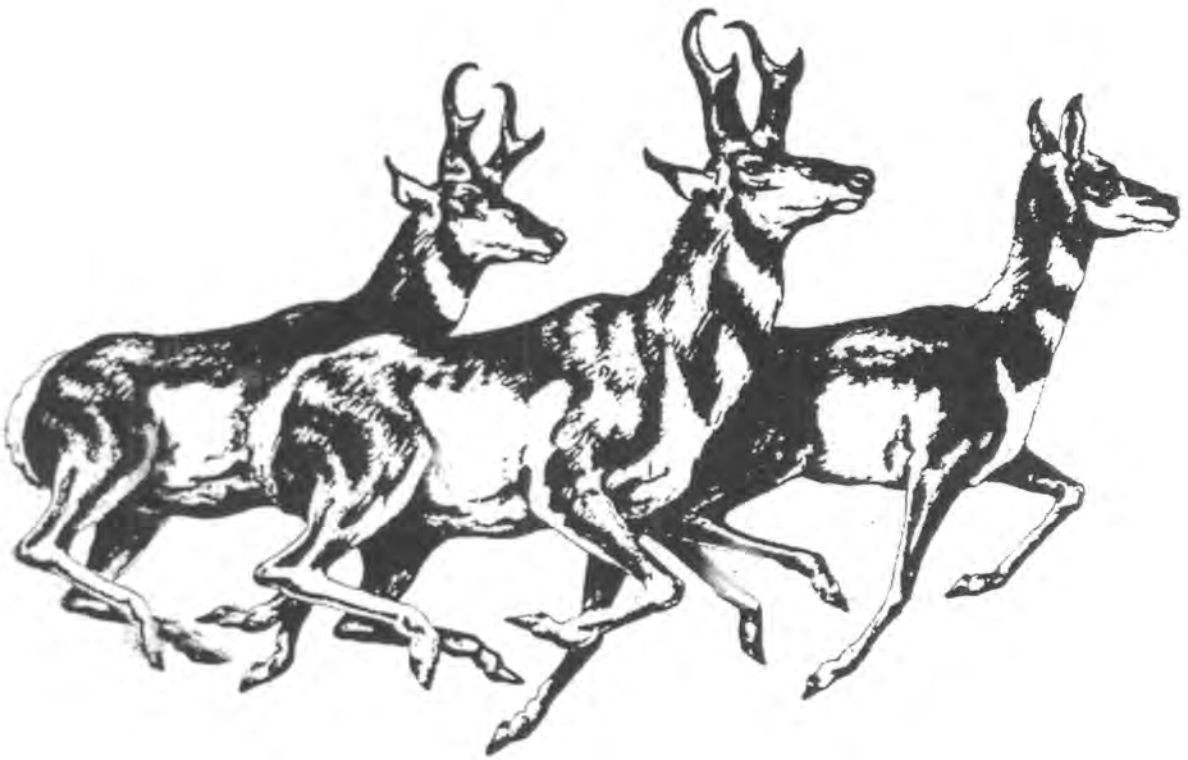
PROCEEDINGS
of the
FIFTEENTH BIENNIAL

PRONGHORN ANTELOPE WORKSHOP



ROCK SPRINGS, WYOMING
JUNE 8-11, 1992

Chairman
Phil Riddle

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PREFACE

The 15th Biennial Pronghorn Antelope Workshop was hosted by the Wyoming Game and Fish Department in Rock Springs, Wyoming. There were 91 people registered for the event.

Ten states presented status reports for the antelope in their states and twelve technical papers were presented. A field trip was conducted on the second full day of the meeting. The theme for the trip was to show the various impacts to pronghorn caused by energy development, fencing, livestock grazing, urban development and recreation. At selected stops, various resource users met with workshop participants to discuss specific issues and problems.

Technical papers were assigned to volunteers for editing. No alterations of technical data or nature were made without consent by the authors.

"Guidelines for the Management of Pronghorn Antelope" a publication of the workshops was discussed and plans made to publish it every four years.

Kansas will host the 16th biennial workshop in 1994.

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Summary of Pronghorn Workshops Held To Date

Meeting dates and locations	Number Attending	Chairman	Host Agency
April 14-16, 1965 Santa Fe, NM	18	W. Huey	New Mexico Dept. of Fish and Game
Feb. 16-17, 1966 Denver, CO	32	G.D. Bear	Colorado Game, Fish and Parks Dept.
Feb. 5-6, 1968 Casper, WY	97	J.L. Newman	Wyoming Game & Fish Commission
Jan. 27-28, 1970 Scottsbluff, NE	85	K.I. Menzel	Nebraska Game & Parks Commission
June 19-22, 1972 Billings, MT	85	H.O. Compton	Montana Fish and Game Dept.
Feb. 19-21, 1974 Salt Lake City, UT	52	D.M. Beale	Utah Division of Wildlife Resources
Feb. 24-26, 1976 Twin Falls, ID	68	R. Autenreith	Idaho Dept. of Fish and Game
May 2-4, 1978 Jasper, Alberta	84	M.W. Barrett	Alberta Fish and Wildlife Division
April 8-10, 1980 Rio Rico, AZ	64	J.S. Phelps	Arizona Game and Fish Dept.
April 5-7, 1982 Dickinson, ND	69	J.V. McKenzie	North Dakota Game and Fish Dept.
April 10-12, 1984 Corpus Cristi, TX	45	C.K. Winkler	Texas Parks and Wildlife Dept.
March 11-13, 1986 Reno, NV	43	M. Hess	Nevada Dept. of Wildlife
May 31-June 2, 1988 Hart Mt., OR	43	D. Eastman	Oregon Dept. of Fish and Wildlife
May 22-24, 1990 Silver Creek, CO	45	T.M. Pojar	Colorado Division of Wildlife
June 8-11, 1992 Rock Springs, WY	91	P. Riddle	Wyoming Game and Fish Dept.

Provincial and State Status Reports

ARIZONA ANTELOPE STATUS REPORT - 1991
RAYMOND M. LEE, 2221 W. GREENWAY RD., PHOENIX, AZ 85023

POPULATION ESTIMATE:

Arizona's pronghorn antelope population is composed of three subspecies; *Atilocapra americana americana*, *A. a. mexicana*, and *A. a. sonoriensis*. Arizona's post-hunt adult antelope population is approximately 7,300; 6,600 *americana*, 600 *mexicana*, and 100 *sonoriensis*. This is a reduction in numbers since a recent population peak in 1987. This reduction is due to the severe drought which occurred throughout Arizona in 1988, 1989, and 1990. The game management units with the largest *americana* populations are Units 5B, 10 and 19B; these units contain nearly 33% of the total population. The largest populations of *mexicana* occur in Units 31 and 32.

SURVEY:

Pronghorn antelope in Arizona are surveyed primarily from fixed-wing aircraft (Piper Super Cub, or STOL equipped Cessna 182 or 206). Surveys are conducted in July and August, prior to the hunt and after most fawning mortality. A total of 7864 *americana* were surveyed in 1991, resulting in buck:doe:fawn ratios of 29:100:34; close to the 15-year average of 32:100:33. A total of 353 *mexicana* were surveyed, resulting in ratios of 35:100:43. Fawn survival was much improved in 1991, reflecting the increased rainfall throughout the state.

Sonoriensis are not hunted, being listed as an endangered species, and are not routinely surveyed. These animals have been surveyed in Mexico the past three years as part of an interagency cooperative program. The surveys are done as part of a radio-collaring effort to determine habitat selection by antelope in Mexico. Further survey and radio-telemetry work is planned in Mexico. Surveys are planned in Arizona as part of the Sonoran Pronghorn Antelope Recovery efforts

HARVEST:

In 1991, a total of 543 antelope were harvested. Application rates for the various weapon types varied considerably. When archery hunting first began in 1974, 16 hunters applied for the 50 permits available. In 1991, 678 archers applied for the 549 permits (1.1 applicants per permit). Muzzleloader permits were over-subscribed with 608 applicants for 143 permits (7.6 applicants per permit) and the centerfire rifle hunters' application rate was 9047 for 574 per-

mits (13.7 applicants per permit). These application rates led to minor adjustments in the 1992 permit levels to more accurately allocate permits by demand. Additional 1991 harvest information is shown below:

Weapon	Permits	Hunters	Days afield	Harvest	% Success
Cfr	574	565	1225	442	76
Mzl	143	138	441	55	58
Arch	549	521	2999	46	9

One of the most significant results of Arizona's antelope harvest is in the Boone and Crockett scores. A number of trophies in excess of 90 points have been reported. Unofficially, Arizona has now produced 12 of the top 20 scores.

MANAGEMENT GUIDELINES AND STRATEGIC PLANS:

The Arizona Game and Fish Department (AGFD) provides each of its Wildlife Managers with an antelope species management guidelines. This document gives guidance on how to survey, make hunt recommendations for, fence, supplemental feed, etc., their antelope populations. Hunt guidelines are annual guides reflecting the current hunter demand and other more "political" factors for setting season dates and permit numbers. In 1992, season dates will be 8/21 - 9/3 for archers. Muzzleloader and centerfire hunters will have stratified seasons 9/18 - 9/21 and 9/25 - 9/28. In selected units, 6 day seasons will be offered. The prime factor in determining permit numbers is to maintain a post-hunt buck to doe ratio of 25-40:100.

The 1992-1996 strategic plans tell the direction of the AGFD in antelope management and identifies hunting strategies. These plans call for maintaining a pronghorn antelope population between 8200 and 8900 and providing a harvest of 550-600 animals to 1100-1250 hunters in 3500-4100 hunter days.

TRANSPLANTS:

Arizona has engaged in a fairly active antelope transplant program since its first release with Nevada antelope in 1924. Recently, Arizona has had the good fortune of having the money and excess bighorn sheep to initiate trades with several western states for pronghorn antelope. Frequently we are helping to remove depredating animals. Recent transplants have been canceled due to drought produced habitat limitations and inclement weather in the capture states. We have been "in the market" for the *mexicana* sub-species to repopulate historic range.

SPECIAL PROJECTS:

A Sonoran pronghorn study has been underway in Mexico for several years. Primarily, the research is concerned with habitat use, fawning rates, and movement patterns. A total of fifteen antelope have been fitted with radio-transmitters for this work.

The AGFD is engaged in an active program to aerially gun transplant sites and game management units where the fawn crop falls below 20:100 for 2 consecutive years. This activity has produced considerable opposition from animal rights groups.

A research program was recently started. The objectives of this project are to determine the areas, locations, habitat characteristics, and land ownership or seasonal pronghorn antelope habitats throughout Arizona.

SPECIAL PERMITS:

The AGFD auctions and raffles special big game permits for fund raising purposes. Since 1984, over $1,000,000 has been raised through this program. The most successful permits have been for bighorn sheep ($85,000 for a raffle permit and $67,000 for an auction permit). Special antelope permits usually result in approximately $12,500 per permit. These funds are earmarked for antelope management and have been expended on the antelope transplant program and the accompanying coyote control effort.

CALIFORNIA PRONGHORN ANTELOPE STATUS REPORT - 1992

Laura Colton
California Department of Fish and Game
Sacramento, California

Historically, pronghorn antelope inhabited California's central valley, deserts, and coastal plains. By the mid 1940's, pronghorn antelope were extirpated from a majority of thier historic range, except for populations in northeastern California. Annual censuses conducted in northeastern California since 1942 indicate the population has increased to approximately 7,908 animals (January, 1992).

Since 1947, the Department has translocated approximately 1,010 pronghorn antelope to areas within their historic range. The translocated populations remain small, especially due to the recent drought. In 1992, southern California received record amounts of rain. Unfortunately, northeastern California received below average snow and rainfall. Agricultural developments in northeastern California may be sustaining an increasing pronghorn antelope population. Issues regarding pronghorn antelope on private land are expected to increase over time. Fortunately, large expanses of winter and summer ranges occur on public land.

The 1991 pronghorn antelope hunting season statistics include the following:

	TAG ALLOCATION	ANIMALS HARVESTED	HARVEST SUCCESS	NUMBER APPLICANTS
Archery Buck	70	19	.27	278
Archery Doe	35	12	.34	81
General Buck	595	515	.87	9474
General Doe	300	207	.69	1023
Junior Hunt-Doe	10	6	.60	112
TOTAL	**1010**	**759**		**10968**

In 1992, the Department prepared an environmental document to assess the potential impacts of hunting on pronghorn antelope and their environment in northeastern California, pursuant to the California Environmental Quality Act (CEQA) and CEQA Guidelines. This document is accepted as a functional equivalent and in lieu of an Environmental Impact Report or a Negative Declaration. The document provides information to the Fish and Game Commission to use in the decision making process and to the public to consider the potential effects of the proposed action of hunting pronghorn antelope.

Between February 7, 1992 and April 23, 1992, the Department prepared four public notices to amend the pronghorn antelope hunting regulations. The Commission adopted the final notice and amended the regulation to include a 56 percent increase in the pronghorn antelope tag allocation as follows:

Archery buck	69
Archery doe	35
General buck	671
General doe	787
Junior Hunt either-sex	10
Special Fund-raising	9
Total	**1,581**

The above tag allocation applies to only the northeastern California pronghorn antelope populations in hunt zones one through six. Pronghorn antelope populations in all six hunt zones have exceeded the goals stated in "The Northeastern California Pronghorn Management Plan", 1989. The Department plans to gradually reduce the pronghorn antelope population in the six hunt zones over a five year period. The desired buck:doe ratio is 24:100 (post hunt), and the desired fawn:doe ratio is 60:100. Due to the declining buck:doe and fawn:doe ratios, the 1992 doe tag allocation reflects a proposal to reduce the doe population.

Only residents are permitted to apply for pronghorn antelope archery-only and general season license tags. In 1992, the regulations were amended to eliminate the 10-year waiting period for doe. The regulations retained the 10-year waiting period for buck.

Due to a recent change in the statutes, the regulations permit the issuance of a specific number of special fund-raising tags. Both nonresidents and residents are eligible for these tags. The season is expanded to permit hunting a week before the general season. The area includes all six hunt zones. Six nonprofit organizations auctioned or raffled eight special fund-raising tags this year. The proceeds from the sale of these tags provided the Department with $31,660. The funds raised by the sale of the tag during this event will initiate new research and management programs that directly benefit pronghorn antelope.

The Private Lands Wildlife Management Area (PLM Program has been in effect since 1983.) For inclusion in the PLM Program, landholders must submit applications and plans for habitat improvements to the Commission. After the Commission approves the applications and the landholders complete specific habitat improvements, the Department may issue hunting license tags and PLM licenses for the operation of wildlife management areas.

This Program encourages private landowners to maintain and enhance wildlife habitat. In exchange for valid general license tags, landowners often sell the opportunity for access to hunt big game animals such as pronghorn antelope. In 1991, the Department issued 27 buck and eight doe pronghorn antelope tags to landowners. Hunters harvested 20 buck and six doe. In 1992, the Department anticipates issuing approximately 35 buck and 12 doe pronghorn antelope tags. Unfortunately, the Northern California Sportsmen's Council has filed suit against the Department with regard to the PLM Program.

COLORADO PRONGHORN STATUS REPORT - 1992

John P. Gray, Colorado Division of Wildlife, Grand Junction
Thomas M. Pojar, Colorado Division of Wildlife, Ft. Collins

POPULATION

The projection for Colorado's pronghorn 1992 prehunt population is 59,492 animals. The 1991 posthunt population was approximately 50,355 and the 1992 posthunt objective is 51,440. The population in all parts of the state appears to be relatively stable and close to the long-term objective of 52,880 animals.

Survey methods include pre- and post-hunt aerial flights using both fixed-wing aircraft and helicopters. Surveys are done to obtain production, age and sex ratio, and/or total population data. Kinds of counts include stratified random quadrants and line and strip transects. Prehunt ground surveys are done in some units to obtain herd structure information. Most Game Management Units (GMUs) are counted in some way each year or scheduled every other year.

Populations are modeled for each Data Analysis Unit (DAU = one or more GMUs which are grouped to form a "herd unit") utilizing POP-II, Ver. 6.8 software.

HERD STRUCTURE

With a wide range of values, the 1991 post-hunt age and sex ratios averaged 33 bucks and 56 fawns per 100 does. The 1992 pre-hunt projections average 44 bucks and 53 fawns per 100 does. Data were taken from the 1992 POP-II models.

HARVEST/HUNTING REGULATIONS

Year	Licenses issued	Number hunters	Harvest	% Success
1989	11506	11456	8532	74
1990	12144	11842	8620	73
1991	10080	10016	7315	73
1992	11395	-	-	

The regular rifle season (which includes muzzleloading) is 7 days in length. In the northern half of the state (north of Interstate 70), the 1992 dates are September 26 through October 2. The season in the southern half runs Oct. 3-9. The regular archery season is August 15-September 20 each year. All licenses are totally limited except for archery season licenses in eastern Colorado. For 1992, there are 9 "Wildlife Ranching" hunts involving portions of 17 GMUs; all but one of these hunts is in the southeast quarter of the state and each can have season dates outside the regular framework.

RESEARCH

In the late 70's a small group of pronghorn from North Park pioneered into historic range in Middle Park (northcentral Colorado). This population has been monitored by radio telemetry since 1986. During the first few years of habitation in Middle Park, the populations' annual rate of increase ranged from 30 to 50 percent. The rate of increase in the past couple years has declined to less than 20 percent. Based on a linear regression for rate of increase and population size, the projected K-value (carrying capacity) for this population is 350-400 animals. The 1991-92 winter population was 292 animals and it is projected that the K-value will be reached in 3 or 4 years. However, the population is currently inhabiting only about 50 percent of the available sagebrush steppe habitat in Middle Park. If they pioneer into other areas of the park, the rate of increase will likely return to a higher level and the K-value projection will be extended accordingly.

MANAGEMENT PLANS/GUIDELINES

A statewide Management Analysis Guide was written by Tom Pojar in 1991; it covers the next three years - 1992-94. Issues from the social, political, economic and biotic environments were explored to see if changes in management strategy should be initiated. The general public, pronghorn hunters and the Division of Wildlife (DOW) employees were surveyed to get their opinions on these issues. The key issues that surfaced during general public and DOW focus groups are:

1. Should we hunt pronghorn during the breeding season,
2. Should we establish a hunting season structure to reduce hunter density, and
3. Should we limit archery licenses on a statewide basis?

The results from the survey strongly indicate that, although these may be issues, they are not issues that demand any immediate corrective action. In general, all groups are satisfied with the present management and season

structure for pronghorn in the state.

Hunting pronghorn during the breeding season is not a concern of hunters (70%) or DOW employees (70%), however, 59% of the general public prefers to have no hunting of pronghorn during the rut. An indication of some mild concern by all groups is evidenced by their unanimous agreement that research should be conducted to determine if hunting during the rut is detrimental to the population.

Hunter density does not seem to be a problem. Seventy-five percent of the hunters agree that the quality of their hunting experience is not impeded by the present density of hunters. When given the choice between the current 7-day season and a split season of 5 days each to reduce hunter density, 71% of DOW employees were in favor of the 7-day season.

Regarding the issue of limiting archery licenses statewide, DOW employees are almost evenly split, with 47% in agreement and 53% opposed.

Slightly over half of the general public and hunters believe there are two few pronghorn in the state while over half (54%) of DOW employees believe the number of pronghorn is just right.

All the groups surveyed apparently are satisfied with the current management of pronghorn in Colorado. Therefore, the Wildlife Commission has adopted a *status quo* management plan for at least the next 3 years.

KANSAS PRONGHORN STATUS REPORT - 1992

Keith Sexson, Big Game Program Coordinator, Kansas Wildlife and Parks

Population

Aerial counts using fixed wing aircraft are conducted in July (production counts) and January (winter counts). Counts in January, 1992, produced a population estimate of 1,500 to 1,600 animals in the major west-central Kansas pronghorn range. There is an additional estimated combined total of 600 animals in southwest, southcentral and east-central Kansas.

July 1991 production counts in the major range, provided a ratio of 59 bucks per 100 does and 78 young per 100 adult does. This compares to 76, 56 and 68 young per 100 does in 1988, 1989 and 1990, respectively.

Archery Season

A 9 day pronghorn archery season is held in late September. Archery hunting is open in portions of 10 counties in west-central Kansas. No archery permit quotas are established, but archers are limited to one permit. A total of 74 and 89 permits was issued in 1990 and 1991, respectively. Hunter questionnaires are mailed with all permits. Sixty-eight and 84 active archers reported harvesting 14 and 16 animals for 20.6 and 19.0 percent success in 1990 and 1991, respectively. Hunters reported 262 and 341 mandays of archery hunting in 1990 and 1991, respectively.

Firearm Season

Pronghorn firearm seasons in Kansas were initiated in 1974. The firearms season is held in early October and, beginning in 1990, was increased from a 3 day season to 4 days. A total of 170 and 150 permits were available in three hunting units in 1990 and 1991, respectively. The number applications for firearm permits exceeds the number available by 3 - 4 times. Permits are available to residents only and applicants are not eligible for the first drawing if they held a permit for any of the previous 5 years. In 1991, 145 active hunters spent 196 mandays hunting and harvested 137 pronghorn for 94.5 percent success. The 1991 harvest consisted of 119 bucks and 18 does/fawns. In 1990, 158 active hunters harvested 151 animals (131 bucks and 20 does/fawns) for a success rate of 95.6 percent. Each firearms hunter receives a mail questionnaire and incisor tooth envelope with his permit. Nearly 75 percent of the buck harvest are greater than 1.3 years old.

Transplants

Restoration efforts in 1978 - 1983 resulted in the release of nearly 600 pronghorn in Kansas. Release locations included the counties of Gove (west-central), Morton (southwest), Ellsworth (central), Clark (southcentral) and Chase (east-central). No restoration efforts occurred from 1984 - 1990.

In 1991 and 1992, approximately 50 animals each were released in Chase and Morton counties. Animals released in Chase County were included in a Flint Hills pronghorn restoration evaluation project. Future Flint Hills restoration efforts will center on evaluation project findings and landowner tolerance for pronghorn. Restoration efforts in Morton County will continue.

Research

In cooperation with the Kansas Biological Survey, a project has been initiated to classify and integrate remote sensing imagery in a geographical information system to evaluate land use changes (1978 - 1989) in the extent and distribution of pronghorn habitat in Wallace and Sherman counties (west-central).

An evaluation of pronghorn restoration in the Flint Hills was initiated with the release of animals in 1991 and 1992. Evaluation objectives included 1) determining post-release mortality rates, 2) determination of post-release dispersal and behavior, and determine establishment of home range, territories and movement patterns, 3) determining productivity rates, fawn survival, and fawning site selection, 4) monitoring population density and land use changes and 5) determining food habits.

NEBRASKA ANTELOPE STATUS REPORT

June 1992

Harvey Y. Suetsugu

Antelope occupy the open short-grass plains of the Panhandle and between 1958 and 1962 were reintroduced into the Sandhills. About 7,000 of the 14,000 square miles in the Panhandle are considered primary antelope range and 10,000 of the 20,000 square miles in the Sandhills are considered secondary range.

With the reintroduction of over 1,000 animals, the statewide antelope increased to 10,000, with the Panhandle supporting 8,000, by the mid-70's.

Due to a severe winter in 1978-79 some herds experienced 40 to 60% mortalities, while other herds were decimated. Two management units recovered from the high mortalities but others have not.

Population estimates for the state climbed to 10,000 by 1982 but six years later dropped to 3,000. Thus, in 1988 and 1989 a strategic management plan was developed.

Examining the data from each unit, we attempted to raise the doe:fawn ratio on the assumption that production was occurring but survival was poor. During 1990 and 1991 a study of the effect of predators on the fawning grounds was conducted. Results of this project are scheduled to be presented at this session.

Aerial surveys and mandatory harvest checks are currently used. Only two of the five Panhandle units were open to hunting in 1991 with 366 permittees taking 326 adult male antelope for an 89% success rate (88 and 91%).

Harvest in the North Sioux Unit was restricted to bucks only for two seasons. However, for 1992 it has been liberalized by doubling the number of permits allowed and making them all either sex (250 buck only increased to 500 either sex). The Banner Unit is still restricted to 100 buck only permits.

Archery hunting for antelope is quite popular in Nebraska. Last year 263 bow hunters harvested 45 antelope during the buck only season for a 17% success rate.

NEW MEXICO PRONGHORN STATUS REPORT

New Mexico's pronghorn population is estimated at 30,000 animals. Primary populations occur in the eastern plains and the northeastern part of the state. Pronghorn also occupy scattered habitat throughout the western half of the state. In the northeastern part of the state, pronghorn populations have experienced increases, while in the southeastern part of the state, pronghorn populations have experienced declines. These declines can be attributed to the effects of the parasitic stomach worm *Haemonchus* spp. which was diagnosed in southeastern populations around 1988 and the drought conditions which followed, resulting in low forage production. The drought conditions did, however, assist in bringing the parasitic worm under control. Beginning in the summer of 1991, the southeastern quarter of the state began receiving good precipitation and it appears that the pronghorn populations have stabilized and have began to recover.

There were sixteen pronghorn hunts during the 1990-91 season; four archery, five muzzle-loader, six rifle and one in which only physically handicapped hunters could hunt. Total archery harvest was 176 pronghorn by 682 hunters for a 25.8% success rate. Total muzzle-loader harvest was 209 by 389 hunters for a 53.7% success rate. Total rifle harvest was 4,049 by 4,576 hunters for a 88.4% success rate. Total harvest during the handicapped hunt was 22 by 22 hunters for a 100% success rate.

Population trends are monitored by flying 100% surveys in several of the 69 pronghorn units on a rotational basis during the months of March and April. The surveys are flown on north and south lines 1/3 to 1/2 miles apart, depending on topography, with all animals recorded.

New Mexico has continued its transplant program by moving pronghorn from areas where there is a surplus and relocating them to new ranges or areas of low productivity. One of our largest pronghorn relocation projects was completed during January of 1992, when 224 animals were removed from a ranch near Las Vegas, New Mexico. The animals were relocated to five different release sites, most in the western half of the state. All releases augmented existing herds.

Currently there are no research projects being conducted in New Mexico on pronghorn antelope.

NORTH DAKOTA ANTELOPE STATUS REPORT

James V. McKenzie
North Dakota Game and Fish Department

Weather conditions during the winter months play an integral role in the ecology of American pronghorn in North Dakota. Specifically, a winter with below normal snow precipitation and above normal temperatures is usually a harbinger to a good year for pronghorn. The reverse is also true.

Since the winter of 1964-1965, North Dakota has experienced five major winter-kills. The losses have reduced pronghorn numbers from the modern-day high of about 15,000 animals in 1964-1965 to about 1,800 pronghorn antelope by 1980. Severe winters do treat pronghorns rough in North Dakota.

The years since 1980 have been comparatively mild winters, consequently, little if any winter mortality has occurred and resultant reproduction has been good (.8 to 1.0 kids per doe). The pronghorn population in North Dakota has responded in a positive way to the interim management plan that you, this group, helped to establish. The population estimate in 1991 was placed at 9,661 animals.

Annual population estimates are derived during a July aerial survey on portions of the pronghorn range in North Dakota and are based on as near a complete count as possible of approximately one-third of the range each year. Cumulatively, this provides a look at most management units once every three years. Population densities and distribution, sex ratios, and fawn production are obtained through his method.

The 1991 sex ratio of pronghorns in North Dakota was 37 horned bucks per 100 does, however, the production figures were not comparable to previous surveys because the survey had to be flown too early to provide accurate production information. Hopefully, the licensing logistics have been corrected for this year (1992) and production figures will warrant a fair degree of confidence.

Both gun and archery seasons are held annually in North Dakota. The most recent year that harvest information is available is 1990.

During that year, 2,700 permits were issued for the gun season and 2,555 of these hunted. They harvested 2,292 pronghorns for a hunter success of 89.7%. The buck:doe:kid ratio of the harvest was 3.82:1:.74. Also, 1,279 licenses were issued to archers. Of these, 1,164 individuals hunted and they harvested 243 pronghorn antelope for a 20.9% hunter success and a buck:doe:kid ratio of 3.19:1:2.33.

In his recent book, Big Game in North Dakota, Joe Knue summarizes many of the feelings regarding needs of pronghorns in North Dakota. He writes

"It seems that numbers have a lot to do with the interest North Dakotans have in the future antelope. Antelope are not very dense anywhere in the state, but they are the most dense down in the southwest corner of the state in Bowman and Slope counties. In some of the pronghorn management units in those counties there are more pronghorns per square mile than there are people. What that adds up to is that very few people see antelope very often in North Dakota. It is not surprising that pronghorns are not much in the public mind.

On the other hand, some of the people who do see antelope seem to see far too many of them. If an agricultural operator has both deer and antelope on his property, he is apt to tolerate the deer and want to be rid of the antelope. Pronghorn behavior is partly to blame for this. Deer spend daylight hours in heavy cover and move into a feeding and bedding area at night. They prefer taller cover. Pronghorns, on the other hand, stay out in the open. For them it is a survival strategy—they can see everything that is going on around them for quite a distance. They are rarely in cover taller than 15 inches unless they are passing through it on the way to somewhere else. Their habits make them far more visible than deer, and perhaps they give the impression that there are more of them than there are deer.

You almost need to see them from the air to understand the distribution of antelope herds. From the air you can see how antelope clusters are distributed close to small scattered patches of grassland. More and more these small grassland areas have been surrounded by cropland, turning them into islands. To think that pronghorns are there for the cropland which surrounds them is a mistaken impression. But it is easy to see how the impression is created.

The key to the future security of the pronghorn in North Dakota is habitat, just as it is the key for every wildlife species. We cannot "manage" the game of North Dakota without it. Without habitat, pronghorns will not go into the winter healthy, and they might not come out of the winter at all. But as we have seen, good habitat is more than food and water. To understand good habitat we— "we" being not only people responsible for game management but people who own the land that pronghorns live on—have to understand some of the life history and behavior of pronghorns. Creating that understanding is part of the job of game management ____."[1] There is a need to improve this understanding - both within the game management community itself as well as the various publics it serve. Perhaps Joe Knue's book has started this process.

[1] A short history of Big Game in North Dakota; Joseph Knue; North Dakota game and Fish Department; 1991; Part II; Chapter 8; pp 217-218.

OREGON PRONGHORN STATUS REPORT - 1992

Walt Van Dyke, Oregon Department of Fish and Wildlife, Portland, Oregon.
Mitch Willis, Oregon Department of Fish and Wildlife, Hines, Oregon.

Pronghorn management has changed very little over the last two years. Census is conducted in the spring by flying traditional winter ranges in fixed wing aircraft. Herd composition counts are conducted in late summer, usually prior to the hunting season. Buck only or either-sex firearm seasons provide a majority of the hunting opportunity. Limited muzzleloader only and archery only opportunities are also available. Some hunts are specifically designed to address pronghorn damage to agricultural croplands.

During spring 1991 inventory, 18,595 pronghorn were counted which is the highest count on record in Oregon. The total population was estimated to be 26,500 head which was an increase of 1500 head over the 1990 estimate. Mild winter conditions during 1991-92, allowed pronghorn to be widely scattered (some remained on summer ranges) and the 1992 inventory resulted in 16,127 antelope being counted. The lower count is not a reflection of a decrease in total population but is related to poor counting conditions.

Fawn survival over the last 5 years has steadily decreased from a high of 53 fawns per 100 does (1987) to a 21 fawns per 100 does (1991). The decrease in fawn survival is related to two primary factors - drought and coyote predation.

Most of southeast and southcentral Oregon has experienced drought conditions over the last 5 years which has reduced the quality and quantity of forage for pronghorn. Several fire rehabilitation projects that were attempted, to improve forage availability after large scale wild fires, failed because of drought. In addition, water became limiting in many areas, causing a change in pronghorn distribution and in some cases, caused crowding at remaining sources of free water. Although we have no direct evidence to support it, biologists believe that the drought has had a negative impact on overall productivity.

Prices of coyote pelts have been low during the last few years and coyote removal by trappers and hunters has declined accordingly. As a result, coyote numbers are increasing and at the same time, pronghorn fawn survival rates are decreasing. In response to decreasing recruitment, hunter opportunity will be reduced in some units in 1992.

The 1991 hunting season provided hunters the most opportunity ever experienced in the state. Success rates remained comparable to prior years in

most categories. Archer success has increased in recent years, mainly because of the drought which tends to congregate animals at water sources. Archers have used this change in animal behavior to their advantage. A summary of hunting results is provided in Table 1.

Table 1. Pronghorn hunting season statistic for Oregon, 1991

Type of Permit	Number Issued	Number of Hunters	Number Taken	Percent Success
Rifle Buck	1960	1890	1458	77
Rifle Either Sex	335	310	241	78
Rifle Antlerless	210	189	121	64
Muzzleloader	740	427	36	8
Archery	60	48	5	10
TOTALS/AVERAGES	**3305**	**2864**	**1861**	**65**

In 1991, population modeling of all pronghorn populations in the state was initiated using the POP II model. This process will be used to identify weaknesses in data collected, as to more accurately predict harvestable surplus in the future.

Concern with the impact of heap leach mining operations on certain pronghorn populations continues. At the current time, only one heap leach project is being developed, but there may be additional proposals in the future. The Department has developed a series of special regulations which will be used to minimize the impacts of such operations on wildlife. The effectiveness of these rules will be evaluated on this first mining project.

SOUTH DAKOTA ANTELOPE STATUS REPORT - 1992

John Wrede, South Dakota Department of Game, Fish and Parks, Rapid City

POPULATION

South Dakota's pronghorn population has continued to build in response to mild winters, relaxation of drought conditions and conservative harvest strategies. During the spring of 1991, moisture levels from late spring snows, generous spring and early summer moisture provided excellent foraging conditions throughout most of the main antelope range. The welcome drought relief during the 1991 growing season coupled with moderating winter temperatures during the 1990-91 winter provided the incentive for increased natality and recruitment. During the 1991-92 winter, mild weather has encouraged a decrease in natural mortality factors thereby permitting, what appears to be, another year of population increase in Western South Dakota.

In 1991, South Dakota's Pronghorn population was projected to be 46,668 animals. 1991 spring census figures indicated a population of 7,591 bucks, 19,842 does and 19,235 fawns throughout South Dakota prior to the fall hunting seasons. This represents an overall increase of 33 percent from 1990 in which there were 5,173 bucks, 14,059 does and 12,244 fawns in the pre-hunt population. The average doe/fawn ratios also increased 10 percent from 100:87 in 1990 to 100:97 in 1991.

Thus far, in 1992, population increases look promising due to reduced winter mortality but; below normal spring moisture levels and temperature may have some impact on fawn production and recruitment. There was an increase in adult breeding population carried through from the 1991 hunting seasons in several management units that provide the potential for population expansion; at least in some management units as suggested by aerial surveying that is incomplete at this writing.

Distribution of South Dakota's pronghorn populations has improved greatly since the destabilizing impacts of severe winter-kill that occurred during the 1985-86 winter. The main antelope range in western South Dakota has witnessed some pioneering of antelope back into traditional areas as well as suspected migrational movements into voids created by winterkill. Population density is greatest in those counties bordering Montana and Wyoming outside of the geographic area of the Black Hills in Lawrence, Pennington and Custer counties. Northeastern South Dakota still maintains a small population of pronghorn that appears to have stabilized at approximately 100 animals distributed in small herds throughout 5 counties.

CENSUSING

Antelope in South Dakota are principally managed by the respective Conservation Officers in their assigned districts that generally follow county line boundaries. Some districts include more than one county or portions of counties. Late spring aerial census of adult populations using a 33 1/3 sampling technique is conducted by the conservation officers and data gathered is used by the C.O.'s, as well as the State's management staff to develop harvest and management guidelines. Management units with very low density populations (less than .10 antelope per square mile) are generally surveyed from the air every other year. Some low density units along the eastern fringes of the Missouri River and in Northeastern South Dakota are surveyed by ground count methods and landowner survey.

Random doe/fawn surveys from the ground are conducted from July 1 through the end of September to determine reproduction and fawn survival. This survey period was extended through the month of September due to an observability problem that appeared during the 1989 survey period. Fawns were difficult to observe during early to late summer and were sometimes hidden by the doe as she browsed or evaded observers. Later in the summer and early fall, the fawn or fawns were more likely to be up and moving with the doe or small herd making them more visible to observers. The random ground surveys appear to yield as good or better results than those of the aerial surveys used in previous years. A 10 year trend in aerial doe/fawn ratios was developed from historical information and is used in comparison to current ground counts to establish a basis of reliability for the current ratio in the respective management units.

HARVEST

The 1990 regular firearm antelope season was held from October 6, through October 14, 1990. A total of 5,104 resident licenses were issued for the nine day season. The projected harvest was 4,408 antelope for a 78 percent success rate. Harvest distribution during the 1990 season was comprised of 72 percent bucks and 28 percent does.

The 1990 archery antelope season was held from August 18, through October 31, 1990. The South Dakota Game, Fish and Parks Commission extended the season length approximately 30 days to accommodate requests by archers and a growing antelope population. There were 334 resident and 52 nonresident archery licenses issued for the season. Harvest projections showed 72 antelope taken for an 18.65 percent harvest success.

A special archery antelope season was held in two units in the northeast-

ern quadrant of the state from August 18, through October 31, 1990 for resident archers only. A total of 55 permits were issued for the two units. 15 antelope were harvested in the two units for an average of 27 percent success.

The 1991 hunting seasons were structured much the same as the 1990 seasons. The general firearm antelope season was held from October 5, through October 13, 1991 with a total of 7,263 licenses sold. Unlike the 1990 season, resident licenses left over after the second lottery drawing were made available to both resident and non-resident on a first come, first served basis. 1991 was the first year since 1985, that South Dakota has permitted non-resident antelope hunting in the state. Projected harvest during the 1991 season was 7,542 antelope for an overall success rate of 83 percent does. There were 1759 two tag licenses issued for the season which accounts for the additional antelope harvested above the total number of licenses issued.

The 1991 Archery season was open from August 17, through October 31, 1991 except during the firearm seasons. There were 419 resident and 61 non-resident licenses issued. Success was calculated at 22.9 percent with a projected harvest of 110 animals.

A special archery antelope season was held in two units in the northeastern quadrant of the state from August 18, through October 31, 1991, except during the firearms seasons, for resident archers only. 35 permits were issued for the two units. A total of 8 antelope were taken in the two units for a combined success rate of 23 percent.

Harvest regulations for 1992 have not been established as of the date of this writing however, license quotas and harvest projections are expected to elevate in response to the expanding herd. In the next two to three years, South Dakota will be working on population and management goals for the pronghorn that will eventually establish more well defined population management objectives. Currently, range carrying capacity estimates suggest that the state can effectively manage approximately 38,000 to 42,000 antelope under normal environmental conditions. Conservation Officers are being encouraged to develop harvest strategies that will bring the state's population into conformity with present range conditions.

RANGE CONDITIONS

The past two years have provided marginal improvements in range condition for pronghorn in South Dakota. Above normal spring moisture in 1991 encouraged good forage growth on both public and private lands that suffered dramatically from over-utilization by domestic livestock and drought. It also appears that the USDA Cropland Reserve Program has provided some addi-

tional benefits to wintering pronghorn that were unexpected.

According to research conducted in Harding County in the north and west corner of South Dakota, pronghorn spent a great deal of time in private CRP acres during early summer and in the winter thereby lessening the agricultural land depredation conflict that has always existed in the state. During years of normal to above normal precipitation, most private landowners tend to be more tolerant of pronghorn on cash crops and alfalfa. It appears that the CRP program has not only provided an alternative forage source for antelope but has also slowed the conversion of native rangeland and provided an opportunity to reduce depredation damage on agricultural lands (Griffin-1991). Conservation Officers, the Regional Land Staff and Habitat Liaison Personnel continue to work the U.S. Forest Service, BLM and private property owners to protect and enhance native sage brush prairie for the benefit of pronghorn and sage grouse. In some rare cases, livestock stocking rates have been adjusted or alternative grazing systems have been implemented with wildlife in mind but the losses continue to outweigh the gains.

MOVEMENTS AND DISTRIBUTION

In the past two years, many of the gaps in habitat left from winterkill have been filled by antelope. There are still areas of traditional range that have few animals which suggests that complete repopulation has yet to be achieved. There is still suspected migration or movement between the states of South Dakota, Wyoming and Montana in the counties in South Dakota that border the Cowboy and Big Sky states. Large increases in population in Fall River, Harding and Butte Counties that have appeared in census results tend to suggest that South Dakota gains antelope in most cases.

RESEARCH

There is no current research on pronghorns in South Dakota and none has been suggested for the immediate future. A research project was completed in 1991 in Northwest South Dakota on the "Pronghorn Use of Agricultural Lands" in that region of the state.

PROBLEM AREAS

Hunter ethics is an ominous difficulty with antelope hunting, particularly in the face of the anti-hunting/animal rights movement. South Dakota attempted to address the fair chase principle during the 1991 hunting season with a letter included with every antelope license. The results of the letters message are inconclusive.

South Dakota continues to struggle with the development of accurate and reliable censusing techniques that will yield a reasonable estimate of population by unit area. Of particular concern are doe/fawn ratios that seldom correlate to pre-hunt or post-hunt population estimates.

Landowner tolerance is a source of concern, particularly in areas where a great deal of small grain production occurs. Depredation damage, particularly to alfalfa and winter wheat continue to be a source of aggravation to the Conservation Officers as they attempt to move the animals off to satisfy complaints. Complaints of animals eating the greenery is not as prevalent now as is the complaint of uprooting the new plants or hoof damage to soil that results in wind erosion!

ANTELOPE STATUS REPORT FOR TEXAS - 1992

Danny A. Swepston, Texas Parks & Wildlife Department, Amarillo, Texas.

Historically, pronghorns were distributed over the western two-thirds of Texas. Because of loss of habitat, unregulated hunting and restriction of movements by fencing the herds are currently confined to scattered locations in the High Plains, Edwards Plateau and Trans-Pecos Ecological Regions.

Population estimates and herd composition data is obtained annually by flying low altitude strip counts at 1/4 mile intervals on individual ranches during the period of mid-June through July. Ranches in each herd unit that contain major antelope concentrations are flown annually. Marginal populations in each unit are surveyed at 1 to 2 year intervals. During 1991, 290 hours were expended on census statewide.

For the period of 1977-1991 the Texas pronghorn population has varied (Figure 1) from 12,800 to 26,800, averaging about 18,500 antelope with approximately 70 percent occurring in the Texas-Pecos, 20 percent in the Panhandle, and 10 percent in the Possum Kingdom District. The buck to doe ratio in 1991 varied from 1:2.5 in the Panhandle to 1:1.4 in the Possum Kingdom district for a statewide ratio of 1:1.8. Fawn production increased significantly in the Possum Kingdom and Trans-Pecos districts from .73 and .21 to .80 and .59 fawns per doe, respectively in 1991. The number of fawns in the Panhandle increased slightly from .12 fawns per doe to .16. As a result, the 1991 statewide antelope population increased by 43 percent to an estimated 19,940 antelope. This increase is expected to continue in 1992 due to above average range conditions and a mild winter in 1991.

The antelope hunting season opens on the Saturday nearest October 1 and continues for 9 consecutive days. The bag limit is one antelope per hunter per year by permit only. Archery and all firearms, except for those using rimfire ammunition, are legal for harvesting antelope.

The pronghorn harvest is controlled by permits, designated either for a buck or doe antelope and are issued to the qualified landowners. The permits cannot be sold, but the landowners can charge a trespass fee. A total of 1,011 buck and 30 doe permits was issued to 270 landowners (Av. of 3.9 permits/landowner) representing 5,690,362 acres of antelope range in 1990. During the 1991 the issuance increased to 1,347 buck and 49 doe permits issued to 303 landowners (Av. of 4.6 permits/landowner) representing 6,054,907 acres of antelope range.

An estimated 497 and 584 hunters participated in the 1990 and 1991 hunts, respectively. Hunter success was 92 percent in both years. During the

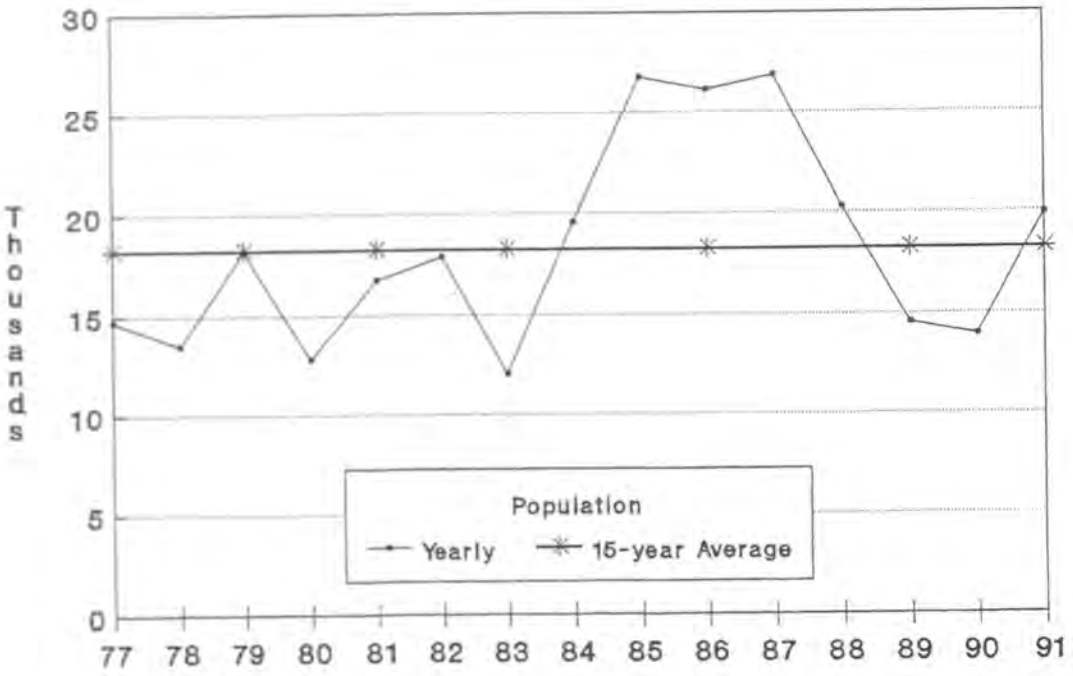
past 15 hunting seasons hunter success has ranged from a low of 89 percent in 1979 and 1980 to a high of 95 percent in 1982.

Fifty-nine and 57 percent of the landowners issued antelope hunting permits in 1990 and 1991, respectively allowed hunting. This represents a decline of 1 percent in 1990 and 3 percent in 1991 from the 1989 total of 60 percent. Some factors which may have contributed to this low permit utilization include (1) landowners not allowing hunting (2) some landowners feel the use of all their permits would result in an excessive harvest (3) some landowners have overpriced the cost of an antelope hunt and (4) harvest opportunities were reduced because of herd movements between landowners that received permits and those that did not.

Relocation efforts in Texas in 1990 and 1991 were limited to the stocking of 100 head of antelope received from the state of Utah in December, 1990. These were released in Gray County in the northern Panhandle.

Pronghorn research in Texas during the last two years has been confined to a study conducted by Texas Tech University concerning fawn survival in the Trans-Pecos. Results of this study will be presented at this workshop.

Figure 1. Texas Pronghorn Population
1977 to 1991



WYOMING PRONGHORN STATUS REPORT - 1992

Scott G. Smith, Wyoming Game and Fish Department, Cheyenne.

POPULATION

Wyoming's 1991 posthunt pronghorn population estimate was 453,378. The 1991 statewide population objective was 380,260. Over the last five years (1987-1991), Wyoming has averaged 405,204 animals and has experienced steady population growth despite drought conditions throughout much of the state. Seventy-five percent of the pronghorn herds in the state exceed herd unit population objectives.

Population estimates were derived using POP-II, Ver. 6.3 software. Data from total herd size estimates using aerial line transect sampling (May), ground sex/age surveys (August) and harvest estimates from hunter questionnaires (November) were used in the POP-II model to generate population estimates.

HARVEST STATISTICS

Pronghorn harvest totaled 65,102 in 1991. Harvest over the past five years averaged 53,605, slightly above the statewide objective of 51,290. Hunter success averaged 140% in 1991 indicating many hunters took advantage of additional antlerless licenses. License sales in 1991 totaled 41,394, which is a 9% increase over the five year average of 37,891.

MANAGEMENT ISSUES

Over the past 6 years, the Wyoming Game and Fish Department has transplanted pronghorn to the Wind River Indian Reservation in central Wyoming. Approximately 450 animals have been moved to suitable habitat on the reservation. Quality habitat and enforcement of game code has enabled the pronghorn to flourish.

The eastern half of Wyoming is predominately private land. The ability to obtain adequate harvest, especially antlerless harvest, is difficult due to limited hunter access and cost of antlerless licenses in addition to trespass fees. In 1991, 20% of the antlerless permits were not sold. Most of the unsold permits were valid for hunt areas in eastern Wyoming.

To encourage nonresident hunters to take advantage of antlerless permits, the fee for these permits was reduced to $25. The department anticipates this lower fee will result in greater antlerless harvest in areas where permits

are typically not sold.

The department recently completed a two year study documenting location and specification of BLM fences in southwest Wyoming. Fence type and location was compared with antelope seasonal distribution to quantify potential conflicts with migration corridors. Resolution of conflict areas will be addressed at the field level.

Technical Session

SEASONAL HABITAT PREFERENCE OF PRONGHORN ANTELOPE IN CENTRAL ARIZONA

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Abstract: Year-round habitat selection by pronghorn antelope (*Antilocapra americana*) in Central Arizona was characterized using 350 observations. Data were collected from four biological seasons (fawning, nursing, rutting, and gestating) with an equal number of observations taken from each quarter of the day, over a two year period. Data collected at each observation site included: activity, physical site characteristics (slope, aspect, macro and micro topography), and vegetative characteristics (macro- and micro-site vegetation type, herbaceous and woody height, and cover by cover class). Habitat availability was determined using 200 randomly located points per year, for a total of 400 locations. Data collected at these points coincided with that collected at use sites. Significant slope use occurred on areas of < 5% slope, during fawning, nursing, and rutting, while areas of > 15% slope were avoided during fawning and nursing. Macro topographic features selected for were hill tops during fawning, and rolling hills during nursing and gestating, mesa tops were avoided during nursing. Micro topographic features selected for were rolling hills and hill tops during the fawning and nursing season respectively, mesa tops were avoided during fawning and nursing. Macro habitat types selected for were grasslands during fawning, nursing, and rutting, while grassland-shrubs were avoided during nursing. Grassland-shrub micro habitat type was selected for during fawning, nursing, and rutting, with the grassland type avoided during those same seasons. Cover class use was greater than availability for bare-ground rock and litter during rutting, use of shrubs > 0.5 m was below availability during nursing. Herbaceous vegetation 25-37.5 cm in height were selected for during fawning and nursing, while plants < 12.5 cm in height were avoided during these same two seasons. Areas with no woody vegetation were selected for during fawning and nursing, woody plants > 50 cm were avoided during nursing.

Loss of or non-use of suitable pronghorn habitat in Arizona is a concern that has been raised by wildlife managers, and a potential limiting factor for pronghorn populations (Neff 1986). Pronghorn antelope habitat characteristics and requirements in the sagebrush-grassland steppe, were described by Yoakum (1980). Individual site use has been found to be influenced by the

relative availability of forage and water. Knowledge of the availability of these factors and their use is essential for identification of suitable pronghorn habitat on a broader scale.

Several studies have been conducted describing the general attributes of habitat preferred by pronghorn antelope (Sundstrom et al. 1973, Amstrup 1978, Autenreith 1978, Schmidt and Gilbert 1978, Yoakum 1980, Kindschy et al. 1982, Neff 1986). However, little research has been published on habitat preference by pronghorns, on a seasonal basis. The objective of this study was to characterize the habitat selected by pronghorn antelope on a seasonal basis over a two year period. The authors would like to acknowledge the Arizona Game and Fish Department for funding this study.

STUDY AREA

The study area was located approximately 115 km north of Phoenix in the central portion of Arizona. Elevation on the 30 square kilometer study area ranged from 1320 to 2040 meters. Marlow Mesa is somewhat isolated from other habitats by natural barriers, affecting pronghorn movement into and out of the area. Average annual precipitation at Cordes Junction, Arizona, 28 km southwest of the study area, was 35 cm, with most falling as rain during summer monsoonal thunderstorms from July through September, and some portions of the winter precipitation, December through February, occurring as snow. Temperatures ranged from -9 C in winter, to 40 C in summer. Average daily temperatures in December were 7 C and 27 C in July.

Vegetative communities represented were in the Arizona semidesert grassland (Brown 1982). The mesa is characterized by an open expanse of grassland, with the dominant grass specie being tobosa grass (*Hilaria mutica*). Pockets of low lying shrubs are found on the mesa with the dominant species consisting of catclaw (*Acacia greggii*), broom snakeweed (*Gutierrezia sarothrae*), and wright buckwheat (*Erigonum wrightii*). There are also juniper species that inhabit smaller pockets within and around the perimeter of the mesa. Other species include curly mesquite (*Hilaria belangeri*), sideoatss grama (*Bouteloua curtipendula*), hairy grama (*Bouteloua hirsuta*), red brome (*Bromus rubens*), redstem filaree (*Erodium cicutarium*), western ragweed (*Ambrosia psilostachya*), false dandelion (*Agoseris glauca*), dandelion (*Taraxacum officinale*), indianwheat (*Plantago spp.*), shrub live oak (*Quercus turbinella*), prickly pear and cholla cacti (*Opuntia spp.*).

METHODS

Seasonal habitat used by pronghorns was determined from 350 animal

observations, collected from October 1989 through September 1991. Seasons in which the data was collected, were classified based on animal physiology (Table 1). Initially animal locations were aided using three collared pronghorn, and by observing uncollared groups. However, by the middle of the first summer two of the collared animals had died, and the third had moved off the study area until the end of the summer, and was later found dead in December of that year. The remaining animal locations were made by visual location of uncollared animals, and when available, were aided by the use of a night scope.

Table 1. Seasonal classification for determination of habitat use pattern by pronghorn antelope in central Arizona.

Season	Time Period
Fawning	April - May
Nursing	June - July
Rutting	August - September
Gestating	October - March

Physiognomy of each site was recorded and included elevation, percent slope, aspect, macro/micro topography features, and macro/micro habitat types. Percent composition, average plant height, and the dominant specie were estimated at each point for grass, forb, shrub, cactus, and trees. Percent composition of bare-ground rock and litter was also determined at each site. Cover data was collected at each point using 4 line intercept transects, radiating at right angles from the center of the observation site. Each transect was 25 m in length, with structural classes being bare-ground rock litter, herbaceous vegetation, shrubs < 0.5 m in height, and shrubs > 0.5 m in height. Topographic features were classified as mesa top, hill top, flats, hillside, rolling hill, swale, drainage, and canyons. Habitat types were classified as grasslands, grassland-shrub (5-30% shrub), shrubland (>30% shrub), savanna (5-10% trees), open woodland (10-30% trees), and riparian gallery.

Habitat availability on the study area was characterized using 396 randomly located plots, which were collected during the summers of 1990 and 1991. The coordinates of these plots corresponded to 6 digit Universal Transverse Mercator (UTM)
($P<0.05$).

Cover class use by pronghorn was evaluated in relation to availability as determined by the random sampling. Pronghorn were observed to use areas of bare-ground/rock/litter during the rutting more frequently than availability, and areas of shrubs >0.5 m less often than availability during nursing ($P<0.05$). While not significant, pronghorn demonstrated a tendency towards avoiding

Table 2. Seasonal use patterns of physical characteristics of available habitat by pronghorn antelope on Marlo Mesa in central Arizona.

Class	Season				
	Fawning	Nursing	Rutting	Gestating	Avail.
	(←	%	→	)*	(%)**
Slope: (%)					
< 5	76.2[a]	83.7[a]	39.3	78.7[a]	49.4
5 — 10	17.9	16.4	55.7[a]	18.7	27.0
10 — 15	4.8	0.0[b]	3.3	0.0	8.6
> 15	1.1[b]	0.0[b]	1.7	2.6	15.0
Total Chi Square = 151.5 df = 9					
Aspect:					
North	10.7	11.6	8.2	8.0	13.1
Northeast	8.2	6.2	3.3	8.0	3.4
East	2.4	4.7	1.6	1.3	5.0
Southeast	11.8	11.6	11.5	17.3	12.3
South	15.3	23.3	24.6	21.3	21.8
Southwest	8.2	16.3	31.1	14.7	14.8
West	23.5	11.6	8.2	13.3	13.8
Northwest	18.8	14.7	11.5	14.7	15.8
Total Chi Square = 47.2 df = 21					
Macro Topography:					
Mesa Top	40.0	19.4[b]	44.3	34.7	50.0
Hill Top	37.6[a]	18.6	18.0	17.3	14.9
Rolling Hill	17.6	52.7[a]	34.4	44.0[a]	24.0
Other	4.8	9.3	3.3	4.0	11.1
Total Chi Square = 132.3 df = 9					
Micro Topography:					
Mesa Top	3.5[b]	0.8[b]	1.6	4.0	17.6
Hill Top	68.2	77.5[a]	80.3	65.3	55.0
Rolling Hill	9.4[a]	3.1	3.3	0.0	2.6
Swale	1.2	2.3	6.6[a]	1.3	1.1
Other	17.6	16.3	8.2	29.4	23.7
Total Chi Square = 119.2 df = 12					

* Amount of use within season.
** Relative amount of total area.
[a] Means in columns are significantly greater than availability ($P < .05$).
[b] Means in columns are significantly less than availability ($P < .05$).

Table 3. Seasonal use patterns of vegetative characteristics of available habitat by pronghorn antelope on Marlo Mesa in central Arizona.

Class	Season				
	Fawning	Nursing	Rutting	Gestating	Avail.
	(←	%	→	)*	(%)**
Macro Habitat:					
Grassland	80.0[a]	86.8[a]	73.8[a]	61.3	48.6
Grassland-Shrub	18.8	12.4[b]	26.2	36.0	30.0
Other	1.2[b]	0.8[b]	0.0[b]	2.7[a]	21.4
Total Chi Square = 151.9 df = 6					
Micro Habitat:					
Grassland	40.0[b]	7.0[b]	6.6[b]	74.7	71.4
Grassland-Shrub	60.0[a]	93.0[a]	93.4[a]	25.3	20.3
Other	0.0[b]	0.0[b]	0.0[b]	0.0[b]	8.3
Total Chi Square = 715.1 df = 6					
Cover:					
Bare, Rock, Litter	60.4	70.9	77.2[a]	63.9	63.2
Herbaceous	37.1	26.3	19.6[b]	30.1	30.2
Shrubs < .5m	1.8	2.0	2.1	3.3	3.6
Shrubs > .5m	0.6	0.8	1.5	2.7	3.0
Error df = 392					
Vegetation Height:(cm)					
Herbaceous Spp:					
< 12.5	11.8[b]	8.5[b]	13.1	33.3	30.9
12.5 - 25	64.7	71.3	67.2	52.0	57.4
25 - 37.5	17.6[a]	17.8[a]	18.0	13.3	8.3
> 37.5	5.9	2.4	1.7	1.4	3.4
Total Chi Square = 79.4 df = 9					
Woody Spp:					
None	35.3[a]	30.2[a]	19.7	12.0	11.5
< 25	31.8	36.4	45.9	44.0	32.3
25 - 50	25.9	32.6	29.5	34.7	36.3
> 50	7.0	0.8[b]	4.9	9.3	19.9
Total Chi Square = 138.0 df = 9					

* Amount of use within season.
** Relative amount of total area.
[a] Means in columns are significantly greater than availability ($P < .05$).
[b] Means in columns are significantly less than availability ($P < .05$).

areas with >0.5 m shrub cover during fawning. Evaluation of the influence of vegetation height revealed that pronghorn were found on areas where herbaceous vegetation was between 25-37.5 cm in height during fawning and nursing, and that they did not use areas with herbaceous height of < 12.5 cm ($P<0.05$). All other herbaceous heights were used in proportion to availability. Areas with no woody vegetation (shrubs and cacti) had significantly more use during fawning and nursing, with areas having woody vegetation > 50 cm receiving only limited use during nursing ($P<0.05$). All other woody heights were used in proportion to their availability.

DISCUSSION

Several authors have reported pronghorn antelope preference for slopes < 30% (Amstrup 1978, Yoakum 1980, Kindschy et al. 1982). Amstrup reported a high preference for slopes < 10%, which agree with the findings of this study, particularly during the fawning, nursing, and gestating seasons. Pronghorns use of slopes of < 10% may reflect a need to select areas that provide for early detection of predators and allow for rapid acceleration to escape a perceived threat. Aspect did not seem to play a role in the habitat selection of any particular area in this study.

Pronghorn habitat has been characterized as undulating wide open expansive terrain (Schmidt and Gilbert 1978, Yoakum 1980). The Marlow Mesa area is typical of this description. The topography of the study area was divided into macro and micro features to allow for a more detailed examination of pronghorn selection of topography. Similarly, vegetative types were divided into macro and micro habitat types for the same reason. During fawning, pronghorn selected for hilltops on a macro topographic level and for rolling hills on a micro topography level. Macro habitat type selection was for grassland, with grassland-shrub as the selected micro habitat type. Through cross tabulation analysis using GIS, it was determined that the grassland habitat type amounted to 55.8% of all hilltop vegetation, and the grassland-shrub vegetation type comprised <1.0% of the vegetation on rolling hill micro topography. The presence of grassland-shrub inclusions could provide hiding cover needed for young fawns. Preferred mean height of vegetation by pronghorn antelope, has been documented by some researchers to be approximately 37.5 cm, however, these were yearly averages with no seasonal preference reported (Schmidt and Gilbert 1978, Yoakum 1980). Kindschy et al., reported preferred average plant height ranging between 37.5-60cm (1982). Pronghorn on this study selected for herbaceous height of 25-37.5 cm, while avoiding heights of < 12.5 cm. It is speculated that on the micro site level, does may be selecting to bed their fawns in the grassland-shrub inclusions on rolling hills, with mean herbaceous height of 25-37.5 cm, to meet the hiding cover requirement by fawns. On the macro site level, selection of hilltops dominated by grasslands

provide for long range visibility and early detection of any potential predators. The avoidance of mesa top micro sites during fawning may be attributed to the lack of hiding cover for fawns.

During nursing, pronghorns selected for rolling hills on a macro topographic level and for hilltops on a micro topography level. The selected macro habitat type was for grassland, with grassland-shrub as the selected micro habitat type. The grassland habitat type amounted to 43.7% of all rolling hill vegetation, and the grassland-shrub vegetation type comprised 22.4% of the vegetation on hilltop micro topography. As with fawning, during nursing pronghorns were selecting for herbaceous height of 25-37.5 cm, and avoiding heights < 12.5 cm. Although fawns are more mobile during nursing, adequate hiding cover is still required. It is speculated that on the micro site level, does continued to bed fawns in the grassland-shrub inclusions with herbaceous heights between 25—37.5 cm, to meet the hiding cover required by fawns. The selection of hilltops on the micro site, may be a response to obtain greater long range visibility on the part of the doe. On the macro site level, selection of rolling hills dominated by grasslands supports the need for long range visibility and early detection of potential danger. The selection for areas with no woody vegetation and avoidance of woody plants > 50 cm in height, may also be a response of maintaining long range visibility. The avoidance of mesa tops on macro and micro sites during nursing, may be attributed to the lack of adequate hiding cover for fawns.

Pronghorn selected for swales on a micro topography level, during rutting. Although this selection was statistically significant, the sample size was small (n=4), thus diminishing the significance of this selection. Macro habitat type selected for were grasslands, with grassland-shrub as the selected micro habitat type. In this season, pronghorn exhibited no apparent preference or avoidance of macro topographic features or vegetation heights. It is speculated that use of the grassland-shrub inclusions within the grassland macro habitat type, may be a foraging response by the pronghorn, and not a response for hiding cover by fawns.

Pronghorns exhibited no apparent selection or avoidance during the gestating season, for any habitat trait except macro topography. One possible explanation for the use of the rolling hill macro topography feature during this season relates to forage availability. A survey of vegetative types available on rolling hills found that 65% of the area was dominated by herbaceous species. During this biological season, a primary requirement of the doe would be adequate nutrition for the development of the fetus. The ready availability of forage species would be critical and may explain the use of rolling hill macro topography during this season.

Several authors reported the use of areas with approximately 50% veg-

Table 4. Summary of seasonal habitat selection or avoidance by pronghorn antelope on the Marlow Mesa study area, Central Arizona.

Habitat	Fawning		Nursing		Rutting		Gestating	
Trait	Pref	Avoid	Pref	Avoid	Pref	Avoid	Pref	Avoid
Slope (%)	< 5%	> 15%	< 5%	> 10%	5 — 10%	N/A	N/A	N/A
Macro-Topography	Hill Tops	N/A	Rolling Hills	Mesa Tops	N/A	N/A	Rolling Hills	N/A
Micro-Topography	Rolling Hills	Mesa Top	Hill Tops	Mesa Tops	N/A	N/A	N/A	N/A
Macro-Habitat Type	Grassland	N/A	Grassland	Grassland-Shurb	Grassland	N/A	N/A	N/A
Micro-Habitat Type	Grassland-Shrub	Grassland	Grassland-Shurb	Grassland	Grassland-Shrub	Grassland	N/A	N/A
Vegetative Cover (Class)	N/A	N/A	N/A	> 50 cm	0	N/A	N/A	N/A
Herbaceous Vegetation Height (cm)	25-37.5cm	< 12.5 cm	25-35.5 cm	< 12.5 cm	N/A	N/A	N/A	N/A
Woody Vegetation Height (cm)	0	N/A	0	> 50 cm	N/A	N/A	N/A	N/A

N/A — No apparent preference or avoidance.

etative cover, and 50% bare-ground/rock/litter, by pronghorn antelope (Schmidt and Gilbert 1978, Yoakum 1980, and Kindschy et al. 1982). Sundstrom et al. in 1973, reported vegetative cover on pronghorn habitats to be approximately 40-60%. The cover used by pronghorns on this study averaged 63% bare-ground/rock/litter, and 37% live vegetation. Pronghorns selected for bare-ground/rock/litter above available during rutting, which may indicate a use of areas with little visual obstruction and low amounts of hiding cover. Fawns are at an age and size that hiding cover, is no longer a concern. However, it is speculated that bucks are selecting for open areas because of their susceptibility to predatioon, due to their preoccupation with rutting. Shrubs > 0.5 m in height were avoided during nursing. It is speculated that shrub cover of this height could decrease visibility of the surrounding area, decrease the pronghorns ability to obtain rapid acceleration in escaping a perceived danger, and therefore increase their susceptibility to predation.

SUMMARY

A summary of the seasonal habitat selection or avoidance by pronghorn antelope on this study are presented in Table 4. During fawning and nursing, pronghorn antelope selected habitats with low slopes (<5.0%) on rolling hill and hilltop topographic features. They selected habitats that were predominately grasslands with grassland-shrub inclusions. Heights of the herbaceous vegetation selected on these habitats ranged from 25-37.5 cm, with no woody vegetation present. During rutting, pronghorn selected habitats with slopes of 5-10% on topographic features used as available. Sites dominated by bare-ground/rock/litter were selected for within grassland-shrub inclusions, in Grassland habitats. Except for the rolling hill macro topography selection, pronghorn showed no apparent preference or avoidance of any habitat trait during the gestating season.

The long term goal of this study is to identify the factors affecting pronghorn antelope habitat selection and distribution. These findings should provide a base for the development of a more detailed analysis of seasonal patterns of pronghorn antelope habitat use in central Arizona. These data can then be incorporated in the long term management planning of rangeland resources utilized by pronghorn antelope.

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FAWN BED-SITE CHARACTERISTICS OF TRANS-PECOS PRONGHORN

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Abstract: Micro-habitat characteristics of pronghorn

(*Antilocapra americana*) fawn bed-sites were measured in the spring and summer of 1990 and 1991 for the Trans-Pecos region in Texas. A total of 321 bed-sites were evaluated from 20 fawns, tagged with radio transmitters, in 1990 and 34 fawns in 1991. Seventy-five randomly selected sites were also evaluated each year for comparison purposes. Measurements taken to estimate visibility from the site suggest bed-sites were chosen in areaas where visibility was greater at long distances. Vegetation characteristics measured showed greater ($P<.05$) forb and grass cover and higher understory on bed-sites than random sites in 1990, but no differences were detected in 1991. Slope was greater ($P<.05$) on bed-sites than random sites both years. Another year of research was accomplished in 1992, but the data are not available in this report.

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INTRODUCTION

Pronghorn fawning habitat, including parturition sites and fawn bedding sites, is considered an important factor for fawn survival. The attributes of "good" fawning habitat, however, are difficult to determine. Moreover, the literature is confusing and contradictory. In central Idaho, Bodie (1978) showed a negative correlation between fawn survival and brush cover. Fawns that bedded in tall sagebrush (*Artemisia spp.*) had higher mortality than fawns in the short sagebrush/grass community type. He believed that predators preferred the increaased hiding cover provided by the taller shrub areas, and pronghorn does were more successful in defending fawns in the short sagebrush/grass community type. Beale and Smith (1973) suggested that predation by bobcats might be lower in open and flat terrain where the keen eyesight

of pronghorn can be used to greater advantage and there is less opportunity for stalking predators to be effective.

Although the above studies indicated that pronghorn fawns may have higher survival rrates in more open country, other authors have found the opposite to be true. Pyrah (1974, 1987) found that reduced cover volume was associated with reduced fawn survival in central Montana. In study of fawn bedding sites in Alberta (Barrett 1981), pronghorn had no "traditional" fawning areas but survival of fawns was greatest on native range and increased with greater cover density and use of depressions. Neff and Woolsey (1980) showed significant amounts of fawn predation by coyotes in areas of very sparse fawning cover in Arizona. Following examination of 760 bed sites over a 10-year period in Idaho, Autenreith (1978) concluded that total vegetation canopy cover is strongly related to fawn survival. A goal of over 40% canopy cover was suggested as a long-term solution to predation loss. In Wyoming, Alldredge et al. (1991) found that parturient pronghorn and fawns selected more dense shrub cover, but the tallest, most dense cover was avoided. Other reports have shown additional cover to be important in reducing the ability of predators to locate fawns (Neff and Woolsey 1979, Autenreith 1980, 1982 McNay 1980).

In most of their endemic range in the western United States, pronghorn typically inhabit land forms characterized by low rolling expansive terrain (Autenreith 1978). Most pronghorn habitat management guidelines have been devised for shrublands and suggest an optimum vegetative structure no taller than 61 cm (24 in) and ground cover >50% (Yoakum 1978, Kindschy et al. 1982). Pronghorn commonly inhabit broad, open rangelands in the western states as well as in the Trans-Pecos of Texas, where this study is being conducted. In Brewster County of the Trans-Pecos, Tucker and Garner (1983) found that shrubs were not a major component of any bed-site but cover characteristics of bed-sites were taller than cover characteristics of the surrounding area. In a study conducted in southeast New Mexico, Howard et al.(1983) found that forb production, especially in the fall, was the most important vegetation characteristic in determining viability of potential translocation sites.

Based on the literature, it is apparent that there is a considerable amount of variation in the characteristics of habitat selected for fawn bed-sites. This study is being conducted to further define those characteristics important for fawning habitat in the Trans-Pecos region of Texas.

STUDY AREA

The study area is primarily located in the 6070ha Buckhorn pasture on the Double U Ranch (University of Texas Lands), 72 km east of El Paso in north Hudspeth County, Texas. Hudspeth County is in the Trans-Pecos Moun-

tains and Basins ecological area west of the Pecos River. This semi-desert area is broadly categorized into 2 soil associations, the Conger-Ratliff, with shallow to deep, loamy, nearly level to sloping soils in the uplands, and the Lozier Rock outcrop, with very shallow to shallow, strongly sloping to steep, calcareous soils on the hills and mountains (Soil Conservation Service 1990). Elevation ranges from 1465 m to 1675 m. Topography ranges from steep to gentle hills on the west side bordering the Hueco mountains, to open flats on the east side of the study area. Typical range sites are stony hills, clay flats, gypsum flats, and deep uplands (Correll and Johnston 1970). Climate includes dry winters and wetter summers with most of the annual precipitation (~30.5 cm) occurring in late summer months. Temperatures range from -18°C in the winter to over 38°C in the summer.

The most important vegetation types are the yucca (*Yucca elata*) savannaks, grama (*Bouteloua spp.*) grasslands, creosote (*Larrea tridentata*) - tarbush (*Flourensia cernua*) desert shrub areas (Correll and Johnston 1970), and, based on our observations of the study area, the sotol (*Dasylirion leiophyllum*)-ocotillo (*Fouquieria splendens*) type on slopes and ridges. Dominant grasses include gramas, Muhlenbergias (*Muhlenbergia spp.*), and threeawns (*Aristida spp*). Forbs vary considerably among sites and seasons with the most common being of the genera: *Aster*, *Astragalus*, *Croton*, *Dyssodia*, *Gilia*, and *Sphaeralcea*. Common overstory species include yucca, cholla (*Opuntia imbricata*), creosote bush, tarbush, and broom snakeweed (*Gutierrezia sarothrae*).

METHODS

Fawning season in the Trans-Pecos lasts from late April to early June. The objective during this period was to capture as many fawns as possible and fit mortality-sensing, ear-tag transmitters to each. To obtain fawns for study, the area was intensively searched from vehicles in an attempt to find females which were close to parturition. Fawns were then located with binoculars and spotting scopes and usually captured within five days of parturition when cryptic behavior was still prevalent.

Fawns were captured with a 1-m diameter hoop net with a 3-m handle. Surgical gloves were used in handling of fawns and transmitters were placed in plastic bags containing creosote leaves to mask any foreign scent. Because of the fragile nature of the fawns at this young age, we did not take body weights, body size measurements, or body temperature measurements in order to minimize time and disturbance of the fawn and subsequently, potential abandonment by dames.

Capture sites that were natural bed sites were marked with flags; those sites at which a fawn bedded because of our disturbance were not marked. All sites were marked on maps. Tagged fawns were radio-tracked daily, and visually appraised for general condition. All bed sites were flagged, usually from a distance of 20 to 40 m to minimize disturbance, and marked on maps for subsequent habitat evaluations.

Fawn habitat evaluations began during the latter part of fawning season. In 1990, 20 fawns were captured from which 102 bed-sites were measured. In 1991, 34 fawns were captured and 219 sites evaluated. Seventy-five random sites, selected from a gridded map using random numbers, were measured each year for statistical ccomparisons. Bed- and random-site evaluations consisted of the following:

(1) Short-range visibility estimates (SRV) were taken in the 4 cardinal directions, from 3 height positions (0.1m, 0.5m, 1.0m) to represent a fawn prone, standing, and an adult standing. The observer sighted at these 3 heights from the bed-site out, towards an assistant holding a 2.4m, marked pole at 25m and 50m distances from the site. The proportion of the pole visible was recorded (in cm) at each location (N,S,E,W at 25m, and N,S,E,W at 50m). Long-range visibility (LRV) was placed into 2 catagories: clear to partially-obstructed sight-line, and totally-obstructed sight-line. The observer sighted out from the center of the site from the 3 height positions (0.1m, 0.5m, 1.0m) to an estimated distance of 150m or greater. Basically, if the observer had a sight-line at this distance the clear to partially-obstructed category (PC) was selected; if the observer had no sight line at this distance, the totally-obstructed category (TO) was selected. The purpose of this measurement was to try to obtain a general indication of long-range visibilty. Percent of each category selected in each cardinal direction in bed- and random sites was compared for statistical analyses. For example, for the 0.1m height, mean percent of PC for all bed-sites was determined for each cardinal direction (N,S,E,W) and compared with mean percent of PC in all random sites for each cardinal direction; thus, n=4 for the anlysis (N,S,E,W). Likewise, mean percent of TO was compared in bed- vs. random sites, thus the variables %PC and %TO are inversely proportional to each other at each height.

(2) Shrub canopy cover and density were measured with 30 x 2m rectangular quadrats. Holding a 1m rod, the observer walked on each side of a 30m line from the center point in each cardinal direction and (1) counted the number of each shrub species present, then (2) measured the cover of each shrub species present with the rod, marked in 10cm increments.

(3) Basal cover of grasses and forbs was measured by tossing 24 0.1m squared rectangular quadrats in the area surrounding the site within a 30m radius. Percent cover of each species, bare ground, and rock were estimated for each quadrat.

(4) Average vegetation height of understory and overstory was measured by taking measurements at 10 random points surrounding the site for a total of 10 understory measurements and 10 overstory measurements at each site.

(5) Other data taken at each site consisted of: (a) dominant brush species, dominant grass or forb species, (b) slope, (c) aspect, (d) slope of bed-site itself (bed-slope), (e) presence or absence of shade, and (f) nearest neighbor (1991 only). Nearest neighbor was distance (cm) from center of bed-site to nearest plant or object assumed to be of cover value.

Data were analyzed with pooled t-tests (Statistical Analysis System 1985) to compare vegetation and other characteristics between random and actual bed-sites. Statistical analysis between years are not included.

RESULTS

In 1990, SRV at 50m for a standing female was greater ($p<.05$) at bed-sites than at random sites (Table 1). In 1991, SRV at this height and distance was slightly greater at bed-sites than random sites, but was not different ($p<.05$). At the 25m distance, fawn-bedded position, SRV was lower in 1991 at bed-sites than random sites (Table 1). Other SRV measurements were similar (p..05) (Table 1).

The LRV estimates (Table 2) perhaps more clearly indicate selection for areas of greater visibility. Percent of totally-obstructed sight-lines, at both the fawn-standing (1990 and 1991) and adult-standing (1991) positions, was greater ($P<.05$) at random sites than bed-sites. Although this difference was not significant ($P>.05$) in 1990 at the adult-standing position, there was a substantial difference between bed-(50.7%) and random sites (60.3%). Similarly, percent of partial to clear sight-lines were numerically greater at bed-sites than at random sites but were not statistically different ($P>.05$) at the adult-standing position in 1990. In 1991, values were statistically greater ($P<.05$).

Vegetation and other microhabitat features revealed few differences (Table 3). In 1990, differences ($P<.05$) were found between random and bed-sites in uderstory height, percent grass and forb cover, slope and bed slope. In 1991, only slope and bed slope were different. Slope was greater ($P<.05$) at bed-sites than random sites during both years. Bed slope was less ($P<.05$) at bed-sites than random sites both years.

Shrub density and cover measurements included all cacti species and half-shrubs. Often these species were very small, young plants, thus these measurements, especially density, may appear greater on paper than their actual appearance in the field. Both cover and density were numerically greater at random than bed-sites in both 1990 and 1991 but no differences ($P>.05$) were found (Table 3).

The "nearest neighbor" variable was measured in 1991 only. This was measured because it appeared that fawns tended to bed near a plant or object

providing cover. Although the distance from a bed-site to a "nearest neighbor" was lower compared to random sites, no statistical differences (P>.05) were found.

DISCUSSION

Results to date suggest that vegetation characteristics of fawning habitat in this region of the Trans-Pecos differ from those found in most pronghorn habitats, especially those in the shrub-steppe biome. The Trans-Pecos is within the Chihuahuan desert ecosystem and offers different types of vegetation than found in other biomes where pronghorn occur. Autenreith's (1978) suggested goal of over 40% canopy cover as a long-term solution to predatioon loss is not attainable in most of the Trans-Pecos. If pronghorn do indeed require greater than 40% canopy cover, this may help explain the low survival rates of our tagged fawns (10% in 1990, 21% in 1991) (Canon and Bryant 1992), and the generally lower fawn crops thoughout the Trans-Pecos than those in areas with more cover. Analyses of bed-sites characteristics between surviving and non-surviving fawns have not been completed but such data may provide useful insight into the relationship between canopy cover and fawn predation.

In 1991, substantially more bed-sites (than 1990) were evaluated in the eastern portion of the study area, where the creosote-tarbush desert shrub type is more prevalent. Further analyses will have to be conducted to adequately determine the overall effect of this apparent shift in fawn use of vegetation types. However, the differences in vegetation and other microhabitat features between the eastern and other portions of the study area may help explain some of the inconsistencies which appear between 1990 and 1991.

The combination of differences (P<.05) between bed- and random sites in SRV at the 50m, adult-standing position in 1990, adult-standing LRV in 1991, and fawn-standing LRV in 1990 and 1991 suggest that bed-site areas may have been selected based on long-range visibility as perceived by the female or the fawn. The vegetation-type selected for bedding areas is generally thought to be selected for by the dam while the bed itself is selected by the fawn (Fichter 1974, Autenreith and Fichter 1975). Thus, long-range visibility is likely selected for by the dam and individual microhabitat characteristics are more likely features of fawn selection.

Differences (P<.05) between bed- and random sites in understory height and percent grass cover in 1990, and fawn-bedded SRV at 25m in 1991 suggest that the bed itself was selected by the fawn based on hiding cover rather than visibility. The importance of hiding cover to pronghorn fawns is usually associated with shrub cover (Pyrah 1974, Autenreith and Fichter 1975, Barrett

1984, Alldredge et al. 1991). However, shrubs are not a common component of bed-site areas in the Trans-Pecos simply because they are not available (Tucker and Garner 1983). The presence of more grass cover and higher understory at bed-sites in 1990 was not evident in 1991. However, the lower SRV at bed-sites compared to random sites in 1991 (99.4 vs. 116.5) suggests that fawns were still able to select sites with more visual obstructions. The nature of these visual obstructions is, as yet, unclear.

Differences in slope and bed slope in both 1990 and 1991 indicate that steeper sites were selected for bedding areas but the bed itself was flatter than random sites. Overall lower slope values recorded in 1991 are believed to be related to bed-sites in the eastern portion of the study area as discussed earlier. Although it seems logical that fawns would select flatter spots for the bed itself, the significance of the selection of steeper slopes for bedding areas is unknown at this point, but may be related to presence of forbs and visibility.

The lack of consistency and even contradictions between 1990 and 1991 data have resulted in more questions than answers. Possible confounding factors such as differences in precipitation between years and cattle-grazing schedules will be considered. Hopefully, detailed analysis and another year of data will help answer some of these questions.

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Table 1. Short-range visibility (SRV) estimates at adult standing (1m), fawn standing (0.5m), and fawn bedded (0.1m) heights, 25m and 50m distant from the bed-site in 1990 and 1991, Double U Ranch, Hudspeth County, Texas.

	Year			
	1990		1991	
Category/distance	Random-site value(cm)	Bed-site value(cm)	Random-site value(cm)	Bed-site value(cm)
Adult standing, 25m	215.3a[1]	216.7a	219.3a	217.9a
Adult standing, 50m	189.2a	199.8b	199.2a	201.2a
Fawn standing, 25m	196.5a	195.2a	202.1a	197.3a
Fawn standing, 50m	155.4a	163.8a	165.6a	170.4a
Fawn bedded, 25m	150.7a	150.5a	116.5a	99.4b
Fawn bedded, 50m	92.5a	100.7a	57.3a	51.5a

[1] Values not followed by a common letter are different ($P < 0.05$) and represent within-year comparisons only. Greater values = greater visibility.

Table 2. Long-range visibility (LRV) from adult standing (1m), fawn standing (0.5m), and fawn bedded (0.1m) heights in 1990 and 1991, Double U Ranch, Hudspeth County, Texas.

	Year			
	1990		1991	
Category/sight-line[1]	Random-site value(%)	Bed-site value(%)	Random-site value(%)	Bed-site value(%)
Adult standing, TO[2]	60.3a[4]	50.7a	56.0a	38.4b
Adult standing, PC[3]	39.7a	49.3a	44.0a	61.6b
Fawn standing, TO	73.0a	60.5b	70.7a	52.7b
Fawn standing, PC	27.0a	39.5b	29.3a	47.3a
Fawn bedded, TO	87.0a	84.6a	92.7a	91.4a
Fawn bedded, PC	13.0a	15.4a	7.3a	8.7a

[1] Values represent percentage of totally-obstructed views vs. partial to clear views from 4 cardinal directions, (N,S,E,W), at each random site (n = 75) and each bed-site (1990, n = 102; 1991, n = 219)

[2] TO = totally-obstructed sight-line.

[3] PC = partial to clear sight-line

[4] Values not followed by common letter are different ($P < 0.05$), and represent within-year comparisons only.

Table 3. Micro-habitat features of bed sites for pronghorn fawns, 1990 and 1991, on the Double U ranch, Hudspeth County, Texas.

	Year			
	1990		1991	
Micro-habitat feature	Random-site value	Bed-site value	Random-site value	Bed-site value
Shrub cover	3.89a[1]	3.40a	3.39a	2.85a
Shrub density(plants/ha)	1937a	1520a	1449a	1225a
Understory ht. (cm)	16.4a	19.6b	12.9a	12.9a
Overstory ht. (cm)	49.7a	53.1a	63.2a	61.6a
Grass cover (%)	16.6a	26.6b	16.1a	16.5a
Forb cover (%)	2.7a	4.1b	2.4a	2.0a
Rock cover (%)	19.0a	14.6a	14.7a	12.6a
Bare ground (%)	61.7a	54.7a	66.8a	68.9a
Slope (%)	5.0a	7.9b	3.3a	4.8b
Bed slope (%)	1.8a	0.9b	0.8a	0.4b
Nearest neighbor (cm)[2]	-	-	99.6a	76.5a

[1] Values not followed by common letter are different ($P < 0.05$), and represent within-year comparisons only.

[2] Variable not measured in 1990.

PRONGHORN ANTELOPE USE OF TEBUTHIURON-TREATED AREAS IN NORTHWESTERN NEW MEXICO

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Abstract: Eighty-five pronghorn antelope (*Antilocapra americana*) were transplanted to historic range in northwestern New Mexico in the spring of 1989. They were observed approximately four days per week from April 1990 to April 1991 to track areas of herd use. Areas treated with the hervicide tebuthiuron (to kill sagebrush) comprised 40% of the total area used by the antelope, but antelope were observed there 68% of the time (year-long mean). They showed a preference for sage-killed areas in every month except January. Vegetation transects (line intercept method) showed that grass cover was 13.7% higher in tebuthiuron areas than non-treated areas, and forb cover was 1.7% higher (year-long production). Tebuthiuron treatment of sage can benefit antelope if adequate sage is left for winter use.

Key Word: antelope, *Antilocapra americana*, habitat preference, herbicide, line intercept, New Mexico, pronghorn, sage control, tebuthiuron, vegetation transects.

INTRODUCTION

Pronghorn antelope numbers in North America probably originally numbered 30-40 million (Yoakum 1980). Russell (1964) estimated that the population in New Mexico prior to 1540 was over 100,000. By 1883, antelope in the study area of San Juan and Rio Arriba counties were extirpated (Bailey 1931). The New Mexico Department of Game and Fish (NMDGF) conducted a vigorous transplant effort from 1938 to 1956. They succeeded in establishing small populations in the Farmington area, but these are steadily declining (pers. comm. with local residents). There were also antelope transplanted to the Jicarilla Apache reservation, which borders the study area to the west.

In an effort to re-establish pronghorn on historic range, the Bureau of Land Management (BLM) and NMDGF relocated 85 animals from the Clayton, NM area to Ensenada Mesa in early 1989. This observational study was undertaken as an effort to assess impacts of natural gas drilling on the herd. Of particular interest was ascertaining which areas the herd preferred at which time of year.

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STUDY AREA

Ensenada Mesa is located approximately 50 miles sotheast of Farmington, New Mexico. It exists within the pinon-juniper woodland type, intermixed with grama-galleta steppe (Kuchler 1985). Elevations range from 6300 feet in the canyon bottoms to 6700 feet on the mesa top. Precipitation averages 12 inches per year.

The mesa is comprised of 50,000 acres of grass/sage flats intermingled with 3,000 acres of pinon-juniper along canyon and bluff edges. Grazing permittees and the BLM have treated 5,500 acres of sage with the herbicide tebuthiuron (SSPIKE 20-P) at the rate of 0.5 pounds a.i./acre from 1985-1987 (Renwald 1988), obtaining approximately 90% kill.

Predominant use of the land is for natural gas/oil production. As a result, there is an extensive network of approximately 150 miles of roads. Cattle grazing also occurs on two allotments, with 7,376 AUM's designated for cattle. Archeological artifacts from Anasazi and Navajo peoples are scattered throughout the area.

METHODS

Herd Dynamics

Animals were observed an average of four days per week. However, because of impassible road conditions during wet weather, observations were sometimes less frequent during winter. A standard vehicle travel route was established which covered the mesa as geographically sequentially as possible. In other words, it was necessary to begin on one side of the mesa and work methodically through adjacent pastures to the other side, so that as antelope moved, duplicate observations could be avoided. Observations were made primarily from a vehicle using binoculars and a 20-45x60 mm window-mounted Bushnell spotting scope.

Each group was observed for whatever length of time was necessary to determine age and sex composition. It was often necessary to wait until stationary animals moved to determine their category. Each observation record included date, time, weather, age and sex composition., legal location, tebuthiuron status, distinguishing characteristics of individual animals (some were collared), and any unusual behavior. Young were included in the adult categories beginning June first when they were one year old.

Tebuthiuron Use

In computing statistics such as percent tebuthiuron use, total numbers

of animals were used rather than group numbers. For example, one group with five animals was counted as five, not one. The term "average" in the text and tables refers to the statistical mean of the data.

The digitized geographic information system called MOSS was used to compute acreages.

Use preference of habitat types was determined using the simple formula: P=U/A (Krueger 1972), where U is the percent of use of a habitat and A is the percent availability. A value for P greater than one indicates a preference for using that habitat.

Vegetation transects

Line intercept forb transects were conducted bimonthly at six sites, three of which were in tebuthiuron areas and three which were not. The starting point of each was randomly placed in a localized area of antelope use. A 100 foot steel tape was then stretched along a random bearing, and the species of plant basally occurring at one-foot intervals was recorded. Dead plants and dry grass were recorded as litter. The half-shrub *Gutierrezia* was included in the forb category, while *Opuntia*, moss, and lichen were listed under miscellaneous. Each bimonthly repetition of transects retained the same starting points and bearings.

RESULTS

Herd Dynamics

Fawn production in 1989 was understandably low because of stress from recent handling and transplanting. Three fawns survived to one year of age: two females and one male.

Production in 1990 was satisfactory, but fawn survival was low. It was estimated that 75% of the does were pregnant. Given an average of 1.8 fawns per pregnant doe (Yoakum 1980), 45 fawns should have been produced. Seven survived to one year of age, giving a survival rate of 16%. All fawn mortalities occurred during the three week "lying-low" period. The only carcassess found during the study were a set of twins which were evidently stillborn or died of natural causes immediately after birth.

Fawn survival in 1991 is estimated at less than ten. Age structure of the herd in December 1991 (Table 1) gave a buck:doe:fawn ratio of 75:100:12.

Table 1. Age Structure of Antelope Herd on Ensenada Mesa. 12/91

AGE CLASS	BIRTH DATE	MALE	FEMALE	TOTAL
Fawns, 0-1 yrs.	5/91	0	3	3
Yearling, 1-2 yrs.	5/90	6	1	7
Adults, 2+ yrs.	5/89	18	31	49
Herd Total	12/91	24	35	59

Tebuthiuron Use

Antelope use of tebuthiuron-treated areas average 68% over the entire year. Amount of use remained relatively constant during summer months, but rose dramatically in October and November, then fell off in December and January when snow remained on the ground (Table 2).

Table 2. Tebuthiuron Use by Antelope on Ensenada Mesa. 4/90-4/91.

Month	% Teb. Use	Pref. Value
Apr. 1990	45	1.1
May	67	1.7
June	78	1.9
July	69	1.7
Aug.	66	1.6
Sept.	63	1.6
Oct.	80	2.0
Nov.	93	2.3
Dec.	67	1.7
Jan. 1991*	39	0.0
Feb.	75	1.9
March	68	1.7

* data for two weeks only

Vegetation Transects

Comparison of vegetation cover in tebuthiuron areas versus non-treated areas gave expected results (Table 3). Grass cover was 13.7% higher, and forb cover was 1.7% higher (year-long average). *Artemisia tridentata* was the only species of shrub recorded. Eight species of grass were registered, with *Bouteloua gracilis* the dominant species. Forb genera recognized were *Astragalus, Cymopterus, Gutierrezia, Phlox, Plantain, Sphaeralacae*, and several species of the family *Cruciferae.*. *Opuntia* comprised most of the miscellaneous category. Complete transect results can be obtained form the author.

	6/90	8/90	10/90	12/90	2/91	MEAN
Teb. Transects	53.00	53.00	67.33	snow	96.33	67.42
litter						
shrubs	1.00	1.00	0.67	0.00	0.00	0.53
grasses	41.33	44.23	28.67	snow	1.00	28.83
forbs	4.00	1.67	3.33	snow	2.33	2.83
misc.	0.67	0.00	0.00	snow	0.33	0.25
Non-Teb. Transects	57.00	57.33	61.00	snow	76.33	62.92
litter						
shrubs	20.00	18.67	21.00	20.00	20.67	20.07
grasses	21.67	23.00	15.33	snow	0.67	15.17
forbs	0.67	0.67	2.67	snow	0.67	1.17
misc.	0.33	0.33	0.00	snow	1.67	0.58

DISCUSSION

Herd Dynamics

Reasons for low fawn recruitment have remained elusive. Since pregnancy rates appeared normal up until time of parturition, it can be assumed that birth rates were also normal. Forage availability does not appear to be a limiting factor due to high grass production, however it is possible that a lack of forbs may be causing nutritional deficiencies.

The most acceptable explanation for fawn loss is predation. Coyote numbers on the mesa have not been estimated or recently controlled, but reports by area people indicate that numbers are high. Instances of coyotes harassing nursing does have been observed, as well as a fawn carcass recovered (summer 1991) which showed signs of predator tooth marks.

A supplemental transplant was conducted in early 1992 in an effort to raise fawn production to a level that will allow some fawns to escape predation.

Tebuthiuron Use

The most significant finding of this study is the antelope's preference for sage-killed areas. It is noted throughout the literature that antelope are prima-

rily sage browsers, also using forbs extensively in the summer (Mason 1952, Bayless 1969, Beale 1970, Mitchell 1971, Yoakum 1958, 1990). Most studies report grass use at less than 10%, but Hlavachick (1968) reported high grass consumption by antelope in Kansas, and theorized it was in response to high availability. Our herd conformed to this generality (Table 4), with a year-long average use of 67% browse, 2% grasses, 29% forbs, and 2% miscellaneous (Theresa Foppe, unpubl. rep., Composite Analysis Laboratory, Fort Collins, CO, 1990).

Antelope preference for treated areas is presumably primarily due to increased forage availability. Other compounding factors may be increased ease of movement, increased visibility, and differing microclimate. Antelope never had to travel over 1.5 miles to reach untreated sage, travel effort would not keep them from using untreated areas. Water was equally available in both vegetation types.

Table 4. Vegetative Matter in Fecal Samples (% relative density) of Antelope on Ensenada Mesa. 1989.

1989	Jan.-Mar	Apr-June	July-Sept	Oct-Dec	Year Ave
Shrubs	95.92	32.34	57.32	84.11	67.42
Grasses	1.74	1.90	2.43	2.69	2.19
Forbs	.98	61.94	39.99	13.09	29.00
Misc.	1.36	3.81	.17	.11	1.36

Vegetation Transects

While vegetation transects showed low forb percentages, I feel the transect methodology under-represented actual forb abundance. Transects gave results as percent cover, but production (dry weight in pounds/acre) may have been a better measure. This is upheld by the fact that pellet analysis did not show forb content as lacking. Inclusion of dry grasses analysis did not show forb content as lacking. Inclusion of dry grasses and dead forbs in the "litter" category also minimized apparent production, because standing dry grass is still of some nutritional value.

A study conducted on similar habitat that had received the same tebuthiuron treatment showed an increase in forb production (lbs/ac) of 822%, while grasses increased production by 326% (BLM unpubl. rep.,1984).

CONCLUSION

Success of this transplanted herd of pronghorn antelope in northwestern

New Mexico is questionable at the time of this writing. It is apparently a problem of predation. However, in spite of this problem of recruitment, preference for sage-killed areas is notable.

It should be cautioned that while these antelope prefer herbicide treatments most of the time, they still rely on sagebrush for forage in the winter. These results should not be used as justification for unlimited brush control. Brush treatments on ranges used by antelope would be preferable at an application rate of 0.3 pounds a.i./acre, thus leaving more sage alive and reducing the need for animals to travel. Patterns of application should create a mosaic where untreated sage is available in close proximity to untreated areas.

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ANTELOPE UTILIZATION OF LICHENS IN THE BIRCH CREEK VALLEY OF IDAHO.

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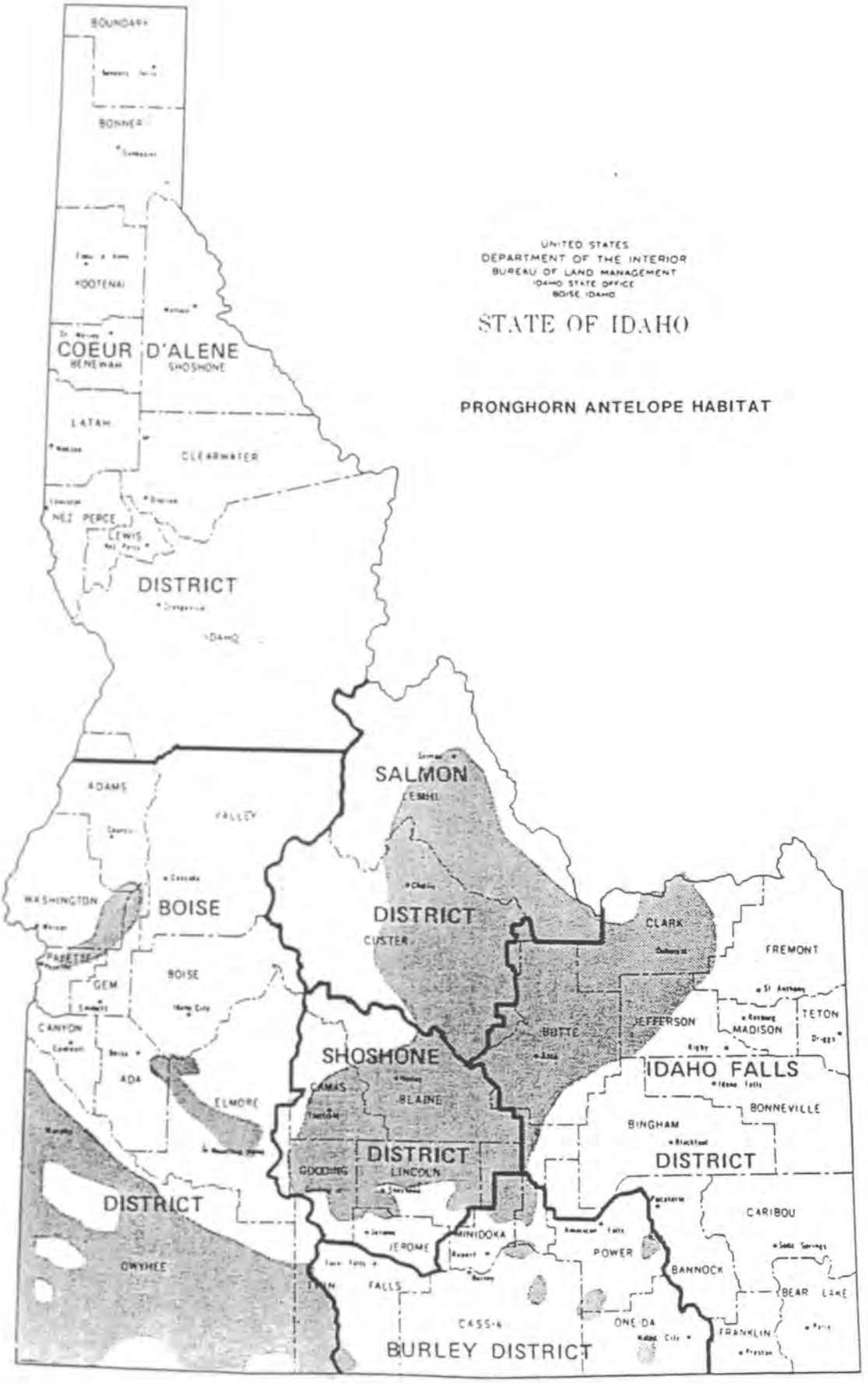
Abstract: Major pronghorn antelope populations winter in or near the Idaho National Energy Laboratory (INEL) in southcentral Idaho. Each spring, they migrate northwestwardly up three valleys (Birch Creek, Little Lost, and Big Lost valleys) for fawning and summer range. These valleys, separated by high mountain ranges, contain extensive windswept, calcareous gravel benches and flats. These sites support a sparse cover of vascular plants which are often dormant during the migration period and an abundance of lichens growing loose over the soil. During years of normal to severe snowfall, adjacent vegetation is covered by crusted snow well into June; a condition which would appear to be stressful to pregnant does and other migrating antelope. During these periods of stress, four recently-identified species of the vagrant lichen Rhizoplaca may become the major food source.

In 1987, Idaho wildlife biologists in the Bureau of Land Management (BLM) reviewed big game populations and habitats as a preliminary step in developing our state and district goals and objectives for our Fish and Wildlife 2000 plans (Thomas 1987). The pronghorn antelope chapter by Russ McFarling noted that about 80 percent of the state's antelope habitat occurs on some 5.5 million acres of BLM. He developed maps of statewide habitat (Figure 1) and areas of crucial habitat (Figure 2). Of special importance to this report is the large numbers of antelope (CA 8,000) that winter in or near the Idaho National Energy Laboratory (INEL) in southcentral Idaho on the first map, and the key spring migratory routes shown on the second map where antelope move northwestwardly up the Birch Creek, Little Lost, and Big Lost valleys to fawn and move to summer habitats.

The three valleys are separated by steep mountain ranges (Beaverhead Mountains, Lemhi Range, Lost River Range, and the White Clouds/Boulder/Pioneer complex) which are managed by the Forest Service. The valleys each slowly gain some 2,000 feet in elevation, reach summits, and then north-flowing drainages are formed which eventually reach the Salmon River. The Birch Creek Valley stretches about 60 miles to the Gilmore Summit and becomes the Lemhi River Valley. The BLM manages most of the land in all three valleys through either our Idaho Falls or Salmon district offices.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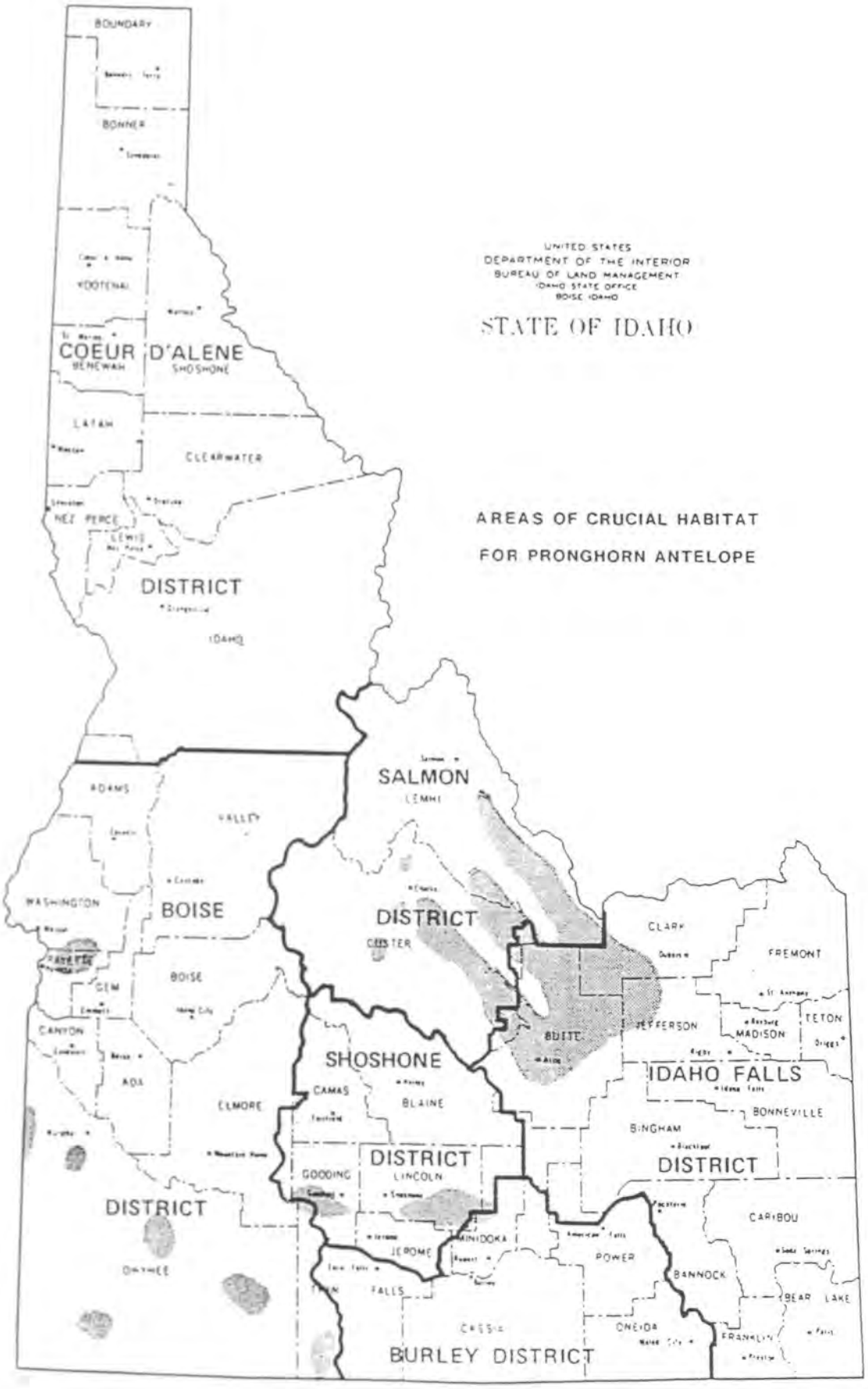
UNITED STATES
DEPARTMENT OF THE INTERIOR
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AREAS OF CRUCIAL HABITAT
FOR PRONGHORN ANTELOPE
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HABITAT CONDITIONS DURING SPRING MIGRATION

The three valleys are characterized by having extensive windswept, calcareous gravel banches and flats leading from the mountain slopes to the drainage bottoms. Dips between these benches capture better soils and moisture, and contain the larger shrub species (sagebrush, saltbrush, and winterflat) found in the winter range. The benches themselves support a sparse cover of vascular plants which are often dormant during the antelope migration. These plants are very small, grow close to the ground, and have very course and sharp vegetative parts during the dormant stage. These sites contain chicken sage, *Tanacetum nuttallii*, and needle and thread grass. About 75 percent of the area is bare ground (Bernt 1976). An abundance of free-growing or vagrant lichens can be found scattered over the soil.

This region is suffering from its sixth year of drought and less than normal snowfall. However, observations during normal to severe winters showed that snow collects in the dips between the calcareous benches. The snow develops a crusty top layer due to actions of the wind and cycles of thawing and freezing. The vegetation often remains covered by the crusted snow well into June. Therefore, these snow-covered sites are unavailable for utilization by pronghorn antelope.

The windswept benches are normally snowfree, allowing for travel corridors for the migrating antelope. However, the benches are essentially without the "normal" antelope forage of grass, forbs, and shrubs (Beale and Scotter 1968, Cole 1956, Kindschy et al. 1982, Salwasser 1980). Bernt (1976) recorded antelope spending large amounts of time in the windswept chicken sage sites.

McCarty (1982) found evidence of antelope die-off in the mid-1950s which coincided with severe low temperatures and snowfall in the winter range. However, the populations increased to an all-time high by the mid-1980s in spite of many years of the normal or severe springtime conditions described above.

The following questions then arose: (1) what are the antelope eating during these stress periods, and (2) why has this apparent lack of food not resulted in increased mortalities in antelope fawns?

FIELD INVESTIGATIONS

In the mid-1980s, Rosentreter began investigations of the vagrant or non-attached lichens of these three valleys. The most common vagrant lichen, *Xanthopaarmelia spp.*, sometimes called range lichen (MacCracken et al. 1983),

was sparsely scattered throughout the area. While not abundant enough to be an important diet component for antelope, range lichens could be important source of trace minerals, salt, and free water during the winter and spring (Sharnoff 1992). A recent review of the distribution of vagrant *Xanthoparmelia* species (Hale 1990) with that of pronghorn antelope reveals that antelope seldom occur without the presence of these lichens.

Of greater significance were abundant populations of an unknown vagrant lichen distributed throughout the calcareous benches. Rosentreter found the greatest abundance and variety of the lichen near the mouth of Birch Creek. We have intensified our investigations in this area. Four varieties in the shape of the lichen were found in lower Birch Creek (Figure 3). Table # 1. presents the common names we have used to refer to these vagrant lichen species. Fewer variations were found as we progresse northwest up the Birch Creek Valley or westward to the Little Lost and Big Lost Valleys. We found only the rough, "coral" lichen at the Willow Creek Summit at the head of the Big Lost Valley.

Table 1. Common names for some vagrant lichens.

COMMON NAME	SCIENTIFIC NAME
Range lichen	Xanthoparmelia spp.
Folded Grouse Pellet	Rhizoplaca crispus
Loose Grouse Pellet	R. cerebriformis
Grouse Pellet	R. idahoensis
Coral lichen	R. haydenii

The four varieties were verified by experts at the Smithsonian Institute to include one described species and three undescribed and unknown to science. The individual species of the genus *Rhizoplaca* are indicated on figure 3. The four species are believed to have originated at the mouth of Birch Creek and been spread to the other areas by the wind and from being caught in the hair of bighorn sheep and antelope. This could explain why the most coarsely branched species, *R. haydenii*, is the only one spread as far as Willow Creek Summit. *Rhizoplaca haydenii* is also known from the Laramie Hills of Wyoming. All four species appear to prefer limestone substrates.

Bernt (1976) established 27 transects in areas heavily used by antelope. These transects included both the calcareous benches and the vegetated dips. Ground cover averaged 12.4 percent shrubs, 5.6 percent bunchgrasses, 3.9 percent forbs, 2.0 percent lichens, and 74.9 percent bare ground/litter. For the sparsely covered bench areas, the major vascular plants are chicken sage,

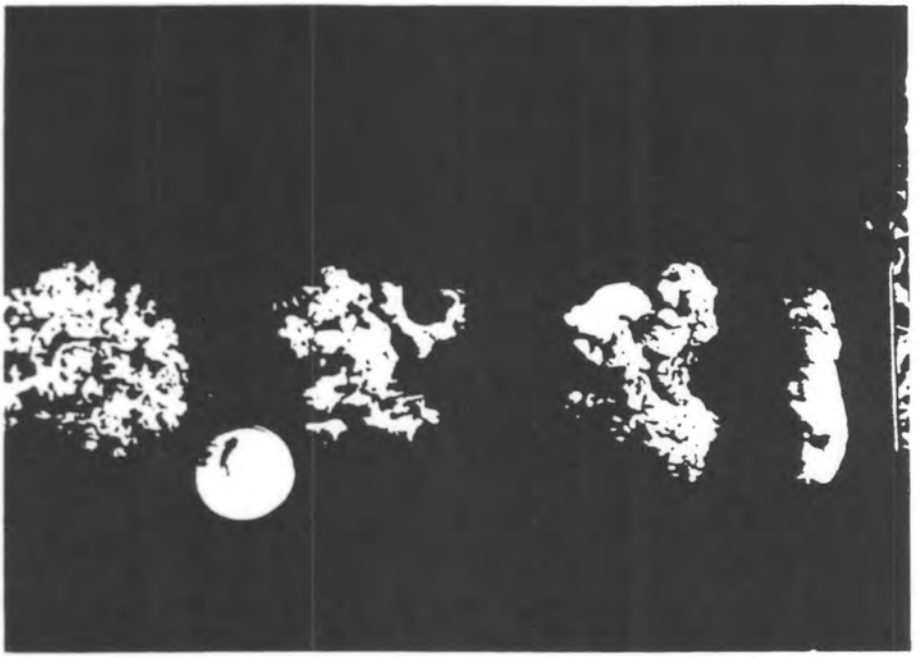

Figure 3. From the left, the lichens are *Rhizoplaca haydenii*, *R. crispus*, *R. cerebriformis* and *R. idahoensis*.

Hood's phlox, alpine mustard, and small-flowered penstemon. While only making up about 2 percent of the total ground cover, lichens are locally abundant on the benches. Similar cover ratings done in early spring before the vascular plants have sprouted would show a relatively high percent of the plant cover as lichen compared to the decidous vascular plants. (This abundance of the lichens in lower Birch Creek is shown by the fact that handfuls of lichens can easily be collected in seconds from undisturbed sites).

IMPORTANCE OF LICHENS TO ANTELOPE

Antelope were observed eating lichens (Bernt 1976) but no technique to evaluate the consumption of free-growing lichens was developed. A rumen sample he obtained from the Big Lost Valley contained 51 percent lichens. Obviously, antelope will eat lichens, at least under stress conditions when shrubs may be covered by crusted snow. Lichens absorbing the sun's radiant energy may be thawed and provide free unfrozen moisture on sunny days in the early spring when the snow remains frozen.

Chemical composition of similar lichens (Scotter 1972) showed that the protein content of lichens never exceeded 2 percent. This percentage was significantly lower than protein levels of vascular plants. However, the crude fiber content of lichens normally contains high levels of lichenin and isolichenin, carbohydrates that are readily digestible. In addition, the high fiber content of the lichens may liberate large amounts of energy when broken down by rumen bacteria and protozoa. This energy release would be an important advantage to stressed antelope.

Due to six springs of below normal snowfall in these valleys, we have had no opportunity to directly observe increased use of lichens by antelope under stress conditions. Our speculation is that during years of light snowfall, the lichens remain a relatively insignificant component of the habitat. It is only during these periods of heavy snowfall, when the vascular vegetation is covered by crusted snow, that the value of lichens to the biodiversity of the region is expressed.

MANAGEMENT IMPLICATIONS

Undisturbed bench areas had abundant populations of lichens. We visited areas heavily grazed by cattle and found that lichens were still present, but were usually smaller in size. We believe that this size difference is more due to trampling by cattle than by feeding on the lichens. We visited an adjacent pasture and holding area for domestic sheep and found essentially no lichens. We believed that sheep seek and eat the lichens. We gathered several

sacks of the free-growing lichens and gave them to friends who raised sheep in the Leadore area. The lichens were made available to lambs that were being fed high protein pellet diets. When lichens and pellets were placed side-by-side, the lambs quickly abandoned pellets and ate the lichens.

This information may point out the need for relative low levels of livestock grazing, especially domestic sheep, in crucial antelope habitats such as described in this report. There also may be a relationship between the major decrease in antelope populations in the Birch Creek-Little Lost Valleys during the 1920's (McCarty 1982) and availability of lichens. Peak domestic sheep grazing occurred in the area after 1920 when extended drought conditions in southern Idaho ranges resulted in livestock to be moved to higher elevation foothills and valleys in search of water and forage.

In conclusion, we believe that these vagrant lichens are critical to pronghorn antelope populations in stress periods, but only during years with heavy snow cover or later than normal spring green up. These lichens and their habitats may be necessary for the long-term viability of the pronghorn antelope populations in these valleys.

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SURVIVAL OF TRANS-PECOS PRONGHORN

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Abstract: We used radio telemetry to estimate survival on 58 adult pronghorn (*Antilocapra americana*) and 54 fawns in 1990 and 1991. Adult survival estimates in the 2-year period are .906, 1.0, and .888 for all adults, bucks only, and does only, respectively. Cause of death in adults was attributed to mountain lion (*Felis concolor*) predation, dietary and parturition complications, and unknown causes. Fawn survival estimates were .097 in 1990 and .166 in 1991. Fawn losses in 1990 were attributed to predation by coyotes (*Canis latrans*) (50%), mountain lion (20%), golden eagle (*Aquila chrysaetos*) (5%), and unknown causes (15%). In 1991, predation was also the major cause of fawn mortality with 53% attributed to coyotes, 9% bobcat (*Lynx rufus*), 6% mountain lion, 6% golden eagle, and 6% unknown. Another year of research is planned for 1992.

Historical evidence of Texas pronghorn indicates that populations were found throughout much of the state but were greatest in the Trans-Pecos, High Plains, and Rolling Plains resource areas of the west and northwest portions of the state (Leftwich 1977). These populations remained abundant until the late 1880's when the population numbers and historic range began to decline. Populations reached their lowest levels in the 1920's when remnant herds were the only animals remaining, primarily scattered throughout west Texas. Of the 2400 animals remaining in Texas in 1924, a few nuclei herds were protected by concerned ranchers and from these herds the present population in Texas developed (Buechner 1950). The Trans-Pecos herd grew after that time as a result of protection from hunting and from predator control efforts (Hailey 1986).

The effect of predators, especially bobcats, coyotes, and golden eagles, on pronghorn, has been documented extensively in the literature. Nelson (1925) reported that a full grown buck in good condition was killed during a snow storm in Montana by a bobcat. Other instances of adult pronghorn being killed by predators appear to be related to the presence of heavy snow cover (Nelson 1925, Bruns 1970, Bruns 1977, Firchow 1986, Gese et al. 1988). Bruns (1970) suggested that pronghorns are relatively easy prey for coyotes during adverse snow conditions in Alberta. Several instances of full grown or nearly full grown pronghorn being killed by golden eagles are found in the

literature (Fisher 1942, Lehti 1947, Thompson 1949, Bruns 1970, Hailey 1986). Evidently, coyotes, bobcats, and golden eagles are all capable of killing adult pronghorn, however it is commonly believed that the impact of predators on pronghorn populations is greater on fawns rather than adults.

Predation on pronghorn fawns is most often associated with coyotes, however many studies have shown that bobcats and golden eagles can be very effective predators of fawns also. Beale and Smith (1973) in an intensive study of pronghorn fawn mortality in Utah, found 27 of 44 fawns that died within 4 months of age were killed by bobcats. They further stated that bobcat predation was the most important cause of fawn losses in the study herd and was the greatest single decimating factor affecting net productivity of pronghorn. Other authors also have found bobcats accounting for a substantial percentage of fawn mortality (Barrett 1978, Beale 1978, Bodie 1978, Autenreith 1980, Brodie and O'Gara 1980, Smith and Beale 1980).

Golden eagles also are known to prey upon pronghorn fawns in areas where both species are found. In Idaho, Autenreith (1982) reported 33% of 24 known predator kills on fawns were the result of golden eagle predation. Eyewitnes's accounts of golden eagle predation on pronghorn fawns suggest that this form of predation may be a more significant mortality factor than previously thought (Goodwin 1977). Other studies have supported these theories, showing significant percentages of fawn mortality being caused by golden eagles (Buechner 1950, Beale 1978, Bodie 1978, Brodie and O'Gara 1980).

Although bobcats and golden eagles are known to prey upon pronghorn fawns, coyotes have historically been implicated as the major predator. Coyote predation was the primary cause of low fawn survival on Anderson Mesa in Arizona (Neff and Woolsey 1979, 1980, Neff et al. 1985). In a study in southeastern Colorado, coyote predation was believed to be responsible for 71% of fawn mortality (Firchow 1986, Gese et al. 1988). Fawn survival rates in southeast New Mexico were 14% greater in 2 of 3 years in a coyote-controlled vs. non-controlled area (Larsen 1970). Other studies also have shown evidence of coyote predation on pronghorn fawns varying from 31% to 12 % of known fawn mortality (Barrett 1978, Beale 1978, Bodie 1978, Von Gunten 1978, Corneli 1979, Autenreith 1982).

Other forms of pronghorn fawn mortality including disease, (and,or abandonment), weak fawn syndrome (Brodie and O'Gara 1980), and stress have been reported in the literature. However, these factors are highly variable and are considered to be uncontrollable by usual management methods. In a Trans-Pecos pronghorn study on fawns and adults, antelope herds were found to be extremely clean of external parasites and diseases (Hailey 1986). It is believed that the relatively dry, desert-type climate is an aid in preventing the spread of diseases or parasites in the Trans-Pecos. Other forms of adult mor-

tality are highly variable and often related to severe weather in one form or another (Bradybaugh and Howard 1982, Buechner 1950, Hailey et al. 1966, Martinka 1967).

STUDY AREA

The study site is located in north Hudspeth County, Texas, on University of Texas Lands, primarily in the 6070 ha Buckhorn pasture of the Double U Ranch. Hudspeth County is in the Trans-Pecos Mountains and Basins ecological area west of the Pecos River. Elevation on the study area ranges from 1465 to 1675 m. Topography ranges from steep to gentle hills on the west side bordering the Hueco mountains, to open flats on the east side of the study area. Typical range sites are stony hills, clay flats, gypsum flats, and deep uplands (Correll and Johnston, 1970). Climate includes dry winters and wetter summers with most of the annual precipitation (<30.5 cm) occurring in late summer months. Temperatures range from -18°C in the winter to over 38°C in the summer.

The most important vegetation types are yucca (*Yucca elata)* savannahs, grama (*Bouteloua spp.*) grasslands, and creosote (*Larrea tridentata*)-tarbush (*Flourensia cernua*) desert shrub areas (Correll and Johnston 1970). Dominant grasses include gramas, Muhlenbergias (*Muhlenbergia spp.*), and three-awns (*Aristida spp.*). Forbs vary considerably among sites and seasons with the most common being of the genera: *Aster, Astragalus, Croton, Dyssodia, Gilia,* and *Sphaeralcea.* Common overstory species include yucca, cholla (*Opuntia imbricata*), creosote bush, tarbush, and broom snakeweed (*Gutierrezia sarothrae*).

METHODS

On March 5, 1990, 79 pronghorn were trapped with a corral-type drive trap and helicoptered to the south-central portion of the Buckhorn pasture. Twenty eight bucks and 51 does were trapped (1:1.8), of which 50 does and 8 bucks received mortality-sensing radio collars. The does also were tagged with numbered ear tags. All animals captured were considered to be in good condition with minimal external parasite loads. Approximate ages were recorded via horn length and mandibular dentition (Buechner 1950, Dow and Wright 1962). Of animals captured, 37% were 2 years old or less, 28% 3 years, and 36% were 4 or more years.

Radio tracking began on a daily basis within 2 days of capture and release. Because an immediate objectives was to check physical condition of animals following trapping, tracking was done from a pickup using a hand-held

H-antenna, with visual observations obtained using binoculars and a spotting scope. Visual locations of animals were obtained by reading ear-tag or collar numbers and marking locations on USGS topographic maps reduced to 8x11 inch size for field use. Home range and mortality data were gathered in this manner from March through August of 1990 and 1991. In September through February of both years, animals were located 1 to 3 times per month for home range and mortality purposes. Although triangulation was originally considered as a means of obtaining fixes on animals, visual locations were facilitated by the open terrain and were an efficient and accurate means of locating animals with minimal disturbance.

Fawning season in this part of the Trans-Pecos begins in late April and continues until early June. To obtain fawns for study, the area was intensively searched from vehicles in an attempt to find does which were close to parturition. Fawns were then located with binoculars and spotting scopes and usually captured within 5 days of parturition when cryptic behavior was still prevalent. A hoop net with a 1 m diameter, round net and 3 m handle was used in capture. Transmitters were placed in plastic bags containing creosote leaves to mask any foreign scent and surgical gloves were used in handling of fawns. Because of the fragile nature of the fawns at this young age, no body measurements, weights, or body temperature measurements were taken in order to minimize time and disturbance of the fawn and bedding site and subsequently, abandonment by does. Time spent tagging each fawn averaged 1 to 2 minutes.

After tagging the first 3 fawns, we positioned observers to monitor the does' acceptance of the fawns after handling. The does exhibited minimal negative reactions to our handling of the fawns or the transmitters themselves. Tagged fawns were radio-tracked daily, and visually appraised for general condition. Daily relocation was critical in determining cause of death in fawns. In all cases of mortality, fawns were seen alive and in apparent good health the day before being found dead. Fawns that were found dead were carefully inspected for cause of death. The area surrounding the site was searched thoroughly for other evidence. All information was recorded in field note books and photos were taken of the site and surrounding area. Fawn carcasses or remains of carcasses were frozen after preliminary inspection, for further inspection later. Carcass inspections were very thorough and generally followed procedures outlined by O'Gara (1978). Similar procedures were used in determining cause of death in adults.

Fawn and adult survival was estimated using the Kaplan-Meier procedure (Kaplan and Meier, 1958) modified to allow staggered entry of animals (Pollock et al., 1989). This approach allows new animals to be added to the model throughout the fawning season.

RESULTS

Adult survival was estimated for the period extending from March, 1990, through February, 1992. Buck survival in the 8 bucks collared during the 2-year period was 1.0 (Fig. 1). This estimate does not represent hunting mortality in the general population because none of our collared animals were harvested. However, non-hunting mortality is assumed to be very low since no collared bucks have been lost in this study. Doe mortality on our study area has been slightly higher and the survival estimate reflects this, S(t)=0.888 (SE=0.056), (Fig. 1). Four does were lost within 2 weeks of trapping (Table 1) and cause of death was attributed to trapping stress in 3 of these. One of the four was found dead and buried by a mountain lion 2 weeks after trapping. This doe was included in the survival estimate. Since that time, 4 known doe mortalities have occurred. Cause of death in these four varied. In 1990 after an extended dry period, 1 doe died from rumen impaction caused by eating cactus. In 1991, one doe died during parturition and was found the day following death with a fawn lodged in her cervix. No evidence of predator involvement was detected. Another doe was killed by a mountain lion and the fourth died from unknown causes. This latter doe died during hunting season and was found too late to determine cause of death. Two other does have not been located in one year or more and are presumed dead.

Fawn survival in 1990 was 0.097 (SE=0.065) and 0.166 (SE=0.057) in 1991 (Fig. 1). The death rate was greatest between day 1 and day 45. Fawn mortality was primarily attributed to predation (Table 2a). Two fawns in 1990 and one in 1991 were lost due to transmitter malfunction or other causes. One 1991 fawn was lost from unknown causes but cardiac arrest is suspected based on physical evidence and discussions with two veterinarians. Coyotes were the primary predator involved in the predation losses (Table 2b). Other predation was attributed to mountain lions, bobcats, and golden eagles. Estimated fawn crops from University of Texas Lands census information in our study area were 11% in 1990, comparable to 10% in our tagged fawns. However, in 1991 the fawn crop estimate on tagged fawns was lower (21%) than the census estimate (33%). Age of fawns at death in 1990 ranged from 1 to 63 days and averaged 18 days. In 1991, the range was 1 to 82 days and the average was 19 days. Fawns still alive at the conclusion of the field season in late August were assumed to have survived.

Although data analyses on long-term precipitation and annual census information are yet to completed, there appears to be a correlation between previous year's precipitation and the following year's fawn crops. Fawn crops in 1990 and 1991 seem to follow this trend since precipitation in 1989 was well below average (1989 ppt.= ~19cm, mean annual ppt.= ~30.5 cm), and 1990 precipitation was slightly above average (~32cm). This relationship will be further investigated upon completion of the 1992 field season.

DISCUSSION

These preliminary results indicate that while fawn recruitment to the population in this region of the Trans-Pecos can be very low, overall population numbers may remain relatively stable. High survival rates in adults may compensate for years of low fawn crops.

Survival of pronghorn in the Trans-Pecos may be most strongly related to precipition. Hailey (1986) reported very little adult winter mortality in Texas but severe reductions in adult populations have occurred following drought, primarily caused by starvation. In southeast New Mexico in an area very similar to our study area, Bradybaugh and Howard (1982) found that decreases in the normal amount of monthly precipitation over several months can create problems in reproduction and survival of both fawns and adults. Heavy snow in severe winters is also known to cause signigicant reductions in adult populations in both northern and southern pronghorn habitats (Martinka 1967, Bradybaugh and Howard 1982). Buechner (1950) also reported that the correlation of antelope populations with adverse weather is more nearly a cause-and-effect relationship than that of predations. It is apparent from our data thus far that adults are able to survive even in very dry years on the Double U study site. Neither long-term drought nor heavy snow accumulations have occurred; however in the relatively short time span of this study and those conditions, according to the literature, are the types of situations that are most likely to seriously impact adult populations.

While the effect of drought on Trans-Pecos pronghorn populations can hardly be disputed, the relationship among fawn survival, drought, and predation appears to be complex. No evidence of doe abandonment of fawns has been detected in our study, even in the very dry fawning and post-fawning season of 1990. Predation has been the major cause of death in this study in both low and average precipitation years although survival was higher in 1991 than in 1990, the season following higher precipitation. It is apparent at this point in the study that predators significantly reduce fawn survival, but the degree of reduction is depndent on other factors which are probably related to precipitation. Another field season is planned for 1992 that will hopefully contribute to our understanding of predator-prey relationships and fawn survival.

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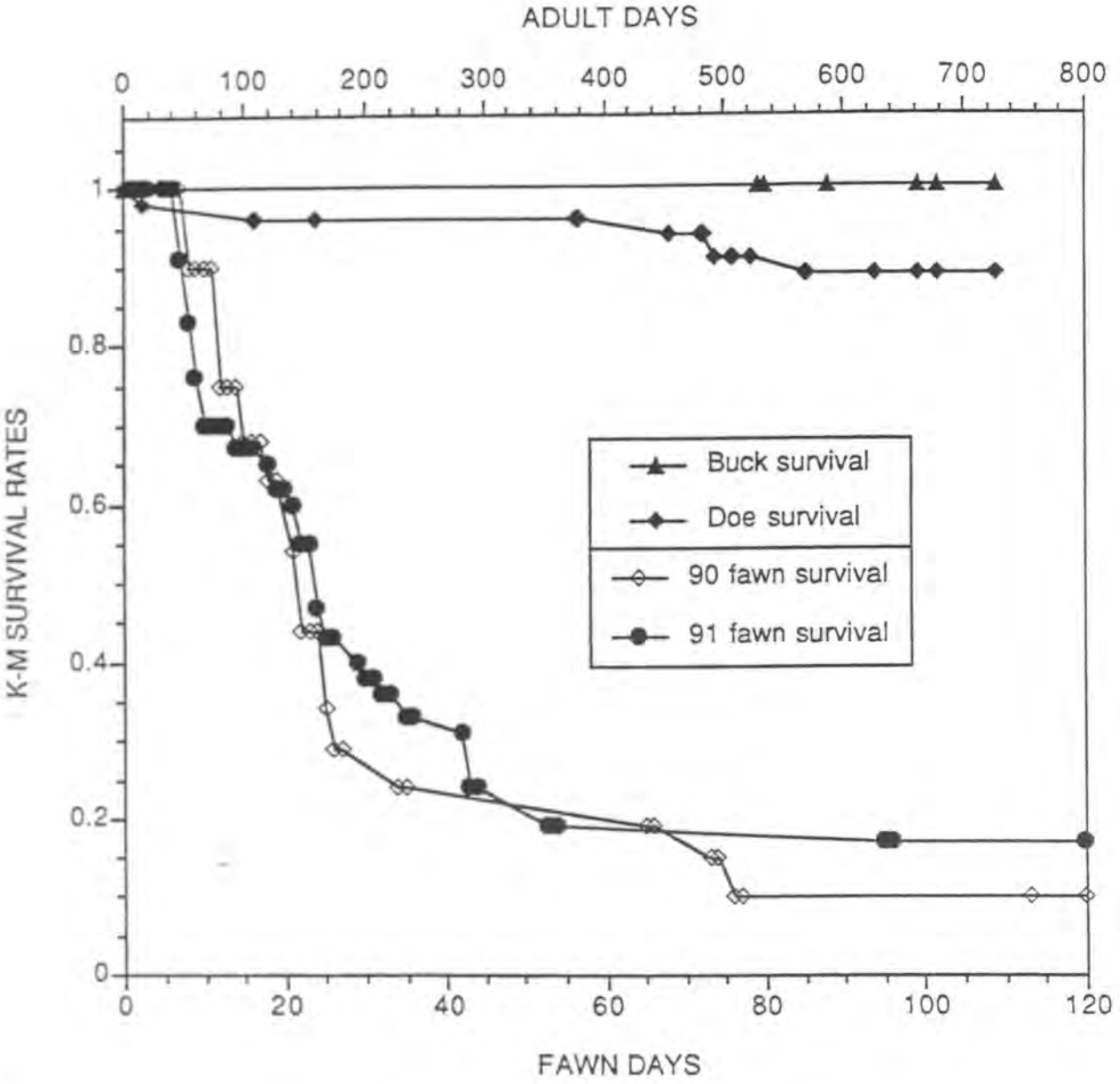

Figure 1. Adult and fawn survival, 1990-91, Double U Ranch, Hudspeth County, Texas

Table 1. Causes of mortality in adult pronghorn on the Double U Ranch, Hudspeth County, Texas March, 1990-March, 1992.

		Cause of deaths							
Sex	n	Trapping[a] Stress	Predation	Parturition	Diet	Unknown	Censored	Total	Less trap-related
Male	8	0	0	0	0	0	0	0	0
Female	50	4[a]	1[b]	1	1	1	2[c]	10	6
Percent	1.00	.08	.02	.02	.02	.02	.04	.20	.12

[a] One of these 4 females found buried by lion 2 weeks after trapping.
[b] Mountain lion
[c] Two females presumed dead, no location in > 1 yr.

Table 2a. Fates of tagged fawns and census information, Buckhorn pasture, Double U ranch, Hudspeth County, Texas.

Item	1990		1991	
	n	%	n	%
Fawns captured-tagged	20	1.00	34	1.00
Fawns survived	2	.10	7	. 21
Census fawn crops for same pasture		.11		. 33
Lost transmitters	2[a]	.10	1[b]	.03
Unknown cause of death	1[c]	.05	1[b]	.03
Death by predation	15	.75	25	.74

[a] Suspect eagle predation
[b] Transmitter failure or other causes
[c] Suspect lion predation

Table 2b. Known fawn mortality by predation, Buckhorn pasture, Double U Ranch, Hudspeth County, Texas.

	1990		1991	
Predator	n	Percent of Total Mortality	n	Percent of Total Mortality
Coyote	10	.50	18	.53
Mountain Lion	4	.20	2	.06
Bobcat	0	0	3	.09
Golden Eagle	1	.05	2	.06
Death by predation	15	.75	25	.74

MORTALITY AND HOME RANGE OF PRONGHORN FAWNS IN CENTRAL ARIZONA

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Abstract: Eleven (4f, 7m) neonatal pronghorn (*Antilocapra americana)* were captured during 1991 in central Arizona. Fawns were collared with mortality-sensing telemetry units. We monitored signals on a nearly -daily basis for 1 month, then 3 times/week until 6 months of age. Mortalities were investigated and cause of death determined. Relocation data were imported into software program HOME RANGE for calculation of core area and home range size (minimum convex polygon method). Five of 11 fawns died within 14 days of estimated birth. Two died within 48 hours. Estimated causes of death were: 1) unknown, 2) maternal abandonment, 3) coyote (*Canis latrans*) predation, 4) kicked or butted in head by adult or other large ungulate, and 5) unknown predator. Six of 11 survived 6 months of life. Break-away collars on 2 of the 6 fawns slipped off after 3 and 5 months, but both were seen later. Use areas were very small for the first 21 days (x=1.06 km squared). Use areas increased significantly between 4 consecutive 21-day periods. Home range size for 6 fawns averaged 15.1 km squared for the first 6 months. Core areas averaged 7.7 km squared. For the first 2-week period, average distances to water was 0.76 km. Overall, for 6 months, fawn relocations averaged 0.93 km from an identified water source. Only 2 fence crossings were documented and home ranges appeared to be partially determined by fence distribution.

Key words: Pronghorn, antelope, fawns, *Antilocapra americana*, home range, mortality, fence, water, Arizona.

Pronghorn are widely distributed throughout western North America, occupying habitats dominated by low growing grasses and shrubs (Autenrieth 1978, Kindschy et al. 1982). In Arizona, pronghorn occur in a wide band across the northern part of the state and in isolated pockets between southern mountain ranges (Anon. 1987). Excluding Indian reservations, Arizona has approximately 52000 square km of occupied pronghorn habitat (Anon. 1987).

Vriend and Barrett (1987) reviewed literature and concluded that low pronghorn fawn survival was a mangement reality throughout most of North America. They found that fetal counts were much higher than fawn counts in

mid-summer classification surveys. Fawn losses of 25-65% of production typically occurred in the first 2-3 months of life. Low fawn survival, thus recruitment into a population, has been suggested as the most important management problem for pronghorn in Arizona (Neff 1986).

Mortality factors affecting pronghorn fawn survival are numerous, with predation researched most (Yoakum 1980). Coyotes have been found to be significant predators on fawns, particularly neonate fawns (Von Gunten 1978, O'Gara 1978, Neff and Woolsey 1979, Yoakum 1980, Barrett 1984, O'Gara and Malcolm 1988). Bobcats (*Lynx rufus*) have also been shown to be a significant predator on pronghorn, again, especially on neonate fawns (Beale and Smith 1973, Yoakum 1980, O'Gara and Malcolm 1988). Golden eagles (*Aquila chrysaetos*) prey on neonates (Bodie 1978, Yoakum 1980, Autenreith 1982, O'Gara and Malcolm 1988), taking as much as 33% of the yearly production (Autenrieth 1982). Less significant mortality factors, but still important, are hypothermia (Barrett 1978), traauma or injury (Barrett 1978), abandonment caused malnutrition or starvation (Bodie 1978, Barrett 1984), and disease (Beale and Smith 1973). Barrett (1978) noted that doe mortality due to parturition, stillborn fawns, and fawn entanglement in fences were present in pronghorn populations, but not as significant as other causes. Bodie (1978) found that small raptors also prey upon neonate fawns, but not to the extent of golden eagles.

Information on size of area used by fawns would assist land managers with establishing critical buffer zones around areas of habitat that match necessary habitat components for fawning sites. Unfortunately, little information is available on size of area that pronghorn fawns use, either as neonates or in the first several months of life. Bayless (1969) found that fawns used 6-10 square km during the winter, but this is after the first 6-month critical period.

Because of lack of managment data on fawns, we undertook this study on mortality factors and home range characteristics for pronghorn fawns in Arizona grassland habitats. Our objectives were to:

- Review literature and determine potential mortality factors on pronghorn fawns,
- Determine adequate capture techniques for neonate pronghorn fawns,
- Document pronghorn fawn mortality factors in central Arizona,
- Determine sizes of pronghorn neonate fawn use areas and home ranges of fawns in central Arizona,
- Determine if pronghorn fawn relocations were related to water distribution, and
- Determine if pronghorn fawn home ranges are affected by fence distribution.

S.G. Andrews, P.G. O'Brien, and P.R. Crouch assisted in capture efforts. W.K. Carrel, S.G. Andrews, S.M. Schuetze, and K.E. Thompson helped monitor and relocate collared fawns. Pilots W.H. David, D.W. Hunt, S.A. Sunde and B.D. Coffman provided aerial relocation support. J.A. Casteel and C.D. Chevalier consulted on graphical and statistical analysis. R.L. Glinski, R.M. Lee, and J.S. Phelps reviewed the manuscript and provided valuable comments. J.C. DeVos and R.L. Glinski administered the project. Fain Land and Cattle Company generously allowed the use of their lands for the study. Major funding for the study was provided by Federal Aid in Wildlife Restoration Act Project W-78-R and contracts from U.S. Forest Service and U.S. Bureau of Land Management.

STUDY AREA

The study area was located in central Arizona, bordering the eastern town edge of Prescott Valley and north of the town of Dewey. The Fain site was named after the ranch it was located on, and encompassed 139 square km of gently rolling hills and flats in an area dominated by Great Plains grassland vegetation (Brown 1982). This shortgrass prairie is bordered by interior chaparral shrublands.

On the eastern half of Fain, chaparral vegetation, such as scrub oak (*Quercus turbinella*), skunkbrush (*Rhus trilobata*), and beargrass (*Nolina microcarpa*), dominates foothills and is also found on north-facing slopes of rolling hills in the middle of the site. Shortgrass species like ring muhly (*Muhlenbergia torreyi*) and various grama (*Bouteloua* spp.) grasses predominate the western edge of Fain, as well as ridge tops and southern exposures in the middle of the site. Scattered clumpls of catclaw (*Acacia greggii*) are found along ridgelines. The western half of Fain has only a few scattered shrubs , except in a small hilly area on the northern edge, where numerous beargrass and juniper (*Juniperus* spp.) occur in clumped distributions. Scattered agave (*Agave* spp.), oak (*Quercus* spp.), and cholla/prickly pear (*Opuntia* spp.) are distributed throughout Fain.

Climate is mild, with the valley situated from 1400-1600 m in elevation, and foothills over 1600 m on the eastern slope. Precipitation is generally summer thunderstroms, irregular gentle winter rains, or occasional snow storms. Most of the valley lies within a precipitation zone of 25 to 38 cm per year (Sellers and Hill 1974). Average monthly valley temperatures are above freezing for all months. Temperature extremes range from -29 to 40°C, with daily variations up to 20°C (Sellers and Hill 1974).

METHODS

We capture pronghorn neonate fawns using a variety of methods. Typically, doe behavior was observed to determine if a fawn was in the area. Spotting scopes and 10x50 binoculars were used to systematically scan the area in question. A pair of camouflaged biologists approached the fawn hiding spot, one to distract the fawn and the second to approach the blindside. A drop-net on the end of an extending pole (Beale and Smith 1973, Bodie 1978, Von Gunten 1978) was used on several fawns, a jacket was dropped on another, and neonates less than two days old were approached directly. We captured fawns in May-June of 1991. Each fawn was fitted with an expandable radio transmitter neck collar and released at the capture location.

We monitored pulse rates nearly daily for mortality signals during the first month of life. Relocations were made twice a week from the air using a rotatable, belly-mounted H-antenna and once a week from the ground for the first 6 months. Relocations were plotted on 7.5' U.S.G.S. maps and UTM coordinates, to the nearest .1 km, were recorded.

We investigated mortality signals by locating collars to determine if fawns had died or not. Evidence of cause of death was determined by locating carcasses, searching the area for physical sign or evidence of predators, or having carcasses necropsied at University of Arizona's Veterinary Diagnostic Laboratory.

Home ranges were calculated by importing data into program HOME RANGE (Ackerman et al. 1990). Because of small sample numbers of relocations, we selected the minimum convex polygon method. Home ranges and core areas were calculated for the first six month period, whereas use areas were also determined for the first four successive 21-day periods (1-20, 21-41, 42-62, 63-83 days). Differences in mean use area size by time period was determined by Kruskal-Wallis ANOVA (Zar 1974).

Fences and waters were mapped and digitized into a Geographical Information System (GIS) database. Fawn relocations were plotted against fence and water overlays for visual inspection of home ranges for each fawn. Distance to nearest water was calculated by GIS for each relocation. Changes in distances by age of fawn was tested by ANOVA (Zar 1974). Observed significance level, or alpha, was set at 0.10.

RESULTS

Eleven neonate pronghorn fawns were captured during May-June 1991 (Table 1). Four fawns were female and seven were males. Radio-transmitter

collars were stretched over their heads and animals released within minutes of capture.

Table 1. Capture and mortality data for pronghorn fawns in central Arizona during 1991.

Animal ID	Sex	Capture date	Mortality date	Mortality cause
37	M	5/3/91	5/15/91	Unknown
38	M	5/3/91	5/5/91	Abandonment
39	F	5/3/91	5/5/91	Coyote
40	F	5/9/91	3/19/92	Slipped
41	M	5/14/91	3/3/92	Slipped
42	F	5/14/91	10/21/91	Radio fail
43	M	5/14/91	5/24/91	Trauma
44	M	5/15/91	10/7/91	Slipped
45	M	5/18/91	5/30/91	Unknown
46	F	6/10/91	5/18/92	Slipped
47	M	6/14/91	9/3/91	Slipped

Mortality

Five of 11 fawns died within 14 days of birth (Table 1). The remaining 6 fawns survived past 6 months of life. Two fawns died within 48 hours of capture. On May 5, 1991 fawn 38 was found dead and female abandonment was suggested. This mortality may have been capture related. The fawn looked thin and coat quality was judged to be poor. Necropsy findings concluded abandonment as stomach and small intestiness were empty of milk and no lesions were found. On May 5, 1991, we found fawn 39 buried in a drainage bank near the birth site. Possible coyote tracks were found in the drainage bottom. The neonate's skull was crushed and body cut in half, with the entire front half buried into a soft dirt bank.

On May 16, 1991 fawn 37 was found dead within 80 m of houses on the west end of Fain. Evidence of death was uncertain, however possible teeth marks were found on the throat and the carcass had been dragged 5-6 m. We observed some consumption by ravens (*Corvus corax*) on the carcass hind quarter.

Fawn 43 was found on May 24, 1991 and the carcass suggested the fawn had been in good body condition. No tooth marks or drag marks were found and the carcass had not been fed upon. Field evidence suggested the possibility that cattle may have stepped on the neonate. Necropsy evidence showed that the fawn had been nursing, but had been interrupted by sudden trauma to the skull. The fracture was caused by a "sharp blow from a rather pointed object"

and cause of death was determined as focal trauma to the brain due to a sharp blow to the head. Cattle may have been the cause, but an adult pronghorn was more likely.

On May 30,1991 a mortality signal for fawn 45 was investigated and only the collar was located. No animal remains were found, nor did we find any predator tracks or drag marks. The collar had been chewed on and had blood marks. Cause of death was determined to be unkown, with a predator the likely cause.

Home Range

We calculated home ranges and core areas for 6 fawns in which sufficient relocations were taken over a 6 month period (Table 2). Minimum convex polygon home range size averaged 15.1 square km (SD = 7.0, n = 6). We determined core area size to be approximately one-half home range size, averaging only 7.7 square km (SD = 3.2, n = 4) for the same time period. Two fawns (#42 and #47) did not establish a core area as determined by HOME RANGE. Core areas accounted for an average of 30.7% of estimated 100% harmonic mean home range size.

Mean use area size by 21-day periods (Fig. 1) differed significantly (x squared = 7.543, P = 0.057). Average size for the first 21 days of life was 1.06 square km (SD = 0.96). Size of use area increased with each 21 day period.

Distance to an identified water source averaged 0.93 km (SD = 0.39, n = 328) for the 6 month study period. No significant (F = 1.207m 1,20 df, P = 0.243) difference in mean distance to water by age in weeks was found (Fig. 2). However, mean distance for the first 2-week period was only 0.76 km (SD = 0.28, n = 37). Minimum distance to water during the first 2-week period was 0.19 km.

Relocation plots for each fawn, particularly those with sufficient relocations, showed only a single relocation crossing a fence, with a subsequent return, for fawn 41 (Fig. 3). Shapes of home ranges appeared to be closely related to fence distribution.

DISCUSSION

Mortality

We found that attempting to capture fawns in low density pronghorn populations over a 1300+ square km area was a very time consuming task and

Table 2. Home range and core area[a] size (Km^2) of pronghorn fawns in central Arizona in 1991 for first 6 months of life.

Animal ID	Number locations	Home range[b]	Core area	Percent Core area[c]	Use of Core (%)
37	5				
38	2				
39	2				
40	59	19.9	7.4	31.5	54.6
41	58	18.8	10.3	34.8	62.4
42	56	24.2	--	--	--
43	2				
44	61	12.7	9.9	25.3	67.3
45	5				
46	49	7.9	3.3	31.3	53.3
47	36	6.9	--	--	--
		15.1	7.7	30.7	59.4

a Home range by minimum convex polygon from HOME RANGE.
b Core area calculated by program HOME RANGE.
c Percent core is of the 100% Harmonic mean contour.

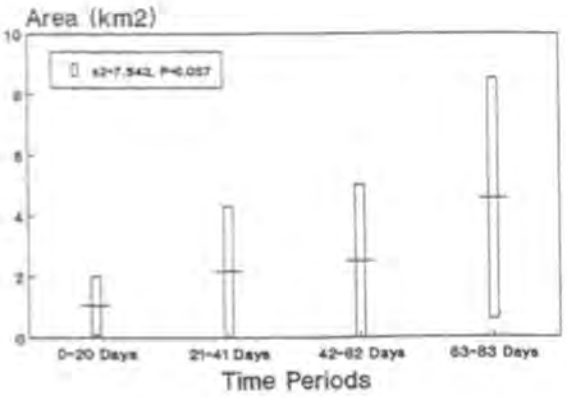

Fig. 1. Mean (± SD) use area of pronghorn fawns in central Arizona in 1991.

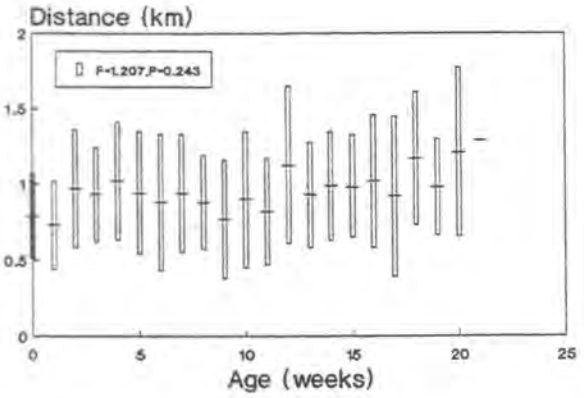

Fig. 2. Mean (± SD) distance to water source by age for pronghorn fawns in central Arizona in 1991.

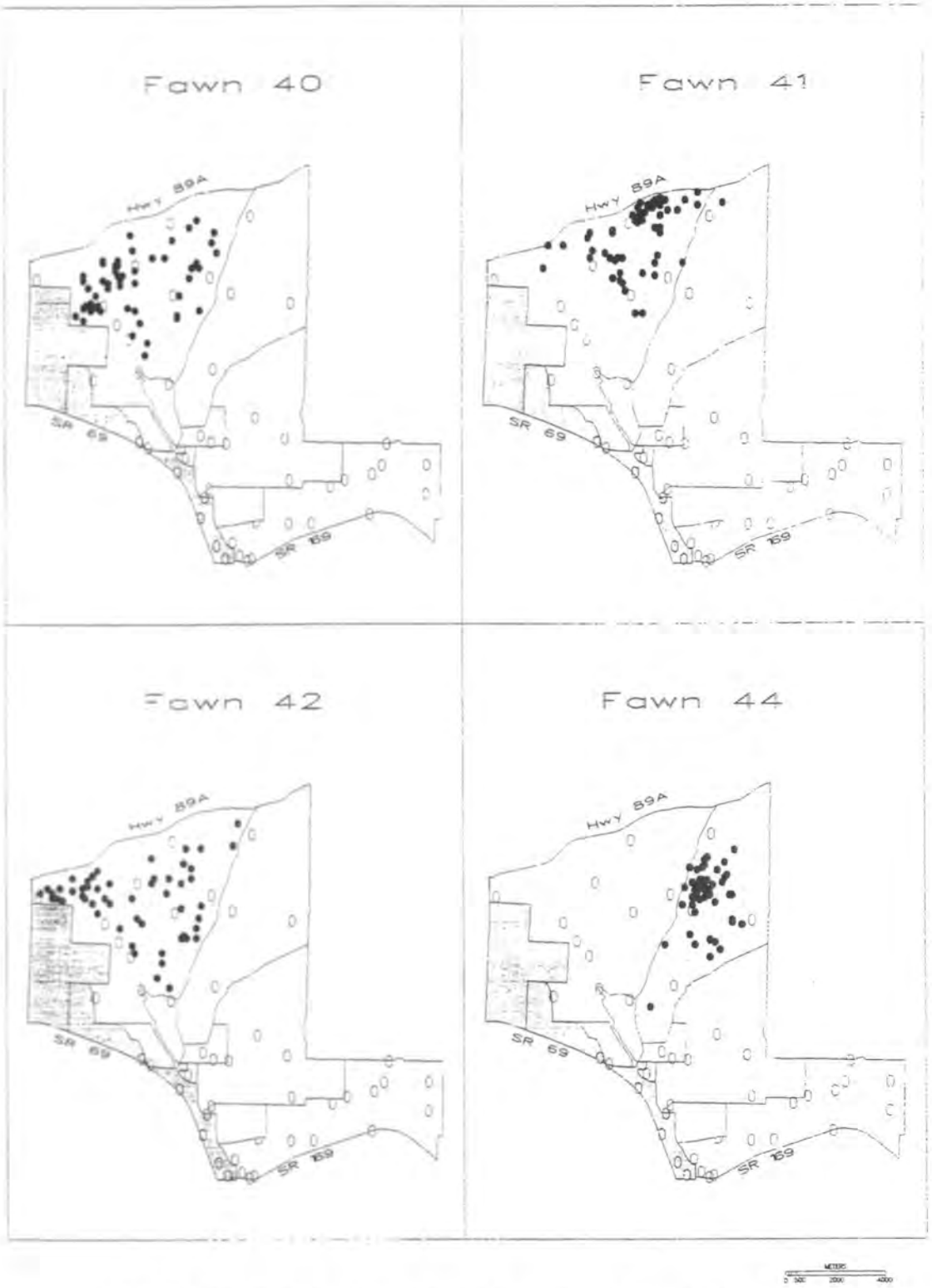

Fig. 3. Relocations of pronghorn fawns in relation to fence distribution for central Arizona in 1991. Solid lines indicate fence lines, solid circles indicate fawn locations, hollow circles indicate water sources. Shaded areas are human developments.

required more personnel than available. We therefore concentrated personnel and time into only a portion of the original study area for ongoing pronghorn studies in Arizona. When we concentrated on Fain, which contains a relatively high population of pronghorn compared to the rest of the original study area, successful capture occurred. However, this reduced activities to a single population of pronghorn in only 1 habitat type. Because of this, our estimates may be biased relative to causes of overall pronghorn fawn mortality and fawn home range size in Arizona.

Survival of fawns in Fain, a subsection of Game Management Unit 19A, as estimated by mid-summer surveys, tends to be higher than for most of Arizona (Anon. 1991, S.G. andrews, Wildlife Manager, Arizona Game and Fish, personal comm.). Mortality of collared fawns was 5 of 11 (45.5%), thus survival was 54.5% for the first 6-month period. Aerial recruitment surveys for Fain were flown July 8, 1991 and showed 67.1 fawns per 100 does. This is approximately one-half of potential production (140-180 fawns:100 does, Yoakum 1978). Our estimated survival rate, even with small sample size, was likely a reasonable estimation for Fain. Fawn survival or recruitment in Arizona, on a statewide bais, tends to be much lower, below 25 fawns:100 does for the last 3 years (Anon. 1991).

We did not document extensive coyote predation in this study, with only 1 known coyote predation and 1 highly likely predation, for 11 fawns captured. Other areas in Arizona have shown or suggested high losses due to coyotes (Arrington and Edwards 1951, Neff et al. 1985). During aerial relocation flights and ground relocations, coyotes were observed throughout Fain and numerous coyote-pronghorn interactions were observed. For example, collard buck 36, south of Fain in an area where fawning was observed from late-March through April, was seen chasing a coyote on April 4, 1991. The most compelling observation was on June 15, 1991, when the junior author and several Department audio-visual specialists observed the largest buck pronghorn leave his buck herd (of 15) and chase down a coyote that was pursuing an uncollared neonate fawn. Without the buck's intervention, they judged that the fawn would have been caught and killed.

Numerous studies have shown that intensive coyote control programs increase pronghorn fawn survival (Arrington and Edwards 1951, Udy 1953, O'Gara 1978, Hailey 1979, Neff et al. 1985, O'Gara and Malcolm 1988, Willis 1988). Annual trapping by ranch managers and federal trapping agents on Fain, as well as sport hunting for coyotes, probably reduced coyote densities on Fain and effectively reduced predation pressure on neonates. Smith et al. (1986) concluded, based on computer simulation models, that coyote control would temporarily increase pronghorn fawn survival, and over a long period of time would show economical benefits above cost of control, if done selectively in a localized area.

Much of Fain, particularly the western half where most fawns were captured, had very little hiding cover for bobcats. In Utah, Beale and Smith (1973) documented 27 of 55 fawn mortalities to be bobcat caused in an enclosure dominated with brushy drainages. Thus, bobcat predation on neonates must be considered if habitat is favorable and bobcat densities are high. Predator control to assist pronghorn populations in Arizona has been directed mainly at coyotes, without considering bobcats as an effective predator on neonate fawns (Beale and Smith 1973).

Golden eagles were commonly observed in Fain during the May-June fawning period. Several eagles were also seen around collared does, from our major study area, that had previously been judged to be pregnant, but we never found evidence of fawns after parturition. Autenrieth (1980) speculated that avian predators would be more successful when vegetative cover was low and sparse. Low ground cover that occurred over most of Fain would certainly benefit aerial predators like eagles, smal raptors, and ravens. Ground predators like coyotes and bobcats could be more efficient in low ground cover also. Ravens were observed harassing and disorienting a neonate on May 9, 1991, by flying around its face and landing on its back. However, we did not document losses due to avian predators in our small sample of captured neonates.

Neff (1986) noted that many wildlife biologists assumed hiding cover for neonate pronghorn fawns was a critical factor in regards to predation. Numerous studies have documented microsite habitat characteristics of neonate fawns (Barrett 1981, 1984; Autenrieth 1984, Smith and Beale 1980, Dorothy in prep). These studies suggest that habitat selection by fawnss plays an important part in fawn survival (Yoakum 1980, Kindschy et al. 1982). Vulnerability to predation tends to increase as vegetative cover decreases (Autenrieth 1980). Autenrieth (1980) speculated that coyotes would be more successful when cover was uneven and fawns selected clumps for bedding. Predator search images and search times would be reduced in such a situation. Poor range condition, particularly on marginal rangelands, with its reduced grass cover and patchy environment, has been suggested as an important factor controlling fawn survival due to predation (Udy 1953, Autenrieth 1978, 1984; Neff and Woolsey 1979, Kindschy et al. 1982).

Home Range

Barrett (1984) found that mean daily movements and use area size of fawns increased with age. Our data supports that conclusion. Size of use area for the initial 21-day period, a time of critical survival importance, was relatively small at 1 square km. Use area tended to double each additional 21-day period.

The fact that fawns use only a small area in their first 21 days suggest that management for hiding cover during fawning periods may not have to be widespread if traditional fawning areas are used. However, Autenrieth (1976) and Barrett (1981) found that traditional sites did not exist as some land managers assume. Observations at Fain suggests that some does do group together in limited "fawning areas," but not all does do. If selected areas cannot be managed specifically for pronghorn fawns because fawning is not restricted to "traditional areas," then widespread habitat management is necessary. Additional research regarding "traditional fawning areas" is necessary before critical management decisions can be made.

If fawn survival is as critical as suggested, then management activities must consider information on neonate fawn home ranges. Home range sizes for adult pronghorn are better documented than for fawns, being typically large, ranging up to 8-16 km in diameter (Yoakum 1978). Amstrup (1978) found adult mean seasonal activity areas to be as large as 39.9 km^2, and Wiltse (1978) documented adult minimum use areas as large as 177 square km^2. One would expect home ranges for neonate fawns to be considerably smaller in the first days of life, even less than that of adult pronghorn females. How much smaller is open to debate. Our data and observations indicate an initially small use area is needed for neonates, however, area rapidly increases to match that of does. As with mortality, the first 2-3 weeks of life seems to be the critical period for pronghorn fawns.

It appears from our data and general observations that water is an important, if not critical, factor in determining fawn bedsites for at least the first 2-week period. Most relocations were between .48 and 1.04 km from water. After the first 2-weeks, does are starting to move fawns around with them. After that first critical period of life, distance to water stayed, on the average, near 1 km (Fig. 2). Barrett (1981) had previously found that fawn sites in Alberta averaged .59 km from water in 1 study area, however, he later found no relationship with distance to water in another (Barrett 1984). We found no significant relationship over the 6-months, as fawns aged week by week. It is conceivable that water distribution is very critical for only the first 2-weeks of life, but for a mobile animal like a pronghorn, the effect rapidly loses importance to either doe or fawn.

Minimum distance to water may be as important as maximum distance is for fawn survival. Maximum distance is probably related to water balance in nursing does. Minimum distance may be a function of predation. Predators would not be able to key around water sources as efficiently if does maintain fawns a reasonable distance from water. Moving away from water rapidly increases search area for predators, as area increases as a function of distance from a center point. Does may be optimizing fawn survival behaviorally (Byers and Byers 1983) by remaining in a distance zone from water that looks at both nursing and predation interactively.

Fences have been found to be detrimental to pronghorn populations (Hailey 1979), and this may be particularly important to fawns. Lack of fence crossings by collared fawns in our study may only indicate that pastures in Fain are large enough to establish home ranges for adults, thus home ranges for fawns. Conversely, lack of movements into new areas may be due to pronghorn unwillingness to cross fences. It appears, at least in Fain, that fences partially determined home range size and boundaries for collared fawns. Unfortunately, we did not capture neonates in pastures smaller that average home range size. Captures in such pasture would have provided better data to base conclusions upon.

Fences are also potential injury or mortality sources. For example, fawns have run into 4-stand barbed-wire fences and have been seriously injured near Williams, Arizona, after being spooked by vehicles (D. Gaska, Wildlife Manager, Arizona Game and Fish Department, personal comm.).

MANAGEMENT IMPLICATIONS

With the possible exception of overall habitat loss, fawn survival is likely the most important management issue for pronghorn in Arizona. Therefore, it is critical that as much information as possible be gained regarding pronghorn fawn mortality and home range characteristics. However, it must be recognized that fawn survival can not be interpreted independently from adult mortality to fully understand its significance in population dynamics.

Literature review strongly suggests that predation is the most important mortality factor over time. Coyotes, bobcats, and golden eagles are 3 significant predators on neonate fawns. The fact that coyotes may not be the only significant predator on neonate fawns should be considered in management activities to increase fawn survival. In fact, this may be why coyote control does not always relate to increased fawn survival in localized areas. Information on coyote, bobcat, and golden eagle population densities could be used to determine appropriate management actions for predator control, by species, just prior to fawn drop.

Range management of pronghorn habitat for increased fawn survival should concentrate on areas near accessible water. Habitats within 1 km of water appear to be key fawn bedsite areas for neonate fawns. The first two to three week period is when fawn mortality, thus survival, is most critical. Increased residual or annual vegetative growth near waters should reduce aerial predation, and likely ground predation from coyotes and bobcats. Deferred grazing until fawn drop is completed would increase residual cover. GIS analysis should be used to determine how much and what areas are within 1 km of available water. For example, 56.7% of Fain was within 1 km of water, thus,

43.3% of Fain was likely less effective as fawning areas. Additional waters can then be constructed.

Additional information is needed to determine if fence distribution affects establishment of home ranges of pronghorn fawns. Areas with numerous fences may be avoided by prepartuition does, therefore reducing area available for fawning. Minimizing fencing in pronghorn habitat would allow establishment of home ranges by water, food, and cover resources, rather than by man-made obstructions. If fences are necessary for proper range management, fence structure modificaitons should be considered to allow free movement of pronghorn between pastures. Water availability, as well as predator hiding cover, should be considered in the location of new fences.

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IMPROVED SURVIVAL OF PRONGHORN FAWNS WITH COYOTE CONTROL

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Abstract: Fawn:doe ratios in most Nebraska populations of pronghorn antelope (*Antilocapra americana*) have been low in recent years. In the Box Butte Unit in Nebraska's westcentral Panhandle fawns ranged from 21 to 39:100 does from 1975 through 1989, with the exception of 66:100 in 1988. An aerial coyote (*Caniss latrans*) control program was conducted from 14-17 May and 30 May-2 June 1990 and from 1-4 April and 20-23 May in 1992. We killed 112 coyotes on about 440 square km in 1990 and 88 coyotes on about 390 square km in 1991. Sixty-eight percent of the female coyotes killed in 1990 were lactating and presumably had dependent young whereas only 10% were lactating in 1991 and 43% were pregnant. The April control removed females prior to parturition and did not result in any apparent immigration of coyotes prior to antelope fawning. Aerial surveys of pronghorn in 1990 showed significantly better fawn ratios on the coyote kill area on 19, 23 July (70:100) than on the adjoining non-kill area 10-18 July (44:100), and also in August (62:100 vs. 25:100). Results in 1991 also showed significantly better ratios on the kill area in both July (76:100 vs. 42:100) and August (58:100 vs. 35:100).

Pronghorn numbers have declined in Nebraska in recent years, at least partially as a result of poor production. Estimates from aerial surveys in the primary range showed 7,000 to 8,000 antelope in the mid-1970's, and from 2,400 to 3,000 in the late-1980's.

Concern for low antelope populations led to development of a management plan along with area meetings to allow for public input. Primary options identified were reduction of hunting, translocation of antelope from other states, and investigating coyote control as a means of increasing fawn survival.

Studies in Arizona (Smith et al. 11986), Montana (O'Gara and Malcolm 1988), Oregon (Willis 1988), and Texas (Hailey 1979) showed that reduction of coyotes in areas with consistently low fawn production resulted in major increases in fawn:doe ratios. In order to be effective, control should be exerted shortly prior to fawning season (Smith et al. 1986, Willis 1988).

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STUDY AREA

The Box Butte Management Unit is located in the central portion of Nebraska's Panhandle. An area of about 3,200 square km, including parts of Box Butte, Dawes, Morrill, Scotts Bluff, and Sioux counties, has been surveyed annually since 1955. This area held an average of 3,200 pronghorns in 1973 and 1974 and only 560 in 1988 and 1989. Fawn:doe ratios exceeded 60:100 in 11 of 18 years prior to 1972 but were greater than 40:100 only once since 1974.

Within the survey area, highest densities of antelope normally occur in central Sioux County. This area is primarily shortgrass prairie with limited farming. Topography varies from flat to moderately rough and elevation ranges from about 1280 to 1460 m. Precipitation at Agate 3E averages 37.4 cm with 80% of this between April and September.

Selection of a study area was based on relatively high antelope densities and on landowner acceptance of coyote control. Agreements with landowners covered 440 square km in an area with maximum external boundaries of 42 km east to west by 28 km north to south. Agate Fossil Beds National Monument is 29 km south and 10 east of Harrison NE and is near the center of the study area. All land is privately owned except the 1,215 ha Monument.

METHODS

Cooperative agreements with landowners allowed access to their property for the purpose of killing coyotes. In 1990 we obtained agreements covering about 440 square km. Eight persons withdrew from the contract in 1991 leaving about 390 square km.

The Nebraska Game and Parks commission (NG&PC) contracted with Animal Damage Control (ADC), Animal and Plant Health Inspection Service, U.S. Department of Agriculture, for aerial control work. Their contract pilot used a Super Cub with modification for aerial gunning which included grouped wing tips; larger than normal motor, propeller, and wheels; and a window which opened on the left.

Since Sioux county has a contract with ADC, NG&PC was charged only for flight time ($70.00 per hour), per diem for the gunner and ground crew, and for supplies, which included shotgun shells, denning cartridges, and flagging markers. Total contract charges were $7,053.61 in 1990 and $7,064.54 in 1991.

Control operations were conducted from 14-17 May and 30 May-2 June

1990 and from 1-4 April and 20-23 May 1991. One or two ground crews worked the area while the plane was in the air to provide safety backup if necessary, to assist in moving coyotes with vehicles or by howling or with predator calls, and to examine dispatched coyotes where practical. Ground crews also attempted to locate dens of lactating females in 1990.

Effectiveness of coyote control was evaluated on the basis of pronghorn fawn:doe observations on a 570 square km kill area which was "generalized" because of the patchwork nature of land under cooperative agreement. These observations were compared to those from the remainder of the Box Butte survey area from aerial inventories made in July and August.

RESULTS

Coyote Kill

We killed 112 coyotes in 1990, with 108 taken during 60 hours of aerial hunting (1.8 per hour) and 4 taken by ground hunters using predator calls. In 1991 we took 86 coyotes in 58 hours of aerial hunting (1.5 per hour) and 2 from the ground (Table 1). Success was related to weather - high winds caused difficulty in low level flying and overcast skies made it harder to observe coyotes. Weather was especially inclement on 30 May and 1 June 1990 and on 22 May 1991. Fewer coyotes were taken during the second kill period each year than during the first, although at least part of this was weather related. The second highest kill rate was 2.5 per hour on 31 May 1990, which was during the second period for that year.

Table 1. Coyote hunting effort and kill in 1990 and 1991.

Date	Hours	Plane	Ground	from plane	Male	Wet*	Dry
14 May 1990	8	23	0	2.9	7	1	2
15 May	8	13	0	1.6	3	3	2
16 May	8	15	0	1.9	3	0	1
17 May	7	14	3	2.0	2	0	0
Total	**31**	**65**	**3**	**2.1**	**15**	**4**	**5**
30 May	6	4	1	0.7	0	2	0
31 May	8	20	0	2.5	7	3	1
1 June	8	7	0	0.9	2	4	0
21 June	7	12	0	1.7	1	2	1
Total	**29**	**43**	**1**	**1.5**	**10**	**11**	**2**
1 Apr. 1991	8	16	1	2.0	9	5	3
2 Apr.	8	14	0	1.7	7	6	1
3 Apr.	8	12	0	1.5	6	4	2
4 Apr.	6	10	0	1.7	4	3	3
Total	**30**	**52**	**1**	**1.7**	**26**	**18**	**9**

20 May	8	9	0	1.1	5	0	4
21 May	8	14	1	1.7	9	1	5
22 May	4	2	0	0.5	1	1	0
23 May	8	9	0	1.1	5	2	2
Total	**28**	**34**	**1**	**1.2**	**20**	**4**	**11**

* Females shown as wet were lactating (1990 and May 1991) or pregnant (April 1991).

Kill rate was lower in 1991 than in 1990, suggesting that coyote densities were lower. Flying weather was better in 1991, so the proportionate kill of coyotes was probably greater than the preceding year. Overall kill rate of 1.6 per hour was similar to the 1.9 per hour reported by Smith et al. (1986) for Anderson Mesa in Arizona. Our assigned contract cost of $72.77 per coyote killed was lower than their average of $259.25 for helicopter gunning but we did not include salaries.

Forty-seven of the 112 coyotes killed in 1990 were examined. Sex ratios were not different between periods ($P > 0.10$) but the proportion of lactating females was higher ($P < 0.025$) the second period (57%) than the first (17%). Direct projections indicate that from 31 to 35 lactating females were killed in this operation. We located only 2 dens in association with lactating females and 1 other den on random search. Gas cartridges were used on these dens.

Inability to locate dens caused a problem - either the pups survived and contributed to a higher coyote population or else they starved. We therefore changed the dates for treatment in 1991, with the first period (1-4 April) intended to precede whelping.

Fifty-three coyotes were taken and all were examined. Eighteen of 27 females were pregnant and none had borne young. Embryo ages were estimated utilizing a growth curve developed by the Denver Wildlife Research Center. Indicated birth dates were 19-25 April for 9 litters and 30 April - 6 May for 9 litters.

The second control period in 1991 was advanced about 1 week from 1990 because we observed 2 coyotes with freshly killed antelope fawns (one with doe nearby) on 2 June 1990. Thirty-five coyotes were killed and examined, of which only 4 were lactating.

The second period contributed 39% of the kill in 1990 and 40% in 1991. If there had been significant immigration of coyotes in 1991, with about 7 weeks between control periods vs. 2 weeks in 1990, the proportion of kill in the second period should have been greater in 1991. However, if the proportion of population killed was greater in the first period in 1991 than in 1990 then a limited amount of immigration could have gone undetected.

We obtained information on parturition rate and litter size for 64 females (Table 2). Pregnant/lactating females averaged 4.6 embryos/placental scars in 1990 and 5.1 in 1991. No age data were gathered, so age-specific reproduction rates are not available.

Table 2. Frequency of placental scars or embryos in 1990 and 1991 from Sioux County coyote control area.

	Number of embryos or placental scars											
Year	0	1	2	3	4	5	6	7	8	9	Av.	S
1990	7	0	0	3	3	6	3	0	0	0	3.1	2.4
1991	20	1	1	1	6	4	5	1	2	1	2.7	2.9

Pronghorn Surveys

T- tests of aerial antelope survey data from 1985 to 1989 showed no differences in antelope fawn:doe ratios within years or in total between the area selected for treatment and the remainder of the Box Butte Unit (Table 3). Data were sufficient for individual year analysis only in 1985 and 1987, but it appears that the area selected for control did not have better fawn production/ survival prior to the time of coyote control.

Table 3. Antelope does and fawns observed inside and outside area which involved coyote kill in 1990 and 1991.

	1990-1991	Pronghorn Observed		
Year/dates	Kill area	Does	Fawns	Fawns/100 does
1985	Yes	14	6	43
	No	54	15	28
1986	Yes	4	5	125
	No	35	12	34
1987	Yes	19	8	42
	No	16	5	31
1988	Yes	7	2	29
	No	37	27	73
1989	Yes	4	2	50
	No	62	21	34
1990				
10-18 Jul	Yes	12	5	42
10-18 Jul	No	18	8	44
19, 23 Jul	Yes	33	23	70
6, 7 Aug	Yes	40	25	62
10-13 Aug	No	48	12	25
1991				
9-13 Jul	Yes	21	16	76
9-13 Jul	No	43	17	42
13-15 Aug	Yes	31	18	58
13-15 Aug	No	57	20	35

Fawn:doe ratios were better on the coyote kill area on 19, 23 July 1990 (70:100) than on the non-kill area 10-18 July (44:100, P = 0.001), and also in August (62:100 vs. 25:100, P = 0.0001). Similarly, in 1991 higher fawn rates were found on the kill area in both July (76:100 vs. 42:100, P = 0.032) and (August 58:100 vs. 35:100, P = 0.003).

DISCUSSION

No attempt was made to measure numbers of coyotes or alternate prey species. Seasonal movements of pronghorn are sufficient to make it impractical to ascribe a change in numbers (if any) to this program.

Although a positive cause and effect relationship was not established, it appears that control of coyotes prior to fawning season has a beneficial effect on survival of pronghorn fawns. Based upon pronghorn age composition and normal embryos:doe the potential fawn:doe ration is about 160:100. The 1990 August ratio of 25:100 off the kill area represents a "loss" of 84% of the fawns, and 62:100 would be a loss of 61% (Vriend and Barrett 1978). Similarly, the 1991 ratios indicate losses of about 78% and 64% respectively. These data suggest fawn survival improved by about 140% in 1990 and 65% in 1991 on the area where coyotes were killed.

Because of the patchwork nature of the area under cooperative agreement it was necessary to designate about 570 square km as the coyote kill area instead of the 440 and 390 km^2areas actually hunted. Therefore, indicated beneficial effects are probably minimal. Furthermore, benefits probably extended outside of the kill area.

This program would have continued in 1992 but several landowners declined because of concern for: lower coyote numbers, increased rodent populations, and possible problems to crops from increases in pronghorn numbers. The coyote kill area would have been reduced to about 260 square km, with a large part removed from the central portion. We will conduct aerial survey in 1992 and will compare fawn:doe ratios from kill and non-kill areas to check for effect from prior coyote removal.

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LESSONS LEARNED FROM AN INTERTRIBAL, INTERREGIONAL PRONGHORN ANTELOPE REINTRODUCTION

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HISTORICAL BACKGROUND

The San Carlos Wildlife Management Program is about 3 1/2 years old today. It functions within the tribal Recreation & Wildlife Department. One of the first priorities of the Program was getting a herd of pronghorn antelope (*Antilocapra americana*) reestablished in a place called "Ash Flats".

First we had to locate some pronghorn. (In this report the word "we" refers to the San Carlos Wildlife Management Program, at times in consultation with the U.S. Fish & Wildlife Service.) There is a herd in a different area of the reservation, but it only numbers about 100 head. As Scott (1990) illustrated, the minimum number of pronghorn for a genetically viable population can be a dubious figure that is complex to derive, but splitting 100 head almost certainly would have genetically shortchanged one group or the other. During the winter of 1989/1990, we contacted every major pronghorn state in the west, but they all had at least two-year waiting lists. We also feared that some of their expendable herds might be characterized by low buck:doe ratios and young animals, such as hunted bucks explored by Fichter and Autenrieth (1978).

Finally we became acquainted with the Fort Belknap tribes (Assiniboine and Gros Ventre) of northern Montana. They happened to have about 4,000 head of pronghorn. They also had working with them the Fish & Wildlife Ser-

vice Technical Assistance Office from Bozeman. The Fish & Wildlife Service personnel from Bozeman handled most of the logistics of the trapping operation.

COMPARATIVE ECOLOGY OF THE TWO RESERVATIONS

SAN CARLOS APACHE RESERVATION

The San Carlos Apache Reservation consists of 1.8 million acres in eastern Arizona. Although most of the reservation is mountainous, there are large plains at various elevations. The mid and high elevation plains are mostly grasslands. Ash Flats consists of nearly 200 square miles of plains grassland as described by Brown (1982) in the middle of the reservation, and is separated from the only other pronghorn herd by a major escarpment called the Nantac Rim (Figure 1).

Fort Belknap Reservation consists of about half a million acres in north/central Montana. Most of the reservation is northern shortgrass prairie and is classic buffalo/pronghorn country. The Fort Belknap herds have excellent social structure. As early as 1942, "big game workers (were) well agreed that the most satisfactory results are obtained in restocking projects when adults and younger age classes are introduced together" (Nichol, 1942). In deciding whether of not to obtain our pronghorn from Fort Belknap, the high buck:doe ratios and the age distribution of the Belknap herds outweighed the great transportation distance involved.

METHODS OF REINTRODUCTION

Most of the operation took place in January of 1991 and January of 1992. Their were four main phases during both years; trapping, loading, transporting, and releasing.

TRAPPING

The Fish and Wildlife Service was the lead agency in building the trap, with help from the San Carlos Wildlife Management Program and several of the Montana tribes including Assiniboine and Gros Ventres from Fort Belknap, and Flatheads and Blackfeet from western Montana.

The trap consisted of wing fences, a runway, and a corral at the end (figure 2). A helicopter was used to move the animals into the wings and into the corral. It helped to find an area where the running herd couldn't identify

the corral until the last moment (e.g. by placing the trap at the base of a sudden descent).

In 1991 the entire corral was made out of net walls, whereas in 1992 a series of canvas panels were used. The advantage to having canvas was the calming effect since the animals couldn't see the humans outside of the corral. Another advantage was that gatekeepers hid behind the panels as the animals come in so the trap was closed off quicker.

The advantage to an entire net arrangement was that the corral didn't catch the wind, and the animals had less to be wary of while they ran toward the corral. Overall we found arrangement superior to canvas panels. One could place canvas over the corral after the pronghorn are trapped to gain the benefit of the calming effect.

In 1991 the wings were constructed of woven wire. In 1992 we tried using jute, which we thought would be cheaper and easier to work with. In retrospect woven wire was the easier material to work with, and the jute seemed to deter the animals from entering the trap wings. This may have been due to the strong odor of the jute. We weren't able to capture a sizable herd until we replaced the jute with woven wire.

LOADING

The idea in loading pronghorn is to create an area in the corral where you can catch individual animals to carry to the trailer. You can't drive them through a loading chute.

The best way to catch the animals is to create three within the corral; the holding area where most of the herd stays, the culling area into which 5-8 animals are separated from the herd, and a tiny catching chute where most of the grabbing should occur. This is how we caught a the animals in 1991 (Figure 3).

In 1992 we didn't have enough construction material to do this, and we settled for creating two areas within the corral, a holding area and a catching area, with no separate catching chute. This was harder on the animals and more dangerous to the people. It gave the animals too much room to run around amongst the people. More animals and people received minor injuries in 1992.

In 1992 we also tried using temporary blindfolds, taking them off as the animals were put into the trailer. They didn't immobilize the animals, but they did help somewhat.

TRANSPORTING

In 1991 we transported the animals with a semi-tractor and double drop-deck trailer. The trailer had three large compartments: a middle belly compartment and two raised compartments to front and rear. It was dark inside, well ventilated, and it had airbag suspension. It worked well, but it cost $4,000 to contract.

In 1992 we used two pickup trucks and trailers. One was a four-horse trailer supplied by the Fish & Wildlife Service, and the other was a trailer built by the Arizona Game & Fish Department for hauling bighorn sheep.

The 1,650 mile drive from Fort Belknap to San Carlos can be made in about 33 hours, so we could have captured the animals early enough in the day to release them at San Carlos the next evening before dark. However, San Carlos has some of the highest densities of lions and coyotes in the country, so we didn't want to release them in the dark, in unfamiliar country and in a weakened condition. We stretched out the drive so that we would arrive in Ash Flats around sunrise, two days after leaving Fort Belknap.

RELEASING THE ANIMALS

During both releases, we had a big crowd of visitors including the tribal chairman and Recreation & Wildlife Commissioners. An important part of the release was keeping the observers at a distance and in a strategic location to allow a good route of dispersal by the animals.

It was very easy to release the animals from the semi trailer in 1991 and from the horse trailer in 1992. It was a little harder to release them from the bighorn trailer in 1992, because it got stuck (due to 4-wheel drive unit malfunction) in a bad position relative to where the crowd had gathered, and also because it's a double decker and many of the animals were reluctant to jump from the top shelf. Many of these animals, both from the upper and lower deck, had to be physically extracted from the trailer. The ones that did jump from the upper deck didn't seem to be hurt by the jump, however.

RESULTS

In 1991, we trapped about 150 head in two bunches. Four animals died during trapping and loading. Twenty animals (does and bucks) were collared with visual collars and four does with radio collars. We loaded 76 head into the semi trailer and four more died on the journey.

In 1992, we trapped about 120 head, also in two bunches. Four died again during trapping and loading. We radio-collared four does again, but no visual collars. We loaded a total of 68 animals, and we lost 17 in transport, including three of the radio-collared animals.

DISCUSSION

These seemed to be the most important reasons for the high mortality in 1992, in order of importance:

1) No resting period between trapping and loading - We thought we would combine all of the adrenalin rush into one major event, and that this would be easier on the animals. In retrospect, it seemed to be easier on the animals to break the trauma into two lesser events (trapping and loading) as we did in 1991. When the animals are loaded immediately after trapping, they are still physiologically "hot" from the morning's feed and from the exercise of trapping.

2) Too much visibility from the bighorn sheep trailer - the bighorn sheep trailer allowed the animals to see activity outside the trailer, and enough light came through to see clearly on the inside as well. This led to more nervous movements inside the trailer, causing direct injury and more stress. This should have been remedied with canvas early in the trip, but we were lulled into a false sense of security, since the trailer was specially designed for hauling big game animals.

3) Warm weather in the Phoenix valley - an overnight rest was taken in Phoenix by the drivers with the bighorn trailer. They took the Phoenix route to avoid the Salt River Canyon of eastern Arizona, but they were too fatigued to pass through the valley into cooler weather to the east.

4) Attachment of radio collars before loading instead of at the release site - this factor seemed to work in combination with other factors, since it didn't seem to operate in 1991.

5) Use of light elk-size radio collars instead of normal - size pronghorn collars - this may have been one of the major factors that operated in combination with #4.

6) Less gentle suspension of the trailers - it appeared that a high percentage of the mortality occurred during the last few hundred miles of the 1,650 mile journey. This could be seen as evidence that the spring-steel suspension of 1992 took a greater toll on the stamina of the animals than the airbag suspension of 1991.

7) Places in the bighorn sheep trailer for feet to get stuck - at least one animal was extracted from the bighorn trailer that had gotten a hind foot wedged into a space between a panel and the floor. This could be considered a direct source of mortality.

8) Not separating bucks from does in small compartments - there was a lot of horning activity by bucks in both 1991 and 1992. In 1991, the horned animal could move around enough in one of the three large compartments to evade the aggressor. In 1992, with the smaller compartments of both trailers, the horned animal did not have enough room to escape. The amount of horning may have been reduced by separating bucks from does, as the presence of does probably triggered territorial, aggressive instincts by the bucks.

CONCLUSION

Although there was too much mortality during the 1992 transport to be acceptable, the overall operation should be considered a great success, because:

1) It helped the species by reestablishing a herd on range from which pronghorn had been extirpated.

2) It was, both in 1991 and 1992, perhaps the longest standard type of pronghorn relocation ever conducted.

3) It was a first in intertribal big game exchange, setting a good precedent for many other tribes.

4) It was a first in tribal cooperation with state and federal wildlife agencies from different regions, setting another good precedent.

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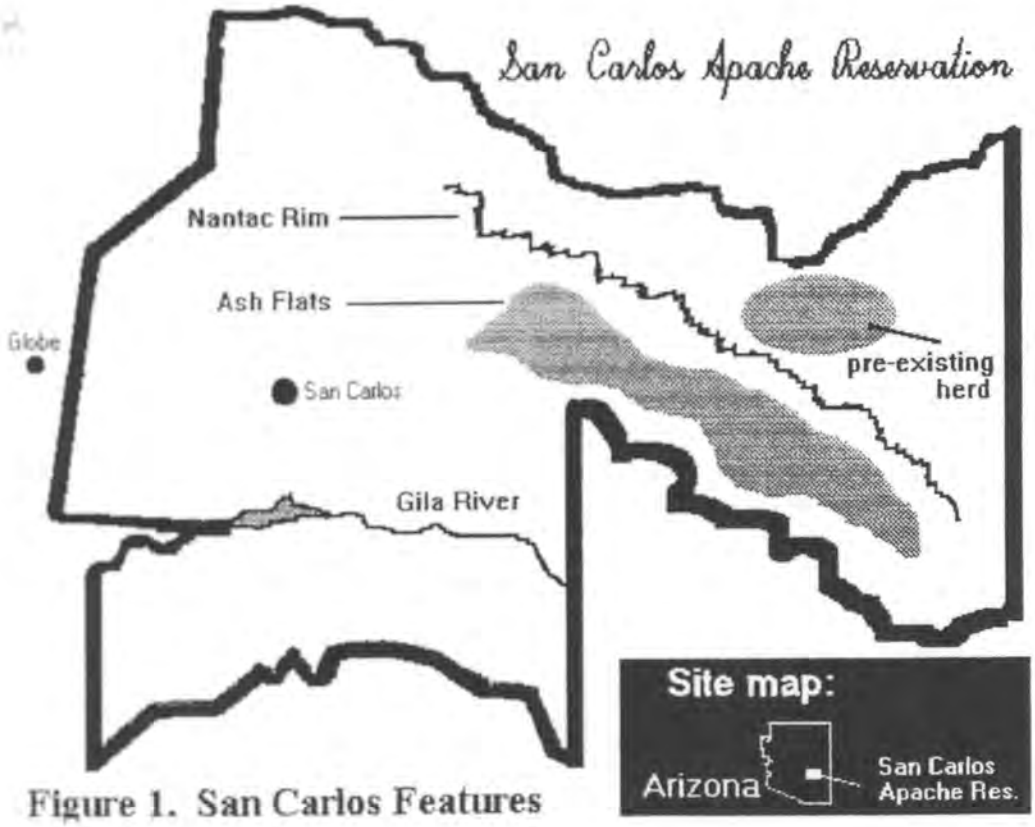

Figure 1. San Carlos Features

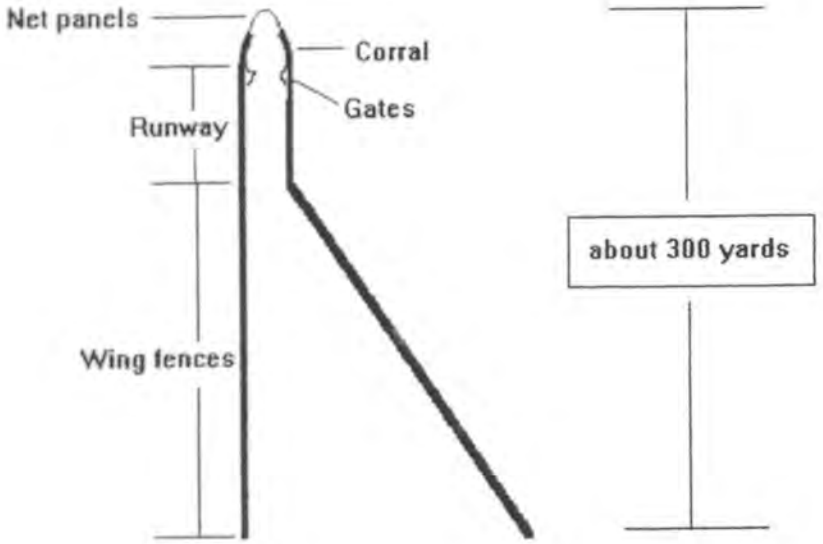

Figure 2. Trap Configuration.

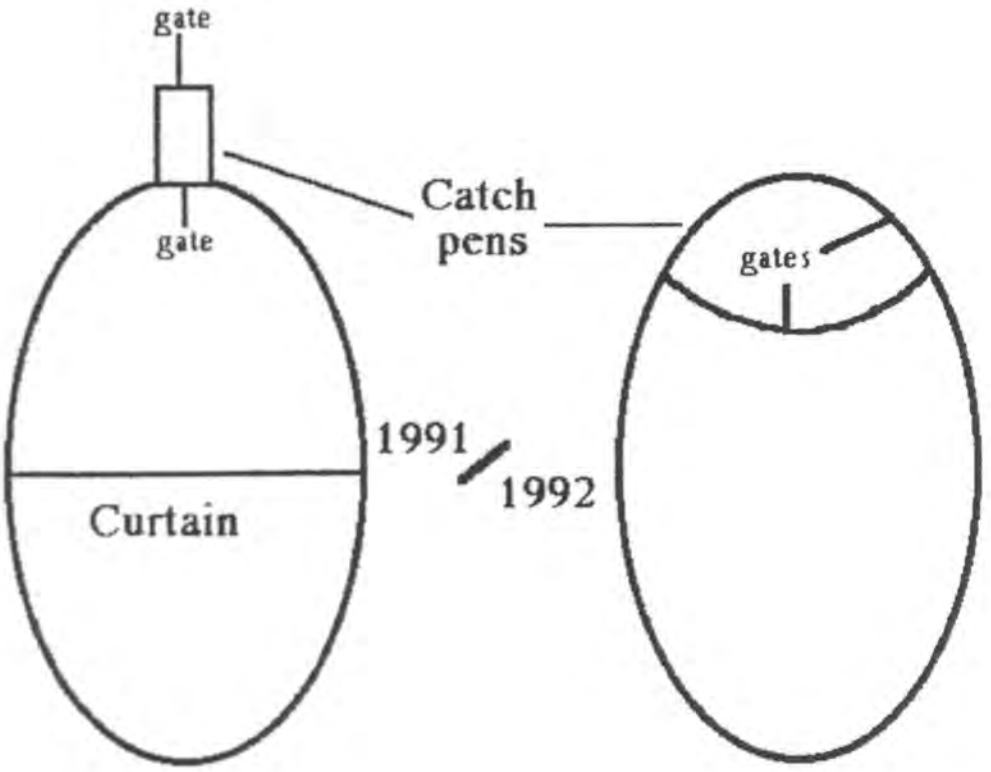

Figure 3. Corral Designs, 1991 and 1992.

RECOVERY EFFORTS FOR ENDANGERED SONORAN PRONGHORN

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Abstract: Cabeza Prieta National Wildlife Refuge has lead responsibility for recovery of Sonoran pronghorn. In 1982 a Recovery Plan was completed to implement recovery efforts for this species. The estimate for the U.S. population is about 80-120 pronghorn. In 1991, 34 Sonoran pronghorn were sighted in Sonora, Mexico. In May 1991, a Core Working Group was formed with six agencies to coordinate the recovery efforts for Sonoran pronghorn and to review the Recovery Plan. The Group's primary goal is obtaining an updated, revised population estimate for the pronghorn. The Group along with other agency expertise is planning a bi-national test survey to determine what type of survey will produce an updated population estimate.

INTRODUCTION

Sonoran pronghorn (*Antilocapra americana sonoriensis*) are one of the five subspecies which inhabit North America and are found in southwest Arizona and Sonora, Mexico. The subspecies was first described by Goldman (1945) as having smaller skull characteristics and a paler pelage. The historic distribution of the Sonoran pronghorn is not certain. U.S. Fish & Wildlife Service listed the Sonoran pronghorn as endangered in 1967. Recovery efforts officially began in 1975 with the first meeting of the Sonoran Antelope Recovery Team. After writing the 1982 Sonoran Pronghorn Recovery Plan, the Team disbanded in 1988. Lead responsibility for advising the Regional Director of Region II on Recovery Efforts for Refuge at this time. In 1991, the Refuge established a "Core Working Group" composed of one representative from six agencies who is now continuing the recovery effort.

STUDY AREA

Sonoran pronghorn are found mostly on Cabeza Prieta National Wildlife Refuge (348,178 ha) and Organ Pipe Cactus National Monument (135,133 ha) in southwest Arizona. The Luke Air Force Base Gunnery Range which includes Cabeza Prieta established in 1941 was later changed to Barry M. Goldwater Air Force Range. Scattered sightings are recorded from areas north of Cabeza on the Barry M. Goldwater Air Force Range. More information is presently being collected by Arizona Game & Fish and El Centro Ecologico de Sonora on areas used by Sonoran pronghorn in Sonora, Mexico.

The present range of Sonoran pronghorn lies in the Lower Sonoran Desert Life Zone (Shreve and Wiggins, 1964). Two subdivisions which are in southern Arizona are the palo verde - saguaro association and the creosote - bursage association. Heat and arid conditions dominate this part of the Sonoran desert. Annual precipitation is less than 13 cm per year which falls in a bi-modal pattern in the summer and winter. This results in this habitat as being one of the driest in the southwest US. (Sellers and Hill 1974).

METHODS

In the 1970's, AGFD biologist John Carr investigated the life history of this species. Arizona Game & Fish Department in cooperation with US Fish & Wildlife Service began research on the Sonoran pronghorn in 1983. Studies including aerial flights and radio collaring continued until 1986 when a final report was written (Wright, deVos 1986). In November 1987 funds received from Luke Air Force Base, Wyoming One-Shot Antelope Foundation, and Arizona Game & Fish Department enabled the research to continue.

In 1987, AGFD captured 9 pronghorn and fitted them with radio collars. Studies evaluated movement patterns of the pronghorn to see if movements were influenced by the locations of concentrated military activities. The findings do not indicate that the presence of military activity areas is a major factor in determine the use of habitat areas by Sonoran pronghorn. Topography and vegetation types appear to be the more important factors determining movement patterns (deVos 1989).

AGFD results from blood and cultures taken in 1987 from 9 collared animals do not indicate a presence of serious disease factors in Sonoran pronghorn populations. (Recovery Team 1988 meeting notes).

From 1987 until 1990, information on Sonoran pronghorn habitat utilization was investigated by Keith Hughes with FWS Coop Unit. Objectives were to describe habitat utilization relative to distribution of water and vegetation characteristics; record life histories observations; and record reactions to human disturbance. Incidentals gathered were pronghorn reaction to military overflights, mortality and natality. The last working radio collar on Sonoran pronghorn in the US population apparently ceased transmitting in 1991.

In 1987, the Recovery team agreed that adequate data existed to meet recovery needs as outlined in the Sonoran pronghorn recovery plan. The Draft Final Report stated there were "no clear means of increasing the population except by habitat protection." (Wright, deVos 1986)

Responsibility for coordination of Sonoran pronghorn recovery efforts

was transferred to Cabeza Prieta NWR in March 1988. Also in 1988, the Marine Corps submitted a biological assessment on their Weapons Tactical Instructor training on the Barry M. Goldwater Range for spring 1988 and Ecological Services issued a "No jeopardy" opinion on these operations.

In 1988, Organ Pipe Cactus National Monument and Cabeza Prieta NWR began removing the fence on their border (since cattle and burros had been removed) to remove barriers to pronghorn passage. There have been approximately 6.8 km of fence removed by YCC crews and 4.3 km remain to be removed.

In1988, contact was made between California Fish & Game and Arizona Game and Fish Department regarding reintroducing Sonoran pronghorn in the Chuckwalla Bench along with other areas of southeast California. In 1992, California Fish & Game has become involved with Sonoran pronghorn and again expressed interest in the reintroduction discussion.

In 1991, the Core Working Group consisting of six agencies (Arizona Game & Fish, National Park Service, Bureau of Land Management, El Centro Ecologico de Sonora, Tohono O'odham Nation, Cabeza Prieta National Wildlife Refuge) was formed. These agencies form the core of the known and potential use areas for this species. Priorities for this group were determined as obtaining an updated population estimate, revisit and revise the 1982 Recovery Plan and continue recovery efforts.

AGFD is presently working with the University of Arizona in Tuscon using air-borne video linked with Geographic Information System in obtaining information on vegetation types in pronghorn known and potential habitat. Cabeza Prieta NWR had obtained aerial photo coverage of the refuge previously to assist with vegetation analysis. Beginning in 1983 vegetation plots were set on and off the refuge and coordinated with BLM.

RESULTS

The Recovery Team in 1975 agreed that priority for recovery of Sonoran pronghorn was to protect their habitat. In 1977, Organ Pipe Cactus National Monument removed 1,700 head of cattle and 80 burros from the monument. By 1988, Cabeza Prieta had removed all their cattle.

Evidence indicates Sonoran pronghorn staying within .5 km of permanent water sources (Wright, deVos 1985). In 1989, Cabeza Prieta modified their drinkers to increase access. To date, there has been only one documented photo taken of a Sonoran pronghorn with its head down at a water source. Debate still continues on whether water sources within preferred Sonoran

pronghorn habitat enhance their population. The 1982 Recovery Plan recommends determining habitat requirements before increasing water supply. Some believe Sonoran pronghorn would use free water when available. At present, all proposals for new water developments within Cabeza Prieta NWR are being evaluated before any actions are taken. The refuge is attempting to return the ecosystem of the Sonoran desert within its boundaries to its natural state.

During late summer to early spring Sonoran pronghorn show a preference for bajada foothill habitat and during late fall to winter they occupy creosote flat habitat. Results showed rutting occurring July through September with fawning occurring from January through early May. AGFD observations showed sex ratios of 55 bucks:100 does:42 fawns (Wright, deVos 1986).

It was determined from studies done before 1987 by AGFD that free interchange between US and Mexico population of Sonoran pronghorn does not occur. This is still in question. In January 1954, a doe with a broken rear leg was found entangled in the border fence (between Cabeza Prieta and Mexico) near Monument 174 which suggests that at times, they attempt to go through or over the fence (Monson, 1968). In 1990, while flying along the south central portion of Cabeza Prieta, the Refuge Manager of Cabeza reported seeing pronghorn running along the fence on the US side (Schumacher, pers.comm.). This suggests the possibility that if there were a break in the fence, these pronghorn might use it to travel south to Mexico.

From 1988 to 1989 Cabeza was involved with Luke Air Force Base regarding their proposal to establish a F-15E Beddown LANTIRN aircraft training program. An early Refuge proposal to construct an enclosure to facilitate study of overflights and Sonoran pronghorn was considered by both AGFD and FWS and was later decided against because of adverse biological effects.

The Core Working Group has held five meetings to date. The group agreed to work primarily on finding a method that will aid in finding a population estimate for the species. The first phase of a test survey was completed in April 1992. Three methods were simultaneously tried: line transect (Johnson, Lindzey, Guenzel 1991) double count (Eberhardt, Simmons 1987) and mark-recapture (Roff, 1973) while completing flights in Mexico and Arizona for one week. Flights were done at approximately 200 ft. AGL at about 80 mph. Analysis has not yet been completed. Discussion regarding the survey centered on the fact that these animals are difficult to survey due to observation difficulty and the large area they occupy. The next phase of the test survey is tentatively scheduled for December 1992.

The population number for the US is estimated to be about 80-120 animals. Arizona Game & Fish just completed a second collaring effort in Sonora,

Mexico and counted a minimum of 78 (Castillo 1992) Sonoran pronghorn. Approximately 36% of potential pronghorn habitat has been flown in Mexico (Castillo, pers.comm.) which leads to the possibility that the population estimate in Mexico might well be higher than that of the US.

DISCUSSION

The Recovery Team formed in 1975 suggested that the best option for recovery of this species was to protect their habitat. The home ranges for Sonoran pronghorn is larger than those of the other four subspecies. For females, home ranges were from 4.1 to 114.4 square km and for males ranged from 4.9 to 122.4 square km (deVos 1990). Increased development and human presence presents difficult barriers in providing protection for additional areas that are now not under federal or state protection. The 1985 AGFD Interim Report recommended habitat protection and improvement by continuing to remove domestic livestock and developing water sources. Present day management by the Fish & Wildlife Service is evaluating the presence of water developments in regards to actual needs of Sonoran pronghorn for free water.

During a ten month study period, Sonoran pronghorn were not observed drinking free water (Hughes, Smith 1990). In the dry and wet season, there was no statistical difference between mean distance from pronghorn locations to permanent water sources. Recommendations from this study are to verify Sonoran pronghorn use areas outside of military restricted areas which are not protected now and place these under protection. A census of the entire pronghorn range was mentioned which is a priority project for the Core Working Group.

The Core Working Group is presently evaluating techniques to use with Sonoran pronghorn to obtain information to demonstrate whether this subspecies is increasing, decreasing or stable. The test surveys are being completed in spring and winter to compare visibility and if this influences observations. Upon obtaining a credible population estimate or population trends of this species, steps towards recovery will be followed. AGFD and USFWS have established a working relationship with Mexico regarding recovery efforts. The Core Working Group as they update the 1982 Recovery Plan will explore the option of making the Plan an International Recovery Plan which would certainly bond the two countries in their efforts.

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REDUCTION OF STRESS BEFORE, DURING, AND AFTER CAPTURE OF PRONGHORN ANTELOPE

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Abstract: The reduction of stress-induced mortality of captured pronghorn (*Antilocapra americana*) is an implicit goal of management programs that utilize corralling techniques to conserve or enhance populations of this species. While the stress of capture, handling, and confinement is generally regarded as potentially detrimental to the animal's condition or survival, few studies document the direct and indirect effects of capture stress on pronghorn, let alone other wildlife species. Even fewer studies discuss techniques to reduce stress generated by or during the capture. This paper reviews current capturing and handling procedures, and offers recommendations for improvement.

INTRODUCTION

The capturing of pronghorn (*Atilocapra americana*) is a tool to aide in the study of pronghorn survival, to augment existing populations or to establish new populations. But in the use of modern day capturing techniques pronghorn are exposed to many stress generating stimuli that can be detrimental. In order to understand and reduce stress several questions need to be answered. These include:

1) What is stress?
2) What are the stimuli which generate stress during capture and handling?
3) How does stress affect the animal?
4) How can stress be minimized during capture and handling?

Some of these questions need further research, if the role of stress and its affects on captured and transplanted animals are to be fully understood.

WHAT IS STRESS?

Stress as applied to animal husbandry has various meanings (Stott 1981). The definition of stress which relates best to wild animals is "The non-specific response of the animal resulting from interactions with its environment via receptors" (Selye 1973:692-693). For the purpose of this paper I am defining stress as: the response(s) of an animal (both internal and external) to forced alterations in its environment.

WHAT ARE THE STIMULI GENERATING STRESS DURING CAPTURE AND HANDLING?

Fowler (1978:54) classified stressors as:

Somatic stressors: The somatic stressors that may act during capture and handling procedures include strong sounds, sights, odors, possibly taste, unexpected touches, changes in position, abnormal stretching, heat and cold changes, effects of chemical or drugs used in capture, and insufficient oxygen as a result of struggling or the application of excessive pressure. In prolonged captivity thirst and/or hunger may also be stimuli.

Harthoorn (1981a:249) noted that black wildebeest (*Connochaetes gnou*) would die before drinking from an above-ground trough, while in captivity.

Psychological stressors: The chasing of an animal is a mild psychological stressor that may intensify to anxiety, fright or terror, the latter being the most severe form.

Behavioral stressors: Those stressors that act due to the capture or relocation into unfamiliar surroundings.

Miscellaneous stressors: Any external interaction that has not already been mentioned, that could reduce the condition of the animal (i.e., surgery, drugs, toxins, infectious agents, etc.).

Harthoorn (1982a) stated that exertional and/or physical stress is readily caused by the chase prior to capture or to the flight after capture.

In the case of pronghorn, the stimuli generating stress during capture could be any combination of stressors, for they are exposed to a wide range of stressors during this process. These potential stressors may range from intense physical exertion due to being chased by a helicopter, to the noise of and handling by humans, combined with the intense stimulation of being crowded into an area with many other excited pronghorn.

An aspect which should be investigated, in territorial male pronghorn (Kitchen and O'Gara 1982), is the stress due to capturing and handling such males. Autenrieth et al. (1981) reported a 36% mortality rate of mature pronghorn males during or after capture procedures. During the same procedures, no does and only 17% of immatures died. The Utah Division of Wildlife Resources had four mature males die, out of 39 pronghorn, during a 1967 transplant (Smith and Beale 1980).

HOW DOES STRESS AFFECT THE ANIMAL?

Fowler(1978:55-57) describes three pathways of bodily responses to stress related capture:

1) Voluntary motor: The impulse that is generated from the stimulus is initiated peripherally or internally. Responses generated by the voluntary motor system may induce avoidance, struggle, escape attempts, defensive or protective postures, vocalization and aggressive behavior (Jenkins, cited in Fowler 1978).

2) Sympathetic nervous system - adrenal medulla: Stimulation of this pathway induces the fight or flight reaction, also called the alarm reaction leading to somatic stressor effects.

3) Hypothalamic adrenohypophoseal adrenocortical: This pathway involves the neuroendocrine system. Continuous adrenal cortex stimulation and excessive production of cortisol elicit many adverse metabolic responses. Psychological as well as physical changes then occur.

One of the outcomes of stress due to the precapture, capture, and handling of wild animals is capture myopathy. Capture myopathy is also known as overstraining disease, stress myopathy, polymyopathy, white muscle disease, transport myopathy, spastic paresis, muscle necrosis, and leg paralysis (Chalmers and Barrett 1982). Capture myopathy is primarily a disease of captured wildlife, and is a potentially fatal condition (Chalmers and Barrett 1977, 1982, Young and Bronkhorst 1971). Harthoorn (1982a) observed cases where wild animals died due to the chase during capture attempts.

In ungulates, the clinical signs of capture myopathy include depression, muscular stiffness, weakness, incoordination, recumency, paralysis, metabolic acidosis, myoglobinuria (Chalmers and Barrett 1977, 1982) and the passing of red-brown urine (Young and Bronkhorst 1971). Death can occur up to thirteen days after capture (Chalmers and Barrett 1977, 1982). Harthoorn and Young (1974) noted deaths in zebra (*Equus burchelli*) up to one month after capture due to fibrotic lesions in the myocardium. Harthoorn and Van Der Walt (1974) stated that the deaths with capture myopathy symptoms seem to be due to acidosis rather than exhaustion or overstraining of muscles and vital organs. The extent of the physiological changes depends on the speed and length of the chase (Harthoorn 1981a). Harthoorn (1982a) also states that physical stress leads to lactacidemia and a decline in pH. An increase or decrease in the pH level has been shown to cause death in forced exercised wild animals (Harthoorn and Van Der Walt 1974, Harthoorn 1981a, 1982a, and 1982b).

The elevated values of serum enzymes glutamic oxaloncetic transaminase, glutamic pyravic transomire, lactic dehydrogenase, and creatine phosphokinase have been observed in capture myopathy affected animals (Chalmers and Barrett 1977, 1982, Harthoorn 1982a, Herbert and Cowen 1971). The elevated values of serum enzymes probably reflect extensive damage to skeletal and cardiac muscles, and possibly to kidneys, livers and other

organs. And elevations of serum potassium, blood urea nitrogen, creatine glucose and lactate which are also indicators of muscle and organ change (Chalmers and Barrett 1977, Harthoorn and Van Der Walt 1974, Harthoorn 1981a, 1982a, Young and Bronkhorst 1971).

The pathologic findings in capture myopathy-affected pronghorn, revealed to Chalmers and Barrett (1977) showed, grossly and histologically, muscular lesions were present in most of the major locomotive muscles. There were epicardial and endocardial hemorrhages along with many other subcutaneous problems with these animals.

During captivity, after handling and after captivity, there is an increase in rectal temperature, respiration rate, and heart rate of wild animals due to stress (Autenrieth et al. 1981, Franzman and Thorne 1970). These could possibly be used as indicators of the amount of stress the animal is experiencing (Stott 1981). Harthoorn (1982a) said that the best indicators for the degree of exertional stress is the free myoglobin and serum potassium, due to the length of time that is required for the other serum enzymes to show the full extent of the damage in a blood sample.

The full effect of the disturbance from the total trapping procedure is unknown. According to Workman, (unpublished data) the effect of a person standing in a pen, for ten minutes, with captured pronghorn caused the heart rate of two does to increase to an average of 114.5 beats per minute, from a 24 hour resting heart rate of 61.5 beats per minute. The rate increase lasted for 1.7 minutes. A helicopter flying over resulted in a heart rate increase to an average of 132.0 beats per minute where it stayed up for 0.7 minutes. A second fly over had less effect.

HOW CAN WE MINIMIZE STRESS DURING THE CAPTURE AND HANDLING OF PRONGHORN?

Aerial Pursuit

For many cases a helicopter is used to pursue pronghorn during the capturing process. The pronghorn may be shot with a dart or a net from the helicopter or chased into a trap, in many cases the trap is a corral trap. To aide in the reduction of stress prior exposure to the trap is recommended (Harthoorn 1979, 1981a, 1981b, 1982b, Murison et al. 1986, Pyshora 1988). During prior exposures the trap should be open so they can run freely through. Chalmers and Barrett (1977) and Harthoorn (1981a) recommended low intensity aircraft pursuit, and Harthoorn and Van Der Walt (1974) recommended low intensity pursuit from a distance greater than 2 KM. Sullivan et al. (1991) will not haze white-tailed deer (*Odocoileus virginianus*) for more than 9 minutes,

nor will they push them to full pace until it is within 200 meters of the trap. Also, any extra noise devises on the aircraft could induce more stress to the animals (Chalmers and Barrett 1982).

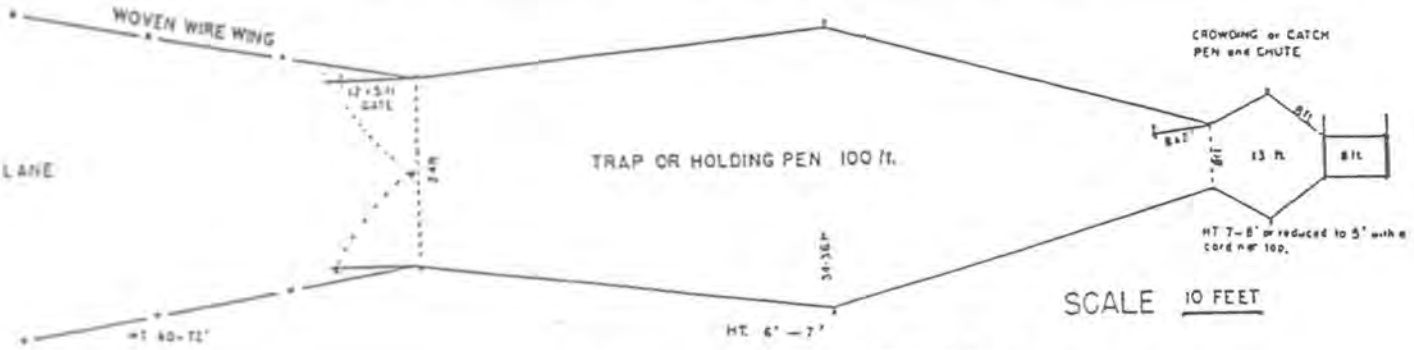
The Trap

Of the trap designs that I have examined, the design described by White (1987) (see fig. 1) appears to be the most effective at reducing damage and stress. This trap is similar to the one used by the Utah Division of Wildlife Resources with good success (Welch 1991, personal communication, Big Game Biologist for Utah Division of Wildlife Resources.). The advantages of this design are:

1) Large and mobile.
2) Compartmentalization:
   a) the individual handling area
   b) pre-handling chamber
   c) capture area

The individual handling area is small enough that the hand capturing can be done without excessive damage to the individual pronghorns. A few animals are moved to the pre-handling chamber after being separated from the large group, prior to the individual handling area. The capture area is the largest of the three areas, it can hold a high number of animals without over-crowding, allowing the animals to calm down, reducing stress levels. The Utah D.W.R. has captured up to 250 pronghorn at one time without any problems caused by overcrowding (Welch 1991, personal communication).

A tarp on the inside of the trap would prevent damage to the captured animals, such as the loss of hair due to rubbing against the netting. The tarp should be black or dark colored to prevent shadows produced outside the trap from showing inside the trap. Workman (1992 personal communication, Ungulate disturbance researcher, Utah State University) uses burlap or a fine fiberglass netting on the inside of his traps. Harthoorn (1981a, 1981b) uses



Holding pen, catch pen, and chute (Russell 1964).

polyproylene plastic in his traps and taming corrals.

Barrett (1974) and Chalmers and Barrett (1977) recommended the trapping of pronghorn be done during the late fall and early winter, when temperatures are between -31.1°C to -1.11°C (-24 F to +30 F). Trapping within this temperature range should reduce the chance of overheating (Chalmers and Barrett 1982). Harthoorn (1981a) also recommended attraction into the trap, by the use of water or feed, rather than chasing the animals with a motor vehicle or helicopter.

Drugs

Immobilizing agents to be used on pronghorn need further investigation (Autenrieth et al. 1981). Beale and Smith (1967) used succinycholine chloride within the range of 6.05-9.93 milligrams per 100 pounds (45 Kg) of body weight, on pronghorn with good success. Autenrieth et al. (1981) used etorphine hydrochloride, but recommend that it be used only on selected immatures and females. Harthoorn (1965) stated that the capture of wild animals including antelope for relocation is probably best achieved by using a centrally acting drug. Harthoorn (1965) advises against the use of Flaxedil on antelope.

Several things should be considered in the use of drugs. Autenrieth et al. (1981) reported an average cost of $70 for the drug and supplies, and 1.7 hours of helicopter time per animal. It appears that there are many factors in addition to drug overdose or incomplete recovery that contribute to mortality or disease after chemical capture or immobilization (Harthoorn 1982a:70). These include the weakened state of the animal increasing the risk of predation and susceptibility to injury by rutting males (O'Gara 1992)

Handling The Animals

Harthoorn (1981a) recommended the use of a highly trained trapping team, because of the reduced mortality rate when such a team is used. Handlings of pronghorn being done by volunteers who do not understand or are not concerned about the stress created by that type of handling can result in an increase of injuries. Handlers need to be reminded that pronghorn are not livestock, but are wild animals that are not habituated to human harassment. Handlers also need to be told that pronghorn's limbs are very fragile, especially to pressure applied sideways on the limb, and the head of the pronghorn needs to be held above the level of the rumin. The handlers should be encouraged to use a blindfold on the captured pronghorn as a means of reducing excitement in the animal.

Transportation

When the pronghorn are to be transported, it should be with trailers that have been blackened out on the inside. Remember that pronghorn need sufficient air and cooling during transit to prevent hypothermia (Harthoorn 1982b). O'Gara (1992) recommended that when pronghorn are being transported, they be hosed down with water to keep their ambient temperature below 21°C (70°F). Workman (1991 personal communication) stated that it appeared that the trailers need not be blackened out because the animals tend to lay down when the vehicle is moving. It appeared that the pronghorn that we loaded into blackened out trailers calmed down faster than those loaded into unblackened out trailers. A tarp inside the door of which the pronghorn are to be loaded helps prevent the previously loaded animals from seeing out and attempt an escape.

The floor of the trailer should be modified to prevent slippage. Hoover et al. (1959) recommends six inches (15cm) of sand covered with alfalfa. Harthoorn (1982b) recommends 15 cm depths of earth or sand as well as litter, and a little dung form the animals. Workman (1991 personal communication) uses a rubber mat with a little alfalfa on the floor of his trailers when transporting wildlife.

CONCLUSION

The reduction of stress can reduce mortality to pronghorn during, and related to, capturing procedures. Some stress reduction could be accomplished through some procedural modifications. However additional research is needed to further reduce stress during capture and handling.

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RESPONSES OF PRONGHORN TO PETROLEUM DEVELOPMENT ON CRUCIAL WINTER RANGE

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Abstract: Increasing petroleum exploration and development on public land has raised concern about its effects on local wildlife populations. One area with increasing petroleum development is in the Rattlesnake Hills, west of Casper, Wyoming. This area has been designated as crucial winter range for pronghorn by the Wyoming Game and Fish Department. We conducted a study to determine what effects petroleum-related activities may be having on pronghorn populations using this winter range. We captured, marked, and radio-collared pronghorn on the winter range to monitor distribution of animals in relation to oil fields. Distribution data was used to determine use/avoidance of oil fields in relation to other portions of the winter range. We measured habitat characteristics at animal location, at random sites within oil fields, and at random sites outside of oil fields to determine if characteristics of the habitat may explain distributional patterns of pronghorn. We also collected pronghorn fecal samples to compare food habits and forage quality from random sites on winter range. During the winter of 1990, we were able to intensively monitor distribution of pronghorn around a well site before, during, and after drilling. Although groups of animals were commonly seen near oil fields, our distribution data indicated that numbers of pronghorn in and near active oil fields were lower than expected. We were unable to detect differences in habitat characteristics between animal use sites and random sites within oil fields, nor were there differences in forage quality from random sites on the winter range. Distances of pronghorn groups from the well that was drilled during winter of 1990 were greatest during drilling than before or after drilling activity; although distances were only significantly different between the drilling period and post-drilling. Because petroleum-related activity had occurred in the area before the study began, we were unable to conclusively prove that this activity caused displacement of pronghorn. We recommend that the stipulations prohibiting drilling on crucial pronghorn winter range between November-April remain in effect, however, it may be possible to waive the stipulation in late winter during mild weather conditions and adequate forage available. More importantly, drilling in crucial winter range should only occur during summer.

INTRODUCTION

Public opinion to lower the United States' dependence on foreign energy sources has increased pressure to open more public lands to oil and gas devel-

opment. Unfortunately, the geologic structures associated with the oil-bearing strata also provide favorable microclimates for wildlife during periods of harsh winter weather. One such area with high potential for petroleum production and importance to wildlife lies near the Rattlesnake Hills in western Natrona County, Wyoming. A portion of this area has been identified as crucial winter range for pronghorn (*antilocapra americana*) by the Wyoming Game and Fish Department (WGFD) (Pate 1984). The effects of ongoing petroleum development on pronghorn populations of this region are unknown. Drilling activities during winter are of major concern.

Petroleum exploration and development on crucial wildlife ranges has potential to adversely impact big game populations (Shideler 1986, Bromley 1985). In Alaska, Dau and Cameron (1985) found that caribou (*Rangifer tarandus*) were displaced from calving grounds as a result of oil field road construction. This displacement continued after construction had subsided. Development of a natural gas field in western Wyoming caused elk (*Cervus elaphus*) to abandon historic crucial winter ranges (Johnson and Wollrab 1987). Hiatt and Baker (1981) also suspected that oil and gas drilling caused a shift in the distribution of elk and mule deer in Wyoming. In North Dakota, Fox (1989) found that mule deer avoided areas within 100m of an energy production facility for bedding and diurnal feeding.

In the 1985 environmental impact statement (EIS) on the Platte River Resource Area (which includes the Rattlesnake winter range), the Bureau of Land Management (BLM) stated:

"No surface development will be allowed from November 15 through April 30 in critical pronghorn winter ranges....This decision can be waived by the district manager." (Bureau of Land Management 1985:29).

The first exemption of this seasonal restriction occurred the following year when the BLM approved an application for permission to drill on crucial pronghorn winter range near the Rattlesnake Hills. Between 1987 and May 1991, the BLM had suspended the seasonal restriction and allowed 18 drilling exemptions during winter on the Rattlesnake winter range.

This study was prompted due to the ongoing development in crucial winter ranges without consideration for the seasonal restrictions as per the BLM's 1985 EIS. The objective of this study was to determine if petroleum exploration and development on crucial winter range influenced winter distribution or habitat use of pronghorn. We also attempted to quantify habitat losses on crucial winter range that may result from petroleum development.

STUDY AREA

The study area (632 square km) is located in western Natrona County,

Wyoming, north of the Rattlesnake Hills. The area encompasses 215 square km of designated crucial winter range (Fig. 1). Approximately 60% of the study area is privately owned, 31% is federal land administered by the BLM, and 9% is owned by the state. Major economic uses of the area include petroleum development, ranching and recreation (i.e. hunting).

Petroleum exploration began in and around the Rattlesnake winter range about 1910, but little drilling occurred until after 1955 (Bureau of Land Management 1989). Drilling activity peaked in the late 1960's and slowly declined to 62% of peak levels by the mid-1980's (Bureau of Land Management 1989). Although total drilling in the Rattlesnake Hills area decreased, the amount of drilling activity during winter has increased (Bureau of Land Management 1989).

There are currently six oil fields within the study area (Fig. 1). Four of the fields were active (ongoing exploration and drilling) during winters of 1988-90: Sun Ranch field, North Grieve field, Wallace Creek field, and Raderville field. The Sun Ranch and North Grieve fields are adjacent to each other and will be considered as one field. Human activity was generally lower in the Raderville field during winter than in summer. The Diamondback and Forgey fields have not had extensive drilling activity for several years.

Vegetation across the area is characterized as sagebrush-grass rangelands dominated by Wyoming big sagebrush (*Artemisia tridentata*). Green rabbitbrush (*Chrysanthemum nauseosus*), black greasewood (*Sarcobatus vermiculatus*), wheatgrasses (*Agropyron* spp.), threadleaf sedge (*Carex filifolia*) and bluegrasses (*Poa spp.*) are common in the study area. Topography varies from steep outcroppings, badlands, and rolling terrain, to flat, open plains. Elevations in the study area range from 1,830 to over 2,500m above sea level.

Annual precipitation averages 29.0cm, 43% of which falls from April through June (U.S. Dept. Comm. 1969-91). The greatest mean monthly snowfall occurs in March and April, with most of the major storms occurring in March (Martner 1986). Winds are predominately from the southwest, however, during major snowstorms winds are from the north or northeast (Martner 1986). The mean annual temperature is 7°C; lowest temperatures occur in January and highest temperatures occur in July (U.S. Dept. Comm. 1969-1991).

METHODS

Because exploration and production of petroleum had occurred in this area for several years prior to the onset of this study, we could not assess the initial impacts of petroleum-related activity on pronghorn populations. In

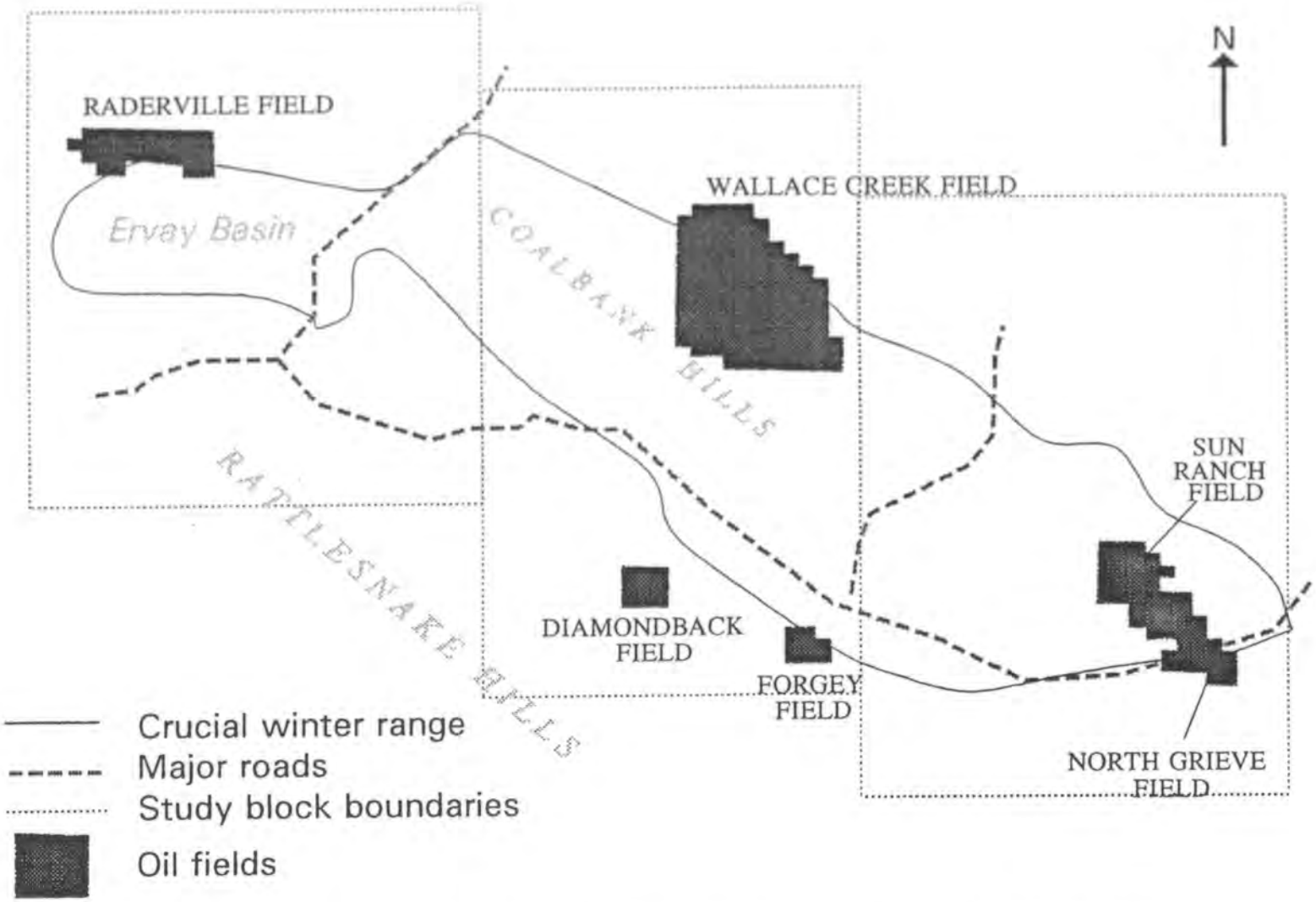

Figure 1. Area map for the Rattlesnake pronghorn winter range-petroleum impacts study.

addition, we could not determine if the petroleum-related activity had previously affected pronghorn distributions. Therefore, we attempted to document if animals had been displaced away from oil fields. Displacement of animals from oil fields may indicate avoidance of these areas due to lower quantity or quality forage and/or higher energetic costs associated with the habitat near oil fields. We also attempted to detect the influence of these factors.

A winter severity index (Leckenby and Adams 1986), modified to use weekly data, was used to measure the severity of winters from 1970-1990. "Winter" includes the months of November through April. Data on wind velocity, maximum and minimum temperature, and snow accumulation were obtained from monthly climatological data collected at Natrona County International Airport (National Oceanic and Atmospheric Administration 1970-91), 56-80km from the study area.

Pronghorn were trapped and marked to obtain identifiable individuals to use in documenting distribution of animals. From 3 to 5 December, 1988, 223 pronghorn (133 F, 90 M) were captured at 4 sites using drive traps (Fisher 1942). Animals were hazed into traps using a Hiller 12E helicopter and manually restrained by ground crews. All pronghorn were aged (Dow and Wright 1962) and ear-tagged. Twenty adult females were fitted with radio transmitters (Telonics, Mesa, AZ); while 175 animals were fitted with individually identifiable neckbands, and 28 males were eartagged only. There were six trap related mortalities. Efforts were made to haze animals from near oil fields into traps. Because few animals could be found around the fields, in August 1989, we used a netgun (CODA Enterprises Inc., Mesa, AZ) deployed from a Bell Jetranger 206 to capture 4 female pronghorn from near the oil fields. Radio transmitters were placed on 2 of these animals, 1 was neckbanded, and the fourth animal died from injuries sustained during capture.

Pronghorn distributions were documented by aerial surveys conducted approximately twice per month from November through April 1989-91. An area encompassing the entire crucial winter range and the immediate outlying areas (375 square km) was flown using a Bellance Scout. These surveys were conducted at 90-120m above the ground along 0.8km wide transects. The number of individuals in each group was either counted (if less than 15-20 animals) or estimated. The locations of all groups observed during surveys were plotted on 1:24,000 U.S.G.S topographic maps. Universal Transverse Mercator (UTM) coordinates for locations were entered into a computer database.

Distributional data were used to document which portions of the study area were used or avoided by animals. We hypothesized that, since geological and vegetational trends were similar across the winter range, there should be no reason for any part of the range to be used in greater than another. Chi-

square tests whether or not animals used oil fields in proportion to availability (Neu et al. 1974, Byers et al. 1984). The availability of an oil field was calculated as the proportion of the winter range covered by the developed area within the official boundary of each oil field. Expected use of an oil field by pronghorn was calculated in proportion to each oil field's area.

Radio-collared pronghorn were relocated from the air an average of three times per month. The UTM coordinates for locations of redio-collared animals were used to calculate home ranges for each animal.

Three sampling units (blocks) were created to allocate sampling effort across the entire study area (Fig. 1). The eastern sample unit (Block 1) included the North Greive and Sun Ranch oil fields and encompassed 180 square km. Topographic relief in this block resulted from the Coalbank Hills uplift, badland features, and assorted drainages. The central sample unit (Block 2) included the Diamondback, Forgey, and Wallace Creek fields and encompassed an area of 200 square km. Topographic relief in block 2 resulted from rolling terrain and the Coalbank Hills. The west sample unit (Block 3) included the Raderville field and encompassed an area of 252 square km. Block 3 contained a portion of the Rattlesnake and Coalbank Hills and a flat, open plain.

Habitat and microsite characteristics were measured at pronghorn feeding and bedding sites, at randomly selected sites on and off the area designated as crucial winter range, and at random sites within oil field boundaries. The sites used by undisturbed animals were classified as feeding or bedding based on behavior of the majority of individuals in each group. The UTM coordinates of random sites were determined using a random number generator. Once each site was located, three additional points were selected at 250m intervals oriented toward the center of the winter range. Consequently, four measurement points were established for each randomly selected location. Random sites included areas designated as year-long range, winter range, and crucial winter range. Data for random sites within oil fields were only collected during the 1990-91 field season. For each winter month (November-April), habitat data were collected from a minimum of 20 sites within each block.

Characteristics of the habitat that may affect energetics of animals and forage availability were measured at each site. Depth of snow was measured and percent snow cover was visually estimated. Snow hardness was measured using a 6.6 kg weighted pole dropped from 10cm above the snow surface. This value estimated the sinking depth of a pronghorn hoof impacting the snow surface. Percent shrub coverage was estimated by the frequency of shrubs encountered along a 33m transect. Slope and aspect were measured using a Silva Ranger compass with a clinometer. Wind velocity was measured using hand-held anemometers at 0.3m at bedding sites, 1m at feeding sites, and both at random sites. Distances (km) to maintained roads and to active petroleum wells were measured for each site using topographic maps marked with well locations.

Habitat variables were compared among animal use sites and random sites to predict which components of the habitat were important to animals. Habitat characteristics measured within oil fields and at animal use sites were used to determine if these characteristics accounted for animal distributions rather than possible avoidance of human activity by animals. Data were analyzed using PROC GLM (SAS Institute Inc., Cary, NC) and subsequent mean separation tests (Tukey's studentized range test and Scheffe's multiple comparisons procedure). A significance level of $P=0.05$ was used for all comparisons.

Differences in diet composition and forage quality may partially explain animal distributions throughout the study area. To detect these differences, 10 fresh fecal samples were collected from pronghorn each month from each block. Fecal samples composited by block were analyzed to assess forage selection of pronghorn (AAFAB Composition Analysis Lab., Ft. Collins, CO). Individual fecal groups were analyzed for fecal nitrogen and percent crude protein (Range Science Nutritional Analysis Lab, Ft. Collins, CO), which indicated diet quality (Leslie and Starkey 1985). Diet composition, fecal nitrogen, and percent crude protein were compared among blocks, months and years using PROC GLM (SAS Institute Inc., Cary, NC).

Until the 1990 field season, there had not been an opportunity to monitor the direct impacts of drilling activity on pronghorn. Previous efforts to obtain pre-drilling information were unsuccessful because of lack of cooperation from the BLM and oil companies to allow for adequate monitoring. In February 1991, the BLM deferred the winter stipulation and approved a permit to drill during winter. The well site was located in Block 1 of our study area, along the Middle Fork of Casper Creek (UTM 322800, 4744100). Topography and vegetation was typical of the entire study area.

We attempted to intensively monitor distribution of animals around the well site before, during and after drilling activity. A 2-man crew surveyed an area approximately 16 square km around the well site recording locations and group sizes for all pronghorn. An effort was made to cover the entire area in one day and observe all animals present. Broken terrain allowed for observations of undisturbed animals. If animals were disturbed before they were noticed by observers, the original location of the group was estimated by considering the activity of the group (e.g., running, standing), direction of moving animals, and terrain.

Thirty-eight walking surveys were completed over the area around the well site from 7 December 1990 to 29 May 1991. Data on pre-disturbance distribution of animals were collected from 7 December to 28 February during 16 surveys. Construction of an access road and well pad began on approxi-

mately 1 March, 1991. Drilling activity began on 22 March and ended on 23 April. The unproductive well was capped and abandoned by 25 April. Fifteen surveys were conducted during the duration of activity. Post-disturbance distribution of animals was monitored from 26 April to 29 May during 7 surveys.

Distances of animal groups from the well site were compared among time periods (before, during, and after drilling activity) using PROC GLM (SAS Institute In,., Cary, NC). To determine if crowding of pronghorn occurred in areas away from drilling activity, densities of animals before, during, and after drilling were estimated based on the number of animals observed in 1km intervals from the well site.

RESULTS

Winter Severity

With the exception of a few winter storms, weather conditions during this study consisted of mild temperatures and little snowfall. The winter severity index averaged 1801 for the winters of 1970 through 1990. Weather conditions were more severe than average during the winter of 1988 (2039; within 1 SD of mean), less severe during the winter of 1989 (1530), and average during the winter of 1990 (1807). Because the weather data were collected 35-50 miles from the study area, actual conditions in the area may have been different. Data from the Casper airport weather station were used because it provided the most complete data available.

Distribution

The number of pronghorn observed during distribution flights averaged 2,136 (SD = 652, range: 1148-2879) animals per survey during November-February. There was a drop in the number of pronghorn counted during March and April each year, presumably due to seasonal migration. Therefore, data from these months were not included in the calculation of the mean numbers of pronghorn on the winter range.

During distribution flights, densities of pronghorn on oil fields were generally lower than densities outside of oil fields (Table 1). During the study, only 110 (5%) observations of pronghorn groups were within oil fields. An unusually large number of pronghorn were seen in the Raderville field in 1988; however, 82% of these observations were made during 2 flights immediately after periods of inclement weather. Chi-square analyses and Bonferroni confidence intervals indicate that the inactive oil fields were used in proportion to their availability (Table 2). The two most active oil fields, North Grieve/Sun

Table 1. Mean density of pronghorn (animals/km²) observed on and off of oil fields during distribution flights during October-April of 1988-91.

Oil Field	Area (km²)	Mean Density of Pronghorn Observed 1988	1989	1990
Low activity				
Diamondback	1.4	1	<1	5
Forgey	1.1	1	6	11
Raderville	3.4	17	3	5
High activity				
North Grieve/Sun Ranch	8.2	2	3	1
Wallace Creek	18.2	2	2	2
Outside fields	337.6	6	6	5
Total	370.0	5	6	5
Number of flights		8	13	9

Ranch and Wallace Creek, were consistently used less than expected ($P<0.05$). The Raderville field was used in proportion to its availability except during the 1990 field season when it was used less than expected. Use of the area within 1km of these oil fields was also less than expected ($P<0.05$). Correspondingly, areas outside of oil fields were always used more than expected.

Analysis of Radio-telemetry Data

Three radio-collared pronghorn had home ranges that were partially within boundaries of oil fields during at least one winter. Based upon relocations throughout the study, two of these were probably non-migratory animals. In addition to the animals discussed above, four radio-collared pronghorn had home ranges within 1km of oil fields.

Habitat Analysis

The only habitat characteristic that was consistently different between pronghorn use sites and random sites was shrub frequency (Table 3). Pronghorn selected sites for bedding and feeding that had higher frequencies of sagebrush than random sites ($P>0.0001$). Mean distances from pronghorn use sites to the nearest major road and active well were less than distances from random sites to roads and active wells ($P=0.0001$). However, most of the animal use sites were located while observers were on the roads. Percent snow cover, snow depth, and sinking depth were greater at oil field sites than at pronghorn use sites, however, this is probably due to a bias in data collection. Greater accessibility of oil fields during and immediately after inclement

Table 2. Number of pronghorn groups observed, simultaneous 95% confidence intervals around the number observed, and the number of groups expected inside and outside of oil fields during distribution flights in the Rattlesnake winter range during October-April of 1988-91.

Year	Oil field	Number of groups observed: Actually observed	Number of groups observed: 95% CI	Groups expected	Used or avoided[1]
1988					
	Low activity				
	Diamondback	1	0 - 3	2	=
	Forgey	1	0 - 3	2	=
	Raderville	5	0 - 11	5	=
	High activity				
	N. Grieve/Sun Ranch	6	0 - 12	13	<
	Wallace Creek	15	5 - 25	29	<
	Outside fields	561	547 - 575	537	>
1989					
	Low activity				
	Diamondback	2	0 - 6	4	=
	Forgey	7	0 - 14	3	=
	Raderville	4	0 - 9	9	=
	High activity				
	N. Grieve/Sun Ranch	8	1 - 16	22	<
	Wallace Creek	30	16 - 44	48	<
	Outside fields	939	921 - 957	903	>
1990					
	Low activity				
	Diamondback	1	0 - 4	3	=
	Forgey	4	0 - 9	2	=
	Raderville	2	0 - 6	7	<
	High activity				
	N. Grieve/Sun Ranch	4	0 - 9	16	<
	Wallace Creek	20	8 - 31	36	<
	Outside fields	714	699 - 729	679	>
1988-90					
	Low activity				
	Diamondback	4	0 - 9	9	=
	Forgey	12	2 - 21	7	=
	Raderville	11	2 - 18	21	<
	High activity				
	N. Grieve/Sun Ranch	18	7 - 30	51	<
	Wallace Creek	65	44 - 86	114	<
	Outside fields	2214	2187 -2240	2119	>

[1] < indicates area used less than expected,
> indicates area used greater than expected,
= indicates area used in proportion to availability

Table 3. Habitat characteristics (means ± SD) of pronghorn use sites vs. random sites measured in and around the Rattlesnake winter range during winters of 1988-90.

Variable	Site Type				P Value
	Pronghorn		Random sites[1]		
	Bed	Feed	WRS	Oil	
Shrub density (%)	26.1a[2] (12.6)	32.6b (15.0)	16.5c (13.0)	16.8c (11.6)	0.0001
Snow cover (%)	20.3a (35.0)	26.3a (36.5)	31.2ab (39.4)	40.3b (41.2)	0.0017
Snow depth (cm)	2.4a (4.1)	4.2 (10.0)	3.2a (5.3)	6.0b (7.8)	0.0001
Sinking depth (cm)	2.2a (4.0)	2.9 (4.3)	2.2a (3.6)	3.9b (5.8)	0.0001
Slope (%)	5.7 (4.0)	5.4a (4.3)	5.5a (5.2)	7.2b (5.5)	0.005
Temperature (C)	5.3 (7.6)	4.5 (7.0)	5.1a (7.0)	3.0b (6.1)	0.015
Wind velocity[3] 0.3 m (m/s)	2.6 (1.5)	–	2.9 (2.0)	3.2 (2.2)	0.089
Wind velocity 1.0 m (m/s)	–	3.7 (2.1)	4.0 (2.6)	4.3 (2.7)	0.163
Distance: major road (km)	1.0a (1.1)	1.2a (1.2)	2.0b (1.5)	1.1a (1.6)	0.0001
Distance: active well (km)	3.5a (2.3)	3.0a (2.2)	4.3b (2.6)	0.6c (1.2)	0.0001

[1] WRS = Winter range sites, Oil = Sites within oil field boundaries

[2] Values within a habitat variable followed by the same letters are not significantly different at specified P level; values without letters are not different from other site types within the same variable.

[3] Wind velocities taken from 1.0 m at random sites during the 1988 and 1989 field seasons were adjusted for 0.3 m using the regression equation $Y=^{-}0.103+0.751X$.

weather influenced these measurements. Random sites had aspects that were equally distributed across all directions (X squared =8.2, 7df, P>0.05); while pronghorn chose aspects that were distributed differently form random sites (X squared =39.5 and 24.7, respectively, 7df, P<0.05). Pronghorn most often selected sites on leeward aspects (east, north, and northeast).

There were significant differences between habitat characteristics of oil fields and other portions of the range (Table 3). Slope within oil fields was greater than at random sites (P=0.08). Snow cover, snow depth, and sinking depth were also greater at oil field sites (P=<0.05), again due to increased accessibility of the oil fields. Understandably, oil field sites were closer to major roads and active wells than were other random sites. Shrub density was not different (P>0.05).

Diet Analysis

Analysis of composited fecal pellets collected January through April 1989-91. Indicated that big sagebrush comprised 94% of pronghorn winter diets. During green-up in April, the occurrence of sagebrush in fecal samples decreased to 84%, while graminoids increased from 0.7% to 11.5% (P<0.05). In April, there was also an increase in percent nitrogen and crude protein in fecal samples. Diet composition, fecal nitrogen and percent crude protein did not differ among the three sample blocks of the study area (P>0.05). This indicates that diet selection and quality were not different across the entire study area.

Response to Drilling Activity

Table 4. Mean distance between animal sightings and drilling activity, number of groups seen per survey, and density of animals different distances (km) from the well site before, during, and after petroleum-related activity in the Rattlesnake winter range, 7 December 1990-29 May 1991.

Period[1]	Mean distance	# groups per survey[2]	Density (animals/km²)			
			0-0.9	1.0-1.9	2.0-2.9	3.0-3.9
Before	2.09[3]	6.5	15	66	52	30
During	2.14	14.3	9	47	84	19
After	1.92	28.1	30	72	31	16

[1]Before= 7 December-28 February, During= March-25 April, After= 26 April-29 May.

[2]There were 16 surveys conducted before drilling activity, 15 surveys during drilling activity, and 7 after drilling.

[3]Distance between pronghorn observations and well site significantly different between active drilling period and post-drilling period (one-way ANOVA: P=0.03).

Distances between locations of animal groups and the well site were greater during drilling activity than before and after drilling (Table 4). Although differences were slight, they were significant for pronghorn locations between active periods and post-active periods (P=0.03).

Although groups of pronghorn were often observed within sight of the well pad during drilling, pronghorn numbers within 1km of the well site decreased after road construction and drilling activity began (Table 4). There was a corresponding increase in the number of pronghorn 2.0-2.9km from the well after activity began. After human activity in the area subsided, pronghorn numbers within 1km of the well site increased to predisturbance levels. Although numbers of pronghorn changed between time periods, highest densities occurred between 1.0 to 3.0km of the well during all time periods (Table 4). Pronghorn within sight of the access road did not always run in response to traffic going to and from the well pad unless vehicle moved slowly or stopped.

Survival

Twelve radio-collared pronghorn (55%) died from various causes during the study. Mean annual mortality rates for collared adult pronghorn during the entire study was 22%. Mortality was lowest during the second year of the study and highest during the last year. Predation, hunter harvest, and trap-related injuries accounted for only 1 mortality each. Unknown and natural causes accounted for 75% of observed mortalities. Natural mortality was probably due to exposure and/or malnutrition, based on condition of bone marrow. For pronghorn that died of natural and unknown causes, ages at time of death averaged 7 years old (range 5-11). As of the end of the study, only 15 neckbanded pronghorn (9%) were known to be dead. Six mortalities were from unknown causes, 8 were harvested, and 1 was from predation.

DISCUSSION

There were over 58 operating oil and gas wells, gauging stations, or storage facilities on the Rattlesnake winter range during the study. There were also several unreclaimed, abandoned well pads and many miles of roads associated with petroleum production. Habitat is also lost because animals will only approach within certain distances of a well, especially if there is excessive noise or human activity. Considering only the surface area actually disturbed (0.2-0.3ha per well site), there was 17.4ha, or 0.03% of the winter range removed from production of forage. Moreover, each facility represents a much larger proportion of an individual pronghorn's home range. High densities of oil production facilities in concentrated areas (i.e., sections or townships) may also account for a much greater proportion of that area and may have significant effects on local populations.

Shrub frequency (predominantly big sagebrush) was greater on sites selected by pronghorn than random sites on and near the Rattlesnake winter range. Sagebrush was also a major winter forage for pronghorn on the Rattlesnake winter range. Because random sites within oil fields had lower shrub density than animal use sites, oil fields may not represent optimal habitat. Cook and Irwin (1985) suggested that browse availability may be a limiting factor when shrub cover is less than 15%. The mean frequencies of shrubs on oil fileds was greater than 15%; therefore, browse should not have been limiting on oil fields.

Diet composition and dietary quality of pronghorn were not different among blocks within the study area. It was not possible to confirm if pronghorn had been within oil fields long enough to affect composition of fecal samples. Therefore, we did not separate fecal samples collected within oil fields from those collected outside fields. Consequently, we can only assume that quality of forage near oil fields did not differ from other areas of the winter range. Thus, pronghorn should not have avoided oil fields due to limited quality of forage.

Distributions observed during flight surveys suggested that pronghorn using the Rattlesnake winter range avoided oil fields in which active drilling or well maintenance was occurring. The number of groups of pronghorn observed on the active oil fields was less then expected based on the amount of land area available. The Raderville field was used in proportion to its availability due to high use during the winter of 1988. Most of the animal observations in this field, however, were during periods of inclement weather and animals may have entered the field seeking shelter during storms. During storms the topographic relief near the oil field provided the only protection from harsh winds.

Observation of pronghorn near oil fields and around the well that was drilled in March 1991, indicated that they move away from disturbances. Groups of pronghorn were observed within sight of the well and existing rigs; however, animals were more commonly isolated from activity by some type of topographic feature.

Pronghorn on the Rattlesnake winter range may be adapting to human activity associated with petroleum exploration and production. Home ranges of several radio-collared pronghorn overlapped with oil fields and the pronghorn did not abandon the home range entirely. These animals may have habituated to human activity. Big game animals may become acclimated to noises and activity caused by industrial activity (Geist 1978). Guenzel (1987) found a dramatic shift in pronghorn distribution in response to pad construction and drilling in the Sun Ranch oil field. He conducted distribution flights immediately after winter storms and may have observed many non-resident animals

that were not habituated to human activity. Petroleum-related disturbances would affect non-resident animals more drastically.

Radio-collared pronghorn whose home ranges overlapped oil fields may have been able to use the fields when human activity was minimal. Pronghorn appear to be opportunistic and, if other areas are available, will relocate to take advantage of more favorable conditions (Bruns 1977, Amstrup 1978, Clary and Beale 1983, Gibb 1989). If a portion of an animal's home range became unavailable due to drilling activity, it may use other portions of its home range. If snow accumulations or adverse weather force animals to use areas near an oil field, as occurred near the Raderville field, human activity would place more stress on animals, even reseident animals. Since this study did not begin until after oil fields had become established, we could not observe the initial effects of the development on distribution of resident populations.

If petroleum-related activity caused dispacement of animals, the observed animal densities away from oil fields may be higher than normal. Guenzel (1987) did in fact find shifts in distribution of pronghorn in reaction to drilling activity. We found that areas outside of oil fields were used in greater proportion than expected, which may be due to animals relocating to areas away from oil fields. At high population densities, the occurrence of intraspecific interactions becomes more frequent (Bruns 1977) and foraging efficiency may decrease (Berger et al. 1983). Hobbs (1989) determined that mortality during a severe winter will increse with increasing animal densities. Overcrowding on optimal or suboptimal habitats may have adverse effects on animal populations and habitat conditions.

Even slight disturbances may lower feeding efficiency and increase energy costs of animals. We were unable to determine if petroleum-related disturbances altered the amount of time animals spent foraging versus other activities. Fox (1989) found that mule deer near oil fields were less active during the day than were deer away from the fields. Berger et al. (1983) found that pronghorn exposed to mining activities responded more vigorously to disturbances, foraged less efficiently, and spent more time vigilant than did pronghorn exposed to only light vehicle traffic. There is an increase in the metabolic rate of animals when they are forced to stand and/or run in response to distrurbance (Wesley et al. 1973, Gates and Hudson 1979, Mautz and Fair 1980). Additionally, depletion of energy reserves is greater during colder temperatures and deep snow accumulations (Wesley et al. 1973, Gates and Hudson 1979, Freddy 1984). Therefore, any unnecessary disturbances of animals on winter range will decrease limited energy reserves.

Mortality of radio-collared pronghorn on the Rattlesnake winter range that was attributable to natural causes (22%) were unusually high for open

winters with mild temperatures. Only 4% of all mortalities of radio-collared female pronghorn reported by Gibb (1989) was due to natural causes. Sundstrom (1969) reported that natural causes accounted for only 11% of mortality in the Red Desert of Wyoming. Hailey et al. (1966) and Barrett (1982) reported mortality rates for pronghorn of 36-65% during winter die-offs. We had no way to determine if the high rate of natural mortality that we observed was due to increased stress caused by petroleum related activities.

RECOMMENDATIONS

Results of this study indicated there was some displacement of pronghorn from oil facilities that could not be accounted by differences in habitat or forage. If animals are forced to seek shelter near oil fields during storms, human activity could add considerably more stress, making die-offs more likely. Effects of human activity on pronghorn would also be intensified if larger concentrations of animals use the winter range. It takes a minimum of one month to drill a well and it is impossible to predict the occurrence of a winter storm that far in advance. It is also difficult to predict a major die-off even in mid to late winter (Bartmann and Bowden 1984). Therefore, we recommend the winter stipulation remain as part of the BLM's Resource Management Plan, with provisions for stipulations to be deferred in late winter during years with adequate forage and mild weather. More importantly however, drilling in crucial winter range should only occur during the summer when animal use of the area is less critical.

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Business Meeting

Business Meeting
15th Biennial Antelope Workshop

Rock Springs, WY 82901
June 11, 1992

Attendance:

Bart O'Gara	MT	Coop. of Wildlife Res.
Jim Yoakum	NV	BLM
Winford Hooe	AZ	Game & Fish Dept.
Mitch Willis	OR	Dept. Fish & Wildlife
Jim McKenzie	ND	Game & Fish Dept.
Danny Swepston	TX	Parks & Wildlife Dept.
Thomas Pojar	CO	Div. of Wildlife
Greg Hiatt	WY	Game & Fish Dept.
Leonard Hopper	KS	Dept. of Wildlife & Parks
Kathleen McCoy	AZ	Navajo Fish & Wildlife Dept.
Laura Colton	CA	Dept. of Fish & Game
Harvey Suetsugu	NE	Game & Parks
Kim Brinkley	CA	Los Angeles Zoo
Tom Christiansen	WY	Game & Fish Dept.
Ted Chu	ID	Dept. of Fish & Game
Lonn Kuck	ID	Dept. of Fish & Game
Brian Gleadle	NM	Dept. of Game & Fish
Keith Sexson	KS	Dept. of Wildlife
Richard Ockenfels	AZ	Game & Fish Dept.
Phil Riddle	WY	Game & Fish Dept.

Minutes of the 14th Biennial Meeting were read by Workshop Chairman Phil Riddle.

It was suggested that all participating state representatives should review a copy of the Workshop By-Laws. Chairman Riddle to send those out with minutes of 15th Workshop.

Guidelines for the Management of Pronghorn Antelope

Subject of paying for cost of printing the guidelines was addressed. Riddle suggested that each State should share the cost equally. A suggestion to consider Pitman-Robertson funding, covers, etc. was made. It was noted by Yoakum that Robb Hitchock of North American Pronghorn Foundation (NAPF) has expressed interest in contributing to the effort. Tom Pojar, Laura Colton and Phil Riddle were to contact these agencies on possible printing costs.

A discussion on how many copies were needed. One thousand (1000) was seen as a reasonable number to accommodate state - federal agency biologists, libraries, etc. After discussion on binding types, it was agreed by all that a bound copy rather than a loose leaf style would be more appropriate. Additionally, it was discussed and agreed upon by all that the Guidelines should be updated by a committee every four years for reprinting, to be available in the sixth year.

Jim McKenzie, Tom Pojar and Mitch Willis agreed to review the Guidelines when Bart O'Gara has the draft ready. Bart will have the draft ready by September 30, 1992 and copies to reviewers who will complete the review and get back to Bart by October 31st. Other than punctuation and grammatical editing, authors will be contacted by reviewers prior to any other editing. Bart O'Gara will have discretion on what black and white prints or drawings should be added to texts. As soon as possible after October 31, 1992, O'Gara will advise of total pages on the Guideline, for printing information.

Riddle will contact all State Wildlife Agency Directors to ask their support for printing costs (if NAPF does not do it).

A committee was selected to review papers to be printed in the Proceedings. Rich Guenzel, Jim Yoakum, Tom Pojar and Tom Christiansen will serve on the committee. Papers will be divided and sent out to them with a due date back to Phil Riddle by September 1, 1992. Again, any editing needed other than grammatical and punctuation should be discussed with the authors.

Tom Pojar pointed out that a full complement of the workshop proceedings are available at the Denver Wildlife Research Center Library of the USFWS. (See attached by-laws)

Jim McKenzie has extra copies of the 9th and 10th proceedings.

The location for the 16th Biennial Workshop was discussed. Kansas representative Keith Sexson offered to host the next workshop. The group accepted the gracious invitation by Keith

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Bart O'Gara also expressed concern that the USFWS used to keep track of pronghorn numbers in North America but no longer do. There was expressed by the group a need to have such information.

It was felt that such an undertaking would be an ideal task for the NAPF. Riddle is to discuss the possibility with Robb Hitchcock.

Bart O'Gara also expressed concern (after the field trip) about the planting of only grass species by oil and gas developers as reclamation in antelope habitat.

After discussion, the group agreed to adopt a resolution to support the proposals of Plumber, et.al. 1968. Bart also suggested that buying out livestock AUM's would be proper mitigation and the group agreed.

Jim Yoakum brought up the plight of the A. americana sonoriensis and A. americana peninsularis in Mexico. He believes a resolution from the Antelope Workshop indicating our interest and concerns for the subspecies and offering technical support to Mexico would be appropriate. Jim will draft that resolution on request of the group and submit it to representatives attending the LaPaz meeting.

Discussion was held concerning sending representatives of the Workshop to a meeting in LaPaz, Mexico on September 25, 1992. The group felt that Arizona, California representatives and O'Gara could convey Workshop feelings at that meeting. Yoakum also related that NAPF was interested in helping with some of those expenses.

Riddle will contact Robb Hitchcock of NAPF to see if the Foundation would be agreeable to:

1) Pay for the printing and distribution of Guidelines and Proceedings.
2) Be the central repository for the Guidelines (and other Pronghorn Publications).
3) Contact Alberta, Saskatchewan and Mexico to encourage attendance at future Workshops and perhaps help with financial assistance if needed for representatives. (Need State reports from them if nothing else).
4) Do a biennial survey of U.S. pronghorn populations to present at each workshop.

It was suggested, discussed and agreed upon by all that the logo used for workshops in each 4th year be the logo for the cover of the Guidelines. (Approval for using the Wyoming logo is approved with a copyright notice).

No other business needed attention and the meeting was completed at 1200 hours.

Phil Riddle
Workshop Chairman

ORGANIZATION and FUNCTION

of the

PRONGHORN ANTELOPE WORKSHOP

BY-LAWS

I. Designation

This organization shall be known as the "Pronghorn Antelope Workshop". The official publication of the Workshop shall be known as the Pronghorn Antelope Workshop Proceedings.

II. Goal

The goal of the Workshop is to provide information relative to and encourage the perpetuation of sustainable wild stocks of pronghorn antelope as an ecological, aesthetic, and recreational natural resource on western rangelands, both public and private, at their most productive levels consistent with other proper land uses.

III. Objectives

A. To provide an opportunity for all persons interested in pronghorn antelope to meet and discuss current research and management of the species and its habitat.

B. To provide a vehicle for disseminating research and management findings to the various agencies and organizations concerned with pronghorn antelope management.

C. To promote species-oriented research for development of new information on all aspects of pronghorn antelope ecology, life, history, and management on western ranges.

D. To identify particular problems associated with pronghorn antelope management and to formulate recommendations and resolutionss directed to the appropriate agency or organization including the Western Association of State Game and Fish Commissioners.

E. To promote cooperation among all agencies and

organizations concerned with pronghorn antelope management and research, particularly among the various provincial, state, and federal agencies with the primary responsibilities of managing this species and its habitat.

IV. Organization

A. The Pronghorn Antelope Workshop shall be open to any person interested in pronghorn antelope and its management.

B. Voting

Voting members shall consist of one representative of each of the following:

1. State, provinces and countries.

   Alberta, Arizona, California, Colorado, Idaho, Kansas, Montana, Mexico, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, Saskatchewan, South Dakota, Texas, Utah Washington, Wyoming.

2. Federal Agencies.

   Bureau of Land Management, Forest Service, Soil Conservation Service, U.S. Fish and Wildlife Service, National Park Service, Parks Canada, and the Direction General de Fauna Silvestre.

3. Universities and Colleges.

   The chairman may appoint up to three people to represent colleges and universities. This appointee shall come from any college or university actively engaged in antelope research.

Voting representatives for the states, provinces and countries shall be appointed by the agency directly responsible for wildlife management within the above named states, provinces, and countries.

The chairman shall request that each of the above named

federal agencies appoint one voting member. This request shall be directed to one of the regional offices or service centers in the western United States, Canada, and Mexico.

Voting shall be accomplished only by those authorized representatives in attendance at the business meeting of the Workshop.

C. The Pronghorn Antelope Workshop will be scheduled biennially on even numbered years. The host state, province, or country shall select the time and place of the meeting. The host shall appoint one of its representatives who will act as Chairman. The duties of the chairman shall be:

1. To serve as chairman for the two year period following his appointment.

2. To call for papers and prepare an agenda for the Workshop and assemble and distribute any recommendations or resolutionss made or passed at the Workshop.

3. To prepare and distribute the transactions of the Pronghorn Antelope Workshop for which he has been responsible.

4. To organize and conduct the meeting and business of the Workshop.

5. To appoint committees as necessary.

6. To maintain the goals and objectives of the Workshop.

7. To prepare and make a formal report to the Western Association of State Game and Fish Commissioners.

D. The new host state, province, or country shall be selected and announced at the business meeting of the Workshop. It is the intent of the Workshop that host state, province, or country will be volunteered on a rotating basis among the actively participating member states, provinces, and countries.

E. The mailing list of the Pronghorn Antelope Workshop shall be:

1. The Western Association of State Game and Fish Commissioners.

2. The Director and Game Chief of every member state, province, and country.

3. All biologists known to be conducting antelope research.

4. All state BLM offices and BLM Regional Service Centers in the western United States.

5. All regional Forest Offices of the western United States.

6. All regional offices of the U.S. F. & W.S. in the western United States.

7. All regional offices of the S.C.S. in the western United Statess.

8. All Cooperative Wildlife Research Units in the western United States.

9. All persons attending the Workshop.

10. Any person or organization requesting a copy of the Proceedings.

F. The chairman shall forward the mailing list and any other pertinent material to the new Workshop chairman upon completion of his responsibilities as chairman of the current Workshop.

As amended April 10, 1980 at Rio Rico, Arizona.

The Denver Wildlife Research Center Library, U. S. Fish and Wildlife Service, has a complete set of Antelope Workshop Proceedings. Anyone wishing to borrow all or part of the set must have his/her library request the materials through inter-library loan. Any library can provide service, so if there is no reseearch library available, you may use whatever library is convenient. The loan period will be for two weeks.

Individual copies of articles from the proceedings may be obtained by contacting DWRC library directly or through your library. We will photocopy the articles free of charge. Please provide as complete a citation as possible.

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