adult	Seriously crippled
January, 1955	Lake County	Dirt	1		Adult	Found in borrow pit
July, 1955	Lake County	Dirt	1		Adult	Hind quarters broken, had to be killed
July, 1955	Lake County	Paved highway	1		Kid	Carcass seen on road (53)
January, 1956	Lake County	Dirt	1		Kid	Carcass found eight yards from road
March, 1956	Deschutes County	Paved highway	2		Adults	Some animals killed immediately; others shot. 18 fetuses in the 10 adult does
			4		Yearlings	
			2		Yearlings	
			10		Adults	
June, 1956	Lake County	Dirt	1		Adult	Rear quarters broken, had to be killed

Summary		
	Kids	2
	Yearlings	6
	Adults	16
	Total	24

one accident.

Predation

Animals classified as predators of pronghorn antelope in North America included coyotes, Canis latrans; dogs, Canis familiaris Linnaeus; bobcats, Lynx rufus; mountain lions, Felis concolor; and golden eagles, Aquila chrysaetos Linnaeus, Appendix D. All of these animals, except the mountain lion, have been observed or recorded as molesting antelope or feeding on pronghorn carcasses in Oregon. However, no eye-witness accounts of predators actually killing antelope were seen or located in any reports.

The coyote, Canis latrans lestes Merriam, and the bobcat, Lynx rufus unita Merriam, have been credited (50, p.75; 73, p.14) as being the more important predators to antelope in Oregon. Data collected during this study and pertaining to these two predators will be discussed here and additional information regarding the other species will be reported later in this chapter.

From an inspection of table 9 it could be readily postulated that in 1955, Hart Mountain had a higher population of coyotes and bobcats than Drakes Flat. These data were compared to the condition of antelope carcasses collected since coyotes and other predators were known to have utilized carrion, figure 6. The percentage of intact carcasses located on Drakes Flat was 63, 95 out of 140, while the percentage of intact carcasses found on Hart Mountain was 15, or an incidence of 7 from 57 carcasses collected.

Figure 6. A coyote observed feeding on the shoulder of a fresh antelope carcass.

Figure 7. Picture of two fresh antelope kid carcasses under a bitterbrush plant from which an adult bobcat was scared away. (Photo by Rodney Canutt)

Table 9

Number of Observed Bobcats and Coyotes in Relation to Condition of Antelope Carcasses Located on Drakes Flat and Hart Mountain from June, 1954, to July, 1956

Study Areas	Predators Seen		Antelope Carcasses	
	Bobcats	Coyotes	Intact	Scattered
Hart Mountain *	8	26	15%	85%
Drakes Flat **	3	1	63%	37%

* based on 20 days of observation
** based on 380 days of observation

During the summers of 1954 and 1955, coyote and bobcat fecal pellets were collected on Drakes Flat and Hart Mountain. A total of 816 pellets were collected at random. These collections were shipped to the U. S. Fish and Wildlife Service's Wildlife Research Laboratory at Denver, Colorado. The laboratory examinations of the fecal material were reported (129, 130) by Angus L. Ward and are summarized in table 10. Antelope remains were 3.8 per cent of 161 items. These data indicated that antelope were not an important quantitative food source for bobcats and coyotes during the study period.

To further evaluate predator-antelope relationship problems, each predator species will be discussed individually.

Coyotes

Several observations were made of coyotes and their behavior toward antelope on Hart Mountain. One of the first signs of coyote predation noted was near the location of an active den. Two rear legs

Table 10

A Summary of 816 Bobcat and Coyote Fecal Pellets Collected on Hart Mountain and Drakes Flat, Oregon, During the 1954 and 1955 Summers and Examined for the Occurrence of Antelope Remains

Food Item	Occurrence	
	Number	Per cent
MAMMALS:		
Antelope	6	3.7
Deer	16	10.0
Coyote	1	.6
Bobcat	1	.6
Rabbit (Lepus sp.; Sylvilagus sp.)	38	23.6
Mice (Microtis sp.; Peromyscus sp.; and Perognathus sp.)	44	27.3
Squirrel (Citellus sp.; Sciurus sp.)	13	8.1
Marmot (Marmota flaviventris flaviventris)	3	1.9
Pocket gopher (Thyomoys sp.)	2	1.3
Domestic sheep (Ovis aries)	1	.6
BIRDS:		
Sage Grouse (Centrocercus urophasianus)	15	9.3
Mallard Duck (Anas platyrhynchos platyrhynchos	1	.6
Passeriformes	3	1.9
Bird, unidentified	1	.6
REPTILES:		
Rattlesnake (Crotalus viridis lutosus)	1	.6
INSECTS:		
Orthoptera, grasshoppers	1	.6
Diptera, larvae	2	1.3
Carabidae	1	.6
ARACHNIDS:		
Acarina, Argasidae	1	.6
VEGETATION:		
Gramineae, grass	6	3.7
Other vegetative materials	4	2.5
TOTAL	161	100.0

of a kid antelope, cleaned of meat, were found 45 feet from the den, and patches of hair from an adult antelope were sparsely scattered among the rocks at the lair site. The den was in the center of the largest antelope concentration on the Hart Mountain area. In this same area a fresh doe antelope carcass was located on August 1, 1956. The dead animal was first seen through binoculars a half mile away. While two field men approached the carcass, a coyote walked up to the remains and began eating the shoulder. The canine continued its eating for a half hour and allowed the field observers who were in a pick-up truck to approach within 300 yards. At one time the coyote left the area only to return immediately to continue feeding, figure 6. Scratches and torn skin in the carcass's throat region led field observers to surmise the animal had originally been a victim of predation.

One of the best descriptions of a coyote stalking an antelope kid was written in detail by Einarsen (50, p.76). The same type of an episode has been seen repeatedly on Oregon's ranges. For example, during the 1955 kidding season on Hart Mountain, Frank Grogan, district field agent, Oregon State Game Commission, observed the following incident, while tagging antelope kids. A young antelope was watched during its early morning nursing period. Three coyotes came over a nearby ridge and in a matter of a few seconds the kid dropped to the ground, assuming the prone hiding position. Meanwhile the mother antelope led the coyotes away from the kid and then started chasing the coyote farther away. On another occasion, an adult doe

was observed to chase a domestic dog which was molesting her young. This was during the 1955 kidding season on Drakes Flat. The dog was used to help catch kids for ear tagging purposes. When first noticed, the kid was in the lead with the dog about 20 feet behind and the doe antelope some 20 feet behind the dog. The dog finally caught the kid but the doe did not try to attack the dog although it was possible for her to have accomplished this. Two other cases very similar to the above occurred and in each episode the kid was caught by the dog and the doe did not attack.

A collection of seven coyote stomachs from trapped animals was made on the Hart Mountain antelope range in 1954 and examined for antelope remains. Three of the stomachs were devoid of food, two contained portions of Oregon jack rabbit, Lepus californicus walla-walla Merriam, and one was full of rainbow trout, Salmo gairdneri gairdneri Richardson. No evidence of antelope remains were noted in this small sample. Wildlife technicians in California conducted a similar research problem of collecting and examining coyote stomachs from antelope ranges. Their samples disclosed an antelope occurrence frequency of 2.7 per cent for 37 stomachs examined having identifiable food particles (1, p.24).

Domestic Dogs

Two observations were made of domestic dogs, Canis familiaris Linnaeus, chasing antelope herds on Drakes Flat during winter months. Although the dogs were not pressing the antelope closely, their pursuit was prolonged. Possibly such acts might have serious

consequences to animals in poor health. An adult doe carcass, later diagnosed as having died from external hemorrhaging through puncture wounds in the throat region, was located in an area in which dogs had been previously seen chasing antelope. Biologists working in California reported (1, p.25) an old doe antelope as having been killed by three dogs.

Bobcats

On several occasions during the course of this study, bobcats were chased from fresh adult and kid antelope carcasses in Oregon. In June, 1956, two kid carcasses were located on Drakes Flat under a bitterbrush plant from which a bobcat was scared away. The carcasses were partially covered with nearby debris. Both kids at time of death were approximately a month old as determined by ear tags from the 1956 kidding season. Each was a single from two separate sets of twins. Only the head and legs remained of one carcass while the other was intact. Both were partially covered with nearby debris. The intact carcass was taken to Dr. Victor Hill, D.V.M., Lakeview, who performed an autopsy. A report of the veterinarian's examination stated:

> "The external general appearance would lead an observer to think that the animal had been healthy and robust. There were bloody areas near the head and upper neck region, particularly the jaw and throat areas.
>
> "The skin was removed from both sides of the neck by a midline incision. The skinning process was continued over the jaws and neck to expose all injured parts. There were bilateral multiple puncture wounds into the parotid areas and down to the throat region. The right jugular vein was

punctured so as to permit external hemorrhage. Massive contusion-type hemorrhage was seen just anterior to the left parotid gland. The left mandible was fractured about 1/2-3/4 inch below the articular area.

"The trachea was severed at its proximal extremity and had filled with blood that had clotted.

"There was no other abnormality or deformity noted in the entire autopsy."

A picture of the kid carcasses as they appeared when first found is presented in figure 7. The location was in the center of the Drakes Flat kidding ground. No signs of a struggle between the antelope kids and any predator were visible.

Another account of a bobcat observed at a fresh kid carcass was reported (74) in the winter of 1947 by Ellis Mason, district game agent, Oregon State Game Commission. He saw the bobcat on the open Hart Mountain plains and immediately shot the animal. Upon approaching the bobcat, a fresh antelope kid carcass was found nearby. Tracks in the snow indicated the kid was killed in the immediate area and that it had not run over 60 feet after being attacked.

Still another report of a bobcat at a fresh antelope carcass was seen and recorded by Robert Long, trapper, U. S. Fish and Wildlife Service (70). The incident occurred approximately 25 miles north of McDermit, Nevada, in April, 1954. The bobcat was observed eating on the antelope carcass, and was shot. The area was then examined for evidence contributing to the antelope's death. Long recorded the following pertaining to the case: "The cat had the antelope down three or four times. There were three or four patches of hair about 20 or 30 feet apart on the hillside and the antelope's throat had

been cut and its ears were partly chewed. The cat weighed 29½ pounds. It looked like the cat had been feeding on the carcass for about three days."

A total of four pronghorn carcasses partially covered with debris was located on the two study areas during 1955 and 1956. In each case the characteristic bobcat signs of consuming part of the carcass and then attempting to cover the remainder was evident. In one case noted, a bobcat apparently spent the night near an adult doe carcass as two fresh but dissimilar bedding areas were located in the fresh snow three feet from the carcass. Another antelope carcass which was partially covered with nearby dirt and dry vegetation was observed. The animal, which was an adult buck, had a head infection. In this case it was not known whether predation or disease was the primary cause of death.

On January 16, 1956, while watching a herd of 24 antelope through a 20 power spotting scope, an adult bobcat was seen slinking along as though hunting. It continued in a straight line about 150 yards in front of a herd of antelope and appeared not to have seen them, although the antelope definitely saw the bobcat and came towards it for a distance of approximately a hundred yards. The antelope remained in a tight herd and watched the wildcat for 15 minutes, then started walking and feeding in the opposite direction of the predator.

An attempt was made to collect stomachs from trapped bobcats on antelope ranges to ascertain the importance of antelope as a food item. Only two stomachs were obtained and these were devoid of food.

A similar project was undertaken on a neighboring range in California where 32 bobcat stomachs were collected and 16 of these contained food (1, p.23). No antelope remains appeared in this study.

The number of bobcat observations made on the two study areas from June, 1954, to July, 1956, is recorded in table 9. Three bobcats were seen on Drakes Flat during 380 days of observation and eight bobcats were observed on Hart Mountain in 20 days.

Mountain Lions

Knipe (67, p.28) conducted an antelope survey in Arizona and stated that mountain lions preyed considerably on antelope. This report cited five antelope were killed by cougars. No other state listed lions as a predator of antelope, Appendix D.

In Oregon there is little or no overlapping of antelope and mountain lion ranges; consequently, this condition could account for the scarcity of cougars preying on pronghorns.

Golden Eagles

The golden eagle, Aquila chrysaetos Linnaeus, inhabits most of the antelope range in Oregon. On several occasions eagles were observed molesting antelope during kidding seasons. An adult bird landed on a bitterbrush some 200 yards from three does, whereupon the does immediately ran straight towards the eagle and the bird quickly took to the air.

On two occasions eagles were seen at fresh antelope kid carcasses and four observations were made of eagles at carcasses several days

old. The primary cause of death was not ascertained. One eagle was observed to approach a kidding ground on Drakes Flat, circle twice, and land alongside a fresh kid carcass. The animal had been dead for several hours and it was not known whether it had died the previous night or early that morning. On another occasion an eagle was flushed from the site of a fresh kid carcass. The remains were investigated and it was noted to have been tagged during the 1956 kidding season. This same carcass was previously reported on page 16. Only fragments of the skull attached to the legs by a strip of hide and several bones (scapula and parts of the pelvic girdle) were found scattered nearby. Hanson's (56, p.63,64) thesis contains two pictures of carcasses found in a similar condition.

In the spring of 1956 at Drakes Flat, three adult eagles were seen feeding on an adult doe carcass. One eagle was feeding on a front leg which appeared to have been dragged 12 feet from the remainder of the carcass. The carcass, however, was credited as an animal which became a mammalian predation. This was based on the findings of an autopsy examination. After skinning the carcass, it was evident that the animal had bled excessively into the tracheal region from external puncture wounds in the throat.

How successful eagles are in preying on antelope has long been a question of many biologists. Authenticated eye-witness accounts were limited to one report during this study. In April 1955, Cecil Langdon (96), district game agent for the Oregon State Game Commission, observed an eagle attacking a running antelope kid. Langdon was

taking an aerial census of pronghorns when he noticed the eagle hit an antelope in the back, almost knocking it down. The action was repeated several times until the antelope stopped running and the airplane crew chased the eagle away. The animal refused to move when the airplane flew close by and an examination of the hide revealed that it was severely ruffled. A similar report of an eagle attacking an antelope kid was made by a biologist flying an aerial census in Utah. In this case it was reported (49, p.6) the eagle successfully killed the kid.

Human Kills

Hunting Seasons

The annual antelope hunting season kills have been recorded each year from 1938 to 1955 by the Oregon State Game Commission. These legal kill data are believed to be fairly complete since antelope hunting has been controlled by the issuing of a limited number of permits requiring a return record of the hunter's success. From figures tabulated in table 11, it was apparent that a large number of antelope was not harvested since animals harvested in 15 hunting seasons varied from 1.0 to 7.8 per cent of estimated total populations. An average annual kill for 15 hunting years was 3.7 per cent, or an average of 512 kills for an estimated annual population of 13,045 antelope. This was far below the annual average harvest of antelope in eight other states that had antelope populations varying from 4,000 to 20,000, table 12. These states had a weighted average

antelope population of 11,049 and killed 1,544 annually, an average annual harvest of 13.9 per cent. Oregon has consequently harvested 11.2 per cent less annually than the other eight states. Of these eight other states, North Dakota, South Dakota, and Colorado had increasing herds even though they harvested more than 25 per cent in successive years.

Although the figures in tables 11 and 12 record antelope taken by hunters, the tables do not include the numbers of animals crippled or lost. Fatally wounded and lost animals probably do not represent an important percentage but the number could possibly have been decreased with improved hunting tactics. For example, while conducting a reproductive study in 1955-56 on Drakes Flat, a total of 21 adult does were shot. Of these 21 animals, four were crippled and could have been lost if particular effort had not been exerted to collect them. Two of the does were hit in the abdomen and ran about 400 yards. They were re-stalked and again shot the same day. Another doe was hit high in the front shoulder, and a fourth doe was shot in the hind quarter. These latter two ran over a mile from the hunters and were lost that day. When the hunters returned to the same area the following day, the cripples were located and shot.

Workers in Wyoming reported (14, p.13) in 1954 that for every 100 antelope the hunters brought in from the field, 18 were left behind to die of wounds. This was determined by flying over a designated area before, during, and after the hunting season.

Table 11

Oregon's Estimated Antelope Population and Hunter Kill Percentages from 1938 to 1955.

YEAR	Estimated Antelope Population[1]	Number of Hunters[2]	Hunter Kill[2]	Per cent Kill of Population
1938	18,115	242	175	1.0
1939	19,206	292	214	1.1
1940	18,240	514	399	2.1
1941	17,570[3]	2,471	1,378	7.8
1942	16,900	695	594	3.5
1943	14,210	1,119	691	4.9
1944	12,900	1,267	712	5.5
1945	9,670	799	328	3.4
1946	8,000	None	None	None
1947	9,000	None	None	None
1948	10,000	None	None	None
1949	10,000	929	586	5.9
1950	14,000	1,422	679	4.9
1951	14,000	1,133	600	4.3
1952	10,000	1,075	448	4.5
1953	10,000	380	181	1.8
1954	12,000	589	334	2.8
1955	11,000	570	358	3.3
Average	13,854	899	512	3.7

[1] 1938-1945 figures from Einarsen (50, p.11)
1946-1955 figures from McKean (82)

[2] 1938-1952 figures from Oregon State Game Commission (94, p.10)
1953-1955 figures from Oregon State Game Commission (91, p.38; 92, p.45; 93, p.53)

[3] Average of 1940 and 1942 populations

Table 12

Hunter Kill of Nine States with Antelope Estimated Populations Ranging from 3,000 to 20,000 from 1950 to 1954

STATE	Number of Years	Mean Annual Estimated Population*	Mean Annual Kill*	Per cent Annual Kill
California	1	4,000	280	7.0
Colorado	5	10,000	2,901	29.0
Idaho	5	12,709	1,128	8.9
Oregon	5	12,000	488	3.7
New Mexico	5	21,100	869	4.1
Nevada	4	3,535	173	4.9
North Dakota	3	3,450	1,233	35.7
South Dakota	5	12,239	4,358	35.6
Texas	2	9,000	427	4.8
WEIGHTED MEAN		11,049	1,544	13.9

* Figures from U. S. Fish and Wildlife Service (125)

Illegal Kills

Since factual records of poaching are difficult to obtain, quantitative data on illegal kills are incomplete. The number of illegal kills noted during the study indicated that illegal kills were a minor decimating factor for antelope populations in Oregon. Reasons for this apparently were sparse human inhabitation on antelope range and the opinion that antelope meat was unsavory.

Seventeen illegal kills authenticated in 1954 and 1955 are listed in table 13 and most of these occurred in open hunting seasons. It was the field worker's opinion, based on observations, that more malicious antelope killing took place in the 1954 and 1955 antelope hunting seasons than occurred from poaching during the remainder of each year. Generally, the high "accidental" killing of does and kids during hunting seasons resulted when hunters knowingly shot into mixed sex and aged antelope herds in an attempt to kill a mature buck.

Knipe (67, p.28) believed that previous uncontrolled killing by man nearly exterminated antelope numbers in Arizona. Buechner (26, p.297), working in Texas, reported four illegal kills, or 4.8 per cent, of 84 antelope found in Texas.

Table 13

Illegal Antelope Kills Noted During
1954 and 1955 in Southeastern Oregon

Date Case Noted	Estimated Date Killed	Number	Sex	Age	General Notations
Aug. 1954	Aug., 1954	1		Kid	Killed by hunter during antelope season
Aug. 1954	Aug., 1954	2	♀	Adult	Killed by hunters while shooting at bucks in herds
		3		Kids	
June 1955	1954-1955	2		Adult	Only remains of hide and feet found
June 1955	spring, 1955	1		Adult	Remains of two carcasses found together
June 1955	1955	1		Adult	Remains of hide and feet located
June 1955	1954	1		Adult	Two feet found burned and buried
Aug. 1955	Aug., 1955	3	♀	Adult	Killed by hunters who were shooting into herds for adult bucks
		1	♂	Yearling	
		1		Kid	
Oct. 1955	Oct., 1955	1	♂	Adult	All of carcass found except one hind quarter had been cut away
TOTAL		17			

Range Management

Range conditions may influence antelope survival through such factors as inadequate supply of available forage, livestock-wildlife competition, agricultural practices, mineral or plant nutritional deficiencies, and poisonous plants. None of these factors have been studied sufficiently to warrant classifying them as decimating agents of antelope populations in Oregon. However, a number of them were considered contributing causes of decreasing antelope herds in Texas (19, p.350), Arizona (25, p.38), California (127, p.41), Utah (24, p.45), Montana (164), Colorado (165, p.153), and Wyoming (166, p.154).

Limited evidence collected during this study indicated a possible correlation between range conditions and antelope population dynamics for the two study areas. A survey of the vegetation provided data on plant composition. Food habits studies disclosed the relationship of pronghorns to classes of forage utilized. Additional information on antelope numbers and distribution was correlated with plant composition and vegetative type interspersion, table 14.

Plant composition was determined by the ocular reconnaissance method. Although the percentage composition figures given in table 14 were only approximate because of the method employed, a definite difference in the proportion of forage classes between the two study areas was noticeable. Perhaps the main reason for this was the result of a wild fire in 1945 which swept through approximately 7,000 acres of Drakes Flat and the fringe of an adjacent forest.

Table 14

A Comparison of Plant Composition and Antelope Population Dynamics for Drakes Flat and Hart Mountain from 1954 to 1956

Range and Antelope Data	Hart Mountain Study Area (approximately 180 square miles)	Drakes Flat Study Area (approximately 30 square miles)[1]
Plant Composition:		
Browse	85 %	70 %
Forbs & other misc. species	10 %	10 %
Grass	5 %	20 %
Antelope Food Habits:		
Browse	68 %[2]	59 %[3]
Forbs & other misc. species	31 %	23 %
Grass	1 %	18 %
Antelope Kid:Adult Ratios:		
1954	34:100[4]	74:100
1955	16:100	68:100
1956	47:100	60:100
Antelope per square mile:		
1954	3.6[4]	5.9
1955	1.1	7.2
1956	.7	7.8

[1] Area includes 18 square miles mapped in figure 1 and an additional 12 surrounding adjacent square miles.

[2] From Mason (81, p.388)

[3] From Yoakum (131, p.6)

[4] From Deming (44)

Immediately after the fire, the burned area was seeded with grass, figure 8 (163). This accounts for the higher percentage of grassland on Drakes Flat than on the Hart Mountain study area. Grass meadows also added valuable forage to both study areas. Drakes Flat contained a good stand of bitterbrush and black sage, Artemisia nova, two browse species which were less abundant on Hart Mountain. Both areas contained high forb production on seasonal dry lake beds. In general, it can be stated that the Drakes Flat range possessed a more desirable interspersion of forage classes than the Hart Mountain area.

A comparison of pronghorn food habits from the two study areas provided data on the direct relationship of the animals to their utilization of the forage. Food habits data were obtained by rumen analysis of approximately 30 animals from each area. The animals were collected throughout the year; consequently, the representative seasonal samples were small. Antelope on Drakes Flat consumed 59.3 per cent browse, 23.1 per cent forbs and miscellaneous plant species, and 17.6 per cent grass; whereas, pronghorns on Hart Mountain (81, p.388) ate 67.6 per cent browse, 30.9 per cent forbs and 1.5 per cent grass, table 14.

These data indicate that either a difference exists between the food habits of the two herds, or that insufficient data were obtained on each or both areas. The questions of seasonal grazing and phenological succession become equally important. Plant composition estimates are tabulated in table 14. Figure 10 illustrates seasonal

Figure 8. A wild fire created a diverse edge of sage and grasslands on Drakes Flat.

Figure 9. The northern section of Hart Mountain maintained a good interspersion of meadows, grasslands, and browse species.

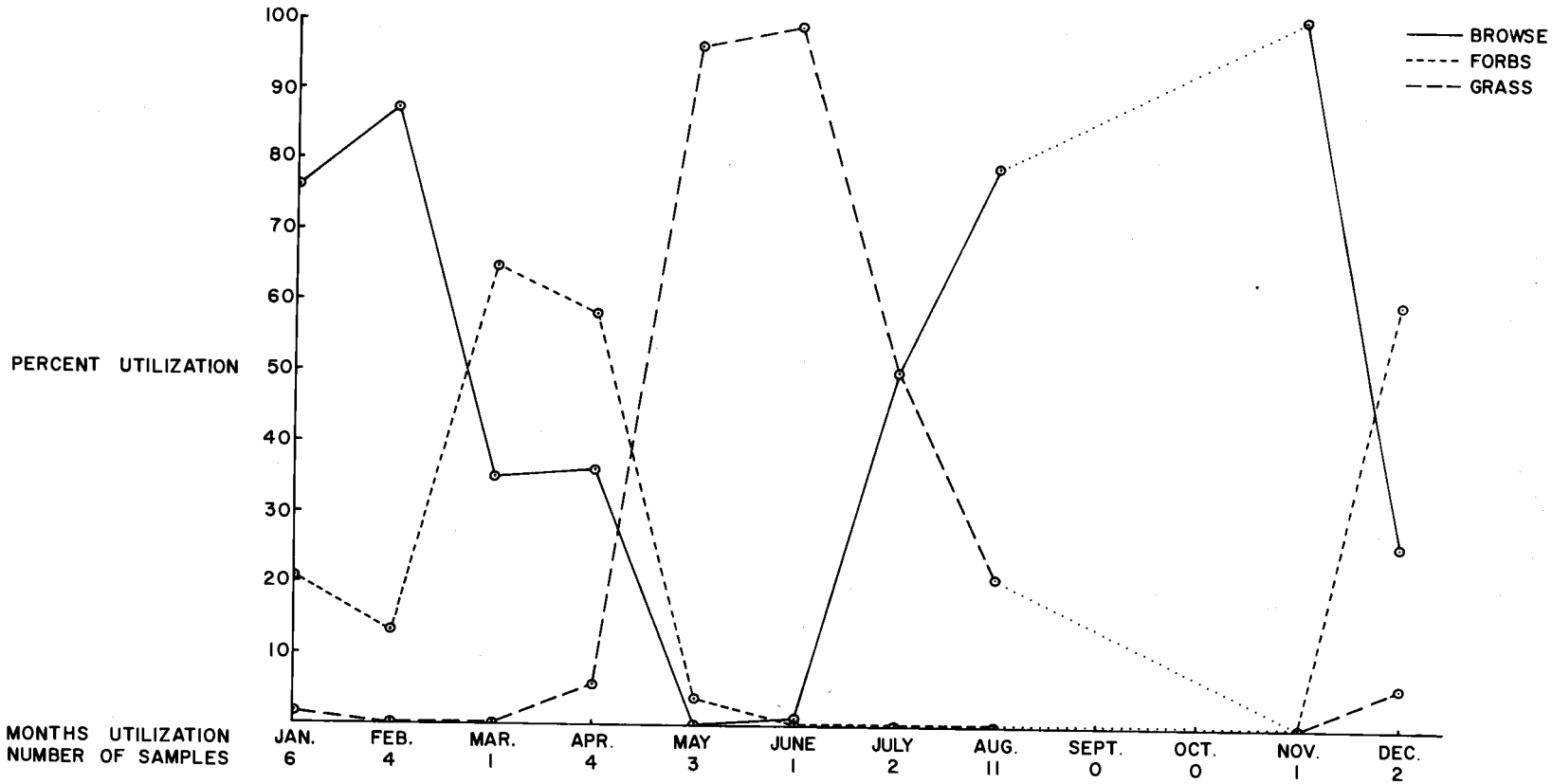


FIGURE 10. FORAGE CLASS UTILIZATION AS INDICATED BY VOLUME PERCENTAGE OF ANTELOPE RUMEN SAMPLES (131, p.11).

grazing by antelope on Drakes Flat. The utilization of grasses and forbs was definitely higher when they were available.

Antelope kid:adult ratios were compared on the two areas and it was noted that Drakes Flat had a higher ratio for three successive years than Hart Mountain, table 14. It was not possible to relate this ratio difference to either production and/or survival; all that is known is that the difference existed. Figures for these ratios were taken in July except for the 1956 count on Drakes Flat which was completed in August.

Hansen (56, p.71) provided data from a small antelope herd in the northern Hart Mountain area as possessing a kid:doe ratio one third again as great as the herd on the southern Hart Mountain range. The northern area has a greater diversity of grass, forbs, and browse than the southern region, figure 9. The northern area was also characterized by more favorable moisture conditions than the southern ranges.

Ackerly and Regier (1, p.21), working in California, stated that areas of greater vegetation maintained a higher kid:adult ratio. In this case the variety of green feed available to the antelope throughout the critical period following parturition was believed to have been the contributing factor.

For the period of this study, the Drakes Flat area maintained 15.5 more antelope per square mile than did Hart Mountain. This population was maintained throughout the year by resident animals, whereas the Hart Mountain herd fluctuated in numbers resulting from movements

away from the area in winter months.

An area of approximately 15 square miles on Drakes Flat was observed to support a high concentration of antelope. This area was in the middle of the region burned and seeded in 1947. It was also the center of greatest interspersion of vegetation. Antelope inhabited the area extensively, even during periods of heavy snowfalls. In fact, the animals traveled four to five miles through 10 to 12 inches of snow in order to reach the area's wind-swept, snow-free ridges of dry grass. These trips were accomplished early in the morning and, after feeding all day, the antelope returned in the evening to lower elevations more free of snow. Rumen samples collected from antelope on the ridges contained dry grass during each month of the year.

Collection of Carcasses

A total of 370 antelope carcasses was collected on the two study areas from 1954 to 1956, table 15. Classified by age, there were 186 adults and 184 kids. These data indicated that an equal mortality rate existed between adults and kids.

The estimated ages in months represented by 225 carcasses collected from June, 1954, to September, 1955, were obtained by techniques described by Dow (48). The carcasses comprised the following percentages of mortality based on 121 cases which were correlated with seasons of the year: 12% for September, October, and November; 19% for December, January, and February; 35% for March, April, and May; and 34% for June, July, and August. The analyzation of these

Table 15

Sex and Age of Antelope Carcasses Located on Drakes Flat and Hart Mountain, Oregon, from 1954 to 1956

Area and Year	Kids			Adults		
	Males	Females	Sex Undetermined	Males	Females	Sex Undetermined
Drakes Flat						
1952*[1]			25			10
1953*			20			13
1954*			19			5
1954[1]			22	20	30	11
1955[1]	2	1	10	5	8	3
1955	5	9	19	9	18	3
1956	4	3	7	2	3	0
Hart Mountain						
1952*[1]			3			6
1953*			4			10
1954*			2			2
1954[1]			16	5	11	6
1955		2	13	2	1	1
TOTAL	11	15	160	43	71	70

Summary: Kids 186
Adults 184
Total 370

* From Hansen (56, p.51)

[1] Death was either of this or a previous year

findings suggests a higher winter loss than previously known.

Since the exact periods of death were difficult to ascertain for carcasses examined, estimated seasonal periods of occurrence were made from the carcasses of 66 animals including both sexes. The adult female death rate was especially high in May and June and could have been possibly correlated with the parturition period.

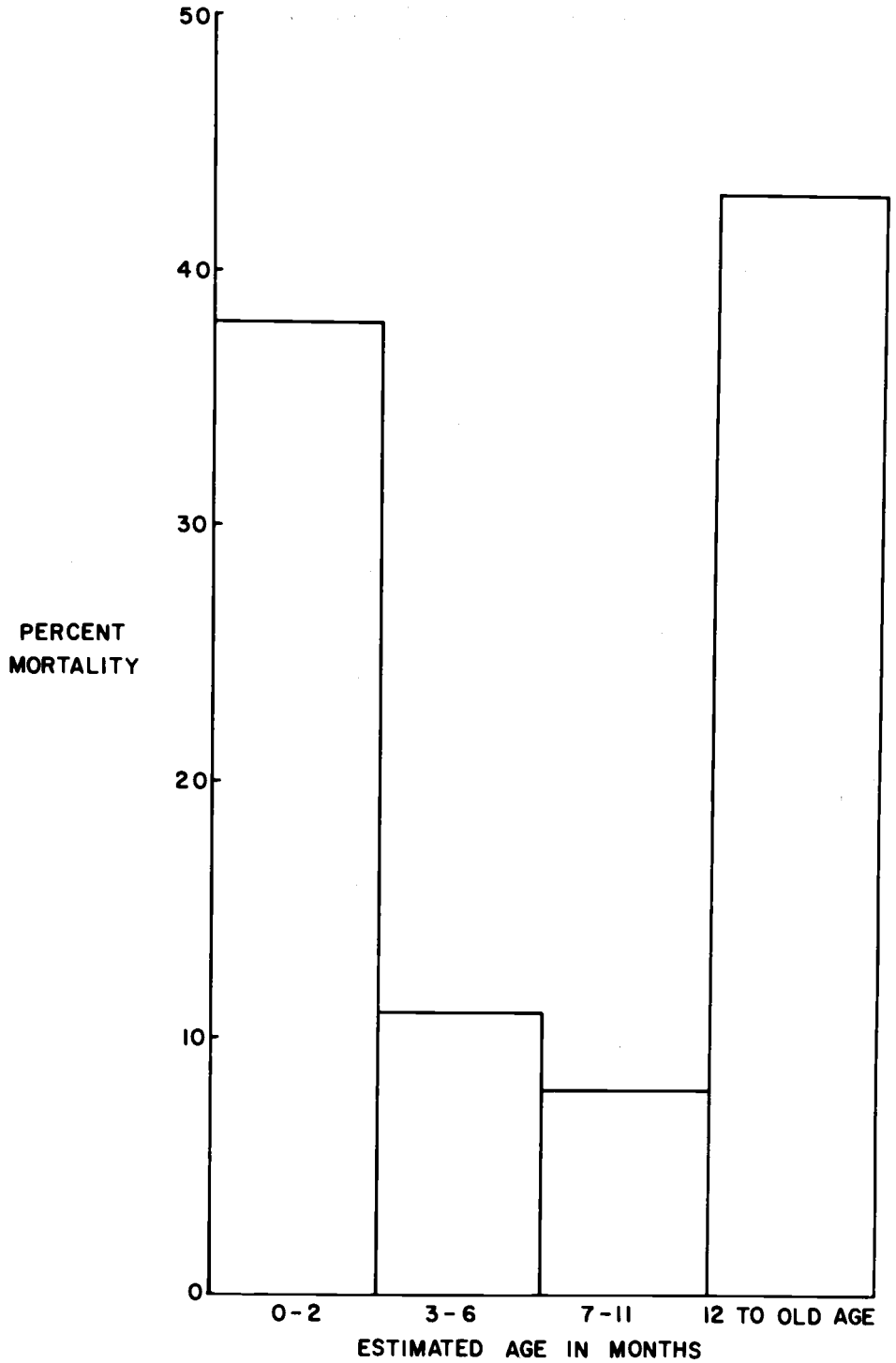


FIGURE 11. PERCENT MORTALITY BY ESTIMATED AGE OF DEATH FOR 225 ANTELOPE CARCASSES FOUND ON HART MOUNTAIN AND DRAKE'S FLAT, OREGON, DURING 1953, 1954 AND 1955.

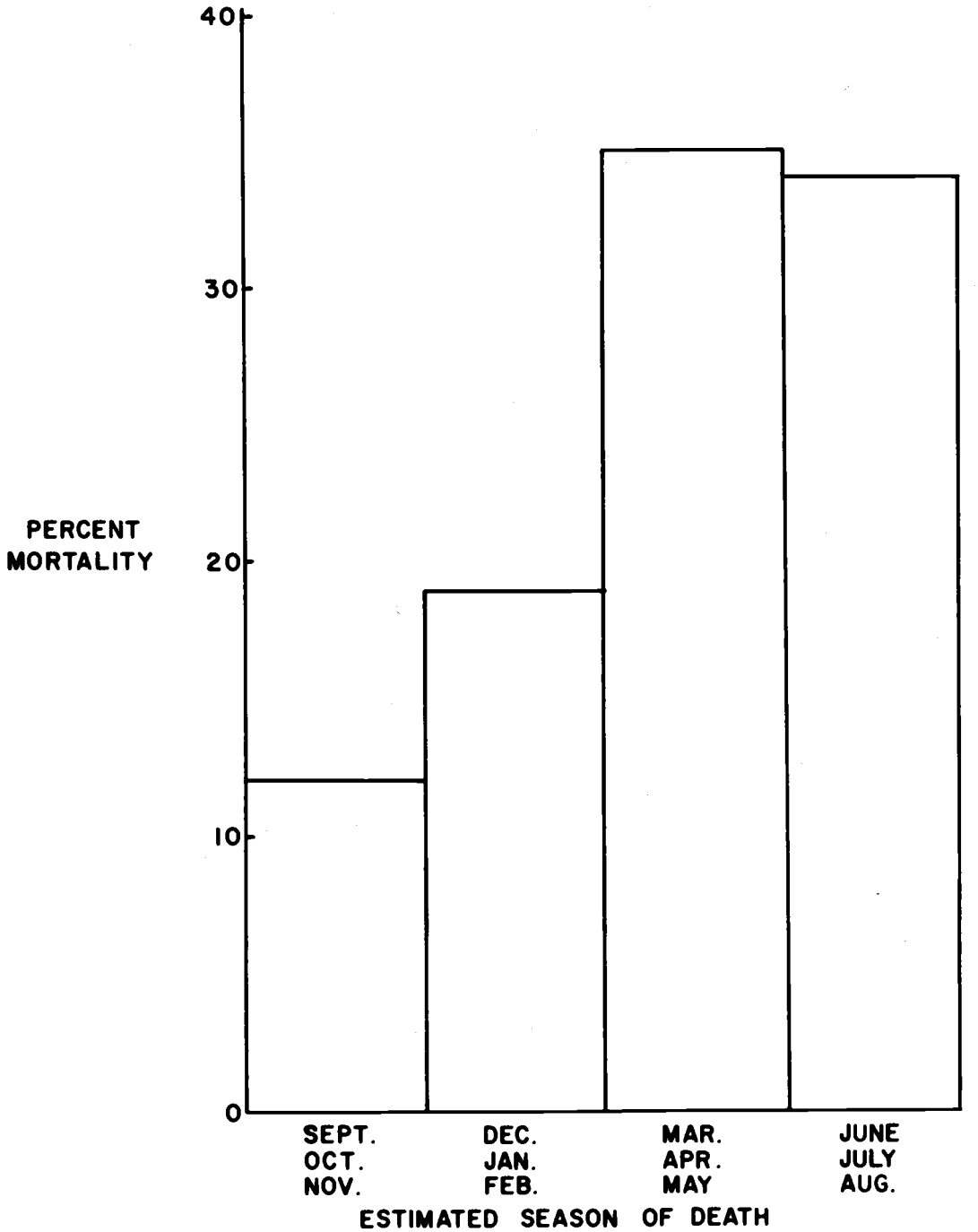
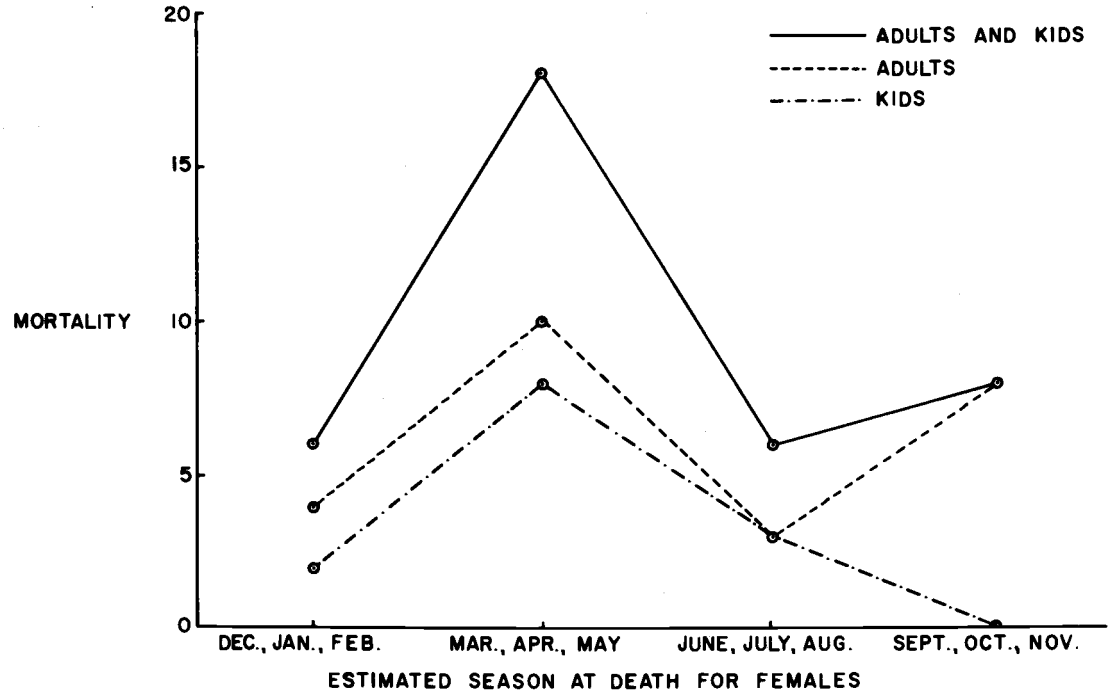


FIGURE 12. PERCENT MORTALITY BY ESTIMATED SEASON OF DEATH FOR 121 ANTELOPE CARCASSES FOUND ON HART MOUNTAIN AND DRAKE'S FLAT, OREGON, FROM SEPTEMBER 1, 1954 TO SEPTEMBER 1, 1956.



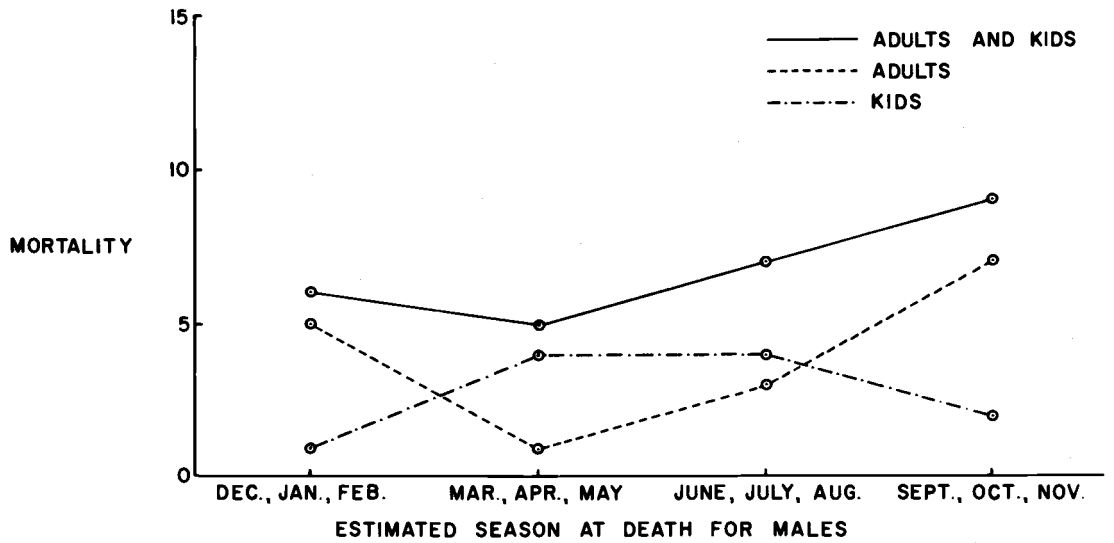


FIGURE 13. ESTIMATED SEASON OF DEATH BY SEX FOR 66 ANTELOPE CARCASSES FOUND ON HART MOUNTAIN AND DRAKE'S FLAT, OREGON, FROM SEPTEMBER 1, 1954 TO SEPTEMBER 1, 1956.

DISCUSSION AND RECOMMENDATIONS

Mortality Rate and Factors

Positive evidence of factors affecting antelope survival was difficult to collect and analyze since a mortality case often involved both primary and secondary causative agents. For example, winter kill is classified by many biologists as any animal death at winter time, while other biologists consider winter kills as losses directly caused by winter weather conditions. Consequently, it becomes necessary to differentiate whether the primary agent of death was weather conditions, old age, disease, malnutrition, and/or other factors. The diagnosis of the case becomes extremely difficult in a case such as a weakened animal falling victim to predation. In such a case the mortality cause becomes a question. Was the animal's death attributed to inclement weather or predation? This approach serves to point out that many cases of mortality cannot be attributed to one factor alone but rather to a combination of factors. A case history, therefore, should be well investigated before passing judgment on the causative agent, or agents, of death.

The suspected high die-off of antelope kids mentioned in reports of the last decade are not new in Oregon, for Branson in 1940 reported (23, p.5) 18 dead kids and two dead adults in one day's ride through a portion of the Hart Mountain Wildlife Refuge. Jewett (85, p.46) reported in 1924 20 dead kids within a 15 mile radius of Fort Warner on Hart Mountain. Repeated reports of this nature were substantiated

by this study, figure 11.

This brings up the question of whether or not the more recent suspected high antelope kid die-offs were abnormal or followed a normal high rate of death in young, for antelope in Oregon. Earlier investigations were substantiated with quantitative data, figure 11, in this study that the most common age of kid death was from birth to three months of age. From the work accomplished to date, it is believed that there was a higher frequency of kid deaths from three months to one year than previously known. Possibly the reason that this winter mortality has not come to the attention of field workers is that the technicians are not consistently in the field at these times. Insufficient knowledge of proper methods in aging antelope may also confuse the issue in attempting to "age" recovered carcasses at this period.

Various antelope mortality factors have been studied and recorded to date in Oregon, but it remains difficult to reduce mortality by causes to a percentage table. Few investigations of single or combined factors were so conclusive that they permitted bold classification. However, present findings disclosed the following decimating factors to have caused limited losses: prenatal and parturition deaths, old age deaths, winter weather kills, illegal human kills, hunting season kills, drowning, miring and succumbing in muddy lake beds, and horn-locking fatalities among bucks. Also, evidence was collected that indicated disease, parasites, range conditions, and predations were possible contributing factors effecting population

decreases. As previously mentioned, no single factor or combination of factors were known to have a definite gross limiting effect. Rather, it appeared that each factor affected a small percentage of the herd and the combination of factors listed represented the total mortality. Obviously not all mortality factors affecting antelope in Oregon were investigated or listed since all were not known. Possibly the indirect agents that are less known may be important factors. Of these factors, disease, parasites, and predation have received considerable attention, but evaluation of range conditions as a factor in antelope dynamics has not been included in currently planned studies.

In 1954, a report by the Oregon State Game Commission (95, p.21) suggested that antelope populations in the state may be in a static condition. From the estimated annual populations listed in table 11, a statistical analysis would probably indicate that insufficient data have been accumulated to date to support this contention. It is probable that certain herds within the state might be static but others such as the Drakes Flat herd have definitely fluctuated. Einarsen credited (50, p.170) the Drakes Flat herd with 68 animals in 1944 and, in 1956, it was over 600; consequently, it has not been a static herd. Should some ranges possess an apparent static population and no specific limiting factor is known but possibly many different ones, then it is postulated that this may be evidence that the herd is limited by the carrying capacity of the range.

A proper understanding of the term carrying capacity and its

properties in management is important; consequently, work from the following authors will be used to discuss this phase of population dynamics (69, p.54; 5, p.44-60; 43, p.192; and 112, p.147). Carrying capacity is the amount of animal life which any piece of land can support or "carry" for a definite period of time without seriously damaging the vegetation or soil.

Few persons today generally accept the viewpoint of wildlife biologists that the condition of the range and not the number of animals should be used to determine the quantity of wildlife that can occupy a given range. The carrying capacity of any given unit of range at any particular time is specific for that particular range at that particular time. The most reliable criterion upon which to base carrying capacity is a careful analysis of available forage on the range. Numbers of animals are meaningless unless they are associated with specific units of range and definite amounts of forage. An objective method in evaluating carrying capacity involves evaluation of range conditions, or favorable trends leading to that condition rather than numbers of animals. An acceptance of the relationship of range condition and trend to game population trends provides a definite basis for developing management regulations and policies. The effectiveness of this approach will be in direct proportion to the ability of land and wildlife managers to recognize and interpret the trends exhibited by both game and range. This concept of carrying capacity should better enable the manager to determine how many animals can be maintained on a range and that methods

of increasing wildlife populations are dependent on improving the range condition. This is not a new concept. Allen (5, p.62) quotes Leopold as stating in 1929: "If there is any breeding stock at all, the one and only thing we can do to raise a crop of game is to make the environment more favorable."

With no change in total acreage of various cover types, it may be possible to manipulate the important plants and thus double or triple the number of animals a given area will support. Composition and interspersion are the two principal determinants of potential abundance of game range. Management of game range is largely a matter of determining the environmental requirements and cruising radius of the wildlife species, and then manipulating the composition and interspersion of types on the land, so as to increase the density of its game population. This is not a simple undertaking on pronghorn ranges since antelope inhabit a mixed pattern of land custodianships.

This principle of vegetative interspersion and succession has been indicated to influence antelope populations in Oregon. Antelope herds on an 18-square-mile area on Drakes Flat with a high edge effect have maintained a larger population than adjacent areas with less vegetative edges. Similar results were obtained in California (1, p.40). It is conjectured that the lack of edge interspersion effect could be a factor limiting the increase of antelope herds in Oregon at the present time. Another possibility could be the lack of a sufficient quantity or variety of plants at various seasons of the year.

A return of grass and forbs on range lands, along with other factors, has been credited as an important factor contributing to the increasing antelope populations in Wyoming (18, p.154) and Colorado (117, p.153). Knipe (67, p.38), working in Arizona, states that the preservation of antelope is synonymous with the restoration of grasslands. Intensive range studies by Buechner in Texas (26, p.351) provide supporting data that pronghorns prefer a variety of nutritious legumes, mallows, buckwheats, and other forbs found on ranges in good condition. In Oregon, it has been recently observed that an antelope herd is drifting to an area that is rapidly developing into grass and pasture lands near Fort Rock (119, p.3). It was also noted that on Drakes Flat, antelope preferred a particular area burned of sagebrush and later seeded to grass in comparison with adjacent vast tracts dominated by sagebrush.

Further evaluation is needed in checking the history of livestock grazing in relation to antelope populations. It appears that western ranges were in their worst condition in 1934 when the Taylor Grazing Act was inacted (28, p.2). Since then the ranges have gradually improved. Antelope populations have also fluctuated in the past three decades, table 11. Possibly antelope population figures need to be thoroughly studied in relation to range trends, livestock competition, the influence of weather conditions, and agricultural practices.

Recommendations

Additional knowledge is needed on population numbers if antelope herds are to be maintained on a managed basis in Oregon. The information now available is mearely an inadequate sample estimate. Herds have not been studied or their habitats determined. Apparently some herds are increasing and others are remaining static or decreasing in numbers. Only more accurate data pertaining to individual herds will add the needed information for determining the best management practices. It was noted in this study that herds on Drakes Flat made seasonal migrations of 10 to 15 miles. Small herds in Warner Valley were believed to have remained resident on an area five miles or so in diameter. Still other herds, such as those on Hart Mountain, traveled 30 or more miles depending on different conditions.

The preferred habitat requirements of antelope still remain relatively unknown. Methods of manipulating habitat and its influence on population increases or survival may be the key to increasing pronghorn herds. Since antelope utilize public and private ranges, every effort should be made to assist agencies and ranchers having primary responsibility for the management of the antelope's habitat. Range condition and trend studies are recommended in cooperation with land owners.

An ultimate goal in game management is for man to harvest the surplus animals on a sustained annual yield basis. The need for increasing the state's herd numbers is limited, if present numbers

are not currently harvested and managed wisely. It is apparent that the harvesting of antelope in Oregon could be increased on certain herds, but should be restricted on others. This requires detailed knowledge of individual herds and their range conditions.

Pertinent recommended studies and management practices of pronghorn antelope in Oregon therefore include:

1. Improved census techniques combined with knowledge of individual herd movements and distribution.
2. A study of range conditions, trends and improvements in relation to population numbers of both livestock and antelope.
3. A working plan for properly harvesting the antelope increment in relation to the current condition of the range.

SUMMARY AND CONCLUSIONS

A study was undertaken to account for and authenticate all mortality factors affecting pronghorn antelope herds in Oregon. Work commenced in June, 1954, and terminated in July, 1956. Information pertaining to antelope mortality in other states was also collected for comparison with Oregon conditions.

Mortality factors investigated and their importance were:

Prenatal and Parturition Deaths: Fetal deaths accounted for 14 of 370 carcasses located, or a known incidence of four per cent during the two year study. The primary cause of most of these deaths remained unknown; however, in some cases congenital abnormalities and complications at birth were noted.

Old Age: Four of 89 carcasses examined manifested signs of old age. Since no proven technique of aging antelope in Oregon was known, it was not possible to determine the percentile of old age mortality.

Diseases: The only diseased antelope discovered through post mortem examinations made during this study were limited cases of single animals. Clinically diagnosed diseases were: "pinkeye" (Keratitis); "lumpy jaw" (Actinomycosis and/or Actinobacillosis); "Necrotic stomatitis" (Spherophorus necrophorus); "scours" (Diarrhea); pneumonia; and subcutaneous abscesses. Approximately 70 blood samples were collected for laboratory tests of Brucellosis and

Leptospirosis and all findings for these two diseases were reported negative. Based on present findings, it could be definitely stated that no epizootic disease was known to have occurred in Oregon antelope populations during 1955 and 1956. There was likewise little supporting evidence authenticating wide spread disease in previous years. Disease was reported to have been unimportant as a mortality factor among antelope populations in other states.

Parasites: During the study there were no deaths attributed to parasite infestations in Oregon. Two yearling females were collected that possessed a high incidence of intestinal parasites which possibly could have affected the animal's welfare. A total of six genera and seven species of internal parasites were collected and identified. The finding of liver flukes, Fasciola hepatica Linnaeus, may have been the first North American record of this parasite in pronghorn antelope. The tapeworm, Moniezia expansa (Rudolphi), was recorded for the first time in antelope herds of Oregon. The discovery of the intestinal worm, Ostertagia trifurcata Ransom, in pronghorns was believed to have been a new record for the host.

External parasites were rarely found on antelope in Oregon from 1954 to 1956. Rocky Mountain spotted fever ticks, Dermacentor andersoni Stiles, were the most commonly found external parasites and these were most prevalent on kids less than a month old. The finding of winter ticks, Dermacentor albipictus Packard, identifies antelope as a possible new host species for these parasites in Oregon. Other

states indicated that internal parasites may be a possible factor affecting antelope kid survival.

Severe Winters: The weather conditions in the 1954 and 1955 winters were analyzed for their relationship to antelope losses. No evidence of high winter mortality was gathered during these winters, although reports of small losses in previous years were located and investigated.

Drought Seasons: Based on present findings in Oregon, there apparently have been few, if any, antelope deaths resulting from drought years.

Natural Accidents: Natural accidents such as miring in muddy lakes, drowning, and locking horns were occasionally reported in records previous to 1954 in Oregon. Since 1954, there were no similar reports located or observations made of these types of death.

Man-influenced Accidents: Road kills were the largest known single factor in this category. Records were obtained for 24 cases of antelope killed on public roads during the two-year study. No reports were found of antelope deaths caused by trains or fences.

Predation: The problem of predator-antelope relationships was not investigated in detail. General observations were recorded and additional data were collected pertaining to coyotes, bobcats, domestic dogs, and eagles either molesting or feeding on antelope

carcasses. Four observations of bobcat predation on fresh antelope carcasses were noted.

Hunting Season Kills: For 15 years antelope hunters in Oregon have harvested an annual take of 3.7 per cent of the estimated annual population, or an average take of 512 animals for an average estimated annual population of 13,854. As a means for comparison, data pertaining to hunter harvest in nine states averaged 1,544 kills for a weighted mean annual population of 11,049 animals, or an annual per cent kill of 13.9.

Illegal Kills: The illegal or "poaching" take of antelope was not found to have been a serious problem in southeastern Oregon. Reasons for this were apparently sparse human inhabitation on or near antelope ranges and the general opinion that antelope meat was unsavory. "Accidental" killings of does and kids during the hunting seasons were three times greater than poaching losses occurring the remainder of the year.

Collection of Carcasses: A total of 370 antelope carcasses was collected. This datum was classified as to sex and age, estimated season of death, and per cent mortality by age group. Earlier investigations reporting a high rate of kid deaths occurring from birth to three months of age were substantiated by findings from this study, but it was not determined whether this was a normal or abnormal loss in the kid mortality rate.

Based on present knowledge, no single or combination of decimating agents could be uncovered as limiting factors in holding antelope in Oregon at a static population level. However, indications were noted whereby antelope densities and kid:adult ratios were highest on ranges with a greater vegetation interspersion and edge effect. Consequently, the key to increasing Oregon's antelope herds could possibly be obtained by investigating and managing the range carrying capacity and range forage manipulation.

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APPENDICES

APPENDIX A

Recorded Diseases of Pronghorn Antelope in North America

Disease	Literature Cited	State	Remarks
Hemorrhagic septicemia ?	(20, p.214)	South Dakota	Death of one animal attributed.
"Shipping fever"	(97, p.15)	Arizona	3 antelope afflicted.
Pasteurella septica	(64)	Idaho	Cultures killed mice.
Pneumonia	(40, p.22)	Colorado	5 of 26 animals pathogenic.
	(see p.31)	Oregon	one adult buck.
Miliary tuberculosis	(104, p.163)	Montana	Animal died in captivity, 2/28/26.
Corynebacterium ovis	(20, p.15)	Montana	Localized outbreak in 1947.
C. pyogenes	(61, p.12)	Wyoming	Caused arthritis in hind foot.
C. sp.	(61, p.15)	Wyoming	2 antelope had liver lesions.
C. sp.	(see p.32)	Oregon	3 individual cases noted.
Unknown fatal epizootic	(106, p.451)	From Missouri to Yellowstone River	Summer of 1873. Many antelope died.
Constipation	(40, p.23)	Colorado	Slight case.
Diarrhea "Scours"	(60, p.1)	California	Appears fairly common.
	(60, p.1)	Nevada	Dietary intestinal upset.
	(see p.27)	Oregon	(see page 27)
	(61, p.176)	Wyoming	Associated with parasites.
Mucosal disease	(101)	North Dakota	Several cases seen.

APPENDIX A (Continued)

Disease	Literature Cited	State	Remarks
Keratitis "Pink eye"	(26, p.317)	Texas	One buck died, another sick.
	(61, p.36)	Wyoming	Year old buck, May, 1955.
	(40, p.24)	Colorado	Blind, emaciated, skin abrasions.
	(see p.19)	Oregon	(see page 19)
Streptococcus	(see p.31)	Oregon	Two cases noted, adult animals.
Necrotic stomatitis	(see p.26)	Oregon	Adult buck afflicted.
	(20, p.15)	South Dakota	Four antelope in 1947.
Actinomyces, sp. & Actinobacillus sp. "Lumpy jaw"	(20, p.15)	South Dakota	1 old doe and 2 adult bucks.
	(105)	Montana	6 or 13 animals diseased.
	(27, p.634)	Oklahoma	Thin adult doe.
	(22, p.101)	Wyoming	Particularly virulent.
	(see p.23)	Oregon	(see page 23)
Subcutaneous abscesses	(40, p.23)	Colorado	In lower jaw of one animal.
	(see p.33)	Oregon	4 individual cases noted.

APPENDIX B

An Annotated List of Internal Parasites Found in Antelope of North America Excluding Oregon

Parasite	Literature Cited	State	Location and Abundance
Eimeria sp.	(84, p.16)	Montana	Colon and caecum
" antelocaprae	(62, p.167)	Wyoming	200 oocysts
Salenomonas ruminantium	(30, p.27)	California	
Coccidea-eimeria sp.	(20, p.14)	South Dakota	In colon & caesium
Nematodirella longispiculata antilocaprae	(20, p.14)	South Dakota	10 of 14 animals afflicted.
" " "	(84, p.16)	Montana	Abomasum and small intestine.
" " "	(52, p.639)	North Dakota	Very prevalent in antelope.
" " "	(45, p.134)	Wyoming	3,447 in one kid
" "	(61, p.175)	Wyoming	One of most numerous helminths.
Nemadoirus antilocapra	(98, p.1)		
" "	(105, p.105)	Montana	
" abnormalis	(72, p.2)		
" "	(61, p.174)	Wyoming	
" spathiger	(72, p.2)		
" "	(84, p.16)	Montana	In small intestine.
" "	(61, p.173)	Wyoming	
" "	(52, p.641)	North Dakota	
" "	(20, p.14)	South Dakota	In intestine.
" filicollis	(52, p.641)	North Dakota	
" "	(118)		
Haemonchus contortus	(26, p.315)	Texas	Usually 3-5.
" "	(72, p.2)		
" "	(20, p.14)	South Dakota	7,900 in one female.
" "	(84, p.16)	Montana	In abomasum
" "	(52, p.639)	North Dakota	
" "	(61, p.169)	Wyoming	

APPENDIX B (Continued)

Parasite	Literature Cited	State	Location and Abundance
Ostertagia sp.	(105, p.105)	Montana	
" *ostertagia*	(52, p.640)	North Dakota	
" "	(20, p.14)	South Dakota	1 specimen in 14 animals.
" *circumcincta*	(61, p.161)	Wyoming	
" "	(52, p.640)	North Dakota	
" "	(84, p.16)	Montana	In abomasum
" "	(20, p.14)	South Dakota	
" *bisonis* (?)	(52, p.640)	North Dakota	
" *bullosa*	(45, p.134)	Wyoming	
" "	(99)		
" *marshalli*	(61, p.167)	Wyoming	
Pseudostertagia bullosa	(72, p.2)		
" "	(84, p.16)	Montana	In abomasum
" "	(52, p.640)	North Dakota	
" "	(20, p.14)	South Dakota	1,561 in one animal
Dictyocaulus sp.	(105, p.105)	Montana	In 4 animals
Setaria sp.	(20, p.14)	South Dakota	3 of 14 animals
Cooperia bisonis	(72, p.2)		
" "	(52, p.641)	North Dakota	Small numbers
" "	(20, p.14)	South Dakota	In intestines
" *oncophora*	(61, p.157)	Wyoming	
" "	(52, p.641)	North Dakota	
Marshallagia marshallia	(72, p.2)		
" "	(20, p.14)	South Dakota	3 of 14 afflicted
" "	(84, p.16)	Montana	In abomasum
Capillaria sp.	(52, p.641)	North Dakota	1 collected
Protostrongylus macrotus	(45, p.93)		
" "	(61, p.179)	Wyoming	Lungs

APPENDIX B (Continued)

Parasite	Literature Cited	State	Location and Abundance
Trichostrongylus colubriformis	(20, p.14)	South Dakota	3,400 in one intestine.
" "	(52, p.641)	North Dakota	Small numbers
" "	(61, p.154)	Wyoming	
" "	(84, p.16)	Montana	In small intestine
Strongylus contortus	(113)		
" "	(113)		
" papillosus	(40, p.26)	Colorado	1 of 26 animals afflicted.
Onchorcerca flexuosa	(46, p.246)	Idaho	From subcutaneous tissue.
Trichuris discolor	(72, p.2)		
" sp.	(52, p.641)	North Dakota	Lower intestine
" sp.	(61, p.198)	Wyoming	
" sp.	(84, p.16)	Montana	In caecum and colon
" ovis	(20, p.14)	South Dakota	In colon and caesium.
Thysanosoma actinioides	(40, p.26)	Colorado	In small intestine
" "	(124, p.154)		Not uncommon
" "	(13, p.96)		
Moniezia expansa	(26, p.316)	Texas	3 in 1 animal
" "	(52, p.641)	North Dakota	
" "	(20, p.14)	South Dakota	In intestines
" "	(61, p.119)	Wyoming	
" "	(40, p.24)	Colorado	Small intestine
" benedeni	(52, p.641)	North Dakota	
" "	(40, p.24)	Colorado	Small intestine and abomasum.
" sp.	(105, p.105)	Montana	

APPENDIX C

An Annotated List of External Parasites on North American Antelope

Parasite and Literature Cited	State	Area from Host	Number of Parasites
Hippoboscid fly (*Neolipoptera ferrisis*) (57, p.16)	California	1944 upper lip eye lid 1943	 1 1 1
Winter horse tick (*Dermacentor nigrolineatus*) (26, p.316)	Texas	head and body	abundant
Rocky Mt. wood tick (*Dermacentor andersoni*) (29, p.24)	Oregon		
"" (see page 44)	Oregon	head, sternum, anal region, ears	from 1 to 33
"" (38, p.120)	Colorado	neck	1
Winter tick (*Dermacentor albipictus*) (see page 44)	Oregon	sternum	2
Wood tick (105)	Montana		
Spinose ear tick (*Ornithodoros megnini*) (26, p.316)	Texas	deep in ear channel	

APPENDIX D

An Annotated List of Author Citations Concerning Antelope-Predator Relationships in North America

State	Literature Cited	Predator Problem			
		Coyote	Bobcat	Lions	Eagles
Arizona	(17, p.179)	X			
Arizona	(67, p.27)	X		X	X
California	(1, p.23)	X	X		X
California	(115, p.100)	X			
Canada	(100, p.14)	X			
Oregon	(50, p.75)	X	X		X
Oregon	(73, p.14)	X	X		
Oregon	(56, p.75)	X			X
Texas	(26, p.310)	X			X
Texas	(65, p.12)	X			
Utah	(52, p.76)	X	X		
North America	(106, p.449)	X			X
North America	(132, p.146)	X			
North America	(16, p.15)				X