Arizona Statewide Pronghorn Operational Plan

Arizona Game and Fish Department
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In 2006, about 8,000 American pronghorn are found in Arizona, chiefly in the north-central portion of the state. Small, scattered herds of Chihuahuan pronghorn occur in southeastern Arizona and the endangered Sonoran pronghorn are found in southwestern Arizona. Sonoran pronghorn are not addressed in this document, but are addressed in a separate recovery plan for this federally endangered subspecies. Most of Arizona's pronghorn population is found between 3,000-7,000 feet elevation. Sometimes, northern herds occur as high as 10,000 feet during summer. This range in elevation encompasses a variety of grassland habitats ranging from desert grasslands to forest and mountain meadows. Pronghorn prefer flat, open grassland areas, but also use rolling or broken hills and mesa tops of less than 20 percent slope. They also use such diverse habitats as sparse deserts, woodlands, and open forests. Pronghorn home range estimates are quite large, and can vary from 20-40 mi^2.

The Department's statewide goal is to maintain pronghorn populations that provide diverse recreational opportunities for the public. Specific objectives for pronghorn management include maintenance of a statewide population of 8,250 to 10,000 post-hunt adults, and to have an annual harvest of between 600 and 800 animals. We would like to provide recreational opportunity for 1,200 to 1,600 pronghorn hunters per year. These objectives are to be accomplished through several strategies identified in our primary wildlife management planning document: the *Wildlife 2006 Strategic Plan.*

This statewide operational plan is designed to implement the statewide strategies by identifying issues and opportunities with individual pronghorn herds. This is designed to be a document that is updated whenever changes dictate.

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INTRODUCTION

Early explorers and military personnel moving into or through southeastern Arizona in the mid-late 1800s reported that pronghorn (*Antilocapra americana*) where common throughout all grassland areas. As more and more people poured into the region, unregulated market and subsistence hunting took its toll on all native ungulates, but especially our pronghorn. This high of level of livestock grazing peaked in the 1890s when southeastern Arizona experienced a period of severe drought. All of these early pressures caused a widespread decline in pronghorn in southeastern Arizona. By 1907 Mearns reported *"the pronghorn antelope is already a rare animal in the region of the Southwest, where it ranged in the thousands 25 years ago."*

The pronghorn is an important wildlife resource in Arizona. Pronghorn historically occurred in the grasslands of northern and southern Arizona at elevations ranging from 1,000-8,000 feet. Pronghorn are less widely distributed today than in the mid-1800s. Under pristine conditions, pronghorn ranged west of the Mississippi River from southwestern Canada through the Rocky Mountain region south to central Mexico. By the 1920s, pronghorn numbers reached a low of about 30,000 with only about 650 in Arizona. Possible factors leading to this drastic decline in pronghorn numbers include subsistence and market hunting and disease introduced by domestic livestock.

When pronghorn were more numerous and widespread, there was free interchange among groups concentrated in the different major valleys in the southeastern portion of the state. In contrast, they are now and probably always will be relegated to distinct and isolated populations associated with remnant expanses of grassland. Present-day pressures of urban expansion, agriculture, highways, canals, and fences preclude the establishment of one large continuous population in our sky island and valley dominated landscape. Each population has its own management issues and challenges.

Many pronghorn populations in Arizona are declining due to poor fawn recruitment. Maintaining and maximizing use of existing habitat are the most important issues in pronghorn management in Arizona.

This plan draws heavily from the baseline habitat description and evaluation done by Ockenfels et al. (1996). The text from that report is used in some places here to describe the habitat used by southeastern Arizona pronghorn populations. That work provides important basic information about the quantity and quality of habitat available and also the major issues facing each population.

GENERAL STATEWIDE MANAGEMENT GUIDELINES

The estimate for the statewide pronghorn population in 2003 was about 8,000 post-hunt adults, with 21,000 mi^2 of occupied habitat. The Department's goal is to maintain pronghorn populations at levels that provide diverse recreational opportunities. Specific objectives for pronghorn management are to maintain a statewide population of 8,250 to 10,000 post-hunt adult pronghorn and to have an annual harvest of between 600 and 800 animals; to provide recreational opportunity for 1,200 to 1,600 pronghorn hunters per year and 4,500 to 6,000 hunter days per year; to maintain existing occupied habitat, with emphasis on retention of medium and

high quality habitat, and to restore the historical range in Arizona by repopulating through transplants. These objectives are to be accomplished through several strategies identified in the Department's *Wildlife 2006 Strategic Plan.* These strategies are:

- Manage and enhance habitat through partnerships with public agencies, property owners, lessees, and conservation organizations.
- Improve conditions of declining or low-density herds through research, conservative hunt management, supplemental transplants, and predator management.
- Identify suitable new transplant locations.
- Establish self-sustaining pronghorn populations at all transplant sites.
- Identify important habitats for populations and determine where protection and improvement are possible, in cooperation with land management agencies, property owners, and lessees.
- Use population surveys and modeling to assist in permit recommendations.
- Provide hunter recreation that stresses the quality of the hunting experience.

This document is intended to provide a template for management of pronghorn populations. To facilitate a more efficient planning process, a framework was developed where information common to all of the planning areas was incorporated into a single document and specific information on each herd was incorporated into individual chapters. These individual chapters are designed so they can be removed from the document and provide background and strategies for specific populations. The Department uses Game Management Units (Units) as the typical boundary for managing game populations within the State. Where there was known or documented movement of pronghorn between units, attempts were made to combine these units so they would represent a single population.

Purpose and Need

Arizona has experienced tremendous population growth over the past decade and current projections indicate growth will continue at a rate of 2-4% per year over the next 10 years (Arizona DES Population Projections). Beginning in the late 1980s, the Arizona Game and Fish Department expressed concern over the loss of high quality pronghorn habitat that was being eliminated at an alarming rate through urban sprawl and population expansion into rural areas. Throughout the 1990s, continued loss of habitat caused some local pronghorn populations to be drastically reduced or eliminated. An example is the Willow Lake herd that is located within the city limits of Prescott. Over 80% of the habitat for this herd has been lost since 1973. Attempts to monitor and relocate the Willow lake population were met with considerable controversy due to the high visibility of this herd and "adoption" of these pronghorn by local residents. This herd continues to decline and it is anticipated that the population will eventually be eliminated. The Department realized this type of problem has the potential to increase and spread into other areas of the state. It became evident that there was a need to identify factors affecting pronghorn populations and develop a plan to address these issues and to begin a process for working on the most critical problems. In 2002, the Arizona Game and Fish Commission directed the Department to create plans for all pronghorn populations in the state.

The decline of pronghorn populations across Arizona continues to be a concern for the Arizona Game and Fish Department. Our statewide pronghorn population estimate in 1987 was nearly

12,000 post-hunt adults; by 1999 this estimate had declined to less than 8,000. The Department conducted a statewide evaluation of pronghorn habitat in 1995 (Ockenfels et al. 1996). In that analysis, we quantified and ranked the quality of pronghorn habitat according to a variety of parameters. Pronghorn occupied an estimated 21,000 mi^2 of habitat across the state in 1999. About 250 mi^2 of this land was classified as high quality habitat.

Causes of decline in pronghorn herds across Arizona are numerous, but generally consistent. Paramount to the persistence of any wildlife species is presence of quality habitat. Continued urban sprawl and associated highway construction has fragmented and damaged quality pronghorn habitat (the latter continues to cause direct mortality via collision with vehicles). Grasslands historically dependent upon predictable fire regimes have been reduced in size by invasion of juniper and shrub species resulting from of decades of fire suppression. Past livestock grazing and historic fencing practices have reduced habitat quality and created barriers that pronghorn cannot maneuver. Finally, persistent drought and predation has impacted pronghorn populations to varying degrees statewide. The combination of these factors has led to a reduction in habitat availability and quality, a substantial decline in fawn recruitment, and a correlated increase in efficiency of pronghorn predators.

Plan Focus

The focus of this plan is to outline a framework for management of pronghorn. Strategies to mitigate the identified impacts to pronghorn in Arizona are addressed in the *Wildlife 2006* and *Statewide Pronghorn Habitat Evaluation* (Ockenfels et al. 1996) planning documents. Implementation of these strategies should be the critical focus in achieving Department Goals and Objectives. The purpose of this pronghorn plan then, is two fold. First, this document is designed to provide a readily available source of information about location of pronghorn, status, and management direction. Second, this document is intended to provide specific management direction aimed at arresting pronghorn population declines. Management actions developed and proposed within this plan are intended to provide clear direction to accomplish specific tasks. In some cases, currently available information is inadequate for developing specific management direction. It was therefore necessary to formulate some tasks directed at filling these gaps in knowledge. Effective implementation of this plan necessitates that specific tasks derived from this document be tiered down into annual operational plans.

Management Issues Regarding Arizona Pronghorn Populations

Tree and Shrub Encroachment: Pronghorn generally occupy open grassland or shrub-steppe habitats. Encroachment of shrubs or trees have reduced suitability of habitat, resulted in habitat abandonment, and isolated herds from historic interchange. Canopy cover should be <20% and tree density should be <15/acre.

Forage Availability: Pronghorn rely on forbs as the predominant food item, although shrubs may be important seasonally. Optimal vegetative composition should be short (<25 inches tall) shrubs (10-35% ground cover) and forb and grass (30-50% ground cover), emphasizing a diversity of forb species. Nutritional considerations of digestibility, quality, and nutrient levels are also important.

Water Distribution: Optimal water distribution is 1 water within each mi^2 of occupied habitat with little screening vegetation nearby.

Fawning Cover: Fawning cover is generally provided by herbaceous vegetation that is >11 inches in height, with little shrub cover. Inappropriate grazing management or drought may adversely impact fawning cover.

Fences: Pronghorn traverse fences by passing under, rather than over, the fence. Woven wire or fences with bottom wires below 20 inches act as barriers to their movement. Keeping a smooth bottom wire ≥20 inches above ground level or equipping the bottom wire with plastic pipe "goat bars" facilitates their movement through fences. Fences become more impervious barriers to pronghorn movement when they are placed near high-traffic roads. **Refer to the most recent *Wildlife Development Standards* published by the Arizona Game and Fish Department Development Branch for current fencing standards.**

Small Population Size: Isolated populations become increasingly vulnerable to extirpation as size decreases. Genetic consequences are commonly considered, but stochastic events like predation, disease, and climatic events have greater likelihood of causing extirpations.

INDIVIDUAL HERD PLANS

REGION I

Unit 1 Pronghorn Herd Management Plan

History and Background

Pronghorn distribution and population densities in Unit 1 are seasonal. Summer ranges vary across the unit with the greatest densities existing in the Big Lake to Wahl Knoll to Pat Knoll areas, in the grassland areas between State Highways 260 and 60, and the area north of Escudilla from the New Mexico State Line to Highway 191. There is also a transplant population at the Sipes White Mountain Wildlife Area. Pronghorn have been sighted throughout the unit during the summer months in such areas as around Greens Peak, Cerro Montosa west to the town of Vernon, and in the Lee Valley area. At times there are a significant number of pronghorn in these areas. During drought, pronghorn expand their range throughout the unit in search of water and adequate forage. They have been observed in the Kettle Holes area along the Black River and in the forest around Mineral Creek.

Winter and year round range is located primarily in the lower elevation grasslands along both sides of Highway 260, in the grasslands between Highways 260 and 60, in the pinyon-juniper country north and west of Escudilla, and in the area surrounding the Sipes White Mountain Wildlife Area.

Habitat Description

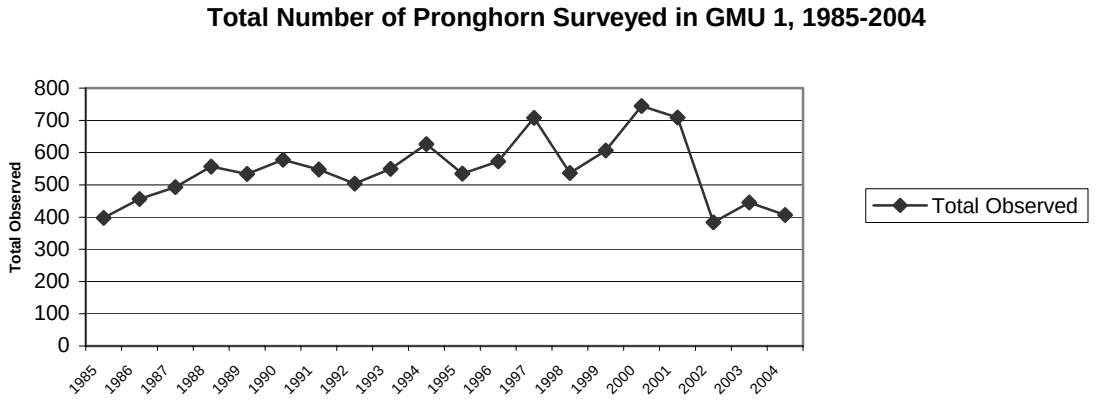
The Unit 1 pronghorn herd occupies three main habitat types. The summer range from 8,000 plus feet in elevation is primarily Montane Grasslands dominated by fescue grasses. The grasslands below 8,000 feet in elevation are Colorado Plateau Grasslands. There are extensive areas with no tree canopies, primarily east of the USFS boundary in the northeastern quarter of Unit 1. The third component is Colorado Plateau Grasslands with various degrees of pinyon-juniper canopy cover. This third habitat type is predominately found east of highway 180 and from FR 117 west to the unit boundary.

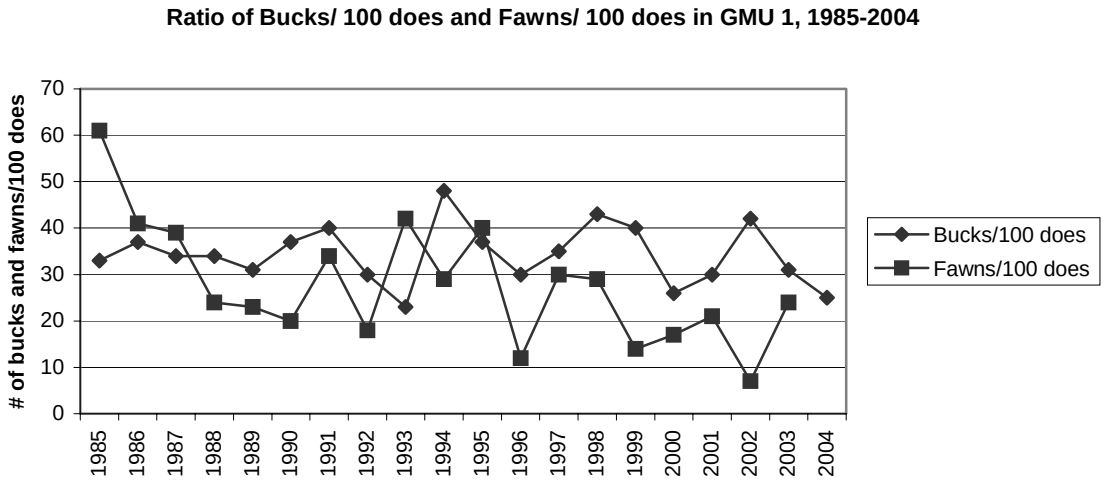
The majority of the pronghorn habitat in Unit 1 is composed of United States Forest Service (USFS) and Arizona State Trust Lands. Private lands also provide pronghorn habitat in this unit, but not to the extent of the Public and State Trust lands. In addition to this, the Arizona Game and Fish Department (AGFD) owns three wildlife areas within the pronghorn habitat in Unit 1. These are the Sipes White Mountain Wildlife Area (1362 deeded acres), the Grasslands Wildlife Area (2850 deeded acres), and the Becker Lake Wildlife Area (338 deeded acres). This is a total of 4550 acres. AGFD also administers 8142 acres of State Trust Lands associated with the Grasslands Wildlife Area. Of this 8142 acres, 5000 acres are grazed under a plan developed by Region I. The grazing plan is geared toward low intensity grazing to provide pronghorn in the area with residual fawning cover and to improve the forb component within the area.

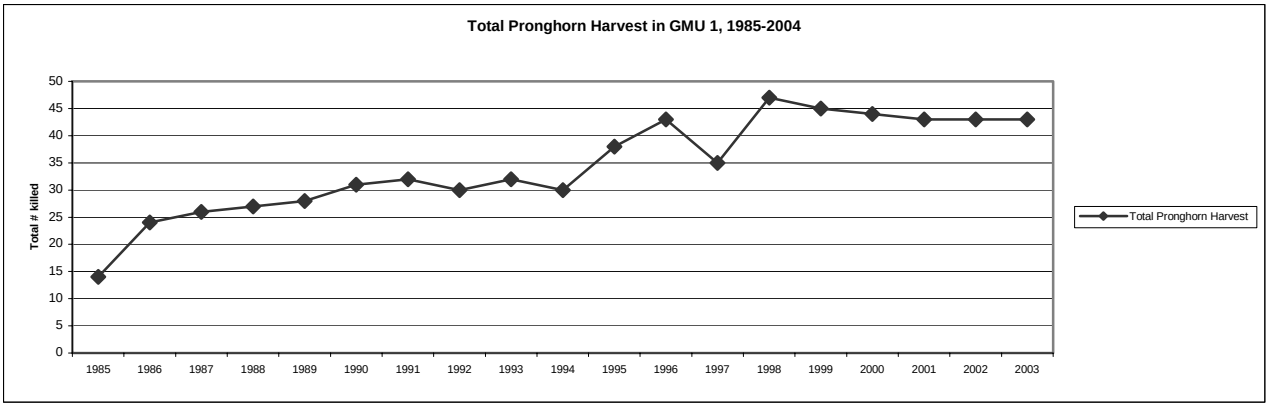
The habitat quality classifications determined in 1996 during the Research Branch habitat evaluation for Unit 1 were 68 mi^2 low, 117 mi^2 moderate and 48 mi^2 high quality.

Survey and Harvest Trends

Unit 1 holds one of the largest pronghorn populations in Region I. These populations consistently provide substantial wildlive viewing and harvest opportunity.







Management Goals

1. Fences:

Numerous fences occur throughout the pronghorn range in Unit 1. Some of these fences need to be modified to be pronghorn passable. This is being accomplished on a case-by-case basis. Interior fences on the Department-owned wildlife areas are being removed and existing boundary fences are either being modified or replaced. In addition to this, highway right-of-way fences along Highway 260 are being modified to allow passage of pronghorn. Any new fences being built or old fences being replaced along highway right-of-ways are being built to wildlife passable specifications.

2. Water Availability:

There are no major concerns within the unit for water distribution. Considering a four (4) mile radius around waters for pronghorn use, there is enough overlap within the unit to provide adequate water for pronghorn. Waters developed by ranchers, the U.S. Forest Service, and natural water sources provide adequate water distribution. During drought, however, these water sources should be monitored. Critical waters for pronghorn have been identified for this unit.

3. Tree-Shrub Encroachment:

In portions of Unit 1 encroachment from pinyon, juniper and Ponderosa pine trees are a concern. This is especially evident north of highway 260 and east of highway 180. In some areas the increasing canopy cover may reduce habitat suitability and block traditional movement corridors.

4. Plant Diversity:

Forage conditions and plant diversity could be an issue on USFS allotments grazed by sheep early in the growing season, i.e. overuse of the forb component could affect female pronghorn in the last trimester of pregnancy and during lactation. Additionally, late season or winter season grazing on USFS and State Trust lands could affect critical hiding cover for fawns the following spring.

5. Recreation:

Human activity may be a limiting factor in some portions of Unit 1, however it is not considered to be a widespread problem. Most recreational activity during the critical fawning period occurs in forested portions of the unit, which the does tend to avoid.

6. Human Encroachment:

Current and potential development in Unit 1 is a concern primarily in the area between Vernon and Springerville. There also is a proposed development west of Springerville immediately south of the Grasslands Wildlife Area along the Little Colorado River. This area is considered important to this herd since this area is both a migration route and serves as year round range.

Most of the undeveloped private land is used for livestock grazing by the landowners. If these landowners exit the livestock business, there is an increased probability that these lands will be sub-divided.

7. Translocation:

Two pronghorn reintroductions occurred on the Sipe White Mountain Wildlife Area in the mid to later 1990s. One group of animals came from near Moab, Utah and the others were captured near Prescott Valley, Arizona. These animals have established a resident herd near the release site. In addition, marked individuals have been observed across Unit 1 and even in Unit 27 and 2C. Recruitment for the transplant herd near the wildlife area has been low, with coyote predation on fawns believed to be the primary cause.

8. Predation

As noted above, predation of fawns has been a concern on a local level. There is no planned coyote control scheduled in Unit 1. An interesting note is that fawn survival rates in this herd consistently are highest in the Montane Grasslands. These grasslands offer more fawn hiding cover and possibly higher nutritional values.

9. Agency Coordination:

Coordination of pronghorn management issues has occurred with the Springerville Ranger District. This primarily happens when allotment management plans are being revised in the Montane Grasslands and during the annual hunt recommendation process.

Management Goals

Maintain current pronghorn population and distribution on private, State, Game and Fish and Forest Service Lands.

Management Objectives

Objective 1: Coordinate with land management agencies (primarily the U.S. Forest Service and the Arizona State Land Department) and private individuals and entities to insure that key pronghorn habitat is identified as well as identifying potential threats to key habitat. Use Heritage funds to acquire key pronghorn habitat, providing for parcels of significant size to allow for enhanced management opportunities.

Strategy 1a. Ensure that pronghorn needs are met when evaluating Allotment Management Plan revisions.

Strategy 1b. Evaluate any properties offered for sale to the Department for pronghorn habitat suitability.

Objective 2: Reduce Ponderosa pine and juniper encroachment on north end of unit.

Objective 3: Improve pronghorn forage conditions on Department properties:

Strategy 3a. Maintain appropriate grazing practices on State Lands associated with Grasslands Wildlife Area.

Strategy 3b. Promote burning and fertilization to increase nutritional levels of forbs and other desirable forage species.

Objective 4: Identify and maintain key migration route(s) between summer and winter range.

Strategy 4a. Attach GPS telemetry collars to pronghorn summering in Montane grasslands. Monitor pronghorn locations during fall and spring migration periods.

Unit 2A Pronghorn Herd Management Plan

History and Background

Pronghorn distribution and population densities are relatively the same across all of Unit 2A, with the exception of the area north of Interstate 40, where pronghorn occur in minimal numbers. The Navajo Indian Reservation borders the northern part of Unit 2A and on the Reservation pronghorns were proposed as an endangered species, because of extremely low numbers and the risk of extinction there.

According to the last winter survey (in 1996), the overall pronghorn density for this unit was 0.50 pronghorn/mi^2. The total pre-hunt population of pronghorns, according to the current computer model estimate, will be around 682 animals or about 0.48 pronghorn/mi^2, for 2003.

Habitat Description

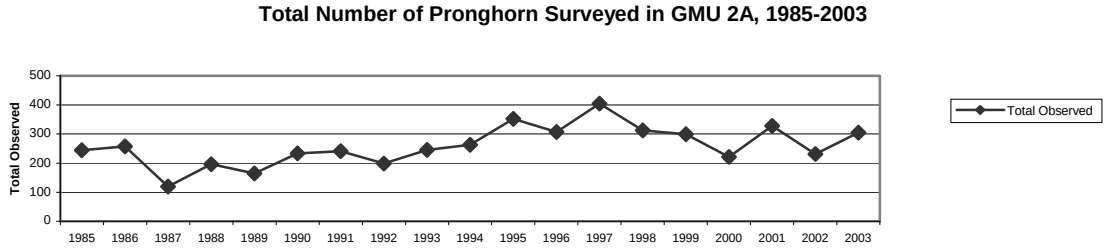
Unit 2A is large with about 1,415 mi^2. The majority of the pronghorn habitat within the unit is comprised of private lands and Arizona State Trust Lands with 51 and 23% respectively.

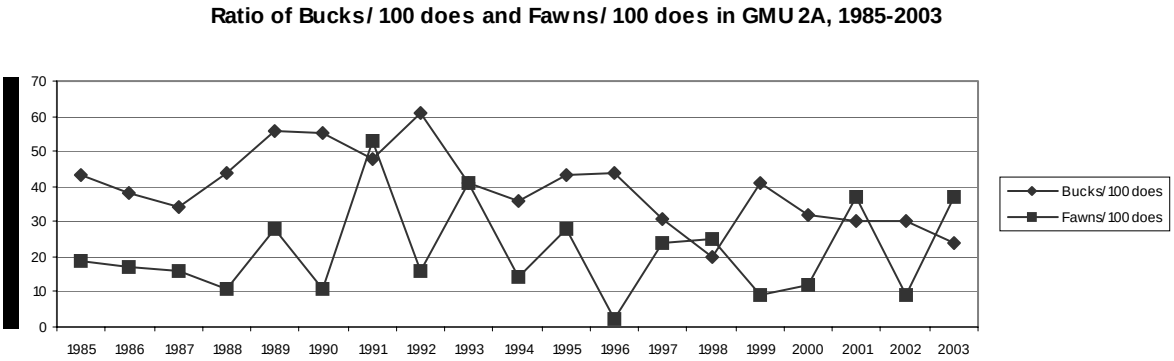
The Petrified Forest and Painted Desert National Park currently occupies 10% of Unit 2A. However, the Park Service is negotiating a land purchase and the park maybe expanded and about doubled in size within the next few years.

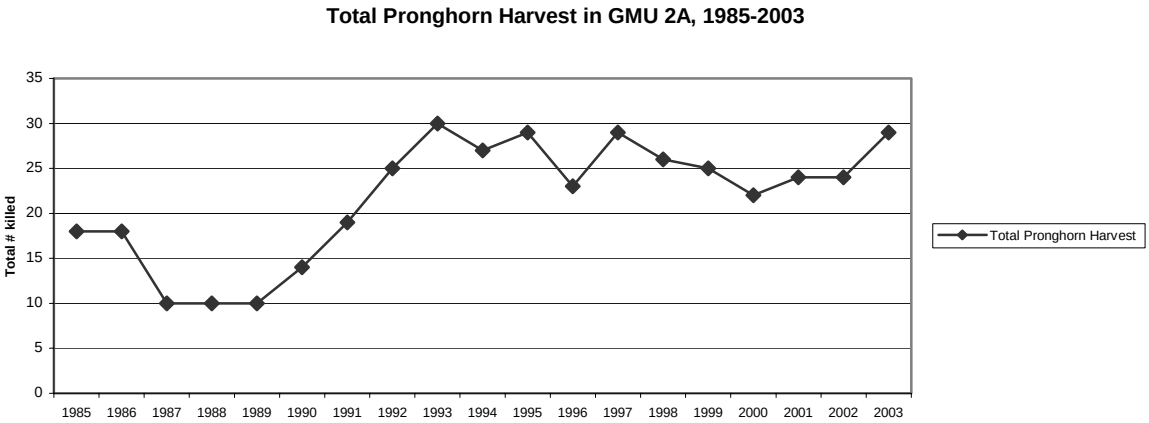
Research Branch evaluated Unit 2A for pronghorn habitat suitability, with 314 mi^2 rated as low, 567 mi^2 rated as moderate and only 24 mi^2 rated as high quality.

Survey and Harvest Trends

Unit 2A survey data indicates a stable to slightly increased population from 1985 to the present.







Management Issues

1. Fences:

   Numerous fences occur throughout the pronghorn range in Unit 2A. Most of the fences are older 4-wire fences, which normally allow for adequate wildlife movement. But there are a few fences that may need to be modified to increase the movement of pronghorn, through them. New fencing projects on State Trust Lands and along State-Federal Highways are supposed to be built to wildlife specifications, to allow pronghorn movement.

   Interstate 40 and the Santa Fe Railroad cross the northern part of this unit. These two routes parallel each other, generally within a mile or so of each other, and each has right of way fences. The interstate and railroad with the combined four fences is a very impervious barrier to pronghorn trying to move north or south. As noted previously, few pronghorn occupy lands north of Interstate 40.

   The fences along the Santa Fe Railroad within the Petrified Forest National Park were removed, in accordance with an agreement between the Railroad and Park. There is an ongoing study to see how this affects the movement of pronghorns in that area. However, the total distance that the railroad is within the park boundary is only about one mile.

2. Water Availability:
All of the waters for pronghorn in this unit are either natural occurring water sources (very limited) or water sources built for livestock operations (dirt tanks, windmills, water lines with drinkers, etc.). All of these are still dependent on rainfall patterns and on maintenance of the systems by the livestock operators.

Waters developed by ranchers and natural water sources would probably provide adequate water distribution, if all were available, all of the time. Many factors affect the water distribution (i.e., rainfall patterns, droughts, water sources shut down when livestock are moved or not present, manmade water sources not maintained), and water availability could easily be a limiting factor in parts of this unit for pronghorns during some years.

Critical waters for pronghorn have not been identified for this unit, based on the many factors listed above, the availability of water is always changing.

As a note, the pronghorn occurring on the Petrified Forest National Park are mostly dependent on water sources outside of the park, because of the very limited natural occurring water sources in the park. The Park Service is evaluating the potential to redevelop two dirt tanks to provide more permanent water for pronghorn.

3. Tree-Shrub Encroachment:
In portions of Unit 2A encroachment from pinyon and juniper trees is a concern. There are extensive areas of pronghorn habitat without trees, and this is not considered a major limiting factor for this herd.

4. Plant Diversity:
The following table shows the breakdown of the major vegetation types occurring in Unit 2A.

Habitat type	Mi^2	%
Great Basin Conifer Woodlands	60.3	4%
Great Basin Desert Scrub	184.9	13%
Plains and Great Basin Grasslands	1169.3	83%

The rangeland within this unit is normally grazed year round, with most having some livestock movement between pastures as needed. Range conditions vary greatly with rainfall pattern and associated livestock stocking rates. Excessive forage use is a concern in this unit.

5. Recreation:
Human activity may be a limiting factor in some portions of Unit 2A, however it is not considered to be a widespread problem.

6. Human Encroachment:

During the 1960s about 100 sections were subdivided within this unit. This would be about 7% of the unit and 14% of the private land within the unit. There is high turnover of residents with people moving in and out, associated fences being built and other fences falling down. However, these barriers still have a detrimental effect on the pronghorn.

Within the last 5 to 10 years, about 60 sections have been subdivided. This approximates 11% of the unit and about 22% of the private land being subdivided.

Not all of these subdivisions are in pronghorn habitat, but most are. But with the low profitability of the livestock industry, at this time, there is a great fear that more of the private land will be sold off for subdivisions, having a greater negative effect on the pronghorn population.

There are efforts to expand the Petrified Forest National Park. NPS is looking to add about 153 mi^2 to the Park, which would double the size of the Park. As mentioned above, the pronghorn depend mostly on areas outside the Park for water sources now. National Parks normally manage their wildlife with a hands off approach. With this approach, the water sources for pronghorn in this enlarged area will diminish (i.e., windmills shut off; dirt tanks silt in, or dams wash out—leaving no water) and this will adversely affect the pronghorn populations within the Park and near its borders.

Most of the undeveloped private land is used for livestock grazing by the landowners. If these landowners exit the livestock business, there is an increased probability that these lands will also be sub-divided and additional water developments abandoned.

7. Translocation:
Pronghorn have not been transplanted to or from Unit 2A.

8. Predation
Predation of fawns has been a concern. Aerial coyote control has been conducted in portions of Unit 2A. The fawn survival rates did not respond as well as expected. Drought conditions reduced fawn survival rates substantially even with a reduced coyote population.

9. Agency Coordination:
The Department does coordinate with the Petrified National Park personnel. Research Branch has conducted movement studies inside the park boundary.

Management Goals
Maintain and enhance current pronghorn population and distribution across Unit 2A. Increase survival rates of fawn pronghorn to a five year average of 35 fawns per 100 does.

Management Objectives
Objective 1: Increase forage conditions in "moderate" and "low" quality habitats.

Strategy 1a. Acquire key pronghorn habitat, providing for parcels of significant size to allow for enhanced management opportunities.

Objective 2: Maintain water distribution system if National Park expanded.

Strategy 2a. Recommend that park not be expanded.

Strategy 2b. If park expanded, recommend that wildlife waters be built and maintained to replace livestock waters that will be removed.

Strategy 2c. Recommend allowing managed livestock grazing on the affected areas to allow for maintenance of water sources.

Objective 3: Conduct water distribution analysis, and increase water availability where needed.

Strategy 3a. Conduct water distribution and dependability analysis.

Strategy 3b. Develop cost share agreements with livestock operators to redevelop and enhance water systems.

Strategy 3c. Coordinate with landowners and livestock operators to leave waters available to wildlife when livestock are absent.

Unit 2B Pronghorn Herd Management Plan

History and Background

Pronghorn distribution and population densities are similar across Unit 2B. According to the last winter survey (1997), the overall pronghorn density for this unit was 0.81 pronghorn/mi^2. The total pre-hunt population of pronghorns, according to the current computer model estimate, was around 714 animals or about 0.87 pronghorn/mi^2 in 2003.

Habitat Description

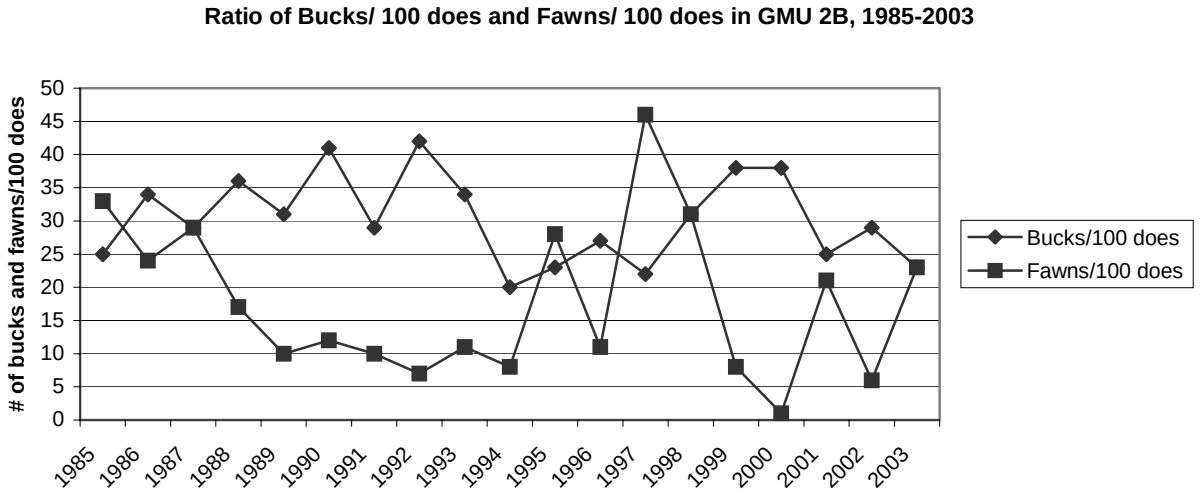
Unit 2B is about 821 mi^2 in size. The majority of the pronghorn habitat within the unit is comprised of private lands (354 mi^2) and Arizona State Trust Lands (400 mi^2).

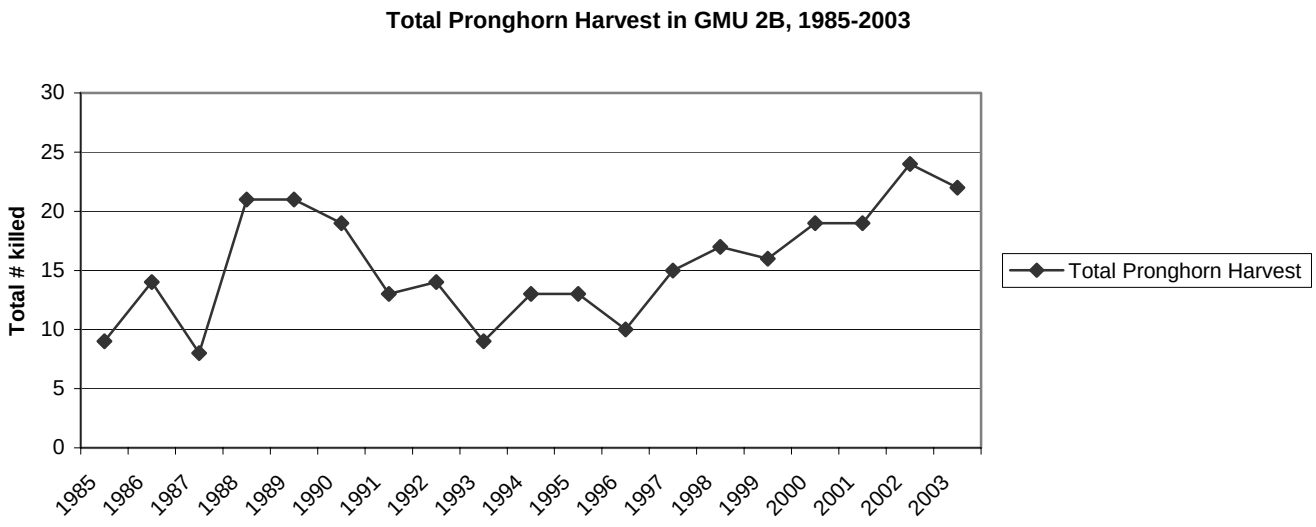
In 1996 Research Branch published data on Unit 2B's pronghorn habitat suitability. Access to about 36% (296 mi^2) of Unit 2B was denied for this evaluation. The ranked portion of Unit 2B was rated as 139 mi^2 of low, 160 mi^2 of moderate and only 7 mi^2 as high quality.

Survey and Harvest Trends

This herd is annually surveyed in August using fixed wing aircraft. Numbers surveyed have varied from around 50 in 1980 to 420 in 1997. In January 2003 a complete winter survey was conducted. A total of 482 pronghorns were observed. The 2003 population estimate was 658 adult animals. Unit 2B survey data indicates a relatively stable population from 1985 to the present. However, the fawn recruitment rates are below other units in the region.

Unit 2B traditionally has been managed as a muzzleloader only pronghorn hunt. Permit levels have varied from 20 to 35 from 1982 to 2003. Hunt success averages around 55 to 60%.





Management Issues

1. Fences:
   Numerous fences occur throughout the pronghorn range in Unit 2B. Most of the fences are older 4-wire fences, which normally allow for adequate wildlife movement. But there are a few fences that may need to be modified to increase the movement of pronghorn, through them. New fencing projects on State Trust Lands and along State-Federal Highways are supposed to be built to wildlife specifications, to allow pronghorn movement. However, subdivision of large areas increases fence densities, and designs can impede or prevent pronghorn movements. One livestock operator installed two strand electric fences within key pronghorn habitat. The effects of this fence on the pronghorn are unknown.

2. Water Availability:
   All of the waters for pronghorn in this unit are either natural occurring water sources (very limited) or water sources built for livestock operations (dirt tanks, windmills, water lines with drinkers, etc.). All of these are dependent on rainfall patterns and on maintenance of the systems by the livestock operators.

   Waters developed by ranchers and natural water sources would probably provide adequate water distribution, if all were available, all of the time. However with these many factors affecting the water distribution (i.e., various rainfall patterns, droughts, water sources shut down when livestock are moved or not present, manmade water sources not maintained), water availability could easily be a limiting factor in parts of this unit for pronghorn in some years.

   Critical waters for pronghorn have not been identified for this unit. Based on the many factors listed above, the availability of water is always changing.

3. Tree-Shrub Encroachment:
In many portions of Unit 2B encroachment from pinyon and juniper trees is a concern. This is believed to be a significant factor in providing cover to coyotes, which prey upon the fawns.

4. Plant Diversity:
The following table shows the breakdown of the major vegetation types occurring in Unit 2B.

Habitat association	Mi^2	%
Great Basin Conifer Woodlands	311	38%
Great Basin Desert Scrub	39.1	5%
Plains and Great Basin Grasslands	473.1	57%

The rangeland within this unit is normally grazed year round, with most having some livestock movement between pastures as needed. Range conditions vary greatly with rainfall pattern and associated livestock stocking rates. There is concern with forage overuse, especially during droughts and prior to pronghorn fawning.

5. Recreation:
Human activity may be a limiting factor in some portions of Unit 2A, however it is not considered to be a widespread problem.

6. Human Encroachment:
During the 1960s about 20 sections were subdivided within this unit. This comprises about 2% of the unit and almost 6% of the private land within the unit. Most of this area is not fully developed, with people moving in and out and associated fences being built and other fences falling down. However, these still have a detrimental effect on the pronghorn.

Within the last few years about 145 sections have been subdivided or are in the process of being subdivided. This is about 20% of the unit and about 47% of the private land being subdivided and converted from livestock grazing.

Not all of these subdivisions are in pronghorn habitat, but most are. But with the low profitability of the livestock industry, at this time, there is a great fear that more of the private land will be sold off for subdivisions, having a greater effect on the pronghorn population.

Another new threat to this population is the exploration and extraction of subterranean carbon dioxide gas. The gas is extracted through drilled wells and is transported by pipeline to oil fields to aid in oil recovery. Many wide roads have been and are being built. These roads facilitate vehicle access, reduce forage availability, and hinder pronghorn movement.

7. Translocation:
Pronghorn have not been transplanted to or from Unit 2B.

8. Predation
Predation of fawns has been a concern. Aerial coyote control was conducted in portions of Unit 2B in 1995, 1996 and 1997. The five year average fawn crop for 1990–1994 was 9 fawns per 100 does. The fawn to does ratios for 1995, 1996 and 1997 were 28, 11 and 46 per 100 does respectively. However, the five-year average fawn recruitment rate for 1998 to 2002 declined to 14 fawns per 100 does.

The high density of juniper tree cover and lack of extensive herbaceous fawning cover facilitate predation and are believed to be main causes for the low fawn to does ratios.

9. Agency Coordination:
Unit 2B is composed primarily of State Trust Lands and private lands. There has been no significant coordination with the State Land Department.

Management Goals

Maintain and enhance current pronghorn population and distribution across Unit 2B. Increase survival rates fawn pronghorn to a five-year average of 30 fawns per 100 does.

Management Objectives

Objective 1: Increase forage conditions in "moderate" and "low" quality habitats.

Strategy 1a. Use Heritage funds to acquire key pronghorn habitat, providing for parcels of significant size to allow for enhanced management opportunities.

Strategy 1b. Remove pinyon and juniper trees as needed and as opportunities arise in and adjacent to occupied habitats.

Objective 2: Conduct water distribution analysis, and increase water availability where needed.

Strategy 2a. Conduct water distribution and dependability analysis.

Strategy 2b. Develop cost share agreements with livestock operators to redevelop and enhance water systems.

Strategy 2c. Coordinate with landowners and livestock operators to leave waters available to wildlife when livestock are absent.

Unit 2C Pronghorn Herd Management Plan

History and Background

Pronghorn distribution and population densities are similar throughout Unit 2C. The only winter survey, occurred in this unit in 1991, indicated an overall pronghorn density of 1.2 pronghorn/mi^2. The total pre-hunt population of pronghorns, according to the current computer model estimate, was around 414 animals or about 1.3 pronghorn/mi^2, for 2003.

Habitat Description

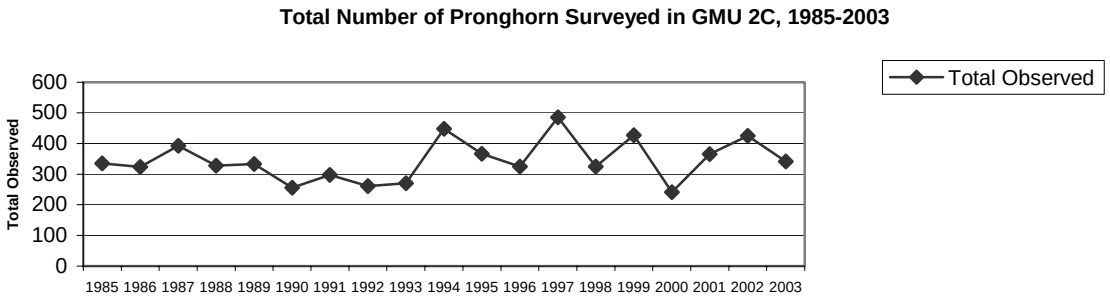
Unit 2C is a relatively small unit with about 315 mi^2. The majority of the pronghorn habitat within the unit is comprised of Arizona State Trust Lands (167 mi^2) and private lands (128 mi^2).

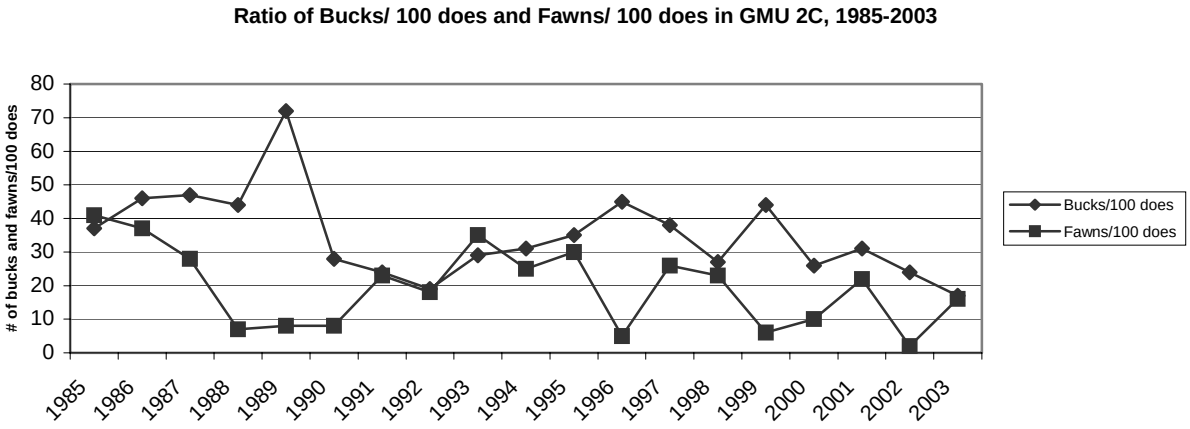
In 1996 Research Branch published data on Unit 2C's pronghorn habitat suitability. This unit scored well with 125 mi^2 rated as moderate and 88 mi^2 rated as high quality habitat.

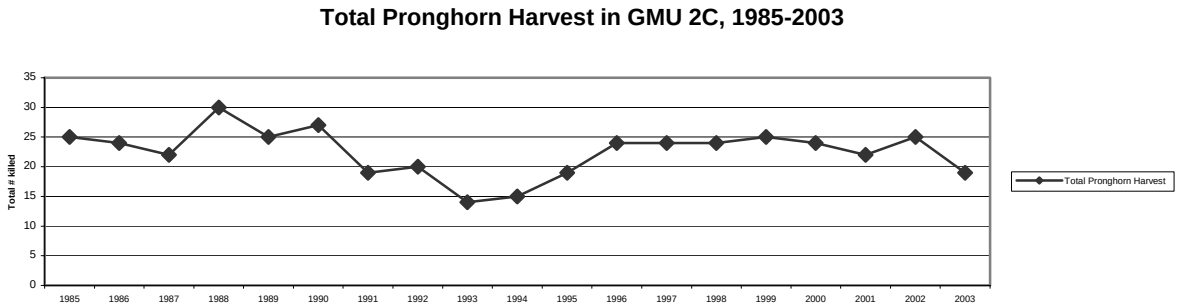
Survey and Harvest Trends

This herd is annually surveyed in August using fixed wing aircraft. Numbers surveyed have varied from around 96 in 1979 to 485 in 1997. The 2003 population estimate is 414 adult animals. Unit 2C survey data indicates a robust population with high observations per hour. The population appears stable over this period.

Unit 2C traditionally has annually offered a rifle hunt. Permit levels have varied from 15 to 40 from 1977 to 2004. Hunt success averages 90 to 100%. Success rates for the rifle hunt have averaged around 95% since the mid-1980s.







Management Issues

1. Fences:
   Numerous fences occur throughout the pronghorn range in Unit 2C. Most of the fences are older 4-wire fences, which normally allow for adequate wildlife movement. But there are a few fences that may need to be modified to increase the movement of pronghorn, through them. New fencing projects on State Trust Lands and along State-Federal Highways are supposed to be built to wildlife specifications, to allow pronghorn movement.

2. Water Availability:
   All of the waters for pronghorn in this unit are either natural occurring water sources (very limited) or water sources built for livestock operations (dirt tanks, windmills, water lines with drinkers, etc.). All of these are dependent on rainfall patterns and on maintenance of the systems by the livestock operators.

   Waters developed by ranchers and natural water sources would probably provide adequate water distribution, if all were available, all of the time. However with many factors affecting the water distribution (i.e., rainfall patterns; droughts; water sources shut

down when livestock are moved or not present; manmade water sources not maintained), water availability could easily be a limiting factor in parts of this unit for pronghorns, in some years.

Critical waters for pronghorn have not been identified for this unit. Based on the many factors listed above, the availability of water is always changing.

3. Tree-Shrub Encroachment:
Encroachment from pinyon and junipers is occurring in portions of Unit 2C. However, the scale is not considered a significant limiting factor.

4. Plant Diversity:
The following table shows the breakdown of the major vegetation types occurring in Unit 2C.

Habitat Type	Mi^2	%
Great Basin Conifer Woodlands	64.5	21%
Great Basin Desert Scrub	1.9	1%
Plains and Great Basin Grasslands	248.2	79%

Most of the rangeland within this unit is normally grazed year round, with most having some livestock movement between pastures as needed; but a fair portion is grazed only in the winter and early spring. Range conditions vary greatly with rainfall patterns and associated livestock stocking rates.

5. Recreation:
Human activity may be a limiting factor in some portions of Unit 2C, however it is not considered to be a widespread problem.

6. Human Encroachment:
During the 1960s at least 14 sections were subdivided within this unit. This comprises about 4% of the unit and almost 11% of the private land within the unit. Most of these subdivisions are smaller lots than the subdivisions in Units 2A and 2B; yet most of these are not developed.

Within the last few years about 28 sections have been subdivided or are in the process of being subdivided. This makes a total of 13% of the unit being subdivided and about 33% of the private land being used for residential purposes. Most of the development is on the west and southwest portions of the unit.

Not all of these subdivisions are in pronghorn habitat, but most are. But with the low profitability of the livestock industry, at this time, there is a great fear that more of the private land will be sold off for subdivisions, having a greater effect on the pronghorn population.

7. Translocation:
Pronghorn have not been transplanted to or from Unit 2C and the population currently is not in need of a transplant.

8. Predation
Predation of fawns has been a concern. Aerial coyote control has not been conducted in Unit 2C for at least 15 years.

The lack of extensive areas of quality herbaceous fawning cover are believed to be main causes for the low fawn to does ratios

9. Agency Coordination:
Unit 2C is composed primarily of State Trust Lands and private lands. There has been no significant coordination with State Lands.

Management Goals

Maintain and enhance current pronghorn population and distribution across Unit 2C. Increase survival rates fawn pronghorn to a five year average of 30 fawns per 100 does.

Management Objectives

Objective 1: Increase forage conditions in "moderate" and "high with problems" quality habitats.

Strategy 1a. Use Heritage funds to acquire key pronghorn habitat, providing for parcels of significant size to allow for enhanced management opportunities.

Strategy 1b. Remove pinyon and juniper trees as needed and as opportunities arise in and adjacent to occupied habitats.

Objective 2: Modify more livestock fences to wildlife friendly standards.

Strategy 2a. Inventory current livestock fences. Prioritize modification projects.

Objective 3: Work with land agencies and individuals to protect and enhance pronghorn habitat. Assist them in looking for all available funding sources to allow more projects that would enhance the pronghorn habitat to take place (pinyon-juniper treatments to reduce the encroaching of these woodlands, fence modification or providing more water sources available to pronghorn).

Strategy 3a. Work with the 26 Bar Ranch Manager to identify projects to benefit pronghorn on their private and State Land lease.

Strategy 3b. Identify and prioritize all water sources as part of a critical waters mapping effort.

<u>Unit 3A Pronghorn Herd Management Plan</u>

History and Background

Pronghorn area distributed throughout the undeveloped areas within Unit 3A. Any seasonal variation in distribution is influenced primarily by rainfall patterns and livestock grazing which produce variations in the quality and quantity of available forage. There is no distinction between winter and summer ranges.

Habitat Description

The majority of the pronghorn habitat in Unit 3A is comprised of private, Arizona State Trust, Bureau of Land Management (BLM), and U.S. Forest Service lands. The east half of the unit (east of Highway 77) is about 75% private land, about 25% State Trust Land with a few scattered sections of BLM land. There are 19 sections of Forest Service land in the southwest corner of the unit. The remaining part of the unit west of Highway 77 is about 60% private and 20% each of State Trust and BLM land in a checkerboard pattern.

The 1996 research Branch report on Unit 3A Pronghorn Habitat ratings classified 157 mi^2 rated as low, 396 mi^2 rated as moderate and 25 mi^2 rated as high quality.

Survey and Harvest Trends:

Pronghorn density within the unit has fluctuated over the last 15-20 years, but population status derived from survey trends and animals observed per hour does not appear to conclusively show that the population is either increasing or decreasing. The number of animals observed/hour during regular surveys is displayed in the graph below:

Unit 3A Survey and Harvest Trend Information

Unit 3A survey data indicates a relatively stable population, but has several consistent years of low fawn recruitment.

Management Issues

1. Fences:
   Numerous fences occur throughout the pronghorn range in unit 3A. Most of these fences need to be modified to be pronghorn passable. Fences and fenced highways, which surround (State Routes 277, 377 and 180) and bisect (State Highway 77) unit 3A, were said to be the most pressing problem for pronghorn management in the unit by the 1996 "Statewide Evaluation Of Pronghorn Habitat in Arizona" (Ockenfels et. al.). The unit's fences need to be inventoried and prioritized so that a plan to modify these fences can be formulated.

2. Water Availability:
There are no major concerns within the unit for water distribution. There is one Game and Fish catchment in the unit, which was built primarily for pronghorn. Silver Creek and the Little Colorado River run through the west half of the unit, but neither is a perennial stream. The remaining waters are dirt stock tanks maintained by ranchers. Unit 3A is prone to drought conditions, and water availability needs to be monitored during droughts. Because of the number of BLM sections in the west half of the unit, the opportunity exists to build additional pronghorn waters should it be determined that the need exists. The various stock tanks in the west side of the unit should be evaluated for reliability and accessibility to make this determination.

3. Tree-Shrub Encroachment:
In primarily the western portions of Unit 3A encroachment from pinyon and juniper trees is a concern. This is believed to be a significant factor in providing cover to coyotes, which prey upon the fawns.

4. Plant Diversity:
Forage conditions and plant diversity are a critical issue throughout the unit. Heavy livestock use coupled with frequent drought periods act to reduce the forb component during the growing season. Additionally, late season or winter season grazing could affect critical hiding cover for fawns.

5. Recreation:
Human activity may be a limiting factor in some portions of Unit 3A, however it is not considered to be a widespread problem.

6. Human Encroachment:
Habitat juxtaposition is a concern in some parts of Unit 3A. The east half of the unit has been inundated with residential developments; primarily 40 acre ranches. Development in this area was not planned to provide easements and travel corridors for pronghorn. Development has not been as widespread on the west half of the unit, though there is some development spreading north from Snowflake along the Highway 77 corridor. For most of the west side of the unit, except for the previously mentioned fences, there is little development to restrict pronghorn movement and use of available habitat.

7. Translocation:
Pronghorn have not been transplanted to or from Unit 3A. There is no current need for transplants into Unit 3A.

8. Predation
Predation of fawns has been a concern. Aerial coyote control has been conducted in Unit 3A for at least two sessions in the past ten years. The western portion of the unit is scheduled for control in 2005. There have been moderate increases in fawn to doe ratios that correlate with predator removal efforts.

The lack of extensive areas of quality herbaceous fawning cover and the juniper component facilitate predation and are believed to be main causes for the low fawn to does ratios.

9. Agency Coordination:
Unit 3A is composed primarily of State Trust Lands and private lands. There has been no significant coordination with the State Land Department.

Management Goals

Maintain and enhance current pronghorn population and distribution across Unit 3A. Increase survival rates fawn pronghorn to a five year average of 30 fawns per 100 does.

Management Objectives

Objective 1: Maintain and enhance large blocks of pronghorn habitat.

Strategy 1a. Acquire key pronghorn habitat, providing for parcels of significant size to allow for enhanced management opportunities.

Strategy 1b. Coordinate with private land ranchers and developers to consider pronghorn in future planning and development efforts.

Objective 2: Modify more livestock fences to wildlife friendly standards.

Strategy 2a. Inventory current livestock fences. Prioritize modification projects.

Objective 3: Work with land agencies and individuals to protect and enhance pronghorn habitat. Assist them in looking for all available funding sources to allow more projects that would enhance the pronghorn habitat to take place (pinyon-juniper treatments to reduce the encroaching of these woodlands, fence modification or providing more water sources available to pronghorn).

Strategy 3a. Encourage key landowners to participate in the Show Low Habitat Partnership Committee Work. Their input can better direct future projects to benefit pronghorn.

Strategy 3b. Coordinate with land management agencies (primarily the BLM and the Arizona State Land Department) and private individuals and entities to insure that key pronghorn habitat is identified as well as identifying potential threats to key habitat.

Objective 4: Increase water availability and dependability.

Strategy 4a. Analyze water dependability and availability during drought periods, identify areas that would benefit from additional waters.

Strategy 4b. Develop cost share agreements with livestock operators to redevelop and enhance water systems.

Strategy 4c. Coordinate with landowners and livestock operators to leave waters available to wildlife when livestock are absent.

Unit 3C Pronghorn Herd Management Plan

History and Background

Pronghorn habitat and distribution is currently restricted to that portion of Unit 3C that is north of State Highway 260. The unit's habitat type transitions from ponderosa pine south of Highway 260, to pinyon-juniper woodlands north of Highway 260 to pinyon-juniper grasslands and grasslands on the north end of the unit. Pronghorn are distributed throughout the area north of Highway 260. There may be some seasonal migration of animals from the pinyon-juniper woodland north to the grasslands resulting from snow in the winter months, but most pronghorn movement is to take advantage of higher quality forage that results from variable or "spotty" rainfall patterns. Prior to 1991, Unit 3C was managed in conjunction with Unit 3B.

Habitat Description

The majority of the pronghorn habitat in Unit 3C is comprised of U.S. Forest Service lands. In the north part of the unit, where the best pronghorn habitat lies, there are 22 – 23 sections of private land and about 9 sections of State Trust Land. The Forest Service land in the unit is evenly distributed administratively between the Black Mesa Ranger District (west) and the Lakeside Ranger District (east). The administrative dividing line runs north-south near Clay Springs.

The 1996 Research Branch report on Pronghorn Habitat ratings classified 40 mi^2 as low, 34 mi^2 as moderate and 5 mi^2 as high habitat quality. About 80% of Unit 3C was ranked as unsuitable or poor.

Survey and Harvest Trends

Unit 3C survey data indicates a relatively stable population. This unit consistently yields a higher fawn recruitment rate, when compared to adjacent units.

Management Issues

1. Fences:
   Numerous fences occur throughout the pronghorn range in Unit 3C. Most of these fences need to be modified to be pronghorn passable. Fences along Highways 277 and 77 restrict movement of pronghorn to and from Units 3A, 3B and 4B. Additionally, few if any of the unit's interior livestock fences are wildlife friendly. The unit's fences need to be inventoried and prioritized so that a plan to modify these fences can be formulated.

2. Water Availability:
   As is evident in the habitat evaluation scores above, only a small part of Unit 3C is suitable habitat for pronghorn. In the small, discreet area that forms a band along the north part of the unit, water sources are plentiful. There are numerous dirt stock tanks, as well as some Forest Service trick tanks. However, the unit is subject to drought conditions and these waters need to be monitored during droughts.

3. Tree-Shrub Encroachment:
Across Unit 3C encroachment from pinyon and juniper trees is a concern. This is may provide cover to coyotes, which prey upon the fawns.

The Forest Service is very aware of the tree encroachment issue and supports removal of some stands to retain and enhance the grassland communities. Additionally, there are some areas adjacent to existing pronghorn habitat that were burned during the Rodeo-Chediski Fire, which may increase the amount and quality of habitat available to pronghorn.

4. Plant Diversity:
While the north part of Unit 3C is subject to drought conditions, in most years the unit receives enough precipitation to provide adequate forb growth. There is also adequate species richness in most areas. The primary factor affecting species richness is probably forage use.

5. Recreation:
Human activity may be a limiting factor in some portions of Unit 3C, however it is not considered to be a widespread problem. As expected, the areas surrounding the urban areas receive more human activity.

6. Human Encroachment:
Fortunately, most of the pronghorn habitat in Unit 3C is on the Sitgreaves National Forest. There is some development moving south and west from Taylor. There are some roads that cut through the unit's pronghorn habitat (Pinedale-Taylor Rd, Clay Springs Rd., Aripine Rd.), and they do experience high levels of traffic at times, most sections are unfenced and only the Clay Springs Rd. is paved.

7. Translocation:
Pronghorn have not been transplanted to or from Unit 3C.

8. Predation
Predation of fawns is relatively speaking not a concern. Unit 3C consistently has higher fawn to doe ratios when compared with other surrounding units. Since most of the pronghorn habitat is on Forest Service lands, perhaps the grazing system in place favors fawn survival. This unit has some widespread stands of juniper, which can increase predator cover. It is possible that an increase of herbaceous cover or better water distribution compensates for the juniper cover.

9. Agency Coordination:
Unit 3C is composed primarily of Forest Service Lands, with the unit roughly equally divided between the Lakeside and Black Mesa Districts. Pronghorn needs are considered when evaluating water projects and livestock grazing management.

Management Goals

Maintain and enhance current pronghorn population and distribution across Unit 3C.

Management Objectives

Objective 1: Maintain and enhance large blocks of pronghorn habitat.

Strategy 1a. Continue with pinyon-juniper treatment in and around existing pronghorn habitat to reduce cover for predators and increase forage production for pronghorn.

Strategy 1b. Actively participate in allotment management plan revisions to insure that pronghorn needs are addressed.

Strategy 1c. Explore opportunities to plant-seed browse and forbs in conjunction with future juniper treatments.

Objective 2: Modify more livestock fences to wildlife friendly standards.

Strategy 2a. Inventory current livestock fences. Prioritize modification projects.

Objective 3: Increase water availability and dependability.

Strategy 3a. Analyze water dependability and availability during drought periods, identify areas that would benefit from additional waters.

Unit 4A Pronghorn Herd Management Plan

History and Background

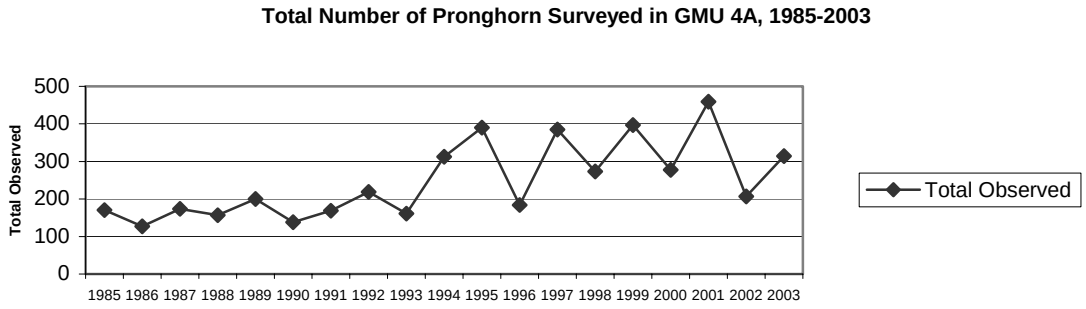
Pronghorn Distribution and population densities in Unit 4A remain constant throughout the year. The primary use area includes everything north of the forest boundary. On Forest Service land, pronghorn distribution remains adjacent to the forest boundary from Chevelon Canyon to East Clear Creek. Pronghorn generally range about 2 to 4 miles south of the forest boundary. Pronghorn sightings rarely occur further south on the Forest in the ponderosa pine habitat.

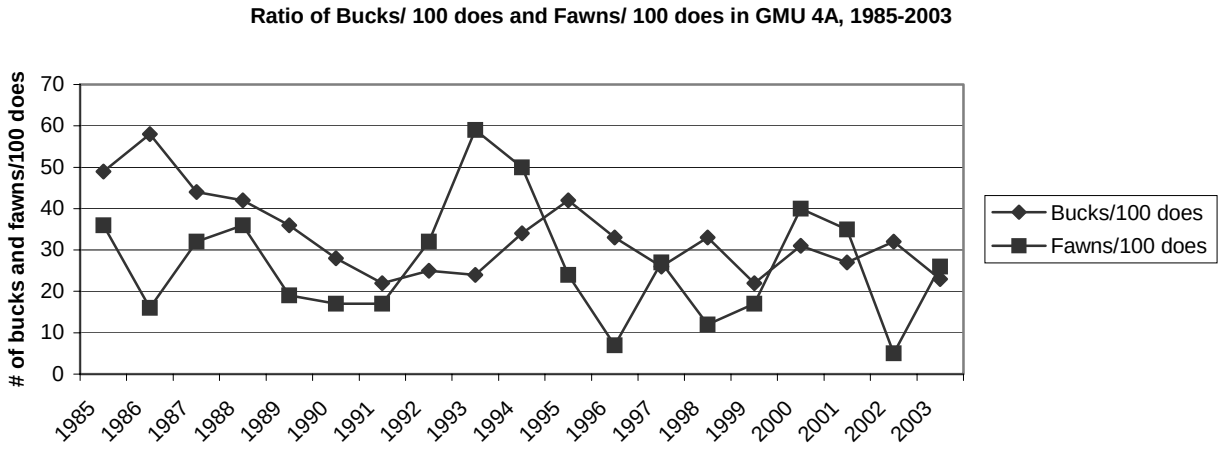
Habitat Description
The majority of the pronghorn habitat in Unit 4A is comprised of private and leased Arizona State Trust Lands. The private land habitat is comprised of three major landowners. They include the Hopi Indian Tribe, the Ohaco Family, and Molly McCauley. Within the McCauley Ranch there are several small parcels of land that are developed. Unit 4A pronghorn habitat is comprised of roughly 263 sections of land. Livestock management on these 263 sections of land is managed by (State sections figure into the lessees percentage): Hopi Indian Tribe - 63%, Ohaco - 27%, McCauley - 7%, and Forest Service - 3%.

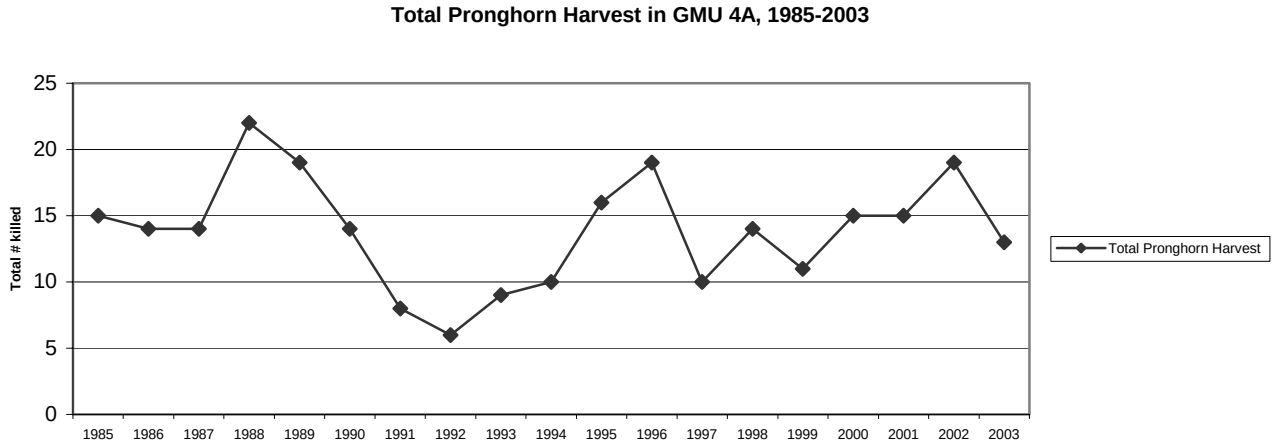
1. The 1996 Research Branch report on Pronghorn Habitat Evaluation for Determination of Habitat Quality classified Unit 4A with 23 mi^2 of low, 206 mi^2 of moderate and 25 mi^2 of high quality habitat.

Survey and Harvest Trends

Unit 4A survey data indicates a robust population which has increased since 1985. Success rates for the rifle hunt has varied from 60% to 100%.







Management Issues

1. Fences:
   Numerous fences occur throughout the pronghorn range in Unit 4A. Some of these fences need to be modified to be pronghorn passable. This needs attention on a case-by-case basis.

2. Water Availability:
   Water distribution in Unit 4A is highly variable throughout the year. The three main ranches in Unit 4A utilize wells and dirt tanks to provide water for their livestock. These same waters make up all the available wildlife waters. There are a couple of exclusive wildlife waters on Forest Service Land, which are utilized by pronghorn.

   There are 6 wells and numerous dirt tanks distributed across the Hopi Ranch. Water distribution on this ranch is good when the dirt tanks contain water. Without water in the dirt tanks, the ranch relies on six wells (currently there are only four in operation) for

water. There are no water systems in place off these wells, so water distribution become poor when relying strictly off these wells.
Of the many dirt tanks on this ranch, eight dirt tanks are considered very important to maintain good water distribution for wildlife. All eight tanks are functional and have the capacity to provide long-term water for wildlife. In most cases when these tanks reach 75% capacity or better in the summer, they sustain themselves until the next summer. These reliable tanks are Chevelon Tank, Corbet Tank, Big Tank, Red Tank, Pablo Tank, Antelope Tank, Twenty-eight Mile Tank and Broken Tank.The six wells on the Hopi Ranch assist in water distribution across this ranch. Three wells on this ranch are windmill driven while three operate with a submersible pump and portable generator. None of the wells on the Hopi Ranch have a developed water system that distributes water over a large area. These wells only provide water to the immediate area. Currently, two of the windmills wells are not functioning and require major repairs. The other windmill and the three submersible wells are in working order. The operational wells on the Hopi Ranch include Fidel Windmill, White Tank, Red Hill and Pablos. Both the Mitchell Windmill and Big Windmill are out of service.

There are no real water distribution issues on the Ohaco Ranch and Forest Service lands. The Ohaco Ranch utilizes several wells tied into many miles of pipeline to provide excellent water distribution for wildlife and livestock on their Ranch. Hi Point Well and Ellsworth Well supply the two main water delivery systems. These water systems are in service and provide water to livestock and wildlife year-round. There are also numerous dirt tanks on the Ohaco Ranch. Most dirt tanks on the Ohaco Ranch are functional and assist in excellent water distribution. However, these dirt tanks are not as important as the dirt tanks on the Hopi Ranch due to the two water systems on this ranch. When these dirt tanks catch water, they greatly reduce the time and cost associate with the well operations.

The McCauley Ranch often experiences poor range conditions. During very wet years, the few dirt tanks and some natural sinks provide water.

3. Tree-Shrub Encroachment
Pinyon-juniper encroachment is an issue on the southern parts of the pronghorn habitat. This mainly occurs on Forest Service Land. Grassland maintenance and expansion needs have been addressed during Forest Service Management Planning process. This will help maintain or even expand pronghorn habitat.

4. Plant Diversity:
Forage conditions and plant diversity is a year-to-year issue. With the majority of pronghorn habitat on checker boarded private and state land, overgrazing can be an issue. Overgrazing becomes an issue during the last trimester of the doe's pregnancy and the fawning period. Pronghorn does rely on the spring forbs to maintain a high quality body condition through their last trimester. Fawns rely on the residual summer grasses for hiding cover from predators (mainly coyotes). When winter and spring precipitation reaches normal levels, forb production is good. However, to maintain adequate ground cover, it is important to have widespread summer rains. When Unit 4A experiences this

type of rainfall, the ranching operations can utilize some pastures during the winter while leaving other pastures ungrazed. These ungrazed pastures become very important for fawns in the spring. If summer rains are scattered there is not always enough feed to leave any ungrazed pastures by fawning season. Without this ground cover fawn predation can be a limiting factor.

Habitat juxtaposition seems to be adequate at the present time. There are no major develop plans currently in the works in the north part of Unit 4A. The land development on the McCauley Ranch has been in the works since the early 1970's. This development has been slow and probably has a lesser affect on pronghorn habitat than the poor range condition experienced on this ranch.

5. Recreation:
Recreational use in the core pronghorn habitat is low. Citizens from the town of Winslow to the north do travel on Highway 99 to reach the National Forest. When compared to other areas the impacts are minimal.

6. Human Encroachment:
Human activity is currently low. An exception is Highway 99, which runs north and south through a majority of the better-rated habitat. Most of the highway does not have a right of way fence, which is a definite benefit to the pronghorn. The development on the McCauley Ranch has a limited impact, since the surrounding habitat is of low quality.

7. Translocation:
Pronghorn have not been transplanted to or from Unit 4A.

8. Predation:
Predation primarily by coyotes is a concern. Control efforts have been conducted in this unit on several occasions, with some marked improvements in fawn recruitment.

9. Agency Coordination:
The Department coordinates pronghorn management activities with the National Forest personnel, owners of the Ohaco Ranch and the Hopi ranch manager. Most pronghorn management on the National Forest centers on clearing of encroaching pinyon and juniper woodlands and wildlife water distribution. In the mid-1990's the Department worked collaboratively with the National Forest Service and the Ohaco Ranch owners to install a major water delivery system across the southwest portion of the pronghorn habitat. Pronghorn surveys have been flown with Department and Hopi representatives as observers since 1998.

The Hopi Nation is in the process of purchasing the State Lands associated with the Hopi ranch. They have announced their intentions to convert this ranch into Reservation Status, and the Department will no longer have management responsibility of these pronghorn. The Department is coordinating with members of the Hopi Nation, and has offered to assist in wildlife management issues. However, what future role the Department will play is unknown.

Management Goals

Maintain and enhance current pronghorn population and distribution in suitable habitat in Unit 4A. Become an active partner in the management of the wildlife on the Hopi Ranch.

Management Objectives

Objective 1: Maintain and enhance large contiguous blocks of pronghorn habitat.

Strategy 1a. Promote pinyon-juniper treatment in and around existing pronghorn habitat to reduce cover for predators and increase forage production for pronghorn. This issue occurs on small portions of the Ohaco Ranch and on Forest Service land.

Strategy 1b: Promote fence modifications with the three major landowners.

Strategy 1c: Become an active partner with the Hopi Nation to assist in designing livestock grazing regimes that benefit the pronghorn and the livestock operation.

Objective 2: Increase water dependability and distribution.

Strategy 1a: Promote tank maintenance and well development on the Hopi Ranch. Seek funding through stewardships to assist with the repair of the two broken wells on this ranch.

Objective 3: Continue to maintain a viable pronghorn population across all suitable habitat.

Strategy 3a: Continue to promote coyote control on the Hopi and Ohaco Ranches if the fawn crop falls below maintenance levels for several consecutive years.

Strategy 3b: Continue to coordinate with the National Forest on land management issues that may impact or benefit pronghorn populations.

Strategy 3c: Strive to develop ongoing communication with the Hopi Nation concerning management activities on their ranch. Offer to provide management guidance where possible to promote sound pronghorn management activities.

Unit 27 Pronghorn Herd Management Plan

History and Background

The pronghorn in Unit 27 are located primarily within the Upper Eagle Creek watershed. The population consists of a small indigenous pronghorn herd that received a supplemental transplant of 55 head in 1999. Pronghorn typically range from the Mud Springs area south to Sunflower Mesa, and have been seen no further east than Black Mountain. Many pronghorn travel back and forth onto the San Carlos Indian Reservation.

Habitat Description

The majority of the pronghorn habitat in Unit 27 is comprised of U. S. Forest Service lands. There are some small private lands along Eagle Creek.

The 1996 Research Branch report on Pronghorn Habitat ratings classified Unit 27 with 79 mi^2 of low and 11 mi^2 of moderate rated habitat. Over 90% of Unit 27 was classified as unsuitable pronghorn habitat.

Survey and Harvest Trends

Aerial surveys are annually conducted for pronghorn in Unit 27. Anywhere from 12 to 38 animals are classified.

No pronghorn hunts have been recommended in this unit.

Management Issues

1. Fences:
   Numerous fences occur throughout the pronghorn range in Unit 27. These fences separate public and private land, allotments, and pastures within those allotments. Fencing that does not meet game standards is common in the area. Efforts are being made on public lands to modify or replace existing fences to make them more suitable to pronghorn movement. Fences on private lands will be dealt with on a case-by-case basis as necessary. Any new fences on public land will be built to wildlife passable specifications.

2. Water Availability:
   There is very good water distribution in the area. Eagle Creek is a perennial stream, and there are numerous stock tanks, windmills, and wells throughout the area. Water sources are maintained by ranchers and the U.S. Forest Service for livestock use, thus maintaining available water for pronghorn as well. Phelps Dodge operates 21 wells in the area that are used to send water to Morenci for use in the mine. Several of these wells pump above ground available water directly into Eagle Creek. Even during drought periods, waters remain easily available in the area, usually within a 2-mile radius of each other.

3. Tree-Shrub Encroachment:
Tree and shrub encroachment is a concern in unit 27. Pinyon and Juniper continue to invade grassland areas that are critical to pronghorn. With such a small fraction of the unit suitable for pronghorn use, it is important that these areas are maintained.

4. Plant Diversity:
Forage conditions and plant diversity could affect pronghorn on U.S.F.S. allotments if overuse of these areas occurs. Overuse of the forb component could affect nutrition for pregnant female pronghorn, and late season grazing could affect critical hiding cover for fawns.

5. Recreation:
Human activity may be a limiting factor along Eagle Creek, however it is not considered to be a widespread problem. The area does receive a fair amount of deer hunting pressure, which may influence pronghorn use areas. This hunter impact is of short duration, and is not during the critical fawning period.

6. Human Encroachment:
Fortunately, most of the pronghorn habitat in Unit 27 is on the Sitgreaves National Forest. There is a strip of private land along Eagle Creek. Human encroachment is not an issue with this herd.

7. Translocation:
Pronghorn were transplanted into this area in 1999. A total of 55 pronghorn were captured in Prescott Valley and released about one mile east of Eagle Creek by Double Circles ranch. There was initial mortality, and some of the animals moved onto the San Carlos Indian Reservation.

If more pronghorn become available then recommend a supplemental transplant be analyzed and prioritized.

8. Predation
Predation of fawns is a concern. Since this is such a small population, it is even more important to maintain fawn survival at or above maintenance levels. Given the close proximity to steep terrain and dense cover, this herd is susceptible to predation from many predator species. They include mountain lions, bobcats, Mexican wolves, coyotes and golden eagles.

9. Agency Coordination:
Most pronghorn habitat in Unit 27 is managed by the Forest Service. The Clifton Ranger District supports continued efforts to increase the pronghorn population. Pronghorn needs are considered when evaluating livestock grazing management.

Management Goals

Maintain and enhance current pronghorn population and distribution in Eagle Creek portion of Unit 27.

Management Objectives

Objective 1: Maintain and enhance large blocks of pronghorn habitat.

Strategy 1a. Continue with pinyon-juniper treatment in and around existing pronghorn habitat to reduce cover for predators and increase forage production for pronghorn.

Strategy 1b. Actively participate in allotment management plan revisions to insure that pronghorn needs are addressed.

Strategy 1c. Encourage cooperation with San Carlos in maintaining or improving pronghorn habitat on their lands adjacent to Upper Eagle Creek.

Objective 2: Modify more livestock fences to wildlife friendly standards.

Strategy 2a. Inventory current livestock fences. Prioritize modification projects.

Objective 3: Consider Unit 27 for future pronghorn transplants.

REGION II

Units 5A and 5B – Anderson Mesa Herd Pronghorn Operational Plan

Origin and Future of this Plan

The Arizona Game and Fish Department developed a larger plan specifically for the Anderson Mesa pronghorn herd as part of a process involving the Arizona Game and Fish Department, the Coconino National Forest, the Arizona State Land Department, the Hopi Tribe, The Diablo Trust, ranchers from the Flying M and Bar T Bar, the Arizona Antelope Foundation, the Arizona Wildlife Federation, and the National Wildlife Federation. Greater detail may be found in that plan, along with an implementation matrix with tasks and timelines.

History and Background

Units 5A and 5B contain the Anderson Mesa pronghorn herd. The boundaries of the herd area are Interstate 40, Leonard Canyon, the Mogollon Rim, Highway 87, Forest Highway 3, and Walnut Canyon. The herd area includes all of Units 5A and 5B, except a small portion of Unit 5A which lies north of Interstate 40. Pronghorn in 5A north of Interstate 40 are functionally connected to pronghorn herds in Units 4B and 7.

The pronghorn habitat in the Anderson Mesa Herd Area varies from ponderosa pine to great basin grasslands. This herd has historically been larger than it is currently, and has fluctuated a great deal. The herd has suffered die offs and had large increases since 1900.

Habitat Descriptions

Along the Mogollon Rim, ponderosa pine forest dominates the landscape, gradually changing to pinyon-juniper woodland, then to shrub-grassland as the elevation decreases to the north. The higher elevation ponderosa pine, pinyon-juniper and grassland habitats are primarily summer range while the lower elevation pinyon-juniper; shrub and grasslands are used by some pronghorn year around and by others only in winter. Unit 5B includes the Raymond Wildlife Area, an Arizona Game and Fish Department Wildlife Area managed for buffalo and pronghorn.

Ockenfels et al (1996) completed their field evaluation of pronghorn habitat in 5A and 5B during 1994 and estimates pronghorn habitat quantity in Unit 5A at 569 mi^2, most of which is contiguous habitat and classed as moderate quality habitat. The estimate of habitat that will support pronghorn from Ockenfels et al (1996) in Unit 5B is 331 mi^2 most of which was rated as moderate quality habitat.

The largest block of summer habitat on Anderson Mesa is from Marshall Lake south to the Hay Lake area; this area is grassland intermingled with pinyon-juniper woodland. Broken meadows around Pine Mountain, Hutch Mountain, Turkey Mountain, and Bald Mesa also provide summer habitat; these were interspersed in ponderosa pine forest or pinyon-juniper woodland

Year-round or winter habitat occurred throughout the eastern portion of the area. These lands are mostly private or Arizona State Land Department lands and mostly grasslands and shrub communities. Rainfall is much lower than on Anderson Mesa. Because portions of the pronghorn herds migrate, open corridors between summer and year-round habitat along the rim of Anderson Mesa could benefit pronghorn. Routes off the escarpment need to be identified, maintained, and in some cases widened.

Survey and Harvest Trends

Current Population

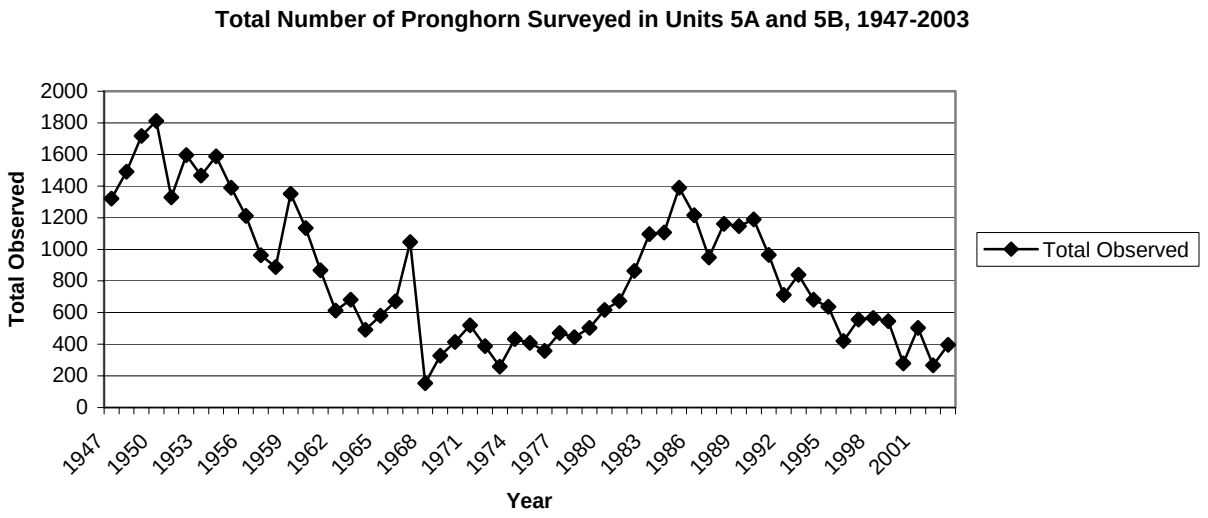
The herd of pronghorn is functionally split in two. One group of pronghorn spends the winter in the lower elevation lands and spends the rest of the year on Anderson Mesa. The second group lives year-round in the lower elevation habitat. We are referring to these as functionally separate because they breed and give birth while in separate areas. They all winter in the same grasslands and shrub lands, primarily on State Land Department and private lands. We know very little about interchange of pronghorn between these herds.

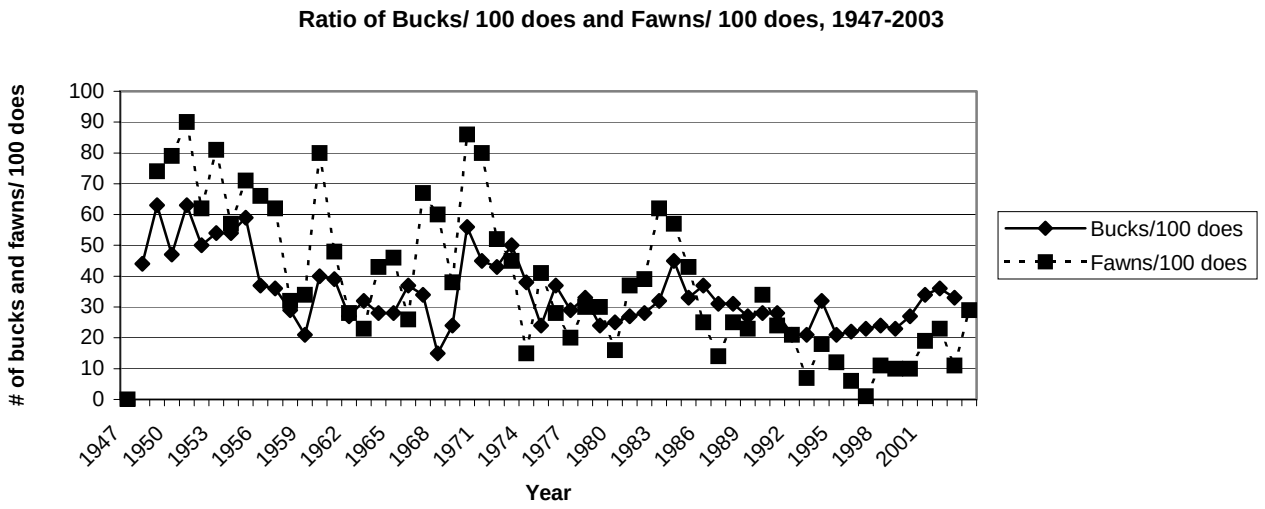
Discussion of Pronghorn Herd Trends

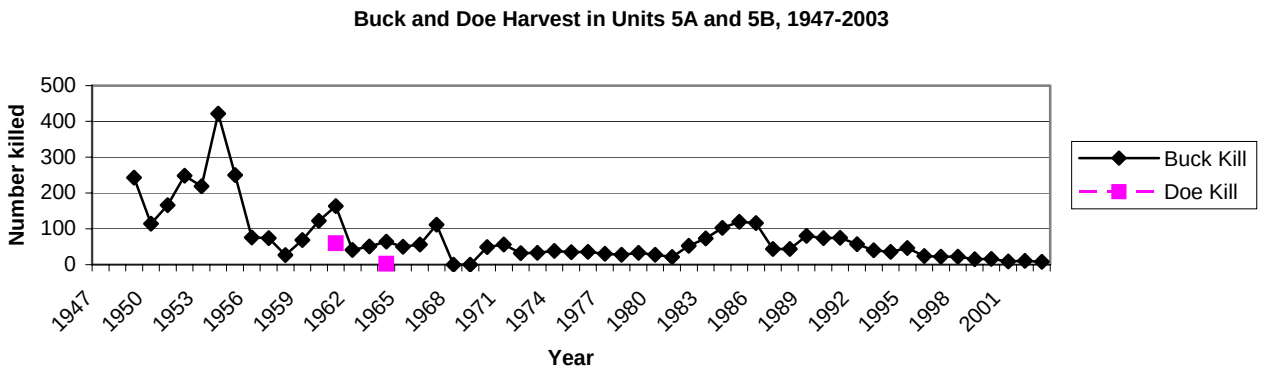
The most important trend is the low fawn recruitment. Research results from other populations of pronghorn have shown pronghorn normally conceive and carry two fawns. Even where fawn numbers have been very low when surveyed, birth rates always have been over 100 fawns per one hundred does. Neff and Woolsey (1979) showed a higher birth rate compared with numbers of young observed during summer surveys. Three possibilities to explain low recruitment are:

- Fawns are being born healthy and are being killed.
- Fawns are being born weak or diseased and cannot live long after birth.
- Does are dropping viable young but not in adequate physical condition, or do not have the nutritional basis to provide for the nursing fawns.

Hunter harvest peaked at 421 in 1954, which was a uniquely high harvest. Normal hunter kill before 1967 ranged between 50 and 250 bucks. Since 1968 the harvest has slowly declined to 16 bucks in 2000. Survey and harvest data are shown in the figures below.


Total Number of Pronghorn Surveyed in Units 5A and 5B, 1947-2003
Total Observed
Year
Total Observed


Ratio of Bucks/ 100 does and Fawns/ 100 does, 1947-2003
# of bucks and fawns/ 100 does
Year
Bucks/100 does
Fawns/100 does



Management Issues

1. Fawn Recruitment

   The primary management issue for the Anderson Mesa Pronghorn Herd is low fawn recruitment. Information from the literature on pronghorn suggests several potential causes including predation, competition, disease, nutrition and disturbance. From 1991 to 2000, surveyed fawn per 100 does varied from between 1 and 21. The breakeven point where recruitment is balanced with mortality varies as weather changes direct and indirect mortality factors. The breakeven point is most likely to be in the range of 20 to 35 fawns per 100 does. A long period of low recruitment as occurred in the 1990s, raises higher concerns because the losses of does to aging.

2. Plant Community Diversity and Health

   The Arizona Game and Fish Department conducted a statewide habitat assessment for pronghorn (Ockenfels et al 1996). The habitat assessment involved visiting each section (one mi^2) of habitat, rating the habitat and listing major observed problems with the habitat. This assessment collected and published this information by unit and is a major source of information for this document. Ockenfels et al (1996)**,** found plant community diversity and health was a major issue within these units. Ockenfels et al (1996) described this issue as a combination of tree and shrub encroachment, and plant species richness. Plant community diversity translates for pronghorn into both nutrition and fawn hiding cover.

3. Fawn Hiding Cover

   Increasing hiding cover for fawns also could improve fawn survival. There is a debate among stakeholders on the question of whether fawning cover can be much improved. On much of Anderson Mesa the dominant grass is blue grama, which is a warm season grass. The debate hinges on whether other grasses might grow in some areas with reduced livestock and elk grazing.

   Leaving grass cover standing in the fall in selected pastures can provide fawn hiding cover the next spring under some conditions. After wet winters the residual pronghorn fawn cover

may not be as useful if the grass cover is packed down by snow and ice. The other source of fawn hiding cover is new growth from the current spring. The amount of growth before fawns are born appears to vary a great deal with the weather.

4. Nutrition

Nutritional needs can be approached both through management and research. Nutrition has proven important to raising and maintaining birth rates in livestock in the general region around Flagstaff, and may be important in pronghorn as well. Supplementing mineral intake has increased birth rates in cattle on Flagstaff area Ranches. Nutrition in the last trimester of pregnancy has been shown to be very important to pronghorn. Various pronghorn management guidelines emphasize the need for a diversity of forbs for pronghorn in late pregnancy and following birth. Forb diversity has been considered to be problem in pronghorn habitat throughout Arizona.

Three methods have been proposed for improving nutrition: 1), burning, 2), cutting pinyon, juniper, and pine where trees have invaded grasslands or have become denser on savannas, and 3), altering grazing practices.

5. Fawn Predation

Predation on pronghorn fawns has been shown, by past research, to be a serious problem on Anderson Mesa. The only remedy that has a known effect is to kill coyotes, which worked 3 years in five during the research, but is not popular with much of the public. Killing coyotes yields a short-term gain in fawn recruitment, and must be repeated for a number of years to be effective. Coyote control should be proposed as part of a larger integrated management package, but may be necessary until other solutions can take effect.

There are 2 alternatives to killing coyotes that may be worth investigating, predator swamping and aversive conditioning.

- Predator swamping proposes taking advantage of the behavior of the pronghorn. When pronghorn fawns are first born they avoid predators by hiding for the first ten days to two weeks. This hiding period is when most fawn predation is believed to occur. Predator swamping would provide other food for coyotes, such as road killed deer and elk, to distract the coyotes from hunting fawns during the time when the majority of fawns would be hiding. The idea is untested with coyotes and pronghorn.
- Aversive conditioning would attempt discouraging coyotes from hunting pronghorn by teaching coyotes to associate the smell of pronghorn with a bad experience. In practice baits are made up of a piece of pronghorn hide containing a chemical which tastes very bad or which makes the coyotes sick to their stomach. This idea has received some pen testing in Arizona, however the most likely chemical is not registered for this field use.

6. Disease

The possibility of having disease present in the herd, and its effect on the herd, and also possible remedies, can best be addressed through research. Disease research is part of a research study that has just begun. Disease research could help explain what is happening to the herd, however if disease were problematic, developing an effective response would probably require further research.

7. Ease of Movement

The ability of pronghorn to easily move throughout their home range is another management concern in this herd. Pronghorn are unique among Arizona's big game (excluding black bear) in that they normally go under fences. Net wire fences, fences with low bottom wires or even appropriately built fences close on both sides of a highway are barriers to most pronghorn movement. When the winterkill occurred in 1967-68, fences in many places reportedly blocked pronghorn movements.

The most important of the fence standards for pronghorn is the height of the bottom wire because it impacts the ability of pronghorn to move throughout their habitat. The current Forest Plan has a standard that the bottom wire be at least 18 inches above the ground. Forest Service and Game and Fish Department personnel monitored large portions of the fences on Forest Service land during the summer of 2001 for compliance with the fence standards. Of the about 200 miles of fences monitored by Game and Fish and Forest Service crews, about half met or exceeded the18 inch bottom wire fence standard. About 60 miles of fence were also improved during the monitoring by adding "goat bars" to make it easier for the pronghorn to get under the fences.

8. Water Availability

Water availability is good on Forest Service lands and fairly dependable. On the State Land Department and private lands there is less information. The largest question is not so much whether a stock tank is present but whether the tank is likely to hold water in normal or drought conditions during the fawning season.

Other considerations include provision of water in drinkers and troughs that are at or near ground level since it has been noted in research that pronghorn are reluctant to use water from high sill tanks and troughs. Also the waterlot fencing used on most livestock waters may be interfering with the free access to water that pronghorn require due to their reluctance to enter into confined and low sight distance situations.

9. Disturbance

Disturbance has been recognized as a potential impact on the pronghorn on Anderson Mesa. A spring motor vehicle closure near Pine Hill is intended to prevent disturbance of fawning pronghorn on a portion of their Anderson Mesa fawning habitat. Compliance has been reasonably good and complaints have been rare with the Pine Hill closure.

Recreational impacts have been increasing rapidly across the forest. A recent study in Oregon (Gregg et al 2001) found disturbance tended to prolong the fawning period. With fawning prolonged, coyote were able to take more fawns. The Department and the Forest Service may consider implementing fall motorized vehicle closures in selected areas of pronghorn habitat. In order to know if breeding or fawning season motorized closures are effective, we need to know where the pronghorn does which breed in the closure area, fawn. This could be learned by radio-tagging pronghorn does.

10. Pronghorn Hunting
Some people have expressed concern that pronghorn hunts may be detrimental to the herd because of its low population size. There seems to be an assumption that hunting could harm the population by removing too many bucks, through incidental take of females, or by increasing disturbance. Such limited take will have no effect on the population and disturbance is minimal. The Department will continue to review the hunt design and permit numbers yearly through the existing public process.

Management Goal

Maintain a herd in the historical (1900 to 1967) range of pronghorn numbers for Anderson Mesa, both the migratory herd, which summers on Forest Service Lands, and the nonmigratory herd which lives on State and Private lands year around. Despite limitations in using surveys numbers as a herd estimator, use total pronghorn observed on surveys to monitor this goal as the best available information. Focus on increasing fawn recruitment into the herd through habitat project funding, and cooperation between the Arizona Game and Fish Department, the Forest Service, State Land Department, Hopi Tribe, ranchers, and other stakeholders.

Use the following triggers for increasing management action to benefit these pronghorn. If surveys decline to 200 or fewer does observed 3 years out of 5, or if surveys show fewer than 25 fawns per 100 does more than twice in 5 years, take additional action to increase the herd. (See implementation plan sections on how triggers for further actions were selected and how they are intended to be applied.)

Objective 1. Improve forage diversity and health, and fawn hiding cover in pronghorn habitat

Strategy 1. Continue Arizona Game and Fish Department and Forest Service funding, as well as support for State Land Department, Hopi Tribe, rancher and stakeholder efforts to remove juniper, pinyon and ponderosa pine trees from invaded grasslands and savannas, and efforts to improve forage and cover.

a. In order to benefit fawn recruitment, test, and evaluate grassland burning on 1000 acres including the variety of soils and grassland vegetation types on Anderson Mesa. If tests show prescribed burning can benefit the grasslands and the pronghorn, include 5,000 acres per year for two years of grassland and savanna burning in the practices for pronghorn habitat treatment in item 1b below, then reevaluate.

b. Target 60,000 acres of pronghorn habitat treatment (including both woody vegetation removal and burning of woodland, slash, and grasslands, within 10 years on Forest Service lands. These treatments should be spread across Anderson Mesa summer pronghorn habitat, from Jacks Canyon north to Marshall Lake. Prioritize for treatment areas of historical grassland and savanna adjoining existing pronghorn habitat, travel ways between blocks of existing habitat, potential fawning habitat, and transition range along the base of Anderson Mesa.

c. Recommend slash be lopped and scattered or crushed and left on some pine and pinyon juniper treatments to provide ground cover, and micro sites for seedling establishment to increase plant species diversity, and to

avoid reducing the ability of pronghorn to see potential predators. Request lop and scatter to 15 inches or less and up to 30% of the ground covered by slash left thin enough for plant growth to occur under the slash. If residual slash will be in excess to these recommendations suggest burning the slash or other disposal.

d. Encourage and assist the Forest Service, State Land Department and Diablo Trust in developing and implementing fire plans for areas of pronghorn habitat.
e. Target 20,000 acres of treatment (including both woody vegetation removal and burning) on State Land Department, Hopi and private lands within 10 years.
f. Target 2000 acres of treatment (including both woody vegetation removal and burning) within 5 years on Raymond Ranch Wildlife Area.
g. Target projects for special tag funds. Put a special emphasis on developing Habitat Partnership Committee Projects in this area for 2002, 2003, 2004, and 2005.
h. Coordinate project implementation to maximize efficiency and integration of projects, including prioritizing work, to attempt to insure enough gets done in some area or areas to potentially affect the pronghorn.

Strategy 2. Manage elk herds with the intent of avoiding significant negative impacts on pronghorn forage or fawning cover in the frequent years of below normal precipitation.

a. Manage elk at a level where elk impacts on pronghorn forage or fawning cover are not significant through the fawning period.
b. Manage elk at a population level that provides improved forage diversity and health, on sites where forage diversity and health are significantly below potential.
c. Continue use of hunt design established in the 2001 season for reducing summer elk use of winter range.

Strategy 3. Support managing livestock with the intent of avoiding significant negative impacts on pronghorn forage or fawning cover in the frequent years of below normal precipitation.

a. Advocate managing livestock at the level where livestock impacts on pronghorn forage or fawning cover are not significant through the fawning period.
b. Advocate livestock management that provides improved forage diversity and health, on sites where forage diversity and health are significantly below potential.
c. Support research on grassland and savanna communities and grazing effects including effects on fawn cover, and pronghorn forage, including establishing any exclosures needed for the research.
d. Support altering grazing as needed to implement recommendations for improving nutrition and fawn hiding cover, including some areas that are:
    i. Excluded from livestock grazing,

ii. Deferred from livestock grazing after August fifteenth in the year before it is to be included in the modified grazing acreage for fawning, to retain cover grown in the late summer and fall, and deferred from livestock grazing until June 15 in the spring of the year when it is included in the modified grazing acres for fawning to retain cover grown in the current spring and early summer.

Strategy 4. Investigate the possibility of using range fertilization, nutritional supplements for pronghorn, forage seeding and other techniques that may be suggested over time, to improve nutrition and forage diversity and health.

Objective 2. Investigate potential causes of fawn mortality.

Strategy 1. Conduct disease investigations on pronghorn in this area.

Strategy 2. Conduct research on pronghorn nutrition levels in this area.

Strategy 3. Use GPS technology to record survey locations and to compare pronghorn fawn recruitment on treatment and control areas including both areas on Forest Service lands and on state and private land.

Objective 3. Improve forage availability for pronghorn on Anderson Mesa ephemeral wetlands.

Strategy 1.

a. Upgrade, repair, or replace, as needed, fences on Ducks Unlimited projects on the Mesa.
b. Modify fences as needed to permit passage by pronghorn and to improve durability.
c. Record use of ephemeral wetlands by pronghorn when incidentally observed to provide information about the timing of use.
d. In upcoming Anderson Mesa area planning, recognize value of ephemeral wetlands as pronghorn forage.

Objective 4. Improve distribution of pronghorn, access migration routes and access to forage by improving fences.

Strategy 1. Complete inventory of fences on Forest Service and private (with permission) land on Anderson Mesa.

a. Target completion by September 30, 2002.
b. Bring fences on the Forest into compliance with Forest Service standard of having bottom wire at least 18 inches high.
c. Use "goat bars" to improve fences rapidly where the amount of fence modification is large and can not be completed in a timely manner.

Strategy 2. Meet or exceed 18 inch bottom wire standard on all fences on Raymond Wildlife Area.

a. Complete removal of all unneeded fences on Raymond Wildlife Area.

Strategy 3. With permission and cooperation, inventory fences on State Land Department, Hopi Tribe and private lands for compatibility with pronghorn needs.

a. Prioritize areas of pronghorn seasonal movements for inventory and fence improvement.

Strategy 4. Investigate the potential for removing or modifying fences (such as with let down panels) in movement corridors, such as from Anderson Mesa to winter range.

a. When electric fence is being used, request fence continued to be turned off when cattle are not in the pasture, and that the bottom wire always be a ground (not electrified).

b. Monitor pronghorn use of pastures with or adjacent to electric fence to determine if electric fencing is deterring use of pastures by pronghorn.

Objective 5. In conjunction with other objectives, use predator management when appropriate to reduce predation with the emphasis on predation on pronghorn fawns.

Strategy 1. Implement appropriate predator management techniques when surveyed does drop below 200 for three of five years, or if surveyed fawns per 100 does drops below 25 for more than two years out of any five years in Units 5A and 5B combined.

Strategy 2. When coyote control is implemented, continue control for at least 3 years to avoid potential rebound effect.

Strategy 3. Develop predator management plan for these units, with public input and review.

Strategy 4. Inform public and stakeholders of the impact of predators on pronghorn, limits of possible solutions, and how predator management fits in overall pronghorn management.

Strategy 5. Investigate using other methods to reduce coyote predation on pronghorn fawns as an alternative to coyote control.

Strategy 6. Monitor status of aversive agents and if they become available for field use, field test aversive training with chemical baits.

Strategy 7. Monitor pronghorn fawn recruitment on predator management areas.

a. Treat a large enough area with any predator management technique for surveys to detect differences in pronghorn fawn recruitment.

b. Segregate pronghorn fawn recruitment survey data between area with and without coyote control to detect any differences in recruitment.

Strategy 8. Be prepared for major snow events with pronghorn supplemental feed ration, a plan for pronghorn feeding, and a plan for control of both coyotes and dogs if they prey on pronghorn in areas of concentration.

Strategy 9. When and where practical use coyote hunters to achieve these objectives.

Objective 6. Evaluate and Reduce as Needed, Disturbance of Pronghorn During Breeding and Fawning.

Strategy 1. Monitor pronghorn fawn recruitment inside and outside motorized vehicle closure areas.

a. Monitor large enough areas of closure and control area on surveys to detect differences in pronghorn fawn recruitment.
b. Segregate fawn recruitment data during pronghorn surveys to detect any significant differences in recruitment.
c. Monitor levels of human use on surveyed areas.

Strategy 2. Locate breeding areas through observation of pronghorn bucks during the breeding season.

a. Record locations of pronghorn seen in breeding season.
b. Monitor human use of pronghorn breeding areas after they are identified.

Strategy 3. Work with Forest Service and stakeholders to continue protection of Hay Lake and Pine Hill closure areas.

Strategy 4. Work with Forest Service and stakeholders to initiate a breeding season motorized vehicle closure on the Pine Hill Closure Area.

Objective 7. Improve water availability

Strategy 1. Continue to update AGFD Regional drought plan, as needed, in response to pronghorn concerns as information becomes available. Include consideration of emergency water distribution system for Pine Hill, which may minimize water-hauling effort.

Strategy 2. Determine location, quality and reliability of waters in pronghorn fawning habitat.

a. Target determining locations by July of 2002 and evaluate reliability during subsequent fawning seasons.
b. Develop and/or improve waters in areas where needed, in cooperation with Forest Service, Hopi Tribe, ranchers and stakeholders.
a. Submit proposals for funding as needs are identified.

Strategy 3. For areas where elk are only desired during winter, consider any reasonable suggested means of limiting summer elk access to waters built for pronghorn.

Strategy 4. Improve access to waters by modifying water lot fences in pronghorn habitat in cooperation with ranchers.

Objective 8. Improve the ability of pronghorn to travel between habitat areas.

Strategy 1. Open passages through pinyon-juniper and ponderosa pine stands between adjacent grassland and shrub habitats, include both within and between seasonal ranges.

a. Recommend passages in comment letters on the design of range and forestry projects where appropriate.
b. Use special tag funds and Habitat Partnership Committee projects to open passages.
c. As new corridors used by pronghorn are found, evaluate need for clearing, enlarging or maintaining the corridors and support Habitat Partnership committee grant development to fund these projects.

Strategy 2. Evaluate use of special fence modifications, such as gates for pronghorn movement or let down panels, in high pronghorn use areas such as seasonal migration areas.

Objective 9. Supplement population

Strategy 1. If does on surveys drop to below 200 animals for 2 years and fawn doe ratio is below 25 for the same 2 years, and if habitat conditions are adequate to support the pronghorn, evaluate supplementing the population with pronghorn from other areas.

Unit 6A Pronghorn Operational Plan:

History and Background

Pronghorn were abundant and well distributed throughout 6A in the 1950s but since 1962, the numbers have dwindled and some herds have disappeared. Historically, pronghorn were abundant on Mud Tank Mesa, Cedar Flats, White Mesa, Apache Maid area and in the open parks throughout the ponderosa pine habitat from Upper Lake Mary to Mahan Park. Pronghorn were present in the western part of 6A around Jacks Point and Art's Tank.

With the development of Interstate 17 and the paving of Highway 260 in the late 1960s and early 1970s much of the interchange between summer and winter habitat for pronghorn was fragmented. Pronghorn could no longer use much of the Verde Valley as winter range; areas like Jacks Point were isolated; herds began to decline. As the human development in the Verde Valley increased, more habitat was fragmented and lost. Human development and increased livestock fencing in the pine type reduced pronghorn use of that habitat.

Habitat Description

Unit 6A covers about 1,172 mi^2 but only 23 mi^2 are considered high or moderate quality pronghorn habitat. The unit lies in the area south of Flagstaff and north of Camp Verde. The majority of the pronghorn habitat in Unit 6A is within the Coconino National Forest (USDA). A small percentage of the available habitat is privately owned.

Vegetation within the unit is composed of mixed conifer woodlands, pine-oak woodlands, pinyon-juniper woodlands and grassland-desert-scrub communities. Elevations range from less than 4,000 feet above sea level in the southern portions of the unit to over 8,000 feet above sea level in the higher areas. The unit contains some very large canyons (Beaver Creek, West Fork of Clear Creek) that likely pose tremendous barriers to pronghorn movement. Water is well distributed throughout the unit, in the form of lakes, creeks and earthen stock tanks designed to support livestock grazing operations.

Above about 6800 feet elevation, the unit is dominated by ponderosa pine forests with natural meadows scattered throughout. Between about 4500-6800 feet elevation the vegetation is dominated by pinyon-juniper woodlands. Historically many areas were chained or pushed to create new grasslands or enhance natural grasslands to benefit livestock grazing. Below 4500 feet elevation the pinyon-juniper transitions into a mesquite-grassland community.

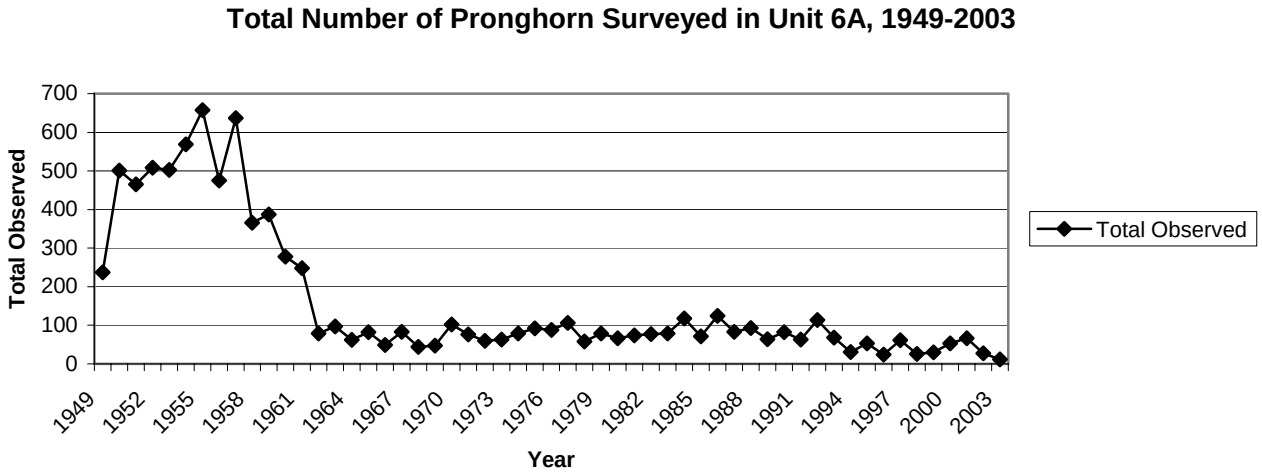
Survey and Harvest Trends

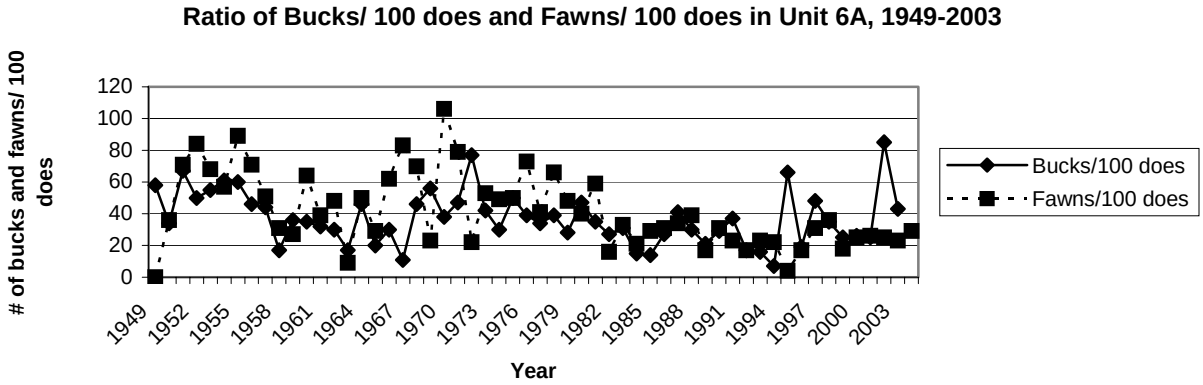
Between 1951-58 there were 465 to 658 pronghorn surveyed annually in Unit 4 (similar boundaries to the current Unit 6A). In 1953, a map of the 99 harvest locations showed some kills near Upper Lake Mary, some near Apache Maid-Cedar Flats and most occurring south of West Clear Creek on Mud Tank Mesa. In 1953, pronghorn were so plentiful on Mud Tank Mesa that an "any antelope" hunt was held. Knipe (1944) reported that no pronghorn were seen in the

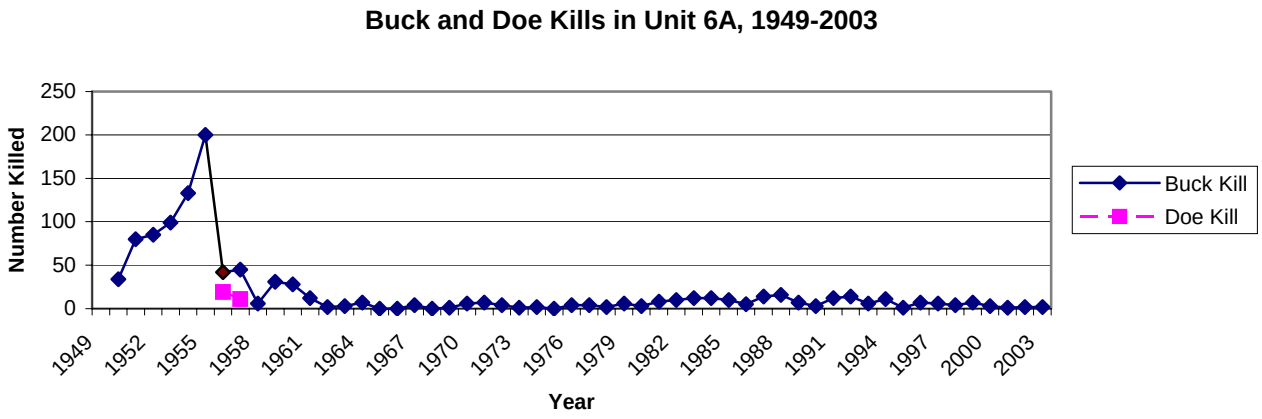
Apache Maid, Mud Tanks, or Hardscrabble Mesa areas during winter flights in 1958 because these animals moved west into the Verde Valley to winter.

Between 1958-61, surveyed numbers dropped from 366 to 248; in 1962 only 79 pronghorn were surveyed. From 1962-1992 surveys classified between 44-124 pronghorn; surveys rarely exceeded 100. Since 1992, surveys have ranged from 24-68 animals.

Harvest data mirrored the survey numbers. In the early 1950s hunters harvested 80-99 bucks annually. By the early 1960s the harvest dropped to fewer that 10 per year and has varied from 1-16 annually since then. Hunts were not held during a few years in the early 1970s. Currently, only 3 buck permits are offered. Survey and harvest data are shown in the figures below.







Management Issues

1. Predation
   Although pronghorn evolved with a number of major predators, habitat degradation and fragmentation have created an imbalance in the predator-prey relationship that does not favor pronghorn. Coyotes, mountain lions, bobcats and golden eagles likely are more effectively able to prey on pronghorn (adults and fawns) in a negatively altered habitat.
2. Pinyon-juniper-pine Encroachment
   The pronghorn in Unit 6A occupy grassland-desertscrub habitats, pinyon-juniper woodland-grassland habitats and less traditional pine-oak woodland habitats. Much of the available pronghorn habitat in Unit 6A is being invaded by pinyon-juniper and pine causing the degradation of habitat by a decreased plant diversity and forage value. Invading species also increase vertical structure making pronghorn more vulnerable to predation.
3. Forage Quality-Plant Diversity
   Land management practices including fire control and grazing have tended to reduce competition for less desirable native and exotic plant species. These species have thrived while many more desirable species have decreased in abundance. As woody species encroachment occurs, the herbaceous understory has suffered from increased canopy cover and direct competition for water and nutrients.
4. Human Disturbance
   It is unlikely that any unit in the state receives as much recreational disturbance as Unit 6A. In summer, Phoenix residents visit top escape the heat; in fall, numerous hunts create constant disturbance on all wildlife; throughout the year OHV use is prevalent.
5. Fencing-Habitat Fragmentation
   Habitat fragmentation is a key issue in Unit 6A as in other areas of the state. The barriers provided by right-of-way fences and highways such as Interstate 17, Forest Highway 3 and Highway 260 have greatly reduced the ability of Unit 6A pronghorn to utilize the available habitat. The barriers provided by roads and fences likely prevent any opportunity for ingress from adjacent pronghorn populations also. Geographic barriers such as steep canyons also tend to fragment the available habitat as does the increasing tree density due to woody plant invasion. Livestock grazing has necessitated the

construction of allotment and pasture fences. These fences have provided additional barriers to pronghorn movement.

6. Overgrazing
   Past heavy grazing by livestock and wildlife has tended to reduce available forage, reduce plant species diversity and limit fawning cover.
7. Availability of Water
   Water is generally well distributed in Unit 6A with earthen tanks being well distributed throughout the unit. Additionally Upper and Lower Lake Mary and Mormon Lake provide water in the eastern portion of the unit. However, sustained drought greatly decreases the amount of available water as stock tanks and even lakes dry up for extended periods. Livestock further deplete the available water during drought.
8. Loss of Habitat to Development
   Although only a fraction of the pronghorn habitat in Unit 6A is privately owned, many parks in the pine-oak woodland habitat types have been developed and the remaining private holdings are in jeopardy.
9. Nutrition
   Reduced plant species diversity, plant stress from overgrazing and direct competition with other ungulates for forage can reduce the nutrients available to pronghorn.
10. Disease
    The stresses caused by the factors listed above undoubtedly result in a higher susceptibility to disease in Unit 6A pronghorn.

Management Goals

Human development has caused permanent loss of pronghorn habitat, mostly in the Verde Valley. Major highways have further fragmented habitat causing additional losses. Options to recover this pronghorn population need to focus on reducing competition with other grazers, reducing shrub encroachment, improving forage quality and plant diversity, removing fences and possibly managing predation. All of these options are within the control of the U.S. Forest Service or Arizona Game and Fish Department and, therefore, can be addressed if those two agencies make a commitment to recovering this pronghorn herd.

Currently, no commitment has been made nor any project priorities established.

Units 7 and 9 Pronghorn Herd Management Plan

History and Background

Land status includes private land (including local municipalities), Arizona State Trust Land (State Trust Land) managed by the Arizona State Land Department (ASLD), and federal land managed by the U.S. Forest Service Coconino and Kaibab National Forests (CNF) (KNF). The Bureau of Land Management (BLM) manages only about 3 sections in Units 7 and 9. Management of federal, and private-state checkerboard lands under the management of Babbitt Ranches and McNelly Ranches offer special opportunities as these private entities are cooperative in efforts to enhance conditions for pronghorn. Neighboring units will be managed under separate Pronghorn Management Plans.

In early 1995, the Department's Research Branch conducted a statewide evaluation of pronghorn habitat. The units contain about 3,239 mi^2 of occupied pronghorn habitat, consisting of about 11 mi^2 of High Quality habitat, 548 mi^2 of Moderate Quality habitat, 670 mi^2 of Low Quality habitat, and 1913 mi^2 of Poor Quality or Unsuitable habitat. The evaluation found that the grasslands had some understory diversity, but areas of short shrub (sage brush and rabbitbrush) invasion should be kept in check. Additionally, tall shrub and tree (pinyon-juniper) encroachment poses a threat to the continued integrity of the grassland. Finally, the evaluation found that habitat quality posed the single greatest concern for pronghorn in the area, while wire fences and lack of water during this time of drought are also very serious.

Habitat Descriptions

Unit 7
About 35 % of Unit 7 is in the ponderosa pine belt. Stands of mixed conifer are found in the San Francisco Peaks and Kendrick mountain areas. The San Francisco Peaks also contain alpine trunda. Alpine grasslands occur at Government Prairie and Kendrick Park. Stands of pinyon-juniper dominate about 30% of habitat types and the remainder, exclusive of Great Basin Desert at lower elevations along the little Colorado River, of Unit 7 supports great plains grasslands. Elevations in the Unit range from 12,600 to 4,500 feet. The Unit has a few widely scattered springs, but man–made catchments, dirt tanks built for livestock, and ranch pipelines supply most of the water available for pronghorn and other wildlife.

Unit 7 encompasses about 1,576 mi^2. About 5.5 mi^2 of the unit are classified as high quality pronghorn habitat and 380 mi^2 are considered to be of moderate quality habitat. Most favorable habitats for pronghorn are located in the upper elevation grasslands-parks interspersed in the ponderosa pine type and at lower elevations north wherever livestock moderately grazed Great Plains grasslands.

Unit 9
Most of the unit is composed of a mix of grassland and pinyon-juniper woodland, but give way to large stands of ponderosa pine forest in the higher elevation areas. Elevations range from about 4,950 feet near the Cataract Creek drainage, to the highest point in unit 9, the Grandview area at the extreme north edge at 7590 feet. Landforms include Cedar Mountain in the

northeastern corner, Red Butte in the south central portion of the unit, a few other rugged hills, rolling short grass prairies, several drainages, and many rugged canyons. Natural water is very limited. Most water is supplied by manmade water catchments, dirt tanks and ranch pipelines constructed to support grazing operations.

The 1,645 mi^2 in Unit 9 include only 5 mi^2 of high quality pronghorn habitat and 164 mi^2 of moderate quality habitat. Most of the suitable habitat is situated along the western boundary.

The majority of the pronghorn in Unit 9 east of highway 64 occur on state and private checkerboard land north of highway 180 and the Coconino National Forest, south of the northern block of the South Kaibab National Forest and to the west of that portion of the Navajo Indian Reservation extending to the south from the forest. Still east of highway 64, another concentration of pronghorn resides in the area of Camp 36. The pronghorn on the east side of highway 64 migrate in a generally north to south pattern ranging from as far north as Camp 36 in Unit 9, to as far south as the Parks area in Unit 7.

The majority of the pronghorn on the west side of Unit 9 generally stay year around on the state and private checkerboard land along Cataract Canyon. The pronghorn will occasionally cross back and forth through the shallow portions of Cataract Canyon to Unit 10.

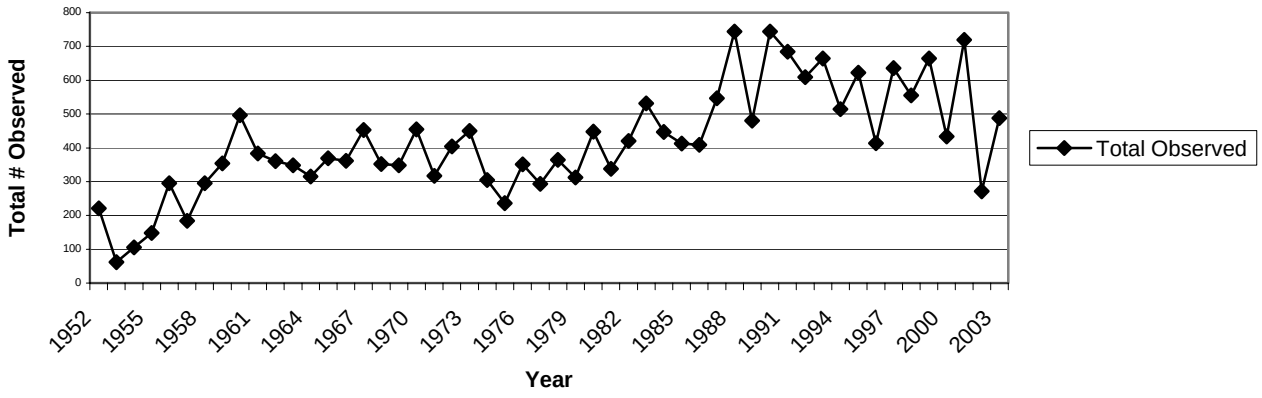
Livestock fencing is present in most of the sections through out the unit, while the western portion of Unit 9 has a greater occurrence of woven wire fence, especially in the area of Little Harpo Canyon. Not only has most of the water availability decreased but there are several of the earthen tanks that have seven, ten, and woven-wire fences surrounding them.

Several projects have been done in the past to help improve pronghorn habitat and populations in the unit including, fence, agra axe, and water projects. The Department plans to continue to propose projects using brush hogs, agra axes, native reseeding projects, removing unnecessary fences, woven wire fences, and seven and ten wire fences around waters, and increasing the availability of year around water sources especially in established fawning grounds.

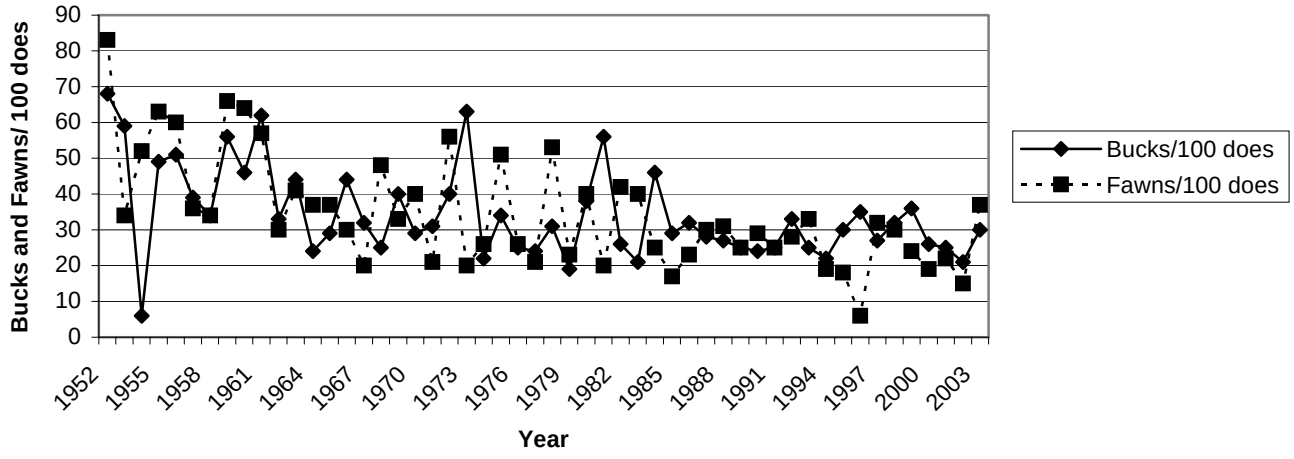
Survey and Harvest Data

The pronghorn population appears to have decreased slightly in the past few years. Drought has likely been the major factor, causing many problems for the pronghorn's survivability. These changes in habitat have caused the poor quality value of food sources, and the availability of water being some of the most noticeable problems. Survey and harvest data are shown in the figures below.

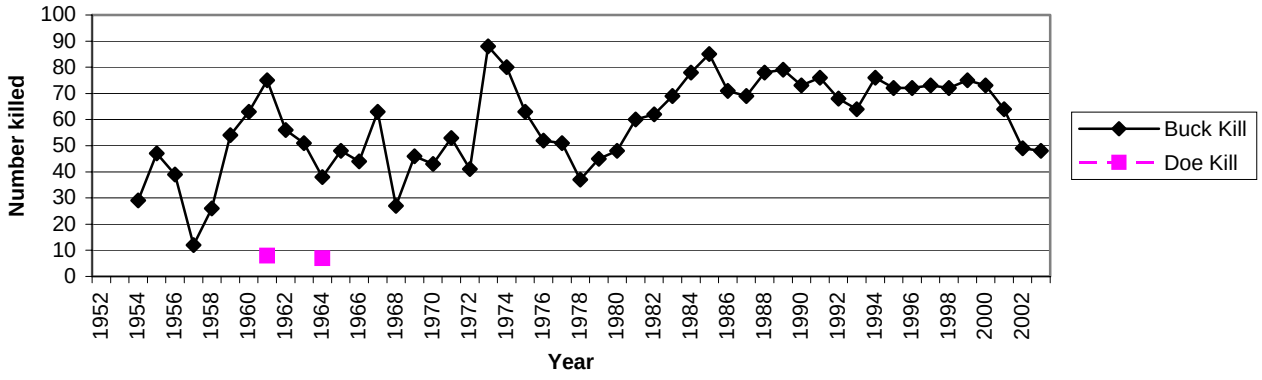
Total Number of Pronghorn Survyed in Units 7and 9 combined, 1952-2003



Ratio of Bucks/ 100 does and Fawns/ 100 does in Units 7 and 9 combined, 1952-2003



Total Number of Bucks and Does Harvested in Units 7 and 9 combined, 1952-2003



Management Issues

Some of the areas primary threats to the pronghorn population are drought (poor quality habitat conditions), range management (competition with livestock), predation, loss of habitat by development, and the resulting fragmentation and isolation. Habitat protection and improvement is the number one priority. Habitat improvements will not allow a drastic increase of the pronghorn population, though they will help ensure a stronger and healthier population. Making greater efforts to capitalize on the mitigation and research opportunities that present themselves will in turn allow the Department to make advancements in producing quality habitat. At that time, other specific management actions available for consideration may also include short-term changes to hunt structures from firearms to muzzleloader or archery, allowing the opportunity for population increases.

Management Goals

Objective 1. Woody Species Invasion.

Strategy 1. Work with land managers to map soil types and lands that formally supported grasslands and savanna habitat types.

Strategy 2. Work with wildlife organizations, land managers, and other publics to develop land management plans to restore grasslands for grassland species.

Strategy 3. Work through the Habitat Partnership Committees and other private organizations and land managers to fund pinyon-juniper and ponderosa removal from invaded grasslands and savannas at all elevations. Target most productive sites initially.

Strategy 4. Aggressively support and encourage prescribed burning of grasslands by land managers; e.g., burning of Government Prairie by the Kaibab Forest.

Strategy 5. Develop plans for maintaining a mosaic of connected openings in areas burned by wild fires in the ponderosa pine belt. In these designated areas, pile and burn down and standing timber and periodically burn to retain open condition.

Objective 2. Forage Needs; In the late 1800s and early 1900s, thousands of sheep in the Flagstaff area significantly affected grasslands. Overgrazing eliminated cool season grasses and desirable browse over much of the range. The native summer grass, blue grama filled in the gaps and now dominates vegetative cover in most ranges below 6500 feet elevation. When the soil warms and moisture is available, blue grama provides nutritious forage with a crude protein content above 10%. With a good hard freeze or when conditions are dry, the crude protein content of blue grama drops to less than 2% and it is essentially worthless for livestock or wildlife. This adaptation of blue grama explains its ability to survive heavy winter use and its ability to out-compete other more desirable forage species.

Strategy 1. Initiate "water harvesting" on the private lands of cooperating ranchers. "Water harvesting" is a technique that creates numerous shallow depressions in the ground to disturb soil and capture water run-off. As a result, the soil in the depressions is more moist and a variety of grasses and forbs establish themselves across the range. The depressions are of varying sizes, one to three feet deep and are one-tenth to one-half acre in size. "Water harvesting" would break dominance by blue grama in treated areas and would allow a better mix of vegetation needed by pronghorn and other grassland species.

Strategy 2. Acquire a tractor and disc plow and disc grassland flats dominated by blue grama on private lands to increase plant diversity. Seeding of disturbed sites with cool season grasses and desirable browse like saltbush and winter fat could benefit the range. Monitor disturbed sites for the presence of undesirable species of exotic plants. Again, ground disturbance on public lands is difficult to achieve.

Objective 3. Forage Overuse.

Strategy 1. On winter range, remove competing pinyons and junipers from areas supporting desirable browse plants.

Strategy 2. Control livestock and elk use to protect desirable browse on winter range.

Objective 4. Predation .

Strategy 1. Lion predation on pronghorn is most often associated with cover in some form. The obvious solution to the problem of lion predation is to significantly reduce woody cover in areas managed for pronghorn.

Strategy 2. Reducing the lion population in areas managed for pronghorn may also benefit pronghorn.

Strategy 3. In extreme situations, removal of lions and coyotes by the Department may be required.

Strategy 4. Concentrated use of steel trapping on private lands can be effective in reducing the density of coyotes to benefit pronghorn. Landowners that run sheep would likely be very responsive to steel trapping on their property.

Strategy 5. We suggest pursuit of use of lithium chloride or other taste aversion substances (castor oil?) in a management experiment to reduce coyote predation on pronghorn fawns. The plan would require personnel to acquire pronghorn hides and leftover carcass parts at meat processors, perhaps in Wyoming. Personnel would then freeze the pronghorn parts and retrieve them at peak fawning times. Pronghorn meat-pronghorn parts would be soaked in the taste aversion substance and tied up in a piece of pronghorn hide-skin. The last step would be to scatter the samples along trails and crossings used by coyotes in key pronghorn fawning areas. Again, non-lethal control of coyote predation on pronghorn might be achieved.

Strategy 6. Packs of free ranging dogs are not uncommon in Unit 7 East and in the Woodland Ranch and Red Butte areas of Unit 9. These dogs harass and likely kill pronghorn and other wildlife.

Objective 5. Fences .

Strategy 1. Map fences in pronghorn range that need modification or could be removed.

Strategy 2. Evaluate new cross-fence construction by land managers. Educate land managers about the problem fences pose for pronghorn.

Strategy 3. Work with Arizona Game and Fish Department I and E Branch to produce a brochure with guidelines for the kind and location of fences and the need to restrict fencing in subdivisions.

Objective 6. Loss of Habitat to Human Development.

Strategy 1. Document examples of losses and educate the public about the problem.

Strategy 2. Investigate federal programs and educate Department employees about those programs; e.g., conservation easements, so they can explain them to landowners. Some landowners are vitally interested in maintaining their ranching heritage.

Strategy 3. Educate people in subdivisions about the needs of wildlife like pronghorn to help people live with wildlife.

Strategy 4. Actively participate in land-planning efforts; e.g., Coconino County Planning, to provide information and influence on behalf of the needs of pronghorn.

Objective 7. Fragmentation of Habitat.

Strategy 1. Map movement-migration corridors used by pronghorn.

Strategy 2. Work with the Forest service to open up forests and woodlands in movement corridors used by pronghorn.

Strategy 3. Work with landowners and land managers to remove unneeded fences and to provide "goat bars" in required fences to lessen the impacts of fences on pronghorn movements, with an emphasis on migration corridors.

Objective 8. Water Distribution.

Strategy 1. Map surface waters available for pronghorn and plan construction of new waters where distribution of waters is lacking. Pursue grants; e.g., HPC funding, for new construction.

Strategy 2. Improve-rebuild-repair key existing water facilities. Pursue grants for funding.

Strategy 3. Work with land managers and private landowners to provide access to heavily fenced livestock waters. Providing a small water outside the enclosed livestock water may be required. Such water could be shut off and emptied of water during livestock gathering operations.

Objective 9. Human – Related Disturbance.

Strategy 1. Encourage OHV clubs to use the Cinder Hills OHV Area and discourage dispersed OHV use of rangelands.

Strategy 2. Support efforts by the Forest Service to relegate OHV and motorcycle use to roadways.

Strategy 3. Used fixed-wing monitoring and on-ground enforcement during spring antler-search times and during pronghorn hunts to prevent illegal off-road travel by persons using OHVs on state lands and on Babbitt Ranch private property.

Strategy 4. Develop road management plans and conduct closures of wildcat roads on State Trust Land; e.g. those on volcanic craters.

Strategy 5. Work with the Forest Service to close unnecessary roads traversing grasslands and parks in the ponderosa pine belt.

Units 12A and 12B Pronghorn Herd Management Plan

History and Background

Pronghorn were historically present in the Great Basin Grassland plant community in House Rock Valley in Unit 12A/B according to Hoffmeister. This population has been cyclic in a direct relationship with precipitation. Post survey population estimates have varied from 91 pronghorn to 142 pronghorn over the last 10 years. During periods of drought, poor fawn survival has resulted in low recruitment, and conversely during normal to above normal precipitation years fawn survival and recruitment increase.

Several augmentations have taken place over the years to supplement the existing population and provide genetic diversity. In 1951 99 pronghorn originating from Unit 5B were released into House Rock Valley. In 1982 48 pronghorn originating from the Parker Mountains of Utah were released and the last release occurred in 1984 with 81 pronghorn originating from Crestone, Co. Since 1984 no augmentations have taken place, despite two documented attempts.

Habitat Descriptions

House Rock Valley is primarily public land managed by the US Forest Service (USFS) and Bureau of Land Management (BLM). There is a small 12ha ranch managed by the Arizona Game and Fish Department (AZGFD) in the southern part of House Rock Valley and a few small private land holdings in the northern part of House Rock Valley. There are three working ranches in House Rock Valley with grazing allotments on the public lands. Overall, pronghorn habitat in these units is very small compared with the rest of the state.

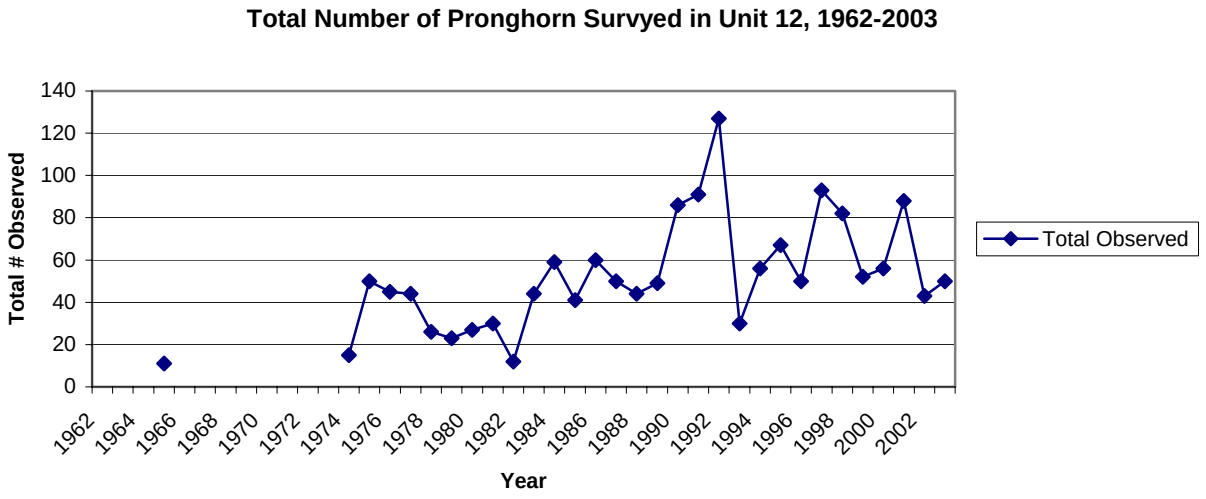
- Total area for Unit 12A is 1,664 mi^2.
- Suitable pronghorn habitat in 12A is 81 mi^2, with only 46 mi^2 being moderate and 0 being high quality.
- Total area for Unit 12B is 1,168 mi^2.
- Suitable pronghorn habitat in 12B is 359 mi^2, with 146 mi^2 being moderate and 2 mi^2 being high quality (Roughly 3/4 of this estimate occurs in House Rock Valley).

Pronghorn habitat in House Rock Valley is primarily Great Basin Grassland with areas of sagebrush, shrub and some juniper encroachment. House Rock Valley has been identified as a reduced species richness grassland. Grasses include Indian ricegrass, blue grama, three-awn, and cheatgrass. Big sagebrush is primarily responsible for the invasion of the grassland with large monotypic stands becoming prevalent in the southern portion of House Rock Valley. Other shrubs found in House Rock Valley include snakeweed, rabbitbrush, saltbush, Mormon tea, and fringed sagebrush. Some of the eastern fingers of the Kiabab Plateau are also used by Pronghorn. These fingers have open stands of grasslands being encroached upon by closed canopy woodlands of junipers and pinyon pine.

Population Trends

The House Rock Valley pronghorn population is a small isolated population, yet it has remained stable. Changes in this population appear to be tied to precipitation. When normal to above normal precipitation occurs, the population increase, and in years of drought the population declines. Summer surveys have resulted in a five-year average of 64 animals being classified. Post survey estimates have varied from 112 to 130 pronghorn over the last several years.

Because of this population's small size, it is necessary to closely monitor this herd. Typically, isolated populations have shown they will decline over time and eventually become unable to sustain themselves. Annual surveys indicate a trend for the House Rock Valley population of a declining buck to doe ratio and an extremely low fawn to doe ratio. Although this is cause for concern, the Arizona Game and Fish Department is very conservative in its hunt recommendation for this unit, and rifle hunter success has been 100% the last three years with less than 2 days expended per kill. This level of success could indicate we are underestimating our population, or just relate to its vulnerability. Historically, rifle tags have varied from 10 to 3 tags, while archery tags have varied from 10 to 5 tags in this unit.



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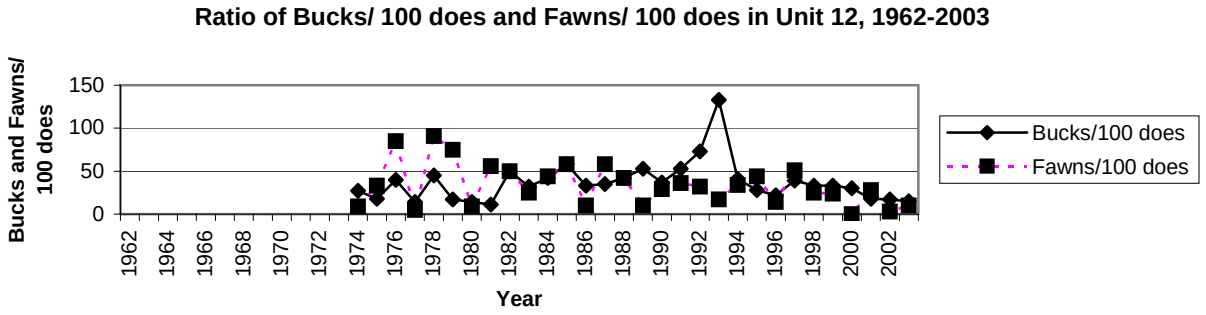
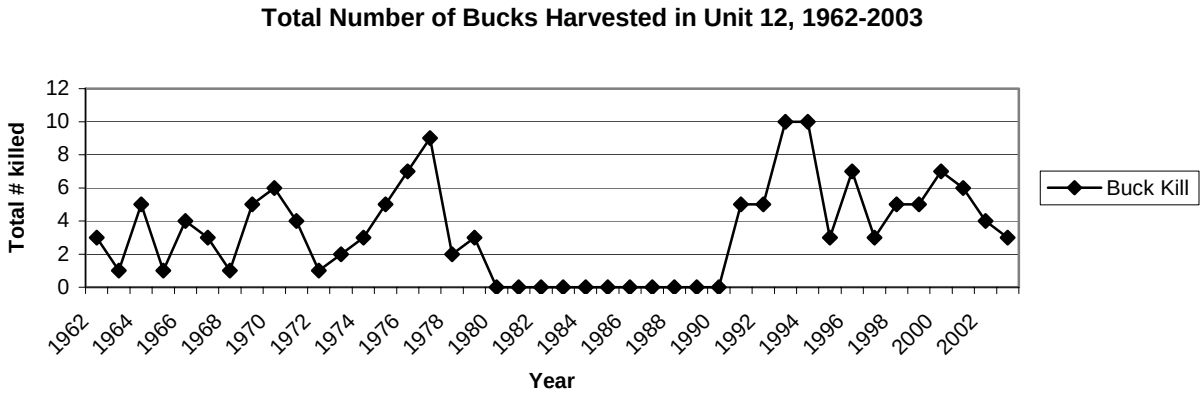




Management Issues

Typical of small populations, the House Rock Valley herd is very susceptible to limiting factors such as lack of plant diversity and overgrazing. Other limiting factors that have been identified are predation, fragmentation of habitat, fences, lack of fawn hiding cover, and possibly over hunting. Many of these limiting factors are directly and indirectly related to one another. Also, drought has long been identified as a having a direct affect on pronghorn populations in Arizona. Primary management issues for the House Rock Valley population in order of having the most impact include:

1. Tree-Shrub encroachment
   While there is little encroachment from PJ, there are large monotypic stands of sage encroaching upon the grasslands. This results in loss of habitat, decrease in forage species richness, blocking of travel corridors, and an increase in predation.

2. Lack of forage diversity
   Besides the encroachment of shrubs, low plant species diversity was identified as one of the main limiting factors for Pronghorn in the moderate to low quality habitat in House Rock Valley. Besides lack of nutrition, low species diversity also relates to lack of fawning cover. Low plant diversity was likely the result of prolonged overgrazing by livestock and fire suppression.

3. Livestock Grazing Practices
   Excessive livestock grazing is detrimental to pronghorn habitat. House Rock Valley is in the rain shadow of the Kiabab Plateau, so forage production is limited. Rangeland managers should carefully consider stocking rates and seasons of use as they directly affect forage availability and fawning cover for pronghorn. Northern House Rock Valley has been identified as being severely overgrazed.

4. Fences
   Miles of fences do not meet game standards and restrict pronghorn movement and survival. Most of these non-game standard fences occur in northern House Rock Valley. There are also some unnecessary fences due to the division of grazing allotments into

small pastures. A fence inventory should be conducted in House Rock Valley to identify specific fences needing modification or taken down. House Rock Wildlife Area Manager Mark Brown has already taken down miles of fences on the Arizona Game and Fish owned property to increase pronghorn movement. Mr. Brown estimates he has taken down about 75 miles of wire.

5. Predation
Coyote predation on fawns has been identified as a probable limiting factor to pronghorn recruitment, especially during prolonged drought periods when fawning cover is limited. While predator control has been proven to work over the short term, it must maintained to be effective, which is usually cost prohibitive.

6. Illegal Harvest
While illegal harvest has not been documented in this area, the illegal harvest of other game species in the area has been documented and would lead one to believe that there is illegal take on this pronghorn population. Because of this population's size, illegal take could substantially limit this population's productivity.

7. Recreation
Increase in human disturbance not only degrades the habitat, it can also have an affect on fawn survival. Fall (hunting season) and spring (shed antler "hunting" season) are the times of highest use. However, House Rock Valley receives little pressure due to its remote location. Currently, only BLM lands restrict off road travel.

8. Water Sources
House Rock Valley has an adequate supply of year round water sources. A water source was within 2-6 km of most of the suitable habitat. The primary source is a water line that feeds multiple tanks on USFS and AZGFD properties (southern part of House Rock Valley). There are also year round water sources on BLM land, however these waters are maintained for livestock use, and some have non-game standard fencing surrounding them.

Management Goals

Objective 1. Tree-Shrub Encroachment

Strategy 1. Identify key areas of sagebrush encroachment and implement management strategies to restore those areas to historic grasslands. Southern House Rock Valley has already been identified as an area with large monotypic stands of sagebrush that is in need of reclamation. Suggested management strategies for this area include prescribed burns and/or mechanical removal.

Objective 2. Livestock Grazing Strategies

Strategy 1. Coordinate with public land stewards and their permitees to incorporate healthier rangeland techniques to address the issues of plant diversity, adequate

forage, and fawning cover. These changes along with a prescribed fire regime have been identified as ways to increase plant diversity and promote the growth of native plants. Monitor habitat conditions, and request the removal of livestock when allowable use has occurred or habitat conditions cannot support use by livestock such as in prolonged drought periods.

Objective 3. Fences

Strategy 1. Complete a fence inventory for House Rock Valley and use data to implement fence modifications. This inventory should include the right of way fence along Highway 89A that bisects pronghorn habitat in the valley. Unnecessary fences should be taken down, such as those already addressed on the AZGFD wildlife area.

Objective 4. Augmentation

Strategy 1. Use transplants when opportunities arise to maintain a viable pronghorn population. The last augmentation was nearly 20 years ago, so one may be needed in the near future.

Objective 5. Predation

Strategy 1. Coyote control is expensive. AZ Game and Fish Department should promote the recreational opportunities for coyotes in House Rock Valley.

Objective 6. Illegal Harvest

Strategy 1. Continue law enforcement patrols to deter illegal take.

Objective 7. Recreation

Strategy 1. Enforce Off-Highway Vehicle laws to eliminate the propagation of wildcat roads, damage to vegetation, and to reduce animal disturbance.

Objective 8. Sport Harvest

Strategy 1. Legal sport harvest should be maintained at appropriate level. During prolonged drought periods, harvest should be conservative, and conversely during years of above normal precipitation, legal sport harvest can be fairly aggressive.

Units 13A, 13B, and 12B West Pronghorn Herd Management Plan

Background and History

Pronghorn were historically present in the Great Basin Grassland plant communities in the Clayhole Valley, Antelope Valley, Lower Hurricane Valley, and Upper Hurricane Valley areas in Units 13A and 13B. This species was extirpated from these areas in the late 1800s.

In 1961, following a habitat evaluation of the area, the Bureau of Land Management and the Arizona Game and Fish Department reintroduced 34 pronghorn south of Antelope Valley near June Tank in Unit 13A. Subsequent releases occurred in 1965 and 1971. By 1977 the herd had established in the unit and had increased to levels appropriate to allow the first sport hunt. 5 permits were authorized. The pronghorn herd in Unit 12B (west side), is believed to have come from the 13A herd. The 12B herd has always been small, with no more than 20 individuals being observed.

In 1979, 84 pronghorn were released into historic habitat in Unit 13B near Diamond Butte in Lower Hurricane Valley. Other releases during the early 1980s helped augment this population, which increased to a point where the first sport hunt was offered in 1989 and five permits were authorized.

Since reintroduction, pronghorn populations have been cyclic in these management units. Pronghorn numbers have increased and decreased in a direct relationship to precipitation. During periods of drought, poor fawn survival results in low recruitment, conversely during normal to above normal precipitation years fawn survival and recruitment increase.

Habitat Description

Unit 13A

- Total Area: 1,949 mi^2.
- Suitable Pronghorn Habitat: 869 mi^2 with 668 mi^2 of medium to high quality habitat.
- Land Ownership is dominated by the Bureau of Land Management with a small percentage of Private and State Land. The Kaibab Paiute Indian Reservation occupies a relatively small portion of pronghorn habitat in the northeast portion of the unit.
- Pronghorn habitat in Unit 13A consists primarily of a Great Basin Grassland community with areas of sagebrush, juniper, and shrub encroachment.

Unit 13B

- Total Area: 3,127 mi^2
- Suitable Pronghorn Habitat: 407 mi^2 with 212 mi^2 of medium to high quality
- Land Ownership is dominated by the Bureau of Land Management with a small percentage of Private and State owned land.
- Pronghorn habitat in 13B consists primarily of a Great Basin Grassland community with areas of sagebrush, juniper, and shrub encroachment.

Unit 12B (West Side)

- Pronghorn habitat is a very small, fragmented section southeast of the town of Fredonia and an area known as Johnson's Run.
- Habitat is rated as moderate to low quality, with none rated as high quality habitat.
- Land Ownership is dominated by the Bureau of Land Management with a small percentage of private and state owned land.
- Pronghorn habitat in the west side of 12B consists primarily of a Great Basin Grassland community with areas of sagebrush, juniper, and shrub encroachment.

Population Trends

Unit 13A

The pronghorn population in Unit 13A has increased significantly in the past 10 years. Historically, the 13A pronghorn population increased when normal to above normal precipitation patterns prevail. During periods of prolonged drought the population declined. Summer surveys have resulted in a five year average of 318 animals classified. Last years pronghorn population was estimated at 438. Hunt permits in Unit 13A have fluctuated between 45 and 15 permits in the last 5 years, with hunters enjoying an average hunt success of 88%.

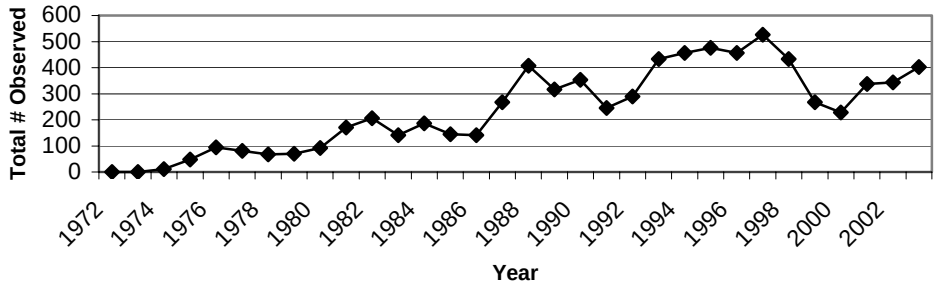
Unit 13B

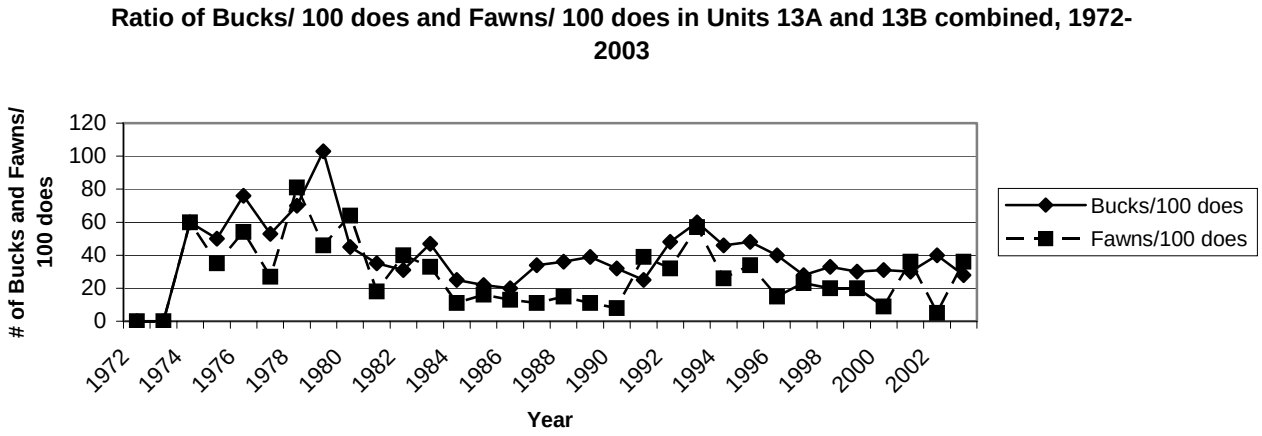
The Pronghorn population in Unit 13B remained stable with a slight increase in the early nineties. Since 1995 the population has decreased. Historically the 13B Pronghorn population increases when normal to above normal precipitation patterns prevail. During periods of prolonged drought the population declines. Summer surveys have resulted in a 5-year average of 59 animals classified. Last years pre-hunt pronghorn population was estimated at 121. Since Unit 13B was opened to pronghorn hunting, general hunt permits have never exceeded 15. However, hunters have enjoyed an average hunt success of 82%.

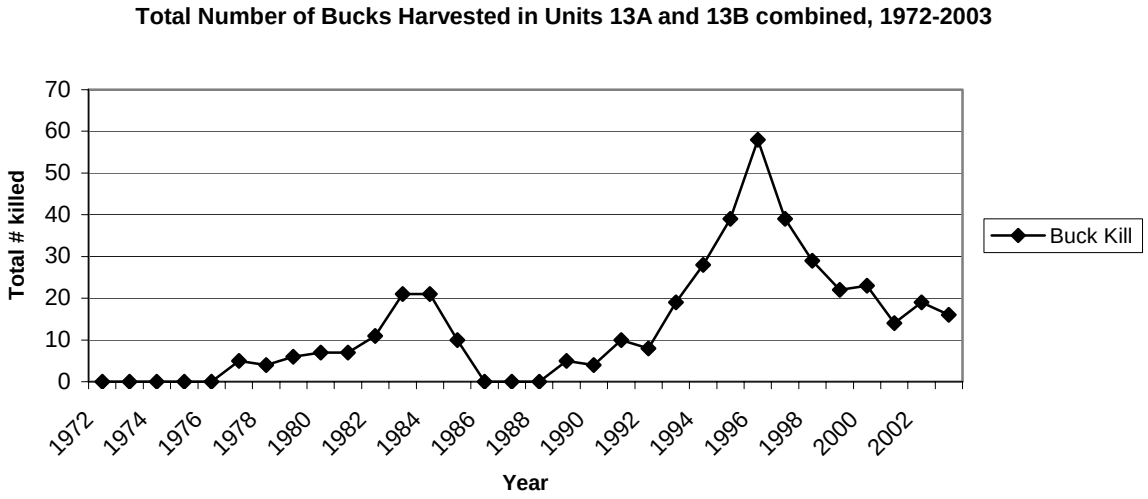
Unit 12B (West Side)

It is believed that this population of pronghorn came from the 13A population. It has remained stable and small with less than 20 animals being observed. There is only one hunt offered in 12B and it is combined with the 12A hunt. In 2002, only 3 permits were authorized for the combined hunt.

Total Number of Pronghorn Survyed in Units 13A and 13B combined, 1972-2003







Management Issues

Primary management issues for Unit 13A, 13B, and 12B (West Side) include:

1. Predation
   Coyote predation on fawns has been identified as a probable limiting factor to pronghorn recruitment, especially during drought periods when fawning cover is limited or absent.

2. Fences
   Many miles of fence do not meet game standards and restrict pronghorn movement and survival. In 2002 a fence inventory was conducted to identify and map unsuitable fences. This project was completed in pronghorn habitat in Unit 13A, and partially completed in Unit 13B. Past livestock management practices have created small pastures, resulting in a proliferation of fences in pronghorn habitat. This restricts pronghorn movement and use

of suitable habitat. Highway 89A bisects the Unit 12B pronghorn population. Several pronghorn have been killed trying to cross the highway.

3. Grazing
Excessive grazing is detrimental to pronghorn habitat. Rangeland managers should consider stocking rates and seasons of use as they directly impact forage availability and fawning cover for pronghorn.

4. Water Availability
Water is a limited resource in the area, with few year round waters available for pronghorn use.

5. Tree-Shrub Encroachment
Sagebrush and juniper encroachment into historic grassland areas are reducing-degrading available pronghorn habitat, increasing predation, and effectively blocking travel corridors.

6. Recreation
Increasing human activity in pronghorn habitat impacts plant communities, pronghorn use of available habitat, and causes increased disturbance of animals.

7. Illegal Harvest
The illegal take of pronghorn has been documented in this area and if uncontrolled can reduce or potentially extirpate the population.

8. Tribal Harvest
A pronghorn hunt currently takes place on the Kaibab Paiute Indian Reservation located in northeast Unit 13A. Pronghorn in this area are likely transitory, using habitat on Reservation land and adjacent habitat off the Reservation.

Management Goals

Objective 1. Predation

Strategy 1. Continue coyote control measures when appropriate to increase fawn survival and to meet management objectives. Control measures should be accomplished through contacts with Wildlife Services. Restore the historic grassland communities.

Objective 2. Fences.

Strategy 1. Complete fence inventories for 13B and 12B and use data to implement fence modification projects throughout all units. Encourage large pasture sizes to decrease the total miles of fences within pronghorn habitat. Remove unnecessary and unmaintained fences.

Objective 3. Grazing.

Strategy 1. Incorporate better range management techniques to address issues with adequate forage and fawning cover availability. Monitor habitat areas occupied by pronghorn, and remove cattle when allowable use has occurred.

Objective 4. Water availability.

Strategy 1. Increase-maintain year-round water availability and distribution throughout pronghorn habitat, identify key use areas, and modify grazing practices to increase fawning cover and forage availability around water. Modify fences around all waters to ensure safe access for pronghorn.

Objective 5. Tree-shrub encroachment.

Strategy 1. Identify key areas of juniper and sagebrush encroachment, and implement management strategies to reverse this process to restore historic grassland communities. Identify historic travel corridors and reopen them through the removal of invading shrub and tree species.

Objective 6. Recreation.

Strategy 1. Enforce Off-Highway Vehicle laws to eliminate the propagation of volunteer roads, damage to vegetation, and to reduce animal disturbance. Close unnecessary roads. Discourage proposals to pave main access routes through pronghorn habitat to minimize habitat fragmentation and animal disturbance.

Objective 7. Illegal harvest.

Strategy 1. Continue law enforcement patrols to minimize illegal harvest of pronghorn in both units.

Objective 8. Augmentation.

Strategy 1. Use transplanted animals when appropriate to maintain a viable pronghorn herd.

Objective 9. Tribal harvest.

Strategy 1. Coordinate with Kaibab Paiute Indian Reservation officials to document harvest levels and discuss pronghorn management issues.

Region III

<u>Units 17B, 19A, and 19B – Central Yavapai County Herd Pronghorn Operational Plan</u>

Planning Unit Goals and Objectives

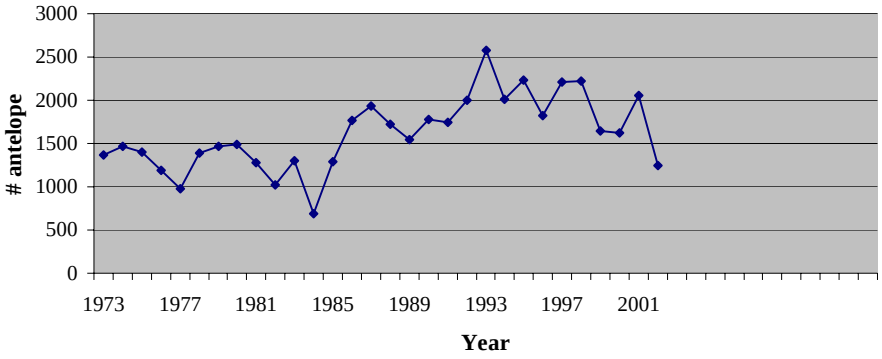
- Maintain all viable populations of pronghorn in this planning unit.
- Maintain or increase hunting opportunity.
- Protect and develop movement corridors.
- Use existing healthy or dwindling populations for translocation efforts.
- Use area as a public education tool regarding pronghorn issues.

Habitat Description

This section describes administrative boundaries and pronghorn habitats in the Prescott, Prescott Valley, Chino Valley, and Paulden areas, collectively known as Central Yavapai County in north central Arizona. The planning unit is comprised of three Units: 17B, 19A, and 19B. Land status in the area includes private land (including local municipalities), Arizona State Trust Land (State Trust Land) managed by the Arizona State Land Department, and federal land managed by the Prescott National Forest (PNF) and the Bureau of Land Management (BLM). Major habitat types in the area include interior chaparral, Mohave desertscrub, Great Basin conifer woodland and desert scrub, pinyon-juniper woodland, and semi-desert grassland. The planning unit contains about 2,191 mi^2 of land. Of this, about 1,362 mi^2 is habitat occupied by pronghorn. Of pronghorn habitat ranked as high quality statewide, about 30% is contained in this planning unit. There are 75.5 mi^2 of high quality pronghorn habitat in Central Yavapai County and 372.3 mi^2 (Ockenfels et al. 1996).

The Central Yavapai County planning area supports one of the highest density pronghorn populations in the State. About 15 to 25 percent of the statewide pronghorn population is found in this area with over 2,500 animals counted on surveys in 1993.

Combined total observations for Central Yavapai Planning Unit 1973-2002
Unit 17B



Management Objectives

- Maintain a population of 150-225 post-hunt adult pronghorn, annually harvesting 5 to 8 bucks, with the majority of these animals residing in the northeastern corner of the Unit.
- Work with landowners to ensure continued access to Unit 17B.
- Create and enhance grassland habitat and travel corridors by working with landowners and land management agencies.

This unit encompasses 671.6 mi^2 (429,835 acres). The eastern boundary is formed by Williamson Valley Road from the junction of Camp Wood Road, south to Iron Springs Road in Prescott. The County highway between Prescott and Bagdad comprises the southern boundary, while Camp Wood Road from Bagdad to Williamson Valley Road encloses the rest of the Unit. Prescott and Bagdad are located at the southeastern and southwestern corners of the unit, respectively. The unit is composed of a mix of grassland, pinyon–juniper woodland, chaparral, ponderosa pine–oak woodland, and Sonoran desert habitat types. Numerous rugged canyons and associated mesas, rolling hills, and flat open grassland characterize the terrain. Elevations vary from 1,800 to 6,466 feet.

The area is primarily comprised of mid elevation (4,620 foot average) open grassland mixed with sparse oak, algerita, pinyon, and juniper stands. A natural seep feeds a meandering wetland that provides water for pronghorn and other wildlife, and habitat for waterfowl. Windmills and dirt stock-tanks provide additional water sources. Most of the area is used as grazing land for livestock. One lightly traveled paved road (Fair Oaks Road) bisects this area. About 41 mi^2 (26,240 acres) of pronghorn habitat exists in the northeastern portion of 17B. Most of this habitat is located on two ranches: the Long Meadow and Las Vegas. Las Vegas Ranch is comprised of a few sections of State Trust and PNF land, but most of the 28,880-acre ranch is privately owned. Long Meadow Ranch is situated immediately south of the Las Vegas. Recent sale of the Long Meadow has resulted in subdivision, and subsequent deterioration of pronghorn habitat.

A limited amount of pronghorn habitat is also present on adjacent ranches in 17B. The Bar U Bar Ranch lies directly south of the Long Meadow and provides a small amount of pronghorn habitat. The Yolo is a large ranch located in the northwestern 17B, southwestern 17A, and eastern 18B. A small amount of habitat exists on this ranch but juniper encroachment compromises its' quality. Indian Rock Ranch also contains pronghorn habitat, but much of this area is limited by lack of water and juniper invasion. Tank Creek Mesa, located within the Indian Rock Ranch in south-central 17B also contains pronghorn habitat. Much of this area is limited by lack of water and deteriorated habitat conditions due largely to shrub and tree encroachment.

Unit 19A

Management Objectives

This unit encompasses about 756 mi^2 (483,910 acres). The northern boundary is formed by the Verde River, beginning at Interstate 17, and then continuing west to State Route 89. State Route 89, from the Verde River south to State Route 69 in Prescott comprises the western unit boundary. The southern boundary is State Route 69 from Prescott on the west, back to Interstate 17 at Cordes Junction to the east. Interstate 17 from Cordes Junction north to the Verde River

hems this unit. Major population centers are Prescott and Prescott Valley, Dewy, Humboldt, and Mayer to the south and southwest; Camp Verde, Cottonwood, Clarkdale, and Jerome to the north and east. Chino Valley is located in the western portion of the unit. Land status is a mix of PNF, State Trust Land, private, and BLM. The unit is composed of a mix of grassland, pinyon–juniper woodland, and interior chaparral habitat types. Stands of ponderosa pine and mixed conifer species occur on Mingus Mountain. Landforms include rugged hills, rolling short grass prairie, riparian drainages, and mountain ranges. With exception of the Verde River, most water available to wildlife in the unit is contained in dirt tanks and ranch pipelines constructed to support grazing operations. Elevations in the area range from 4,500 feet to over 7,500 feet on Mingus Mountain.

The majority of pronghorn habitat in Unit 19A occurs on six ranches that comprise 188 mi^2 or 120,320 acres of land. The ranches are the Fletcher, Perkins, Wells, Deep Well, Granite Dells, and Fain. The Fletcher Ranch is located in the northeastern portion of Lonesome Valley north of Highway 89A. The ranch is composed of State Trust Land, private, and PNF. Several large pastures on the ranch were ranked as high quality pronghorn habitat, but year-round water sources are limited in these pastures. Perkins Ranch, situated in the northern portion of Lonesome Valley, contains 9,600 acres of private and 1,300 acres of State Trust Land. This ranch is currently for sale. Wells Ranch is located along the eastern edge of Lonesome Valley and is a checkerboard pattern of private (3,800 acres), and State Trust Land (2,500 acres). A portion of the Deep Well Ranch is located on the western edge of Lonesome Valley along highway 89. This ranch consists of 3,800 acres of private, and 1,900 acres of State Trust Land.

Granite Dells Ranch is located roughly in the center of Lonesome Valley and extends south across highway 89A to Glassford Hill. It consists of about 18,500 acres of private, and 4,500 acres of State Trust Land. This ranch is contains extremely high quality pronghorn habitat, but subdivision is proceeding rapidly. Fain Ranch is located south of Highway 89A and east of Prescott Valley. This ranch consists of about 16,600 acres of privately owned and 11,520 acres of State Trust Land.

Unit 19B

Management Objectives

This unit covers about 763 mi^2 and roughly forms a triangle in the planning unit with corners at Prescott, Seligman, and Ash Fork. The unit is composed of a mix of grassland and pinyon–juniper woodlands. Landforms include open plains, rolling hills, mesas, and buttes. Big Chino Valley, a high desert grassland, dominates the center of the unit. The majority of this valley provides a historic representation of southern areas in the planning unit that are now urbanized. Water is well distributed throughout the unit, in the form of earthen stock tanks built to support livestock grazing operations. Elevations in the unit range from 4,360 to 7,168 feet. Most pronghorn habitat is found between 4,400-5,100 feet in elevation.

Most pronghorn habitat in 19B occurs on three large ranches: The K-4, CV/CF, and Campbell. The K-4 Ranch is located in Big Chino Valley and occupies the southwestern half of the unit. This ranch contains 83 mi^2 or about 25% of the pronghorn habitat within this unit. Land ownership is private, State Trust Land, and PNF. CV/CF Ranch is the northern portion of Big

Chino Valley. Land ownership is 30,000 acres of private, and 20,000 acres of State Trust Lands. This ranch constitutes about 51 sections or 15% of the unit's pronghorn habitat. Subdivision of this ranch has been recently proposed. The Campbell Ranch is located in the north and northwestern portion of the unit, and is comprised of 55 sections of land. About 38 sections are considered pronghorn habitat, or about 11% of the unit's total. Twenty-two sections lie south of I-40 and are included in this report. Interstate 40 effectively prevents north-south movement of pronghorn on the ranch.

The majority of historic pronghorn habitat that was south of the Atchison, Topeka, and Santa Fe Railroad is now residential housing. Isolated pronghorn habitat is still present, but most is threatened by continued subdivision. Several ranches still exist in this area and continue to provide some habitat for pronghorn. The Deep Well Ranch is semi-isolated from adjacent open grasslands due to its location between Prescott and Chino Valley proper. It contains about 20 sections or 6% of the pronghorn habitat within the unit. Ownership is a mixture of private and State Trust Land. The Lobo Ranch is an open grassland ranch in Big Chino Valley. Although smaller than adjacent ranches, about 8 mi^2 contains important pronghorn browse that is required during drought. The T-2 Ranch is adjacent to the Lobo Ranch and contains pronghorn habitat that is similar in value. Its approximate 12 sections contain Big Chino Wash, adjacent grasslands, and juniper woodlands.

Juniper Woods Estates is a former ranch located southwest of Ash Fork. After the ranch's private property was sold to developers, State Trust Land was also converted to private ownership *via* land trade. Presently, its approximate 131 mi^2 are all private lands subdivided into 40 acre or less residential lots. This area contains about 50 sections of pronghorn habitat. Human occupancy varies with access, but significant damage to pronghorn habitat has resulted. The actual pronghorn use area was substantially reduced following creation of this subdivision. About 5 sections of open juniper woodland on the Kaibab National Forest between Juniper Woods Estates and SR 89 remain suitable for pronghorn.

Pronghorn Distribution and Population Trends

Unit 17B

Most pronghorn in 17B are located primarily on deeded private land within the Las Vegas and Long Meadow ranches. These pronghorn move along north-south routes between Unit 17A, and along west-east routes into Unit 19B. Continued development and the associated traffic volumes on Williamson Valley Road increasingly impact pronghorn movement patterns described above.

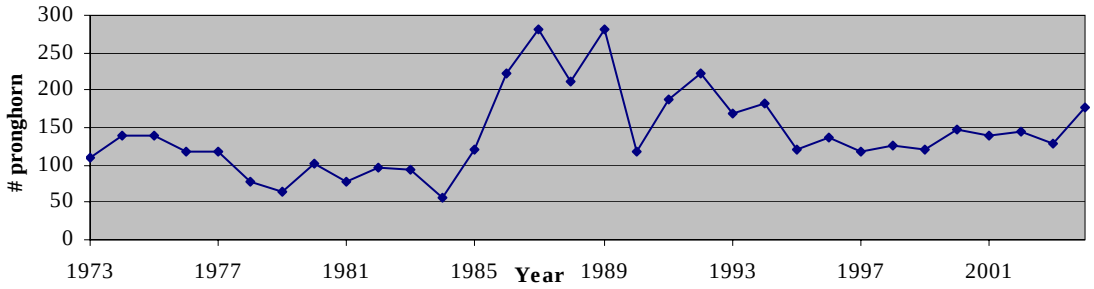
A small number of pronghorn use Tank Creek Mesa in the south-central part of the unit, and Strotjust Flat in the northwestern corner. That population contains only 12-15 animals and has steadily declined in recent years. Other small populations, such as the pronghorn on the Bar U Bar are actually migrants from the Las Vegas-Long Meadow population. Pronghorn that occur in the Strotjust Flat area are mainly associated with a population located in Unit 18B. The animals found on the Yolo Ranch are a part of the Unit 18B population that migrates into 17B.

Pronghorn have been surveyed in Unit 17B since at least 1957; however, survey data were combined with 17A and 19B until 1973. Pronghorn have been hunted in Unit 17B since at least

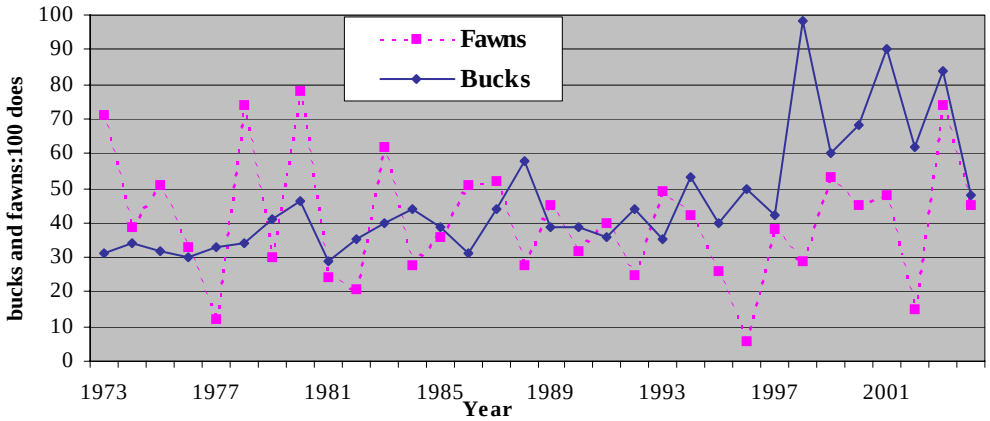
1958, when the unit was combined with Units 17A and 19B. Beginning in 1989, Unit 17B was removed from the multi-unit hunt structure and has been a separate hunt since. Mean legal harvest from 1978 to 2000 was 7 per year. Desired annual harvest is 5 to 8 bucks. Additional bucks are available for harvest; however, access restrictions on private property are limiting. Since the hunt in 17B was combined with 17A and 19B until 1989, hunter days and harvest could have varied dramatically from Unit to Unit on a yearly basis depending on where the animals were. The harvest trend follows the total observations for the same time period. Permits were significantly reduced in 1992 resulting in a corresponding reduction in harvest.

Mean fawn survival in 17B (1973-2001) was 40 fawns per 100 does; the most recent five-year mean was 43:100. Population modeling estimated 166 post-hunt adult pronghorn in the area during 2000. Mean buck:doe ratio during this time was 45:100. Pronghorn numbers during the past 30 years was highest from 1986-1989. The target population of post-hunt adult pronghorn in 17B is 150 to 225 animals.

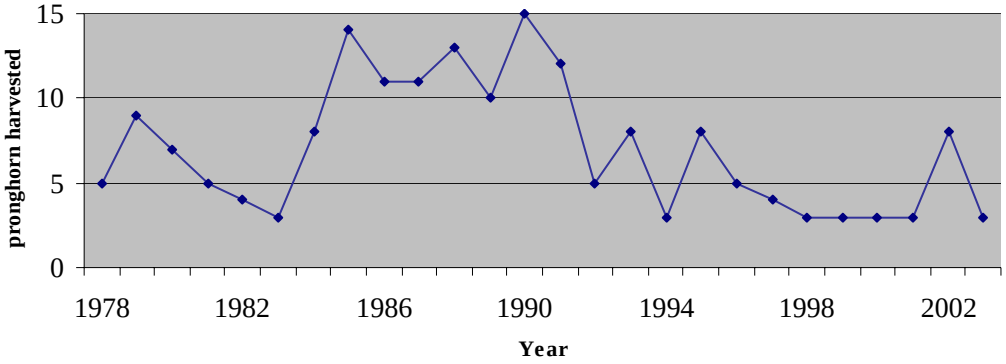
Number of pronghorn surveyed in Unit 17B, 1973-2004



Number of bucks and fawns per 100 does, Unit 17B, 1973-2004



Harvest data for Unit 17B (rifle, archery, and muzzleloader), 1978-2003



Unit 19A

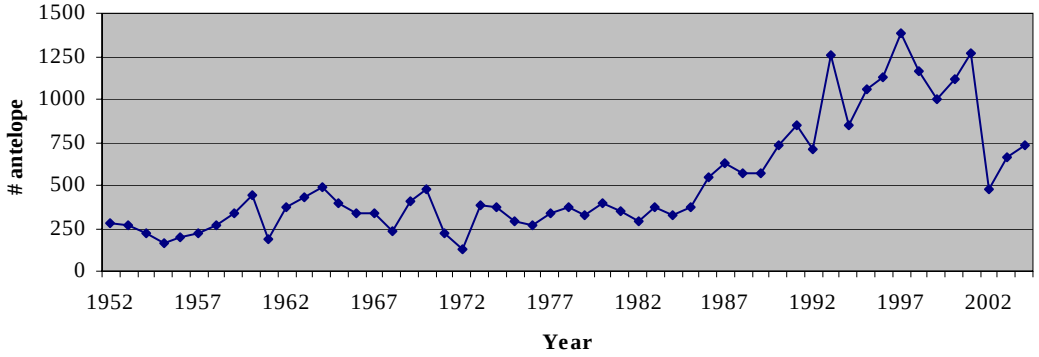
About 1,150 post-hunt adult pronghorn inhabit Unit 19A in eight distinct sub-populations. Geographical features and urban developments functionally isolate these subpopulations. The Orme population resides north of Cordes Junction, between highway 69 and I-17. Much of the habitat occupied by this group consists of a mix of interior chaparral and grassland. Pure grassland habitat is present only in small pockets. The group is threatened by isolation from larger herd units and habitat to the east in Unit 21 by I-17; and from the Lonesome Valley area to the west by SR 169 expansion. Invasion of chaparral into grassland habitats is also problematic for this herd. An additional 20-30 animals (Cherry subpopulation) reside north of highway 169 and west of I-17 on PNF land; the herd similarly has limited connectivity with animals in the Verde Valley. Juniper encroachment also jeopardizes this group.

Continuing west, a Fain Ranch subpopulation is functionally isolated from other pronghorn groups by highway 89A to the north, Prescott Valley to the west, Mingus Mountain to the east, and highway 169 to the south. This herd comprises the majority of pronghorn found in 19A (currently about 275 animals). Fain Ranch is bisected north to south by two double fenced roads connecting highways 89A and 69. One of these roads is currently under construction and will have a large volume of high-speed traffic. The highway design will likely incorporate right-of-way fencing that pronghorn cannot maneuver. Continued habitat fragmentation, an increase in road kills, and herd reduction will result. Recent expansion of Glassford Hill Road and Hwy 89A west of Fain Ranch has already impacted an additional 50-70 pronghorn (the Prescott Valley Subpopulation) in the manner described above. This small herd continues to use undeveloped areas within and around the municipal boundaries of Prescott Valley; but these animals are also functionally isolated. Continued urban development will eliminate remaining habitat and eliminate the remainder of this herd. Translocation should be a priority.

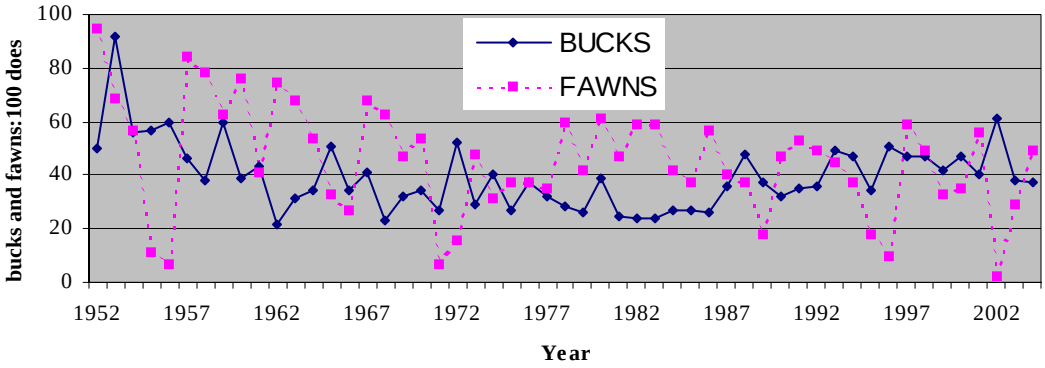
The Antelope Hills subpopulation occupies the lower north slope of Mingus Mountain in the vicinity of the Phoenix Cement Plant. This small group is decreasing in numbers, and is currently part of a study to determine movement corridors and population interchange. Land status is private and PNF. Pronghorn occupy a small area of habitat seasonally on Little Black Mesa. Pronghorn possibly use this area as a movement corridor between Lonesome Valley and areas north of the Verde River.

Glassford Hill is an extension of Granite Dells Ranch south of 89A. Highway 89A to the north, Glassford Hill Road to the east, and Highway 69 to the south isolate pronghorn occupying the Glassford Hill area. Land status is State and private. Historically, as many as 175 pronghorn may have occupied this area, however 2002 survey data indicates about only 30-40 pronghorn currently occupy the area. The area was removed from the 19A archery hunt structure in 2002. A pronghorn population in Lonesome Valley is confined by highway 89A to the south, Mingus Mountain to the east, Highway 89 to the west, and the Verde River to the north. A current telemetry project has documented animal movement into this area from north of the Verde River. Land Status is predominately private and State. Pronghorn do occupy some PNF land to the north and east.

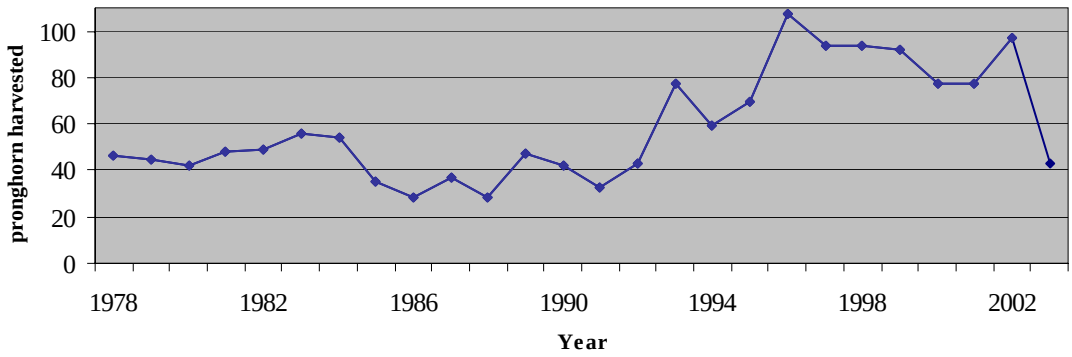
Pronghorn surveyed in Unit 19A, 1952-2004



Bucks and fawns per 100 does in Unit 19A, 1952-2004



Harvest data for Unit 19A (rifle, archery, and muzzle loader), 1978-2003



Unit 19B

The 19B pronghorn herd is distributed among four sub-units: Big Chino Valley (including the Campbell Ranch), Juniper Woods Estates, Deep Well Ranch, and Willow Lake. The area north of I-40 (the Strip) is functionally isolated from other sub-units by the interstate highway, and is not included in this discussion. Distribution of pronghorn within each subunit is discussed below (subunits are listed in order of importance based on the percentage each contributes to the overall population).

The Big Chino Valley grassland valley extends northwest from Paulden to Picacho Butte and the Juniper Mountains. The area historically provided about 230 mi^2 of habitat. Rural residential housing now comprises 12 mi^2 around Paulden. Continued development on checker-boarded sections of private land significantly reduces pronghorn use on adjacent, undeveloped State Trust sections. Invasion of juniper trees into grassland habitat is also problematic. Although the Campbell Ranch lies north of this valley, it is included within the Big Chino analysis because of pronghorn use of a small grassland mesa that separates the two. Juniper management projects continue to convert woodland habitats to open grasslands on this ranch. The number of pronghorn and amount of available habitat on each ranch in Big Chino Valley is presented in the following table.

Estimated adult pronghorn numbers and size of available habitat on Big Chino Valley Ranches, Unit 19B, 1988-2001

Ranch	Pronghorn Habitat (mi^2)	% Habitat*	Number Surveyed**
K-4	80	47	195-420
CV/CF	50	30	125-265
LOBO	7	4	20-40
T-2	10	6	25-50
Campbell	22	13	9-94
Totals:	169	100	374-869

*Habitat values of moderate to high ranking only, not low or poor quality
** Based on pre-hunt population estimates from 1988 to 2001 (range)

A subpopulation of an estimated 157 adult pronghorn inhabits the Juniper Woods Estates area. Extensive pronghorn habitat (50 mi^2) extends south and west, and gradually transitions to juniper woodlands. Over the past 12 years, scattered occupancy of 40-acre lots has greatly reduced pronghorn distribution and numbers. As such, limited management opportunities currently exist with this herd and development trends will likely continue.

The Deep Well Ranch subpopulation is threatened by habitat fragmentation. Presently, the ranch is semi-isolated from adjacent open grasslands by urban infrastructure in Prescott, the Town of Chino Valley, and State Route 89. The ranch currently supports a population of about 85 adult pronghorn**.**

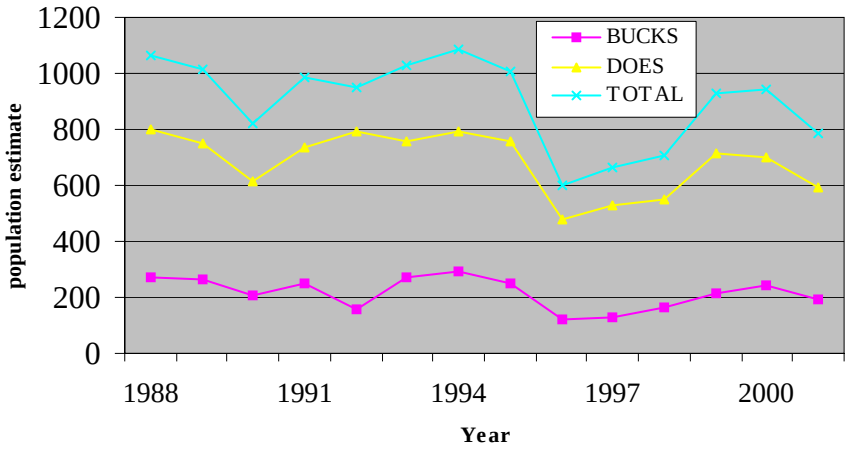
The Willow Lake herd represents a prime example of pronghorn isolation caused by urbanization. This declining subpopulation of <50 pronghorn persists within the Prescott city limits near the Willow Lake-Prescott Lakes area in the southern portion of the unit. The herd occupies habitat that is being rapidly converted to a residential housing-golf course development. Historical dispersal or migration from this area likely influenced the number of pronghorn in the area. However, construction of two roads (and associated fencing) more than 30 years ago created the first major barrier to movement on the northern border of the area. Continued urban development has reduced habitat from 10 mi^2 in 1990 to less than 2 mi^2 in 2000. Although the Willow Lake Park is city property, most of the remaining pronghorn habitat is private property that will be developed in the near future. The herd is frequently surveyed to monitor total numbers, sex-age ratios, and fawn survival. Presently, two radio-collared does are tracked and provide data used to determine area fidelity.

Pronghorn survey data has been collected in 19B since 1961. Specific hunter harvest data for this unit are not available until 1989 because the area was historically combined with adjacent units. Mean sex and age ratio between 1961 and 2001 was 31 bucks:100 does:36 fawns (Figure 14). Between 1961 and 2000, fawn:doe ratios were below guidelines 35% of the years, within guidelines 27% of the years, and above guidelines 38% of these years. Buck:doe ratios were below guidelines 10%, within guidelines 35%, and above guidelines 55% of these years. During the past 10 years (1992-2001), mean sex ratios remained constant; however, age ratios declined

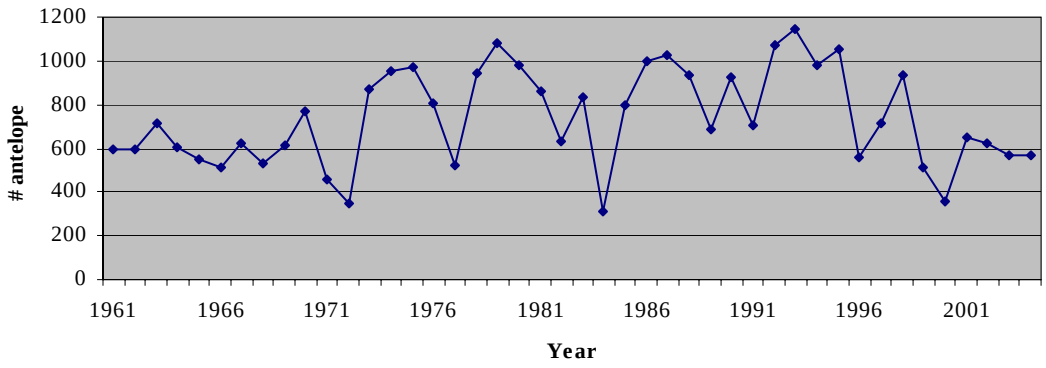
slightly and varied drastically. Mean sex and age ratios were 31 bucks:100 does:30 fawns during this period. Fawn to doe ratios were below guidelines 40%, within guidelines 50%, and above guidelines only 10% of years within this timeframe. The fawn:doe ratio ranged widely during this time from a low of 2 fawns:100 does in the 1996 drought, to a high of 43:100 during periods of ample precipitation in 1993. Buck:doe ratios were below guidelines 10%, within guidelines 40%, and above guidelines 55% of the years since 1992.

Pre-hunt population estimates were compiled from annual hunt recommendations from 1988 to 2001. Pronghorn numbers ranged from 1066 in 1988 to a low of 602 in 1996. Prolonged drought in 1996 is implicated in the population decline. Pronghorn buck numbers have remained relatively stable during this time period, ranging from an estimated low of 125 in 1996 to a previous high of 290 in 1994. The doe population ranged more widely from 602 in 1996 to 1083 in 1994. Population estimates generally coincide with survey data collected in this unit. Number of pronghorn surveyed was lowest in 1972, 1996, and 2000. Peaks occurred in survey numbers at two to three year intervals just prior to each low point. Annual hunter harvest in this unit is typically 50-60 animals. Hunt success for general seasons averages about 90%. Archery hunt success typically averages about 20-25% however this may drastically increase in drought conditions, e.g. 73% success in 2002. Fawn survival averages about 30 fawns per 100 does, however survival during the 1996 and 2002 droughts dropped to 2 and 4 fawns per 100 does, respectively.

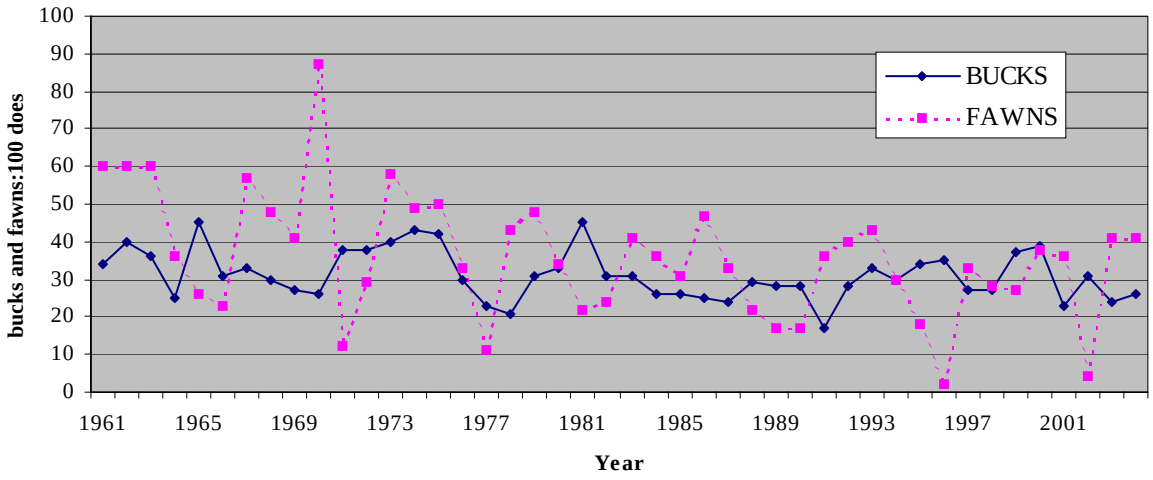
Pre-hunt pronghorn population estimates in Unit 19B, 1988-2001



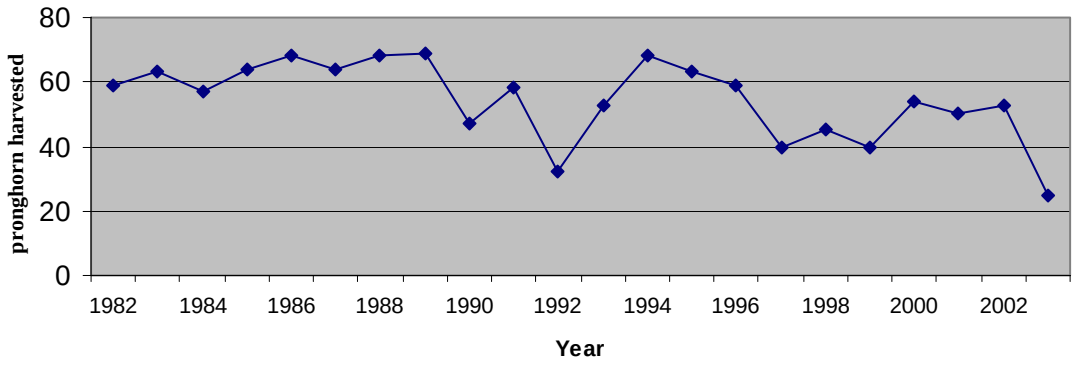
Pronghorn surveyed in Unit 19B, 1961-2004



Bucks and fawns per 100 does in Unit 19B, 1961-2004



Harvest data for Unit 19B (rifle, archery, and Junior seasons)



Specific Issues and Proposed Management Actions

The prevailing threat to pronghorn populations in this planning unit is loss and degradation of available habitat to urban development associated with a rapidly expanding human population. Yavapai County is the fourth largest county in Arizona by population, following only Maricopa, Pima and Pinal counties. The town of Prescott Valley is the seventh largest growing incorporated area in the state, with 161.5% growth occurring between 1990 and 2000. Much of this growth has occurred in high-quality pronghorn habitat, and much more development is forecasted. Ancillary impacts to pronghorn are often common to many areas; however, others may be site specific. This section identifies threats common to multiple subpopulations, which were discussed in the introduction of this document. Threats and issues specific to the 14 subpopulations that occur in this planning unit are detailed in this section.

Habitat Management

Issue 1 – Loss of grassland habitat to development on American Ranch (Unit 17B).

Strategy 1a. – Work with American Ranch developers to ensure fencing is constructed to wildlife specifications thus allowing emigration of resident pronghorn.

Issue 2 – Loss of grassland habitat to development on Long Meadow Ranch (Unit 17B).

Strategy 1a. – Educate new landowners as to the importance of constructing new fence to wildlife specifications to allow for movement of pronghorn.

Strategy 1b. – Work with neighboring ranches and land management agencies to create and enhance grassland habitat adjacent to Long Meadow ranch.

Issue 3 – Fragmentation of habitat by paved double fenced roadways in Unit 19A

Strategy 1a. – Participate in the roadway planning process to align paved roadways in a way that minimizes fragmentation of key habitat

Strategy 1b. – Ensure right-of-way fences meet or exceed wildlife specifications. Use gap fencing, overpasses or other measures to allow pronghorn to cross paved roadways.

Issue 4 – Annexation of northern Lonesome Valley by the town of Chino Valley

Strategy 1a. – Work with city planners to pursue mitigating measures such as land exchanges or conservation easements to maintain large blocks of grassland habitats.

Issue 5 – Expansion of Prescott Valley into Fain Ranch

Strategy 1a. – Work with city managers to plan development in a way that does not fragment or isolate blocks of habitat.

Issue 6 – Range Conditions-Fawning Habitat

Strategy 1a. – Work with livestock operators to manage grazing in a way that maximizes cover during fawning period in key fawning areas.

Issue 7 – Mortality of adult pronghorn on newly opened or widened roads, specifically the new section of highway 89A and the soon to be opened Fain Road alignment.

Strategy 1a. – Work with ADOT and the county or have pronghorn crossing signs installed at key locations. Ensure right-of-way fences are built to pronghorn specifications and have setbacks at key locations.

Strategy 1b. – Investigate ways to keep monsoon runoff from creating green-up along roads during drought conditions – supplemental feedlots and watering stations?

History of Management Actions

Unit 17B

- Pronghorn have been surveyed in Unit 17B since at least 1957.
- Pronghorn hunts have been held in Unit 17B since at least 1958.
- In 1963, most of the Las Vegas and Long Meadow Ranches were root plowed to remove snakeweed.
- The Las Vegas Ranch routinely employs cholla cactus removal practices.
- The Las Vegas Ranch has completed numerous juniper treatments in the past.
- Juniper treatment (cutting with hydraulic shears) near Strotjust Flat (Units 18B and 17B) scheduled for July of 2001.
- Research Branch personnel evaluated pronghorn habitat in 1995.

Unit 19A

- Population surveys begun in 1948.
- Pronghorn hunts begun in 1941.
- Fain ranch study on Home Ranges, Movement Patterns and Habitat Selection, 1989-1994.
- Habitat evaluation Research Branch, June 1996.
- Fain Ranch Capture for translocation, January 2000.
- Attempt to drive pronghorn from K-Mart area of Prescott Valley, April 1996.
- Juniper chaining in Little Black Mesa, Del Rio Area.

Unit 19B

- Pronghorn have been surveyed in Unit 19B since at least 1948. Data from 1961 to the present is presented in this report.

- Pronghorn hunts were initiated in 1941, 1942, and 1943. There is no data for 1944-48, so possibly no hunts were conducted. Annual harvest data is available statewide from 1949 to the present.
- Juniper management has been conducted on the Campbell Ranch to increase habitat and increase movement between the Campbell Pasture and Juniper Woods Estates.
- Documentation of open space change within Yavapai County from 1988 and 1997 (USGS contract: http://TerraWeb.wr.usgs.gov/projects/OpenSpaces/).
- Water source mapping and classification of all waters (AGFD, Region III "Critical Waters Project") completed in 2000.
- Fence mapping and classification within Big Chino Valley (April 1996).
- Landscape-level pronghorn habitat evaluation (September 1996).

Units 6B, 8, and 19A – Verde Valley Herd Pronghorn Operational Plan

Background and History

The pronghorn herds in the Verde Valley function as metapopulations. Physical obstacles such as the Verde River and Highway 89A separate distinct herd units. Documented interchange between population centers allows genetic diversity to flow through these population-permeable barriers. Managing these obstacles to ease pronghorn movement will add gene flow to improve marginal herd genetics.

In 2000 and 2001 mountain lion predation on the adult cohort was identified as a serious population threat in both units. Both units face three critical management objectives:

1. Maintain genetic viability,
2. Consolidate habitat and maintain travel corridors, and
3. Reduce predation.

Habitat Description

Pronghorn were historically widespread throughout the Verde Valley. The journal of E.A. Mearns (1985) while stationed at Fort Verde commented on the frequency of pronghorn observations in the Beaver Creek, Oak Creek area (Brown, D.E., editor, Wildlife Views). Pronghorn used winter range at Wingfield Mesa and Cottonwood Basin, east of Camp Verde in Unit 6A into the 1970s (Andrews, S. and Kohls, R., personal communication).

The residual pronghorn populations in the Verde Valley use habitat in Units 6B, 8, and 19A. The range straddles the Verde River as it flows southeast from Perkinsville to Camp Verde. Units 6B and 8 are administered through the Department's Region II office in Flagstaff, while Unit 19A is managed through the Department's Region III office in Kingman. The United States Forest Service (USFS- Coconino, Kaibab, and Prescott National Forests) manages most pronghorn habitat in Units 6B and 8. Arizona State Trust Lands managed by the State Land Department occupy about 35 sections, mostly in the northern third of Unit 6B. The checkerboard arrangement of the State Land sections and State ownership of Rogers Lake expand their value to pronghorn beyond their spatial imprint. Coconino County and/or the city of Flagstaff through Arizona Preserve Initiative strategies may purchase Rogers Lake for conservation-open space objectives. About 6 sections of private inholdings retain value as pronghorn habitat, most notably at Hat Ranch, Garland Prairie, and Rogers Lake. Camp Navajo, a 28,300-acre military facility (Arizona National Guard) occupies the northwest corner of Unit 6B.

The United States Forest Service (USFS) manages most pronghorn habitat in the Valley. Coconino National Forest's Sedona Ranger District manages the east side of the river, and the Prescott National Forest's Camp Verde and Chino Valley Districts manage the area west of the river. Arizona State Trust Lands and private lands (including local municipalities) occupy less of the range.

Unit 6B

The western extension of the Mogollon Rim divides Unit 6B into a northern upland plateau and a southern valley grassland savanna. The northern half supports summer seasonal habitat occupied

by a pronghorn herd with linkage to Garland Prairie in Unit 8. The southern half consistent with the general Verde Valley pronghorn habitat covers about 100 mi^2, roughly bordered by Dry Creek and Boynton Pass Road on the east, Highway 89A, Verde River and Sycamore Canyon. Telemetry observations of marked pronghorn indicated linkage between sub-populations in Units 6B and 19A contiguous to the Verde River (Luedeker, L. 2001).

Vegetative communities in the south half of Unit 6B include semi-desert grassland, juniper savanna, and pinyon-juniper woodland. Skeleton Bone Ridge separates Wheatfield Flat and Duff Flat and supports pinyon-juniper woodland in broken and eroded terrain. The USFS Sedona District has implemented juniper reduction projects near Wheatfield Flat.

A rating system evaluated pronghorn habitat by sections within the area: seventy percent was rated as poor quality; twenty percent was rated as low quality; ten percent was rated as medium quality; none was rated as high quality. The 100 sections of potential pronghorn habitat in the southern half of Unit 6B center on moderate quality habitat (Ockenfels, 1997) around Wheatfield Flat, Duff Flat, and Upper Sheepshead Valley. A total of 124 sections of habitat were rated by Ockenfels as potentially suitable pronghorn habitat.

The Unit 6B pronghorn population herd tends to use the three core areas of medium quality habitat. Additionally, they frequently use the area south and west of the Windmill Ranch headquarters. During drought periods, effluent-irrigated forage at the Sedona Wastewater plant attracts high use. Ponds and water pipelines constructed to support grazing of livestock adequately supplement natural water sources.

The Windmill Ranch (Morrison Brothers) occupies the entire pronghorn range in the south half of the unit. The ranch has been supportive of pronghorn management activities, participating in the Wheatfield juniper control project. The range is grazed during the winter season, and the range condition plots indicate an improving trend in ground cover and species diversity.

Unit 8

Unit 8, encompassing 643 mi^2, but only 50 mi^2 is considered moderate or better quality pronghorn habitat. The northern boundary of the Unit 8 is I-40, from the northwestern of the Navajo Army Depot until its junction with Volunteer Canyon, ten following the canyon until Sycamore Creek, and finally Sycamore Creek to the Verde River. The southern boundary is the Verde River, from Sycamore Creek east until junction with US 89. The well-defined western boundary is US 89, from the Verde River to I-40.

Much of the northern portion of the unit is higher elevation (>7,000 ft) covered with ponderosa pine forest. Much of the landscape in the south and west covered with pinyon-juniper woodland. No highways bisect Unit 8. The only major road is the Perkinsville Road, which bisects Unit 8 in a north-south direction from Williams to FR 492. From Paulden, the Arizona Central Railroad bisects the extreme southern portion of the unit Perkinsville, where it enters the Verde River. Within Unit 8, development occurs at Drake-Paulden area, Sherwood Forest Estates, and in Garland Prairie.

Land ownership in Unit 8 was mostly Kaibab National Forest, with scattered, small, private inholdings. Two large, private inholdings occurred in the northern portion: one at Hat Ranch west of Bill Williams Mountain and the other at the southern end of Garland Prairie. The southwestern corner, near Paulden was equally divided between private and State Trust lands. No substantial human-related fragmentation of habitat because of highways was observed in Unit 8.

Overall, most of Unit 8 was closed canopy, ponderosa pine forest or pinyon-juniper woodland. The higher elevation area provided high quality summer habitat, whereas year-round habitat occurred in the western and southern portions of Unit 8, (note-W and SW area use dependent on range conditions, water availability and summer monsoon season). Numerous small openings occurred throughout the unit. These openings provided limited habitat for pronghorn. Large grassland areas occurred at Garland Prairie, Hat Ranch, Wagon Tire Flat, and a series of opening along US 89 south of Ash Fork to the Paulden area.

Summer Range:
Garland Prairie.
Terrain was gently, rolling hills consisting of large open to semi-open grassland surrounded by ponderosa pine forest. Stringers of pine extended into the grassland meadows. Grass species richness was good. Shrub species richness was low. Stock tanks are abundant and accessible throughout much of the prairie area. Shultz Lake on the west end of the prairie consistently holds water during severe drought conditions and currently is not used for domestic stock use. Development is on goings on private in holdings with continuing improvement on the road systems in the surrounding area. Woven-wire fence exists around private sheep pastures, all on the Manterola property. Other fence and structure impediments occur around the private inholdings near Pine-air Estates and area on the south end of the prairie.

Pine Hill Area.
This area included Pittman Valley, McDougal Flat, and Davenport Lake. Areas consist of small isolated grassland pockets surrounded by ponderosa pine forest. A stock tank generally exists in each of the described area. An important part of use of these areas is highly dependent of corridors that the pronghorn have learned to use. Although these areas may be small in size, they are very productive in relationship to fawning areas.

Hat Ranch-Flat Mesa Area
Just west of Bill Williams Mountain and north to the Matterhorn, the terrain was gentler, with flats and small canyons, than the Bill Williams Mountain area. This opening was where the forest intergraded into pinyon-juniper woodland, and it provided decent summer range, and moderate quality winter range. Previous treatments to pinyon-juniper in the area. Development was low, with ranch headquarters occurring at the eastern edge of the grassland. Livestock fences varied, including electric, game standard, and most not game standard. Water sources were well spaced and available to pronghorn.

Year-Round Range:
Ash Fork-Putney Flat.

This area included the grassland and juniper woodland hillsides from the Welch Interchange west to Ash Fork and south to Hell Canyon. West of Flat Mesa-hat Ranch, the elevation dropped off enough to provide winter and year-round range for pronghorn. Most of the area was a mixture of dense juniper woodland, with a reduced species richness understory, or open juniper woodland, with a good understory of grasses and shrubs. Considerable areas of old juniper pushes occurred along with narrow grasslands, each providing suitable pronghorn habitat. The push areas were being re-colonized by junipers and tall shrubs, substantially lessening their suitability for pronghorn. There have been several projects in the area to address these concerns. None of the opening was large in size. Overall, the terrain ranged from rolling hills, but some sites were rugged bluffs and small canyons to the east. Development was low in the area, but recreational uses of the 2-track roads somewhat lessons the suitability for pronghorn. Furthermore, many of the openings were along US 89, and traffic disturbance lessened their suitability. Few reliable water sources existed in this area. Although water sources were well distributed, few had the capacity to continually retain water.

Wagon Tire Flat Area.
Topography south to Hell Canyon was mostly flat to undulating, with prominent drainages and some canyons. This area comprised the majority of the winter range for pronghorn in Unit 8. Vegetative cover was a mixture of dense juniper woodland, with some open woodland and shrub-grassland. In the open areas, grass species richness was often greater than 4 species, but shrub species richness was low, except in the drainage's and disturbed sites.

The Drake-Perkinsville Road cut through the southern end of Wagon Tire Flat, which decreased disturbance levels and somewhat lessened the suitability of the area for pronghorn. Livestock fences were present in most sections and did not meet game standards. Stock tanks were abundant and accessible to pronghorn. There have been concerns with the new grazing operational plans and the increase of pasture division with electric fences. Several mortalities of collared pronghorn occurred after the initial construction of the new fence. Only one of the collared pronghorn mortality could be definitely attributed to the electric fence. The animal appeared to break its neck by running into it.

Page Flat.
Along US 89, from Hell Canyon south to the Verde River, some shrub-grassland openings occurred in the Page Flat area. Most of the openings in the juniper woodland-chaparral vegetation were small and provided limited habitat for pronghorn. Here, the terrain was flat to undulating, but vegetative characteristics lessened its suitability for pronghorn. Tall shrubs were prevalent in the woodland areas and invaded the openings. Near Paulden, the shrub-grassland areas increased. There is a vegetation project of 5000 acres to treat invasion trees as of 2002.

Human disturbances increased near Paulden, with considerable housing scattered along US 89. Further, the Atchison Topeka and Santa Fe (AT&SF) railroad bisected the area just east of the highway after entering this unit north of Drake. The railroad right-of-way is fenced, but thus only minimally affected pronghorn movements. Livestock fencing occurred in most sections and did not meet game standards. Water sources were abundant and accessible to pronghorn. Waterlot fencing is of concern relative to access to water.

Unit 19A

Unit 19A covers about 750 mi^2 in Yavapai County, central Arizona. The boundaries are Interstate 17 from Camp Verde, south to Cordes Junction, Highway 69 northwest to Prescott, Highway 89 north to the Verde River at Sullivan Lake, and the Verde River southeast to Camp Verde. Mingus Mountain lies in the center of the Unit.

Portions of the Verde Valley area are located on the eastern edge of Unit 19A. Elevations range from 3300 feet at Camp Verde to 4500 feet at the top of Copper Canyon. The area is composed of grassland mixed with mesquite in the valley and near Cordes Junction, with juniper on the upper slopes. Land ownership is mostly U.S. Forest Service, with large blocks of developed private land in the towns of Jerome, Clarkdale, Cottonwood, and Camp Verde. The Orme area consists of U.S. Forest Service, State Land Department, and Bureau of Land Management lands, with minor private land inholdings. Most water used by pronghorn in this area is from earthen stock tanks.

The U.S. Forest Service's Jerome Allotment and private lands of the Phoenix Cement Company are located near the town of Clarkdale and hold the majority of pronghorn distribution in the Verde Valley portion of Unit 19A. This area is not typical pronghorn habitat; it is fairly steep with rocky hills and drainages. Pronghorn also use the Cienega Allotment near the I-17-Hwy 169 intersection, and occasionally the Verde Allotment at Hayfield Draw, between Cottonwood and Camp Verde.

Pronghorn Distribution and Population Trends

Pronghorn classification surveys are conducted between June 1 and September 15 annually. Pronghorn surveys in Region III are typically flown in June, while those in Region II are usually flown in July. Due to the small herd sizes in the Verde Valley populations, survey observations and resulting buck:100does:fawn rations are erratic. Department guidelines recommend desired rations of 25 – 30 bucks:100 does: 30 – 40 fawns; however, since hunting mortality is not significant in the Verde Valley herds, predation management may be the most effective tool to achieving the desired ratios. The pronghorn habitat in the Valley is often contiguous to municipalities, and in other areas associated with intensive recreational use. These factors make aerial gunning of coyotes an unsuitable alternative.

Unit 6B

A pronghorn telemetry project initiated in 1999 has tracked members of the Cement Plant (Unit 19A) and Wheatfield (Unit 6B) herds. A travel corridor across Highway 89A in Unit 19A (with 8 documented crossings) has been identified, as well as a travel corridor across the Verde River between Units 6B and 19A (2 documented uses).

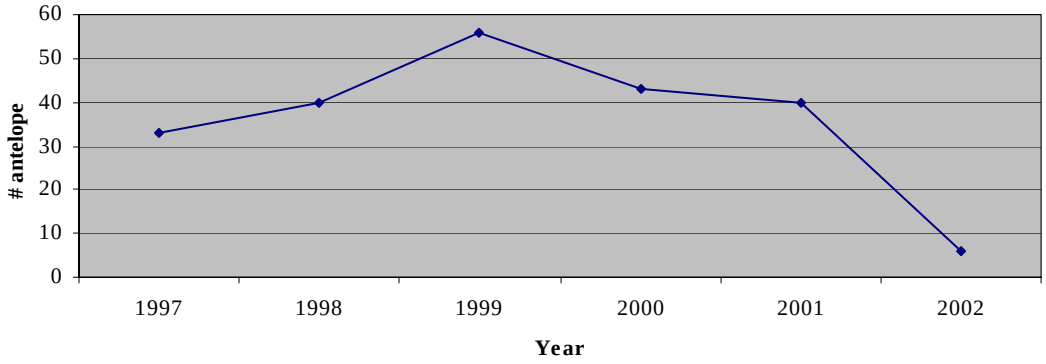
The Wheatfield herd in Unit 6B contains about 40 pronghorn, primarily using Wheatfield Flat, Duff Flat, and upper Sheepshead Valley. Individuals from this herd seldom crossed Highway 89A into Unit 6A, but increased traffic loads and reconstruction of the highway to a four-lane divided standard probably will eliminate crossings. A transmitter-collared doe pronghorn crossed the Verde River north of Perkins Ranch into Unit 19A during the spring of 2001.

The southern half of Unit 6B was not surveyed regularly until 1977 and the existing survey data reports observations from the entire unit. Survey observations reported for the period of 1970 – 1996 produced overall ratios of 25:100:28. In 1997 the aerial survey technique for Unit 6B was changed from a random check of the plateau meadows to a grid search pattern, with one morning spent surveying the Verde Valley and one morning surveying the plateau (Fig. 18).

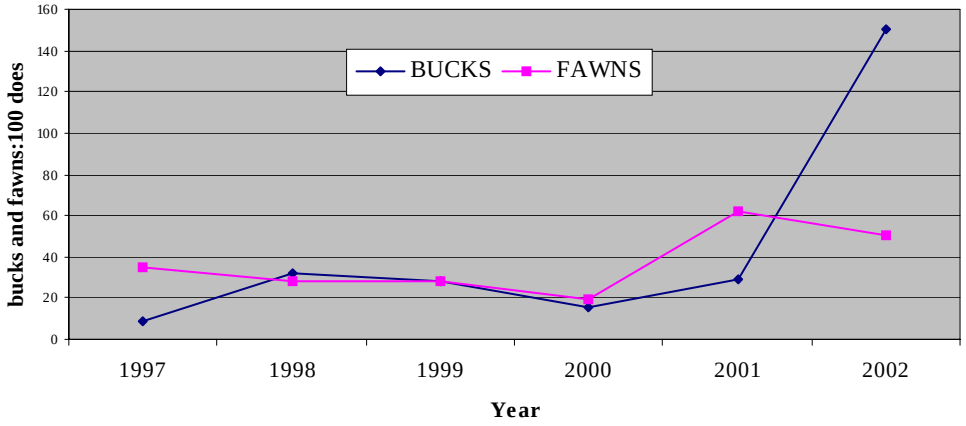
Harvest data also lacks clarity. The reporting technique for the years 1953 – 1956 used a map with dots indicating harvest sites. Although 10 bucks were harvested in the area that would later be designated Unit 6B, the dots indicate they were all taken on the plateau, mostly near Rogers Lake and the Navajo Ordinance Depot.

During the period 1959 – 1996 Unit 6B hunt was usually attached to either the Unit 6A of the Unit 8 hunts. The hunt strategy has favored primitive weapons, either muzzleloader or archery since 1984. From 1997 to the current year Unit 6B has featured a distinct unit archery hunt with 30 tags offered. Seven bucks were harvested in the four years of the archery-only hunt strategy.

Pronghorn surveyed in Unit 6B, 1973-2002



Bucks and fawns per 100 does in Unit 6B, 1973-2002



Unit 19A

Pronghorn in the 19A portion of the Verde Valley are found in several separate areas. Starting at the north, about 30 pronghorn are located west of the Verde River from S.O.B. Canyon to Clarkdale at the Phoenix Cement Plant-Highway 89A. These lands are a combination of private and U.S. Forest Service (Jerome Allotment). These pronghorn possibly interact with pronghorn in western Unit 19A at Little Black Mesa. In dry years, pronghorn have been observed at Red Flat Tank, between these two known herd areas. Pronghorn cross Highway 89A, in the rolling grassy hills east of Jerome, to reach the Haskell Springs area (also on the Jerome Allotment). Up to a dozen pronghorn may reside here at any given time. Continuing southeast through the Verde Valley, up to half a dozen pronghorn have been observed at Hayfield Draw on the Verde Allotment. These observations are believed to be of transient pronghorn, possibly connected to the Haskell Springs herd, and definitely connected to the Cherry herd (northwest of the I-17-Cherry Road [Highway 169] intersection), as confirmed by radio-telemetry.

The Cherry pronghorn herd consists of about 15 animals, down from about 25 pronghorn in the early 1990s. This herd is located on the Cienega Allotment. Although Highway 169 interferes with pronghorn movement, occasional movement to the south is suspected. South of Highway 169 to Cordes Junction are the Orme North and Orme South pronghorn herds (names are consistent with previous AGFD research and survey sub-units). About 30 pronghorn comprise these two herds, in which interaction is suspected but not documented. Most of these pronghorn are located on the V Bar Allotment, but some are also on the Cienega and Ash Creek Allotments.

Although annual pronghorn population surveys are conducted in Unit 19A, these specific areas are rarely included. Low pronghorn numbers, dispersed herds, thick vegetation, and steep topography here result in low cost-effectiveness and highly variable results.

Pronghorn harvest annually occurs in Unit 19A, however, few are taken from these specific areas. The portion of Unit 19A south of Highway 169 has been closed to harvest for about 2 decades, due to low pronghorn numbers. A few bucks in the Cherry herd have been harvested during archery hunts of the 1990s. The pronghorn herds near Clarkdale have received little hunting pressure because the Phoenix Cement Plant prohibits trespass for this purpose. In each of these areas, predation from mountain lions and coyotes has been shown to occur.

Management Goals

Habitat Management

Issue 1 – Juniper encroachment into grassland habitat in the Wheatfield Flat – Anderson Butte area has impacted habitat quality.

Strategy 1a. – Continue work with the USFS. The Sedona District has begun an effective juniper management strategy.

Issue 2 – Threats to movement corridors.

Strategy 1a. – Identify and enhance potential pronghorn movement corridors through juniper, mesquite, desert shrub removal and fence modification.

Issue 3 – Poor habitat-range conditions.

Strategy 3a. – Work with the USFS and livestock operators to develop livestock rotation plans which leave vegetative cover in key pastures during the critical pronghorn fawning season.

Game Management

Issue 1 – Isolated populations may become non-viable due to reduced size, lack of genetic variability, and lack of emigration-immigration.

Strategy 1a. – Determine potential pronghorn corridors between sub-populations and enhance them to encourage pronghorn movement.

Strategy 1b. – Use transplanted pronghorn to bring genetic variability into isolated populations.

Law Enforcement

Issue 1 – Unlawful harvest of pronghorn.

Strategy 1a. – Promote the Department's Operation Game Thief Program in the Verde Valley.

Information and Education

Issue 1 – Lack of understanding by the public of pronghorn values to the community and state.

Strategy 1a. – Participate in media and out-reach opportunities whenever appropriate.

Planning

Issue 1 – No current comprehensive strategy to improve pronghorn habitat.

Strategy 1a. – Use the results of the on-going pronghorn movement research to identify and prioritize areas where habitat treatments could facilitate pronghorn movement between isolated populations.

Research Opportunities within Unit

- Measure physiological effect of tour operators on pronghorn (hot air balloons, other aircraft)
- Evaluate pronghorn response to mineral supplements (selenium, copper)
- Evaluate seeding of native forbs palatable to pronghorn
- Investigate "triggers" for seasonal migration and random long-range movement
- Identify and improve travel corridors to encourage interchange between herd units
- Supplemental transplants
- Continued pronghorn movement research (Units 6B, 8, and 19A) to identify herd movement corridors

- Modify road fences to facilitate pronghorn movement (i.e. wildlife specification fencing, goat bars, staging areas)

Mitigation Opportunities

- Require fence modification (set-backs) along fenced road rights-of-way as a feature of major upgrades or renovation
- Use Red Rock Demonstration Projects funds to restore and protect areas impacted by recreationists
- Encourage wider utility corridors through juniper vegetation to facilitate pronghorn movement
- Use standard wildlife-specification fencing, goat bars, and road set-backs to facilitate pronghorn movement
- Construct water developments
- Haul water to troughs during drought periods
- Habitat improvements (juniper removal, prescribed burns)

Unit 10 Pronghorn Herd Management Plan

Planning Unit Description

Unit 10 covers about 2,400 mi^2 of northwest Arizona, south of the Colorado River. The boundaries are Historic Route 66 and Interstate 40 on the south; the Hualapai Indian Reservation on the west; the Colorado River, the Havasupai Indian Reservation and Cataract Canyon on the north and northeast, and Highway 64 on the east. The town of Williams sits in the southeast corner of the unit near the junction of Interstate 40 and Highway 64. Seligman and Ash Fork sit on the south boundary along Interstate 40. The community of Valle sits on Highway 64 on the east side of the unit.

The unit is composed of a mix of Grassland, Pinyon-Juniper and Ponderosa Pine-Gambel Oak habitat types. Elevations range from about 5,000 to 7,500 feet above sea level. Most of the unit lies between 5500 and 6500 feet above sea level. Landforms include open plains, rolling hills, plateaus, and mountains. About 1,800 mi^2 of Unit 10 could be considered pronghorn habitat. Natural surface water is very scarce. Most water is supplied by dirt tanks and ranch pipelines designed to support livestock grazing operations.

Quality rank of pronghorn habitat in mi^2 for Unit 10

	Habitat Rank					
Unit	High	Moderate	Low	Poor	Unsuitable	Total
10	1	713	495	*	905*	2114

*Ockenfels et al. 1996

* Poor and Unsuitable were combined for MU 10.

Although there are a number of ranches in Unit 10, most of the unit's pronghorn population is located on the 2 largest ranches in the unit. The Big Boquillas Ranch is located in the western half of Unit 10 and accounts for about 50% of the entire unit. The ranch property consists of about 491,000 acres of private lands owned and administered by the Navajo Nation and about 238,000 acres of leased, Arizona State Trust lands. The Boquillas contains about ¾ of the unit's pronghorn habitat and population. This is the largest and the single most important ranch for pronghorn in Unit 10 and perhaps the rest of the state as well. A portion of the Babbitt Ranch is located in the east-central part of Unit 10. The Unit 10 portion of the ranch covers about 184,000 acres of land composed of about 114,000 acres of deeded private land and 70,000 acres State lease. The Babbitt Ranch covers about 12% of Unit 10. The Babbitt Ranch has been a voluntary participant in efforts to research problems limiting pronghorn populations as well as implementing habitat improvements specifically for pronghorn such as fence modifications.

Several smaller ranches contain lesser amounts of pronghorn habitat. These include: Aja Ranch*, Ash Fork Campbell Ranch**, Blair Ranch*, Double A Ranch**, Four Hills Ranch**, Goldtrap Ranch*, Howard Mesa Ranch**, Oden Ranch*, Perrin (McCauley) Ranch, Seven's Ranch**. All or portions of 7 ranches have been subdivided and sold. Ranches marked with an

* are presently closed or partly closed to public access, and those marked with ** are private lands that have been mostly subdivided.

About 36% (820 sections) of Unit 10 is controlled by the Arizona State Land Department and leased to various ranches for livestock grazing. About two thirds of Unit 10 State Lands are important pronghorn habitat.

The U. S. Forest Service, Kaibab National Forest manages about 8.5% (195 sections) of Unit 10. About 25-35 mi^2 of good quality pronghorn habitat are located on the Forest in the southeast corner of Unit 10. Pronghorn inhabiting this area frequently exhibit the highest level of fawn survival in the unit as a whole. Generally higher elevation and higher levels of precipitation are probably responsible.

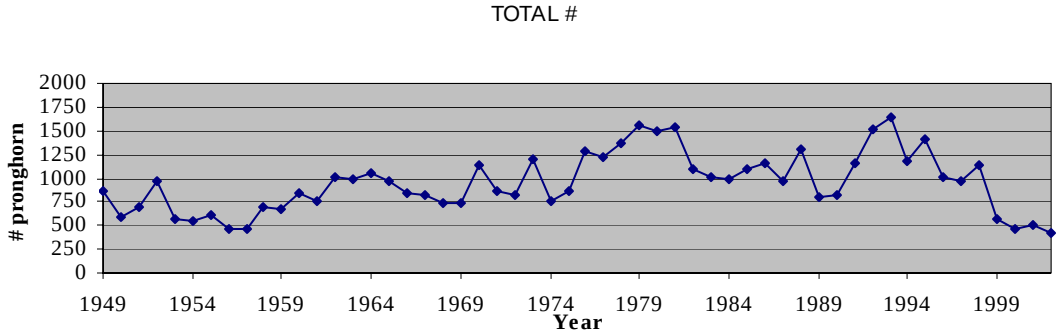
Pronghorn Distribution and Population Trends

The Department desires to maintain a population of between 3/4 to 1 ½ adult pronghorn per mi^2 of habitat, or from 1,350 to 2,700 post-hunt adult, pronghorn in the unit, with a desired harvest of between 100-150 bucks annually. Populations are generally much lower than potential due to long term dismal fawn survival. Conversely, the full potential for pronghorn may well be much higher than the upper limit of the desired population.

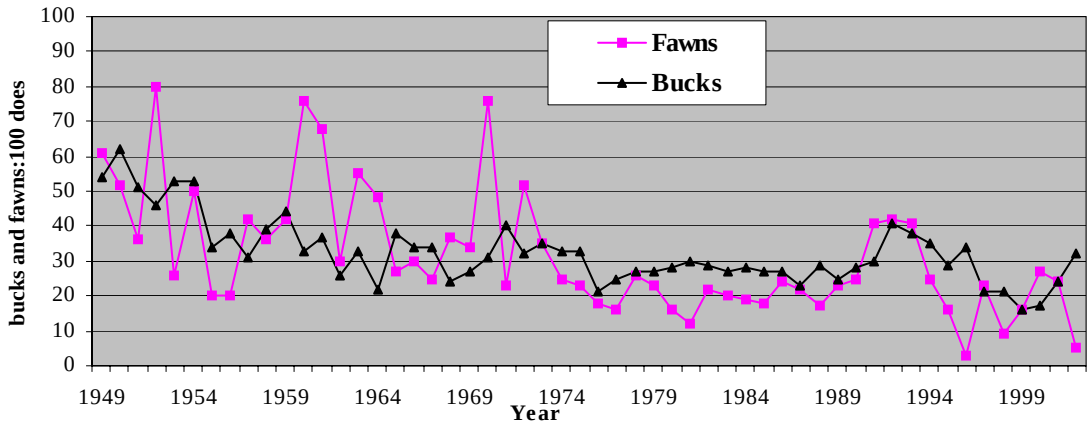
Pronghorn located in Unit 10 are primarily found in five more or less distinct sub-units. These are known as: Sub-unit 1-the Coconino Plateau (about 1,000 mi^2); Sub-unit 2-Central area (Bishop Lake Plateau, Aubrey Cliffs to Rose Well); Sub-unit 3-Aubrey Valley (160 mi^2); Sub-unit 4-Seligman-Pineveta and Sub-unit 5-Williams-Red Hill. Four of the five sub-units are primarily located on either or both the Boquillas and the Babbitt ranches. All of the areas are at least partly open to pronghorn harvest, however all areas have also shown a decline in population numbers in recent years.

The long-term average for fawn survival in Unit 10 equals 33 fawns per 100 does. Fawn survival averaged 45 fawns per 100 does from 1947-1971, during the time when predator control was practiced. Fawn survival from 1972 to the present, the post predator control era, equals 23 fawns per 100 does. Unit 10 has experienced fawn to doe ratios below guidelines for the past 9 years in a row and has exceeded guidelines during only 3 years since 1973.

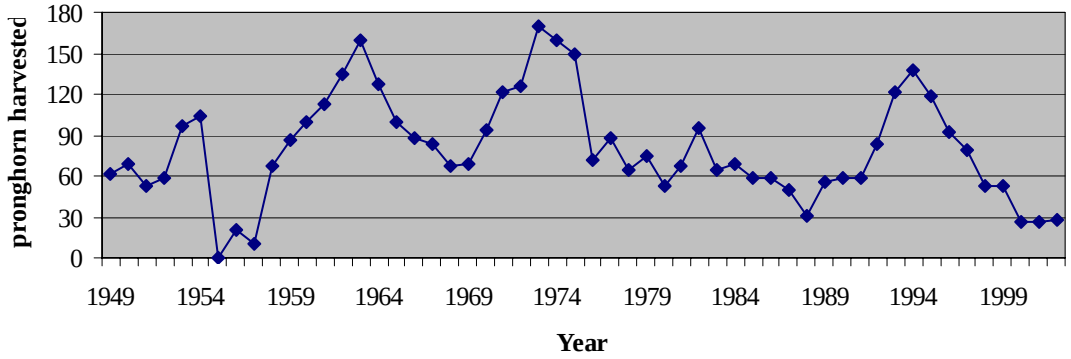
Pronghorn surveyed in Unit 10, 1949-2002



Bucks and fawns per 100 does in Unit 10, 1949-2002



Harvest data for Unit 10, 1949-2002



Specific Issues and Proposed Management Actions

Habitat Management

1. Juniper encroachment

   Clear junipers from grassland areas, especially younger trees and leaving a scattering of older trees for shade; more dense stands may be needed for protection from very bad weather.

2. Water development

   Year round availability or access to water should be pursued. Some corrals are made pronghorn proof; modify with cooperation of management agency and/or private landowner.

   Modify fences to allow free passage of pronghorn. Some work has been completed listing "sheep fence" throughout Unit 10. This work needs to be re-visited and completed.

3. Controlled burning
   Will be evaluated as a tool for improving habitat conditions and/or reducing shrub invasion.

Management Goals

Game Management
Issue 1 – Predation management.

Strategy 1a. – Unit 10 coyote predation management.

Law Enforcement
Issue 1 – Use of Department aircraft should be used as much as possible to cover large areas.

Unit 15A and 15B Pronghorn Herd Management Plan

Background and History

The objective for Units 15A and 15B is to maintain a population of between 70 and 100 post-hunt adults and to have an annual harvest of between 2 to 3 animals. These goals will be more difficult to reach as habitat losses reduce the Department's ability to effectively manage pronghorn and their habitat in the area. Starting with moderate pronghorn habitat and taking into account the effect of prolonged drought and deteriorating habitat conditions these goals will be even harder to obtain.

Habitat Description

This section describes administrative boundaries and pronghorn habitats in the Kingman area. The planning unit is comprised of Units 15A and 15B. Land status includes private, State Trust Land, and federal BLM land. Neighboring units are covered under separate chapters in this plan. Major habitat types in the area include semi-desert grasslands, great basin desert scrub, pinyon-juniper woodland, and interior chaparral. Quality rank of pronghorn habitat in the planning unit, and each unit is contained in the following table. Habitat quality maps and a description of each unit are outlined below.

Quality rank of pronghorn habitat (mi^2) in Units 15A and 15B, in northwest Arizona*

	Habitat Rank					
Unit	High	Moderate	Low	Poor	Unsuitable	Total
15A	0	46.6	91	59.7	328.1	525.4
15B	0	138.1	420.9	321.8	925.1	1805.9
Planning Unit Totals	0	184.7	511.9	381.5	1253.2	2331.3

*Ockenfels et al. 1996

Unit 15A

This unit encompasses about 525.5 mi^2 of Mohave County in northwest Arizona. The northern boundary is the Colorado River from Pearce Ferry to the Hualapai Indian Reservation. The eastern boundary borders a portion of the Hualapai Indian Reservation from the Colorado River, south to State Route (SR) 66. SR 66 west to Antares Road is the southern boundary, and Antares Road and Pearce Ferry Road form the western boundary. The unit is composed of a mix of grassland, closed canopy-pinyon-juniper woodland, chaparral, and Mohave Desert habitat types (Brown 1994). Rugged canyons, mesas, rolling hills, and grassland characterize the terrain. Elevations range from 6768 ft in the Music Mountains to 2953 ft on Grapevine Mesa above Pearce Ferry. Most pronghorn in 15A reside in the Grapevine Canyon Area, Truxton Area, and the Hualapai Valley-Antares Road vicinity. The Truxton and Grapevine Canyon areas are primarily BLM lands; Hualapai Valley -Antares Road area is a checkerboard pattern of BLM and private land.

Unit 15B

This unit encompasses about 1,806 mi^2 of Mohave County. The northern boundary is Lake Mead, from Pearce Ferry, west to Hoover Dam. The western boundary is Highway 93, south

from Hoover Dam to Interstate 40 (I-40), then East on I-40 to Hackberry Road. The eastern boundary is Hackberry Road, from I-40 north to SR 66. This boundary then veers west along SR 66 to Antares Road, and continues north along Antares Road to Pearce Ferry Road. The remainder of the eastern boundary proceeds northeast from the Antares–Pearce Ferry Road junction, and terminates at the Colorado River (Lake Mead). Three major mountain ranges are located in Unit 15B, the Peacocks, Cerbats, and Black Mountains. The area is composed of a mix of grassland, closed-canopy- pinyon-juniper woodland, chaparral and Mohave Desert habitat types. Rugged canyons, mesas, boulder-strewn terrain, rolling hills and grassland characterize the terrain. Elevations vary from 6890 ft in the Cerbat Mountains to 2953 ft in Detrital Valley.

Pronghorn Distribution and Population Trends

Units 15A and 15B

The pronghorn herd in this planning unit is distributed among four areas: in grasslands west of Hackberry road, portions of the Hualapai Valley, north and west of the town of Truxton and on top of the Music Mountains in areas north and east of Grapevine Canyon. Distribution of pronghorn within each subunit is discussed below (subunits are listed in order of importance based on the percentage each contributes to the overall population

Hackberry Road

The Hackberry road runs between SR 66 and I-40 east of the town of Hackberry, and east of the Peacock mountain range. The east side of the Hackberry road is Unit 18A and the subpopulation of pronghorn that reside west of the Hackberry road travel back and forth across the road between the two game management units. The terrain is flat to undulating and is characterized by shrub invaded grasslands and juniper woodlands. The invasion of shrubs and junipers in this area has lessened the potential quality of the habitat along Hackberry Road. Water sources are adequate, but livestock fencing that does not meet game standards and housing developments threaten pronghorn habitat in this area. Hackberry Road has moderate to heavy use creating vehicular disturbance and pronghorn readily travel between Unit 15B and Unit 18A. .

Southern Hualapai Valley

The Hualapai Valley boundaries consist of the area north of SR 66, south of the Pearce Ferry Road. The valley lies between the Cerbats on the west side and the Music and Peacock Mountain ranges on the east side. The terrain is mostly flat or undulating and is characterized by shrub-grasslands. The habitat quality is low due to reduced species richness and the amount of invasive shrubs. The population of pronghorn that reside in the Haulapai Valley are divided by SR 66 and the AT&SF railroad. The southern population is located on the Grounds Ranch and frequently cross I-40 into Unit 16A. SR66 and the AT&SF railroad, which follows SR66, are significant barriers to the movement of pronghorn due to numerous fences and considerable traffic. Livestock fences are also present which do not meet game standards. The Department's statewide evaluation of pronghorn habitat in 1995 stated that developing a management plan for pronghorn in the Hualapai Valley would be difficult. Historically there have been a lot more pronghorn seen in these areas. Due to the deterioration of the habitat conditions, mainly shrub and juniper encroachment, overgrazing and fire suppression, the population has declined.

Northern Hualapai Valley-Antares Road

The population of pronghorn that resides in the northern portion of Hualapai Valley is located in habitat that exists between the Antares Road and the Grand Wash Cliffs along the western side of the unit. The terrain is mostly flat to gently sloping with numerous small ridges as elevation increases towards the Grand Wash Cliffs and occasional mountain ridges extending from the cliffs. Development of the town of Valle Vista north into Hualapai Valley also has created an increase in the amount of disturbance and loss of pronghorn habitat. Vegetation is characterized by shrub and cacti-invaded grassland. Many of the shrubs were excellent forage, but shrub height and cover increase visual obstructions and decrease habitat quality. Grasses are not abundant in this area. Perennial water is a limiting factor in this area and livestock fencing does not meet game standards. Development is increasing in this area leading to a disturbance problem with vehicular travel on the Antares Road and subsequent loss of habitat.

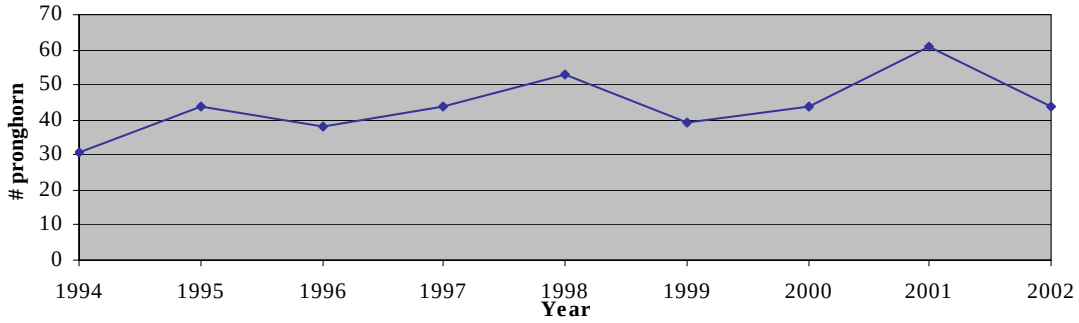
Truxton

The Truxton area is situated in the southeast corner of the Music Mountains, bordered by the Grand Wash Cliffs, SR 66 and the Hualapai Indian Reservation. The terrain is characterized by undulating hills, broken rocky plateaus, and steep canyons along Grand Wash Cliffs. Occupied pronghorn habitat in this area is comprised of a reduced-species shrub grassland, which progresses to a juniper-woodland towards the mountains. Although a good diversity of shrubs are present, much of the grassland habitat is overgrazed and provides little cover or forage for pronghorn. Water sources in the area appear adequate, but several fences effectively prevent pronghorn movement. Urbanization near the town of Truxton and adjacent to SR 66 also compromise the quality of pronghorn habitat. An estimated 30-50 pronghorn use this area on a fairly regular basis. These animals migrate east onto the Reservation, and south across SR 66 into Unit 18A.

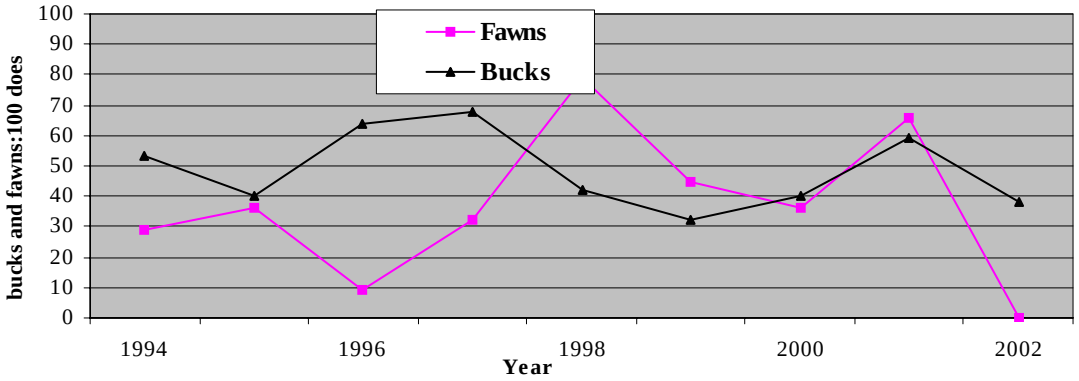
Grapevine Canyon

This area is located on top of the Music Mountains, south of the Colorado River, and north of Grapevine Canyon, bordering the Hualapai Indian Reservation. Broken, low hills and canyons characterize the terrain. The vegetative cover is juniper woodlands or drought-tolerant shrubs. Various sized shrub-grasslands exist in the area and shrub and cactus species richness is good. Grass species richness, however, is lacking. Water availability in this area may be limiting. The fence marking the Reservation boundary does meet not game standards and pronghorn in this area are known to cross back and forth between the Reservation and the unit. Development and disturbance in this area are minimal due to its remote location and presence of a few low-use dirt roads.

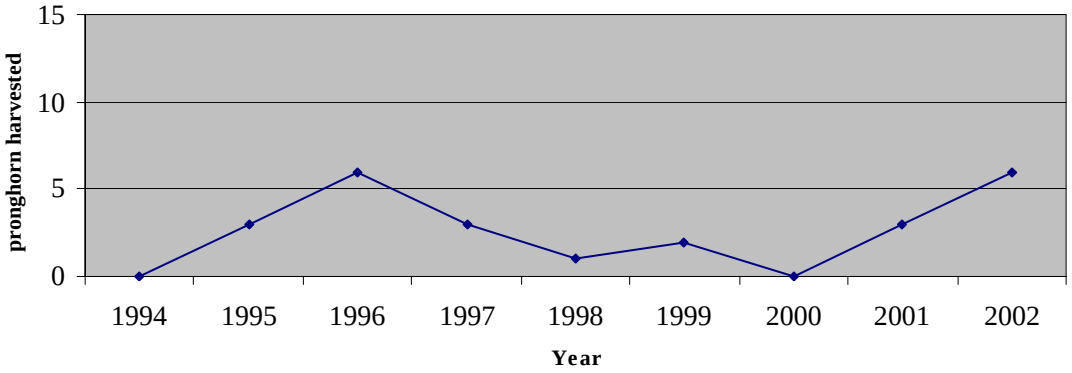
Pronghorn surveyed in Units 15A and 15B, 1994-2002



Bucks and fawns per 100 does in Units 15A and 15B, 1994-2002



Harvest data for Units 15A and 15B, 1994-2002



Specific Issues and Proposed Management Actions

Because of the mixed land ownership, cooperative management options between landowners, land management agencies, and the livestock permittees are essential. Management actions should address effects on populations that are confined in small areas resulting from developments in pronghorn habitat that isolate herds.

Habitat Management

The primary challenge to pronghorn management in Units 15A and B is the continued degradation of habitat that is rated only as moderate. This issue is compounded by the consortium of permittees and land managers. With land ownership consisting of state trust, BLM, and private lands, working through issues will demand cooperation among all parties involved.

- Loss of water sites due to development and drought conditions. Another consideration is the placement of livestock troughs within waterlot fencing. Pronghorn are reluctant to use fenced waters, which can also provide an opportunity for entrapment and predation. Location, quality and reliability of waters in pronghorn habitat need to be established. Working through the Kingman Habitat Partnership Committee waters need to be developed and/or improved is areas where needed.
- Past land exchanges have disposed of public lands eliminating potential pronghorn habitat.
- Fence crossings were installed along the Hualapai Indian reservation in July of 2000 to enhance movement and compensate for loss of habitat to 40 acre lot development in the immediate area. These fence crossings need to be monitored.
- Follow-up and evaluate the 7 proposed multi use exclosures in Hualapai Valley to describe impacts of grazing on wildlife habitat. Studies should include determining range condition, trend, potential and habitat rate recovery (Cerbat-Music Habitat Management Plan).

Game Management

- Explore the possibility of supplemental transplants into areas with isolated populations and use surplus animals from other areas.
- Continue muzzleloader and archery hunts to accommodate developed areas.
- Establish more accurate estimates of sub-unit pronghorn populations.
- Evaluate movement of pronghorn on to Hualapai Indian Reservation and into adjacent game management units.

Planning

In the past, land exchanges have occurred within pronghorn habitat resulting in the loss of that habitat (e.g. Hualapai Mountains 1988 Land Exchange). Some habitat in this area has not been deemed significant in the long-term survival of pronghorn in northern Arizona (Hualapai Mountains Land exchange EIS). Every portion of pronghorn habitat should be considered extremely valuable and each portion significant for the prolonged maintenance of these small populations. Efforts to minimize these exchanges where pronghorn habitat is lost and to mitigate them to the greatest extent possible are necessary for the long-term persistence of these populations.

- Develop comprehensive grassland ecosystem management plan with land management agencies, NGOs and landowners to improve specific blocks of pronghorn habitat.

Unit 17A Pronghorn Herd Management Plan

Background and History

- Maintain a population of 125-175 post-hunt adult pronghorn with an annual harvest of five bucks, with the majority of these animals residing in the New Water area of the Unit.
- Work with landowners to ensure continued access to Unit 17A.
- Protect and enhance habitat and travel corridors by working with landowners and land management agencies.

Habitat Description

Unit 17A covers about 305 mi^2 (195,200 acres) of Yavapai County, in northwest Arizona. The eastern boundary is the Williamson Valley Road from the junction of the Camp Wood Road north to the Prescott National Forest (Forest) boundary. The Forest boundary serves as the northern and western boundaries for the Unit. The Camp Wood Road is the southern boundary from the Williamson Valley Road to the Forest boundary. The city of Prescott sits about 25 miles southeast of the southern boundary of Unit 17A. Seligman is located about 15 miles north of the northern boundary of the Unit. Wildlife in Unit 17A is managed by the Arizona Game and Fish Department's (Department) Region III office, located in Kingman, Arizona.

Unit 17A is composed of a mix of ponderosa pine-oak woodland, pinyon-juniper woodland, chaparral and grassland habitat types. Rugged mountains, canyons and mesas, rolling hills and flat open grassland savannas characterize the terrain in Unit 17A. Elevations vary from 4,600 to 7,272 feet above sea level. Most of the pronghorn in 17A reside in the northwestern portion of the Unit. A few additional animals occur on limited habitat in the southeastern and southwestern corners of the Unit.

Quality rank of pronghorn habitat in mi^2 for Unit 17A

	Habitat Rank					
Unit	High	Moderate	Low	Poor	Unsuitable	Total
17A	6	24	20	*	84 *	134

*Ockenfels et al. 1996

*Poor and Unsuitable habitat were combined for Unit 17A.

The Yavapai Ranch takes in roughly the northern half of Unit 17A including New Water. The New Water area, which accounts for the majority of pronghorn habitat in 17A, is located in the northwestern portion of the Unit. This area encompasses the western one third of the Yavapai Ranch and is about 45 mi^2 or 28,800 acres in size. Elevations range from about 5,600 to 6,500 feet above sea level. The area is composed of a mix of grassland and pinyon-juniper interspersed with cliffrose and other browse species. Land ownership is a checkerboard of Forest Service and private land owned by the Yavapai Ranch. A land trade proposal is currently under consideration, which would result in a large portion of the pronghorn habitat in the New Water area becoming Forest Service lands if accepted in its current form. The only structure located in

this area is the Ranch's west side headquarters. Landforms include open plains, rolling hills and small plateaus. Natural water is very scarce with permanent sources supplied in dirt tanks and ranch pipelines. Most of the area is used as grazing land for livestock.

In early 1995, the Department's Research Branch conducted a statewide evaluation of pronghorn habitat. Within the above-mentioned area, about 38 percent (10,944 acres or 17.1 mi^2) rated as moderate quality, twenty-two percent (6,336 acres or 9.9 mi^2) as low quality and forty percent (11,520 acres or 18 mi^2) as poor quality. The evaluation found that the grasslands were shrub (snakeweed) invaded and lacked species richness. Shrub diversity in the open woodland areas was good, although most were tall enough to obstruct pronghorn vision. The evaluation further suggested that juniper and tall shrub encroachment had greatly reduced the amount of open grassland and that these areas would benefit from removal of these plants.

A small amount of pronghorn habitat is located in the southeastern corner of Unit 17A on the Las Vegas Ranch. Ten to twelve pronghorn regularly use this area and likely move in and out of Units 19B to the east and 17B to the south. In southwestern Unit 17A, a small number of pronghorn are occasionally observed on the Yolo Ranch. These animals move in and out of Unit 18B to the west. Also in southwestern Unit 17A, a small number of pronghorn are occasionally observed on the 7-Up Ranch. These animals move in and out of Unit 18B to the west.

Pronghorn Distribution and Population Trends

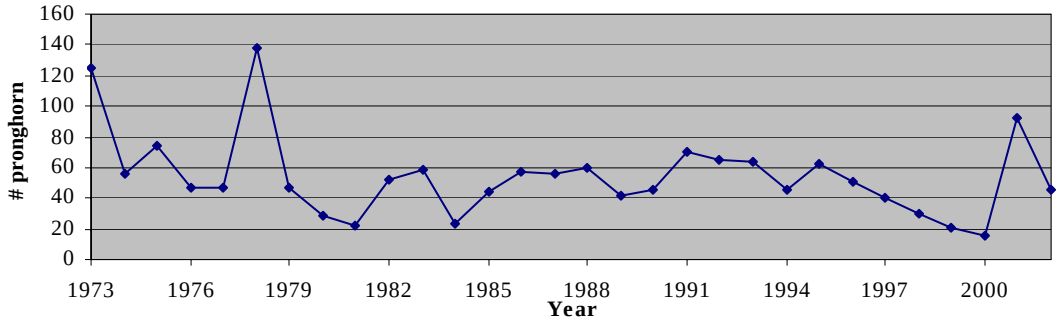
The pronghorn located in Unit 17A are primarily found in three distinct areas. These are the southeastern corner, the southwestern corner and the northern portion of the Unit. The New Water area, located in northwestern 17A provides the majority of the pronghorn habitat and thus is home to most of the pronghorn in the Unit. New Water is not a closed population and substantial movement is known to occur between Units 18B to the south and west and 18A to the west and north. Pronghorn habitat loss, caused by development to the west and north, will increase the importance of the New Water area and the Baca Float to the south. Pronghorn use habitat in the southwest corner of 17A intermittently. This area offers fragmented grasslands that suffer from heavy tall shrub and tree invasion. These pronghorn spend most of their time to the north and west in Unit 18B. The southeastern corner of 17A is a mix of deeded private and State Trust land. A few pronghorn use this area and move back and forth to the south into Unit 17A and to the east into Unit 19B.

The long-term average (1973-2002) of fawn survival in Unit 17A is 27 fawns per 100 does. For the past five years the average is 29 fawns per 100 does. After several years near zero in the late 1980s, fawn survival increased dramatically in 1991. This followed two years (1990-1991) of coyote control in the New Water area. As the effects of the coyote control dissipated, both fawn survival and total observations began a steady downward trend that lasted most of the 1990s. Fawn survival, however, has shown an increase in the past few years. Total observations have also increased recently, but may simply be a result of habitat loss and disturbance to the north and west. While these surveys do not attempt to estimate total population numbers, they do provide trend information based on repetitive survey effort on a yearly basis.

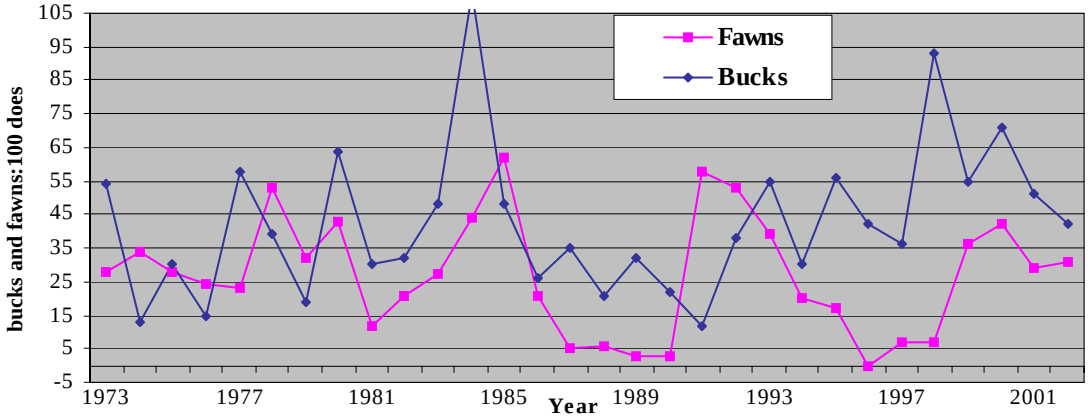
Pronghorn have been surveyed in Unit 17A since at least 1957, at which time survey data were combined with 17B and 19B. Unfortunately, Unit 17A data were not separated until 1973 and the New Water data were not separated out until 1983. Pronghorn have been hunted in Unit 17A since at least 1958, when the Unit was again combined with Units 17B and 19B. Starting in 1989, Unit 17A was removed from the multi-unit hunt structure and has stood alone as a separate hunt since. There have also been archery hunts in 17A in the past.

Lack of recruitment drove the downward trend in the New Water pronghorn population during the 1990s. Some of the factors negatively affecting recruitment include, but are not limited to: predation, precipitation patterns, water distribution, barriers to movement, forage (nutrition) availability, shrub encroachment and lack of fawn hiding cover. Many of these factors can be improved through cooperative habitat management.

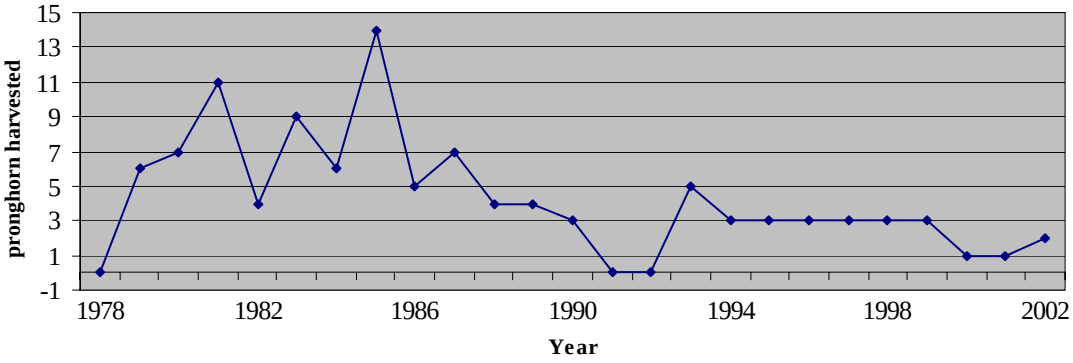
Pronghorn surveyed in Unit 17A, 1973-2002



Bucks and fawns per 100 does in Unit 17A, 1973-2002



Harvest data for Unit 17A, 1978-2002



Management Goals

Habitat Management

Issue 1 – Sections of land within Unit 17A are at risk for potential urban development pending the outcome of a proposed land trade between the Yavapai Ranch and Prescott National Forest.

Issue 2 – Border fences along southwest corner of Yavapai Ranch (New Water) are not to wildlife specifications.

Strategy 1a. – Work with Yavapai, ORO, and OO Ranches and modify fence by either re-stringing bottom two strands of wire or installing "goat bars."

Issue 3 – Grazing sometimes occurs on grassland within Yavapai Ranch prior to and during critical pronghorn fawning period.

Strategy 1a. – Work with Yavapai Ranch and Prescott National Forest Range Program to develop a grazing strategy that defers grazing on grasslands until after May 15th.

Yavapai County is the fourth largest county in Arizona by population, following only Maricopa, Pima and Pinal counties. Although most of this growth is occurring around the tri-city area, more remote areas are fast becoming popular for developers. The Department must therefore ensure adequate involvement and representation in the proposed land trade and in the planning process of any future developments.

Game Management

Issue 1 – Apparent high level of predation by coyotes, ravens and mountain lions in New Water portion of Yavapai Ranch.

Strategy 1a. – Encourage individual sportsmen and varmint calling clubs to hunt coyotes in this area through information and education efforts.

Strategy 1b. – Encourage local sportsman (houndsman) to hunt mountain lions in this area through information and education efforts.

Unit 18A Pronghorn Herd Management Plan

Habitat Description

Unit 18A covers about 1,236 mi^2 in northwest Arizona. The unit boundaries are Highway 66 and the southern boundary of the Hualapai Indian Reservation from Seligman west to the Hackberry Road; The Hackberry Road and Highway 93 south to Trout Creek; Trout Creek and the Prescott National Forest boundary east to the Williamson Valley Road and north to Seligman.

The unit is composed of a mix of Grassland, Pinyon-Juniper and Chaparral and lower desert habitat types. Elevations range from about 2,380 to 6,742 feet above sea level. Most of the unit lies between 4,300 and 5,300 feet above sea level. Landforms include open plains, rolling hills, plateaus, and mountains. About 325 mi^2 of Unit 18A could be considered pronghorn habitat. Natural surface water is very scarce in pronghorn habitat. Most water is supplied by dirt tanks and ranch pipelines designed to support livestock grazing operations.

Quality rank of pronghorn habitat in mi^2 for Unit 18A

	Habitat Rank					
Unit	High	Moderate	Low	Poor	Unsuitable	Total
18A	0	138	233	*	577*	948

*Ockenfels et al. 1996

*Poor and Unsuitable habitat were combined for Unit 18A.

About 44% (535 sections) of Unit 18A is controlled by the Arizona State Land Department and leased to various ranches for livestock grazing. The Bureau of Land Management (BLM) manages about 8 % (99 sections) of Unit 18A. About 50 sections of pronghorn habitat south of the town of Truxton, AZ amounting to about 15% of the unit's pronghorn habitat in the northwest portion of Unit 18A is managed by the BLM. This area is included in the "Crozier Ranch" allotment leased by local ranchers. About 20 % of the unit's pronghorn population is usually observed on Truxton Flat.

About 48% of Unit 18A is private land. There are about 400 mi^2 of remote real estate subdivision within Unit 18A. Communities within Unit 18A include Seligman, Truxton and Valentine. Most of the Unit 18A pronghorn population is located on the Double O Ranch, The X Bar One Ranch and Bureau of Land Management public lands on Truxton Flat, Crozier Allotment. There are smaller amounts of pronghorn habitat on the Denny Ranch, the Echeverria Ranch, Fort Rock Ranch and the Cofer Ranch. All or portions of 10 major ranches have been subdivided and sold. Land ownership is extremely fragmented over most of the unit.

The Double O Ranch is located in the eastern half of Unit 18A. The ranch accounts for about 40% (130 sections) of the unit's pronghorn habitat and a little over half of the unit's pronghorn population. Nearly half of the Double O ranch is leased State Lands. Most of the rest of the ranch is subdivision that is rapidly developing. Housing development has entered pronghorn habitat and has already affected a significant portion of the available habitat. There is one about

40 mi^2 area south-southwest of Seligman that is presently undeveloped. Further development, even in this latter area, is imminent and threatens the viability of this population and any hunting of pronghorn on the east side of the unit.

The X bar One Ranch is located in Central Unit 18A, running east to west, lengthwise. The eastern portion and the western portion both contain pronghorn habitat. The ranch contains about 55 sections of pronghorn habitat or about 17% of the unit's pronghorn habitat. Close to 20 % of the unit's pronghorn population resides on this ranch. The owners of the X Bar One Ranch have chosen to block access to hunters on all private land portions of the ranch in an attempt to run a guided hunting operation. The X Bar One Ranch contains one block of about 25 sections of State Land that is undeveloped. This block of land is probably a big enough area to ensure the future of an pronghorn population and limited hunting into the future.

The Denny Ranch, comprised of about 65 sections was in past years an important pronghorn area within Unit 18A. At the present most of the ranch is subdivided and pronghorn numbers as well as use by pronghorn is considerably less than in past years. The ranch is still of importance to pronghorn but it appears to be used more in the winter than in the summer.

The following ranches contain lesser amounts of pronghorn habitat as well as fewer pronghorn: Blake Ranch, Cofer Ranch, Fort Rock Ranch, Echeverria Ranch, and the Miller Ranch.

All or parts of the following ranches have been subdivided and sold: Blake Ranch, Cofer Ranch, Double O Ranch, Denny Ranch, Echeverria Ranch, Fort Rock Ranch, Miller Ranch, Willows Ranch, Windmill Ranch, and the X Bar One Ranch.

Pronghorn Distribution and Population Trends

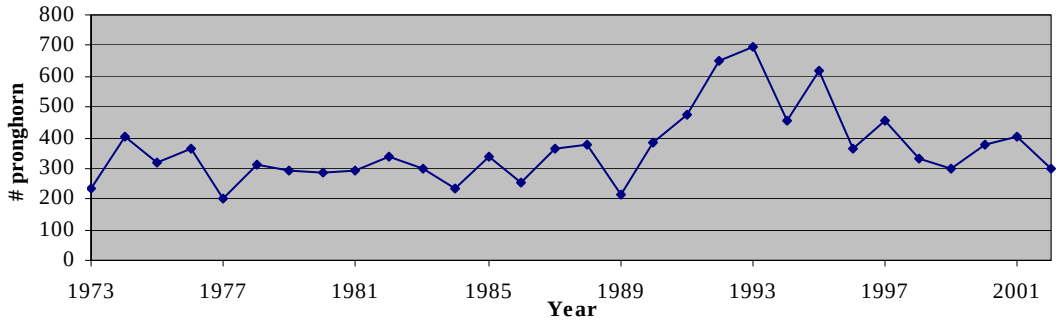
Goals and objectives similar to the Statewide Management Guidelines can be applied to Unit 18A. The Department desires to maintain a population of between 400-700 pronghorn in Unit 18A with a desired harvest of between 15-40 bucks annually.

Pronghorn located in Unit 18A are primarily found in six more or less distinct areas. The areas are: 1) the Chino Wash Drainage; 2) the Aubrey Valley; 3) the 74 Plains (including Munds Well Flat and the Red Lake Drainage); 4) Denny Ranch; 5) Truxton Flat; 6) Round Valley.

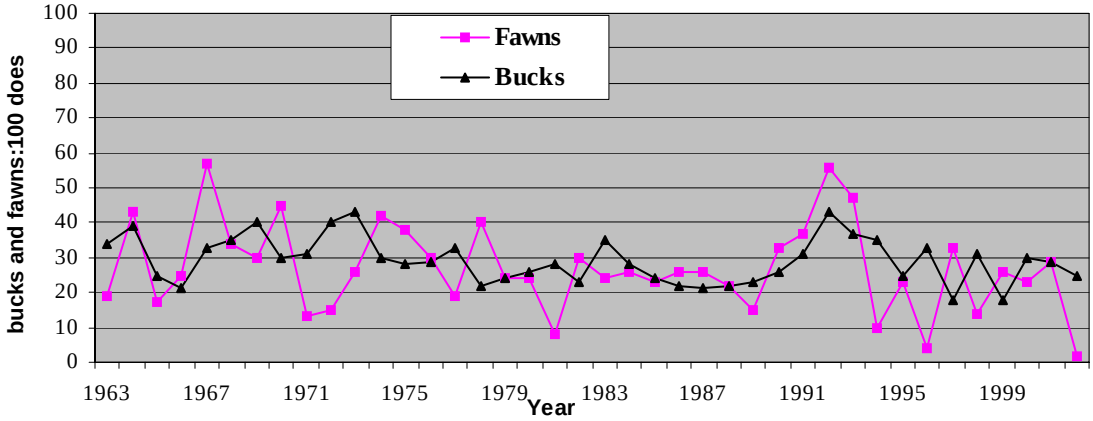
All of the areas are now mostly open to pronghorn harvest. All areas have also shown a decline in population numbers in recent years due to a number of reasons. At this point in time subdivision development may reduce hunting opportunity as much as population trends.

The long term average for fawn survival in Unit 18A equals 27 fawns per 100 does from 1963 to the present. Unit 18A has experienced fawn survival below desired levels for 9 of the past 10 years.

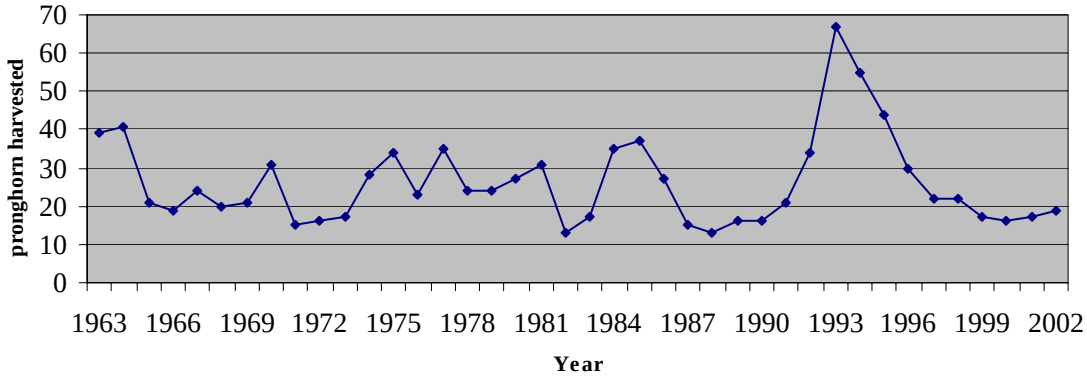
Pronghorn surveyed in Unit 18A, 1973-2002



Bucks and fawns per 100 does in Unit 18A, 1963-2002



Harvest data for Unit 18A, 1963-2002



Management Goals

Habitat Management
Issues here are the same as in Unit 10. One change specific to U-18A would be that Truxton Flat, the block of State land on the 74 Plains and the Chino Wash area near the Double O Ranch HQ should be protected as much as possible as these are the only areas left in Unit 18A that will be undeveloped in the not too distant future.

Unit 18B Pronghorn Herd Management Plan

Planning Unit Description

Unit 18B covers about 1,214.16 mi^2 (777,062 acres) of Yavapai and Mohave Counties, in northwest Arizona. The eastern boundary is the Prescott National Forest and the Camp Wood Road. The southern and western boundary is highway 93 and the northern boundary is Trout Creek and the Davis Dam-Prescott power line. The town of Bagdad is located in the southeastern portion of the unit, and Wikieup is located off of Highway 93 on the western boundary. The unit is characterized by a variety of topographical features and vegetation types. Major landmarks include Bozarth Mesa and Strotjost Flat to the east, and Goodwin Mesa to the west. Burro Creek flows through the middle of the unit between the mesas. Interior portions in 18B contain a mosaic of varied vegetation types including, semi-desert grassland, interior chaparral, madrean evergreen woodlands, pinyon-juniper woodland, and isolated ponderosa stands. Lower elevations consist of Sonoran Desert Scrub habitat. Canyons and drainages provide several well-developed riparian communities of cottonwood, willow, sycamore, ash and walnut. Elevations range from 1,000 to 5,500 feet. The Baca Float (ORO Ranch) also has a sizable pronghorn population but it is not available to most hunters. Most pronghorn habitat occurs across four areas in 18B: Goodwin Mesa, Bozarth Mesa, and Strotjost Flat, and the on Anvil Rock Ranch in the northern portion of the Unit. Quality rank of this habitat is contained in the following table.

Quality rank of pronghorn habitat in mi^2 for Unit 18B

	Habitat Rank					
Unit	High	Moderate	Low	Poor	Unsuitable	Total
18B	4	161	49	*	278	492

*Ockenfels et al. 1996

*Poor and Unsuitable habitat were combined for Unit 18B.

Goodwin Mesa comprises most of the pronghorn habitat in 18B. This area is located in the west central portion of the unit and encompasses the eastern one third of the SV Ranch. The habitat is about 82 mi^2 or 52,480 acres in size. Landforms include open plains, rolling hills and small plateaus. Elevations range from 4,200 to 5,700 feet. The area is primarily composed of semi-desert grassland. Land ownership is almost entirely BLM; two small private parcels are owned by the SV Ranch. No residential structures are found in this area; however, several water-holding tanks are in place to support summer livestock operations. Natural water sources are limited, but permanent sources are supplied in dirt tanks and ranch wells.

The Bartmus Flat-The Island area is located north of Goodwin Mesa. This area encompasses portions of the southern and eastern boundary of the Wagon Bow Ranch, the western boundary of the Mohon Ranch, and the northern and eastern boundary of the SV Ranch. The area contains about 66 mi^2 or 42,240 acres of semi-desert grassland. Landforms include open plains and rolling hills. Land ownership is a checkerboard of private and BLM sections. Although the majority of habitat in this area is closed to the public, the Department continues to survey pronghorn because the area serves as a travel corridor between the Anvil Rock and Goodwin

Mesa populations. Wagon Bow Ranch encompasses the majority of the area but it is closed to public access. Mohon Ranch is owned and operated by the ORO Ranch and is also closed to the public. The SV Ranch accounts for about 23 mi^2 of the total sixty-six, and is open to public access and hunting. There are numerous residential structures located in this area. Natural water sources include Gonzales Wash and Francis Creek. Permanent water sources are also supplied in dirt tanks and ranch wells. Several man-made water holding tanks are in the area to support summer livestock grazing.

The Bozarth Mesa area comprises the second largest concentration of pronghorn habitat in the east central portion of the Unit. This area encompasses the western portion of the Yolo Ranch and is about 78 mi^2 or 49,920 acres in size. The area is primarily composed of semidesert grassland. Elevations range from about 4,200 to 4,950 feet. Land ownership is almost entirely State Land Trust Land; BLM has about 8 mi^2 and there are a few small private parcels owned by the Yolo Ranch. The Bozarth line camp is a residential structure located on the southern end of the mesa. Natural water is available year round in Wilder Creek; however, pronghorn only use developed dirt tanks on the mesa. Natural water is very scarce with permanent sources supplied in dirt tanks and ranch wells. Most of the area is used as grazing land for livestock.

The Windy Ridge-Strotjost Flat area comprises the highest density of pronghorn east of Burro Creek. This area encompasses portions of the Yolo Ranch and the 7up Ranch, and is about 16 mi^2 or 10,240 acres in size. Landforms include open plains, and rolling hills. Elevations range from about 4,900 to 5,740 feet. The area is composed of a mix of primarily semidesert grassland intermixed with invading juniper. Land ownership is almost entirely State Trust Land with about 3 mi^2 of private parcels owned by the Yolo Ranch. The Yolo Ranch manager's headquarters is located in this area. Natural water can be found in Pine Creek with permanent sources supplied in dirt tanks and ranch wells. Most of the area is used as grazing land for livestock.

The Behm and Contreras Mesa's accounts for a small population of pronghorn and is located south of Windy Ridge and east of Bozarth Mesa. This area encompasses portions of the Yolo and Kellis Ranch and is about 30 mi^2 or 19,200 acres in size. Elevations range from about 4,000 to 5,038 feet. Landforms include open plains, rolling hills and small plateaus. The area is composed of primarily semidesert grassland. Land ownership is almost entirely State Land; there are also a couple of very small private parcels. There are no residential structures located in this area. The only man made structures consist of water holding tanks. Natural water is very scarce with permanent sources supplied in dirt tanks and ranch wells. Most of the area is used grazing land for livestock.

The Anvil Rock Ranch area is located in the northern most portion of the unit, north of the Baca Float. This area encompasses portions of the Anvil Rock and Double O Ranches and is about 23 mi^2 or 14,720 acres in size. Elevations range from about 5,400 to 6,000 feet. The area is primarily composed of semi-desert grassland with bands of encroaching juniper intermixed. Landforms include open plains, and rolling hills. Land ownership is a checkerboard of State Trust Land and private. The Anvil Rock Ranch headquarters is located in this area. Natural water is very scarce with permanent sources supplied in dirt tanks and ranch wells. Most of the area is used as grazing land for livestock. Livestock grazing has deteriorated range conditions and pronghorn habitat in the area. Subdivision of private land is also problematic.

The Sanders and Nelson Mesas are located just north of the town of Bagdad on the Kellis Ranch near the Bagdad Airport. The area is used only when pronghorn are forced off of Bozarth, Behm, and Contreras mesas during extreme winter conditions. The area is about 14 mi^2 or 8,960 acres in size. The elevation is about 3,700 feet. Landforms include open plains and plateaus composed of semidesert grassland. Land ownership is a checkerboard of State Trust Land, private, and BLM. Natural water is very scarce with permanent sources supplied in dirt tanks and ranch wells. Most of the area is used as grazing land for livestock. The percentage and quality of available pronghorn habitat among these areas is presented below in the following table.

Rank of available pronghorn habitat (as a percent of the total) among areas across Unit 18B

	Habitat Rank (% of available)				
Location	High	Moderate	Low	Poor	Unsuitable
Anvil Rock		44	30	26	
Goodwin Mesa	5	63	6	26	
Bartmus		23	24	53	
Bozarth Mesa		68	13	19	
Windy Ridge		56	31	13	
Behm-Contreras Mesa		67	20	13	
Sanders-Nelson				71	29

Pronghorn Distribution and Population Trends

Since the early 1950s the Unit 18B pronghorn population has had a peak post hunt population estimate of over 500 pronghorn and a low estimate of fewer than 100. The population reached its peak in the late 60s and its low in the early 90s. The populations have been influenced primarily by weather conditions, range conditions, and predation. Unlike many other habitats in the Kingman region, the Unit 18B pronghorn populations are not significantly impacted by urban sprawl.

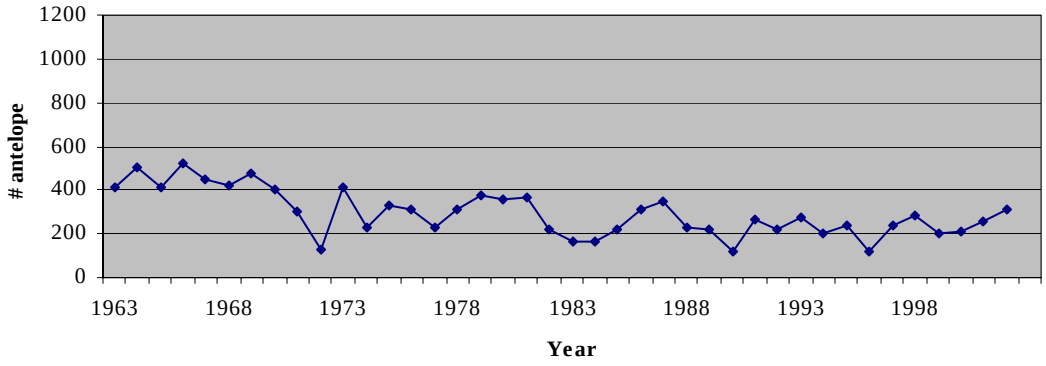
The long term average (1953-2001) for fawn survival in Unit 18B is 44 fawns per 100 does. For the last five years the average is 39 fawns per 100 does. Fawn survival for the unit has remained steady for the most part. It reached a low of 17 fawns per 100 does in 1990 but after a successful aerial coyote gunning campaign the fawn survival rate quickly increased.

The Anvil Rock Ranch area has accounted for the lowest fawn recruitment over the last few years. The lack of recruitment can be attributed to a high coyote population and encroaching junipers that obstruct pronghorn vision and provide cover for predators.

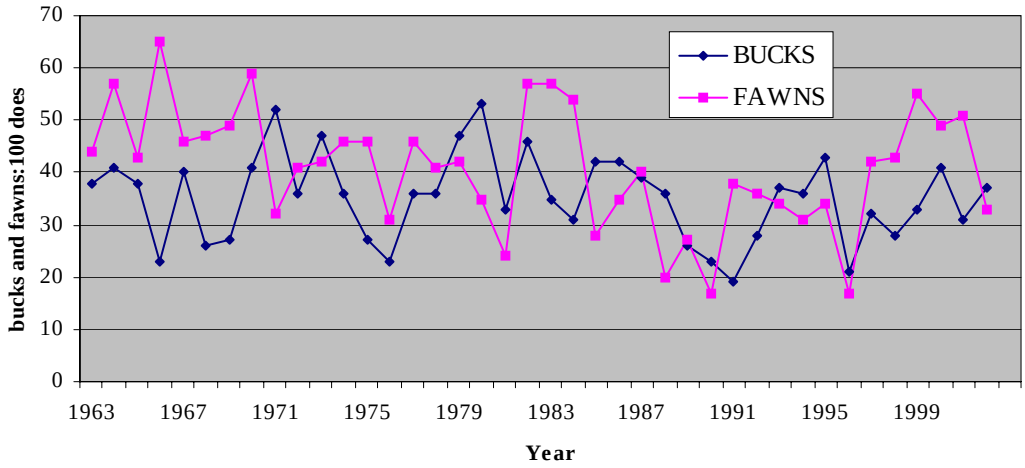
The long term average for buck survival in Unit 18B is 40 bucks per 100 does. For the last five years the average is 39 bucks per 100 does. Buck populations have fluctuated a great deal in the unit during the last 48 years. The fluctuation is due to hunting permits and the availability of the bucks to be surveyed. If the range conditions are better on the ORO or Wagon Bow the buck to

doe population estimates may vary from what was expected. While these surveys do not attempt to estimate total population numbers, they do provide trend information based on repetitive survey effort on a yearly basis.

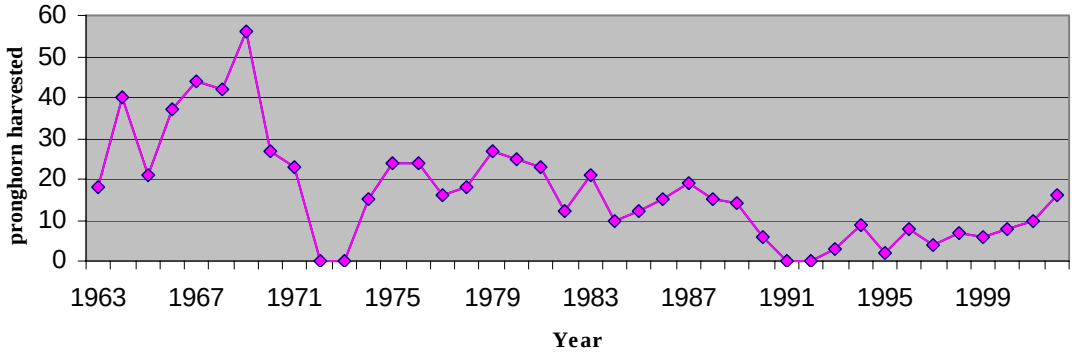
Pronghorn surveyed in Unit 18B, 1963-2002



Bucks and fawns per 100 does in Unit 18B, 1963-2002



Harvest data for Unit 18B, 1963-2002



Specific Issues and Proposed Management Actions

Habitat Management

Construction of additional waters.
Fence modification.
Juniper treatments (e.g. agra-axe, pushes, burns, chainings, herbicides and cuttings) to maintain existing and open past grassland habitat.
Reconnect scattered sections of pronghorn habitat by opening travel corridors through the removal of trees (junipers).
Burn or remove dead and down tree piles.
Small scattered burns to increase species diversity.

Game Management

Aerial gunning to control predators.
Encourage coyote hunters and trappers through information and education efforts.
Pronghorn herd supplementation.
Supplemental feeding coyotes during critical fawning period.
Supplemental feeding pronghorn during times of high nutritional requirements.

Research

Cumulative effects of multiple predators (mountain lion and coyote) on the long-term survival of a pronghorn population relative to populations with only one significant predator (coyote).
Comparison of pronghorn use between two adjacent ranches with different management strategies.
Vegetative analysis of habitats that are currently preferred vs. nonprefered.
Identify current grazing practices and impacts on preferred browse plants.

Mitigation Opportunities

Private property developers maintain travel corridors for pronghorn.
If existing waters are lost to development, new waters shall be created for pronghorn use.

Vegetation treatments (juniper eradication) of areas equal in size to area being lost, resulting in no net loss of pronghorn habitat.

Limitations on road development within areas of pronghorn use (grasslands).

Any changes in public land grazing plans shall incorporate the annual and seasonal habitat requirements of pronghorn.

Avoid any additional fence construction, but if necessary, it should meet Department criteria to allow for pronghorn movement.

Region IV

Hillside-Kirkland Herd Pronghorn Operational Plan

Background and History

Unit 20C contains the Hillside-Kirkland area pronghorn herd. The boundaries of this area are the Weaver Mountains to the south, Date Creek Road-Santa Fe Railroad to the west, Kirkland Creek-County Road 96 to the east, and County Road 96 to the north. This area, located in the north-central portion of 20C, represents only a small part of this unit. It is not known whether these pronghorn are significantly connected to pronghorn herds to the northeast. There is some indication that there is movement between this herd and the Bismark Mesa pronghorn herd. The pronghorn occurring in the Hillside-Kirkland area are the result of transplants by the Arizona Game and Fish Department in 1984, 1993, and 1998. There have been 100 pronghorn released at this location.

The pronghorn habitat in the Hillside-Kirkland area is a semi-desert grassland and shrubland mixture. Only limited portions of this area could be described as pure grasslands. The pronghorn herd existing in this area is the result of transplants as there were no pronghorn inhabiting this location immediately prior to the transplants.

Habitat Descriptions

Glinski (1984) described this area (about 90 miles northwest of Phoenix) covering about 70 mi^2 as rolling grassland 3600-4500 feet in elevation. Areas included in this analysis are located west of the Santa Fe Railroad-Date Creek Road, Kirkland Valley to the east, and the more broken and steeper topography to the north. The field monitoring of these transplants that included radio tagged individuals revealed limited pronghorn use in the steeper areas. Eliminating the rougher topography reduces the available area for pronghorn use to less than 50 mi^2.

Arizona Game and Fish Department has evaluated pronghorn habitat statewide (Ockenfels et al. 1996). In the Hillside-Kirkland area 2 sections rated moderate quality, 19 sections were rated low quality, and the remainder were rated as poor quality pronghorn habitat. This pronghorn habitat evaluation model describes low quality vegetation as "A severe shrub-invaded grassland or savanna; shrub richness-diversity low. If shrubs short (<24" [61cm]), density >30% cover, or if shrubs tall (>24" [61cm]) density >20% and visibility a problem." Except for several small patches most of the area within the Hillside-Kirkland area is best described as a shrub-grassland mix. For the most part shrubs are short and exceed 20% density.

Pronghorn Population Information

There are no references during recent time claiming pronghorn inhabited the Kirkland-Hillside area. Knipe (1944) included this area in the distribution of pronghorn in northern Arizona, but delineates it as an area of little or no "pronghorn drift," and shows pronghorn herds only north of the Santa Maria River.

Recent history of pronghorn transplants and follow-up observations at Hillside.

Date	Pronghorn	Explanation
12/6/84	51(transplant)	Pronghorn from Douglas, Wyoming (23 bucks, 28 does)
5/16/85	35	East of Hillside
7/20/86	29	East of Hillside (5 bucks, 13 does, 1 fawn)
1/18/86	20	Southeast of Hillside (5 bucks, 15 does)
1/15/87	35	Hillside (9 bucks, 21 does, 5 fawns)
1/15/88	33	Hillside (unclassified)
6/29/88	24	Hillside (3 bucks, 17 does, 4 fawns)
1/23/89	33	Hillside (unclassified)
2/8/93	54(transplant)	Pronghorn from Sheridan, Wyoming (13 bucks, 41 does) 6 does fitted with radio collars
1/6/94	22	Hillside (unclassified)
1/9/97	11	Hillside (unclassified)
12/15/98	5(transplant)	Pronghorn from Loa, Utah (5 bucks)
1/5/99	12	Hillside (2 bucks, 8 does, 2 fawns)
1/5/00	13	Hillside (3 bucks, 10 does)
1/3/03	11	Hillside (5 bucks, 6 does)

Pronghorn from the 2 large transplants have exhibited wide-ranging movements. These movements only add to the reduction in pronghorn in the Hillside-Kirkland area. Hillside is surveyed for mule deer each January with fixed-wing aircraft. Any pronghorn observed during these surveys are counted and these counts are the January observations that appear in the above table. There have been years when no pronghorn were observed. In most instances those pronghorn observed were in a single herd.

Pronghorn released at Hillside but later observed outside the release area.

Date	Pronghorn	Location and Distance from Hillside
1/5/85	2	Cotton field near Aguila – 36 mi sw
3/23/93	2	Skull Valley (radio tagged) – 16 mi ene
8/31/93	6	Kirkland Valley (radio tagged) – 9 mi e
4/12/93	2	Quail Valley Ranch – 24 mi sse
8/21/93	1	OX Ranch alfalfa field – 11 mi sw
10/22/93	2	Diamond 2 Ranch (Hassayampa River) – 25 mi sw
9/22/95	1	Las Vegas Ranch (#53 ear-tagged buck taken in pronghorn hunt) – 33 mi nw

There were 6 does from the 2/8/93 release that were fitted with radio telemetry collars. In the first 6 months after release 2 of these does were killed by a mountain lion. One of these does was killed in an area containing mostly grass. The nearest shrub was more than 100 yards away. Two other collared does died in the first 6 months. One was most likely capture-transport related and the second was poached. The last telemetry flight occurred 8/31/93. On that flight only one of the remaining 2 collared does was located in Kirkland Valley along with 6 other pronghorn.

Management Issues

As indicated by the Arizona Game and Fish Department's recent habitat analysis the Hillside-Kirkland area is marginal pronghorn habitat. This reality is further demonstrated by the demise of the transplanted pronghorn. Historically, pronghorn may have inhabited the Hillside-Kirkland area. This area now supports a moderate density mule deer and javelina population. Livestock grazing also occurs and at levels that are likely to favor further increases in shrubs further reducing its limited value as pronghorn habitat. Kirkland and Skull Valley may also have been pronghorn habitat but now contain numerous small horse and cattle ranches with many fences creating small pastures.

Pronghorn Management Goals and Strategies

The Arizona Game and Fish Department recommends that no further efforts be made to establish a pronghorn herd in the Hillside-Kirkland area.

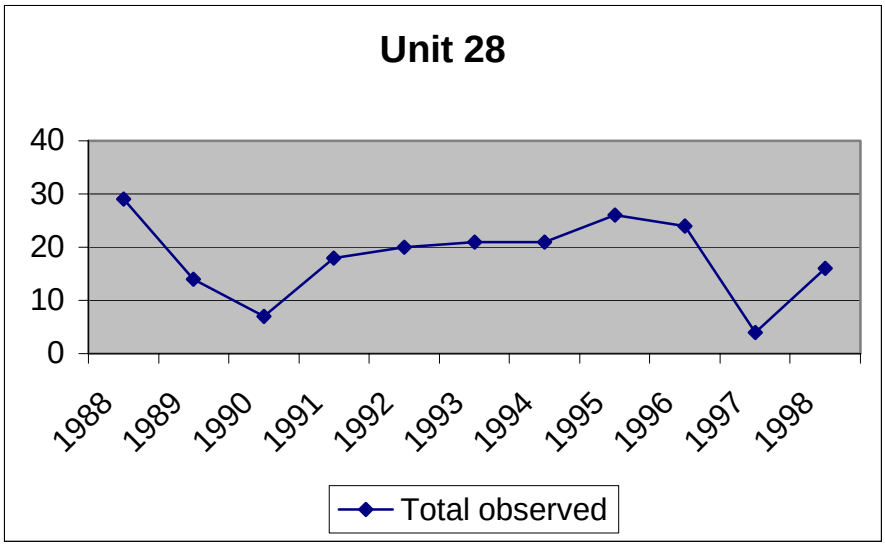
Region V

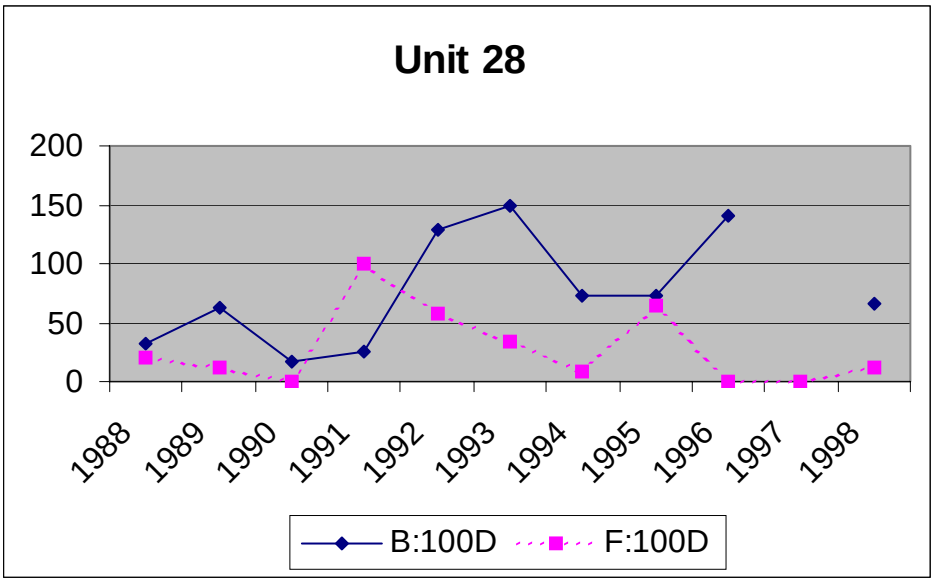
Unit 28 Pronghorn Herd Management Plan (Day Ranch)

Background and History

This population consisted originally of indigenous pronghorn. The occupied habitat is bisected by the Arizona-New Mexico border. Most pronghorn in this population reside in New Mexico but a few bands totaling 20-30 animals are consistently located in Arizona east of the Peloncillo Mountains. The population was estimated at 20-25 in 1966, and at less than 20 in 1973. Because of its small size this population is not surveyed aerially each year. In 1964, 5 permits were issued in this unit resulting in a harvest of 4 bucks. This was the only hunt ever authorized by the Department. This herd may never again be opened to legal harvest given the limited habitat available in Arizona and the fact that the herd has never been estimated at over 50 individuals.

Records show that 2 pronghorn were trapped from Raymond Ranch in northern Arizona and released here in 1941 but did not survive long. A supplemental transplant in 1986 added 36 Texas pronghorn to this population near Winchester Peak-Big Tank area of the Day Ranch in Arizona. The intent was to revive this faltering yet tenacious group of pronghorn. It is believed that many of these translocated animals died or emigrated to New Mexico.





Habitat Description
East of the Peloncillo Mountains.
This area has the largest contiguous area of suitable pronghorn habitat in Unit 28 (Appendix A). Terrain was flat, desert bajadas around and south of Duncan, rising to an area of flat and rolling hills. Some areas around Lost Lake and west and south of there are fairly rocky. Surrounding these flats to the west and south are the steep Peloncillo Mountains. Vegetative cover was a closed canopy, creosote shrubland on the bajadas, which changed to a reduced species richness, semidesert grassland as the elevation increased. These grasslands are fairly open, with some areas of tall yucca and invading mesquite. Closed canopy, creosote shrublands surrounded Round Mountain, extending outward for several kilometers. Shrubs are mostly snakeweed, mesquite and yucca. Grasses consisted of grama, cheatgrass, galleta, and several unknown species. Grasslands continued into the mountains, with juniper trees densities gradually increasing. This area seemed to be good pronghorn habitat and appeared to extend into New Mexico. Forage diversity was lacking in this area. In some areas shrubs are high and dense enough to hinder pronghorn visibility and escape, but for the most part are not yet a major problem.

Development was minimal and consisted of ranch headquarters and airstrip, livestock facilities, and low-use, dirt roads. Scattered homes, pipelines and powerlines are in the northern part south of Duncan. The BLM has a designated rockhound area, with a primitive campground in the eastern side close to the border. Livestock fences on the ranch and in the south are not numerous and most are not game standard. There are a few game standard fences near the Rockhound area. Some electric fences also existed on the ranch. Livestock fences are numerous in the northern end. Waters are abundant and most are easily accessible. Most water sources contained water, but the area had recent heavy rains and the dirt tanks may typically dry up during periods of low rainfall.

Management Goals

Goal 1. Maintain and improve water distribution of water sources available year-round for pronghorn.

Strategy 1a. Inventory water sources available to pronghorn

Strategy 1b. Plan and execute additional water as needed.

Strategy 1c. Require all public and state lease lands to maintain water sources year round. During drought conditions, water must be left in earthen tanks for wildlife.

Strategy 1d. If existing waters are lost to development, new waters should be created for use by pronghorn

Goal 2. Protect and improve habitat conditions for pronghorn.

Strategy 2a. Monitor grazing levels and precipitation in or near areas used by pronghorn, especially the Rotational System on the High Lonesome Ranch.

Strategy 2b. Participate in and comment on range management plans and activities.

Strategy 2c. Encourage greater use of controlled burning to restore grassland habitat and increase plant species diversity.

Strategy 2d. Encourage non-governmental organizations, such as The Arizona Antelope Foundation and The Nature Conservancy, to participate in grassland conservation and management.

Goal 3. Maintain pronghorn travel corridors through cooperation with land management agencies and private or other landowners.

Strategy 3a. Evaluate and modify existing livestock fences to pronghorn specifications.

Strategy 3b. Avoid any additional fence construction, but if necessary, it should meet Department criteria to allow for pronghorn movement (wildlife specification fencing).

Strategy 3c. Limit road development within areas of pronghorn use.

Goal 4. Monitor population abundance and demographics.

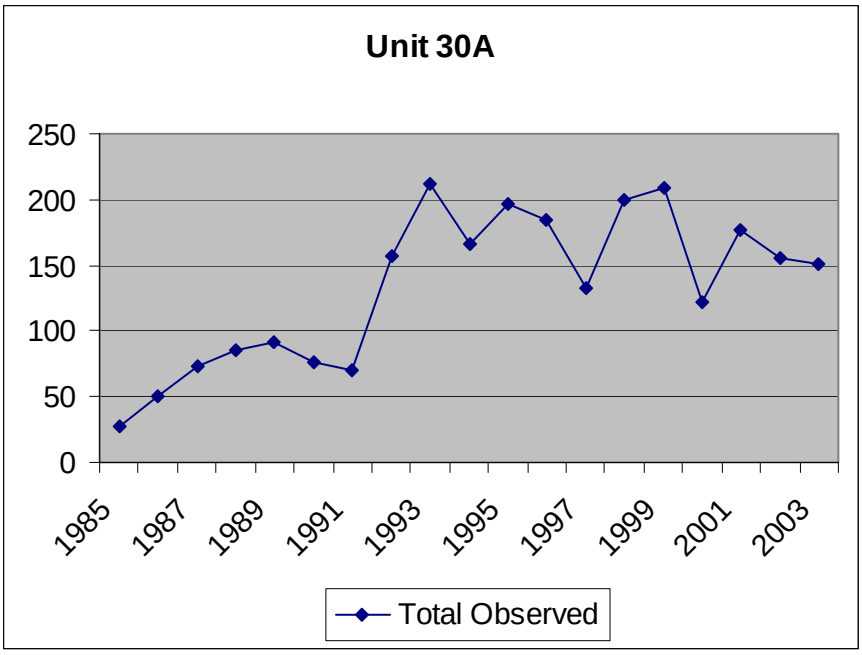
Strategy 4a. Survey from the ground each year informally and once every 5 years from fixed-wing aircraft.

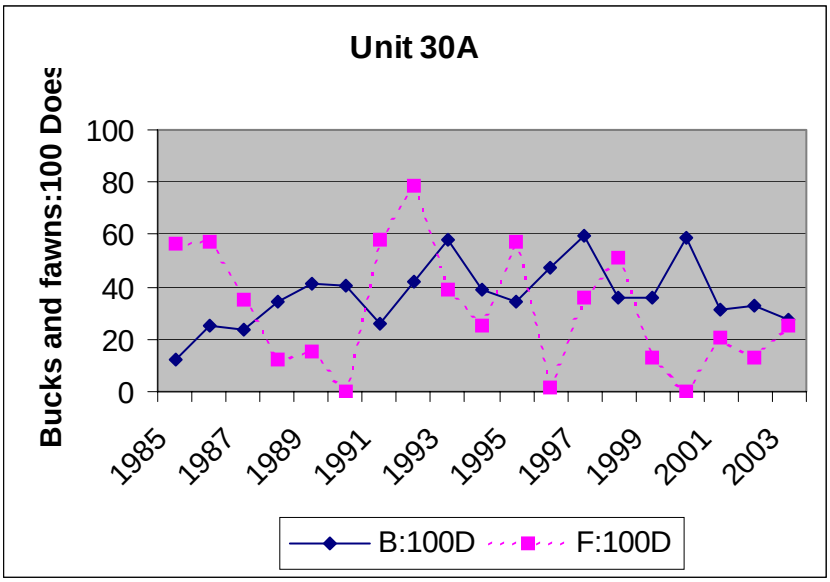
Unit 30A Pronghorn Herd Management Plan (San Bernardino Valley)

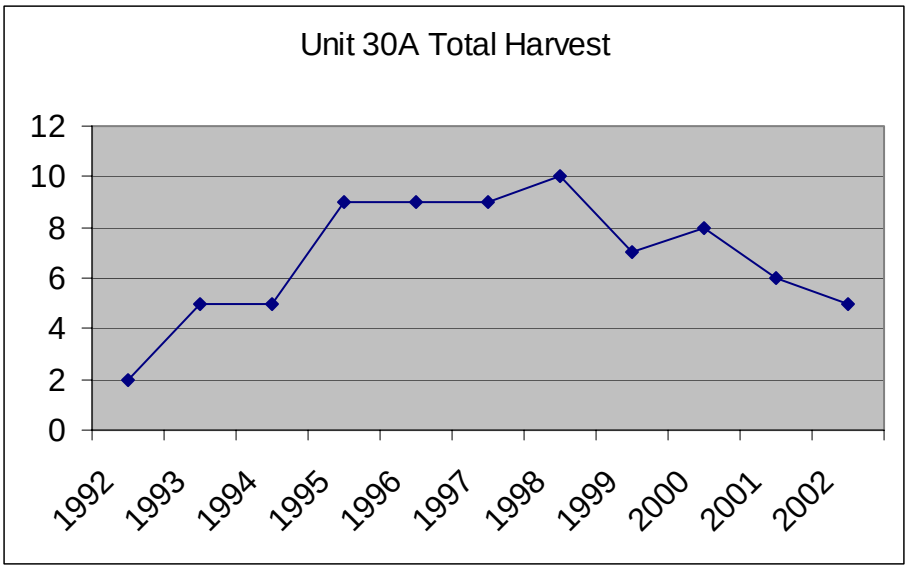
Background and History

Early explorer, James Ohio Pattie reported that pronghorn were *"plentiful"* around the San Bernardino Ranch east of Douglas in 1830. When describing the local landscape in the valley, Robert Whitworth of the Mormon Battalion wrote *"antelope are plentiful here"* in 1849. This large block of excellent pronghorn habitat once teemed with pronghorn, but remained vacant for many years after being extirpated around the turn of the century. Long-term residents in the valley reported that pronghorn persisted until around 1910 near the settlement of Apache.

In November 1984, 32 pronghorn from west Texas were released at Moline Tank in the middle of the San Bernardino Valley. These animals were supplemented with 67 more from the same source in December 1986. This population enjoyed a few years of good fawn survival before the dry cycle in the late 1980s hit the southwest. Fawn survival dropped to an average of 9 fawns:100 does for 1988-90; including a total of 54 does seen in 1990 and none of them had fawns. This drought cycle was then followed by several years of good precipitation and excellent fawn recruitment and the population increased substantially. Fewer than 91 animals were observed on surveys prior to 1991. An average of 163 pronghorn have been observed during the annual surveys 1996-2001.







Habitat Description

The San Bernardino Valley lay between the eastern side of the Chiricahua, Pedregosa, and Perilla Mountains and the western side of Outlaw Mountain-Baker Canyon Wilderness Area, from the Arizona-New Mexico border on US 80. Terrain was flat, but turns into gently, rolling hills near the mountain foothills. Many shallow washes bisect this valley. Prominent drainages including Deer, Silver, and Indian creeks. Valley vegetation is reduced in species richness, tobosa dominated, semidesert grassland, but with some areas of good vegetative diversity. Other grasses included three-awn, blue grama, and fescue. Shrubs included yucca, cholla, joint-fir, mesquite, burrobush, snakeweed, whitethorn acacia, and an unknown. The greatest contiguous

area of good pronghorn habitat lay west of US 80, just south of the Tex Canyon Road. Additional good habitat was also present on the northern side of the Tex Canyon Road in Unit 29. Unfortunately, pronghorn seldom, if ever, use this habitat because stranded fence along US 80 impeds or prevents movements across. There are 3 sections south of Paramore Crater that are also good pronghorn habitat. This entire grassland appears to have the potential for greater vegetative diversity, given adequate precipitation. The vegetation in the peripheral foothills of the surrounding mountains merged into a closed canopy shrubland dominated by mesquite, acacias, and creosote. These tall shrubs are slowly invading this grassland and without some form of shrub will eventually dominate the valley. The southern end of this grassland turned into a closed canopy shrubland within 8 km of the Mexican border (including the San Bernardino National Wildlife Refuge).

Highway US 80, a low to moderate-use, paved road, ran through the northern part of this valley. There are a few isolated ranches within this area. The Geronimo and Skeleton Canyon roads are improved, maintained dirt roads that seem to carry low use. The Geronimo road was fenced with not game standard fencing along both sides of the road where it runs by a Ranch and at the northeastern end at the mountains. There are several 2-track, dirt roads within this valley, but travel on them is restricted by locked gates along the highway.

Livestock fences are abundant and are not game standard. Fence densities are high near ranch headquarters. Highway US 80 was fenced on both sides with not game standard fences. Water sources are adequate and well distributed, but most are sometimes dry. The tank in section 23 of T23S,R30E was too tall for pronghorn to use. An extended drinker from this tank would aid pronghorn accessibility.

Management Goals

Goal 1. Maintain and improve water distribution of water sources available year-round for pronghorn.
- Strategy 1a. Inventory water sources available to pronghorn
- Strategy 1b. Plan and execute additional water as needed.
- Strategy 1c. Require all public and state lease lands to maintain water sources year round. During drought conditions, water must be left in earthen tanks for wildlife.
- Strategy 1d. If existing waters are lost to development, new waters should be created for use by pronghorn

Goal 2. Protect and improve habitat conditions for pronghorn.
- Strategy 2a. Monitor grazing levels and precipitation in or near areas used by pronghorn.
- Strategy 2b. Participate in and comment on existing range management plans and activities.
- Strategy 2c. Encourage the development of grazing management plans for allotments on State Land.
- Strategy 2d. Encourage greater use of controlled burning to restore grassland habitat and increase plant species diversity on the southern end of the valley near Cottonwood Wash.

Strategy 2e. Encourage non-governmental organizations, such as The Arizona Antelope Foundation, Malpais Group, and The Nature Conservancy, to participate in grassland conservation and management.

Goal 3. Maintain pronghorn travel corridors through cooperation with land management agencies and private or other landowners.

Strategy 3a. Evaluate and modify existing livestock fences to pronghorn specifications.

Strategy 3b. Avoid any additional fence construction, but if necessary, it should meet Department criteria to allow for pronghorn movement (wildlife specification fencing).

Strategy 3c. Limit road development or improvement within areas of pronghorn use.

Strategy 3d. Provide crossing gaps along Highway 80 to facilitate movement into unoccupied habitat on the NW side on that barrier (construct custom "Pronghorn Crossing" signs at the fence gaps).

Goal 4. Monitor population abundance and demographics.

Strategy 4a. Survey from fixed-wing aircraft annually.

Goal 5. Provide access to this population for recreational opportunity.

Strategy 5a. With the cooperation of AGFD Access Program, work with landowners to ensure continued access to these areas to the greatest extent possible.

Strategy 5b. Provide landowners information about conservation easements to protect grasslands from housing developments to maintain their ranching heritage.

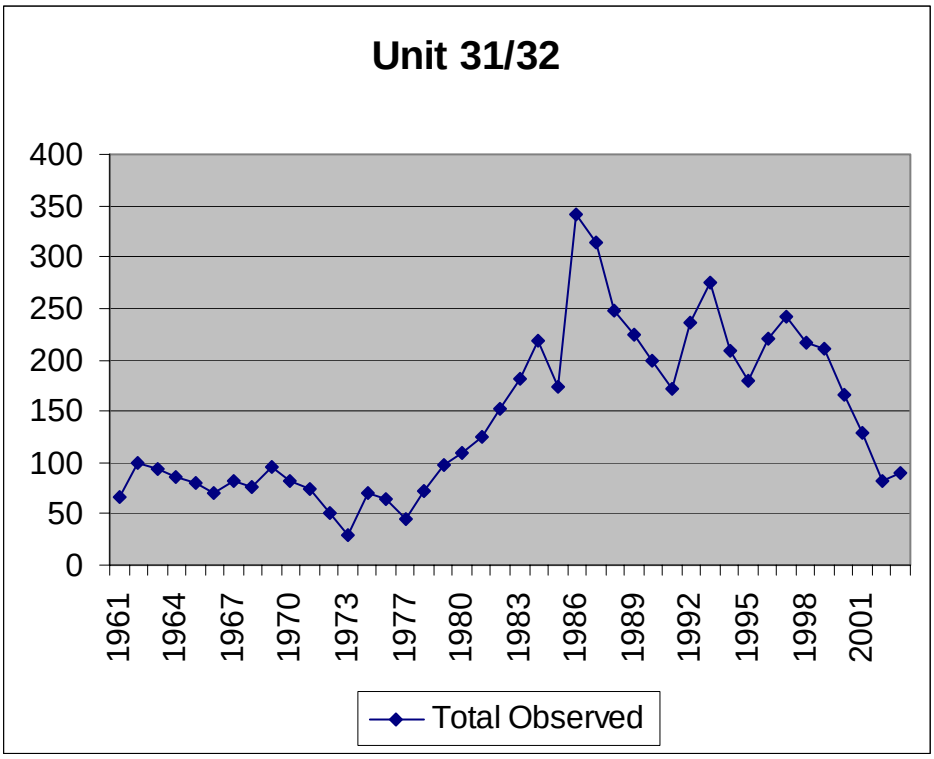
Unit 31 and 32 Pronghorn Herd Management Plan (Sulphur Springs Valley north of Willcox)

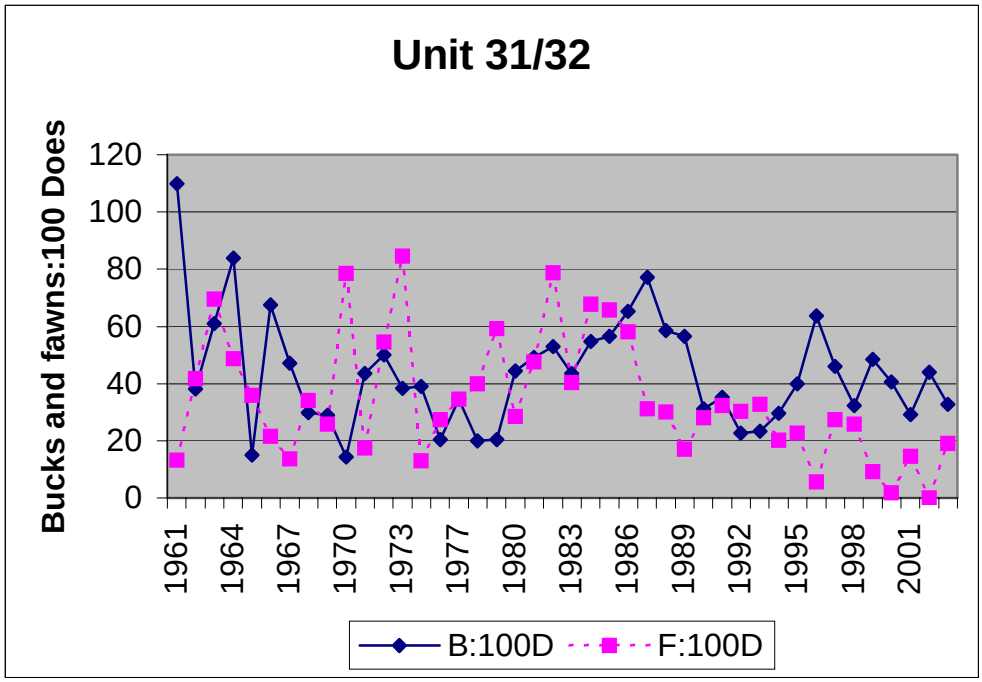
Background and History

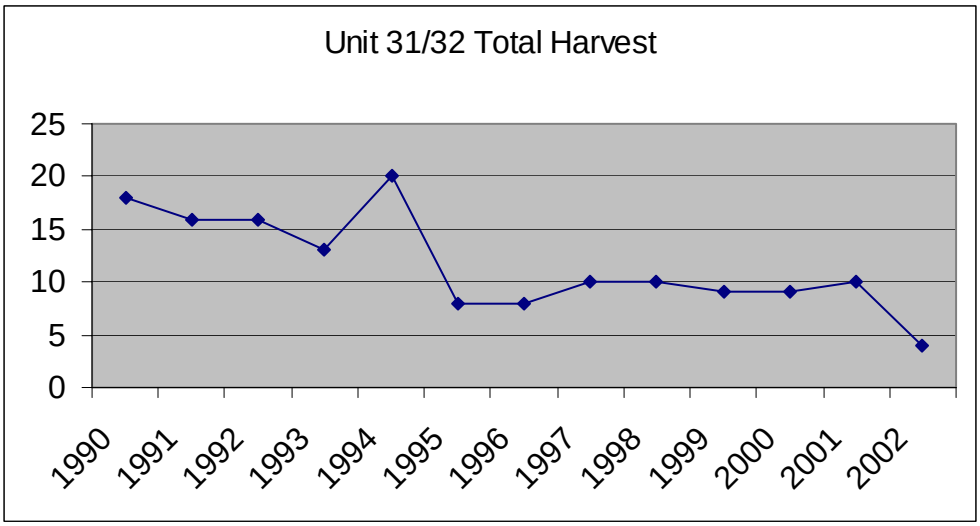
In 1826, James Pattie also found pronghorn "numerous" in the Sulphur Springs Valley east of the Galiuro Mountains. The pronghorn were once very abundant throughout the entire valley but now inhabit only the grassland north of Willcox, east of the Galiuro and Winchester Mountains and west of the Pinalenos. A portion of the population also ranges on Allen Flat to the southwest of the Winchester Mountains.

Department transplant records indicate Raymond Ranch-Chavez Pass pronghorn were released here (22 in 1943, 6 in 1944, 40 in 1945). Pronghorn in northern Arizona were hunted 1941-43 and 1949-present, but it wasn't until 1954 that hunters could hunt pronghorn south and east of Tucson. In 1954 the Sulphur Springs and San Rafael Valleys were open to legal hunting with 50 permits issued. Pronghorn seasons in southern Arizona were closed again 1955-57 and reopened in the Sulphur Springs Valley in 1959 with 20 permits. Since then, 10-30 firearms permits have been issued each year in the Valley. In 1977, harvest was divided among archery and firearms hunters. The years 1987-89 saw the addition of a muzzleloader hunt.

In the last 10 years between 150 and 250 pronghorn have been observed during standard summer aerial surveys. The only exceptions to this were in 1986 and 1987, after several years of good recruitment, when over 300 pronghorn were tallied. The number of pronghorn seen remains high, but the number of bucks per 100 does has steadily declined from 59 in 1988 to 23 in 1993. Last year the number of firearms permits was reduced from 15 to 10 in an attempt to halt this decline. This population appears to have declined slightly; less than might be expected after the low fawn recruitment in the last few years.


Unit 31/32
400
350
300
250
200
150
100
50
0
1961
1964
1967
1970
1973
1977
1980
1983
1986
1989
1992
1995
1998
2001
Total Observed


Unit 31/32
Bucks and fawns:100 Does
120
100
80
60
40
20
0
1961
1964
1967
1970
1973
1977
1980
1983
1986
1989
1992
1995
1998
2001
B:100D
F:100D



Habitat Description

South and Southeast of the Pinaleno Mountains.
This area contains most of the Moderate, as well as some Low quality habitat, for pronghorn. Terrain is flat to rolling, rising to the steep mountains in the north. The flat and rolling foothills were characterized by semidesert, reduced species richness grassland, with yucca and mesquite invasion. Washes and small drainages were usually thick with mesquite. Most of the Moderate habitat is in the southeastern corner (Appendix C). In these areas, forage diversity is low and short shrubs, such as snakeweed, are often thick. Some areas, especially along I-10, have tall yucca that hindered visibility. Outside the reduced species richness grassland areas, tall shrubs such as mesquite and creosote are increasingly more dense, eventually forming closed canopy shrublands.

Development in this area consists of I-10 to the south and US 191 along the eastern side. Highway 266 ran along the northern end of this area. Numerous low-use, dirt roads, a few scattered ranches, livestock corrals and pens, and several pipelines make up the rest of the development. Livestock fences are minimal and most are not game standard. A few game standard fences occur on a ranch east of the Circle I Hills. Water sources are abundant and most are accessible to pronghorn. However, many of the waters are in or near washes and drainages, and are usually invaded by mesquite. Pronghorn may not use these waters, because of the tall trees and shrubs around the tanks.

Sulphur Springs Valley-Southern End.
The southern end of this valley was mostly flat and is predominately agricultural fields, providing forage but little else to pronghorn, thus Poor quality habitat in the long term. Development was high, with numerous homes, dirt and paved roads, and fences.

Sulphur Springs Valley-Northern End.
Further north, ranching is the predominant land use and a large area of suitable habitat for pronghorn still exists (Appendix D). Terrain is flat to high, rolling hills, with the Galiuro Mountains in the west and Winchester Mountains to the south. Steep areas also exist around the

Black Hills. Vegetative cover is reduced in species richness, with areas of severe shrub invasion. Some areas are invaded with short shrubs (mainly snakeweed) and tall yucca, especially further north. The northern reaches of the Eureka Springs area are severely shrub invaded by mesquite or closed canopy, desert shrubs. West of the Black Hills, a few sections of reduced species richness grasslands exist, but with some invading oak and juniper from the nearby mountains. The Mesas area has low diversity, consisting mostly of grama grass, with some prickly pear and cholla. This area is also somewhat rocky.

Development in this area is moderate. Roads consisted of several well-maintained, gravel roads (Klondyke Road, Ash Creek Road, and High Creek Road) and low-use, dirt roads. There are a few homes along the Ash Creek-High Creek loop and near Bonita and Sunset. Scattered ranch headquarters and livestock loading corrals are also present. Livestock fences are numerous and not game standard. Some woven-wire fences are noted in the northern end of the Sulphur Springs Valley southwest of Bonita; these prevented pronghorn movements. Water sources are abundant and accessible.

South of the Galiuro and Winchester Mountains

Large areas of suitable pronghorn habitat also existed in this area, being Moderate and Low quality. Terrain was mostly flat to high, rolling hills, with the Winchester and Galiuro mountains to the north and east. The Little Dragoon Mountains and Texas Canyon area, in the southern end, are steep with numerous large boulders; these are Unsuitable habitat.

Vegetative cover is a mixture of reduced species richness grasslands, severely, shrub-invaded grasslands, and closed canopy shrublands in the south and west. Moderate quality pronghorn habitat exists in the Allen Flat area. There is good grass diversity found in the southwestern portion of T13S, R22E. Grasses include galleta, three-awn, blue and black gramas, and bluestem. Most sections have either too many shrubs or succulents (mesquite, snakeweed, beargrass, yucca, etc.) to be High quality pronghorn habitat, or else have hardly any shrubs, and thus did not have the shrub diversity typically found in High quality habitat. Some areas are reduced species richness, open canopy, mesquite savannas. Moderate areas between Allen Flat and the San Pedro River are reduced species richness, shrub-invaded grasslands, with beargrass and tall yucca hindering pronghorn visibility. This area also has a lot of severely, shrub or cacti-invaded sites, with yucca, mesquite, *Acacia* spp., snakeweed, cholla, prickly pear, beargrass, and other species obstructing visibility. The southern, northern, and western sides of this area are mostly closed canopy shrublands.

Development was minimal and mostly along I-10 in the south. A well-maintained, gravel road ran through this area (Cascabel Road) and another branched north to the Nature Conservancy's Muleshoe Ranch. Low-use, dirt roads, scattered ranches, and corrals are also present. Interstate 10 runs along the southern end. Livestock fences are common and not game standard. Water sources are abundant and accessible. Many have water in them year round.

Management Goals

Goal 1. Maintain and improve water distribution of water sources available year-round for pronghorn.

Strategy 1a. Inventory water sources available to pronghorn

Strategy 1b. Plan and execute additional water as needed.

Strategy 1c. Require all public and state lease lands to maintain water sources year round. During drought conditions, water must be left in earthen tanks for wildlife.

Strategy 1d. If existing waters are lost to development, new waters should be created for use by pronghorn

Goal 2. Protect and improve habitat conditions for pronghorn.

Strategy 2a. Monitor grazing levels and precipitation in or near areas used by pronghorn.

Strategy 2b. Participate in and comment on existing range management plans and activities.

Strategy 2c. Encourage the development of grazing management plans for allotments on State Land where none exist.

Strategy 2d. Encourage greater use of controlled burning and mesquite treatments (e.g., agra-axe, pushes, burns, chaining, herbicides, and cuttings) to restore grassland habitat (reduce mesquite encroachment) and increase plant species diversity.

Strategy 2e. Encourage non-governmental organizations, such as The Arizona Antelope Foundation to participate in grassland conservation and management.

Goal 3. Maintain pronghorn travel corridors through cooperation with land management agencies and private or other landowners.

Strategy 3a. Evaluate and modify existing livestock fences to pronghorn specifications.

Strategy 3b. Avoid any additional fence construction, but if necessary, it should meet Department criteria to allow for pronghorn movement (especially for current project along Fort Grant Road).

Strategy 3c. Limit road development or improvement within areas of pronghorn use.

Strategy 3d. Provide crossing gaps along Fort Grant Road where complete alteration of fence is not possible because of landowner resistance (construct custom "Pronghorn Crossing" signs at the fence gaps).

Strategy 3e. Identify and recommend specific travel corridors to Cochise and Graham County Planning and Zoning to avoid predicted herd isolation.

Strategy 3f. Remove non-functional fences.

Goal 4. Monitor population abundance and demographics.

Strategy 4a. Survey from fixed-wing aircraft annually.

Strategy 4b. Maintain separate survey records for each subpopulation.

Goal 5. Provide access to this population for recreational opportunity.

Strategy 5a. With the cooperation of AGFD Access Program, work with landowners to ensure continued access to these areas to the greatest extent possible.

Strategy 5b. Provide landowners information about conservation easements to protect grasslands from housing developments to maintain their ranching-agricultural heritage.

Strategy 5c. Provide public information on viewing opportunities for pronghorn

Goal 6. Improve fawn survival

Strategy 6a. Ensure adequate fawning cover on state and private land.

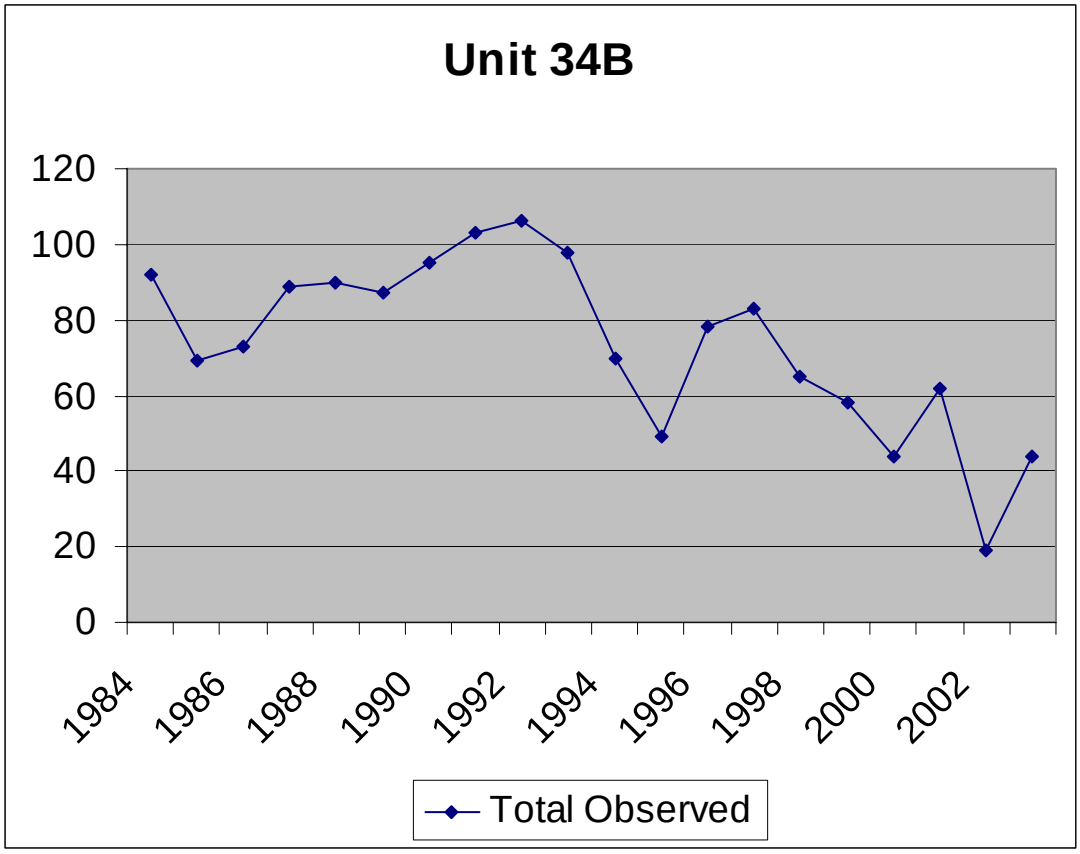
Strategy 6b. Reduce predator densities immediately prior to parturition in areas frequented by pronghorn in years with suitable habitat conditions. Continue to address habitat shortfalls listed above simultaneously.

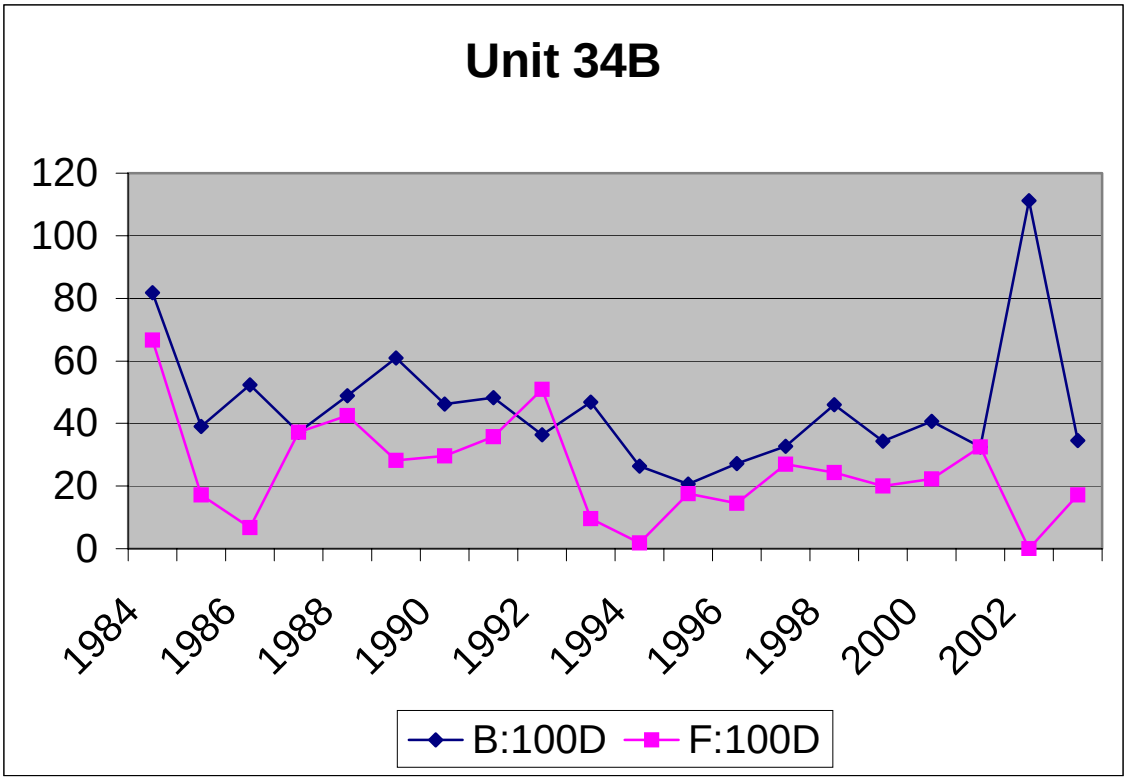
Unit 34B Pronghorn Herd Management Plan (Empire Cienega)

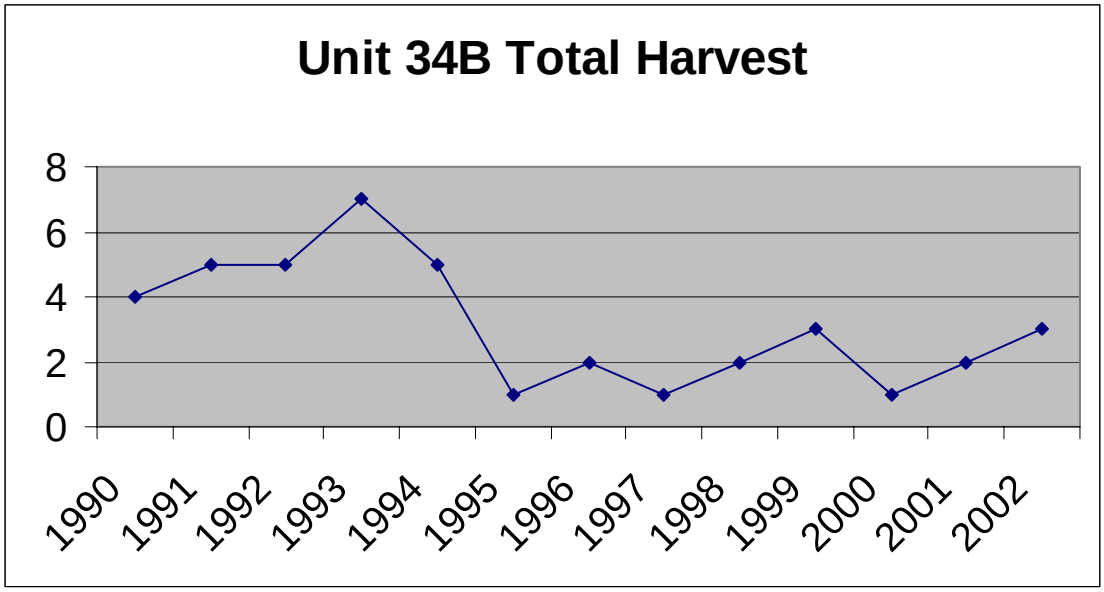
Background and History

The desert grassland area northeast of Sonoita supported pronghorn historically with early explorers mentioning pronghorn throughout the area. In 1851, Colonel Graham reported seeing "a great many antelope" grazing in the luxuriant grassland between the Whetstones and the Santa Rita Mountains. By the early 1900s, these pronghorn disappeared from this area north of Highway 82. In November 1981, 51 pronghorn (10B:21D:20F) trapped near Marfa, Texas where released on the Empire Ranch in Unit 34B. At the time the ranch was owned by the Anamax mining company, but was sold to the BLM along with the adjacent Cienega Ranch in 1989. After some initial mortality (about 20%) and a slow start reproductively, the population began to increase steadily before stagnating in the 1990s.

Recently, pronghorn have been observed consistently on the west side of Highway 83 (Unit 34A). As the population increases some animals are apparently dispersing into unused (in recent times) habitat. Also, pronghorn movements across Hwy 82 east of Sonoita has been reported by Wildlife Managers. Highways and the associated fences are normally an effective barrier to movement but they are not impenetrable. Additional documentation of this came in the form of road-killed pronghorn. One on Highway 83 north of Sonoita and another on Highway 82 east of town.







Habitat Description

This Empire-Cienega Ranch area consists of High and Moderate quality grasslands in the south to Moderate-Low quality savannas and open woodlands further north (Appendix E). Terrain is generally flat to gently, rolling hills, with some broken hills in the east at the edge of the Whetstone Mountains.

Vegetative cover in the south consists of good diversity grasslands. Grass species richness include several species of gramas, *Hilaria* spp., dropseeds, *Andropogon* spp., three-awns, and other unknown species. Shrubs and cacti included snakeweed, rabbitbrush, buckwheats, *Acacia* spp., *Mimosa* spp., prickly pear, yucca, cholla, and other unknowns. Forbs are numerous. Further north, mesquite has invaded grasslands, turning them into savannas and open canopy woodlands. However, the understory remains fairly open and diverse in these sites. Along Cienega Creek, typical riparian habitat vegetation, with large cottonwoods and other riparian species, occurred. Additionally, some canyons contain oak-juniper woodlands, notably on the western side of the unit.

Development consisted of SR 83 on the western edge and SR 82 on the southern perimeter. The small town of Sonoita was in the southwestern corner, and numerous ranchettes have been built both north and east along highway 82. Further from these highways, development is minimal, with several moderate and low-use, dirt roads and scattered ranches. Livestock fences are numerous and mostly do not meet game standards; these occur around the housing developments and in some areas on the ranches. Some of the newer fences around the homes north of Sonoita and on the Ranch are built to game standards. Electric fences also occur in this area. Water sources are numerous and accessible, however, not all windmills, pumps, or pipes to drinkers are functioning.

Management Goals

Goal 1. Maintain and improve water distribution of water sources available year-round for pronghorn.

- Strategy 1a. Inventory water sources available to pronghorn
- Strategy 1b. Plan and execute additional water as needed.
- Strategy 1c. Require all public and state lease lands to maintain water sources year round. During drought conditions, water must be left in earthen tanks for wildlife.
- Strategy 1d. If existing waters are lost to development, new waters should be created for use by pronghorn

Goal 2. Protect and improve habitat conditions for pronghorn.

- Strategy 2a. Monitor grazing levels and precipitation in or near areas used by pronghorn.
- Strategy 2b. Participate in and comment on existing range management plans and activities.
- Strategy 2c. Encourage the development of grazing management plans for allotments on State Land where none exist.
- Strategy 2d. Encourage greater use of controlled burning and mesquite treatments (e.g., agra-axe, pushes, burns, chaining, herbicides, and cuttings) to restore grassland habitat (reduce mesquite encroachment) and increase plant species diversity.
- Strategy 2e. Encourage non-governmental organizations, such as The Arizona Antelope Foundation to participate in grassland conservation and management.

Goal 3. Maintain pronghorn travel corridors through cooperation with land management agencies and private or other landowners.

- Strategy 3a. Evaluate and modify existing livestock fences to pronghorn specifications.
- Strategy 3b. Avoid any additional fence construction, but if necessary, it should meet Department criteria to allow for pronghorn movement.
- Strategy 3c. Limit road development or improvement within areas of pronghorn use.

Strategy 3d. Provide crossing gaps along Highways 82 and 83 to reduce highway mortality caused by pronghorn getting "caught" between the right-of-way fences (construct custom "Pronghorn Crossing" signs at the fence gaps).

Strategy 3e. Identify and recommend specific travel corridors to Santa Cruz County Planning and Zoning to avoid further herd isolation.

Strategy 3f. Remove non-functional fences.

Goal 4. Monitor population abundance and demographics.

Strategy 4a. Survey from fixed-wing aircraft annually, supplemented with surveys on horseback.

Strategy 4b. Maintain separate survey records for 34A and 34B.

Goal 5. Provide access to this population for recreational opportunity.

Strategy 5a. Continue to work with landowners and BLM to ensure continued access to these areas to the greatest extent possible.

Strategy 5b. Provide private landowners information about conservation easements to protect grasslands from housing developments to maintain their ranching-agricultural heritage.

Strategy 5c. Provide public information on viewing opportunities for pronghorn

Goal 6. Improve fawn survival

Strategy 6a. Ensure adequate fawning cover on state and private land.

Strategy 6b. Reduce predator densities immediately prior to parturition in areas frequented by pronghorn in years with adequate habitat conditions. Continue to address habitat shortfalls simultaneously.

Goal 7. Supplement the population with more pronghorn as available.

Strategy 7a. Evaluate and prioritize release sites and complete Environmental Assessments for future translocation efforts.

Strategy 7b. Determine and conduct management strategies at release sites prior to relocation for maximizing animal survival.

Strategy 7c. If large numbers of pronghorn are not available, translocations of 4-8 males would help diversify the gene pool.

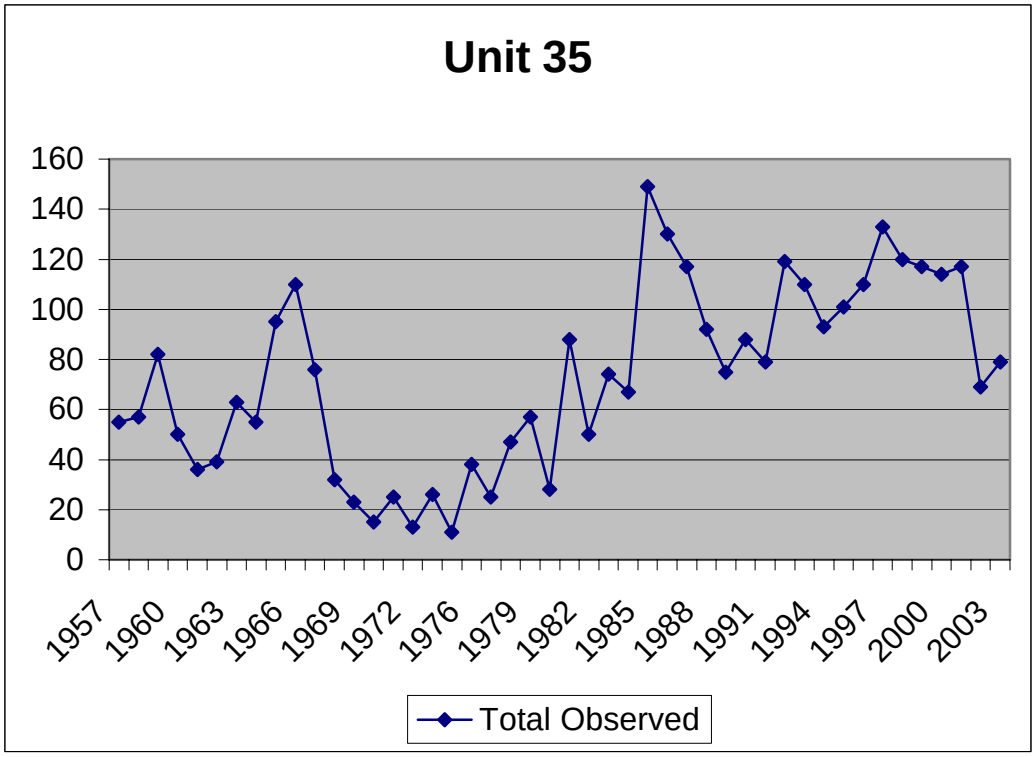
Unit 35A and 35B Pronghorn Herd Management Plan (San Rafael Valley)

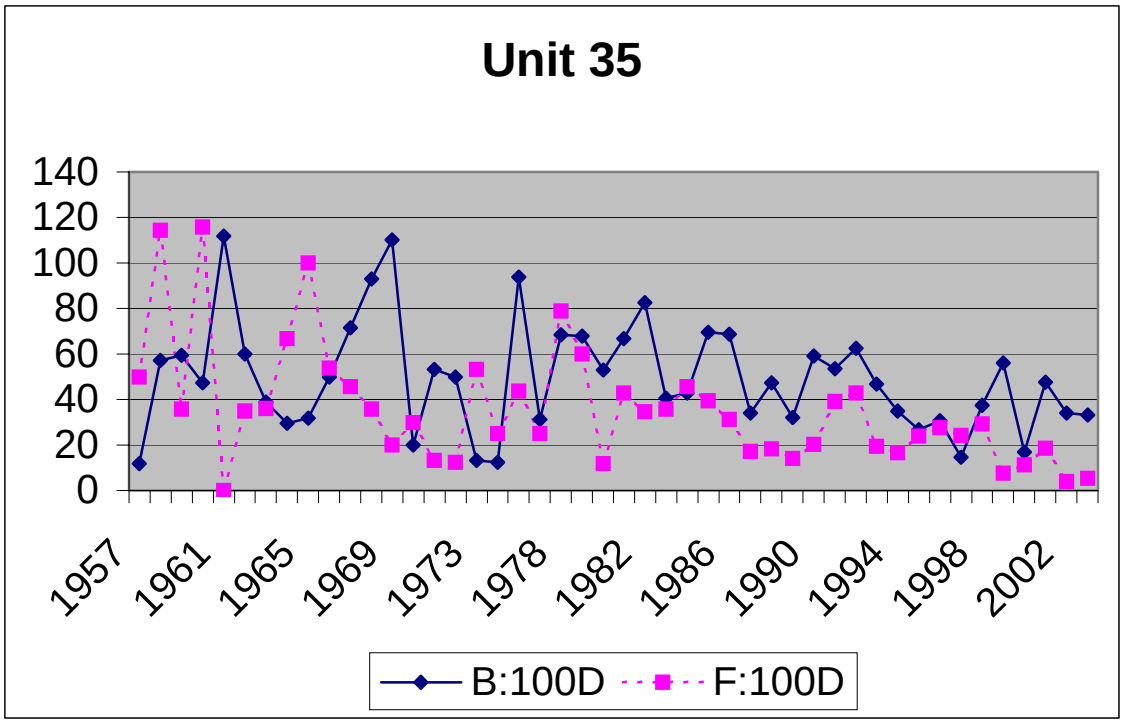
Background and History

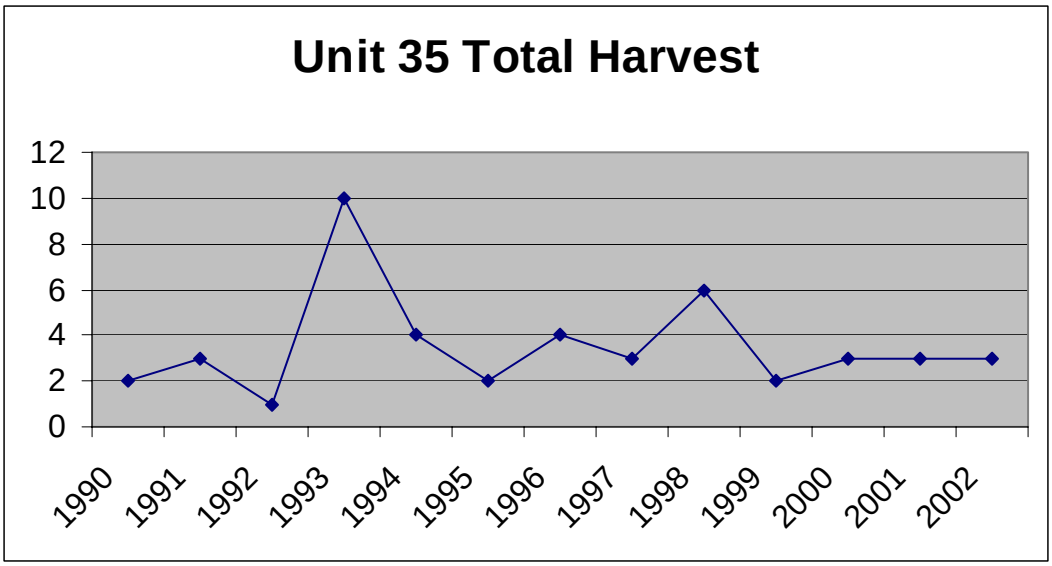
When he reached the headwaters of the Babocomari Creek on September 18, 1851, Colonel Graham recorded seeing "herds of pronghorn several times during the day". Early prospectors in the Patagonia Mountains frequently observed pronghorn right up to the oak woodland in the late 1850s. This native population was greatly reduced by 1920 and was subsequently supplemented with 13 northern Arizona pronghorn in 1945 and an additional 57 in 1951. In addition to these supplements, 72 and 18 northern pronghorn were released on Fort Huachuca Military Reservation in 1949 and 1951, respectively.

Between 50-100 animals were consistently surveyed from the late 1950s to the late 1960s when the population declined and remained low for nearly a decade. From 1968 to 1977, an average of only 23 pronghorn were observed each year during surveys. In the late 1970s, the population slowly recovered to a level similar to the 1950s..

In 1954, pronghorn could be hunted in this area as part of the Sulphur Springs Valley hunt containing 50 permits. No pronghorn hunts were open in southeastern Arizona from 1955-57. The San Rafael Valley was then opened to regulated hunting for the first time since 1913 as a separate block in the 1958-59 season with 5 firearm permits resulting in a harvest of 5 pronghorn bucks. The next year (1959), permits were increased to 15, then stayed between 6-10 until it was closed in 1972 because of concerns over low numbers of pronghorn observed. When the season reopened in 1979, 1 firearm and 4 archery permits were issued, followed by 5 years of only archery permits. A muzzleloader hunt was added in 1986, allowing both weapon types the opportunity to hunt this population. Firearm permits are no longer issued in this area because of the close proximity of housing and rural schools throughout the habitat occupied by these animals.


Unit 35
160
140
120
100
80
60
40
20
0
1957
1960
1963
1966
1969
1972
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
Total Observed


Unit 35
140
120
100
80
60
40
20
0
1957
1961
1965
1969
1973
1978
1982
1986
1990
1994
1998
2002
B:100D
F:100D



Habitat Description

Elgin Area.
Most of this area consists of flats and gently, rolling hills. Babocomari Wash bisects the southeastern end of this area. Vegetative cover of the upper (along southern side of SR 82) and lower (south of the Babocomari) third of this area is very diverse (Appendix F). Grasslands are blue grama dominated, but also contain tobosa, three-awn, and sideoats grama. Shrub diversity is also good, but short-shrub densities need to be higher. Shrub and cacti species include wait-a-minute bush, cholla, prickly pear, yucca, and an unknown. Vegetative cover on the middle (along the northern side of the Babocomari) sections are not as diverse, and there are several fields used for vineyards. The entire western and southern boundary of this area has been invaded by oak trees from nearby Canelo Hills.

Most housing (much of it fenced) occurs along the Lower Elgin Road, which connected Elgin to Sonoita, and is more prevalent closer to Sonoita. There are also many vineyards, fenced with woven wire, and a school along this road. The majority of homes are situated in 2 sections just south and southeast of Sonoita, where housing densities are moderate to high.

Several well-maintained, dirt roads ran through the area. State Route 83 is a moderate-use, paved highway that runs south out of Sonoita, then southeasterly to the Canelo-Lochiel Road. The Lower Elgin Road split from SR 83 eastward to Elgin. Since it is fenced, it separated pronghorn habitat in this area into northern and southern portions.

Most of the upper third of this area is not developed, although it is partially surrounded by development. The southern third of this area contains some isolated homes, paved SR 83, and some maintained, dirt roads. A railroad once ran from Patagonia to Tombstone, but only the grade still exists.

Livestock fences are abundant and not game standard. Additionally, fences occur on both sides of SR 82, SR 83, and the Lower Elgin Road and are not game standard. Both highways and the

Elgin road are paved and fenced on both sides with not game standard fencing. The lowest strand of the Upper Elgin Road fence is raised to 41 cm for the first 4 km from SR 82, but is not smooth wire. Water sources are abundant, but most are probably not full year round.

Babocomari Land Grant

This area is a large tract of private land with low to high, rolling hills, some with extended ridgetops, further east in the foothills of the Mustang Mountains. The Babocomari River is a prominent drainage that runs from Elgin south into the Babocomari Land Grant, where it joined with the Vaughn Canyon drainage and headed eastward towards Huachuca City. The Babocomari River channel is shallow, except for about a 3.2-km strip just east of the ranch headquarters, where the river cuts through the adjacent hills. Much of this area is too steep for pronghorn to cross with ease.

Vegetative cover west of the Babocomari Ranch headquarters is very diverse and is moderate to excellent for pronghorn. Grass species include blue, black, and sideoats grama, tobosa, fluffgrass, lovegrass, dropseed, silver beardgrass, and several unknowns. Shrubs include yucca, beargrass, wait-a-minute bush, whitethorn acacia, burrobush, buckwheat, mexican cliffrose, groundsel, and yerba de pasmo. Vegetative cover east of the Babocomari River to the eastern border consisted mostly of dense thickets of whitethorn acacia. There are open and closed canopy, mesquite thickets on the flats and hills south of the river. The river edge is vegetated with cottonwood and willow trees and other typical riparian vegetation, which nearby changes into a densely vegetated shrubland of whitethorn acacia and mesquite.

Development is minimal. The ranch headquarters is the only home site on the land grant. There are a couple of 2-track, dirt roads that wound through the area, but travel is restricted throughout most of the land grant. The Elgin-Canelo Pass Road along the west boundary is a maintained, low-use, dirt road.

Livestock fences are mostly along the Babocomari boundaries and at the headquarters, and are not game standard, except the fence between the land grant and the National Audubon Society Appleton-Whittell Research Sanctuary. That fence has recently been modified to exceed game standards (smooth, bottom strand >46 cm). Few fences exist within the boundaries of this area. Water sources are abundant, but pronghorn would have to travel through tall, thick vegetation to get to most of them.

Bald Hill-Research Sanctuary

This area lay just south of the Babocomari Land Grant and is bordered by the Elgin-Canelo Pass Road to the west, the foothills of the Canelo Hills to the south, and Fort Huachuca to the east. Terrain is mostly low, undulating to high, rolling hills, with slopes of 10-20%. Bald Hill is just south of the Babocomari Land Grant. Vaughn Canyon, a shallow drainage, runs along the northwestern side of Bald Hill, while O'Donnell Canyon and Turkey Creek, also shallow drainages, run south-north through the eastern side of this area.

Vegetative cover in the Bald Hill vicinity consisted of a very diverse grassland. Grass and shrub species are the same as those listed above for the western end of the Babocomari Land Grant. Lovegrasses dominated the landscape and are very dense east of Bald Hill. Furthermore, the

area to the east is invaded with tall, thick stands of whitethorn acacia and mesquite. Some areas southwest of Bald Hill are invaded with short, wait-a-minute bush. Where the western and southern ends of this area met with the foothills of the Canelo Hills, vegetation merge into oak-juniper woodlands.

Development is mostly moderate. The Elgin-Canelo Pass Road runs along the western boundary. This road is paved from SR 82 south to Elgin, where it turns to dirt; it is fenced on both sides, and carries low to moderate traffic. The Research Sanctuary road is a maintained, dirt road that is a restricted use road. There are a few isolated residences in this area.

Livestock fences are found in most sections outside of the Sanctuary and along the Elgin-Canelo Pass Road, and are not game standard. Water sources are abundant. However, according to personnel at the Audubon Research Sanctuary, there are only 2 water sources that contained water year round; one that is recently installed on top of Bald Hill and Finley Tank located about 1.6 km east of Bald Hill. Finley Tank is completely surrounded by tall bunchgrasses and is therefore inaccessible to pronghorn.

Southern San Rafael Valley

This area is located in the southern end of the valley near the international boundary. It is bordered by the Patagonia Mountains to the west and Canelo hills to the north. Terrain is flat to undulating, with low, extended ridges at the base of the Patagonia Mountains. Vegetative cover on the extended ridges is mostly an open canopy, oak woodland, with a high-diversity, grass understory. Shrub diversity and density is low. Vegetation on the flats and undulating hills is mostly a reduced species richness, grassy shrubland. Again, grass diversity is high, while shrub diversity is low. Grasses include blue, black, hairy, and sideoats grama, lovegrasses, dropseed, three-awn, tobosa, silver beardgrass, wolftail, and several annuals. Shrubs included rabbitbrush, burrobush, and an unknown. Yucca occurred in clumps. Shrub density (but not diversity) and bunchgrass density increases along the Santa Cruz River drainage.

Development is low to moderate, in the form of scattered homes, some maintained, dirt roads (Elgin-Canelo-Lochiel Road, Duquesne Road, San Rafael Road), and several 2-track, dirt roads. Development is high at Lochiel, with housing, fences, and roads. Livestock fences are abundant and not game standard. Fences near Lochiel are in extreme disrepair. Water sources are abundant and accessible to pronghorn, but most may not be full year round.

Management Goals

Goal 1. Maintain and improve water distribution of water sources available year-round for pronghorn.

- Strategy 1a. Inventory water sources available to pronghorn
- Strategy 1b. Plan and execute additional water as needed.
- Strategy 1c. Require all public and state lease lands to maintain water sources year round. During drought conditions, water must be left in earthen tanks for wildlife.
- Strategy 1d. If existing waters are lost to development, new waters should be created for use by pronghorn

Goal 2. Protect and improve habitat conditions for pronghorn.

Strategy 2a. Monitor grazing levels and precipitation in or near areas used by pronghorn.

Strategy 2b. Participate in and comment on existing range management plans and activities.

Strategy 2c. Encourage the development of grazing management plans for allotments on State Land where none exist.

Strategy 2d. Encourage greater use of controlled burning and mesquite-juniper treatments (e.g., agra-axe, pushes, burns, chaining, herbicides, and cuttings) to restore grassland habitat and increase plant species diversity.

Strategy 2e. Encourage non-governmental organizations, such as The Arizona Antelope Foundation and The Nature Conservancy to participate in grassland conservation and management.

Strategy 2f. Require developers to fund vegetation treatments (juniper eradication) of area equal in size to area being lost, resulting in no net loss of pronghorn habitat.

Goal 3. Maintain pronghorn travel corridors through cooperation with land management agencies and private or other landowners.

Strategy 3a. Evaluate and modify existing livestock fences to pronghorn specifications.

Strategy 3b. Avoid any additional fence construction, but if necessary, it should meet Department criteria to allow for pronghorn movement.

Strategy 3c. Limit road development or improvement within areas of pronghorn use.

Strategy 3d. Provide crossing gaps along Highways 82 and 83 to reduce highway mortality caused by pronghorn getting "caught" between the right-of-way fences (construct custom "Pronghorn Crossing" signs at the fence gaps).

Strategy 3e. Identify and recommend specific travel corridors to Santa Cruz County Planning and Zoning to avoid further herd isolation.

Strategy 3f. Remove non-functional fences.

Goal 4. Monitor population abundance and demographics.

Strategy 4a. Survey from fixed-wing aircraft annually, supplemented with surveys on horseback when appropriate.

Strategy 4b. Maintain separate survey records for the northern and southern parts of the valley.

Goal 5. Provide access to this population for recreational opportunity.

Strategy 5a. Continue to work with landowners to ensure continued access to these areas to the greatest extent possible.

Strategy 5b. Provide private landowners information about conservation easements to protect grasslands from housing developments to maintain their ranching-agricultural heritage.

Strategy 5c. Provide public information on viewing opportunities for pronghorn.

Strategy 5d. Modify existing hunt structures to accommodate the predicted urban-rural impact.

Strategy 5e. Resist the annexation of State Trust Land bordering private lands being annexed due to loss of management and hunting opportunities.

Goal 6. Improve fawn survival

Strategy 6a. Ensure adequate fawning cover on state and private land.

Strategy 6b. Reduce predator densities immediately prior to parturition in areas frequented by pronghorn in years with adequate habitat conditions. Continue to address habitat shortfalls simultaneously.

Goal 7. Supplement the population with more pronghorn as available.

Strategy 7a. Evaluate and prioritize release sites and complete Environmental Assessments for future translocation efforts.

Strategy 7b. Determine and conduct management strategies at release sites prior to relocation for maximizing animal survival.

Strategy 7c. If large numbers of pronghorn are not available, translocations of 4-8 males would help diversify the gene pool.

Unit 36A and 36B Pronghorn Herd Management Plan (Altar Valley)

Background and History

Ralph Pumpelly recorded *"great herds of bounding antelope"* in the Altar Valley in 1861. Manual King, who operated the Anvil Ranch since 1885, reported last seeing pronghorn in the Altar Valley in 1933. In 1942, he remarked that the valley was once a vast grassland from "mountain slope to mountain slope with only the occasional tree." There is little doubt this great valley once supported large numbers of pronghorn.

In 1945, 15 pronghorn from northern Arizona were transplanted near Arivaca with little success. In 1987, 87 pronghorn were captured in Texas and released 2 miles south of the headquarters. In the first 6 weeks after the release at least 6 adult pronghorn were killed by coyotes. A year after the release only 50 pronghorn were seen on surveys. This population increased slowly to about 75 individuals.

A total of 88 pronghorn were released in 2 locations in the Altar Valley on January 11, 2000. Monthly telemetry flights tracked the survival and gross movements for 1.5 years, when the number of working collars was only 3. In the northern Altar Valley (Unit 36A), 44 (16M:25F) pronghorn were released, 10 of which had radiocollars. All animals had red ear tags except for 1 individual with a yellow tag that was loaded in the wrong trailer compartment.

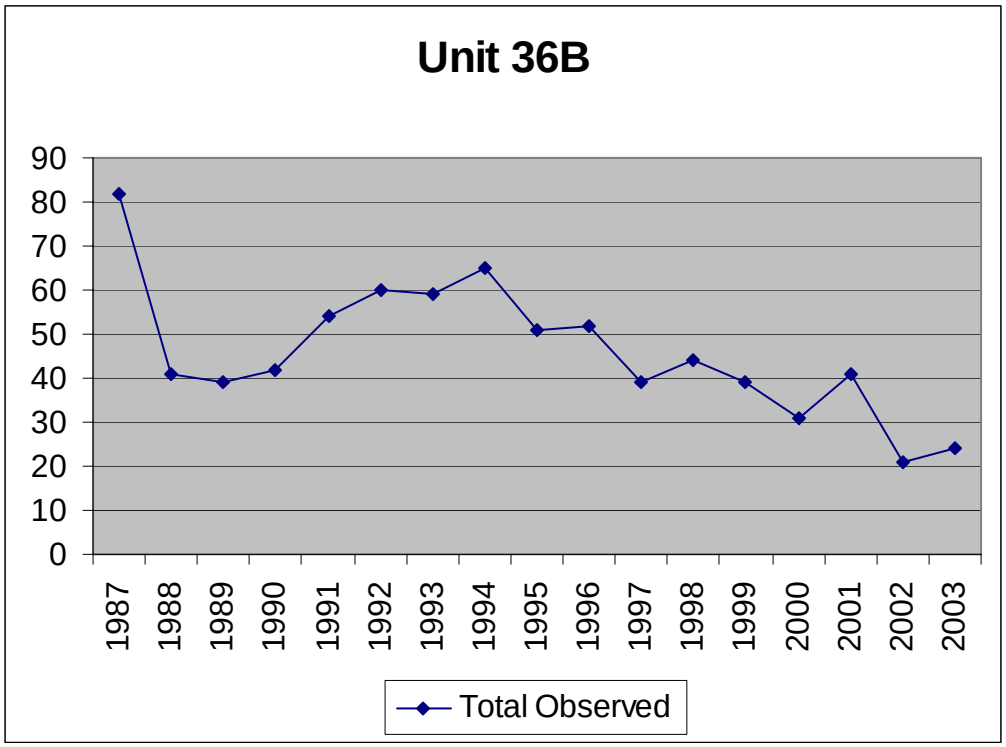
Two of the marked animals from this release stayed together on the Elkhorn Ranch in Unit 36C (west side of 286) in a group that originally numbered 11. For the months following the release and during dry periods, telemetered animals appear to be very closely associated with water sources. Animals located in the first week of July 2002 were also closely associated with what little water is available to them.

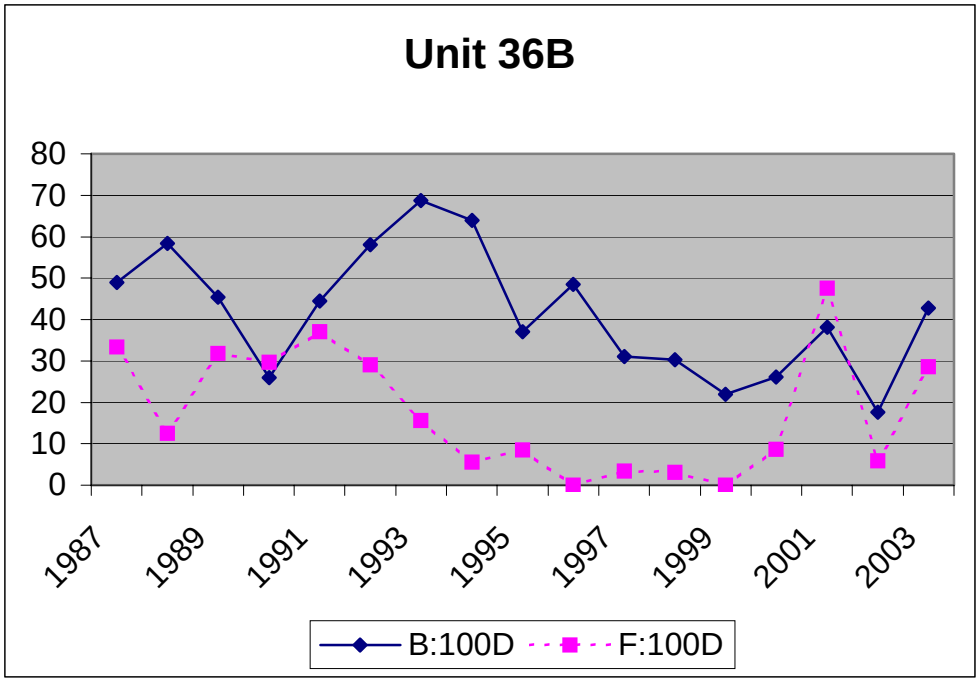
In the southern Altar Valley (Unit 36B), 44 pronghorn (27M:13F) were taken to the release site near Round Hill Tank, 3 miles north of the Refuge headquarters. Forty-three were released with 1 additional animal dead on arrival. Six of these 43 had radiocollars and they all had yellow ear tags. These animals intermingled with the existing pronghorn in this area.

The success of this release was much lower than hoped for. More than half the animals were likely lost in the first few months. It could not have been known during the planning stages that the range conditions upon release would be some of the worst in many decades. According to the Tucson National Weather Service office, the winter of the transplant (1999-2000) was the driest on record with above normal temperatures. In fact, 6 days before the release on BANWR, the Tucson area received one-tenth of an inch of precipitation, which ended the fifth longest streak on record of no measurable rain (100 days). By February 2000 (a month after the release), the Tucson Airport had only recorded 0.29 inches of rain since October 1999. Clearly the animals released in these range conditions were handicapped with a considerably reduced probability of success. In the future we will consider precipitation in the previous 6 months more seriously in our decision where to place animals.

Fawn survival has been low in this population, averaging 3:100 does from 1996-2000. In 2001 fawn survival spiked to 48:100. There may not be enough fawns being born each spring to "swamp" the predators during the first few critical weeks after parturition. A few years of good fawn survival would probably boost the total population to a level that could withstand the present predation pressure on fawns.

In 1959, the only legal hunt in the Altar Valley since the statewide closure in 1913 was conducted. That year 10 permits were issued and 9 hunters harvested 2 pronghorn. That hunt was closed the next year and remains closed today.





Habitat Description

The Altar Valley encompasses the southern portion of Unit 36A (Appendix H), the northern portion of 36B (Appendix I), and the eastern half of 36C. Terrain is mostly flats, with some undulating to low, rolling hills. Vegetative cover is a severely mesquite-invaded grassland, but with a species rich understory. Grasses consists mostly of warm-season perennials and annuals. Several species of grama grasses, lovegrasses, and three-awns are present. Curly mesquite is also common. Lehman's lovegrass, a potentially serious invader, is the most common increaser species. Sacaton and Johnson grass are common increaser species in the wide drainage bottoms created by Arivaca and Puertocito washes. These 2 species averaged 1 to 2 m tall, severely restricting pronghorn visibility. Bare ground is sufficient for abundant and diverse forb growth. Shrubs found include snakeweed, bursage, red barberry, *Acacia* sp., false-mesquite, velvet mesquite, yucca, prickly pear, and cholla. Most drainages are thick with mesquite, but some provide good forage diversity.

Development is minimal to moderate, with scattered residences, low to moderate-use, dirt roads, and numerous primitive campsites. State Route 286, running down the center of the valley, and Arivaca Road are lined on both sides with fences that are not to game standard, thereby greatly restricting pronghorn movements. Old, non-functional livestock fences are numerous in the northern part of the valley, which would hinder pronghorn movements. Water source abundance and availability is better off the Buenos Aires NWR than on. Waters on the refuge are not fenced and are mostly open, but many remain dry throughout the year from lack of runoff due to dense grass cover.

Management Goals

Goal 1. Maintain and improve water distribution of water sources available year-round for pronghorn.

Strategy 1a. Inventory water sources available to pronghorn

Strategy 1b. Plan and execute additional water as already planned and funded.

Strategy 1c. Require all state lease lands to maintain water sources year round. During drought conditions, water must be left in earthen tanks for wildlife.

Goal 2. Protect and improve habitat conditions for pronghorn.

Strategy 2a. Monitor grazing levels (36A) and precipitation in or near areas used by pronghorn.

Strategy 2b. Participate in and comment on existing range management plans and activities off the Buenos Aires NWR.

Strategy 2c. Encourage the development of grazing management plans for allotments on State Land where none exist.

Strategy 2d. Encourage greater use of controlled burning and mesquite treatments (e.g., agra-axe, pushes, burns, chaining, herbicides, and cuttings) to restore grassland habitat and increase plant species diversity.

Strategy 2e. Encourage non-governmental organizations, such as The Arizona Antelope Foundation to participate in grassland conservation and management.

Goal 3. Maintain pronghorn travel corridors through cooperation with land management agencies and private or other landowners.

Strategy 3a. Evaluate and modify existing livestock fences to pronghorn specifications.

Strategy 3b. Avoid any additional fence construction, but if necessary, it should meet Department criteria to allow for pronghorn movement.

Strategy 3c. Limit road development or improvement within areas of pronghorn use (especially on the Buenos Aires NWR).

Strategy 3d. Provide crossing gaps along Highways 286 to reduce highway mortality caused by pronghorn getting "caught" between the right-of-way fences (construct custom "Pronghorn Crossing" signs at the fence gaps).

Strategy 3f. Evaluate the few remaining livestock fences and modify to pronghorn specifications or remove (on the Refuge).

Goal 4. Monitor population abundance and demographics.

Strategy 4a. Survey from fixed-wing aircraft annually.

Strategy 4b. Encourage AZ Department of Transportation employees working in the valley to report pronghorn sightings north of Arivaca Road.

Strategy 4c. Maintain separate survey records for the northern and southern parts of the valley (36A and 36B).

Goal 5. Provide access to this population for recreational opportunity.

Strategy 5a. Provide private landowners information about conservation easements to protect grasslands from housing developments to maintain their ranching-agricultural heritage.

Strategy 5b. Provide the Buenos Aires NWR and the public information on pronghorn biology and population status.

Strategy 5c. Initiate hunts in this population as per guidelines set forth in the latest revision of the Species Management Guidelines.

Strategy 5d. Assure the inclusion of pronghorn habitat needs and harvest opportunity in the Buenos Aires NWR Comprehensive Conservation Plan.

Goal 6. Improve fawn survival

Strategy 6a. Reduce predator densities immediately prior to parturition in areas frequented by pronghorn in years with adequate habitat conditions. Continue to address habitat shortfalls simultaneously.

Strategy 6b. Encourage local sportsman groups through information and education efforts to hunt predators at select times and locations to increase fawn survival.

Goal 7. Supplement the population with more pronghorn as available.

Strategy 7a. Evaluate and prioritize release sites.

Strategy 7b. Determine and conduct management strategies at release sites prior to relocation for maximizing animal survival.

Region VI

<u>Unit 21 Pronghorn Herd Management Plan</u>

Background and History

Unit 21 is located in central Arizona just north of Phoenix and encompasses 3,098 km^2 of mainly rugged terrain. The Verde River bounds the north and east sides of the unit from Camp Verde (at its junction with I-17) to the southern boundary of the Tonto National Forest. The southern boundary follows the Tonto National Forest boundary west of Cave Creek Road, then Cave Creek Road to Carefree Highway, and finally Carefree Highway west until it reaches I-17. Interstate-17 forms the well – defined western boundary from Carefree Highway north to the Verde River at Camp Verde.

Pronghorn home ranges, distribution patterns and habitat selection have been extensively investigated in Unit 21 (see Ockenfels et al. 1996, 1994 and 1992; Ticer 1997; Ticer and Miller, 1994). The Unit 21 pronghorn population is considered a meta-population, and is completely isolated from nearby populations within Yavapai and Coconino counties due to habitat fragmentation and highway barriers. The herd continues to move between the northern and southern portions of the unit despite the development and encroachment of Cordes Junction into what is considered the eastern travel corridor through the unit. This has resulted in pronghorn using movement corridors higher than desirable with shrub densities and topographical barriers such as deep canyons. It is commonly agreed upon that use of these corridors may subject pronghorn to greater risk of predation. Historical management recommendations have included mitigating highway impacts, minimizing livestock fencing impacts, maintaining movement corridors, widespread brush control and corridor maintenance, maintaining and improving quality habitat within the grasslands through prescribed fire and livestock grazing management, controlling predators, and transplanting pronghorn stock to augment the herd. There are two substantial areas of suitable (moderate – high quality) habitat in unit 21. One of which falls entirely within the Agua Fria National Monument, generally speaking the Perry Mesa area (see Ockenfels et al. 1996).

According to a 1974 AGFD report by the Unit 21 wildlife manager (J. Hightower, AGFD memo 8-13-94) there were at least 7 distinct bands or groups of pronghorn in the spring of 1974, during what was considered a dry period. They were located in the following areas: Black Mesa, Perry Mesa, Campbell Tank, Horse Shoe Mesa (actually Horseshoe Mtn. north of Horseshoe Ranch), Cordes Junction, Marlow Mesa, and Dry Creek. Hightower identified Black Mesa as a major fawning area (56 pronghorn 5-10-74). Other key fawning areas he identified included Perry Mesa, Marlow Mesa, Dry Creek and Larry Mesa. In 1975, May-August aerial surveys conducted by the Department began to document the abandonment of Black Mesa by pronghorn as a fawning area. This was believed to be due to poor range condition that resulted in the loss of native perennial grasses, forbs and succulents; extreme hedging browse and prickly pear; and evidence of supplemental feeding of hay to livestock. In 1976 AGFD memos documented past and current concerns with range over-use on Black Mesa (J. McKinley, 1-22-76). In May of 1976 precipitation increased and the Black Mesa range responded (J. McKinley, 5–10-76). Six to twelve pronghorn were observed using the area, possibly to fawn. In recent years (since 1996)

drought conditions have again persisted and this area reflects it. These observations are noted here as an example to underscore the extreme importance of proper range management during dry periods and drought to pronghorn.

Unit 21 was separated from Unit 19A pronghorn habitat by I-17 from Cordes Junction north to the Verde River. Unit 20A was separate from Unit 21 by I-17 from Cordes Junction south. Within Unit 21, the fenced, paved General Crook Trail (Camp Verde cutoff) and SR 260 bisected the flats along the Verde River. General Crook Trail merged with SR 260 in Camp Verde, about 5 km east of I-17. The Dugas Road was paved until near Estler Peak, but was only fenced intermittently until Estler Peak. Part of the fencing was a 2-strand, electric fence.

Habitat Description

Major landscape features in Unit 21 are: (1) Pine Mountain; (2) New River Mountains; (3) Agua Fria River drainage; (4) the southern end of the black hills, which forms an escarpment along the Verde River; (5) and the Perry Mesa grasslands. Terrain is broken and rocky throughout most of the unit. Pine Mountain is the highest point in the unit at 2.077m. A small ponderosa pine-oak forest occurs on top of Pine Mountain, but the area is predominately pinyon-juniper woodland. The lowest elevation occurs along I-17 at Carefree Highway (<650 m), and it is a cresote flat.

The Bloody Basin Road and Dugas Road bisect Unit 21. Numerous paved roads occur in the Carefree-Cave Creek and New River areas. New River, Black Canyon City, and Cordes Junction occur on the western edge of the unit. Camp Verde occurs along the northern boundary. Phoenix lies along the southern boundary. Sub-divisions expanding from Phoenix occur within the unit along Carefree Highway. No communities exist within the interior of the unit, although the town of Cordes Junction is expanding along the central –western edge of the unit.

Landownership in Unit 21 includes Prescott National Forest in the northern portion and Tonto National Forest in the central portion and southeastern corner. BLM lands occur near the Dugas Road south to Black Canyon City, and State Trust lands occur south of Black Canyon City and around Cordes Junction. Private in holdings occur throughout the unit, but mostly in the southern end of the unit.

Seven areas were located in Unit 21 that contain enough semi desert grassland on gentle terrain to constitute suitable pronghorn habitat:

(1.) Cedar Mill-Reimer Draw-Hooker Basin,
(2.) Yellowjacket-Cottonwood-Marlow mesas
(3.) East Pasture Tank
(4.) North of Cordes Junction
(5.) Ash Flat-Sycamore Mesa
(6.) Perry Mesa
(7.) Black Mesa

GIS mapping indicated that the southern and eastern portions of Unit 21 contained no suitable habitat. The non-developed portions of Unit 21 south of the Squaw Creek and the Agua Fria River are largely upland Sonoran desert scrub areas with diverse cacti, xeric shrubs, and xeric trees. Because of tall shrubs and trees, visibility is often severely restricted in xeric areas, rendering them poor in suitability. Much of the mountainous terrain in the eastern half of the unit is dominated by chaparral or dense juniper woodland. These areas have little suitability for pronghorn. Small openings occur that pronghorn could sporadically use, but are too small to support a population.

Unit 21 is rated in the following habitat categories:

Habitat quality	No. of sections	Km^2	% of Unit
High	9	22.9	0.7
Moderate	103	245.8	7.9
Low	144	353.1	11.4
Poor or unsuitable	102	209.2	6.8
Field evaluation		2,266.7	73.2
Mapped only			

The rough estimate of suitable (High + Moderate + Low) pronghorn habitat in Unit 21 is 622 km^2, with most of High and Moderate quality occurring in two blocks, one in East Pasture and eastern mesas (Yellowjacket, Cottonwood, and Marlow), and the others at Perry Mesa and Black Mesa.

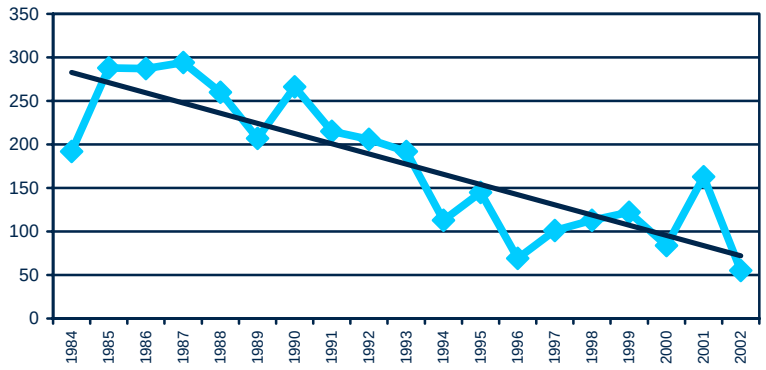
Habitat has always been the foundation for good management of wildlife populations. Pronghorn require succulent nutritious forbs. Availability of forbs is critical to good fawn production. Shrubs are also an important component of the pronghorn's diet. Browsing on shrubs is common throughout the year but most important in winter. Grasses do not provide a major portion of the pronghorn's diet. Recent field observations indicate that a possible major limiting factor to the viability of the pronghorn herd in Unit 21 is the monotypic stand of tobosa grass (*Hilaria mutica)* that occurs throughout the majority of suitable habitat for pronghorn in Unit 21. The forage value of tobosa grass is good only during the summer months when it is green. During the winter month's tobosa grass becomes harsh and wiry and loses most of its value as livestock forage. For proper management, tobosa grass requires burning every third or fourth year during late winter or early spring to maintain quality.

Transects for frequency sampling were initiated in the Yellow Jacket Mesa 50-acre exclosure this June. Until we implement a long-term interagency management plan, we expect the Unit 21 pronghorn population to remain at a lower than optimum level.

Habitat improvement projects such as prescribed burns and removal of woven wire fencing continue to be implemented for this pronghorn herd with assistance from the Arizona Antelope Foundation and cooperating permittees.

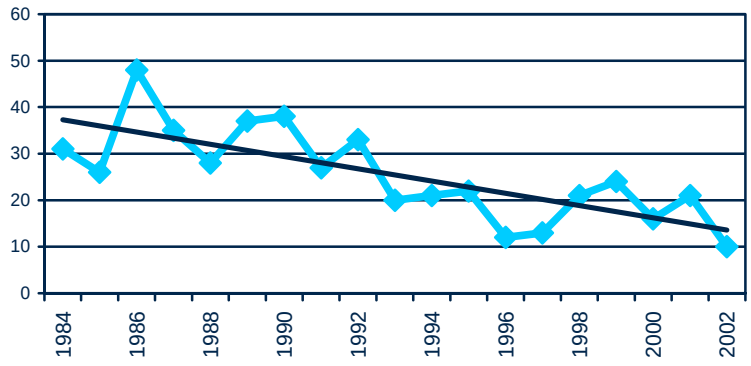
Survey and Harvest Trends

The loss of key fawning areas due to poor range condition is not unique to Black Mesa. The summer of 2002 was particularly hard on pronghorn due to drought, exacerbated by competition with livestock for residual ground cover. Pronghorn population trends have been declining since 1990 based on annual game survey and harvest data collected by AGFD. There has been an 81% decrease in the total pronghorn observed between 1987 of 294 pronghorn and 2002 of only 55 pronghorn.



Pronghorn surveyed from 1984 to 2002 during the annual July fixed-wing effort in Unit 21.

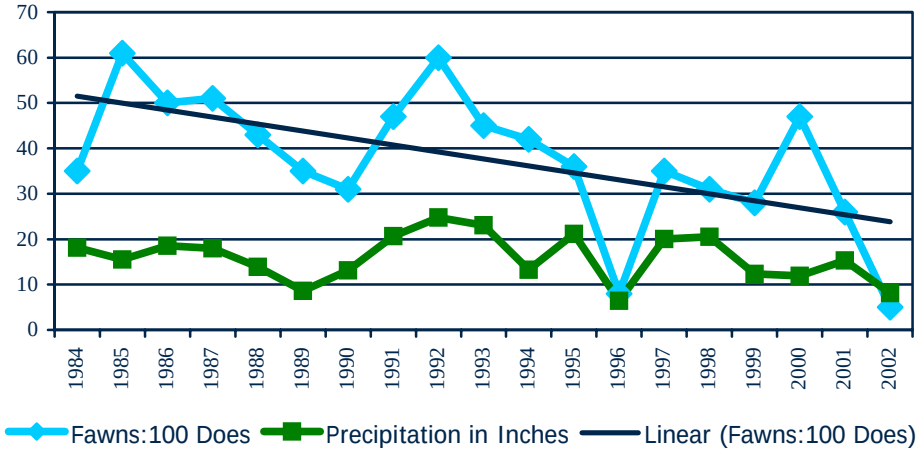
This trend has continued despite transplant efforts to supplement the population with 137 pronghorn in 1997 and 101 pronghorn in 1998. There has been a 56% decrease in total number of groups observed between 1986 and 2002.



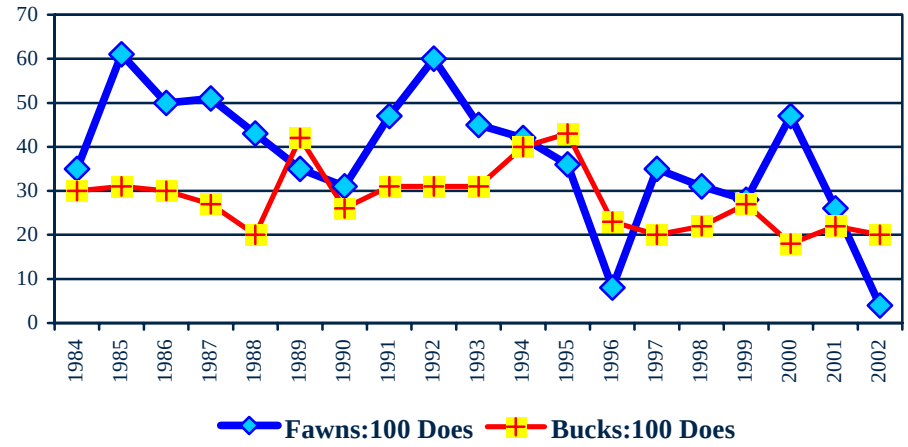
Pronghorn groups surveyed from 1984 to 2002 during the annual July fixed-wing effort in Unit 21.

Pronghorn recruitment rates have been declining and have dropped below AGFD state guidelines of 30-40 fawns per 100 does since 1995, with the exception of 2000. Buck:doe ratios have

remained more stable because they are managed by hunt structure, whereas fawn:doe ratios are subject to extreme fluctuations, habitat conditions and environmental factors.

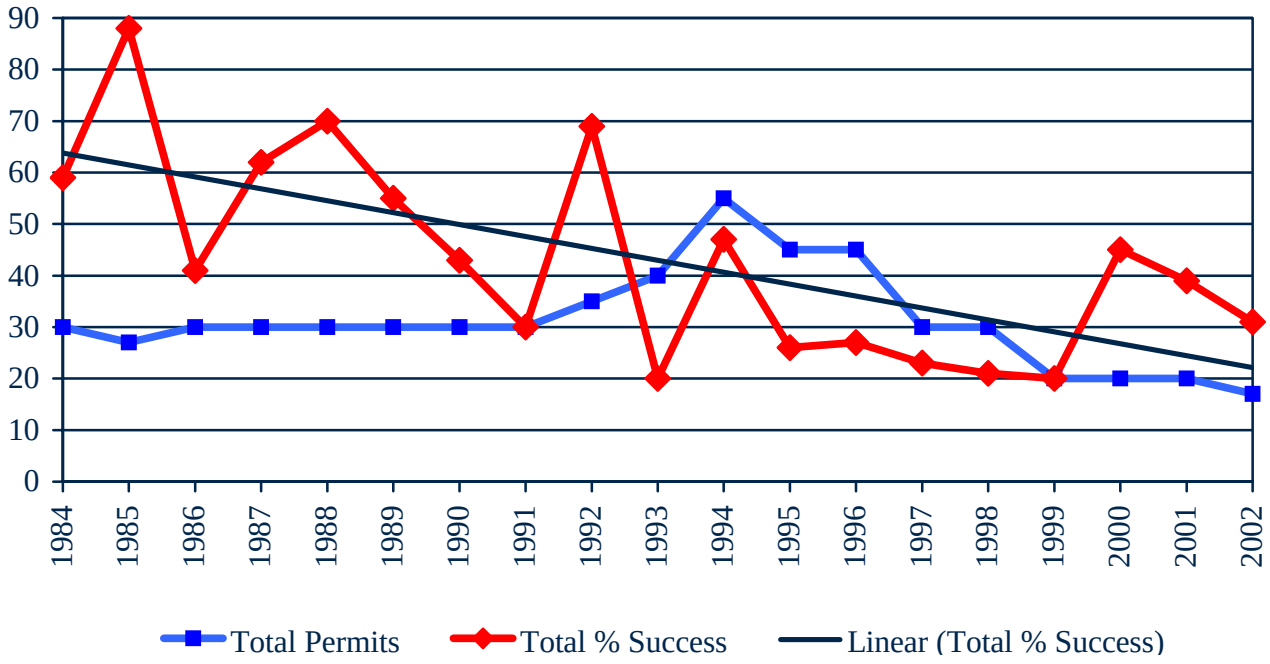


Pronghorn fawn:doe ratios from 1984 to 2002 in Unit 21.



Buck:doe and fawn:doe ratio trends in Unit 21 from 1984 to 2002.

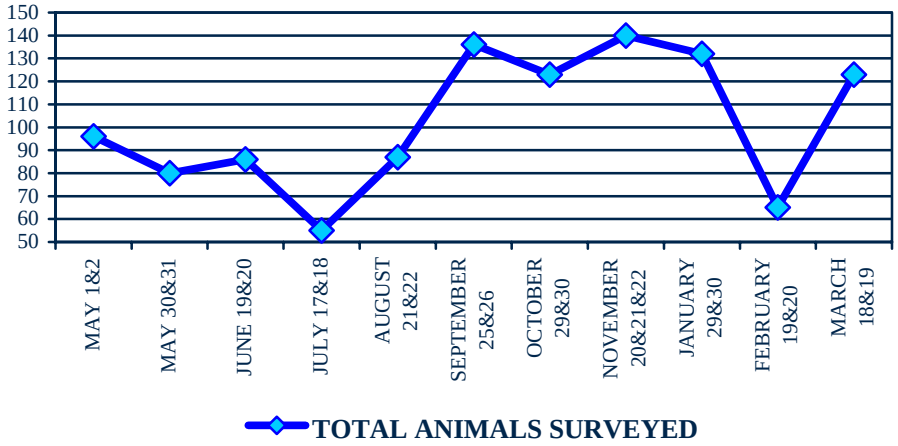
The Department has responded to these trends by reducing the number of hunt permits available to harvest pronghorn in the unit. In fact, permits (rifle and archery) have been reduced by 55% since 1994 and hunt success has declined by 46% since 1994, despite transplants.



Total permits and hunt success for pronghorn in Unit 21 from 1984 to 2002.

Data from the 2000 survey in Unit 21 has shown that the concentration of pronghorn has shifted from the northern half of the unit to the southern half of the unit. In 1984, 71% of the 192 pronghorn surveyed occurred in the northern portion of the unit. During the 2000 survey 68% of the 163 pronghorn were observed in the southern portion. Only one fawn was observed in the northern portion and 28 fawns we observed in the southern portion. The land management agency in the northern part of the unit is primarily the Prescott National Forest and the Bureau of Land Management in the southern part of the unit.

Beginning in May of 2002, Region VI in conjunction with the Arizona Antelope Foundation, has conducted monthly fixed-wing surveys to document pronghorn distribution along with locations of pronghorn in relationship to water throughout Unit 21. One of the unexpected benefits of these flights is the minimum population estimate based on the consistency of total animals observed month to month. Pronghorn began to herd in larger groups during September making locations of pronghorn easier to detect during monitoring flights. The maximum number of pronghorn observed was 140 during November 2002, which consisted of seven groups. This minimum population estimate should be close to the actual population size based on pronghorn herding behavior, consistency of herds to remain in the same areas, and ease of location by observers due to larger pronghorn group sizes. The ability to observe pronghorn was hindered in July and February by overcast lighting conditions.



Trend in total animals surveyed during monitoring flights from May 2002 through March 2003.

Management Issues

1. Fenced Highways
   Interstate 17 separates pronghorn in Unit 21 from those in unit 19A in the Orme Ranch area and in unit 20A in the Cordes area. Further, a small area of suitable habitat occurs in the highway median just north of the Dugas-Orme Ranch Interchange. It is unlikely that any modifications to highway fences can be done to mitigate these impacts. No bridge along this route appears large and open enough for pronghorn to pass under. The bridge at the Agua Fria River has some chance as a passage between 19A and 21, if the mesquite and catclaw thickets on both sides are cleared and the slopes lessened by grading. Because Unit 21 is basically a closed system for pronghorns, it is essential to maintain open rangeland along the Dugas Road and the improved, dirt Bloody Basin Road so pronghorn continue to move across them. Fencing along these roads should exceed game standards to permit easy movement across the roadbed. Either electric fences or bottom smooth wire greater than 46 cm above should be used, although there is some evidence that even two-strand electric fences are a barrier to pronghorn.

2. Livestock Fences
   Numerous livestock fences occur in Unit 21. Most are barbed-wire fences that do not meet game standards. Some have been modified to meet game standards and some electric fences occur in the East Pasture area. Additional fences need to be modified and heightened by removing or replacing the bottom barbed wire strands with a smooth wire 41-46 cm above ground. All interior allotment fences should be modified as a minimum mitigation feature. Coordination with permittees and land manager should determine if any fences can be removed and still maintain adequate livestock control. Fences along the movement corridors between East Pasture and Cordes Junction, and Black Mesa, and between the Dugas area and Perry Mesa should be priorities for removal. A GIS database of fences and natural barriers has been developed for Unit 21. Pasture sizes can be determined. This map can be used to help determine the priority of fences to be removed and modified.

3. Water Availability

Water availability is adequate in Unit 21, if water sources are maintained full year round. Fencing around all tanks, especially those on Perry Mesa, needs to be removed, modified to exceed game standards, or troughs need to be placed outside the corrals. Brush around the waters needs to be removed throughout the unit.

A GIS cover of water sources was developed for Unit 21. This needs to be updated with seasonal water availability, and it should be used as a tool for monitoring and maintaining water availability. Using buffers around waters with known availability, placement of new waters or identifying old waters to modify for year-round availability can be easily accomplished.

4. Tree and Shrub Encroachment

This is the major concern for pronghorn management in Unit 21. Junipers, prickly pear, shrub form mesquite, and catclaw have invaded most of the shrubgrassland areas. Along the movement corridors between the northern and southern portions of Unit 21, reductions in visibility may soon render the corridors unsuitable for pronghorn. All areas of Unit 21 have this problem. Prescribed burning is practical for juniper control, but catclaw and mesquite are not effectively root-killed by most burning programs, particularly summer burns. Herbicides may be necessary to thin catclaw and mesquite dominated grasslands. Cabling, chaining, and pushing may thin numbers, particularly if prescribed fire follows the initial treatment.

5. Plant Species Richness

Tobosa grasslands are typically low in plant species diversity. However, pure stands are generally small because of the lack of heavy soil that tobosa grows on best. Across the unit, we observed that plant species richness is lacking, due we suspect, to long-term overgrazing, fire suppression, and lack of precipitation. Snakeweed and prickly pear invasion on mesas north of Dugas, Black Mesa, and Perry Mesa can be reversed by prescribed fire and modifications to livestock grazing. The grazing scheme (numbers, season, rotation) and species grazed can be controlled. Coordination with permittees and land managers should occur to determine the best means of improving rangeland carrying capacity.

6. Recreation

Unit 21 is near the Phoenix metroplex, and considerable recreational traffic occurs during all but the summer months. Traffic to the Pine Mountain Wilderness is important because the Dugas Road cuts through suitable pronghorn habitat. Realignment of the road away from the middle of the mesa tops may help reduce disturbance levels.

Controlling access to Black Mesa during fawning season (March-May) may be needed to improve fawn survival. Black Mesa has been a key fawning area for the unit because of its early spring greenup.

7. Human Encroachment

Cordes Junction development has resulted in the loss of habitat for pronghorn in Unit 21. Further, it has affected seasonal movements between East Pasture and Black Mesa. Increased development in this area would result in additional loss of grassland habitat, something the small herds in Unit 21 may not be able to recover from. The second area of development seriously impacting pronghorn in Unit 21 is the Sunset Point Interchange. The best movement corridor to Black Mesa was lost to this development. Further development on the east side of I-17 at the interchange could result in fragmenting Black Mesa from the rest of the unit. Clearing and widening the gas line just east of I-17 may mitigate some of the impact.

8. Translocation

During January 1997, 60 pronghorn were transplanted from Larmar, Colorado into Unit 21. Twenty-three of these were released in the southern range (Perry Mesa) and 37 were released in the northern range (Big Flat Well.) All animals were ear-tagged.

During December 1997, 77 pronghorn were transplanted from Parker, Utah into Unit 21. Forty-one of these were released in the southern range (Perry Mesa) and 36 were released in the northern range (Big Flat Well.) All animals were ear-tagged.

During December 1998, 101 pronghorn were transplanted from Parker, Utah into Unit 21. Fifty-nine of these were released in the southern range (Perry Mesa) and 42 were released in the northern range (Big Flat Well.) All animals were ear-tagged and six were radio-collared. After one-month post release, two radio-collared pronghorn died. Cause of death was probably due to stress and trauma from transport.

A total of 238 pronghorn have been released over a two-year period in Unit 21. These transplants have been essential to the viability of this herd. During the 2000 survey one-third of the groups observed contained at least one ear-tagged pronghorn from these transplant efforts.

9. Predation Issues

Ockenfels (1994) documented mortalities on ten of 24 radio-collared adult pronghorn in Unit 21 over a four-year period between 1989 and 1992. Mountain lion predation reduced adult pronghorn survival rates in rugged terrain and most predation occurred less than 1000 meters from canyon edges. A water source for pronghorn along a canyon drainage was a point source for predation by lions. By providing an alternative water catchment away from the canyon drainage further lion predation on pronghorn at the water source was prevented (Ockenfels, personal communication).

A significant factor that is often overlooked from this study is that Ockenfels also states that lion predation is inconsequential in rolling hills grassland habitat of this unit where little cover exists for predators. The evidence then suggest that improving habitat conditions by removing encroaching brush on mesas and providing alternative water sources away from canyon drainages should eliminate any additive effect of predation on pronghorn by lions.

Coyotes occur in the pronghorn habitat of Unit 21. The densities of coyotes in the area are unknown and only 1 coyote was observed during the 2003 monitoring flights, although observers were concentrating on observing pronghorn and coyotes were not obvious would not be located. Coyotes can be detrimental to recruitment of fawns into a pronghorn population especially if adequate hiding cover for fawns is not available.

10. Agency Coordination
The Department has coordinated with the land management agencies (BLM, Tonto NF, and Prescott NF), the Aqua Fria Grasslands Coalition and the Arizona Antelope Foundation (AAF) to improve habitat conditions through various projects within Unit 21. Projects have included fence modifications to wildlife standards, fence removals, water developments, development of broad scale grassland maintenance burns, and juniper cuts. Habitat assessments and various research efforts have continued to focus on identifying pronghorn needs and developing management recommendations. Department concerns with allotment management have been expressed over a period of 10-20 years.

Management Goals

In February of 2002 a Cooperative Workgroup was developed between the Department, Prescott NF, and the AAF to renew communication and planning efforts regarding resource concerns. At that time the Department and AAF were becoming increasingly concerned with pronghorn trends that appeared to be declining in the northern portion of Unit 21. Areas in the northern portion of the unit including East Pasture area, Marlow Mesa, and Yellow Jacket Mesa have historically been preferred areas for pronghorn fawning. At the time, trend data appeared to show a shift in habitat selection to the southern portion of the unit. Workgroup goals are to cooperatively collect data to investigate these trends more intensively and reverse trends if possible through responsive management. The objectives of the workgroup include:

- Collect and analyze data about pronghorn and pronghorn habitat in Unit 21
- Identify key areas of concern based on current distribution patterns and habitat use
- Formulate management recommendations based on that data and professional judgment
- Formulate short term and long term management strategies
- Implement management recommendations
- Improve and maintain a dialogue between Prescott NF, the Department, and AAF regarding issues and concerns.

The land management agency in the northern part of the unit is primarily the Prescott National Forest and the Bureau of Land Management in the southern part of the unit. Continued low fawn recruitment and survival has been attributed to poor habitat conditions. Coordination efforts in Unit 21 continue between the Agua Fria Grasslands Coalition and the Arizona Antelope Foundation to improve habitat conditions. Recent removal of woven wire fencing from Antelope Tank has shown an increased use by pronghorn. Transects for frequency sampling of habitat cover were expanded throughout the unit. Aerial flights are now being conducted each month to monitor fawn survival, changes in pronghorn distribution, and water availability. With this new emphasis

on the habitat conditions in Unit 21 we hope to implement long-term interagency management plans to improve habitat conditions for this population.

The greatest threat to this pronghorn herd is from attempts by the Prescott National Forest to implement a Savory grazing management system with inadequate rainfall. These techniques have proven detrimental to the range conditions in this unit. The region continues to coordinate with the Forest Service regarding appropriate forage use in this unit.

Management Objectives and Strategies

In support of the Cooperative Workgroup goals and objectives, the Department has initiated more extensive pronghorn population and habitat investigations than what is normally collected annually for development of hunt recommendations. This effort is being coordinated through the Region VI Habitat Program. To date investigations include:

- Fixed wing aerial surveys conducted monthly for two years to monitor pronghorn distribution and critical habitat selection in Unit 21 (May 2002-2004). The project was funded by AAF for two years to validate the effectiveness of Adopt A Ranch activities at the Horseshoe Ranch by AAF and to answer why pronghorn trends show a decreasing use of the northern portion of the unit since 1987 and the inverse in the southern portion.
- Pronghorn fawn hiding cover assessment unit wide to measure overall cover and visual obstruction in potential pronghorn bedding sites. Data will be collected for four years and analyzed in conjunction with a statewide study being conducted by our Research Branch. Although Unit 21 is not formally part of that study, data will be collected with identical methodology to allow us to compare Unit 21 fawn hiding cover with areas of high and low fawn recruitment statewide. We will also be able to compare differences in the northern and southern portion of Unit 21.
- Compiling existing allotment and land management information to investigate concerns with habitat management and develop recommendations that may benefit pronghorn.
- Pellet analysis to compare seasonal forage values
- Plans are underway to possibly investigate the following additional habitat components:
  Shrub and tree density unit wide
  Fence density and structure unit wide
  Canopy cover (%) and species diversity in key areas of concern

Overall declining numbers, groups observed, and recruitment rates in recent years despite transplant efforts indicate habitat suitability is below management objectives. Recent drought conditions and continued demands on range resources have exacerbated the situation. Shrub and tree encroachment have reduced habitat suitability in portions of the moderate to good pronghorn habitat in the unit. All these factors combined have led to a year with the lowest fawn recruitment rate since 1961, 0-2% or 0-2 fawns per 100 does. Degraded habitat disrupts ecological functions vital to watershed health such as nutrient recycling, soil protection and development, and hydrological functions.

LITERATURE CITED IN HERD PLANS

Arizona Game and Fish Department. 2001. Wildlife 2006. Arizona Game and Fish Department, Phoenix, AZ.

Brown, D. E. *ed*. 1994. Biotic communities: southwestern United States and northwestern Mexico. University of Utah Press. Salt Lake City, UT 342pp.

Cooper, C. F., 1960, Changes in vegetation structure and growth of southwestern pine forests since white settlement. Ecological monographs 30:129-164.

Department of the Interior Bureau of Land Management Phoenix District Kingman Resource area, Arizona Game and Fish Department Region III Kingman Arizona. 1983. Cerbat – Music Habitat Management Plan 45p

Glinski, P., and R. Remington. 1984. Evaluation of the Hillside-Kirkland area for restocking. Special Report, Proj. W-53-R-34. Ariz. Game and Fish Dep., Phoenix. 15 pp.

Gregg, M. A., M. Bray, K. Kilbride, and M. R. Dunbar, 2001, Birth Synchrony and Survival of Pronghorn Fawns. Journal of Wildlife Management 65:19-24.

Knipe, T. 1944, The Status of the Antelope Herds of Northern Arizona. Federal Aid Project 9-R. Arizona Game and Fish Department, Phoenix 40p.

McGregor, J. C., 1935, Arizona Antelope. Museum Notes 8(3): 13-16. Museum of Northern Arizona, Flagstaff.

Mearns, E. 1907. Mammals of Mexican boundary of the United States. Bulletin 56, Smithsonian Institute, Washington D.C.

Merriam, C. H. 1890. Results of a biological survey of the San Francisco Mountains region and desert of the Little Colorado, Arizona. USDA, Div. Of Ornikth. And Mammal. No. Amer. Fauna No. 3. Washingtgon, D.C. 136 p.

Neff, D. J. and N. Woolsey. 1979. Effect of Predation by Coyotes on Antelope Fawn Survival on Anderson Mesa. Arizona Game and Fish Department. Special report number 8, 36p.

Ockenfels, R. A. 1994. Factors affecting adult pronghorn mortality rates in central Arizona. Ariz. Game and Fish Dep. Digest 16, Phoenix. 11pp.

Ockenfels, R. A., W. K. Carrel, and C. van Riper III. 1997. Home ranges and movements of pronghorn in northern Arizona. Biennial Conference of Research on Colorado Plateau 3: 45-61.

Ockenfels, R. A., C. L. Dorothy, and J. D. Kirkland. 1992. Mortality and home range of pronghorn fawns in central Arizona. Proceedings of the Biennial Pronghorn Antelope Workshop 15: 78-92.

Ockenfels, R.A., C.L. Ticer, A. Alexander, and J.A. Wennerlund. 1996. A landscape-level pronghorn habitat evaluation model for Arizona. Ariz. Game and Fish Dep. Tech. Rep. 19, Phoenix. 50 pp.

Ockenfels, R. A., C. L. Ticer, A. Alexander, J. Wennerlund, P. A. Hurley, and J. L. Bright. 1996. Statewide Evaluation of Pronghorn Habitat in Arizona. Federal Aid in Wildlife Restoration Project W-78-R 296p.

Rush, W.M. 1939. Wild animals of the Rockies. Harper and Bros., New York. 2698 p.

Shaw H. G., 2001, Assessment of Arizona Pronghorn Research Needs as Related to Aerial Gunning of Coyotes. Presentation to pronghorn meeting in Flagstaff Arizona.

Taylor, W. P. 1936. The Pronghorned Antelope in the Southwest. Trans. No. Amer. Wildl. Conf. 1:652-655.

Ticer, C. L. 1998. Pronghorn fawn bed site selection in a shortgrass prairie of central Arizona. M.S. Thesis, Arizona State University, Tempe, Arizona.

Ticer, C. L., and W. H. Miller. 1994. Pronghorn fawn bed site selection in a semidesert grassland community of central Arizona. Proceedings of the Biennial Pronghorn Antelope Workshop 16: 86-103.

Appendix A.

PRONGHORN TRANSPLANT PRIORITIES IN ARIZONA

October 16, 2002

REGION 1:

Unit 27

Eagle Creek; limited, isolated habitat.

REGION 2:

Unit 5A and 5B

Anderson Mesa; habitat improvements and predator management is ongoing. Pronghorn population is responding favorably, but still well below carrying capacity.

Unit 6A

Population at low level and habitat improving.

Unit 12B

Three-6 bucks; 20-40 does; ensure availability of bucks for breeding in several isolated sites, 89A highway right-of-way has isolated pronghorn north of the highway and near Fredonia there is another isolated group of pronghorn, each with only 1-2 known bucks. Forty pronghorn were transplanted into this area in December 2004 and 2005 (30 total) from Torrey, Utah.

Unit 13A

Five-10 bucks; to increase the breeding buck segment and increase genetic diversity of this small population.

REGION 5:

Unit 36A/B-Altar Valley

The population in the Altar Valley has been stagnant for since shortly after the initial transplant. The exact cause is unknown. Pronghorn originally inhabited that entire valley and a supplemental transplant in January 2000 was less successful than we had hoped. The lack of success was due to the release occurring during one of the driest winters on record and lack of suitable watering sites near the release. The first release should be in 36B because the quality of the pronghorn habitat is higher, there are more existing resident animals, and the refuge has been more active in habitat improvement. Once we have over 100 animals in 36B we will release

additional animals in 36A. This will give us time to improve the water distribution in 36A before more releases there.

Apache Pass Area (Unit 29/30A)

This area is northwest of the Chiricahua Mountains north and south of the Apache Pass Road. Almost all of this area is private land, with much of it owned by members of the Riggs family. Past discussions (for a couple of decades) with landowners have been unproductive. The region is exploring recent landowner changes and assistance from AAF that may provide the opportunity to translocate pronghorn into this area.

Northwest of highway 80 (Unit 29/30A)

This area is part of the San Bernardino Valley which supports our most robust pronghorn population. Highway 80 slices through the edge of the valley, isolating about 46 mi^2 of moderate to high quality habitat from the rest of the valley. In discussions with landowners for the last 6 years they have made it clear they would not support pronghorn in this area because of competition for food and water with their cattle; discussions ongoing within the Region.

Existing pronghorn populations in Units 34A/B, 35A/B, and 31/32 could serve as target populations for additional animals. It may be advantageous to drop off some males in these populations to infuse a small amount of genetic diversity (if we are bringing animals to a nearby area). We would need to have further discussions on the effects of supplemental transplants on our hunt structure in these units. Continued efforts to alter fences, provide and maintain water sources, and monitor grazing intensity is likely to have a positive effect on these populations.

REGION 6:

Unit 21

The population in Unit 21 is at a low level. Currently, minor habitat improvements and predator management is ongoing.

Appendix B.

LITERATURE REVIEW

Pronghorn are an important component of Arizona's wildlife community. Prior to European settlement, populations occurred in most areas of the state where the grassland biome occurred. With settlement, came many impacts to pronghorn and pronghorn habitat and both have declined. In the late 1800s and early 1900s, unregulated livestock grazing occurred that altered vegetative structure and species composition. Later, as livestock management strategies were developed, fences were developed to regulate sheep and cattle movements, which restricted pronghorn movements to important habitat components, or to avoid events such as heavy snows. Other impacts include expansion of woody plant species due to fire suppression; fragmentation by roadways, aqueducts, powerlines, and urban developments; and direct loss of habitat due to urbanization. Cumulatively, these and other impacts, have reduced pronghorn habitat quality to the point that less than 1% of Arizona's pronghorn habitat is rated as good or excellent. Although the extent of population decline associated with the decline in habitat is uncertain, many populations contain less than 200 animals, and some populations will likely be extirpated.

Improving habitat conditions is key to improving populations. These sections have guidelines to aid in habitat restoration efforts. As individual herd units plans are developed, these guidelines provide information on desired conditions for what is thought to be the most important limiting factors for pronghorn at this time. Certainly, other factors can and do limit pronghorn, but these were identified during a focus group exercise of pronghorn experts.

It is also important to recognize that other planning documents exist. As an example, predation is not addressed in this plan, as a Predator Management Plan has been approved by the Arizona Game and Fish Commission and would guide predator management activities targeted for pronghorn populations.

Habitat Capacity for Pronghorn

In Arizona, pronghorn occupy about 52,000 km^2 (20,077 mi^2) of habitat in a wide band across the northern part of the state and in isolated pockets between southern mountain ranges (Anon. 1987). Most of Arizona's pronghorn population are found between 900-2,200 m (2,950-7,200 ft) in elevation. In some areas, herds occur as high as 3,000 m (9,850 ft) during summer months. Sonoran pronghorn (*A. a. sonoriensis*) occupy areas below 350 m (1,150 ft). This range in elevation encompasses a variety of grassland habitats ranging from desert grasslands to forest and mountain meadows. Pronghorn prefer flat, open grassland areas, but also use rolling or broken hills and mesa tops of less than 20 percent slope. They also use such diverse habitats as sparsely vegetated deserts, woodlands, and open forests.

Pronghorn are rangeland dependent. If rangelands have the right combination of habitat factors, they have the potential to produce optimum numbers of pronghorn. Therefore, recognizing habitats in good ecological condition and maintaining them is important. This is especially true where the land is managed for multiple-use. Some land managers are not aware of optimum pronghorn habitat conditions and may recommend changing the vegetative composition favoring another use. Under such circumstances, it behooves a wildlife manager to know which habitat conditions favor

the pronghorn habitat requirements and advocate the maintenance of those conditions for the welfare of pronghorn populations (Lee et al. 1998).

Following are descriptions of optimum-desired habitat conditions for pronghorn in 6 areas:

i) Required Habitat Block Size
ii) Canopy Cover Requirements (desired woody component conditions)
iii) Optimal Vegetative Conditions
iv) Water Distribution And Quality
v) Fawning Cover Requirements
vi) Fencing Requirements

REQUIRED HABITAT BLOCK SIZE

Pronghorn habitats must be large enough to include seasonal foraging areas, key fawning sites, strategic bedding sites, and escape terrain. Key rangelands, areas that sustain a population through extreme or limiting conditions (e.g., drought, severe winter storms), must be identified and available (Lee et al. 1998). Movements occur as occasional location changes brought about by drought, blizzards, changing forage conditions, or changes in water availability (Yoakum 1978). Corridors must be available to pronghorn to move between such seasonal use areas.

As a general rule, the required size of habitat available per animal is considered to be 2.6 km^2 (1 mi^2) of grassland (Lee et al. 1998). Minimum population size should be >100. Thus, a rule of thumb is to manage for blocks of habitat >260 km^2 (100 mi^2). Population viability analysis indicates that population levels around 500 better ensure future existence (see Population Viability section). Viable pronghorn populations do occur in smaller areas, particularly if the habitat is consistently excellent in providing seasonal forage; high quality water year round; adequate cover for fawning sites; and a suitable mixture of grasses, forbs, shrubs, trees, and cactus. However, in lower quality habitat, such as that occurring in desert or semi-desert situations, larger blocks are appropriate to manage for.

The block of habitat must be the appropriate vegetative type to sustain pronghorn and the terrain ruggedness must be gentle enough to be selected for. Slope is typically <10% for pronghorn use areas (Ockenfels et al. 1994). Pronghorn are dependent upon open rangeland (Lee et al. 1998). If the physical characteristics and biotic characteristics are appropriate, population viability is dependent upon habitat size. Certainly, the more contiguous and larger the suitable habitat, the more likely the population will be viable.

Fragmentation of habitat can be caused by a number of factors. Natural barriers reduce or prevent movements (Lee et al. 1998). Large bodies of water, large rivers, abrupt escarpments, dense chaparral or forest thickets, or deep steep-walled canyons are considered natural barriers. Type conversions due to undesirable woody species invasion can also fragment habitat.

The man-made barriers that fragment habitat and isolate pronghorn herds include fenced highways and railroad rights-of-way (Yoakum 1978; Ockenfels et al. 1994, 1997; van Riper and Ockenfels 1998). Human developments, often in the form of "ranchettes," also provide effective barriers to movement and fragment available habitat. Fragmentation of habitat results in

isolation of herds, decreasing the number of animals in a single population and increasing the number of small, difficult to manage populations.

The desired condition for pronghorn habitat is for block size to exceed 260 km^2 (100 mi^2) containing contiguous suitable terrain and preferred vegetative characteristics. Movement corridors must be available and maintained between seasonal ranges, particularly in areas of heavy snowfall (Ockenfels 1994). Movement barriers must be identified and eliminated to ensure movements between key habitat areas.

CANOPY COVER REQUIREMENTS FOR PRONGHORN

Overstory

Pronghorn are adapted to open overstory canopy, having evolved on the prairies and deserts of North America (Lee et al. 1998). They range throughout western North America in grasslands and shrub-steppe plains, with a small percentage in deserts (Yoakum 1978). Pronghorn rely on "sight and flight" behavior as their main defense against predators, and they generally select habitats that favor that behavior (Ockenfels 1995).

Vegetative characteristics of preferred pronghorn rangeland have been examined in several biomes, and studies suggest that trees are poorly represented in typical pronghorn habitat (e.g., Alexander and Ockenfels 1994, Ockenfels et al. 1994). Hoffmeister (1986) noted that in Arizona, pronghorn range throughout the open areas of the state, up to the pinyon-juniper zone, and sometimes in ponderosa pine forest. However, open canopy vegetative types, such as meadows or parks, are used in wooded or forested areas, but the woodlands or forests themselves are typically avoided. It has long been known that pronghorn use woodlands (Buechner 1950, Wallmo 1951, Yoakum 1978, Britt 1980), however, as tree densities increase, visibility decreases and pronghorn are more vulnerable to predation. Increased tree density also decreases mobility (Yoakum 1978, Goldsmith 1990), reducing or eliminating movements and isolating individual herd units.

Alexander and Ockenfels (1994) estimated that the most commonly used sites in grasslands and pinyon-juniper zone by pronghorn generally have <5 trees/ha (2/acre) and moderate use sites have on average only 38 trees/ha (15/acre). Limited use of areas with an average of 75 tree/ha (30/acre) is likely. Further, areas with low densities of trees are also selected by fawns; sites with greater than 2 trees/40-m^2 are totally avoided, and most fawn bed-sites have no trees (Ticer and Miller 1994).

Maintenance of habitats with <38 trees/ha (15/acre) is essential for sustaining pronghorn populations. Reduction of tree densities within current or historical pronghorn rangeland to such low levels should benefit pronghorn. Increased visibility should equate to reduced predation and increased mobility (Goldsmith 1990, Alexander and Ockenfels 1994). Savanna conditions, with tree canopy cover <20%, provide thermal cover (Ockenfels et al. 1994) and another forage item without sacrificing security. Such savanna conditions can be accomplished through mechanical removal, use of wild or prescribed fire, or chemical removal of non-desirable woody species. Any remaining tree areas, if a mosaic pattern is desired in the pinyon-juniper zone (Vallentine

1989), should be left along drainages, on ridge tops, and steeper slopes, areas less preferred by pronghorn (Alexander and Ockenfels 1994, Ockenfels et al. 1994).

Desired condition for pronghorn habitat is tree canopy cover <20%, preferably closer to 5%, with trees <38/ha (15/acre). The majority of trees should be mature form, providing adequate thermal cover, but minimal visual obstruction.

Understory

Pronghorn are typically abundant in areas with low vegetation that allows easy predator detection and unobstructed escape (Yoakum 1978). Ground cover in typical habitat averages 20-50% bare ground, rock, or litter; the remaining ground is covered with herbaceous species (grasses, forbs) and shrubs (Yoakum 1978, Lee et al. 1998). Composition of the vegetation averages 10-35% shrubs (Ockenfels et al. 1994, Lee et al. 1998).

Low vegetative structure is preferred (Lee et al. 1998), with an overall average of 25-46 cm (10-18 in). Areas with vegetation over 63 cm (25 in) are generally avoided. Typical chaparral vegetation (Brown 1994), with numerous plants >76 cm (30 in) is used infrequently; mostly for travel between more open sites. Reduced visibility and mobility due to tall vegetation are factors that negatively impact pronghorn survival (Goldsmith 1990).

Pronghorn tolerance for horizontal visibility obstruction is low (Ockenfels et al. 1994). This low tolerance occurs at the microsite, macrosite, and landscape scales. Sites are often selected that contain no shrubs >61 cm (24 in), with some use of areas that contain a single tall shrub. Avoidance of a site increases as the density of tall shrubs increases (Ockenfels et al. 1994).

However, pronghorn forage on shrubs (Yoakum 1990, Lee et al. 1998). They are selective opportunistic foragers, depending on the availability and palatability of plant species in the area. Although their preference for forbs is considerably greater than for shrubs, shrubs are important seasonally (Yoakum 1990). In shrub-steppe rangeland, diet composition for shrubs can exceed 60%. Thus, native shrubs are necessary to sustain pronghorn during periods of reduced forb availability (i.e., winter, drought).

Few food habit studies have been undertaken in Arizona to determine the value of different shrub species to pronghorn. Wallmo (1951) observed pronghorn foraging on a number of shrubs in southern Arizona, whereas Neff and Woolsey (1979) observed pronghorn feeding on shrubs in northern Arizona. Gay (1984) studied winter forage species denoted by Neff and Woolsey (1979), the season that shrubs are used most by pronghorn.

Nearly 60 species that occur in Arizona have been identified as forage items for pronghorn, ranging from excellent quality to poor (AGFD unpublished data). Noted desirable shrub species are various buckwheats, four-wing saltbush, sagebrush spp., winterfat, cliff-rose, Apache plume, horse bush, Mormon tea (ephredra), brickellia, wild grapes, skunkbush, range ratany, shrubby cinquefoil, black greasewood, false-mesquite, mountain mahogany, and ceanothus. Many other shrubs and half-shrubs are opportunistically fed upon by pronghorn.

Therefore, the desired condition of the shrub component in the understory is a mixture of shrubs, averaging 5-10 available shrub species (Yoakum 1978, Lee et al. 1998), that provides 10-35% of

the ground cover. Few plants should be >61 cm (24 in) in height. Dense stands of tall preferred forage species is undesirable due to obscured visibility. Non-desirable woody species invasions of grasslands, from such species as shrub-form mesquite, catclaw acacia, scrub oak, rabbitbrush, and snakeweed need to be reversed or prevented.

OPTIMAL VEGETATIVE CONDITIONS FOR PRONGHORN

Yoakum (1980) identified preferred pronghorn habitat as having the following vegetative cover and composition:

- Ground cover composed of 50% vegetation and 50% bare ground, rock or litter.
- Forage cover with 30-40% grass, 10-30% forbs and 5-30% shrubs.
- Species composition of 5-10 grass species, 10-50 forb species and 5-10 shrub species.
- Average vegetation height of 38 cm (15 inches); average height over 76 cm (30 inches) is avoided.
- Habitat with a diverse mix of vegetative communities is preferred over large areas of monotypic vegetation.

Autenrieth (1978) described similar attributes of high quality pronghorn habitat including:

- Forage cover with 40-60% grass, 10-30% forbs and 5-20% shrubs.
- Species composition of 5-10 grass species, 20-40 forb species and 5-10 shrub species.
- Mosaic of plant communities.

Specific to Arizona, Ockenfels et al. (1996a) described high quality pronghorn habitat as "A rich shrub-grassland mix (shrubs 5-20%) with most plants <24" (61 cm) tall. Sufficient shrubs > 5 species of excellent or good forage plants for winter forage base: (1) distributed evenly throughout; (2) occur in clumped distribution, typically on north facing slopes; or (3) if shrubs or succulents are >24" (61 cm) tall occur scattered or in small clumps so general visibility is not obstructed. Trees are absent or few (<1% cover, <2 per acre or 5 per ha.) in clumps or along drainages. Grasses >5 species in mixture of cool and warm season perennials. Sufficient bare ground (>25% cover) for seasonal forb growth."

Less than 1% of Arizona's occupied pronghorn habitat is rated as high quality (Ockenfels et. al. 1996b). Allen et al. (1984) identified that pronghorn movements are controlled by the habitat needs of water and forage. Bright (1999) monitored habitat use and home range size of pronghorn in northern Arizona and found pronghorn, in sub-optimal habitat, made seasonal movements to use better forage in winter-spring but shifted to areas with dependable water during hotter periods of the year. These movements resulted in much larger home ranges, and thus more bio-energetic demands, for these animals. As pronghorn use sub-optimal habitat, such as denser tree canopy or steeper slopes, they may also become more vulnerable to predation (Ockenfels, 1994).

WATER DISTRIBUTION AND QUALITY FOR PRONGHORN

Water is very important to pronghorn survival and recruitment in the Southwest (Ockenfels et al. 1994). High-density pronghorn populations are associated with abundant drinking water and

conversely, pronghorn in the semi-arid regions and deserts with little available water exist at low densities (Lee et al. 1998). In fact, even with high forage succulence, pronghorn must have access to water during hot weather (Beale and Holmgren 1975). Lactating does are most susceptible to inadequate water availability, which indirectly affects fawn survival (Beale 1974, Fox 1977). This is a very important issue in Arizona because does are lactating in most areas of the state during this critical time period and, according to Fox (1997), even though vegetation may contain a high water content, it is not likely this preformed water is sufficient to meet the does' lactation needs. Optimal water distribution in pronghorn habitat is for all areas to be with in 1.6 km (1 mile) of water (Kindschy et al. 1978). However, these waters must also be useable by pronghorn in that they must contain water year-round or at least during hot, dry, periods; be located in areas pronghorn can access; and be of good water quality.

Although waters were distributed well in central Arizona pronghorn habitat (Ockenfels et al. 1994), they did not all contain water at all times, especially during the hot, dry critical periods of summer. Ticer et al. (in prep.) found that on pronghorn range in north-central Arizona water sources were also well distributed, but in some pastures, during the critical seasons (summer and fawning), there were none or few water sources containing water and thus they were not located within the recommended 1.6 km (1 mile). Within this study area, Ticer et al. (1999) also found that pronghorn were constrained within pastures due to non-game (bottom wire too close to the ground) standard fencing, making it difficult for pronghorn to access watered pastures. Pronghorn will drink from most facilities designed for livestock, but those facilities should remain usable year-round in southern habitats (Lee et al. 1998).

Water placement can also make a water source unusable by pronghorn. To avoid increasing predation on pronghorn, water sources must be placed in areas that pronghorn can easily enter and flee and where visibility (predator detection) is maintained. In addition, water sources should be placed as far as possible from washes, canyon edges, and rocky outcrops that predators may frequent.

Although no quantitative data exists, it has been suggested by many pronghorn biologists that area size of a fenced water may affect pronghorn use. The area should be large enough that pronghorn aren't intimidated by the "close quarters" and would be able to readily escape predation. Water quality may also affect pronghorn and their use of a water source. Other animals, such as livestock and poultry, may suffer a general loss of condition, weakness, scouring, unthriftiness, reduced milk production, bone degeneration, or death from continuous use of water that contains excessive total dissolved solids (TDS) (Lee et al., 1998). McKee and Wolf (1963) recommended that TDS not exceed 4,500 PPM for livestock use and a pH range of 6.5-8.5 for most uses. Sundstrom (1968) found that when the pH of water sources in the Red Desert of Wyoming exceeded 9.2 pronghorn seemed to seek other water sources. In monitoring TDS and pH of waters in 2 pastures of pronghorn habitat in northcentral Arizona, Ticer et al. (in prep) found that even though water TDS increased with decreasing water levels it never rose above acceptable levels, however, pH level rose to above the recommended range with decreasing water levels during the dry, summer season.

Pronghorn waters should be placed in open areas containing little topographic relief and low (<45.7 cm [<18 in]) vegetation heights. Fences surrounding water sources should be constructed

so that the bottom strand is smooth and placed 51 cm (20 in) from the ground. The area size within the fenced area should be large enough to promote pronghorn use and facilitate predator escape. Enough water sources in a pronghorn occupied rangeland must contain water to meet the 1.6-km (1-mile) minimum and these waters should contain enough water to maintain appropriate pH levels. Since TDS and pH will vary according to location and soil type, it is also recommended that water quality be monitored to help determine the amount of water necessary to maintain usable water quality.

PRONGHORN FAWN BED SITE REQUIREMENTS

Pronghorn fawn survivability is thought to be primarily dependant upon the neonate (<3 weeks old) fawns' ability to select adequate bed site cover which provides protection from predators (Beale 1973, Bromley 1978, Neff and Woolsey 1979, Autenrieth 1982, 1984, Neff 1986) and unfavorable environmental conditions leading to hypothermia and illness (Hepworth 1965, Beale 1978, Bodie 1978, Bromley 1978, Barrett 1981). While fawn bed site macrosite characteristics are fairly consistent, fawn bed site microsite characteristics vary considerably which suggests that adequate fawn bed site requirements differ between regions and habitat type. Furthermore, Ticer and Miller (1994) found that neonate bed site selection differed from postneonate selection due to differing anti-predator detection and avoidance strategies and that preferred neonate bed site characteristics should be used to guide fawning habitat management.

Ticer (1998) reported that previous studies documented fawn bed site selection on slopes ranging from <5 % in semidesert grasslands and shortgrass prairies of the arid southwest to 16% in sagebrush habitats and tallgrass communities of other areas, and speculated that fawns select for steeper slopes in tall vegetation habitats where slopes may provide improved visualization of the surrounding area. Adequate visual detection of predators by fawns at bed sites may be crucial to fawn survival (Bromley 1978). Smith and Beale (1980) found fawns select for more open areas on high ground rather than bed in nearby tall cover that offered the greatest opportunity for concealment.

In a semidesert grassland of central Arizona Ticer and Miller (1994) found neonate fawns select for the following microsite (40-m^2 [131 ft^2] plot) characteristics: >3 forb species, low shrub species richness and density (preferred no shrubs present), mean grass height of 29.3 cm (11.4 in), mean shrub height of 44.7 cm (18.0 in), mean total vegetative cover was 31.8%, mean percent grass cover = 12.8%, forb = 11.0%, shrub = 5%, bare ground-rock = 62.9%. There are 2 possible explanations why fawns used such tall shrub cover in this study area; most of the data were acquired in an area where does were traditionally returning to even though grazing practices were favoring tall shrub increase, and/or low percent grass cover forced fawns to use the vertical cover of tall shrubs in place of horizontal grass cover for concealment.

In a shortgrass prairie of central Arizona Ticer (1998) found fawns select for the following microsite (40-m^2 [131 ft^2] plot) characteristics: >4 forb species, up to 2 shrub or cactus species, mean grass height of 29.5 cm (11.6 in) avoiding sites with <15 cm (5.9 in) ht., <15 cm (5.9 in) shrub height, mean percent herbaceous cover = 44.3%, short (<18 in tall) shrub = 3.3%, tall (>18 in tall) shrub = 0%, and bare ground-rock = 49.9%. Ticer (1998) found that the greatest microsite bed site difference between habitats was that in the semidesert grassland neonate fawns selected for bed sites containing taller shrub heights and less percent grass cover than those

selected for by fawns in the shortgrass prairie. In interpreting these results, it should be noted that this study area is the most productive pronghorn rangeland in Arizona.

Percent vegetative cover has been considered a detrimental factor of fawn survival, however, while some studies support this view, others are contradictory (Ticer 1998). Furthermore, Bodie (1978) found a negative correlation between fawn survival and shrub cover, postulating that the higher shrub cover provided hiding cover for predators, which made it more difficult for does to protect fawns. Ticer (1998) suggests that an increase in shrub cover would also impede a fawns ability to spot and hide (lay prone) from predators. In the semidesert grasslands of southwestern Texas and central Arizona and in the shortgrass prairie of central Arizona, shrubs were not a major component of bed sites (Tucker and Garner 1983, Ticer and Miller 1994, Ticer 1998). Within a semidesert grassland of central Arizona, Ticer and Miller (1994) found that neonate fawn bed sites contained more (up to 10%) shrub cover than postneonate bed sites (up to 5%).

Distance of fawn bed sites to water may also affect fawn survival by acting as a limiting factor to lactating does (Beale 1974). Therefore, fawn bed site distances to water may be more a reflection of the lactating requirements of does, thus the need for nearby water sources, than true selection by the fawn. Because of increased water amounts needed to meet the physiological demands of lactation, coupled with limited neonatal fawn mobility, does with neonate fawns need to be relatively close to water (Ticer and Miller 1994). In a semidesert grassland of central Arizona, Ticer and Miller (1994) found that fawn bed site selection in relation to distance to water differed with fawn age and that neonates selected for bed sites 400-800 m (1,312–2,625 ft) from water and avoided areas >1,200 m (>3,937 ft) from water; no selection or avoidance of distance to water by mobile postneonates was found.

Ideal fawn bed site habitat within acceptable pronghorn habitat would be located in areas of gentle topographic relief (i.e., rolling hills) within grassland habitats. Vegetative composition selected for by fawns in the shortgrass prairie study area is consistent with current preferred pronghorn habitat characteristics (Lee et al. 1998). Therefore, it is recommended that the vegetative composition of fawning grounds contain ~45% herbaceous (80% grasses [mean height = 29.2 cm [11.5 in], 20% forbs of which there are at least 5 species) vegetation, ~5% short (<45.7 cm [<18 in] tall) shrubs, and ~50% bare ground-rock. In addition, waters should be spaced throughout the fawning area so that bed sites are always within 400-800 m (1,300-2,600 ft) of waters.

FENCE REQUIREMENTS FOR PRONGHORN

Pronghorn movements are inhibited by livestock fences in rangelands, along highway and railroad right-of-ways, and among human-developments (Buechner 1950, Ward et al. 1976, 1980, Ockenfels et al. 1997, Lee et al. 1998, Ticer et al. 1999). Most fences are designed to manage livestock movements, which also inhibit pronghorn movements and affect their ability to avoid predators or deep snow, and restrict their ability to locate water and forage (Hailey 1979, Yoakum 1979). Fences may indirectly effect fawn survival since they influence doe selection of preferred fawning areas (Buechner 1950) and because of the importance of water to lactating does (Beale and Holmgren 1975).

Fence structure dictates the impact imposed on pronghorn movements. Since pronghorn evolved in open, gentle terrain with limited tall vegetation, their survival did not necessitate jumping obstacles, such as fences (Lee et al. 1998). Therefore, since pronghorn must pass underneath fences, close to the ground fences, such as to-the-ground woven-wire fences, completely eliminate pronghorn movements. Barbed wire fences <40 cm (<16 in) from the ground greatly impede movements, whereas, game-standard (smooth bottom strand placed >40 cm (<16 in) from the ground) (Lee et al. 1998) and 2-strand electric wire fencing facilitate pronghorn passage (McAtee 1939, Spillett et al. 1967,Yoakum 1978). Ticer et al. (in prep.) determined that pronghorn movements across previously unused fences were facilitated by modifying fence segments with 5-cm (2 in) diameter, 1.2 – 2.4 m (4-8 ft) long PVC pipe slid over raised barbed wire fence strands and that the height of modified segments used by pronghorn averaged 53 cm.

Livestock fence construction and modification recommendations vary slightly among resource management agencies as most adopt the fence construction guidelines as outlined in the Pronghorn Management Guides produced by the Pronghorn Antelope Workshops. The most recent Pronghorn Management Guide (Lee et al. 1998) recommends against construction of "wolf-type" or net-wire fences that completely prohibit pronghorn passage and remaining fences such as these should be removed or modified. Lee et al. (1998) also recommend that existing non-game standard fences be modified to facilitate pronghorn passage. Fence modification should include complete removal of unnecessary fence strands, and to ensure that the bottom barbed-wire strand is replaced with smooth wire and located 41-46 cm (16-18 in) above the ground. Ockenfels et al. (1994) recommended that the lower bottom strand of pronghorn fences be raised from the current 41-46 cm (16-18 in) standard to 51-56 cm (20-22 in) and Ticer et al. (in prep.) confirmed the recommendation when they documented that pronghorn preferred to use fences where the bottom strand was situated 53 cm (21 in) from the ground. Pronghorn passes have shown to be of limited value because fawns often break their legs trying to use them. Although not discussed in the Pronghorn Management Guide, electric fences are less restrictive than other kinds of fencing to pronghorn movements (Brown 1990).

The BLM (Bureau of Land Management) discourages the use of net-wire fences, but requests that where they must be used that the bottom strand only be up to 25 cm (10 in) from the ground (Yoakum 1980), which falls below the recommended 41 cm (16 in) minimum. BLM fence construction requires that the bottom strand be placed 40.6 cm (16 in) from the ground and in some instances the bottom strand is smooth. However, if sheep also occupy the range then the bottom strand is placed 38.1 cm (15 in) from the ground. Beyond recommendations of the Pronghorn Management Guides, BLM also recommends no stays between fence posts to provide for a less tight fence and to keep fenced areas "as large as possible".

USFS (United States Forest Service) fence specifications in pronghorn habitat include using a smooth bottom strand placed 40.6 cm (16 in) from the ground. However, the Prescott Forest has been using a modified version since the 1980s, which require that 4-strand boundary and high impact fences are constructed with a smooth bottom strand placed 50.8 cm (20 in) from the ground and that 3-strand pasture division fences are constructed with a smooth bottom strand placed 50.8-55.9 cm (20-22 in) from the ground. Doug McPhee of the USFS has observed pronghorn using these higher fences with greater ease and also found that calves were not as likely to become separated from cows when they also could go back and forth under the fences

rather than escaping through a high spot and unable to find a way back (Doug McPhee, pers. comm).

Highway and Railroad right-of-way fences may be removed in areas of low traffic volume where interference with livestock control would be reduced if areas coincided with rested pastures in deferred-pasture and rest-rotation livestock grazing schedules (Ockenfels et al. 1994, 1997). Ockenfels et al. (1994, 1997) also recommended that right-of-way fences could be modified to game standard, moved farther from the road or railroad and that the construction of overpasses over paved highways would facilitate pronghorn movements across these barriers.

All new fences in current or potential pronghorn habitat should be constructed so that the bottom strand is smooth and placed 51 cm (20 in) from the ground. Current non-game standard fences in pronghorn habitat should be retrofitted with PVC pronghorn passes until they can be modified to fit these standards.

Arizona Game and Fish Department fence construction and modification guidelines recommend construction of a 3-strand barbed wire fence, smooth top and bottom strands, maximum 106.7 cm (42 in) height, the bottom strand must be 51 cm (20 in) from the ground. Refer to the most recent *Wildlife Development Standards* published by the Arizona Game and Fish Department Development Branch for current fencing standards.

PROBLEMS ASSOCIATED WITH SMALL POPULATIONS

When populations drop to a relatively low number of individuals there are associated issues that concern conservationists, particularly if these populations are partially or entirely isolated from conspecifics. The potential problems associated with small populations are related to demographic and genetic consequences (Lande 1988). The demographic effects arise from populations becoming too small to recover from stochastic environmental events or negative effects on demographic variables. This may be manifested in an inability to find mates in a low density population, or reduced ability of the remaining females to "swamp" predators with a synchronized parturition. Genetically, populations that undergo significant population reductions are at risk for losing genetic diversity and accumulating alleles that reduce individual fitness and thereby population viability.

Evaluation of existing extinction modeling exercises for pronghorn

There has been two modeling exercises (Cancino et al. 1994, Defenders of Wildlife 1996) using a stochastic, Monte Carlo simulation model called VORTEX (Lacy 1993) to assess, in part, the minimum pronghorn population required to ensure population persistence for a period of at least 100 years. Both of these exercises focused on endangered pronghorn populations (Sonoran pronghorn – Defenders of Wildlife 1996 and Peninsular pronghorn [*A. a. peninsularis*] Cancino et al. 1994).

The approach taken with these exercises was to use existing data on several input variables where data were available and to use expert opinion for variables were data values were unknown. The utility of computer simulation modeling is that it allows estimation of the

probability of a population's extinction given a large number of interaction biological and environmental processes impossible to assess in other fashions (Lacy 1993).

VORTEX uses a variety of input parameters as it estimates extinction probabilities. These include:

- Mating system
- Average age of first reproduction
- End of breeding age
- Fawn production
- Percentage of breeding males
- Sex ratio at birth
- Mortality rates for fawns and adults
- If inbreeding depression is likely
- Initial population size
- Habitat carrying capacity
- Probability of a catastrophic event to occur

Outputs from the modeling that are useful in determining population trajectory are:

- Deterministic growth rate (a value to assess ratio of births to deaths)
- Probability of extinction
- Population size at the end of simulation period
- Time to extinction, if it occurs

In the Peninsular pronghorn simulations, the minimum initial population for model runs was 100 and the maximum was 200. Using model inputs that the panel of experts agreed was the most likely (60% fawn; 10% female; 15% male mortality rates) the probability of extinction was 0. With the same fawn mortality rate, but with 20% female and 25% male mortality, the growth rate was still positive, and the probability of extinction was only 2.8%.

When fawn mortality increased to 67.5% and adult mortality (10% female – 15% male) was low, extinction probability remained 0. However, with this fawn mortality rate and adult mortality increased to 20% female and 25% male, the consequences to populations were dire. In model simulations with these values, growth rate was negative, probability of extinction was high (0.704), and time to extinction was about 60 years for all simulations. With the highest fawn mortality values used (75%) mortality, high probability of extinction (>0.394) existed with all adult mortality values modeled.

When the initial population value was increased from 100 to 200, probability of extinction was 0 except when fawn mortality was 67.5% and adult mortality was 20% female and 25% male, when both growth rate and probability of extinction increased to unacceptable levels.

The final fawn mortality value modeled was 75%, and under all scenarios of adult mortality, growth rate was negative and probability of extinction was unacceptably high.

In Sonoran pronghorn simulations (Defenders of Wildlife 1996), the most likely scenario entailed an initial population level of 120 animals, with both fawn and adult mortality termed "medium," medium effects of inbreeding, probability of a catastrophic drought of 5%, and deterministic growth rate of 0.058, the probability of extinction was 23% in 100 years. With these same values, but with an initial population of 160, the probability of extinction declined slightly to 19%. No higher population levels were modeled.

deVos and Thompson-Olais (1996) used VORTEX to model Sonoran pronghorn populations. They defined a stabile population as one that had a positive growth rate and a probability of extinction >5%. Their approach to modeling was to use a Delphi (expert opinion) approach to determine input variables where data were lacking. After determining the most likely values for Sonoran pronghorn, they began simulations with and initial value of 25 and increased by increments of 25 until population stability was achieved. Due to the affect of stochastic events within the model, they ran 100 simulations using each value. Population stability, by their definition, was reached when the initial population was 200 (AGFD unpublished data). It is important to note that although population stability was reached at 200, simulations with an initial value of 25 were able to increase to the model defined carrying capacity under optimal conditions.

One value of VORTEX is that the importance of individual input variables can be tested. This is done by holding all variables constant and varying 1value, then testing the impact of this change on the modeling outcomes. In both the Sonoran and Peninsular pronghorn modeling, model performance was sensitive to changes in fawn survival. Another important variable is carrying capacity. In simulations where populations demonstrated a positive growth rate, populations quickly grew to the model-defined carrying capacity then leveled with small annual variation. In simulations where all populations variables were constant but carrying capacity increased, populations grew to the new carrying capacity and leveled.

Monitoring efforts for small populations should focus on determining fawn survival. In simulations where fawn survival was >40%, populations generally increased to carrying capacity. Conversely, when fawn survival was <25% populations were generally unstable. Another management action for small populations is to increase habitat carrying capacity. Population growth for many populations were limited by carrying capacity and when all population variables where held constant, and carrying capacity was increased, greater likelihood of population persistence was achieved.

Assessment of genetic consequences of small populations

Although stochastic environmental pressures usually represent a more immediate influence on big game populations, genetic variation is an important consideration for long-term conservation (Honeycutt 2000). Research on captive, domestic, and laboratory animals has documented reduced survival and reproductive performance of inbred offspring (Ralls and Ballou 1983). This has led to a concern that wild populations that are both small and isolated may also share similar detrimental effects. Pronghorn populations throughout Arizona are isolated by roads, fences, railroad right of ways and natural features such as steep walled canyons (Ockenfels et al. 1994, 1997). In addition, many populations are comprised of less than 100 individuals (AGFD,

unpublished data). This sets the stage for potential problems associated with inbreeding depression and loss of variability necessary for adapting to future environmental changes.

Molecular techniques can index the level of genetic diversity and inbreeding by evaluating the level of heterozygosity, average number of alleles per locus, and percent of loci that are polymorphic (Peles et al. 1999, Rhodes et al. 1999). For each gene in the nuclear genome, an individual inherits an allele from each parent. If both alleles are the same, the individual is said to be homozygous at that locus; if a different allele is inherited from each parent, they are heterozygous for that gene. Some alleles are harmful or fatal (deleterious), but, if recessive, they are masked by a dominant allele from the other parent. If the parents are related through common descent, the offspring will receive the same alleles from both parents for a substantial number genes. This increases the chances of inbreeding depression, whereby many offspring are homozygous for a deleterious allele that reduces their fitness (Hedrick 1995). Even if a deleterious allele only slightly reduces survival, an accumulation of such alleles can reduce population viability. Average heterozygosity has been shown to be correlated with growth and developmental rates, metabolic efficiency, fertility, survival, antler and horn size, and resistance to disease (Allendorf et al. 1986, Fitzsimmons et al. 1995, Smith et al. 2001)

The loss of alleles during a population "bottleneck" is also a serious problem related to, but different from, the reduction in heterozygosity. If a population is greatly reduced, the rare alleles occurring in lower frequency can be lost, while others increase in frequency and may become fixed in a population through genetic drift. If the bottleneck is of a short duration the less common alleles may survive, but the longer it takes for the population to recover to former population levels, the more alleles that are lost (Nei et al. 1975).

A population bottleneck is artificially induced in the case of translocations of pronghorn from one population to establish another. In this case, a relatively small number of founders are moved and these animals represent only a sampling of the genetic variation in the source population. Less-common alleles are not likely to be transferred to the new population (Fitzsimmons et al. 1997). In addition, founding individuals may be somewhat related to each other if capture methods are not random and family groups are captured together. Genetic analysis has shown that historic translocations of pronghorn in Arizona are identifiable by the genetic signature of the reestablished population (Reat 1998, Reat et al. 1999, Rhodes et al. 2001).

Several demographic variables affect the maintenance of genetic diversity. Overall population size is the most important over-riding factor, with large populations being relatively immune to pressures that reduce genomic diversity. Dispersal patterns, social breeding structure, sex ratios, and spatial partitioning of the population all have the potential to increase or decrease genetic diversity (Bleich et al. 1990).

Although the potential seems high, inbreeding depression and reduced variability appears uncommon in ungulates. One immigrant per generation is all that is needed to maintain genetic variability in a population (Avise 1994). Schwartz et al. (1986) argued effectively that inbreeding depression is unlikely for isolated bighorn sheep (*Ovis canadensis*) populations throughout California and Nevada. Peles et al. (1999) found very high levels of genetic

diversity in a mule deer (*Odocoileus hemionus*) population that had been isolated by fence for 9 years.

The genetic variation of pronghorn throughout North America has received some attention. Using protein electrophoresis, Lee et al. (1989) found that small isolated pronghorn populations in West Texas had levels of genetic variation (heterozygosity) that ranged between 0.012 to 0.046 ($\forall$ = 0.027), which is somewhat low, but within the range found in other large ungulates (Baccus et al. 1983). Lee et al. (1994) followed up their original work with a more comprehensive examination of genetic diversity and structure in pronghorn from 29 locations across North America (although Arizona was omitted). Their analysis of allozyme data again showed relatively low levels of diversity (heterozygosity = 0.024, alleles per locus = 1.15, proportion of polymorphic loci = 0.132).

Looking at the mitochondrial (mtDNA) control region, Lou (1998) reported North American pronghorn have moderate levels of genetic diversity. However, an analysis of microsatellite loci from 196 pronghorn in 14 populations throughout the West revealed some populations with heterozygosity levels below what would be expected, indicating the possibility of inbreeding in those populations (Lou 1998). The herd in Yellowstone National Park represents the largest pronghorn herd that has never been augmented from other areas (Scott 1990). This herd contains the highest levels of genetic variation, most likely because it has not experienced the degree of population bottlenecking that most other North American pronghorn herds have (Lee et al. 1994).

An analysis of regional genetic diversity in Arizona pronghorn indicates there are higher than average levels of genetic heterozygosity (ξ=0.064), numbers of alleles per locus (ξ =2.14), and proportion of polymorphic loci (ξ =0.23) than would be expected for pronghorn in other areas of North America (Rhodes et al. 1999). There are also significant shifts in allele frequencies among regional pronghorn populations in Arizona and within regional populations. Rhodes et al. (1999) reported that although there are relatively high levels of genetic variation in the Arizona pronghorn population as a whole; this variation is distributed nonrandomly throughout the state.

A similar but more detailed analysis was then conducted at the population level, rather than large geographic regions. Populations were delineated based on knowledge of isolated populations within units and also units that interchange with one another (Ockenfels et al. 1994, 1997; R. Ockenfels, AGFD, personal communication, 1999). This analysis involving both mtDNA and nDNA revealed higher genetic diversity than reported for most other North American pronghorn populations evaluated (Rhodes et al. *in prep*.).

Pronghorn throughout North America experienced a severe population decline in the late 1880s, however, they have not experienced an extreme loss of genetic variation in nDNA or mtDNA markers as has occurred in species like the Cheetah (Honeycutt 2000). This may have been because population reduction was not severe enough or that the recovery from the bottleneck was immediate, precluding the significant loss of alleles.

When assessing the conservation implications of small populations, it is important to consider both demographics and genetics (Lande 1988). Fragmentation of pronghorn habitats throughout

the state represent a serious conservation challenge to this species. These isolated and sometimes small populations are more immediately threatened by stochastic changes in population size due to environmental factors than detrimental genetic consequences of isolation. However, this is not to say all populations are immune to the negative affects of inbreeding and genetic drift. We should strive to maintain and reestablish movement corridors between populations (Bleich et al. 1990), and consider translocations of small numbers of individuals when a demographic bottleneck indicates a reduction in genetic diversity may have occurred (Hedrick 1995).

HEALTH CONCERNS FOR PRONGHORN HERDS

Although pronghorn have shown antibody titers against many bovine diseases, few infectious agents (Lance and Pojar 1984) have influenced herds. The viral hemorrhagic diseases, bluetongue (BTV) and epizootic hemorrhagic disease (EHD), have been implicated in deaths of pronghorn in Wyoming, and over 3,200 pronghorn died during a bluetongue epizootic in eastern Wyoming in 1976 (Thorne et al. 1988). In 1984, 288 pronghorn carcasses were recovered and bluetongue virus was isolated from necropsied animals, but 600 to 1,000 pronghorn were estimated to have perished from bluetongue infection during the epizootic (Thorne et al. 1988). During summer 2001, EHD was identified as the cause of death in one pronghorn necropsied at the Wyoming State Veterinary Laboratory, but EHD is suspected as the cause of death in three additional pending cases (W. Cook, personal communication), suggesting that EHD is currently active in the western United States.

Biting gnats of the genus *Culicoides* transmit both EHD and BTV to ruminants and epizootics often occur in late summer and early fall with dead animals being found near water. *Culicoides* spp. require water for breeding and development, so epizootics of hemorrhagic disease often follow periods of hot, dry weather that cause gnats and ruminants to concentrate near watering holes (Nettles and Stallknecht 1992).

Clinical signs of hemorrhagic disease include listlessness, lack of appetite, sudden death when disturbed, and little reaction to humans (Thorne 1982a,b). Bluetongue is a fast-acting virus in pronghorn; experimental infection caused death in pronghorn about 8 days after inoculation (Thorne 1982a). Hoff and Trainer (1972) infected 4 pronghorn with the bluetongue virus subcutaneously. Two pronghorn possessed antibodies against bluetongue prior to experimental infection, while the other 2 did not. The 2 individuals that had prior antibodies, did not develop clinical signs of disease, but the 2 pronghorn without antibodies prior to inoculation developed clinical signs and died 7 and 8 days later.

Throughout Arizona, pronghorn appear to be exposed to bluetongue virus periodically, but the effect of the disease on pronghorn populations is not known. Bluetongue antibody titers have been detected in pronghorn in Arizona (Heffelfinger et al. 1999), but the degree of disease resistance provided to exposed pronghorn herds is unknown. Heffelfinger et al. (1999) found that 79% of 288 hunter-killed pronghorn sampled from several sites in Arizona had antibodies against bluetongue virus. Given that hemorrhagic disease epizootics occur in late summer and early fall coinciding with the pronghorn breeding season, infection could cause behavioral or physiological changes thereby decreasing breeding success and therefore fawn recruitment.

Thorne et al. (1988) documented a fawn to doe ratio of 47:100 does one year after a bluetongue epizootic, while a ratio of 101:100 does was calculated outside the area of the epizootic.

The viral hemorrhagic diseases are the most likely agents to cause outright disease in pronghorn, but certain additional infectious organisms could influence thriftiness and reproduction in pronghorn herds. Pronghorn populations on Hart Mountain National Antelope Refuge in Oregon have shown steady decline in the 1990s, and a low fawn to doe ratio (1:100 does) has been identified as a contributing factor to the overall decline on the refuge (Dunbar et al. 1999). As part of an overall health assessment, 104 fawns, 40 adult does, and 9 adult males were evaluated for nutritional and disease status. Sera from adult females were tested for antibodies against several bovine diseases including *Brucella* sp., *Leptospira* sp., bluetongue virus, EHD virus, respiratory syncytial virus, parainfluenza virus type 3 (PI3), infectious bovine rhinotracheitis virus, and bovine viral diarrhea virus. Antibodies against PI3 were found in 67% of the animals tested, bluetongue antibodies were detected in 35% of the does, while antibodies against EHD were found in 30% of the animals. Bluetongue and EHD could dramatically influence pronghorn populations. To date, PI3 infection has not been implicated in an epizootic, but infection could increase susceptibility to other infectious agents or cause behavioral changes in affected individuals (Dunbar et al. 1999). Thorson et al. (1976) isolated PI3 from nasal swabs from 3 of 50 pronghorn sampled in Alberta, and they suggested that PI3 causes infection in pronghorn. Clinical signs of PI3 infection in pronghorn have not been identified (Lance and Pojar 1984).

Chlamydia psittaci is an intracellular bacterium that causes abortion and vesiculitis in domestic sheep (McCafferty 1990). In 1992, the Arizona Game and Fish Department captured about 40 pronghorn from 2 populations in Arizona to radiomark animals for a movement pathways project (O. Alcumbrac, personal communication). Cervical swabs and preputial washes from pronghorn were analyzed for bacterial infection and blood was taken to measure nutritional parameters, including copper and selenium in serum. *Chlamydia* sp. was identified from cervical and preputial samples in about 80 % of the individuals sampled. In addition, serum copper levels were below the adequate range for domestic livestock. Interestingly, copper deficiency predisposes domestic sheep to *Chlamydia* sp. infection. Given that *Chlamydia* sp. cause reproductive problems in domestic sheep (McCafferty 1990), copper deficiency and *Chlamydia* sp. infection could influence fawn recruitment in Arizona (O. Alcumbrac, personal communication).

Pronghorn fawns have been diagnosed with clinical bacterial infections, namely pasterellosis and salmenellosis (Lance and Pojar 1984; Dunbar et al. 1999; Dunbar et al. 2000). Dunbar et al. (2000) isolated *Pasterella* spp. from tissues from 2 necropsied pronghorn fawns in Oregon and concluded that septicemic pasterellosis was the cause of death. In addition, *Pasterella* spp. isolates were cultured from 5 additional pronghorn fawns, but carcasses were scavenged or killed by coyotes, making it difficult to determine the effect that infection had on the fawns. Therefore, it is unknown if *Pasteurella* infection predisposed fawns to predation. *Salmonella* spp. were isolated from two dead fawns from Idaho, and salmonellosis is often found in animals that are young, old, or stressed in some manner (Lance and Pojar 1984). It is possible that a low plane of nutrition predisposes fawns to secondary bacterial infection, thereby influencing fawn survival by causing illness or by causing an increased susceptibility to predation.

Disease susceptibility is influenced by the plane of nutrition in animals (see below), and several individual nutrients including iron, zinc, and selenium have been shown to increase the immune response (Kiremidjian-Schumacher and Stotzky, 1987; Robbins, 1993). As a result, the overall nutritional status of pronghorn should be considered when investigating disease agents.

To determine the potential effects of infectious agents including bluetongue and epizootic hemorrhagic disease viruses on pronghorn, health surveys should be conducted on pronghorn populations in various areas in Arizona. Given that fawns and adults suffer from very different disease problems, both young and adult animals should be evaluated when possible. Collecting blood from hunter-killed individuals will allow baseline sampling of male pronghorn for antibodies against typical bovine diseases. Pronghorn have been shown to carry antibodies against several bovine diseases, including PI3 and *Chlamydia* sp. (Lance and Pojar 1984), but the effect that these infections have on pronghorn populations is largely unknown. Blood samples for disease surveillance should be taken from all animals captured for transplants or radio-telemetry projects. Given that hemorrhagic disease has been implicated as the cause of death for mule deer in one site in Arizona during fall of 2001, pronghorn showing clinical illness should be necropsied and associated tests for hemorrhagic disease should be conducted. When possible, carcasses of pronghorn fawns need to be necropsied to determine if bacterial infections are present.

NUTRITIONAL CONCERNS FOR PRONGHORN POPULATIONS

Pronghorn, being ruminants, are able to use a vast array of forage to obtain nourishment because gastrointestinal microbes are exceedingly efficient at converting forage into usable nutrients (Wallach and Hoff 1982). The energy and protein requirements for an adult ruminant vary with reproductive cycle, and late gestation and lactation are the most energetically and protein costly periods for females (Nelson and Leege 1982). As a result, the protein and energy intake needed to provide adequate nutriment increases drastically during spring and summer. If forage is deficient in either energy or protein during the fawning period, fawns could be born weak or milk provided to fawns by females could lack adequate nutrients for proper fawn growth. Dunbar et al. (1999) measured various nutritional blood parameters in pronghorn from Hart Mountain National Antelope Refuge in Oregon where the pronghorn population had decreased 29% from 1990 to 1995. In 1995, the fawn to doe ratio dropped to 1 fawn per 100 does. The mean blood urea nitrogen levels for both adult females and fawns were significantly lower than those found for fawns and does from a healthy population in Alberta, and the authors attributed this difference to a low protein diet consumed by pronghorn in Oregon. Given the variable nature of precipitation in Arizona and that nutrient content varies in plants with season (Van Soest 1994), inadequate protein or energy content of forage during the spring and summer could contribute to poor fawn recruitment in Arizona.

Minerals are often grouped according to the amount of the mineral required by animals. Calcium, phosphorus, sodium, potassium, magnesium, chlorine, and sulfur are called macroelements because animals must consume relatively large amounts of these elements. Trace elements, such as iron, zinc, copper, molybdenum, iodine, selenium, cobalt, fluoride, and chromium are required in lower relative amounts (Robbins 1993). Pronghorn requirements for most of these elements remain unknown, but deficiencies for certain elements have been

documented. Selenium is needed to maintain tissue integrity, and deficiency leads to muscular dystrophy with degeneration of muscle fibers, reduced immune function, and reduced fertility in affected animals (Kiremidjian-Schumacher and Stotzky 1987; Robbins 1993). Selenium deficiency has been reported in pronghorn from Idaho, and the deficiency coincided with decreased fawn recruitment and clinical signs of "weak calf syndrome" in newborn fawns (Stoszek et al. 1980). The average liver selenium concentration from 55 hunter-harvested pronghorn was 0.52 ± 0.16 PPM dry weight selenium, similar to the concentrations found in cattle suffering from clinical selenium deficiency. Healthy pronghorn from Montana sampled at the same time had a mean liver selenium concentration of 1.21 ± 0.20 PPM. Dunbar et al. (1999) found that adult male pronghorn from a site with chronically low fawn recruitment had a mean liver selenium concentration of 0.11 PPM. Females had a mean liver selenium concentration of 0.13 PPM, suggesting that males and females in this population were suffering from selenium deficiency. Forage sampled from Arizona is deficient in selenium (Kubota et al. 1967; Robbins 1993; Frederick 1997), and Heffelfinger et al. (1999) measured the liver selenium concentrations from 100 pronghorn from several sites in Arizona. Statewide, 73% (73/100) of the samples were below the 0.25 PPM minimum adequate level reported for domestic goats, cattle, and sheep (Puls 1995). The average liver selenium value for pronghorn was 0.19 PPM (range = 0.01-0.81 PPM), below the suggested level for healthy animals (Heffelfinger et al. 1999).

Copper deficiency has also been documented in many free-ranging ungulates including pronghorn (Robbins 1993; Heffelfinger et al. 1999). Copper is needed for hemoglobin formation and as a component of blood proteins and enzymes in the body. Deficiency leads to reduced reproduction, hair loss, hoof deformities, anemia, and cardiovascular disorders (Robbins 1993). According to Puls (1995), 25-150 PPM copper in the liver is adequate in domestic goats and 25-100 PPM is average for domestic sheep and cattle. Heffelfinger et al. (1999) analyzed liver tissue from 100 pronghorn around the state for copper concentration and found that 97% of the pronghorn had liver copper levels below 25 PPM. The mean concentration was 8.3 PPM (range = 1.1-36.0 PPM), and pronghorn sampled from east-central Arizona had the lowest liver copper concentrations. During the same study, 99 pronghorn serum samples from Arizona were analyzed for copper concentration. The range of adequate serum copper values for domestic goats is 0.70-1.20 PPM and the range for domestic sheep is 0.70-2.0 PPM (Puls 1995). Of the 99 pronghorn samples analyzed, 82 (82.8%) were below 0.70 PPM for serum copper, with the average concentration being 0.59 PPM throughout the state (range = 0.22-1.8 PPM). Dunbar et al. (1999) investigated the causes of low fawn recruitment in Oregon and found that fawns were born with an average serum copper level of 0.28 PPM, well below the adequate level for adult ruminants.

Although data regarding mineral status and requirements for pronghorn are lacking in Arizona, it appears that pronghorn have levels of copper and selenium that are far below those seen in healthy domestic animals. Given that copper and selenium deficiencies influence reproductive capabilities of domestic ruminants, it is certainly possible that mineral deficiency plays a role in low fawn recruitment in Arizona's pronghorn populations. In addition, deficiencies of both copper and selenium have caused clinical illness in domestic animals in Arizona (Bradley et al. 1997, Frederick 1997). Baseline data regarding mineral concentration of liver and blood should be gathered from young and adult pronghorn whenever possible. Samples from males harvested during the fall hunt will be easily obtained. In addition, mineral levels in pronghorn tissues

should be compared to local fawn recruitment estimates to determine if a correlation exists. In order to obtain reference values, pronghorn liver and blood samples should be obtained from healthy pronghorn populations with no apparent fawn recruitment problems; pronghorn could be easily sampled during the fall hunt in Wyoming with the help of the Wyoming Game and Fish Department. In order to determine if female pronghorn acquire adequate protein and energy from plants during gestation and lactation, baseline protein and energy levels for forage plants should be determined during the spring and summer months.

Literature Cited

Alexander, A., and R. A. Ockenfels. 1994. Juniper densities relative to pronghorn use in central Arizona. Proceedings Pronghorn Antelope Workshop 16:76-85.

Allen, A.W., J.G. Cook and M.J. Armbruster. 1984. Habitat suitability index models: Pronghorn. USDI Fish and Wildlife Service, FWS/OBS-82/10.65. Ft. Collins, CO, USA. 22pp.

Allendorf, F. W., and R. F. Leary. 1986. Heterozygosity and fitness in natural populations of animals. Pages 57-76 *in* M. E. Soule, editor, Conservation biology: the science of scarcity and diversity. Sinaur Associates, Inc., Sunderland, MA, USA.

Anonymous. 1987. Arizona big game strategic plans 1987-91. Arizona Game and Fish Dep. Fed. Aid Wildl. Restor. Proj. FW-11-R, Phoenix, USA. 132pp.

Autenrieth, R., editor. 1978. Guidelines for the management of pronghorn antelope. Proc. Pronghorn Antelope Workshop 8:473-526.

Autenrieth, R. E. 1984. Little lost pronghorn fawn study-condition, habitat use, and mortality. Proceedings Pronghorn Antelope Workshop 11:49-70.

Autenrieth, R. E., and E. Fichter. 1982. Pronghorn fawn habitat use and vulnerability to predation. Proceedings Pronghorn Antelope Workshop 10:112-127.

Avise, J. 1994. Molecular markers, natural history, and evolution. Chapman and Hall, New York, NY, USA.

Baccus, R., N. Ryman, M. H. Smith, C. Reuterwall, and D. Cameron. 1983. Genetic variability and differentiation of large grazing mammals. Journal of Mammalogy 64:109-120.

Barrett, M. W. 1981. Environmental characteristics and functional significance of pronghorn fawn bedding sites in Alberta. Journal of Wildlife Management 45:120-131.

Beale, D. M. 1973. Use of radiotelemetry in determining causes of mortality among pronghorn antelope fawns. Proceedings Western Association State Game and Fish Commission 53:105-108.

Beale, D. M. 1974. The importance of drinking water to pronghorn antelope does and fawns on desert rangelands. Proceedings Pronghorn Antelope Workshop 6:106-108.

Beale, D. M. 1978. Birth rate and fawn mortality among pronghorn antelope in western Utah. Proceedings Pronghorn Antelope Workshop 8:445-448.

Beale, D. M. and R. C. Holmgren. 1975. Water requirements for antelope fawn survival and growth. Utah Department of Natural Resources, Division of Wildlife, Federal Aid Project W-65-D-23 Final Report, Salt Lake City, USA.

Bleich, V. C., J. D. Wehausen, and S. A. Holl. 1990. Desert-dwelling mountain sheep: Conservation implications of a naturally fragmented distribution. Conservation Biology 4:383-390.

Bodie, W. L. 1978. Pronghorn fawn mortality in the Upper Pahsimeroi River drainage of central Idaho. Proceedings Pronghorn Antelope Workshop 8:417-428.

Bradley, G., T. H. Noon, and C. Reggiardo. 1997. Diagnostic update. Arizona Veterinary Diagnostic Laboratory Newsletter, Volume 2, Issue 2. Arizona Veterinary Diagnostic Laboratory and Cooperative Extension, Tucson, USA.

Bright, J. 1999. Home ranges, habitat selection and distribution around water sources of pronghorn in northern Arizona. Master's Thesis, Northern Arizona University, Flagstaff, USA. 66pp.

Britt, T. L. 1980. Reestablishment of pronghorn antelope on the Arizona Strip. Proceedings Pronghorn Antelope Workshop 9:226-245.

Brown, D. E. 1994. Biotic communities: Southwestern United States and Northwestern Mexico. University of Utah Press, Salt Lake City, USA.

Brown, R. L. 1990. Effects of a Savory grazing method on big game. Arizona Game and Fish Department Technical Report 3, Phoenix, USA.

Bromley, P. T. 1978. Ultimate factors, behavior, and fawn recruitment. Proceedings Pronghorn Antelope Workshop 8:449-471.

Buechner, H. K. 1950. Life history, ecology, and range use of the pronghorn antelope in Trans-Pecos Texas. American Midland Naturalist 43:257-355.

Cancino, J. P. Miller, J. B. Stoopen, and K. Lewis. 1994 Evaluacion de viabilidad de la poblacion y del habitat del berrendo peninsular (*Antilocapra americana peninsularis*). Centro de Investigaciones Biologicas del Noreste, La Paz, Baja California Sur, Mexico.

Defenders of Wildlife. 1996. Population viability analysis workshop for the endangered Sonoran pronghorn (*Antilocapra americana sonoriensis* in the United States. Proceedings from a Population Viability Analysis Workshop, September 4-6, 1996. Phoenix, AZ, USA.

deVos, Jr., J. C., and L. Thompson-Olais. 1996. (Abstract only) Using the vortex model to assess minimum viable population for Sonoran pronghorn. Pronghorn Antelope Workshop Proceedings 17-108.

Dunbar, M. R., R. Velarde, M. A. Gregg, and M. Bray. 1999. Health evaluation of a pronghorn antelope population in Oregon. Journal of Wildlife Diseases 35: 496-510.

Dunbar, M. R., M. J. Wolcott, R. B. Rimler, and B. M. Berlowski. 2000. Septicemic pasteurellosis in free-ranging neonatal pronghorn in Oregon. Journal of Wildlife Diseases 36: 383-388.

Fitzsimmons, N. H., S. W. Buskirk, and M. H. Smith. 1997. Genetic changes in reintroduced Rocky Mountain bighorn sheep populations. Journal of Wildlife Management 61:863-872.

Frederick, H. 1997. Selenium deficiency. Arizona Veterinary Diagnostic Laboratory Newsletter, Volume 2, Issue 2. Arizona Veterinary Diagnostic Laboratory and Cooperative Extension, Tucson, USA.

Gay, S. M. 1984. Winter range forage availability and utilization of range forage by pronghorn (*Antilocapra americana*) near Anderson Mesa. M.S. Thesis, Northern Arizona University, Flagstaff, USA.

Goldsmith, A. E. 1990. Vigilance behavior of pronghorn in different habitats. Journal of Mammalogy 71:460-462.

Hailey, T. L. 1979. A handbook for pronghorn antelope management in Texas. Texas Parks and Wildlife Department Federal Aid Wildlife Report Series 20, Austin, USA.

Hedrick, P. W. 1995. Gene flow and genetic restoration: the Florida panther as a case study. Conservation Biology 9:996-1007.

Heffelfinger, J. R., R. J. Olding, T. H. Noon, M. R. Shupe, and D. P. Betzer. 1999. Copper/selenium levels and occurrence of bluetongue virus in Arizona pronghorn. Proceedings of the Pronghorn Antelope Workshop 18: 32-42.

Hepworth, W. G. 1965. Investigations of pronghorn antelope in Wyoming. Proceedings Pronghorn Antelope Workshop 1:1-12.

Hoff, G. L., and D. L. Trainer. 1972. Bluetongue virus in pronghorn antelope. American Journal of Veterinary research 33: 1013-1016.

Hoffmeister, D. F. 1986. Mammals of Arizona. University of Arizona Press and Arizona Game and Fish Department, Tucson, USA.

Honeycutt, R. L. 2000. Genetic applications for large mammals. Pages 233- 259 *in* S. Demarias and P. R. Krausman editors, Management and conservation of North American large mammals. Stackpole Books, Harrisburg, PA, USA.

Fox, L. M. 1997. Nutritional content of forage in Sonoran pronghorn habitat, Arizona. M. S. Thesis, University of Arizona, Tucson, USA.

Kindschy, R. C., C. Sundstrom, and J. Yoakum. 1978. Range/wildlife interrelationships-pronghorn antelope. Pronghorn Antelope Workshop Proceedings 8:216-269.

Kiremidjian-Schumacher, L., and G. Stotzky. 1987. Selenium and immune responses. Environmental Research 42: 277-303.

Kubota, J., W. H. Allaway, D. L. Carter, E. E. Cary, and V. A. Lazar. 1967. Selenium in crops in the United States in relation to selenium-responsive diseases of animals. Journal of Agricultural Food Chemistry 15: 448-453.

Lacy, R. C. 1993. VORTEX: A computer simulation model for population viability analysis. Wildlife Research. 20:45-65

Lance, W. R., and T. M. Pojar. 1984. Diseases and parasites of pronghorn: a review. Colorado Division of Wildlife Special Report Number 57.

Lande, R. 1988. Genetics and demography in biological conservation. Science 241:1455-1460.

Lee, T. E., J. W. Bickham, and M. D. Scott. 1994. Mitochondrial DNA and allozyme analysis of North American pronghorn populations. Journal of Wildlife Management 58:307-318.

Lee, T. E., Jr., J. N. Derr, J. W. Bickham, and T. L. Clark. 1989. Genetic variation in pronghorn from west Texas. Journal of Wildlife Management 53:890-896.

Lee, R. L., J. D. Yoakum, B. W. O'Gara, T. M. Pojar, and R. A. Ockenfels, editors. 1998. Pronghorn management guides. Proceedings Pronghorn Antelope Workshop 18 (Suppl.).

Lou, Y. 1998. Genetic variation of pronghorn (*Antilocapra americana*) populations in North America. Dissertation, Texas A&M University, College Station, USA.

McCafferty, M. C. 1990. Immunity to *Chlamydia psittaci* with particular reference to sheep. Veterinary Microbiology 25: 87-99.

McAtee, W. L. 1939. The electric fence in wildlife management. Journal Wildlife Management 3:1-13.

McKee, J. E. and H. W. Wolf. 1963. Water quality criteria. State Water Quality Control, Sacramento, California, USA. Publication 3-4.

Neff, D. J. 1986. Pronghorn habitat description and evaluation: a problem analysis report. Arizona Game and Fish Department Federal Aid in Wildlife Restoration Project W-78-R Final Report, Phoenix, USA.

Neff, D. J. and N. Woolsey. 1979. Effects of predation by coyotes on antelope fawn survival on Anderson Mesa. Arizona Game and Fish Department Special Report 8, Phoenix, USA.

Nei, M., T. Maruyama, and R. Chakraborty. 1975. The bottleneck effect and genetic variability in populations. Evolution 29:1-10.

Nelson, J. R., and T. A. Leege. 1982. Nutritional requirements and food habits. Pp. 323-367 *In*: Elk of North America, Ecology and Management, J. W. Thomas and D. E. Toweill (eds.). Stackpole Books, Harrisburg, PA, USA.

Nettles, V. F., and D. E. Stallknecht. 1992. History and progress in the study of hemorrhagic disease of deer. Transactions of the 57th North American Wildlife and Natural Resources Conference: 499-516.

Ockenfels, R.A. 1994. Factors affecting adult pronghorn mortality rates in central Arizona. Ariz. Game and Fish Dep. Wildlife Digest 16. Phoenix, USA.

Ockenfels, R. A. 1995. Pronghorn in the Southwest. Pages 12-15 *in* B. Kattnig and M. Scheider, editors Predator-prey population dynamics workshop. U.S. Department of Agricultural Cooperative Extension Service, University of Arizona, Tucson, and New Mexico State University, Los Cruces, USA.

Ockenfels, R. A., A. Alexander, C. L. Ticer, and W. K. Carrel. 1994. Home ranges, movement patterns, and habitat selection of pronghorn in central Arizona. Arizona Game and Fish Department, Technical Report 13, Phoenix, USA.

Ockenfels, R. A., W. K. Carrel, and C. van Riper, III. 1997. Home Ranges and movements of pronghorn in northern Arizona. Biennial Conference of research on the Colorado Plateau 3:45-61.

Ockenfels, R.A., C.L. Ticer, A. Alexander, and J.A. Wennerlund. 1996a. A landscape-level pronghorn habitat evaluation model for Arizona. Ariz. Game and Fish Dep. Tech. Rep. 19, Phoenix, USA. 50pp.

Ockenfels, R.A., C.L. Ticer, A. Alexander, J.A. Wennerlund, P.A. Hurley, and J.L. Bright. 1996b. Statewide evaluation of pronghorn habitat in Arizona. Ariz. Game and Fish Dep. Fed. Aid Wildl. Restor. Proj. W-78-R Final Rep., Phoenix, USA. 296pp.

Peles, J. D., F. W. Weathersbee, Jr., P. E. Johns, J. Griess, D. L. Baker, and M. H. Smith. 1999. Genetic variation in a recently isolated population of mule deer (*Odocoileus hemionus*). The Southwestern Naturalist 44:236-240.

Puls, R. 1995. Mineral Levels in Animal Health: Diagnostic Data. Sherpa International, British Columbia, Canada.

Ralls. K., and J. D. Ballou. 1983. Extinction: lessons from zoos. Pages 164-184 *in* C. M. Schonewald-Cox, S. M. Chambers, B. MacBryde, and L. Thomas editors, Genetic and conservation: a reference for managing wild animal and plant populations. Benjamin-Cummings, Menlo Park, CA, USA.

Reat, E. P. 1998. Use of genetic markers to determine the subspecific distribution of pronghorn in Arizona. Thesis, Purdue University, West Lafayette, IN, USA.

Reat, E. P., Rhodes, O. E., Jr., J. R. Heffelfinger, and J. C. deVos. 1999. Regional genetic differentiation in Arizona pronghorn. Proceedings of the 18th biennial Pronghorn Antelope Workshop 18:25-31.

Rhodes, O. E., Jr., E. P. Reat, J. R. Heffelfinger, and J. C. deVos. 2001. Analysis of reintroduced pronghorn populations in Arizona using Mitochondrial DNA. Proceedings of the 19th biennial Pronghorn Antelope Workshop 19:45-54.

Rhodes, O. E., Jr., E. P. Reat, J. R. Heffelfinger, and J. C. deVos. *in prep*. Analysis of genetic diversity of Arizona pronghorn populations using Mitochondrial and nuclear DNA. Journal of Wildlife Management.

Rhodes, O. E. Jr., R. N. Williams, J. R. Heffelfinger, L. K. Page, E. P. Reat, and J. C. deVos. 1999. Genetic variation in pronghorn from Arizona. Proceedings of the 18th biennial Pronghorn Antelope Workshop 18:53-63.

Robbins, C. T. 1993. Wildlife Feeding and Nutrition. Academic Press, San Diego, CA, USA.

Schwartz, O. A., V. C. Bleich, and S. A. Holl. 1986. Genetics and the conservation of mountain sheep, *Ovis canadensis nelsoni*. Biological Conservation 35-179-190.

Scott, M. D. 1990. Determining a minimum genetically viable population size for Yellowstone pronghorns. Proceedings of the 14th Biennial Pronghorn Antelope Workshop 14:26-27.

Smith, A. D. and D. M. Beale. 1980. Pronghorn antelope in Utah: some research and observations. Utah Division of Wildlife Resources Publication 80-13, Salt Lake City, USA.

Smith, M. H., J. M. Novak, J. D. Peles, and J. R. Purdue. 2001. Genetic heterogeneity of white-tailed deer: management lessons from a long-term study. Mammalian Biology 66:1-12.

Spillett, J. J., J. B. Low, and D. Sill. 1967. Livestock fences – how they influence pronghorn antelope movements. Utah State University Agricultural Experimental Station Bulletin 470. Logan, USA.

Sundstrom, C. 1968. Water consumption by pronghorn antelope and distribution related to water in Wyoming's Red Desert. Proceedings Pronghorn Antelope Workshop 3:39-47.

Stoszek, M. J., H. Wilkes, N. L. Jordan, and W. B. Walker. 1980. Natural trace mineral deficiency in native pronghorn antelope populations. Proceedings of the Pronghorn Antelope Workshop 9:71-76.

Ticer, C. L. in prep. Assessment and modification of pronghorn habitat in northwestern Arizona. Arizona Game and Fish Department Technical Guidance Bulletin No. #, Phoenix, USA.

Ticer, C. L. 1998. Pronghorn fawn bed site selection in a shortgrass prairie of central Arizona. M. S. Thesis, Arizona State University, Tempe, USA.

Ticer, C. L., S. R. Boe, R. A. Ockenfels, and J. C. deVos Jr. 1999. Factors affecting home ranges and movements of pronghorn on a shortgrass prairie of northern Arizona. Proceedings Pronghorn Antelope Workshop 18:84-90.

Ticer, C. L., J. C. deVos, Jr., and R. A. Ockenfels. in prep. Pronghorn use of modified fences in northern Arizona.

Ticer, C. L., and W. H. Miller. 1994. Bedsite selection of neonate and postneonate pronghorn fawns on desert grasslands in central Arizona. Proceedings Pronghorn Antelope Workshop 16:86-103.

Thorne, E.T. 1982a. Bluetongue. Pp. 5-9 i*n* Diseases of Wildlife in Wyoming, E. T. Thorne, N. Kingston, W. R. Jolley, and R. C. Bergstrom (eds.). Wyoming Game and Fish Department, Cheyenne, WY, USA.

Thorne, E.T. 1982b. Epizootic hemorrhagic disease. Pp. 9-10 i*n* Diseases of Wildlife in Wyoming, E. T. Thorne, N. Kingston, W. R. Jolley, and R. C. Bergstrom (eds.). Wyoming Game and Fish Department, Cheyenne, WY, USA.

Thorne, E. T., E. S. Williams, T. R. Spraker, W. Helms, and T. Segerstrom. 1988. Bluetongue in free-ranging pronghorn antelope (*Antilocapra americana*) in Wyoming: 1976 and 1984. Journal of Wildlife Diseases 24: 113-119.

Thorsen, J., L. Karstad, W. M. Barrett, and G. A. Chalmers. 1977. Viruses isolated from captive and free-ranging wild ruminants in Alberta. Journal of Wildlife Diseases 13: 74-79.

Tucker, R. D., and G. W. Garner. 1983. Habitat selection and vegetation characteristics of antelope fawn bed-sites in west Texas. Journal of Range Management 36(1):110-113.

van Riper, C., III, and R. Ockenfels. 1998. The influence of transportation corridors on the movements of pronghorn antelope over a fragmented landscape in northern Arizona. International Conference on Wildlife Ecology and Transportation (ICO WET).

Vallentine, J. F. 1989. Range development and improvements. Third Edition. Academic Press, New York, NY, USA.

Van Soest, P. J. 1994. Nutritional Ecology of the Ruminant. Cornell University Press, Ithaca, NY, USA.

Wallach, J. D. and G. L. Hoff. 1982. Nutritional diseases of mammals. Pp. 127-144 *In* Noninfectious Diseases of Wild Mammals, G. L. Hoff and J. W. Davis (eds.). The Iowa State University Press, Ames, USA.

Wallmo, C. O. 1951. Antelope range preference study. Arizona Game and Fish Commission Fort Huachuca Wildlife Area Investigation, P-46-R-2, Job 5, Phoenix, USA.

Ward, A. L., J. J. Cupal, G. A. Goodwin, and H. D. Morris. 1976. Effects of highway construction and use on big game populations. Federal Highway Administration Report FHWA-RD-76-174, Washington, D. C., USA.

Ward, A. L., N. E. Farnwalt, S. E. Henry, and R. A. Hodorff. 1980. Effects of highway operation practices and facilities on elk, mule deer, and pronghorn antelope. Federal Highway Administration Report FHWA-RD-79-143, Washington, D. C., USA.

Yoakum, J. D. 1978. Pronghorn. Pages 103-121 *in* J. L. Schimdt and D. L. Gilbert, editors Big game of North America: ecology and management. Wildlife Management Institute, Washington, D.C., and Stackpole Books, Harrisburg, Pennsylvania, USA.

Yoakum, J. D. 1979. Managing rangelands for pronghorns. Rangelands 1:146-148.

Yoakum, J. D. 1980. Habitat management guidelines for the American pronghorn antelope. U. S. Bureau of Land Management. Denver Service Center Technical Note 347. Denver, CO, USA.

Yoakum, J. D. 1990. Food habits of the pronghorn. Proceedings Pronghorn Antelope Workshop 14:102-111.