AN INVESTIGATION OF WHITE-TAILED DEER (ODOCOILEUS VIRGINIANUS COUESI) FORAGE RELATIONSHIPS IN THE CHIRICAHUA MOUNTAINS

by

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ABSTRACT

From June, 1957 until May, 1963 an investigation was made on the growth and use on two species of browse in the Chiricahua Mountains. The effects of range conditions on the health and trend of the white-tailed deer (Odocoileus virginianus couesi) herd were also studied.

Browse measurements were taken in five deer-cattle study areas. Each area was composed of a fenced plot which kept cattle out but allowed free access to deer and a control plot which was open to both deer and cattle use.

Competition between deer and cattle for forage was not a serious problem. Browse use by cattle was not significant except in the lower elevations where cattle were more abundant.

Year-around deer use was found on important winter browse plants. During the 1950's severe over-use by deer caused permanent damage to these browse species and greatly reduced the carrying capacity of the range. The effects of over-use were observed in poorly developed antler growth on yearling bucks, the presence of undesirable plant species in stomach contents of deer, a low productivity in the deer herd, and a decline in the deer population from about 1955 to 1962.

This study was financed by the Arizona Cooperative Wildlife Research Unit and The Arizona Game and Fish Department under Pittman-Robertson Project W-78-R (1-8), Work Plan 5, Job 6. The Cooperative Wildlife Research Unit is maintained by the following organizations: The University of Arizona, The Arizona Game and Fish Department, The U. S. Fish and Wildlife Service, and The Wildlife Management Institute.

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CHAPTER I.

INTRODUCTION

The white-tailed deer (Odocoileus virginianus couesi) populations in Arizona are located primarily in the southeastern mountains of the state. These mountain ranges are managed for both deer and livestock. Proper range use must be maintained or these animals can easily deplete or destroy the habitat necessary for their own growth, reproduction, and survival.

To properly manage our big game herds, it is necessary to have a thorough knowledge of the plant community. This includes a basic understanding of what plants exist on our deer ranges; how they are affected by changes in annual rainfall and other factors of weather; how they are affected by use from both game animals and domestic livestock and lastly how we can maintain the proper combination of plants to avoid static non-productive situations.

There is little published information on the production of browse forage and its use by white-tailed deer and cattle in Arizona. Nichol (1938) conducted a pen-feeding experiment of white-tailed deer in southern Arizona. He tested and rated the palatability of native

plants and determined the average daily consumption of air-dried forage for white-tailed deer.

More recently, White (1957) evaluated white-tailed deer habitats in southern Arizona. White made feeding-minute studies in three areas, one being Barfoot Park in the Chiricahua Mountains. He concluded that an over-population of deer was indicated in the Chiricahua Mountains during the period of his study.

The Chiricahua Mountains have been a controversial area ever since 1955 when the first antlerless white-tailed deer hunt took place in this mountain range. Local sportsmen's organizations bitterly opposed this hunt and subsequent hunts, even though this type of harvest was common practice on mule deer in northern Arizona. Those sportsmen who actually hunted in the Chiricahuas were aware of high deer numbers, but they did not realize that browse plants were being over-used, especially by deer. Many people wanted to blame the cattle for the reported damage, while others were convinced that hedged and high-lined plants normally grew in such shapes, and some were positive no problem even existed.

In 1956 a study on white-tailed deer forage relationships in the Chiricahua Mountains was formulated under the participation of the Cooperative Wildlife Unit of the University of Arizona and the Arizona Game and Fish Department. The objectives of this study were as

follows: (1) to determine the extent of the use of important browse by deer and cattle in the vicinity of exclosures, (2) to determine the amount of forage produced by the important browse plants, (3) to determine the plant composition and density within and adjacent to deer and cattle exclosures, (4) to determine deer diet and condition in the vicinity of the exclosures, (5) to determine the population trend of the white-tailed deer herds in the vicinity of the exclosures.

Field work to evaluate this problem commenced in June, 1957 and continued until May, 1963. Field work was financed under Pittman-Robertson Project W-78-R (1-8), Work Plan 5, Job 6.

Study Area

The Chiricahua Mountains are located in the southeastern corner of Arizona near the New Mexico border. The range extends north and south for approximately 40 miles and is 15 to 20 miles wide. Elevations range from 4773 feet at Portal on the east side to 9795 feet on Chiricahua Peak. Most of the mountain lies within the boundaries of the Coronado National Forest which is under the jurisdiction of the U. S. Forest Service.

One access road extends through the northern half of the mountain from the Chiricahua National Monument and Pinery Canyon on the west side over Onion Saddle (7750') to Paradise and Portal on the east

side. At Onion Saddle a road continues south for about five miles to Barfoot Park (7900') and Rustler Park (8500'). High peaks to the south are accessible only by trails which are maintained for fire control. Numerous short roads extend into all major drainages.

The Chiricahuas are composed of four major vegetation types. These are conifer, oak woodland, chaparral and mountain browse, and grassland (Darrow, 1944).

The conifer forest is separated into two divisions. These are the spruce-fir (Picea Engelmanni-Abies concolor)[1] and yellow pine-Douglas fir (Pinus ponderosa-Pseudotsuga taxifolia). Gambel oak (Quercus Gambelii), deer-brier (Ceanothus Fendleri), and numerous grasses are also abundant in this type.

Oak woodland and chaparral types are mostly interspersed. This vegetation belt is dominated by evergreen oaks (Q. arizonica, Q. Emoryi and Q. hypoleucoides), juniper (Juniperus Deppeana), both Chihuahua (P. Chihuahuana) and pinyon pine (P. cembroides), and several important deer browse plants which include mountain mahogany (Cercocarpus breviflorus), silk-tassel (Garrya Wrightii), and Gregg ceanothus (Ceanothus Greggii).

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[1]Scientific names in this thesis are from Arizona Flora, T. H. Kearney and R. H. Peebles, University of California Press, 1951.

The grassland type occurs in the foothills and also extends into the oak woodland. Grama grasses (Bouteloua spp.) dominate this vegetation type. Yucca (Yucca elata), creosote bush (Larrea tridentata), and mesquite (Prosopis juliflora) are abundant throughout the grassland type.

White-tailed deer inhabit all vegetation types in the mountain. The greatest density is found between 5300 and 7000 feet elevation in oak-woodland, chaparral, and mountain browse types.

Climatic conditions in the Chiricahuas are characterized by extreme wet and dry periods. Precipitation occurs primarily during the summer months of July and August and mid-winter months of December, January, February, and March.

Summer precipitation according to Sellers (1960) is usually produced when deep layers of moist unstable air from the Gulf of Mexico flow up the Sulphur Springs Valley and down the San Simon Valley and pass over the Chiricahua Mountains. Winter rainfall develops from the Pacific Ocean, but these storms do not always extend far enough south to affect the Chiricahuas.

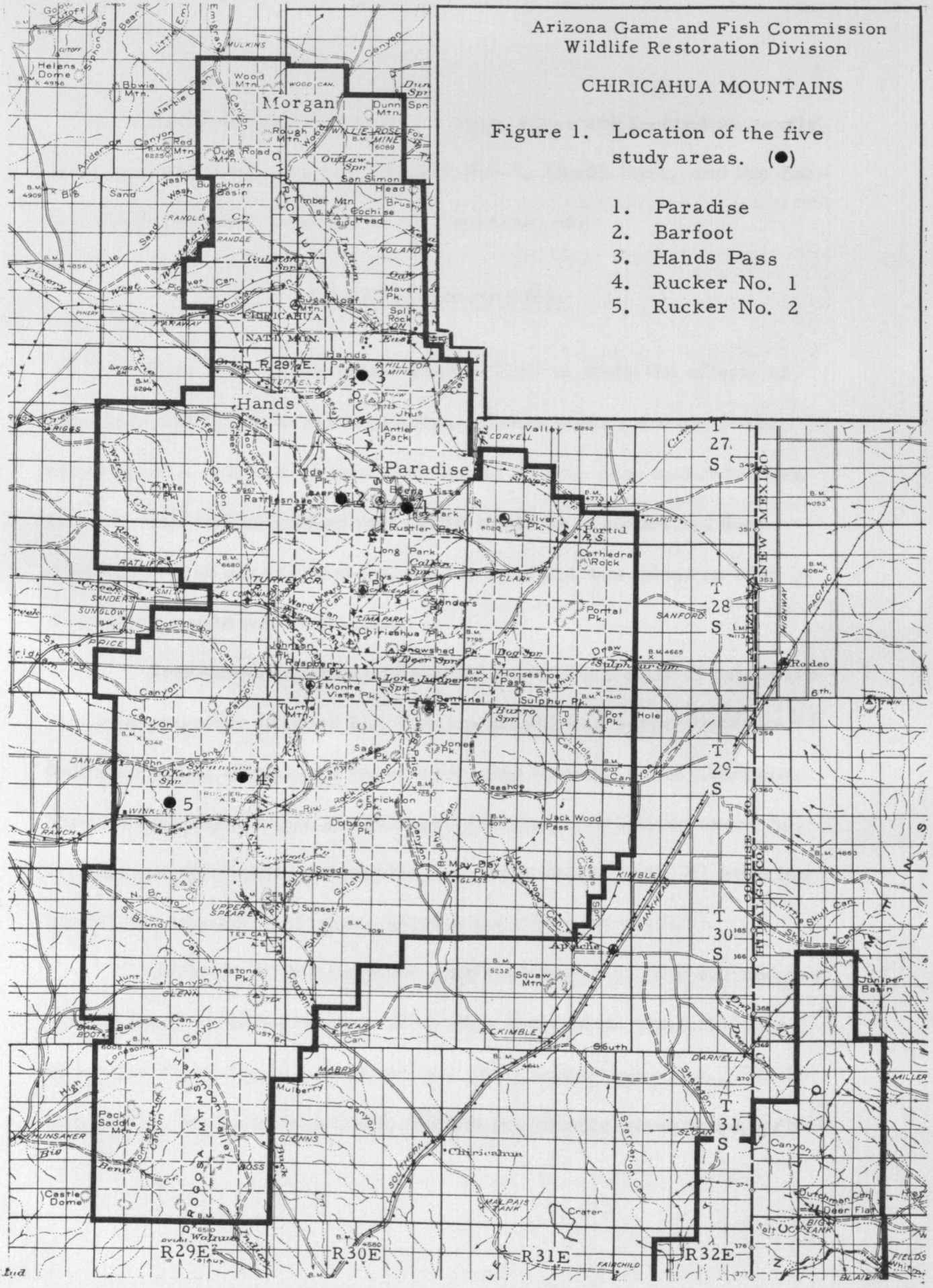
CHAPTER II.

DEER-CATTLE STUDY AREAS

Five individual study areas were selected in the Chiricahua Mountains for specific studies of the vegetation. The study project, however, was not limited entirely to these areas. Study areas were picked on a basis of accessibility, browse abundance, and the presence of white-tailed deer and livestock. Special-use permits were granted by the U. S. Forest Service for each area when sites were approved by the livestock permittee and district Forest Ranger. Study areas were named after well-known landmarks in the vicinity of each area. Figure 1 shows the location of the five study areas.

Grazing Allotments

Each study area is located on a different livestock grazing allotment which is controlled by the U. S. Forest Service. Stocking rates on allotments follow standards set by the Forest Service, and they have not been changed for many years in this area. There are both seasonal and yearly use allotments. Seasonal use varies from five to eight months depending on allotment size and number of livestock units.


Arizona Game and Fish Commission
Wildlife Restoration Division
CHIRICAHUA MOUNTAINS
Figure 1. Location of the five study areas. (●)
1. Paradise
2. Barfoot
3. Hands Pass
4. Rucker No. 1
5. Rucker No. 2
Morgan
Hands
Paradise
Rodeo
Apache
Chiricahua
R29E
R30E
R31E
R32E
T 27 S
T 28 S
T 29 S
T 30 S
T 31 S
NEW MEXICO

Paradise and Rucker No. 1 study areas are located on yearly grazing allotments; whereas, Rucker No. 2, Hands Pass, and the Barfoot study plots are on areas of only seasonal use.

Exclosure Construction

Four areas were established in 1957 to study the effects of both deer and cattle on the vegetation. These plots were about six acres in size with half of each plot fenced to keep deer and cattle out and the other half fenced so that cattle would be excluded but deer would have free access to the plots. A fifth plot was added in 1959 where only cattle were excluded.

Deer-proof fences consisted of two 48 inch rolls of page wire connected together (Figure 2). The top strand was suspended from 12 foot steel poles which were inserted in pipe footings set in concrete. Pipe footings were three and one-half feet deep and spaced every 50 feet around the rectangular exclosure. Pipe stays (3/4"-7') were inserted between the main pipe supports for added strength.

Cattle-proof fences were constructed so that they utilized one side of the deer-proof fences. The other three sides consisted of a four-wire cattle fence with seven foot steel supporting posts. The bottom and top wires were smooth, but the two middle wires were barbed.

Paradise Study Area

This study area is located on the east side of the mountain two miles from the town of Paradise. It is situated on an eastern exposure at about 7000 feet and on a 24 percent slope. The top soil is relatively shallow and consists primarily of decomposed rhyolite and shale.

The total fenced area is 6.2 acres in size. About one-half of this area is fenced to exclude deer and cattle, and it will be referred to in this thesis as the total plot. The other half excludes cattle only and will be referred to as the deer plot. Adjacent to the cattle plot, an area accessible to both deer and cattle was established for comparative study, and it will be referred to as the control plot.

Line Intercept Method

In range studies it is important to know the density and composition of trees, shrubs, forbs, and grasses in each study area. Valuable data will be obtained from future readings to determine vegetation changes in protected and unprotected plots.

In the intercept method all plants were measured that intercepted a steel tape (Canfield, 1950). Grasses were measured at ground level, and data obtained included only the basal growth interception. Forbs were measured by three methods. Stem diameter was measured on single stemmed forbs; rosette or ground creeping forbs were

measured on basal interception; and large spreading forbs were measured by crown spread. Over-story vegetation was measured by vertical projection of the crown spread.

Permanent intercept transects were established in each fenced exclosure and adjacent control plots. Parallel transects were spaced at various intervals depending on terrain and size of exclosures. Transects were marked at the beginning and end by a 36 inch painted witness stake with affixed numbered metal tags. Starting stakes were 24 inches long with a wire loop fastened at the top. These stakes were driven almost flush with the ground, and they were spaced at 50-foot intervals. A Lufkin steel tape 100 feet long and marked in tenths of a foot was used for measuring. A two-inch wire hook was attached to the tape loop which easily hooked on to the starting stakes.

Transects were 200 feet long, and were divided into four lines of 50 feet each. One exception was the Paradise control plot which had two lines of 50 feet per transect. This was done to avoid running into another vegetation type. Vegetation readings more than 50 feet were not possible on the steep brushy hillsides. Even with 50-foot transects it was difficult to align the tape in a straight line on the ground.

Paradise was the first study area established, and five transect lines were arranged in the total plot, and ten in the deer plot and control plot. Transect lines were reduced to five in the other four

areas, because ten lines were too close together, and over-story plants were included on more than one transect line.

Findings on Plant Composition

Line intercept transects at Paradise were established and read in August, 1957. Table 1 lists the plants and density found in the three plots. In the deer plot the amount of plant interception was along 2000 feet of transect. This was reduced to 1000 feet in Table 1 to be comparable with the coverage in the total plot and control plot.

Eleven different species of grass were identified. Side oats grama (B. curtipendula) was the dominant grass in each plot. Approximately 40 percent of the deer plot's grass cover was side oats grama. Figure 3 illustrates the excellent stand of grasses at this study site.

Agave (Agave Palmeri), yucca, and bear grass (Nolina microcarpa) comprised over 70 percent of other understory plants.

Forbs were difficult to identify, especially those that were not completely developed. Unidentified species were lumped as unknown forbs. The most common forbs measured were those in the genera Euphorbia and Verbena and one sage (Salvia Lemmoni).

Overstory vegetation was primarily juniper, pinyon pine, Arizona oak, and Emory oak. Of the important browse species, mountain mahogany was the most abundant.

Table 1. Amount of plant interception along 1000 feet of transect in each plot at the Paradise study area in August, 1957. *

Vegetation	Line Intercept Coverage in Feet		
	Deer Plot	Total Plot	Control Plot
Grasses			
Andropogon cirratus	1.6	1.1	1.6
Aristida Orcuttiana	0.2	1.9	1.6
Bouteloua curtipendula	10.1	3.0	5.3
Bouteloua hirsuta	0.2	0.0	0.0
Eragrostis intermedia	0.3	0.2	0.0
Lycurus phleoides	0.6	0.8	1.1
Muhlenbergia Emersleyi	0.0	0.9	0.0
Muhlenbergia longiligula	2.0	1.4	3.5
Muhlenbergia rigida	0.3	0.0	0.0
Panicum Hallii	0.6	0.0	0.0
Piptochaetium fimbriatum	1.0	0.4	1.3
Total	26.9	9.7	14.4
Forbs and Other Understory			
Agave Palmeri	3.6	8.2	16.3
Artemisia pacifica	0.0	0.3	0.0
Bahia dissecta	0.0	0.5	0.0
Bouvardia glaberrima	1.0	1.1	0.0
Echinocereus sp.	0.0	0.0	0.2
Eriogonum Wrightii	2.1	1.0	0.5
Euphorbia sp.	1.2	0.1	3.0
Eupatorium sp.	0.0	2.8	0.0
Mimosa sp.	0.5	0.9	0.1
Nolina microcarpa	38.0	28.6	9.6
Opuntia Englemannii	1.9	3.2	0.0
Polygala obscura	0.2	0.2	0.2
Salvia Lemmoni	0.2	0.3	0.2
Sanvitalia Aberti	0.0	0.0	0.1
Selloa glutinosa	0.7	0.4	0.0
Senecio longilobus	0.5	0.0	0.0
Trichostema arizonicum	0.1	6.4	0.5

Table 1. (Continued)

Vegetation	Line Intercept Coverage in Feet		
	Deer Plot	Total Plot	Control Plot
Verbena sp.	2.8	0.1	7.2
Yucca sp.	10.3	12.8	16.8
Unknown ferns	0.2	0.2	0.0
Unknown forbs	2.4	3.4	4.3
Unknown mushrooms	0.1	0.0	0.0
Total	65.8	70.5	59.0
Trees and Shrubs			
Cercocarpus breviflorus	41.3	67.5	58.5
Garrya Wrightii	0.6	0.4	5.8
Juniperus Deppeana	55.8	62.0	113.7
Pinus cembroides	125.6	92.6	258.7
Quercus arizonica	94.1	80.0	152.2
Quercus Emoryi	40.2	81.5	0.0
Quercus hypoleucoides	0.0	9.0	0.0
Rhus trilobata	1.0	0.0	0.0
Total	358.6	393.0	588.9

*Both overstory and understory plants overlapped along transects; consequently, the total of the three plant divisions will not equal the total transect coverage.

Figure 2. Deer-proof fence plot at Paradise study area. Page wire is suspended between steel posts 50 feet apart. April, 1958.

Figure 3. Excellent stand of side oats grama in the deer plot of the Paradise study area. April, 1958.

Barfoot Study Area

Barfoot is located on a southern exposure one-half mile east of Barfoot Camp Ground at about 7900 feet. The top soil is moderately deep. Rhyolite outcroppings rise almost 1000 feet above the study area on the north and east sides. Small fractured pieces of rhyolite form small rock slides in the deer plot.

Findings on Plant Composition

Table 2 lists the plant species and density recorded on vegetation transects completed in September, 1957.

Six genera of grasses were identified at Barfoot. The most abundant genus was Muhlenbergia. This genus involved more than one species, but accurate identifications were not made because seed heads were unavailable when measured.

Of the forbs, false-tarragon (Artemisia dracunculoides) had the greatest density. In the total plot these plants were so thick that foot travel was difficult. Other major forbs included fleabane (Erigeron Schiedeanus), mullein (Verbascum Thapsus), lupine (Lupinus sp.), and a grounsel (Senecio Macdougalii).

Barfoot was completely burned over in 1953; consequently, overstory plants were relatively new and not completely established. Silverleaf oak and Arizona oak were the most abundant trees and were present in dense patches. Young ponderosa pines were numerous in

Table 2. Amount of plant interception along 1000 feet of transect in each plot at Barfoot study area in September, 1957.

Vegetation	Line Intercept Coverage in Feet		
	Deer Plot	Total Plot	Control Plot
Grasses			
Bromus ciliatus	0.7	0.0	0.2
Blepharoneuron tricholepis	0.0	0.4	0.0
Eragrostis sp.	0.1	0.0	0.0
Koeleria cristata	0.0	0.6	0.0
Muhlenbergia spp.	18.4	5.8	16.9
Panicum bulbosum	0.4	0.0	0.0
Total	19.6	6.8	17.1
Forbs and Other Understory			
Achillea lanulosa	0.2	0.4	0.4
Agave Parryi	1.0	0.0	0.0
Anthericum Torreyi	0.1	0.0	0.0
Artemisia dracunculoides	152.7	119.7	63.3
Brickellia sp.	2.3	0.0	0.0
Cacalia decomposita	0.0	1.8	0.2
Chenopodium sp.	1.0	0.0	0.0
Cirsium sp.	8.5	1.8	1.1
Cyperus sp.	0.4	0.0	0.0
Commelina dianthifolia	0.0	0.0	0.1
Delphinium andesicola	0.0	1.0	1.1
Erigeron Schiedeanus	16.8	5.7	1.2
Galium asperrimum	0.8	2.4	1.9
Gnaphalium Pringlei	1.6	1.6	0.0
Hedeoma hyssopifolium	1.8	0.0	0.0
Heliopsis parvifolia	1.9	0.0	6.5
Ipomoea costellata	0.0	0.2	0.0
Lupinus sp.	4.9	4.5	3.4
Oenothera sp.	0.0	0.4	0.5
Pteridium aquilinum	0.0	0.0	4.5
Salvia Lemmoni	3.0	0.0	0.0
Senecio Macdougalii	12.0	9.0	1.7
Silene laciniata	0.2	0.0	0.0

Table 2. (Continued)

Vegetation	Line Intercept Coverage in Feet		
	Deer Plot	Total Plot	Control Plot
Stevia serrata	3.4	5.2	2.8
Verbascum Thapsus	12.4	4.7	0.2
Verbena sp.	5.0	2.2	1.8
Verbesina longifolia	1.7	1.6	1.1
Yucca sp.	0.8	0.0	0.0
Unknown forbs	7.7	6.9	4.1
Total	240.2	169.1	95.9
Trees and Shrubs			
Ceanothus Fendleri	38.2	34.4	7.6
Juniperus sp.	0.0	1.4	0.0
Pinus ponderosa	0.0	55.1	18.5
Quercus arizonica	81.4	13.1	66.5
Quercus hypoleucoides	84.9	188.0	276.4
Total	204.5	292.0	369.0

the total plot but were beginning to invade the control and deer plots. Deer-brier was the only shrub species measured, and it was found in low thickets throughout the study area.

Hands Pass Study Area

Hands Pass is located on a western exposure near the eastern boundary of the Chiricahua National Monument at about 7000 feet elevation. Fenced plots are located on a 25 percent slope on a limestone ridge. The soil is shallow at this site and is restricted mostly to crevices, depressions, and washes.

Findings on Plant Composition

Line intercept transects were established in August, 1958. Data from these transects are presented in Table 3.

Total grass density at the Hands Pass area was the highest measured on any study area. Side oats grama was the dominant species and made up over 50 percent of the grass cover.

Sunflower (Helianthus petiolarius) had the highest forb coverage. In the control plot it was the most abundant species. Other dominant understory vegetation included agave, yucca, beargrass, and prickly-pear (Opuntia Englemannii).

Five over-story species were measured on line transects. They included mountain mahogany, silk-tassel, juniper, pinyon pine,

Table 3. Amount of plant interception along 1000 feet of transect in each plot at the Hands Pass study area in August, 1958.

Vegetation	Line Intercept Coverage in Feet		
	Deer Plot	Total Plot	Control Plot
Grasses			
Andropogon cirratus	0.0	0.2	0.2
Aristida sp.	7.6	2.7	0.0
Bouteloua curtipendula	21.8	14.4	17.2
Eragrostis intermedia	0.2	0.0	1.0
Hilaria Belangeri	1.4	0.0	0.0
Leptochloa dubia	0.8	1.4	0.4
Lycurus phleoides	1.4	0.8	3.4
Muhlenbergia longiligula	1.1	5.0	2.2
Muhlenbergia monticola	0.0	0.0	6.1
Poa sp.	0.0	0.0	0.1
Sitanion Hystrix	1.5	0.6	0.6
Stipa Lettermani	0.0	0.0	0.8
Unknown grasses	1.3	0.8	0.3
Total	37.1	25.9	32.3
Forbs and Other Understory			
Agave Palmeri	44.7	25.1	14.9
Aplopappas sp.	4.0	2.0	0.0
Artemisia sp.	0.4	0.4	0.1
Aster sp.	0.0	0.0	1.1
Commelina dianthifolia	0.0	0.0	0.2
Dasylirion Wheeleri	6.6	17.1	9.7
Echinocereus sp.	0.8	0.9	1.2
Eriogonum sp.	0.0	0.0	0.9
Helianthus petiolarius	10.0	12.6	101.8
Ipomoea sp.	0.0	0.0	0.2
Mentha sp.	5.2	1.4	0.0
Mirabilis longiflora	0.0	0.0	3.0
Nolina microcarpa	14.8	50.0	0.0
Opuntia Englemannii	25.2	3.4	14.0
Salvia Lemmoni	0.0	0.0	12.8
Selloa glutinosa	0.0	0.1	2.0

Table 3. (Continued)

Vegetation	Line Intercept Coverage in Feet		
	Deer Plot	Total Plot	Control Plot
Senecio longilobus	0.0	0.4	0.0
Sphaeralcea sp.	0.1	0.0	0.6
Tradescantia pinetorum	0.0	0.0	0.4
Verbena gracilis	1.3	0.0	2.6
Yucca sp.	15.5	20.2	28.8
Unknown ferns	0.1	0.7	0.0
Unknown forbs	0.3	1.0	2.2
Total	129.0	135.3	196.5
Trees and Shrubs			
Cercocarpus breviflorus	165.6	198.4	247.8
Garrya Wrightii	0.0	21.5	0.5
Juniperus Deppeana	37.1	26.7	9.0
Pinus cembroides	6.0	0.0	0.0
Quercus arizonica	0.0	69.1	0.0
Total	208.7	315.7	257.3

and Arizona oak. Mountain mahogany had the highest density, and Hands Pass was the only study area where an important browse plant dominated over-story vegetation. Figure 4 illustrates the dense mountain mahogany cover at Hands Pass.

Rucker No. 1 Study Area

Rucker No. 1 is located one-half mile north of the Rucker Ranger Station on a west facing slope at an elevation of almost 6200 feet. Fenced plots are on a slope of about 22 percent. This site has shallow soil with numerous conglomerate outcroppings in each plot.

Findings on Plant Composition

The density and composition of plants measured and identified are listed in Table 4.

Seventeen species of grass were measured on transects. This was the highest number identified in the study areas. Side oats grama and bull grass (M. Emersleyi) produced the greatest ground coverage.

Golden-eye (Viguiera sp.) and mint (Mentha sp.) were the dominant forbs. Bear grass, yucca, and sotol (Dasylirion Wheeleri) were also abundant ground cover species.

Over-story vegetation was dominated by evergreen shrubs. Sumac (Rhus choriophylla), mountain mahogany, and silk-tassel were

Table 4. Amount of plant interception along 1000 feet of transect in each plot at the Rucker No. 1 study area in September, 1958.

Vegetation	Line Intercept Coverage in Feet		
	Deer Plot	Total Plot	Control Plot
Grasses			
Andropogon barbinodis	0.8	0.0	1.4
Andropogon cirratus	1.4	0.0	2.5
Aristida Orcuttiana	1.4	0.2	1.5
Bouteloua curtipendula	9.6	19.6	6.6
Bouteloua hirsuta	0.2	0.0	1.1
Eragrostis intermedia	0.2	0.0	0.7
Heteropogon contortus	0.3	0.0	1.1
Leptochloa dubia	2.1	2.5	0.6
Lycurus phleoides	0.0	0.2	0.0
Muhlenbergia Emersleyi	4.1	3.0	7.3
Muhlenbergia longiligula	0.0	0.0	2.5
Panicum bulbosum	0.0	0.0	0.3
Panicum Hallii	1.7	1.6	0.2
Piptochaetium fimbriatum	1.7	1.1	0.0
Setaria sp.	0.1	1.2	0.2
Sitanion Hystrix	0.0	0.1	0.0
Trichachne californica	0.0	0.0	1.0
Total	23.6	29.5	27.0
Forbs and Other Understory			
Agave Palmeri	0.0	2.9	1.6
Bouvardia glaberrima	0.0	0.0	1.8
Brickellia californica	2.8	0.0	0.0
Commelina dianthifolia	0.3	0.7	0.4
Dasylirion Wheeleri	4.7	9.9	3.2
Erysimum capitatum	0.4	0.0	0.0
Eupatorium herbaceum	0.0	0.0	0.5
Hoffmanseggia sp.	0.4	0.0	0.0
Ipomoea sp.	2.8	1.2	0.1
Mentha sp.	7.4	10.6	1.3
Mirabilis longiflora	5.7	1.8	0.0
Nolina microcarpa	53.0	9.3	123.4

Table 4. (Continued)

Vegetation	Line Intercept Coverage in Feet		
	Deer Plot	Total Plot	Control Plot
Opuntia sp.	0.0	0.3	4.3
Sanvitalia Aberti	0.7	0.0	1.6
Selloa glutinosa	0.0	0.0	0.4
Senecio longilobus	0.0	0.0	0.1
Sphaeralcea sp.	0.1	0.0	0.4
Trichostoma arizonicum	0.4	0.0	0.0
Verbena gracilis	4.6	0.0	1.6
Verbesina longofolia	1.0	7.1	7.6
Viguiera sp.	9.1	17.5	49.2
Yucca sp.	12.8	16.6	6.6
Unknown ferns	0.2	0.6	0.0
Unknown forbs	5.8	10.8	7.1
Total	112.2	89.3	211.2
Trees and Shrubs			
Ceanothus Greggii	1.7	0.0	0.0
Cercocarpus breviflorus	96.1	82.8	90.1
Garrya Wrightii	156.8	49.4	17.0
Juniperus Deppeana	66.9	14.0	22.0
Pinus cembroides	10.5	23.7	17.8
Quercus arizonica	55.4	0.0	110.9
Rhus choriophylla	139.4	136.0	38.8
Total	526.8	305.9	296.6

the dominant shrubs. Juniper, pinyon pine, and Arizona oak were the important trees at this site.

Rucker No. 2 Study Area

Rucker No. 2 is located two miles north of Rucker No. 1 on a north facing exposure at an elevation of about 6200 feet. Soil depth is moderate, and rhyolite outcroppings are scattered throughout the site.

Findings on Plant Composition

Transects were established in August, 1959. Data from these transects are given in Table 5.

Total grass density was similar in each plot. Side oats grama and blue grama (B. gracilis) were the dominant species.

Morning glory (Ipomoea sp.) was the dominant forb species. Extensive areas were covered by this plant, and many forbs and grasses were completely entwined.

Mountain mahogany, Arizona oak, Emory oak, and Apache plume (Fallugia paradoxa) were the only over-story plants measured.

Table 5. Amount of plant interception along 1000 feet of transect in each plot at the Rucker No. 2 study area in August, 1959.

Vegetation	Line Intercept Coverage in Feet	
	Deer Plot	Control Plot
Grasses		
Andropogon cirratus	1.5	2.1
Aristida Orcuttiana	0.0	1.2
Bouteloua curtipendula	10.8	7.4
Bouteloua gracilis	5.0	9.4
Bouteloua radicosa	2.0	1.8
Bromus sp.	0.0	0.1
Eragrostis intermedia	0.0	0.2
Lycurus phleoides	2.4	0.8
Muhlenbergia Emersleyi	1.8	0.2
Muhlenbergia monticola	1.1	0.2
Setaria lutescens	0.0	4.3
Sitanion Hystrix	0.0	0.1
Unknown grasses	0.5	0.0
Total	25.1	27.8
Forbs and Other Understory		
Aplopappus sp.	0.0	0.4
Artemisia pacifica	9.2	3.4
Boerhaavia purpurascens	0.0	4.1
Bouvardia glaberrima	0.0	3.4
Brickellia californica	30.4	35.8
Chenopodium sp.	0.0	1.7
Cyperus sp.	0.2	0.0
Eriogonum Wrightii	0.0	1.3
Gnaphalium sp.	0.0	0.1
Ipomoea sp.	203.3	276.8
Mammillaria sp.	0.0	0.5
Mirabilis longiflora	0.0	1.0
Nolina microcarpa	22.3	45.5
Opuntia sp.	6.0	10.4
Pectis filipes	0.0	1.4
Portulaca coronata	0.1	1.0

Table 5. (Continued)

Vegetation	Line Intercept Coverage in Feet	
	Deer Plot	Control Plot
Sanvitalia aberti	0.2	0.0
Tribulus terrestris	0.0	0.4
Yucca sp.	14.8	13.8
Unknown ferns	0.1	0.8
Unknown forbs	18.2	39.1
Total	33.1	53.7
Trees and Shrubs		
Cercocarpus breviflorus	69.4	54.3
Fallugia paradoxa	5.3	0.0
Quercus arizonica	35.8	53.4
Quercus Emoryi	41.0	11.7
Total	151.5	119.4

CHAPTER III.

BROWSE PRODUCTION AND UTILIZATION

Knowledge of range forage conditions is of major importance in livestock and big game management. The survival of our big game herds and the production of healthy animals are largely dependent upon the quantity and quality of the forage produced. Failure to keep the herds within the carrying capacity of the range will result in permanent damage to the vegetation upon which the animals must depend. The necessary information to avoid this can be obtained by measuring the growth and use of key browse plants.

Measuring Techniques

One key browse species was selected in each study area for measurements of growth and use. Enough browse plants were present in all plots to give adequate measurements. Mountain mahogany was the key plant at Paradise, Hands Pass, Rucker No. 1, and Rucker No. 2 study areas. At Barfoot the key plant was deer-brier.

Dasmann (1951) describes the visual estimate and twig measurement method for determining use of browse plants. The visual method is an estimate of the total annual growth of the plant that has

been eaten. In the twig measurement method, measurements on marked twigs are made after growth is completed and before new growth begins to be used.

The twig measurement method was used on this study because it was considered the most reliable for determining browse use.

Browse plants for growth and use measurements were selected from 200 foot-line-intercept-transects already established in study areas. The nearest mountain mahogany to each 50-foot stake was selected if it contained eight or more twigs of current growth one-half inch or longer, and growth was no more than four feet from the ground. Five plants were marked on each transect and 25 in each deer plot and control plot.

Deer-brier was selected by two methods. In 1958 the nearest plant to the transect stake was marked, but from 1959 to 1963 the largest plant within 20 feet was marked.

Red, yellow, blue, and green plastic quail and pigeon leg bands were used as markers for locating and identifying individual twigs (Figure 5). Four consecutively numbered bands were attached to branches of each plant. Whenever possible tagged branches were spaced on north, east, south, and west sides at various heights but within four feet. Twig production above four feet was considered largely unavailable to white-tailed deer.

Figure 4. Fence line at Hands Pass study area. Mountain mahogany is the dominant plant. Juniper and oak are present in the washes.

Figure 5. Numbered quail band attached to mountain mahogany branch. Thumb points to one utilized twig. February, 1958.

Eight twigs, two at each plastic band, were randomly picked on each plant for measurements. Twigs were marked with an oil base paint which was applied by a glass eye dropper. Red, orange, and green paints were used, but a different color designated each year. Paint rings were applied to growth scars on mountain mahogany to identify and properly measure the twigs. No distinct growth scars were found on deer-brier, but paint was applied where new growth appeared to originate. This was determined by twig color, new thorns, and leaf growth.

Twigs were measured with an engineer's tape marked in tenths and hundredths of a foot. Measurements were made to the nearest hundredth from paint marks to terminal buds.

Growth rate and period of growth on mountain mahogany and deer-brier were measured in each deer plot, total plot, and control plot. After the first two years the total plot measurements were discontinued because protected plant growth lagged behind plants that were stimulated by use.

Winter-spring use measurements were made at various intervals from October to May, each year from 1957 to 1963 in cattle and control plots. From 1958 to 1963 twigs not utilized during the winter-spring period were measured in the fall to determine summer use on old growth.

In October, 1960 new twig growth was clipped from 50 mountain mahogany plants over one foot tall at the Paradise study area to determine production. Twenty-five plants were sampled in both the total plot and deer plot. Plants were divided into size classes, one to four feet, four to six feet, and over six feet. The number selected in each category was determined by a ratio of the number of plants in each size class growing in the plots. New twigs longer than one-half inch were clipped from the plants below a height of four feet. Clipped twigs were weighed when green and reweighed when dry to determine moisture content. A random sample of 100 clipped twigs was measured from each plant for average twig length.

Photo points were also established in each study area to measure plant recovery and changes in vegetation density.

Accumulative rainfall gauges and maximum-minimum thermometers were stationed at Paradise, Hands Pass, Rucker No. 1, and Barfoot to determine the influence of rainfall and temperature on browse production. Rainfall gauges consisted of one gallon jugs with Coleman funnels stoppered in openings (Hungerford, 1957). About 100cc of kerosene were added to jugs to reduce the evaporative rate.

Browse Plant Phenology

Mountain mahogany species in the Chiricahuas is an evergreen shrub, but occasionally appears tree-like. In the spring new

leaves may appear in February but normally not until March. Leaves are simple and toothed and are usually in clusters. Under favorable conditions twig elongation also begins in March. Blooming frequently occurs after the summer rains begin in July but may not appear until September. Flowers are not showy, but the seeds or achenes have long tails and are quite conspicuous.

Deer-brier is a small shrub that is usually considered deciduous (McKean, 1956 and Dayton, 1937). During mild winters, however, green leaves may remain throughout the winter. Leaves are simple, alternate, and have three ribs. New twigs are green in color, and the growing tip is soft. When growth stops the growing tip hardens into a sharp spine. The main twig has many short side leaders that are also tipped with spines. Blooming occurs in the spring, usually in April and May. Flowers appear in white clusters on the tips of twigs and are rather showy. Seed pods have three cells with one nutlet in each.

Weather Records

Partially complete weather records were obtained in 1959 at four study areas. Weather records for other years collected periodically were incomplete. Table 6 compares temperatures and rainfall records for 1959. Readings were made on different days each month and do not constitute actual monthly or annual totals.

Table 6. Comparison of temperatures and precipitation at four study areas in the Chiricahua Mountains in 1959.

Month	Barfoot (7900')			Paradise (7000')			Hands Pass (7000')			Rucker 1 (6200')		
	Temp (°F)		Rainfall	Temp (°F)		Rainfall	Temp (°F)		Rainfall	Temp (°F)		Rainfall
	Max	Min	Inches	Max	Min	Inches	Max	Min	Inches	Max	Min	Inches
J	66	14	1.05	71	19	0.03	66	18	0.02	70	22	0.00
F	Not read			72	22	2.58	57	24	1.37	68	22	1.99
M	64	18	1.41	71	22	0.48	66	22	0.42	74	22	0.08
A	75	22	0.27	86	30	0.45	78	28	0.08	86	32	0.60
M	83	26	0.00	91	34	T	86	32	0.00	96	37	T
J	90	-	0.29	96	45	T	93	42	0.29	98	44	0.36
J	90	49	6.60	98	57	1.70	94	54	3.67	96	53	5.49
A	Not read			95	55	7.41	Not read			94	56	7.19
S	86	40	14.73*	94	54	4.32	90	50	14.73*	92	54	3.52
O	77	32	0.50	89	41	0.30	80	38	0.31	88	41	0.08
N	78	28	5.20	88	30	3.09	80	25	3.78	87	26	2.71
D	78	25	0.06	78	26	T	78	26	T	68	34	0.23
Total Rainfall			30.11			20.36			24.67			22.25

*Gauge overflowed--incomplete measurement.

Barfoot had the lowest yearly mean temperature and Rucker - No. 1 the highest. Both areas consistently maintained the highest and lowest mean temperatures from 1958 to 1962. The coldest temperature was recorded in the winter of 1961-62 when it was a minus four degrees at Barfoot and Hands Pass. This was the first time temperatures dropped below zero, and they rarely went below 10°F in the winter.

Paradise and Rucker were the only study areas to record temperatures over 100°F. A 104°F was the highest temperature recorded, and it was registered at Rucker No. 1 in either July or August, 1958. Summer temperatures at Barfoot never exceeded 90°F. At Hands Pass summer temperatures seldom went above 95°F.

Precipitation at Barfoot averaged about 25 inches a year; whereas, Paradise, Hands Pass, and Rucker No. 1 averaged around 20 inches. Barfoot is about 1000 feet higher than the other study areas and located in ponderosa pine; consequently, it receives more summer and winter moisture. During the winter the road to Barfoot was snowed-in from one to three months.

The highest rainfall was measured during the summer thunderstorms. Thunderstorms occur almost every afternoon, but are usually of short duration over small areas. Occasionally cloudbursts develop, and flash floods may disrupt road travel in the mountain.

Almost half of the rain falls in July and August. Table 7 compares the July-August and annual rainfall measured at two official weather stations in the Chiricahuas. The Painted Canyon and Chiricahua National Monument stations are about ten miles apart. Since 1960 Painted Canyon on the east side of the mountain has had more rainfall than the National Monument on the west side. However, the 20 year average annual rainfall was 18.63 inches on the Monument, and the 43 year average at Painted Canyon was 18.80 inches (Sellers, 1960).

Browse Plant Growth and Production

Browse growth is controlled primarily by temperature and precipitation. When winter and spring moisture is adequate, growth of browse plants begins as soon as air and soil temperatures rise. During the winter dormancy period the monthly mean air temperatures at study areas were about 40-50°F, but during the growing season they were between 60-75°F.

Table 8 compares seasonal rainfall data from the Chiricahua National Monument with mahogany growth at Hands Pass. Hands Pass data was used for comparison, because it is only four miles east of the Monument.

Mountain mahogany production at Hands Pass from 1958 to 1962 was similar to that of other study areas where mahogany was the

Table 7. Comparisons of rainfall records between two official United States Weather Bureau stations in the Chiricahuas.

Year	Painted Canyon		Chiricahua National Monument	
	Precipitation		Precipitation	
	July-Aug.	Annual	July-Aug.	Annual
1957	11.63	22.85	15.84	26.16
1958	9.93	22.89	9.40	24.34
1959	14.39	Incomplete	13.39	19.77
1960	7.14	19.49	4.57	14.82
1961	8.88	22.57	8.38	17.78
1962	10.32	25.61	5.18	14.56

key plant. The only exception was the year of lowest growth. Production at Hands Pass in 1959 and 1960 was almost identical, and both were years of low growth. For other mahogany areas 1960 was the lowest year.

Years of poor growth were years with reduced winter-spring or summer-fall precipitation. The Monument in 1959 had below-normal winter-spring rainfall, but summer rains were above normal; however, browse growth at Hands Pass still declined. The conditions were reversed in 1960, but the results were the same.

Mahogany growth in 1959 was an exception to the normal spring and summer growth pattern. Extremely low winter-spring rainfall in the mountain delayed growth until June and July. Fortunately summer rains were above normal, and plants grew rapidly in July and August which compensated for the earlier poor spring growth.

Heavy growth occurred in 1958 and 1962 at mahogany study areas. In 1958 early spring growth began in March, reached its peak rate in May, declined in June, but resumed in July, and peaked again in August. Growth did not terminate until the first week of October. Long growing seasons, such as 1958, follow if there is high rainfall in the spring and summer months.

Summer precipitation is considered important for good growth of mahogany. When summer rains begin in July there are at least three growing months remaining. Spring growth is usually restricted

Table 8. Comparison of seasonal rainfall data from the Chiricahua National Monument with the annual mountain mahogany production at Hands Pass.

Year	Precipitation (Inches)		Browse Production
	Winter-Spring Oct. to May	Summer-Fall June to Sept.	Lineal Inches (400 Twigs)
1957-58	11.77	14.85	968.9
1958-59	3.21	14.14	820.5
1959-60	8.51	6.99	820.7
1960-61	5.55	10.51	926.5
1961-62	9.98	7.26	1179.3

to two months, because little growth occurs during the hot, dry months of May and June.

Deer-brier at Barfoot did not follow the same general pattern of growth described for mahogany. Growth of deer-brier begins later and ends sooner. There also appears to be no definite lag in growth during May and June which is common with mahogany.

The lowest growth of deer-brier was measured in 1961 and not 1960 when precipitation declined. Precipitation in the spring of 1961 was below normal at Barfoot, but summer rains began in June and were above normal, and yet browse growth still declined. Summer rains may not be able to overcome the spring deficit because of the shorter growing season at Barfoot.

Winters of 1958 to 1961 were comparatively mild and the die-back on deer-brier was light. In the winter of 1961-62, however, temperatures dropped below zero and the die-back was severe. Subsequent growth in 1962 was so phenomenal that it surpassed any previous year.

A summary of total growth measured in each study area is included in Table 9.

Browse Plant Recovery

Total plots have provided a visual record of the recovery of protected plants. Plant recovery was noticeable after only one

Table 9. Summary of browse growth and use data from deer-cattle study areas.

Study Area	Year	Growth Lineal Inches	Avg. Growth Per Twig	Avg. Use Per Twig	Use Lineal Inches	Percent Used
			Mountain Mahogany			
Paradise						
Deer Plot	1957-58	283.1	2.8	1.9	192.0	67.8
(Deer use only)	1958-59	484.3	2.4	0.8	168.5	32.7
	1959-60	384.7	1.9	1.0	199.7	51.9
	1960-61	344.4	1.7	0.7	147.7	42.8
	1961-62	538.7	2.7	1.1	220.0	40.8
	1962-63	492.9	2.5	0.8	167.2	33.9
Control Plot	1957-58	262.0	2.6	1.6	158.1	60.3
(Deer-cattle use)	1958-59	569.6	2.8	0.7	144.3	25.3
	1959-60	459.4	2.3	1.1	228.7	49.8
	1960-61	394.2	2.0	0.4	71.5	18.1
	1961-62	506.0	2.5	1.1	225.1	44.5
	1962-63	638.5	3.2	0.8	153.8	24.1
Hands Pass						
Deer Plot	1958-59	481.0	2.4	1.1	215.8	44.9
(Deer use only)	1959-60	388.3	1.9	0.6	124.2	32.0
	1960-61	409.3	2.0	0.8	160.4	38.2
	1961-62	464.6	2.8	0.7	136.7	29.4
	1962-63	563.5	2.8	0.4	75.4	13.4

Table 9. (Continued)

Study Area	Year	Growth Lineal Inches	Avg. Growth Per Twig	Avg. Use Per Twig	Use Lineal Inches	Percent Used
Control Plot (Deer-cattle use)	1958-59	487.9	2.4	1.0	211.2	43.3
	1959-60	432.2	2.2	0.5	98.6	22.8
	1960-61	411.4	2.1	0.8	163.6	39.7
	1961-62	461.9	2.3	0.6	122.9	26.6
	1962-63	615.8	3.1	0.2	50.6	8.2
Rucker No. 1						
Deer Plot (Deer use only)	1958-59	611.6	3.0	1.2	243.1	39.7
	1959-60	591.5	3.0	1.2	233.8	39.5
	1960-61	459.1	2.3	1.2	236.8	51.6
	1961-62	448.5	2.2	1.2	237.7	53.0
	1962-63	636.0	3.2	1.5	308.6	48.4
Control Plot (Deer-cattle use)	1958-59	795.7	3.9	1.8	357.0	44.9
	1959-60	654.1	3.3	1.1	211.3	32.3
	1960-61	424.6	2.1	1.2	246.8	55.8
	1961-62	476.2	2.4	1.6	324.8	68.2
	1962-63	683.2	3.4	1.5	295.8	43.3

Table 9. (Continued)

Study Area	Year	Growth Lineal Inches	Avg. Growth Per Twig	Avg. Use Per Twig	Use Lineal Inches	Percent Used
Rucker No. 2						
Deer Plot	1959-60	604.6	3.0	0.6	111.6	18.4
(Deer use only)	1960-61	516.0	2.6	1.3	255.5	49.5
	1961-62	610.2	3.0	0.8	150.0	24.6
	1962-63	567.4	2.8	1.5	308.4	54.4
Control Plot	1959-60	642.4	3.2	1.1	214.4	33.4
(Deer-cattle use)	1960-61	583.6	2.9	1.1	214.6	36.8
	1961-62	600.3	3.0	0.9	183.4	30.6
	1962-63	590.8	2.9	1.7	339.4	57.4
			Deer-brier			
Barfoot						
Deer Plot	1958-59	432.6	2.2	1.2	243.4	56.3
(Deer use only)	1959-60	342.6	1.7	0.5	96.4	28.1
	1960-61	343.1	1.7	0.3	58.9	17.2
	1961-62	307.1	1.5	0.2	43.1	14.3
	1962-63	593.3	3.0	0.6	129.8	21.9

Table 9. (Continued)

Study Area	Year	Growth Lineal Inches	Avg. Growth Per Twig	Avg. Use Per Twig	Use Lineal Inches	Percent Used
Control Plot (Deer-cattle use)	1958-59	399.2	2.0	1.3	250.3	62.7
	1959-60	347.6	1.7	0.7	138.5	39.8
	1960-61	327.6	1.6	0.5	96.2	29.4
	1961-62	260.2	1.3	0.5	108.4	44.7
	1962-63	771.4	3.9	1.1	223.0	28.9

growing season. Even browse plants that appeared dead and decadent before the fences were constructed recovered rapidly.

Figure 6 illustrates recovery and change in growth form of a mountain mahogany in the Paradise total plot. This growth form is typical of small mahogany plants four to five feet tall that have not been utilized for five years. Recovery also took place on large browse plants that were high-lined and severely hedged. Growth after five years of protection has almost erased all signs of past over-use.

Mountain mahogany and silk-tassel seedlings were uncommon at study areas. Because of continuous heavy use, older browse plants actually looked like seedlings. Under full protection these plants recovered rapidly.

Clipping Analysis at Paradise Study Area

A direct comparison of mountain mahogany growth is difficult because of differences in the number of plants in each size class in the two plots sampled. In this analysis more plants over six feet were clipped in the deer plot than in the total plot (Table 10).

Browse growth in the total plot where both deer and livestock were excluded was considerably more than twice that in the deer plot where only cattle were excluded. Plants were protected from use in the total plot from 1957 to 1960; whereas, the deer plot was subject to only deer use during the same period.

Figure 6. Mountain mahogany recovery and growth after five years of protection in the Paradise total plot. Photos taken in 1958, 1960 and 1962.

Table 10. Comparison of length and moisture content of mountain mahogany twigs from plants of various sizes in the Paradise study area in October, 1960.

Plot	Size Class	Number Plants	Twigs Clipped	Avg Twig Length*	Percent Moisture Content
Deer (Deer-cattle use)	1'-4'	7	627	1.58 in	55.0
	4'-6'	4	605	1.78 in	46.5
	over 6'	14	1353	2.13 in	45.5
	Totals	25	2585	Average:	47.7
Total (No use)	1'-4'	11	3943	2.29 in	45.5
	4'-6'	4	763	2.49 in	45.9
	over 6'	10	1735	2.91 in	50.8
	Totals	25	6441	Average:	47.5

*Figures derived from measuring a sample of the total twigs clipped from each plant.

The moisture content of clipped twigs was approximately 47.5 percent in both plots. The percent of moisture decreased with plant height in the deer plot, but increased with plant height in the total plot.

In both plots the average twig length was directly proportional to plant height. Average twig length in each size class was also longer on protected plants than unprotected ones.

Further consideration of the data presents a revealing insight into the carrying capacity of this area. An estimate of the total growth of browse was computed by multiplying the number of mahogany plants in the deer plot by the mean air-dry weight per clipped plant. Thus, a total of 10.6 pounds of forage was available to deer on 3.2 acres or 3.3 pounds per acre. These figures do not include plants less than one foot tall, but such plants would have added little to the estimated forage available.

In the deer plot it would take about 29 mahogany plants of random sizes to produce one pound of green forage but only seven plants in the total plot. In terms of dry weight nearly 56 plants are needed to produce one pound in the deer plot. A mature white-tailed deer needs about two pounds of air-dried forage a day (Nichol, 1938 and French et al., 1955). Thus, if one deer eats only mahogany, it would consume the available forage from about 112 plants in a 24 hour period. Deer naturally feed on a variety of plants, but these data show the amount of forage available on mahogany for deer at Paradise.

Browse Utilization

According to Welch (1960), white-tailed deer in the Chiricahuas do not exhibit a true seasonal migration. Seasonal movements do occur, but they are influenced primarily by food, water, temperature, and breeding activity. Range use by deer then is considered year around in each vegetation type.

Use of browse is almost entirely by deer and livestock, although there is some use by rodents and rabbits during the winter. The density of these animals influences the quantity of browse consumed, but the degree of use depends largely on growth, palatability, and availability of browse as well as other forage species. In the winter there are only a few foods available to help offset use of browse. Mast and winter annuals provide supplementary food, but they are temporary and not dependable every year.

Winter-Spring Use

October to May is considered the winter-spring period of browse use by deer. Browse growth stops in October, and new twigs are marked for use measurements. May is an arbitrary ending period, but it is usually the start of the dry season when growth and use decline.

Paradise study area. Paradise was the first study area established, and winter-spring use measurements on mountain mahogany were made from 1957 to 1963 (Table 9).

On 200 twigs marked there was a use of over 60 percent in 1957-58 in the deer plot (deer use only) and control plot (deer-cattle use). The sample was increased to 400 the following year, but total use in 1957-58 was surpassed only in 1959-60 and 1961-62. After 1957-58, use fluctuated between 25 and 50 percent in the two plots.

Except for the year 1961-62, use in the deer plot exceeded the use in the control plot every year. Cattle were never seen within one-quarter mile of the control plot, although three cattle droppings were counted on deer pellet group transects in 1958, one in 1962, and two in 1963. Browsing on mahogany by cattle was considered light and insignificant in this area. The majority of the cattle on this allotment were observed in the lower elevations where food and water were more accessible.

The higher deer use in the deer plot is probably due to vegetation differences and the cattle-proof fence. More mahogany plants were present in the deer plot than in the control plot. This may attract deer, and the fence may tend to hold them longer.

Figure 7 illustrates the tight hedging and slow recovery on mahogany which was common throughout much of the mountain. This is a typical plant in the three to four foot size class which is completely

Figure 7. A mountain mahogany plant in Paradise deer plot illustrates the slow recovery from tight hedging in 1958 (top photo) to the appearance of basal growth and less hedging in 1961 and 1963.

available to deer. Severe use of this size class evidently occurred prior to the start of measurements in 1957, because numerous plants were already dead or dying. Some of those plants still partially alive were killed during this study.

A distinct browse line or high-lining on larger browse such as mahogany and silk-tassel was also characteristic of range conditions (Figures 8 and 9). Recovery of these plants has been gradual, but more basal growth was present in 1963 than in previous years.

Hands Pass study area. In 1958-59 measurements on mahogany were begun at Hands Pass. Measurements from this year were the highest total use in the deer and control plots. Since 1958-59 there has been a decline of lineal use in the plots. In 1962-63 use dropped sharply and was almost negligible in the control plot. During this period only 70 of the 400 marked twigs were eaten.

Hands Pass was the only study area where a relationship between amount of lineal use and number of deer pellet groups seemed to exist. Whenever a decline or increase in browse use was measured, the number of deer pellet groups indicated a change in the number of deer in the area.

Lineal use by deer in the deer plot was slightly higher than deer and cattle use in the control plot every year except 1960-61. In 1960-61 the difference in measured use between the two plots was

Figure 8. A typical high-lined silk-tassel plant on the east side of the mountain with little basal growth available for deer. April, 1959.

Figure 9. A dense stand of mountain mahogany at Hands Pass study area are high-lined and severely hedged. Most of the plant growth is out of the reach of deer. April, 1959.

about three inches. Occasionally cattle were observed near the study area but never right in the control plot. One or two cattle droppings, however, were recorded in this plot every year. Even so, use of mahogany by cattle was judged to be light in this area.

Rucker No. 1 study area. Total lineal winter-spring use on mahogany was consistently higher at Rucker No. 1 than at Hands Pass or in the Paradise study areas. Only use in 1962-63 at Rucker No. 2 surpassed the use in this area (Table 9).

From 1959 to 1963 there has been a gradual increase in lineal use, but a decrease in deer pellet groups (Table 13). Except for Hands Pass, pellet group counts at study areas have not indicated a change in browse use.

In 1958-59 and 1961-62 winter-spring use in the control plot was about 100 inches more each year than in the deer plot. The difference in use between the plots was significant at the 95 percent confidence level in 1958-59 and at the 99.5 percent level in 1961-62. The significant increase in twig use was considered to be by cattle rather than deer.

Cattle were observed in the control plot on several occasions actually eating mahogany twig growth. Cattle tracks, droppings, and bedding grounds were frequently found at the plot. A cattle feeding trough was located near the study area which kept the cattle in the

vicinity of the plots. Cattle, however, were not always at the site. This study area is located on an allotment where cattle graze all year, but it is divided into pastures and cattle are moved occasionally from one pasture to another.

Rucker No. 2 study area. Four years of use data were obtained at Rucker No. 2 study area. The first use measurements were made during the 1959-60 winter-spring period.

Use on marked plants in the deer plot has fluctuated every year. A total of 111.6 lineal inches of twigs from these plants were eaten in 1959-60 which was the lowest recorded. The highest use was measured in 1962-63 when 308.4 inches were eaten by deer.

In the control plot deer and cattle use averaged slightly more than 200 lineal inches for three years, but then in 1962-63 it increased to 339.4 inches.

Use in the control plot was higher than in the deer plot every year except in 1960-61. The difference in use between the plots was significant at the 99.5 percent level in 1959-60 and 1962-63, and at the 97.5 percent level in 1961-62. Cattle were believed to be responsible for the significant difference in use rather than deer.

Cattle were frequently observed feeding on mahogany plants in the control plot. Some of these plants near cattle bedding grounds showed signs of heavy use. Fortunately cattle were not on the area the

year around. This study area is located on an allotment with eight months cattle use from November to July.

Barfoot study area. The highest use on deer-brier was measured in 1958-59. Deer and cattle use in 1958-59 and in subsequent years was considered light in this study area. Little use was found on plants two to three feet tall. Smaller plants, however, were heavily eaten mostly by cottontail rabbits (Sylvilagus floridanus). Accurate separation of deer, cattle, and cottontail use was not reliable.

Whenever possible large plants were selected for measuring in 1959 to reduce the rabbit use, and in 1959-60 lineal use declined over 50 percent. Pellet group counts the same year indicate a decline in deer numbers which may have had some effect on total use, although most of it was considered to be less rabbit use.

White (1957) on a feeding minute study recorded about 94 minutes of deer use at Barfoot on deer-brier between July and December, 1955 which was the highest browse use recorded by him in this area. He also reported that the plants were badly hedged and under present browsing pressure they would be eliminated or rendered useless.

Heavy use was evident on this species prior to the start of this study. However, the deer population in this area evidently was already beginning to decline and use of deer-brier likewise declined.

Dayton (1931), and Kearney and Peebles (1951) rate deer-brier as good browse for deer and cattle. My observations indicate that it is generally poor deer forage, especially in the winter when the spines have hardened. Deer use is probably more confined to the summer growing season when new twigs and spines are soft and more palatable. It appears logical that deer were forced to consume this species because of high deer numbers and a shortage of preferred foods.

Summer Use

It is impossible to measure summer browse use accurately, because plants are continually adding new growth. Summer use in this study refers to use measured on tagged twigs not utilized in the winter-spring period.

Use at Paradise, Hands Pass, and Rucker No. 1 fluctuated from year to year without any definite trend (Table 11). Study areas averaged approximately 35 to 40 lineal inches of use in the summer. Although the measured use is not high, it is considered important. Old twig growth is undoubtedly less palatable than new growth which is normally available from May to October. Deer apparently consume old growth in the process of eating new growth which develops on the old twigs.

Table 11. Winter and summer mountain mahogany use measured at three study areas.

Study Areas	Year	Growth (Inches)	Use in Inches Taken			Percent Used
			Winter	Summer	Total	
Paradise						
Deer Plot (Deer use)	1958-59	484.3	168.5	22.4	190.9	39.4
	1959-60	384.7	199.7	16.0	215.7	56.1
	1960-61	344.4	147.7	29.0	176.7	51.3
	1961-62	538.7	220.0	21.5	241.5	44.8
Control Plot (Deer-cattle use)	1958-59	569.6	144.3	63.6	207.9	36.5
	1959-60	459.4	228.7	35.4	264.1	57.5
	1960-61	394.2	71.5	45.5	126.0	31.9
	1961-62	506.0	225.1	40.2	265.3	52.4
Hands Pass						
Deer Plot (Deer use)	1958-59	484.3	215.8	45.4	261.2	54.3
	1959-60	388.3	124.2	36.2	160.4	41.3
	1960-61	409.3	160.4	41.6	202.0	49.4
	1961-62	464.6	136.7	26.6	163.3	35.1
Control Plot (Deer-cattle use)	1958-59	487.9	211.2	52.1	263.3	54.0
	1959-60	432.2	98.6	48.2	146.8	34.0
	1960-61	411.4	163.6	54.5	218.1	53.0
	1961-62	461.9	122.9	25.3	148.2	32.1
Rucker No. 1						
Deer Plot (Deer use)	1958-59	611.6	243.1	50.8	293.3	48.1
	1959-60	591.5	233.8	33.0	266.8	45.1
	1960-61	459.1	236.8	34.6	291.4	59.1
	1961-62	448.5	237.7	17.3	255.0	56.9
Control Plot (Deer-cattle use)	1958-59	795.7	357.0	43.3	400.3	50.3
	1959-60	654.1	211.3	54.8	266.1	40.7
	1960-61	424.6	246.8	19.1	265.9	62.6
	1961-62	476.2	324.8	32.0	356.8	74.9

Summer use in 1959 was measured monthly and use occurred each month. There was no definite monthly pattern or preference in use before or after summer rains.

Summer use is important, and when combined with winter-spring data it provides 12 months of use on a sample of marked twigs.

Browse Utilization Discussion

The degree of mountain mahogany use varies considerably in the four study areas. Between 1957 and 1963 at Hands Pass and Paradise, use changed from high to generally moderate and light. The situation was reversed at Rucker No. 1 and Rucker No. 2 with use seemingly on the increase from 1958 to 1963.

Paradise and Hands Pass are located at about the same elevation in a highly productive vegetation type for deer. However, excessive deer numbers in this type severely damaged important browse species and even many undesirable species. Recovery of damaged browse did not become apparent until 1960.

The Rucker study areas are located at the lower limits of mountain mahogany and on the edge of almost pure grassland. Deer numbers were probably excessive in this area before 1958, but the damage to browse plants was not serious. Excellent browse growth in 1958 and 1959 erased most of the signs of over-use and may have

lessened the deer loss in this area. The gradual increase in use suggests that the deer are increasing in the Rucker area.

Winter-spring use on mahogany at the Paradise study area in 1957-58 was about 68 percent in the deer plot and 60 percent in the control plot. Unfortunately, summer use was not measured in 1958, but if the average summer use obtained from 1959 to 1962 was added to the 1957-58 winter-spring figures the use would have been over 75 percent in both plots.

Proper use factors on browse plants vary with each species and area. Julander (1937) on the North Kaibab in Arizona found that the maximum allowable utilization on aspen (Populus tremuloides) and cliff-rose (Cowania sp.) was between 65 and 70 percent. Hormay (1943) found that proper use on bitterbrush (Purshia tridentata) in California was 60 percent. A browse clipping study by Garrison (1953) suggested proper use at 50 to 60 percent on mountain mahogany.

Proper use figures are based on browse plants that receive mostly winter use. In the Chiricahuas, however, browse plants are subject to yearlong use by a resident deer herd. Proper winter use for a resident herd should be lower than winter use by a migratory herd.

Use over 60 percent is probably not excessive in years of good growth, but the same use during a poor year could be detrimental

to the plant vigor. According to Young and Payne (1948) if use of browse plants is too severe during the growing season the plant yield is greatly reduced. Summer use on new growth was not measurable, but it evidently was quite high because 10 to 30 percent summer use was measured on old twig growth.

Summer browsing by deer and cattle is believed to be directly related to available new growth of forbs and grass. During a drouth period the forage production is naturally reduced, and proper summer browse use is probably more important than winter use when managing a resident deer herd.

Competition between deer and cattle was not a serious problem during this study. Browse use by cattle was not significant except in the lower elevations where cattle were more concentrated. Use of browse by cattle was not high because, for the most part, a good growth of grass was available every year. However, during a prolonged drouth period the competition would probably be more serious.

Data gathered from 1957 to 1963 indicate that deer were primarily responsible for the damage to browse in the mountain. Many desirable browse plants died, and vigor was greatly reduced in the remaining plants. Browse deterioration was a major factor in the decline of the white-tailed deer herd.

CHAPTER IV.

TREND IN NUMBERS OF WHITE-TAILED DEER

To properly evaluate the conditions in the Chiricahua Mountains it was necessary to know the general trend of the deer population. This was accomplished by deer surveys and pellet group counts.

Deer survey routes were first established in the mountain by Mr. Steve Gallizioli in 1955 for the Arizona Game and Fish Department (Day and Gallizioli, 1955).

Deer pellet counts have been used in estimating deer densities and deer movements. Various sizes and shapes of sample plots have been used. Belt transects as described by Bennet, et al. (1940) and McCain (1948) were used on this study to measure the presence of deer in study plots. Circular pellet plots established in 1958 by Welch (op. cit.) for a movement study were used to collect trend data.

Deer Survey and Pellet Count Procedures

Deer surveys were made in either December, January, or February by various Game Department personnel. The writer made surveys in this area in 1955, 1956, 1958, and 1959. Survey routes covered geographical areas of the mountain rather than trails and

roads. Routes were usually traversed on foot in either the morning or late afternoon, and age and sex of deer seen were determined through binoculars.

Deer-pellet belt transects six feet wide and 200 feet long were established along permanent vegetation transects in deer and control plots. There were ten belt transects in each study area. Vegetation transect stakes at intervals of 50 feet were considered the center line of the belt. Deer pellet groups were cleared and counted in a strip three feet on each side of the center line. No pellet groups were tallied unless more than half of the pellets were in the transects. Belts were read at the same time that browse measurements were taken. From October, 1958 to May, 1961 readings were made every one or two months, but from October, 1961 to May, 1963 they were made in only October and May.

Transects with circular pellet plots (100 square feet) were located primarily on the east side of the mountain. Transects were divided into the following areas by Welch (op. cit.): Barfoot Park, Turkey Park, Upper Onion, Lower Onion, Petrified Ridge and Crystal Cave. Transects included 288 plots which were usually cleared twice a year on this study, once in July prior to the summer rains and again in November before winter snows. No pellet group was counted unless more than half fell within the plot. The defecation rate of 13 pellet

groups per day per deer was used to calculate the estimated deer per section (Welch, op. cit.).

White-tailed Deer Survey Data

Annual white-tailed deer surveys by the Arizona Game and Fish Department show a definite downward trend in the deer population from 1955 to 1960 (Table 12). The fawn counts dropped from 43 per 100 does in 1956 to 20 in 1962, and the spread in the buck to doe ratio remained narrow each year.

General observations made when traveling by vehicle also reflect a change in deer density. In 1955 and 1956 deer were frequently seen from roads, and it was not uncommon to count 10-20 deer in one trip through the mountain. By 1960, however, deer were seldom seen along the roads.

Study Area Pellet Group Counts

Deer pellet group counts for the winter-spring use period in the study areas are summarized in Table 13.

The pellet count trend has been down in the five study areas ever since the first readings. Counts in 1958-59, 1959-60, and 1960-61 were read at similar time intervals, and they indicated a decline at Paradise, Hands Pass, Rucker No. 1, and Barfoot. The 1960-61 count at Paradise dropped 64 percent from the 1958-59 count. The other areas declined from 23 to 40 percent.

Table 12. Sex and age classification data for white-tailed deer in the Chiricahua Mountains.*

Date	Bucks	Does	Fawns	Total	Does/Buck	Fawns/100 Does
1955	86	158	60	304	1.8	38
1956	62	135	58	255	2.2	43
1957	49	62	26	137	1.3	42
1958	56	50	21	127	0.9	42
1959	43	79	26	148	1.8	33
1960	24	36	11	71	1.5	31
1961	35	38	15	88	1.1	39
1962	33	45	9	87	1.4	20

*Taken from Project W-53-R completion reports, Arizona Game and Fish Department.

Table 13. Winter-spring (October-May) deer pellet group counts at study areas.

Study Areas	Groups 1958-59	Groups 1959-60	Groups 1960-61	Groups 1961-62	Groups 1962-63
Paradise					
Deer Plot	85	59	30	22	18
Control Plot	58	33	39	12	21
Totals	143	92	69	34	39
Hands Pass					
Deer Plot	156	82	98	47	49
Control Plot	140	46	90	53	24
Totals	296	128	188	100	73
Rucker No. 1					
Deer Plot	28	26	24	26	9
Control Plot	40	24	18	16	6
Totals	68	50	42	42	15
Barfoot					
Deer Plot	53	50	38	15	14
Control Plot	38	35	32	7	7
Totals	91	85	70	22	21
Rucker No. 2					
Deer Plot		39	39	8	14
Control Plot		27	33	5	12
Totals		66	72	13	26

Pellet counts in 1961-62 and 1962-63 were made only once, and there probably was some pellet loss due to weathering, washing, insects, and covered groups. Even with such losses, there are indications of continuing declines at Rucker No. 1 and Hands Pass. At Paradise, Barfoot, and Rucker No. 2 the trend appears to be reversing.

Deer pellet group counts in deer plots were consistently higher than in control plots. Only four of the 24 winter-spring counts favored control plots. Deer possibly were attracted to the deer plots at Paradise, Rucker No. 1, and Rucker No. 2; because they contained more browse plants. However, at Hands Pass and Barfoot browse plants were more abundant in control plots.

Higher counts in deer plots were probably influenced more by the fencing than any other factor. Once deer were inside the three acre fence their travel was restricted and some deer may have been temporarily trapped.

Deer Population Trend Data

Table 14 summarizes deer pellet group counts made since 1958 in six areas.

Barfoot Park (about 8200') and Turkey Park (about 7400') are located in pine and pine-oak vegetation types. Deer numbers in both areas have declined sharply. In 1955 deer were abundant at this elevation, and now they are seldom seen.

Table 14. Deer pellet group counts and estimated deer densities in six areas in the Chiricahua Mountains.

Areas	Date	Days Interval	Pellet Groups	Groups per Acre/Month	Estimated Deer/Section
Barfoot Park	1958-59*	348	95	74.7	122.1
	1959-60	393	34	23.6	39.0
	1960-61	224	6	7.4	12.4
	1961-62	344	2	1.6	2.4
	1962-63	349	0	0.0	---
Turkey Park	1958-59	346	144	113.5	186.8
	1959-60	402	12	8.1	13.4
	1960-61	226	2	2.4	4.1
	1961-62	342	7	5.6	9.3
	1962-63	348	1	0.7	1.2
Upper Onion	1958-59	349	282	220.4	360.7
	1959-60	393	65	45.1	88.4
	1960-61	247	23	25.8	42.7
	1961-62	329	26	22.0	36.7
	1962-63	343	30	24.3	39.8
Lower Onion	1958-59	356	248	190.0	311.8
	1959-60	393	53	36.5	60.5
	1960-61	247	21	23.6	39.1
	1961-62	329	20	16.6	27.3
	1962-63	343	16	12.5	20.9
Petrified Ridge	1958-59	348	203	159.1	260.6
	1959-60	403	36	24.4	40.1
	1960-61	223	6	7.3	12.2
	1961-62	342	8	6.4	10.5
	1962-63	351	12	9.3	15.1
Crystal Cave	1958-59	348	146	114.4	187.3
	1959-60	393	25	17.3	28.5
	1960-61	245	8	20.4	33.2
	1961-62	322	11	9.3	15.1
	1962-63	348	5	3.9	6.4

*The 1958-59 readings were by Welch (1960).

No pellet groups were counted at Barfoot in 1962-63, after 349 days, and only one was found at Turkey Park. In May, 1963 a few deer tracks were observed at Barfoot, but evidently the pellet plot sample is not large enough to measure the low deer density.

Barfoot and Turkey Park have few preferred winter deer browse plants available. Consequently, these areas are probably marginal white-tailed deer habitat, unable to support high deer numbers for long.

Petrified Ridge, Lower Onion, and Upper Onion include elevations from approximately 5800 to 7000 feet. The deer trend in this region has been down from 1958 to 1962. Counts in 1962-63 indicate the deer population may be starting to recover. These three areas lie in the most productive vegetation zone. Preferred deer browse is abundant within an association of pine-oak and oak-juniper types. Deer densities in these types were extreme and subsequent deer losses proportionately great.

Crystal Cave at about 5600 feet elevation is the lowest area sampled by pellet transects. The pattern of deer decline here is similar to that in Barfoot and Turkey Park. Portions of this area which lie in the oak-juniper type provide good deer habitat, but much of it is marginal white-tailed deer range.

Pellet groups per acre per month declined drastically in all six areas after the readings by Welch (op. cit.) in 1958-59. Some of

the difference is explainable by changes in sampling methods. Welch read plots every two months which reduced pellet loss to a minimum. He also included any pellet group of which even a portion fell within the circular plot. I read the plots twice a year and no group was counted unless more than half of it fell within the plot. Changes in procedure undoubtedly reduced the total groups counted, but it cannot possibly account for such a large difference. It is also unlikely that sampling error is responsible, particularly in view of the decline in pellet counts in the study plots and the sudden drop in deer survey counts during the same period. The data definitely suggest a marked downward trend in the deer population. The greatest change occurred between October, 1959 and May, 1960.

Further support of this decline was obtained from the Chiricahua National Monument. Welch (op. cit.) assisted National Park Service personnel in establishing 48 circular pellet plots in March, 1959. Estimated pellet groups per acre per month fluctuated from the high of 50.0 in September, 1959 to 3.3 in April, 1963. Though the sample is small the data also suggest a reduction in deer numbers on the unhunted Monument.

CHAPTER V.

WHITE-TAILED DEER ANALYSES

Productivity and physical conditions of a deer herd are important indicators of range conditions. Whenever the food supply is heavily used or depleted, it will usually affect the reproduction, weights, condition, and health of the deer herd. In this study an effort was made to analyze deer specimens to determine if any of these problems were present in the deer herd.

Deer Collections

Thirty-two white-tailed deer were collected in the general vicinity of the study areas between June, 1957 and April, 1960. Deer were usually collected near roads to facilitate transportation to camp where autopsies were made.

Data were collected on whole and dressed weights, body measurements and body condition of each deer. Parasites, stomach contents and reproductive organs from each deer were preserved for separate study.

Stomach samples were washed and air-dried for laboratory analysis. Five stomach samples were analyzed by the California

Department of Fish and Game Field Station in 1959. The remaining 25 were analyzed by the writer. Parasites and internal body organs were stored in ten percent formalin solution. Hides and skulls were preserved and turned over to the Zoology Department of the University of Arizona. All edible meat was given to the Douglas County Hospital.

Hunter checking stations and field contacts were used during the deer hunting seasons to collect additional data on deer weights, ages, stomach samples, ovaries, and body conditions.

Findings From Deer Specimens

Collecting deer was a difficult and time consuming job. Numerous trips for deer ended up as "dry runs", especially when a deer of a particular sex and age class was desired from a specific area. In the original plans, two deer specimens were to be collected every two months. This was soon abandoned when a week was needed to collect one deer. Collections even became more difficult as the study progressed. The number of deer collected each year was as follows: nine in 1957; nine in 1958; ten in 1959, and four in 1960.

External conditions. Collected specimens had no unusual skin growths or papillomas, and only one buck examined during the regular deer hunting season had numerous wart-like growths on the head and body.

Hide and hair conditions were normally good. A few deer, mostly bucks, had bare areas on the chest, neck, and sometimes on the head. Ticks probably caused the irritations and were usually found in the rubbed areas. A doe examined during the 1959 hunting season had a rough scaly hide on the head and neck. This animal was in poor condition and had longer than normal dew-claws on the front feet.

Poor antler development was observed among yearling bucks. It was first seen on a deer collected in April, 1958. This yearling had antler growth barely protruding through the hide similar to that of a fawn in its first winter (Figure 10). It weighed only 31 pounds which was less than a fawn collected two months earlier. A number of these yearlings were also examined on the 1958 and 1959 deer hunts (Figure 11).

Poor forage conditions can produce nutritional deficiencies which can affect antler growth and development (French, et al., 1955 and McEwen, et al., 1957). Over-browsing in this mountain has already been explained. This factor evidently produced antler deficiencies in yearling bucks. Yearling bucks on good range normally have forked antlers or large spikes.

One unusual deer was checked during the 1959 hunt; it appeared to be a hybrid cross between the white-tailed deer and the mule deer (O. hemionus crooki). It was a fawn with large ears and

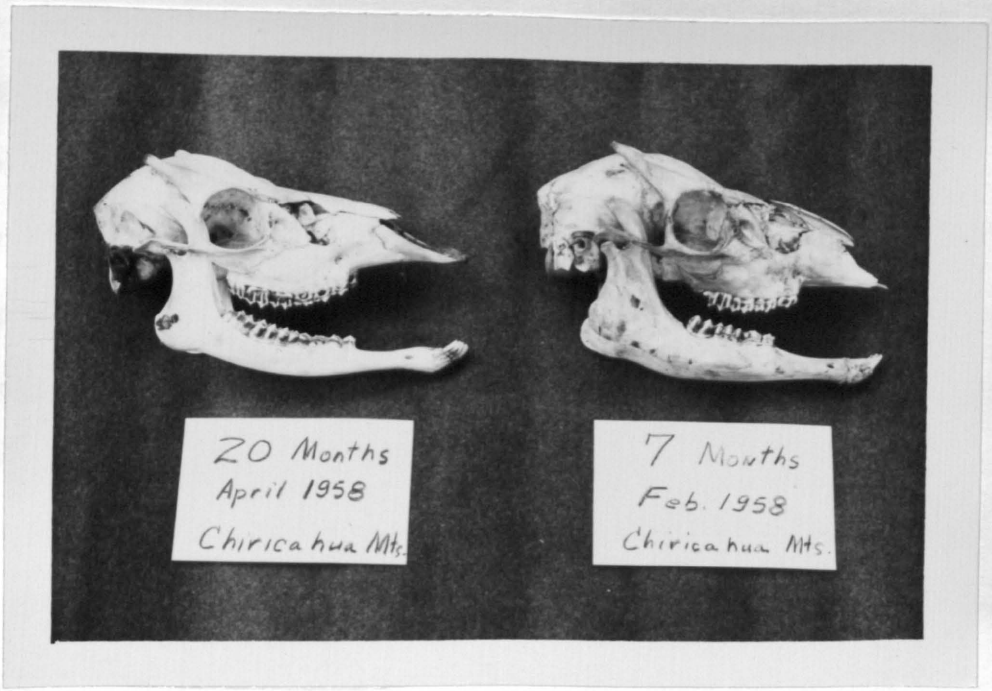


Figure 10. Evidence of undeveloped antler growth in yearling buck. Buck on left is almost two years old, yet antler development is similar to the seven month old male fawn on the right.

Figure 11. A yearling buck with poorly developed antlers shot during the 1959 deer hunt. Antler growth is barely protruding through the hide.

dark pelage typical of a mule deer. The tail, however, resembled that of a white-tail with white beneath and reddish brown on top. Nichol (op. cit.) crossed mule and white-tailed deer in captivity. Offspring from mixed crosses had tail color and pelage similar to white-tailed deer. Since hybrids were produced under penned conditions, it is likely they occasionally occur in the wild. White-tailed and mule deer home ranges overlap in the area where this deer was killed.

Internal conditions. Animal conditions were determined by fat deposits. According to Harris (1945), starvation in deer proceeds with fat being absorbed in the following order: rump and saddle; between hide and body; kidneys and intestines; heart, and then bone marrow.

Only two of the 32 deer collected were judged to be in excellent condition. These were both does collected in February, 1958 and June, 1959. Three other deer were in good condition while the rest were in fair to poor condition.

Twenty-three specimens had no visible fat on the rump and saddle, 15 had none between hide and body, five had none on kidneys, two had none on the heart, and one had only a small amount in the bone marrow.

The deer with little fat in the bone marrow was a buck collected in February, 1958. No fat deposits were found in the body

cavity, and the femur marrow was red in color and gelatinous in texture. Red-gelatinous bone marrow indicates malnutrition (Harris, op. cit., Cheatum, 1949 and Bischoff, 1954). The deer was in the six to eight year age class and infested with ticks, which may have been responsible for the deer's condition. Stomach contents, however, revealed mostly forage species of low palatability.

Bucks killed by hunters and examined during October and November were usually in good body condition every year. However, the majority of the bucks collected from February to April were in poor condition. Their condition was doubtless a reflection of the physical wear of rutting activities. According to Nichol (op. cit.) and French, et al. (op. cit.) food consumption drops and weight loss results during the rut.

Deer weights and measurements. Weights and measurements of 32 white-tailed deer specimens collected during the study are listed in Table 15.

Adult bucks averaged about 84 pounds and does about 67 pounds before field-dressing. Viscera lost when hog-dressed, not including lungs and heart, was about 23 percent in bucks and 27 percent in does. Weight losses were higher among does because 14 of the 19 specimens were pregnant.

Table 15. Average weights and measurements of white-tailed deer collected during the study.

No. Deer	Weights in Pounds		Measurements in Centimeters				
	Whole	Dressed*	Length	Height	Hind Foot	Ear	Tail
Adults							
Buck (7)	83.5	64.4	139.8	78.8	38.8	16.7	20.7
Doe (19)**	67.3	48.9	132.8	73.3	37.9	15.5	20.0
Yearlings							
Buck (2)	50.7	39.7	129.6	68.5	34.7	16.0	20.0
Doe (2)	52.2	39.5	120.8	69.1	36.0	14.8	---
Fawns							
Buck (2)	37.8	27.5	115.2	65.7	34.7	13.6	16.3

*Lungs and hearts included in dressed weights.
**Only 10 does included in average tail length.

The heaviest buck was collected in May, 1959, and it weighed 92 pounds before dressing and 71 pounds after. Bucks collected in the spring and summer were at least 10-20 pounds lighter than those collected in the fall. In November during the deer hunt, bucks were normally near peak physical condition and they averaged about 70 pounds hog-dressed. During the 1959 hunt, two bucks were taken which weighed 112 pounds hog-dressed. These were the heaviest bucks recorded during the study. Very few bucks dressed out over 100 pounds in the Chiricahuas.

Combined yearling and adult dressed weights on the 1959 hunt averaged 71 pounds for bucks and 52 pounds for does. In 1960, however, average buck and doe weights were 65 and 47 pounds respectively. The average loss of six pounds for bucks and five pounds for does was probably a reflection of extremely poor range conditions. It has already been pointed out that summer precipitation was below normal in 1960, and reduced plant growth resulted. The lowest growth on mountain mahogany was measured during this poor year.

Total length of adult deer averaged about 140 centimeters for bucks and 133 for does. Shoulder heights of adult bucks averaged almost 79 centimeters or 2.6 feet; whereas, does were about 73 centimeters or 2.4 feet.

Arizona white-tailed deer are not appreciably larger than the famous Florida Key deer (O. v. clavium) which is reputed to be the

smallest race of deer in North America. Hoffmeister (1962) reports that, "Only O. v. clavium from the Florida keys is as small or smaller than couesi." There are few reliable weights and measurements of Florida key deer available for comparison. Dickson (1955) mentions estimated heights for mature Key deer which ranged from 20 to 28 inches and weights anywhere from 35 to 110 pounds.

Parasites and diseases. No intensive parasite or disease investigation was made on this study. A cursory examination of specimens suggests a low rate of parasite infestation and disease in white-tailed deer.

The most common ectoparasite was biting or sucking lice (Trichodectus odocoilei). Large numbers of these parasites were generally found attached to the hair or hide of the ventral part of the body on all age groups of deer.

Ticks (Dermacenter albipictus) were found on about half of the deer examined, usually on adult bucks. Most of the ticks were located in or behind the ears, along the neck, back or chest, and around the anal region. A few bucks had extensive bare areas on chest and head. These were caused by rubbing areas where ticks had presumably caused irritations.

Nose or throat bots were found in about half of the deer collected during the summer and winter months. Bots are the larval

form of a fly (Cephenomyia sp.). According to Cheatum (1952) adult flies deposit eggs in the deer's nostrils during the warm months. Hatched larvae migrate to the nasal passages where they live and mature. Mature larvae leave the deer in the spring and pupate in the ground. Adult flies emerge in a month or two, mate and begin the cycle again.

Bladder worms or cysticeri were collected occasionally from the body mesentery. This endoparasite is the larval form of an adult tapeworm (Taenia sp.). Deer serve as an intermediate host in the life-cycle of these tapeworms.

A two point buck which was reported to be going around in circles was captured alive in September, 1959 and turned over to the University of Arizona for observation. One week after being captured, the deer weakened from severe diarrhea and was autopsied by Dr. Raymond Reed of the Animal Pathology Department. The animal was totally blind, the cause being a bone infection directly under and around the optic chiasma. Besides secondary infections, there was a heavy infestation of cysticeri around the heart, diaphragm and stomach mesentery. Leonard W. Dewhirst, assistant animal pathologist, tentatively identified the cysticercus as Hydatigera lyncis, although absolute identification was not possible without adult material.

Examinations were made for liver flukes (Fasciolides sp.) and the blood nematode (Eleaophora schneideri), but none were found.

According to Swank (1958) the blood nematode was common in chaparral deer in central Arizona.

Previous mention has been made of skin tumors, papillomas or fibromas, and the frequency of these diseases was extremely low.

A few deer with lumpy jaw were checked during the 1958 and 1959 deer hunts. This is caused by a bacterial infection which usually damages the lower jaw bone and produces uneven tooth wear.

During the 1959 hunting season the Arizona Game and Fish Department cooperated with the State Veterinarian and the Federal Veterinarian Division by collecting blood samples from game animals for brucellosis and leptospirosis tests. Blood collecting tubes were distributed to hunters at two checking stations in the Chiricahuas. Hunters returned 56 samples from both white-tailed and desert mule deer. Tests were negative for this area (Tweed, 1960).

Reproduction. Information on reproduction was obtained from collected specimens, ovarian analyses, and survey data.

Fourteen does were collected between March and August, 1957 through 1960. During this period 11 does were carrying fetuses; two had enlarged uteri, and one had no evidence of pregnancy. One of the specimens with the enlarged uterus was a yearling collected in April, 1960. Unfortunately, the uterus was damaged and no fetus was

found. All of the fetuses appeared normal in development, and there was no sign of fetal resorption (Figures 12 and 13).

Eleven pregnant does had 14 fetuses, or an average of 1.27 per doe. Three of the does or 27 percent had twins and eight contained single fetuses.

Actual observations of twins were rare during this study. Seldom more than one set of twins were reported each year from 1957 to 1963.

Fetuses were aged by the use of the key developed by Armstrong (1950). Table 16 lists the weights, measurements, and approximate ages of fetuses. From collection dates and ages, it was possible to determine the approximate conception date.

Conception or the beginning of fetal development occurred between December 31 and February 25, but the majority conceived between January 19 and the 16th of February. Nichol (op. cit.) observed breeding of white-tailed deer in captivity by January 10 but considered January 18 as the normal starting date. He also reported a gestation period of about 200 days. This means that most of the does examined would have given birth between August 7 and September 4.

Field observations tend to support this finding. Fawn tracks were observed in late June, but no fawns were ever seen until the

Figure 12. Female fetus collected in March, 1960 which is between 66 and 75 days old.

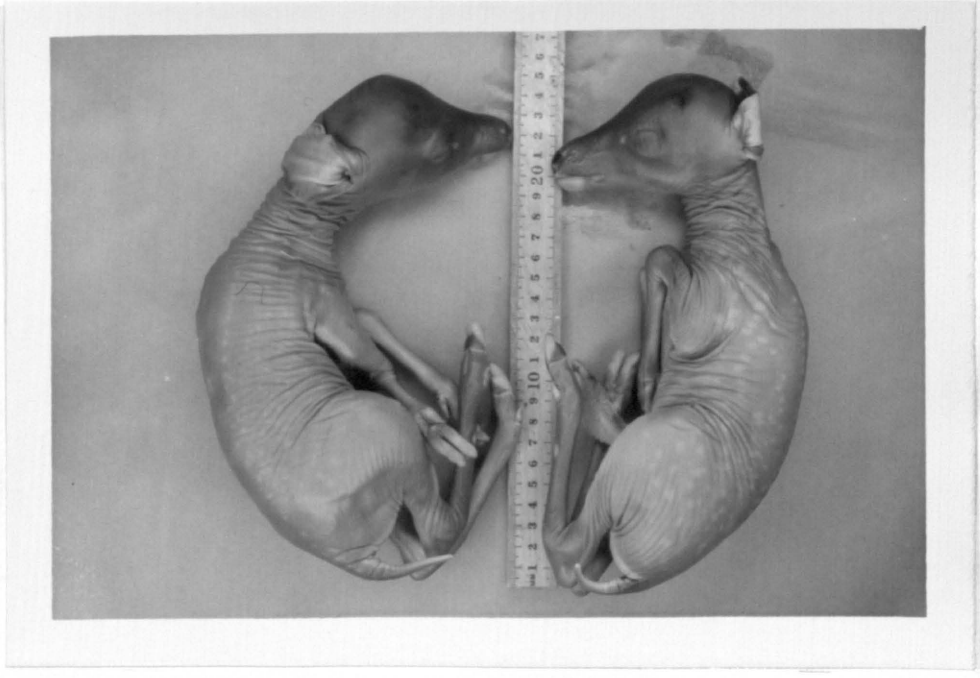


Figure 13. Twin male fetuses collected in June, 1959. Spots are clearly visible between the age of 111 to 120 days.

Table 16. Weights, ages and measurements of white tailed deer fetuses collected from 1957 to 1960.

Doe Number	Single	Twin	Sex	Forehead Rump (mm)	Weight Grams	Estimated Age in Days
1	X		F	320.0	1055.7	133-150
2	X		M	360.0	1718.4	151-180
4	X		M	360.0	1848.4	151-180
15	X		F	245.0	---	111-120
16	X		F	227.1	---	106-110
17		X	M	219.0	475.8	96-105
		X	F	219.6	---	96-105
25		X	M	260.0	760.4	111-120
		X	M	256.0	753.1	111-120
26	X		M	259.0	1090.7	121-132
27	X		F	305.0	1070.4	133-150
29	X		F	105.7	49.5	66- 75
31		X	M	94.5	28.1	66- 75
		X	F	---	---	66- 75

middle of July with the majority being seen in August and September. Peak fawning for the same species of white-tailed deer in the Gavilan River basin of the Sierra Madre Occidental in northwestern Mexico was mid-August (McCabe and Leopold, 1951).

Ovaries were collected during the 1958, 1959, and 1960 any-deer hunts, but only the 1958 sample was large enough to provide information on reproduction. By sectioning the ovaries according to Cheatum (1940), it was possible to determine the number of does conceiving during the previous breeding season.

Table 17 compares three years of ovarian data collected from the Chiricahuas. Findings in 1955 were by White (op. cit.) and in 1956 by Johnson and Swank (1957).

Yearling does were included in the analysis, but only one conceived and this occurred in 1956. Yearlings would have been bred as fawns, five or six months old. Actually few fawns have been found to breed in Arizona. Swank (op. cit.) reports that two of 12 mule deer fawns bred on the Kaibab in 1951. Cheatum and Severinghaus (1950) reported pregnancy rates of 30 percent in eastern white-tail fawns on good deer ranges, but about four percent on poor deer ranges in New York state.

The percent of does conceiving was 78.7 in 1955, decreasing to 65.5 percent in 1956, and then returning to 78.7 percent in 1958. In 1955 and 1958 the conception rate was over 95 percent in mature

Table 17. Three years of ovarian analysis data from the Chiricahua white-tailed deer herd.

Categories	1955	1956	1958
Number ovaries	33	29	61
Number conceiving	26	19	48
Percent conceiving	78.7	65.5	78.7
Number corpora lutea	42	31	68
Average corpora lutea per doe	1.27	1.07	1.11

deer, but it was only 70 percent in 1956. Even though the conception rate was high in 1955 and 1958, the corpora lutea counts remained low.

Stomach analyses. During the November, 1958 hunt 120 white-tailed deer stomachs were turned in by hunters at four checking stations. This sample comprised about 24 percent of the total deer checked at the stations.

The stomach samples represented only a portion of the total stomach contents of the deer. Many of the samples contained plant material that could not be identified. Some of these items were forb species which evidently disintegrate rapidly in the deer's stomach.

The frequency of occurrence of plants identified in the stomach samples is given in Table 18.

Of the plants identified, mountain mahogany had the highest rate of occurrence in the stomach samples. Mahogany foliage was found in 69 or 57.5 percent of the stomachs. Next highest was juniper foliage and berries, which occurred in 58 stomachs or 48.4 percent. Mearns sumac berries and acorns were also high in occurrence. Several unusual items found were dried seeds of both century plant and yucca, and cultivated apples (Malus sp.) and alfalfa (Medicago sativa).

It has already been pointed out that mountain mahogany is an important winter deer food in this mountain. Mahogany plants are

Table 18. Plant species found in the contents of 120 white-tailed deer collected on the November, 1958 deer hunt.

Food Items Scientific Names	Part Taken	Total Occurrences	
		Times	Percent
Agave sp.	seeds	6	5.0
Arctostaphylos sp.	foliage	3	2.5
Bumelia lanuginosa	foliage	3	2.5
Ceanothus Greggii	foliage	7	5.8
Cercocarpus breviflorus	foliage	69	57.5
Fallugia paradoxa	foliage	3	2.5
Garrya Wrightii	foliage	37	30.8
Juniperus sp.	foliage-berries	58	48.4
Malus sp.	fruit	3	2.5
Medicago sativa	foliage	1	.8
Mimosa sp.	foliage-seeds	3	2.5
Phoradendron sp.	foliage	18	15.0
Pinus spp.	foliage	2	1.7
Quercus arizonica	foliage	18	15.0
Quercus Emoryi	foliage	4	3.3
Quercus grisea	foliage	9	7.5
Quercus spp.	acorns	43	35.8
Rhus choriophylla	foliage-berries	53	44.2
Solanum elaeagnifolium	fruit	1	.8
Vitus arizonica	foliage	7	5.8
Yucca sp.	seeds	6	5.0
Ferns unknown	foliage	4	3.3
Grasses unknown	foliage	9	7.5
Legume unknown	seeds	12	10.0
Mushrooms unknown	complete	1	.8
Shrub unknown	foliage	2	1.7

well distributed in the mountain and high frequency of use at this time of year can be expected.

Juniper, of course, is one of the most abundant plants in the lower elevations, and a high rate of use might be expected even though it is low in forage value. Juniper berries were abundant which may have attracted deer to the plant more than the foliage.

There was an excellent crop of acorns and berries throughout the mountain during the 1958 hunt. Acorns from both Arizona and Gambel oaks were evidently preferred by deer if they were available. This also applied to Mearns sumac berries. Deer were probably after the red berries on this plant rather than the foliage, because little use has been observed on this plant. Mearns sumac is only locally abundant in the mountain, but it was found in over 44 percent of the stomach samples.

Table 19 lists the estimated percentage of volume for plant species identified in 30 stomachs from deer specimens collected on this study. Not enough samples were obtained during each season to permit a seasonal-use comparison. Stomach samples were separated into three major areas with similar vegetation types: (1) Barfoot, (2) Rucker, and (3) Paradise and Hands Pass.

Ten deer stomachs were collected in the vicinity of Barfoot (7500'-8200'). In this area three conifers, white fir, Douglas fir, and juniper, comprised 42 percent of the total plant volume. Another 25

Table 19. Plants identified from 30 white-tailed deer stomachs collected from 1957 to 1960.

Food Items Scientific Names	(10 Deer)* % Volume 7500'-8200'	(8 Deer)* % Volume 5700'-6100'	(12 Deer)* % Volume 5700'-7400'
Abies concolor	23.6	---	---
Agave Palmeri	---	---	5.4
Arbutus arizonica	5.0	---	3.1
Arctostaphylos sp.	---	5.9	T
Boerhaavia sp.	---	---	T
Ceanothus Fendleri	T	---	T
Ceanothus Greggii	---	---	6.9
Cercocarpus breviflorus	T	4.4	18.8
Cirsium sp.	5.3	---	---
Cowania mexicana	---	T	---
Fallugia paradoxa	---	11.2	---
Garrya Wrightii	1.5	5.0	21.4
Holodiscus dumosus	T	---	---
Juniperus sp.	6.2	21.5	13.7
Lupinus sp.	T	---	---
Mimosa sp.	---	T	4.8
Nolina sp.	---	9.4	.2
Philadelphus microphyllus	T	---	---
Phoradendron sp.	2.6	4.5	7.0
Pinus cembroides	---	T	T
Pinus leiophylla	---	---	T
Pinus ponderosa	T	---	---
Populus tremuloides	4.0	---	---
Pseudotsuga taxifolia	12.3	---	---
Pteridium aquilinum	T	---	---
Quercus arizonica	1.9	11.6	1.4
Quercus Emoryi	---	2.2	3.7
Quercus Gambelii	23.5	---	---
Quercus hypoleucoides	T	T	T
Quercus reticulata	.1	---	T
Rhus choriophylla	---	T	.4
Robinia neomexicana	4.5	---	.4
Symphoricarpos sp.	T	---	---
Yucca sp.	---	---	T

Table 19. (Continued)

Food Items Scientific Names	(10 Deer)* % Volume 7500'-8200'	(8 Deer)* % Volume 5700'-6100'	(12 Deer)* % Volume 5700'-7400'
Ferns unknown	T	---	T
Forbs unknown	5.9	23.7	11.0
Grasses unknown	3.6	.5	1.8
Lichen unknown	T	---	---
Mushroom unknown	T	---	---

*Ten deer collected in the vicinity of Barfoot, eight deer near Rucker, and 12 deer near Paradise and Hands Pass.

percent consisted of Arizona oak, Gambel oak, and netleaf oak (Q. reticulata). Desirable browse species such as mountain mahogany and silk-tassel were not abundant at this elevation. Forbs were an important part of the diet of deer during the summer months, but conifers and oaks were still heavily eaten.

Eight stomachs from the Rucker area (5700'-6100') were analyzed. Forbs and juniper made up 45 percent of the stomach contents. The forb species were abundant in the spring and summer stomach samples; whereas, the bulk of the juniper was eaten during the winter months. This area is primarily a mixture of oak-juniper and grassland. Good deer browse species are available but not abundant.

At the Paradise and Hands Pass areas, 12 deer stomachs were collected between elevations of 5700 and 7400 feet. The presence here of excellent stands of deer browse was reflected in the stomach analyses, and the two most abundant food items were silk-tassel and mountain mahogany. Both of these species were found in stomachs collected during each season of the year. Juniper and forb species were also found to be an important part of the deer's diet at this elevation.

Even though a small number of stomach samples were collected from each area, the analyses do indicate some of the important food items eaten by deer in this mountain. Most important was

the large quantity of coniferous material in the diets at the different areas. In the higher elevations deer were forced to eat coniferous species in the winter months because little else was available. Use of conifers in the lower elevations was restricted primarily to juniper. During periods of over-use on desirable browse plants, deer were undoubtedly forced to eat more juniper. Juniper, however, remained an important part of the diet of deer even when range conditions began to improve. Smith (1959) reported that juniper taken alone did not appear to be a satisfactory food, but when taken with other food items it was a valuable part of the diet of mule deer.

CHAPTER VI.

DISCUSSION AND CONCLUSION

The data obtained on this study from June, 1957 to May, 1963 support three major conclusions:

1. The white-tailed deer population in the Chiricahua Mountains was too high for the carrying capacity of the range during the first two years (1957 and 1958) of this investigation.

2. The white-tailed deer were primarily responsible for the severe over-use that killed some of the important browse plants in the mountain.

3. Deterioration of the browse plants from over-use by deer was a major factor in the decline of the white-tailed deer herd.

There has been very little information published on the status of the deer herd in the Chiricahuas prior to 1953. Probably one of the first reports on conditions in the mountain was a newspaper article (1929) which reported on an investigation by the Biological Survey, Forest Service, and the Arizona Game and Fish Commission. Personnel from the above agencies estimated the deer population at 2500 animals in the Chiricahuas. The article went on to state, "It is not

felt that there is a surplus as yet, although one will develop if precautions are not taken."

Ten years later Cahalane (1939) reported, "Deer were rapidly increasing in the Chiricahuas in 1933 and in the higher elevations they were too abundant for the carrying capacity." He also noticed and referred to excessive browsing, "Along the principal deer trails the scrub oaks had been so repeatedly cropped that many were dead and most of those still living were clubbed and stunted. The depletion of food was becoming a serious problem at this time."

The circumstances described for 1929 and 1933 are probably similar to the problems found in this study, but it is not likely that they are related. Periodic herd fluctuations in the past are well known for the North Kaibab in Arizona and are probably not uncommon in other mountain ranges of the state.

Wallmo (1963) in a personal communication with the writer reported that the white-tailed deer population in the Chiricahuas was not as high in 1948 as that reported in the 1950's by Gallizioli (op. cit.), Day and Gallizioli (op. cit.) and White (op. cit.). Wallmo's field notes on game surveys in the mountain from October 20 to December 10, 1948 indicated a productivity of 82 fawns per 100 does which was based on a sample of 91 does and fawns. He also found a high rate of twin fawns in 1948. It has already been pointed out that 43 fawns

per 100 does was the highest found from 1955 to 1962, and twin observations were seldom seen during this period.

The productivity in 1948 suggests that the deer herd in the Chiricahuas was beginning to increase. It would take but a few years of similar fawn crops and a high survival for the deer herd to reach the high level reported in the 1950's. Rapid expansion of deer herds is not uncommon and such may have been the case in the Chiricahuas.

All of the data collected on this study indicates that the deer herd in the Chiricahuas was greatly in excess of the range carrying capacity from 1953 to 1958. This high deer population produced severe over-use on both desirable and undesirable plants. High-lining on plants was obvious and common throughout most of the mountain. Important winter deer foods such as mountain mahogany and silk-tassel were permanently damaged by over-use. Dead and dying plants were not uncommon in 1957, and the dead stumps were still present as mute evidence of the conditions even at the completion of this study in 1963.

The first indication of a deer decline was reported by Day (1956). Ranchers on the west side of the mountain began finding dead white-tails in the spring of 1956 before the summer rains. Data accumulated from 1957 to 1963 indicates a continuing decline in the deer herd up until 1962.

Deer harvests during the period of excess deer were not large enough to lower the herd size and alleviate browse over-use. Buck hunting was in effect until 1955, when the first antlerless hunt was recommended. Antlerless hunts in this mountain were opposed by local sportsmen groups, and consequently their potential effectiveness was never fully realized. Even with better acceptance of the antlerless hunts it is questionable whether the die-off could have been averted. The first two antlerless hunts in 1955 and 1956 were conservative, because no one at this time actually knew how serious the deer problem was in the Chiricahuas.

There probably is no single condition that caused the deer population to decline in the mountain. Undoubtedly a swollen deer herd, severe over-use of browse, and inadequate harvest were of major importance in the deer decline. However, another important factor to consider is the age and condition of the deer browse. Many of the mahogany and silk-tassel plants are now over six feet tall and provide little forage for deer. Less desirable species such as oaks and junipers have also increased in size and abundance. These plants dominate the vegetation; consequently, seedlings of such preferred species as mahogany and silk-tassel are not abundant.

As trees and shrubs continue to mature in the Chiricahuas there will be even less food available for deer. Thus, the deer

population will probably remain at the 1963 level or fall even lower unless some change occurs in the habitat.

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