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INTRODUCTION

The Beaver Creek Watershed Project was organized in 1957 by the U. S. Forest Service and various cooperators to test methods of improving yields of water and other products on pine and pinyon-juniper watersheds by means of vegetation treatments (Worley, 1965). Evaluation studies have been concerned with water yields, sediment loss, timber and forage production, wildlife use, and aesthetics. The Beaver Creek pilot watersheds are providing the basic data for economic models which will be used to plan more effective land management for the entire Salt-Verde basin.

Initial treatments were extreme, involving complete removal of all overstory vegetation. Later treatments were designed to refine the results by testing various degrees of overstory removal as well as various methods of removal. Techniques used to date (See Table 1) include aerial application of herbicides (Fig. 1), clearcutting, pushing and cabling in the pinyon-juniper types; clearcutting, stripcutting (Fig. 2), and thinning in the ponderosa pine type. Logging debris has been burned, windrowed, or left scattered. Some treatments have included reseeding with grasses and legumes. Status of treatments and evaluations was recently summarized by Brown (1970, 1971).

The Arizona Game and Fish Department was one of the original cooperators in the Project, and a research biologist has been assigned part or full time to the study of wildlife habitat changes on Beaver Creek since 1957. Robert Jantzen, Clay McCulloch, and O.C. Wallmo preceded the writer on this assignment.

Deer food habits studies by rumen content analysis from hunter kills and special collections were begun in 1959 (McCulloch, 1960). However, by 1962-63 a widespread decline in deer numbers had made deer collections impracticable, and Wallmo turned to the use of tame deer for field forage sampling.

The standard methods of rumen content analysis require the killing of the subject, which is acceptable only if the animals are available in large numbers. The availability of forage at the time and place of feed intake is usually unknown, and herbaceous materials tend to be underestimated because of their relatively rapid passage through the rumen (Medin, 1970; Norris, 1943). The observation of wild deer feeding-minutes is likewise very difficult when the deer density is low, and it is often not possible to determine exactly what species and plant parts the deer are taking. Feeding studies with penned animals have produced classic results in some cases (Nichol, 1938; Smith, 1953) but only a limited and artificial choice of forages can be offered to the deer. The use of tame deer in field feeding trials answers these objections while admittedly introducing some new ones.

The history of the technique was recently reviewed by Wallmo and Neff (1970). Briefly, investigators such as Dixon (1934:108), Dunkeson (1955), and Brown (1961) have found it expedient to employ semi-tame animals for observation of feeding behavior either in enclosed pastures or at large. Wallmo (1951) observed tame and wild antelope grazing together in a fenced enclosure and recognized the potential value of tame animals for food habits studies. However, employment of specially trained animals in systematic food habits research was first carried out by McMahan (1964) in Texas. He compared the food habits of deer with those of cattle, sheep and goats in experimental pastures under various grazing intensities. Watts (1964) and Healy (1971) used harnessed white-tailed deer for feeding studies in unfenced Pennsylvania woodlands. In 1963 Wallmo raised several fawns in a pen at Flagstaff. Various types of harness and other procedures and equipment were tested, including simply turning the deer loose and relying on a psychological tie rather than a physical one (Wallmo, 1964). This free-ranging technique was later perfected in deer habitat studies in Colorado (Wallmo, Regelin, and Reichert, 1972; Reichert, 1972).

Table 1. Characteristics of treatments on Beaver Creek Pilot Watersheds, 1958 to 1972.

Watershed Number	Vegetation Type	Acreage	Date of Treatment	Type of Treatment
1	Utah	332	1963	Cabled, slash burned, reseeded
2	Utah	126	--	Untreated control
3	Utah	362	1967	Fuelbreaks pushed, foliage desiccated with aerial spray; burn failed
			1968	Overstory killed, aerial spray
4	Allig.	346	--	Untreated control
5	Allig.	66	--	Untreated control
6	Allig.	104	1965	Felled
7	Pine	2036	1958	Thinned, Gambel oaks poisoned
8	Pine	1802	--	Untreated control
9	Pine	1121	1968	Regular 1/3 stripcut, slash burned
10	Pine	571	--	Untreated control
11	Pine	188	1958	Clear-cut, slash burned, reseeded
			1967-72	Spring-fall cattle grazing
12	Pine	455	1967	Clear-cut, slash windrowed
13	Pine	910	--	Untreated control
14	Pine	1349	1970-71	Irregular 1/3 stripcut, slash burned
15	Pine	163	--	Untreated control
16	Pine	252	1971	Irregular 2/3 stripcut, slash burned
17	Pine	299	1969	Thinned to 25 sq. ft. basal area, slash windrowed or scattered
18	Pine	242	--	Untreated control

Figure 1. Herbicide-killed juniper overstory on WS-3, with abundant pioneer crop of annual grass, August, 1969. U.S. Forest Service Photo.

Figure 2. Regular stripcut treatment on WS-9 with incomplete slash disposal, March, 1969. Leave strips are not thinned. U.S. Forest Service photo.

THE STUDY AREA

The Beaver Creek Watershed (Fig. 3) lies in the Coconino National Forest, on the east flank of the Verde River valley above the town of Camp Verde. The watershed comprises about 472 square miles, heading up on the high divide between Happy Jack and Munds Park and draining southwesterly.

The Beaver Creek Project includes 18 numbered pilot watersheds of relatively small size (66 to 2036 acres) and two large watersheds, Woods Canyon (11,000 acres) and Bar-M (17,000 acres). Each watershed is equipped with a flume for streamflow measurements and a variety of weather instruments. All treatment and evaluation activity to date (Table 1) has been on the pilot watersheds.

Three pilot watersheds (WS-1, 2, 3) lie in the Utah juniper type below Round Mountain, south of the Stoneman Lake Interchange on I-17 (U. S. 79) at an elevation of 5,000 to 5,800 feet. Three watersheds (WS-4, 5, 6) lie in the alligator juniper type on the north side of Apache Maid Mountain at 6,200 to 6,500 feet. Eight watersheds (WS-7 through 14) lie in the ponderosa pine type at 6,400 to 7,700 feet in the line of hills extending from Fain Mountain south past Stoneman Lake to Bill Back Butte. The T-6 group of watersheds (WS-15 through 18) is located at 6,700 to 7,200 feet near T-6 Springs north of Woods Ranch.

Geology and Soils

Virtually the entire upper end of the Beaver Creek watershed, including all the pilot watersheds, is covered by basalt flows and cinder cones. The sole exception is an exposure of about 300 acres of Kaibab limestone along the main weir road in Rocky Gulch, a half-mile south of WS-11. According to geological studies by Rush (1965) and Beus, et al, (1966) there have been three or possibly four major periods of volcanic activity at Beaver Creek, including two periods of lava flow and a period of cinder cone building. Depth of lava beds over the underlying formations is estimated to be as much as a thousand feet. The present stream flow pattern is the result of the general southwestern slope of the pre-existing topography and the surface conformation of the lava flows and cinder cones. The resulting terrain is a series of gently sloping mesas dissected by deep canyons in the lower juniper country, and rolling to steep ridges and hills with large open parks in the pine type.

A soil survey of the entire Beaver Creek drainage was conducted by Williams and Anderson (1967). Twenty nine different soil series were described, only six of which were included in the areas sampled by the tame deer. All sample area soils in the Utah and alligator juniper were classified as Springerville very stony clay. In the ponderosa pine type sampling sites included areas of Brolliar (Stoneman), Siesta and Sponseller soils, all of which are deep well-drained soils of fair to good value for timber and forage production. Also included within the pine type are small more or less bald areas of Cabezon and Gem soils which are fair to good for grasses and forbs but poor for tree growth.

Vegetation

Three principal vegetation types are recognized in the Beaver Creek pilot watershed areas: Utah juniper, alligator juniper, and ponderosa pine (Fig. 3). There are relatively small inclusions of chaparral, wet meadow, riparian and mixed conifer within the major vegetation types. (See Appendix I for technical and common names of plants).

Utah Juniper Type

Pinyon-juniper woodland is widespread in Arizona although the species composition varies considerably in different areas. South of the Mogollon Rim the woodlands include alligator juniper, Utah juniper, and one-seed juniper (Arnold, Jameson and Reid, 1964), but the latter is rare on Beaver Creek. Alligator juniper is easily identified by the checkered bark;

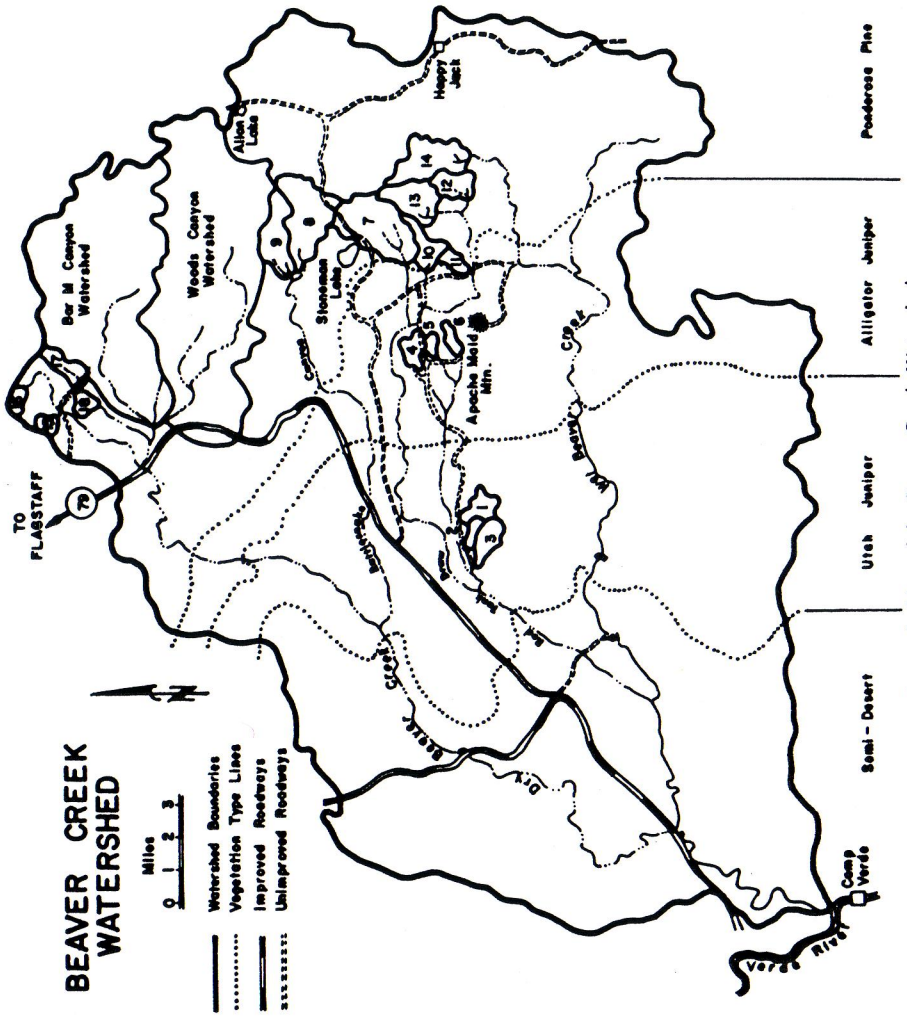

Figure 3. Map of the Beaver Creek Watershed

Utah and one-seed juniper are very similar in appearance and no effort was made to differentiate between them in the field trials.

Overstory stand composition on the Utah juniper watersheds is almost entirely juniper, with only small amounts of pinyon pine. According to an overstory inventory by Ffolliott (1965a) 85 to 89 percent of the Utah juniper stems on WS-2 and WS-3 were less than 13 inches in diameter. These are the juniper invaders which were described by Leopold (1924) and Miller (1921) fifty years ago, which have been the subject of recent investigations (Johnsen, 1962; Arnold, Jameson and Reid, 1964), and which provided much of the impetus for the initiation of the Beaver Creek Project (Wingfield, 1955).

The shrub understory is dominated by shrub liveoak in most of the sample areas, but also includes manzanita, cliffrose, mountain-mahogany, desert ceanothus, silk-tassel, and hollyleaf buckthorn. Shrub stands are best developed on the ledges and steep slopes along the canyons and on the rims and slopes of the old basalt flows and cinder cones.

Vegetative ground cover varies from nil under dense tree canopy to varied and productive in open savannah-like stands. According to Jameson and Dodd (1969) the Springerville heavy clay soils are relatively unproductive of forage when tree cover is appreciable. Arnold, Jameson and Reid (1964: Fig. 13 and 15) reported a severe decline in understory forage production with increasing pinyon-juniper canopy.

Methods of pinyon-juniper tree removal were discussed by Arnold Jameson and Reid (1964). The results of cabling on WS-1 at Beaver Creek were discussed by Clary (1971), who found that the increase in ground vegetation was notable, but most of it was unpalatable snakeweed and goldeneye.

Alligator Juniper Type

At Beaver Creek the alligator juniper type is a zone from one to five miles in width lying between the Utah juniper type and the ponderosa pine type. Some of this area is an open savannah, and much of it has been cleared of all juniper. The swales and gulches are occupied by ponderosa pine stringers. Alligator junipers are also found widely scattered through the ponderosa pine, Utah juniper and chaparral types.

The watersheds in the alligator juniper type are 1000 feet higher and a couple of inches wetter than the Utah juniper watersheds, and are correspondingly more productive of forage plants (Brown, 1970: Tables 1 and 2). Basal area per acre of all tree species is only about ½ that of the Utah juniper watersheds (Ffolliott, 1965b). Again, the pinyon pine is only a minor component of the overstory and the great majority of the juniper stems are in the small size classes, indicating recent invasion of trees into former savannah-grasslands.

Ponderosa Pine Type

The Stoneman Lake group of pine watersheds is cutover forest, last logged in 1950-55. The 1962-65 overstory inventory (Ffolliott, 1966) showed that ponderosa pine was the dominant species, with mean basal area estimates between 72 and 86 sq. ft./acre. Gambel oak basal area varied from 8.8 to 16.6 sq. ft./acre, alligator juniper from 0 to 19 sq. ft./acre, with only a trace of aspen (on WS-8).

Water yield in the pine type is primarily from spring snow melt (Brown, 1970) and snowpack management has been a subject of great interest to the Beaver Creek Project (Ffolliott and Hansen, 1968). The relationship of timber overstory to understory forage production was the subject of research efforts at Wild Bill, northwest of Flagstaff (Pearson and Jameson, 1967) as well as on the Beaver Creek pilot watersheds (Clary and Ffolliott, 1966). Herbage production is negatively related to overstory density in both areas. Chemical control of Gambel oak was attempted on WS-7 in 1958 and resulted in profuse production of root sprouts (Johnsen, et al, 1969). Clear-cutting of oaks on WS-12 in 1967 produced similar results. Gambel oaks of all ages are generally abundant over the pine watersheds and offer forage, mast and

denning sites for a great variety of wildlife (McCulloch, Wallmo and Ffolliott, 1965; Reynolds, Clary and Ffolliott, 1970).

Wildlife Use of Beaver Creek Pilot Watersheds

Mule deer are year-round residents of the Utah juniper watersheds and the adjoining canyons and breaks. However, the majority of the mule deer make the 8 to 12-mile march up into the pine type in April for the summer fawning season. They move down again with the first storms of winter, usually in December. Elk tend to remain higher than the mule deer, usually dropping down no farther than Round Mountain in winter and moving up again during the dry weather periods in midwinter and early in spring. Brushy south-facing knobs and ridges in the higher elevations are favored by elk as wintering grounds. Coues white-tailed deer are found in small numbers on the brushy southwest face of Apache Maid Mountain and in the canyons and gulches leading up into the pine type. A remnant population of antelope frequents the broad benches from Mud Tanks Mesa to Apache Maid. Only 90 to 100 were counted in this area (Unit 6A) in 1970 compared to the 600 to 700 found there in the late 1950s (Arizona Game and Fish Dept., 1970).

Turkeys are found throughout the study area, moving higher into the pine type in summer and dropping down into the pine stringers and juniper types in winter. Javelina are summer residents on the Utah juniper watersheds and on one occasion three were seen by Biologist Harley Shaw in the pine forest on WS-8.

Coyote and gray fox tracks are commonly seen in the snow throughout the juniper types in winter, and occasionally in the pine type. Both species are occasionally seen during spotlight counts of deer and elk in the summer. Bobcats are apparently less common and are rarely seen. Mountain lions and black bears are present throughout the area.

Waterfowl and herons are commonly seen on the stock tanks of the area, as well as on Stoneman Lake. Coots are the most abundant species in summer. Band-tailed pigeons and mourning doves nest in the area and there are a few Gambel's and Mearns quail. Bald eagles, red-tailed hawks, goshawks, sparrow hawks and other raptorial birds are commonly observed.

Cottontails and blacktailed jackrabbits are present in modest numbers and find refuge in the slash-piles in the juniper clearings. Snap-trap sampling in the summer of 1971 indicated fair numbers of woodrats in the juniper types, along with deer mice, white-footed mice, and harvest mice. Pocket gophers are common to abundant in areas of suitable soil depth in the pine type.

Songbirds are abundant and varied. Bluebirds and various woodpeckers are the most prominent summer forest birds. Violet-green swallows, martins, white-throated swifts, and nighthawks are frequently observed soaring over the open meadows. Clear-cut watersheds are attractive to several species of the grassland persuasion, including meadowlarks, horned larks, and lark sparrows. The weed seeds abundantly produced on areas of disturbed soil in the Utah juniper are sought out in winter by mourning doves and by flocks of pine siskins, juncos, and white-crowned sparrows. Shrub liveoak thickets are the favorite haunts of the rufous-sided towhees.

Location of Sampling Areas

Feeding trials were conducted on 12 of the 18 Beaver Creek pilot watersheds, and on several other areas which offered a treatment or vegetation condition of interest. Road conditions prevented sampling in several otherwise attractive areas. A detailed description of the sampling locations is given below.

Utah Juniper Type (Fig. 4):

Watershed 1. Trials were conducted from the stream gauge and from the work road up the center of the valley. The lower half of the watershed below the basalt rim was covered, but only one trip was made up onto the bench above the rim.

Other Treated. These trials were made in the juniper push south of Stoneman

Lake interchange along the old Blue Grade road. The area includes a broad open swale and a brushy hillock marked by a USCGS benchmark (Tell-5277). Four trials were made in the pushed area about three miles up Stoneman Lake Road in Section 21.

Watershed 2. Only four trials were made on the watershed, two from the stream gauge and two from the road near WS-1 stream gauge.

Other Untreated. A number of trials were made in standing juniper near Boiler Tank on the Blue Grade road south and southwest of the Tell benchmark. Another series was conducted in the vicinity of Hunting Tank farther up Stoneman Lake Road. This area included alligator juniper and pine stringer as well as Utah juniper. The third area was a shallow cove in the rim of Rattlesnake Canyon, overlooking the USGS stream gauge, a mile west of Stoneman Lake interchange on I-17.

Watershed 3. The lower half of the watershed was sampled from the stream gauge or from the road at the corner of WS-2. Some trials followed the canyon rims above and below the stream gauge. Vegetation conditions included bulldozed fuelbreak, standing live juniper, and standing herbicide-killed juniper.

Alligator Juniper Type (Fig. 4):

Watershed 4. Four trials were made from the main road into the southwest corner of the watershed.

Watershed 5. All trials were made from the stream gauge and covered the lower two-thirds of the watershed.

Watershed 6. All trials were made from the stream gauge and covered the lower half of the watershed, with feeding concentrated in the rocky brushy breaks close above the stream gauge.

Ponderosa Pine Type (Fig. 5):

Watershed 8. Much sampling was done in the Divide Tank-Jones Mountain burn area and on the hill to the north. This area is actually just outside the watershed. Trials were also conducted along the north base of Lake Mountain south and west of Butch's Tank. Several trials were run along the work road above the stream gauge to Bill Back Spring.

Watershed 9. The steep slopes above the stream gauge were sampled a number of times, while recent logging roads used in the treatment work opened up access to the meadows of the upper end and along the south boundary ridge.

Watershed 10. All trials were made from the stream gauge, covering the lower slopes below the steep bluffs, and with excursions along the meadow fringe below the watershed.

Watershed 11. The entire lower half of the watershed was covered from the stream gauge and from the north gate off the WS-13 road.

Watershed 12. The lower half of the watershed was worked from the stream gauge and from the work road running from the southeast corner up through the center of the watershed.

Watershed 14. Only the southwest corner was sampled since before treatment the work road was too rough to travel with the deer in the truck. The sampled area was from the west boundary to the gulch, up as far as the work road crossing.

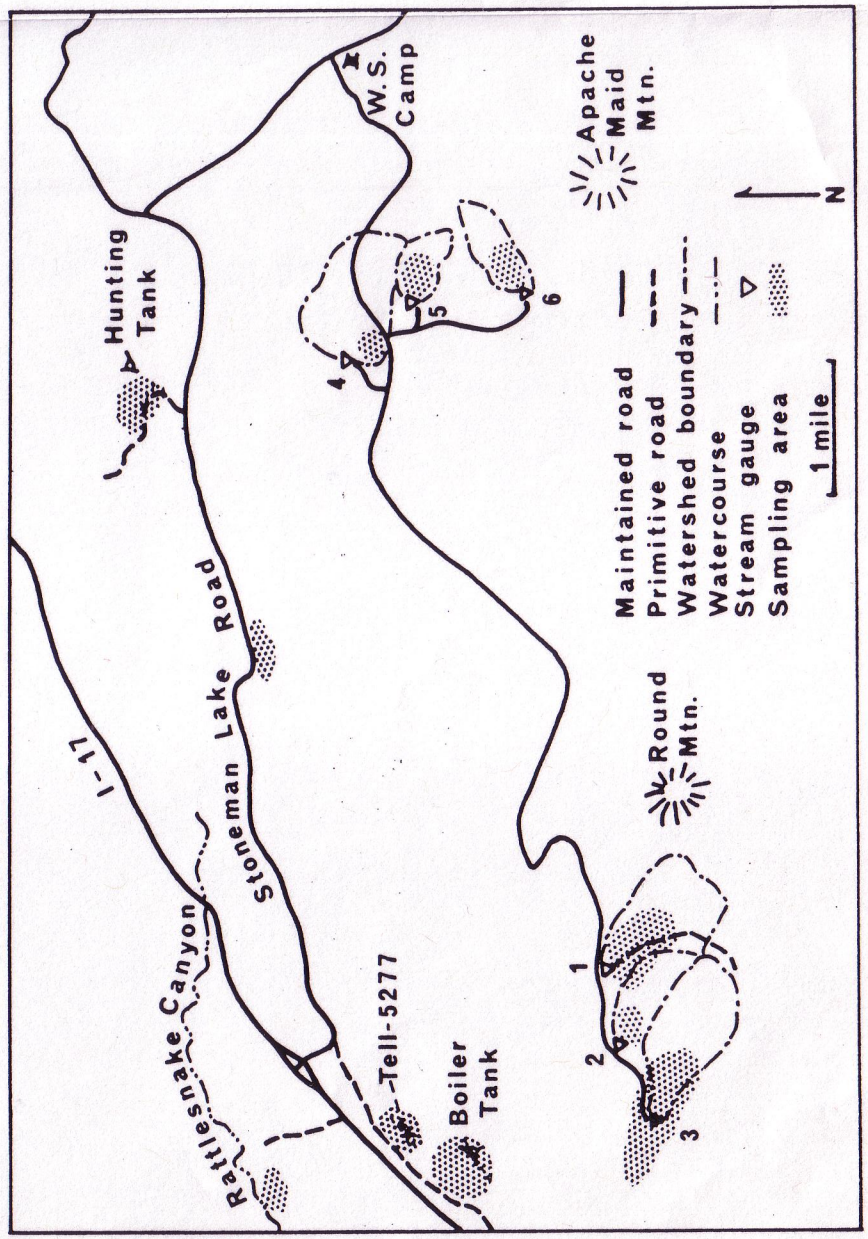

Figure 4. Map of the Utah and alligator juniper sampling areas.

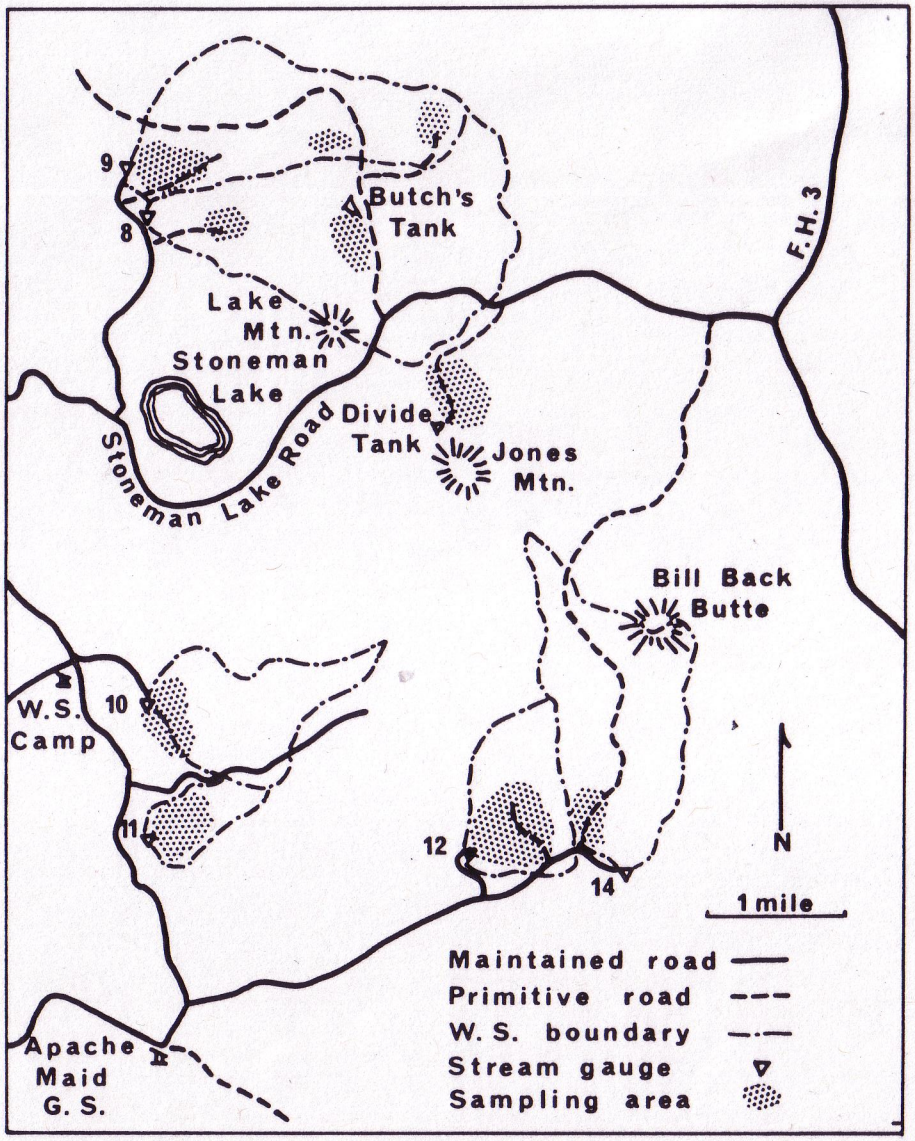

Figure 5. Map of the ponderosa pine sampling areas.

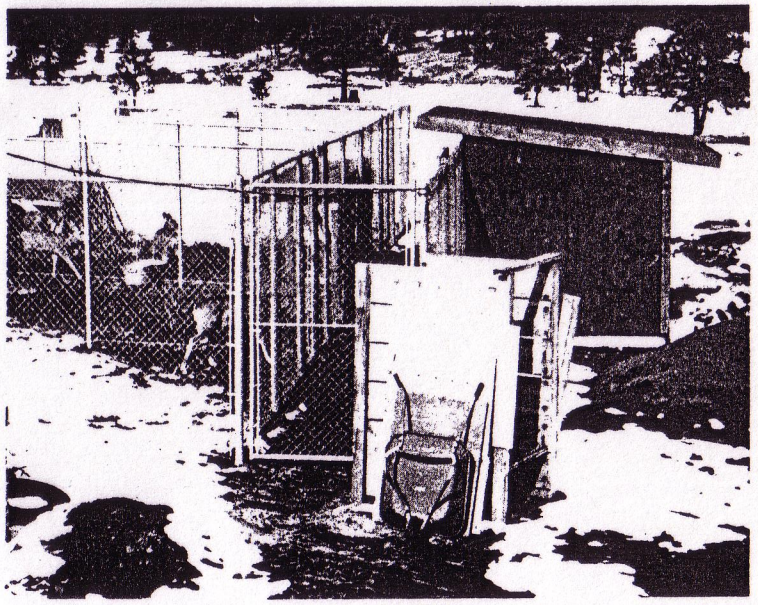

Figure 6. The Flagstaff deer pens with loading chute and storage shed.

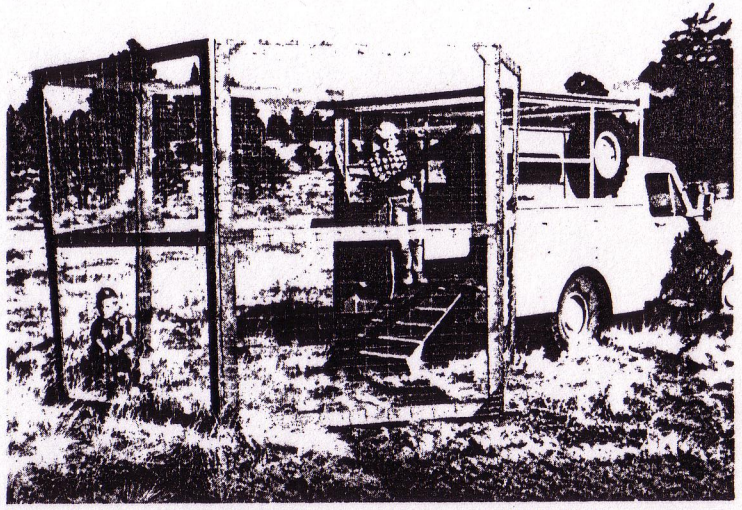

Figure 7. Utility pickup designed to transport deer, with field loading ramp and portable holding pen.

Figure 8. Yearling mule deer buck in harness. Photo by Gertrude Cortright.

Figure 9. Mule deer fawns collected on the North Kaibab in July, 1965.

Methods

Equipment and Facilities

Tame deer are still wild animals who are easily frightened by loud noises and sudden movements. The first requirement for employment of such animals in field trials is the design and construction of facilities which are escape-proof, which work quietly and smoothly, and which reduce the chance of injury to a minimum.

Pens.— Two sets of pens were needed, a home pen at Flagstaff and a holding pen in a central location at Beaver Creek. The first pen built by Wallmo at Flagstaff had not proved adequate, and with his assistance a larger set of pens was designed. The result (Fig. 6) was a complex of four adjacent pens, each 15 by 50 feet, joined across one end by a runway 5 feet wide which permitted movement of deer between pens and out to the loading chute. A storage shed was built beside the runway. All fencing was 8-foot high galvanized cyclone fence with steel posts and a concrete sill under the perimeter fence. At a later date a 6-foot mesh-wire fence was erected 8 feet outside of the perimeter fence to keep the local dogs at a distance. All pens were equipped with bed shelters, feed shelters and troughs, and water tubs.

Vehicles.—The deer were transported to the field in a compartment in the back of a carryall truck, and later in a small van. Neither was satisfactory, and in 1966 a utility-bed pickup was acquired (Fig. 7) with a closed compartment in which deer could be carried without danger of injury from sharp edges and protruding wheel wells. The truck was fitted with a portable ramp which was removed for loading at the Flagstaff pen and replaced for loading and unloading deer in the field.

Deer Harness.—A harness was made of web belting with one strap encircling the neck, another around the body behind the front legs, with the two joined by a hook or strap at the withers (Fig. 8). The leash snapped into both straps at the brisket. The first models were stitched together all in one piece. However, if a deer spooked while being harnessed and ran away with only one strap buckled, the flapping of the loose ends increased the deer's alarm. On two occasions when this occurred a loose snap caught on the fence and the deer panicked. To avoid such problems the two straps were separated and were put on the deer one at a time and then snapped together. Later, deer were harnessed in the truck compartment where they could mill around, but could not run off. The harness was put on immediately before the deer were released from the truck and was removed immediately after reloading.

Collecting and Handling Fawns

Three mule deer were left in the Flagstaff pen when Wallmo left the project. One died and the other two refused to work for their new trainer, a not unexpected event. Plans were made for the collection and training of new fawns in the summer of 1965.

In June, 1965, Research Division personnel assisted by Explorer Scouts from Post 431, Phoenix, captured seven newborn mule deer fawns on the North Kaibab (Fig. 9). In early August two fawns were taken on the Mogollon Rim near Chevelon. Two more were confiscated from persons who were keeping them as pets contrary to state law. Fawns were captured by driving the back roads until a doe was seen who appeared nervous or reluctant to flee. A search was then made for a hidden fawn. A second generation of fawns was raised in the pens in 1967. Five does were bred (four of them as yearlings) by one mule deer yearling buck, and produced seven fawns. Two more fawns were confiscated.

A total of 20 fawns were born in the pens, captured, or confiscated during this study. Seven were successfully trained for field feeding trials and five were used only for pen feeding trials or for other experimental work at Tucson. Seven fawns died of gastroenteritis or other internal infections and one died from accidental injuries.

A vital part of the training process was the imprinting of the newborn fawns by replacing the mother doe with the human trainer (Reichert, 1972). This was quickly accomplished by bottle-feeding at frequent intervals. Bottles were standard 8-ounce baby bottles with enlarged nipple holes. The formula was 3 parts condensed milk and 5 parts water. Feedings were 4 times daily at first and 4 ounces per feeding. Within a few days they were up to 8 to 10 ounces at each of 3 feedings a day, a total of 22 to 30 ounces per day. Diarrhea was frequent and was treated with kaopectate and small doses of tetracycline. Various kinds of baby cereal were also added, about ¼ cup to an 8-ounce bottle of milk. Within a week after capture all fawns were taking small amounts of alfalfa leaf and were beginning to graze on green forbs encountered during brief training forays outside the pens. The fawns were weaned by about 6 weeks, but some bottle feeding was continued until about 10 weeks because of its value in the training process. This feeding routine was a very simple one. Other investigators have used more complicated diets and feeding schedules (Deming, 1955; Long, et al, 1961; Murphy, 1960; Reichert, 1972; Silver, 1961).

Fawns were introduced to short walks in harness within a few days, and this exercise was continued as regularly as possible for several months. Frequent short rides in the truck were begun early, and the fawns were often fed in the back of the truck. Some fawns never accepted either the harness or the truck and these were relegated to a life in the pens.

Penned deer were fed twice a day, primarily to check on their welfare and to have human contact more frequently. Yearlings and adults were fed 10 oz. of 14% milk producer, a pelletized feed made up in Phoenix by Arizona Feeds. Leafy alfalfa hay from Chino Valley was fed ad lib and native browse was frequently collected and brought in.

Operations in the Field

Field feeding trials were conducted with a team of two deer and two observers (Fig. 10). Early experience showed that deer working in pairs were more calm, fed better, and rode more quietly in the truck. The two observers were Rodda and Neff, with occasional visitors who came along to watch. The visitors were no problem if they stayed close to the deer. But unattached personnel wandering off in the distance were cause for great concern and curiosity by the deer. Likewise, other animals caused much excitement on occasion. Wild deer and elk were usually too wary to be approached closely, but several times cattle were abruptly discovered close at hand and a moment of blind panic ensued. Fortunately no injuries were sustained in these stampedes, but sampling areas where cattle were present were carefully avoided thereafter.

Feeding behavior directly following the hour-long ride from Flagstaff was usually skittish and unproductive. The usual practice was to journey to Watershed Camp in late morning and leave the deer in the pen there to settle down until late afternoon. The evening feeding trial was then scheduled to begin about two hours before dark. Trials were usually conducted in morning and evening for three days in a row. In the May-June fly season work was possible only very early and very late in the day.

A field trial consisted of the deer being turned out in a selected sample area, the exact location of which was often dictated by road conditions. The deer were led into the sample area if necessary, not by pulling and hauling, but by the observer refusing to be led by the deer in any other direction. The deer soon became accustomed to the occasional directionality of the observer and would calmly try another tack if stopped by the leash. Once within the sample area the deer were permitted to wander at will unless fences or dangerous ground were encountered.

The area covered during a field feeding trial varied greatly since it was largely left up to the deer. If the feed was good and the deer behaving, an hour might be spent within a hundred yards of the truck. On other occasions a circuitous march of a mile or more might result. Thus the size of area sampled and the feeding data obtained depended on both deer behavior and upon forage availability.

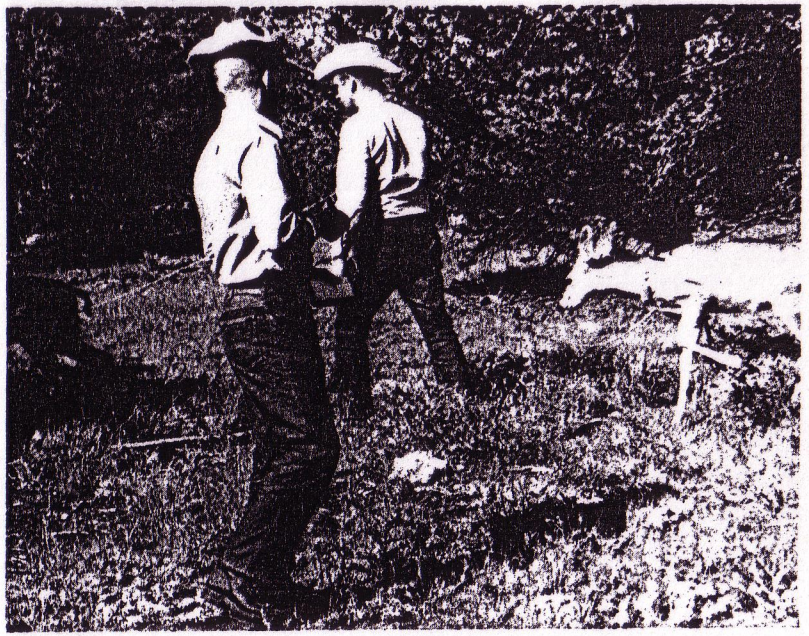

Figure 10. A field feeding trial in progress. Photo by Gertrude Cortright.

Data Collection and Compilation

Each species taken by the deer was listed, using the four-letter Forest Service plant name code. The number of bites taken of each species was counted. A bite was counted each time the deer took a portion of forage material into its mouth and removed it from the plant. Removal was signaled by the sound of breaking or tearing, and by a distinctive lift of the deer's muzzle. The deer often took several bites in rapid succession before pausing to chew or swallow. However, on large-leaved species a single bite could be a mouthful. Fortunately for the observers, the deer showed a definite tendency to direct their attentions to one species at a time, only rarely shifting from one to another in rapid succession. They not infrequently would stay with one species for 20 or more bites at a time, occasionally taking over 100 bites in succession on a favored shrub such as cliffrose. The deer also tended to stay close together, which permitted the observers to consult frequently about species identifications and other problems. Additional notes were taken on plant parts eaten, phenology, and availability. Availability of forage was rated subjectively for each species as Abundant, Locally Abundant, Common, Locally Common, and Rare.

Weight per bite was a function of the size and shape of the forage item, its relative palatability and the behavior of the deer in feeding. Weight per bite was estimated from hand-picked samples taken from 107 species. Samples were taken soon after each trial in careful imitation of deer feeding choices. Each sample consisted of 20 to 40 "bites".

Bite counts, weight estimates and forage preference factors were compiled by a computer program designed and executed by Game Research Supervisor Ronald H. Smith.

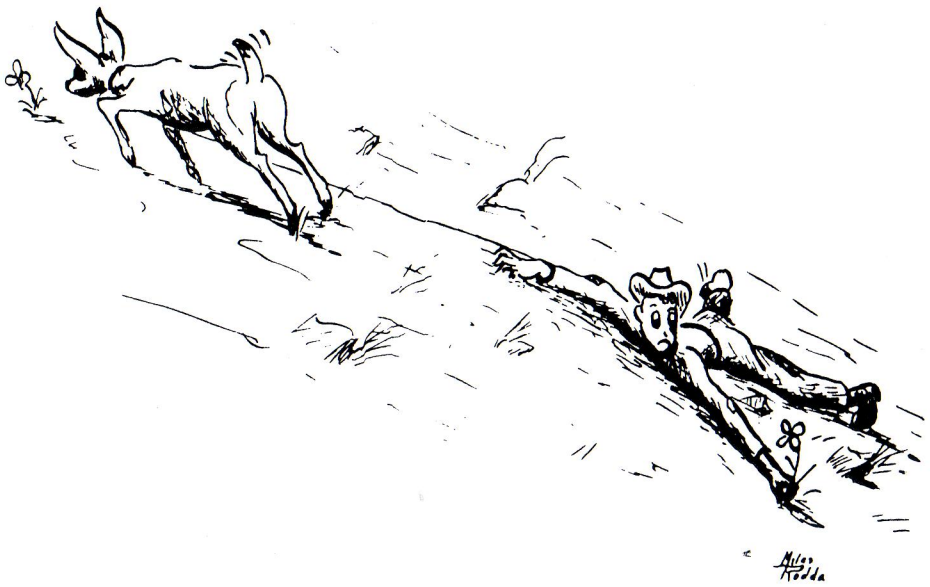

Figure 11. The Unknown Weed. Sketched in the field by Miles Rodda.

Forage Plant Identification

Plant taxa utilized by the tame deer during field feeding trials are listed in Appendix I. Unknown plants encountered in the field were collected, keyed out if possible, and pressed for later verification and mounting. Numerous specimens were submitted to Dr. W. B. McDougall at the Museum of Northern Arizona, and to Dr. James Rominger and Dr. Charles Hevly at the Deaver Herbarium of Northern Arizona University.

Plant identification in this study was greatly complicated by the fact that many species were attractive to the deer when in immature stages of development. It was sometimes necessary to wait several months to obtain flowers and fruits. Grasses were particularly difficult in the early growth stages. In some cases unknowns were identified to species in the herbarium but could not be recognized beyond genus or family in the field. The plant list in Appendix I is the best taxonomy that could be achieved in the field while tied to a hungry deer (Fig. 11).

Results

Field feeding trials were carried out year-round, though with very little activity in the fall because of other field work and the big game hunts. Most of the trials were in the ponderosa pine and Utah juniper types. A total of 337 field trials were completed at Beaver Creek for a total of 431 hours of field observations. The number of trials and hours of observation for each season and sampling site are found in Appendix II. Seasons were divided into winter (Dec.-Feb.), spring (Mar.-May), summer (June-Sept.), and fall (Oct.-Nov.) on the basis of plant phenology.

Diet Composition by Forage Classes

Seasonal changes in the diet of the tame deer in terms of browse, forbs, and grasses were summarized both in bite counts and in estimated oven-dry weight consumed (Table 2). Percent composition of deer forage intake was derived from the estimated weights (Table 3).

In the untreated Utah juniper type (Fig. 12) browse was probably predominant throughout the year, although data are lacking for the fall period. In the treated areas browse was the principle component only in the winter, while grasses, forbs and half-shrubs provided the greater part of the forage the rest of the year. This was particularly noticeable on herbicide-treated WS-3 where there was very little tall browse available. Cabled or pushed areas offered considerable tall browse and some use was made of it at all seasons.

In the alligator juniper type (Fig. 13) winter use was heavy on browse in both treated and untreated areas. Utilization of grasses was greatest in spring and fall. In all seasons there was relatively greater use of forbs and grasses on the treated watershed than on the untreated.

In the ponderosa pine watersheds (Fig. 14) there was a remarkable similarity in diet composition between treated and untreated areas. Use of grass was greater on the treated watersheds in winter primarily because of the heavy seeding of cool season grasses on WS-11. Grasses and forbs were predominant in the diet in spring, forbs continued to make up nearly half the diet in the summer and fall. There was no great difference in browse use on treated vs. untreated watersheds because of the universal abundance of Gambel oaks, and because even the most drastic clearcutting treatment did not disturb the existing patches of mountain-mahogany on the rocky rims and ledges.

Total annual diet composition is summarized in Figure 15. In the juniper types it appears that more herbaceous forage was available to the deer on the treated areas. This was confirmed by forage production measurements conducted by Beaver Creek Project personnel (See Discussion: Overstory Removal and Deer Forage Production). There was no difference in diet composition between treated and untreated areas in the ponderosa pine type, except for slightly more use of grasses in treated areas.

Forage Consumption by Taxa

For each taxon on which use was recorded, the number of bites counted was multiplied by the estimated weight per bite to provide an estimated weight consumption and percent composition of the diet by weight. The percent composition data are listed by sampling area, season of year, and vegetation type in the tables in Appendix II.

In the pinyon-juniper types the greatest variety of taxa was taken in spring and summer. While the juniper country is normally thought of as winter range, there is an abundant and varied supply of forage for the resident deer in summer, particularly forbs and half-shrubs.

The pine forest is primarily spring-summer-fall range but in open dry winters there is movement by both deer and elk back up into the lower pine fringes. The tame deer made much use of dry Gambel oak leaves at such times (especially those still hanging on the trees), along with green pine needles and a variety of forbs and grasses. Grasses contributed both

Table 2. Summary of bite counts and estimated oven-dry weight of forage consumption on field feeding trials, Beaver Creek Watershed, 1966-70, by season, site, and forage class.

Site and Class	Winter		Spring		Summer		Fall	
	Bites	Grams	Bites	Grams	Bites	Grams	Bites	Grams
Utah Juniper Type								
Treated (WS-1, Other)								
Browse	1587	297	426	78	4153	752	556	122
Forbs	668	95	774	122	5818	888	1830	242
Grasses	211	46	594	167	214	22	28	2
	2466	438	1794	367	10185	1662	2414	366
Untreated (WS-2, Other)								
Browse	3488	562	4368	714	2231	387	--	--
Forbs	2566	406	1611	248	781	125	--	--
Grasses	298	87	374	70	37	3	--	--
	6352	1055	6353	1032	3049	515	--	--
Herbicide (WS-3)								
Browse	--	--	75	15	1289	239	19	4
Forbs	--	--	3449	606	3040	532	2324	410
Grasses	--	--	504	110	552	83	451	54
	--	--	4028	731	4881	854	2794	468
Alligator Juniper Type								
Treated (WS-6)								
Browse	3448	522	3331	504	1047	199	329	50
Forbs	777	86	1056	163	4436	621	1485	187
Grasses	488	144	1578	448	368	83	505	118
	4713	752	5965	1115	5851	903	2319	355
Untreated (WS-4, 5)								
Browse	2133	429	3589	560	2355	423	870	156
Forbs	138	23	1492	180	2757	385	698	101
Grasses	31	4	411	114	154	17	37	3
	2302	456	5492	854	5266	825	1605	260
Ponderosa Pine Type								
Treated (WS-9, 11, 12)								
Browse	2769	572	4566	951	4924	2526	234	159
Forbs	1439	216	6070	1036	11584	2248	589	109
Grasses	1636	393	4179	868	466	108	28	6
	5844	1181	14815	2855	16974	4882	851	274
Untreated (WS-8, 10, 14)								
Browse	407	175	2033	420	6060	2967	--	--
Forbs	765	91	4929	823	13329	2516	--	--
Grasses	33	6	1550	594	501	175	--	--
	1205	272	8512	1837	19890	5658	--	--

Table 3. Percent composition of diet of tame trained mule deer in field feeding trials, Beaver Creek Watershed, 1966-70, by season, site, and forage class, based on estimated oven-dry weight of forage consumed.

	Season of Use				Mean Annual
	Winter	Spring	Summer	Fall	
Utah Juniper Type					
Treated (WS-1, Other)					
Browse	68	21	45	33	44
Forbs	22	33	53	66	48
Grasses	10	46	2	1	8
	100	100	100	100	100
Untreated (WS-2, Other					
Browse	53	69	75	--	62
Forbs	39	24	24	--	31
Grasses	8	7	1	--	7
	100	100	100	--	100
Herbicide (WS-3)					
Browse	--	2	28	1	18
Forbs	--	83	62	88	71
Grasses	--	15	10	11	11
	--	100	100	100	100
Alligator Juniper Type					
Treated (WS-6)					
Browse	70	45	22	14	41
Forbs	11	15	69	53	34
Grasses	19	40	9	33	25
	100	100	100	100	100
Untreated (WS-4, 5)					
Browse	94	66	51	60	65
Forbs	5	21	47	39	29
Grasses	1	13	2	1	6
	100	100	100	100	100
Ponderosa Pine Type					
Treated (WS-9, 11, 12)					
Browse	48	33	52	58	46
Forbs	18	36	46	40	39
Grasses	34	31	2	2	15
	100	100	100	100	100
Untreated (WS-8, 10, 14)					
Browse	64	23	53	--	46
Forbs	33	45	44	--	44
Grasses	3	32	3	--	10
	100	100	100	--	100

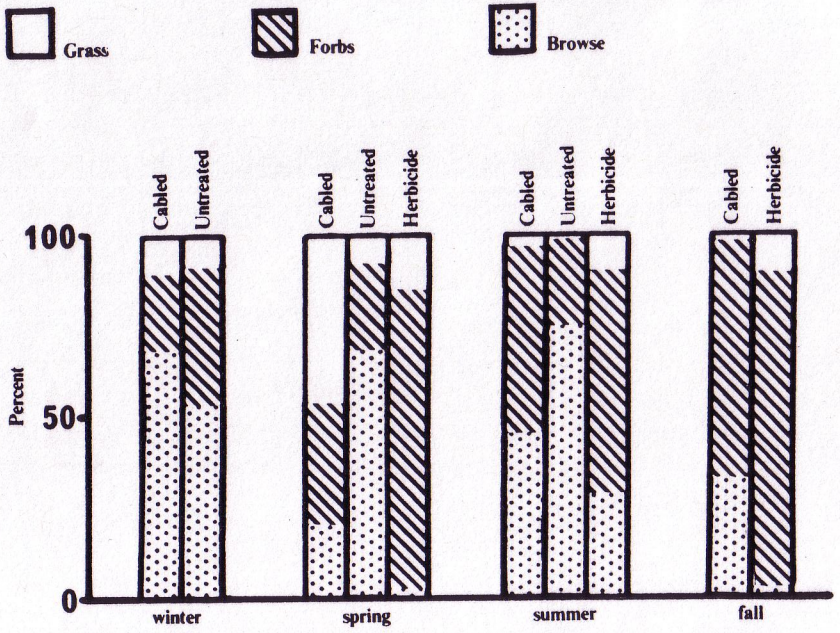

Figure 12. Composition of deer diet in Utah juniper type, Beaver Creek, 1966-70. Percent of estimated oven-dry weight consumed.

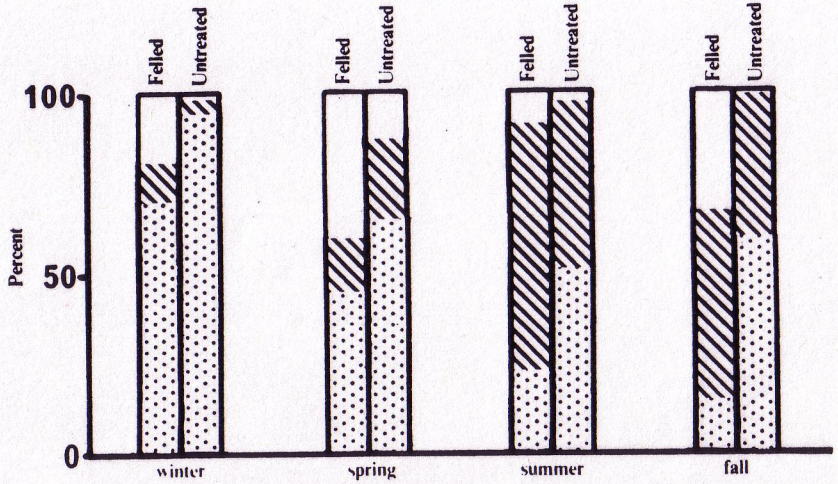

Figure 13. Composition of deer diet in alligator juniper type, Beaver Creek, 1966-70. Percent of estimated oven-dry weight comsumption.

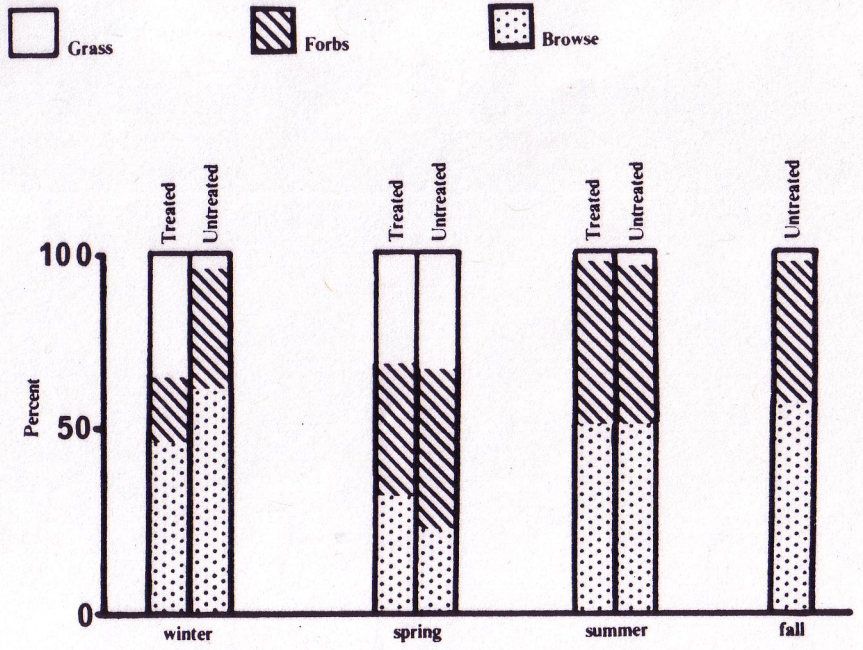

Figure 14. Composition of deer diet in ponderosa pine type, Beaver Creek, 1966-70. Percent of estimated oven-dry weight consumed.

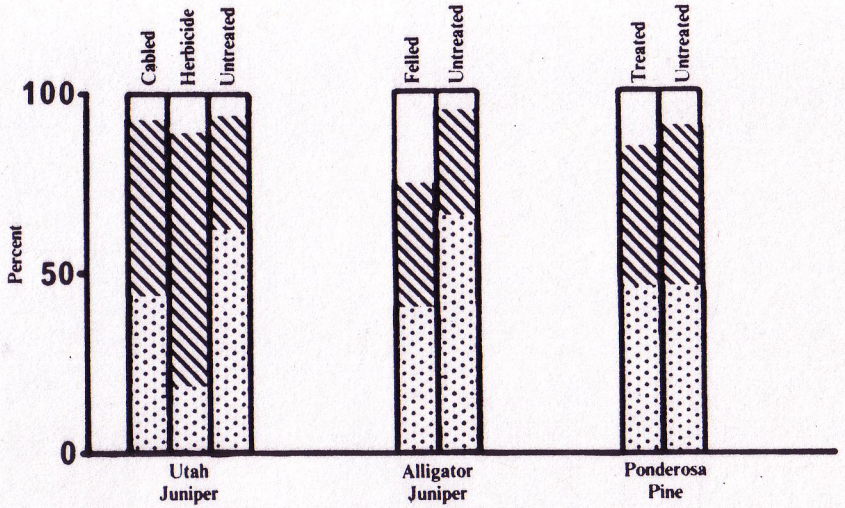

Figure 15. Composition of total annual forage consumption by tame trained mule deer, Beaver Creek, 1966-70. Percent of estimated oven-dry weight consumed.

green leaves and dry seed heads. Grasses were utilized mainly in the winter and spring when cool season species were in the highly palatable early growth stages. A great variety of forbs was available in the pine types in the spring and even more in the summer.

The bulk of the forage consumed by the tame deer in field feeding trials was contributed by only a few species. This was true at all seasons of year and in all sampling areas. Inspection of the tables in Appendix II shows that the ten most preferred taxa in each season and vegetation type contributed from 67 to 95 percent of the total weight of forage consumed. The remainder was provided by the other 10 to 99 taxa. Average contribution of the lesser taxa was 0.2 to 0.5 percent per taxon. Lists of the ten most preferred taxa for each season and type (Table 4) include some old standbys and some surprises. That ponderosa pine is palatable to deer is well known to foresters who have suffered browsing damage to pine plantations. Mountain-mahogany and cliffrose have long been considered to be key browse species, but hollyleaf buckthorn is usually not abundant enough for key status. Shrub liveoak is superabundant in the chaparral type and in much of the pinyon-juniper type south of the Mogollon Rim, and in many cases has been considered to be a pest species. Wright eriogonum is a woody perennial, but it was included with forbs and half-shrubs in this study because of its very low growth form. It is locally abundant at Beaver Creek.

Among the forbs listed in Table 4 showy aster, geranium, and slender astragalus are perennials growing under pine canopy and producing abundant forage when released from the overshadowing pine by fire or logging. Red-and-yellow pea is found over a wide altitudinal range at Beaver Creek in both pine and pinyon-juniper and is always highly palatable until completely dried up in the fall. Prickly lettuce, dandelion and knotweed are highly palatable annuals which are "weedy" invaders on disturbed soils. The clovers and sweetclovers were difficult to distinguish in the field in immature growth stages, but the question is academic since both genera are highly attractive to deer until they begin to dry up.

Utilization of grasses was greatest on the cool season species in late winter and spring. The wheatgrasses and orchard grass were seeded, while squirreltail, junegrass, and several species of bluegrasses are widespread natives in the pine and juniper types.

Weight Per Bite Estimates

Mean weight per bite estimates from hand-picked samples varied among species from 0.03 to 0.73 grams (oven-dry) per bite, depending upon the species and the size and form of the plant parts taken. Variation in weight within a series of samples of the same species was compounded of observer error and variation in bite size as selected by the deer (which was partly due to growth of plant parts between samplings). Variation in weight per bite estimates was believed in most samples to fall within the range set by the deer themselves. Species which were not sampled in the field were assigned weights obtained from species of similar size and growth form.

Some investigators have found that diet composition computed from weight estimates was not significantly different from composition based on feeding minutes or bite counts (Smith and Hubbard, 1954; Wallmo, pers. comm., 1972). In this study, however, the 1:25 range in bite weight was too large to ignore. Comparison of percent composition of diet derived from bite counts with that from estimated weights showed major differences in about ⅓ of the seasonal or total annual diet categories. Differences were greatest in untreated ponderosa pine areas, probably because of large bite sizes of spring grasses, and of Gambel oak at all seasons.

Ratings of Forage Preference

Preference indicates proportional choice by the animals among two or more available foods. *Palatability* comprises the innate characteristics of the plant which stimulate selective response by the animals (Heady, 1964). Evaluation of species preferences in field feeding trials involves comparing consumption with availability for each species tested. Where study areas are small, availability data can be obtained by field plot sampling of forage production and composition. Watts (1964) and Healy (1967) divided total time spent feeding by tame deer on each species by the percent composition by weight of that species. Healy (1971) modified this scheme to percent of total time spent feeding divided by percent composition by weight for each species.

The numerous and sprawling study areas of the Beaver Creek Watershed made quantitative sampling of forage availability impossible. An index to preference was proposed and tested, based on subjective availability ratings:

Number of bites x
Estimated weight per bite/
Availability rating

But without quantitative data on availability the index was useful only for reducing the mass of field data to a more manageable set of approximations which were then reviewed with reference to the original field data. The assignment of a high, medium, or low species preference rating was partially based on this study of the data and partially on subjective impressions of the observed feeding behavior of the deer. This system of analysis is imprecise and variable, as was the feeding behavior which it seeks to describe. There is a degree of order involved, however. Deer preferences were consistent for a given time, place and species. Rarely did a deer rate a species high on one trial and low the next. And two deer feeding together rarely disagreed sharply about the palatability of a plant species.

In Appendix III the principal site of occurrence and the range of availability ratings of each taxon are listed. For each season of the year each taxon is given a general preference rating along with the plant parts taken at that season. Palatability changed within a given species with phenological progression and with the plant parts available. In some cases this change was quite drastic as highly palatable new growth became mature. Seeds of some species were readily taken by the deer when no interest was shown in the earlier vegetative growth.

Rate of Forage Consumption

The feeding behavior of the tame deer, in the field only two or three hours a day, was necessarily different from that of their wild counterparts. Just how different cannot be stated with exactness, but some approximate comparisons can be made. The overall mean forage consumption rate for all field feeding trials was 338 bites per hour and overall mean weight per bite was 0.196 grams. The mean rate of food intake thus was 66.4 grams oven-dry weight of forage per hour of observation.

Nichol (1938) estimated that the mean minimum daily oven-dry weight feed requirement for a mule deer was 2.3 lbs. (1.1 kg.) per hundredweight (CWT). Feed requirements studies summarized by Halls (1970:11) indicate that 1.1 kg. per CWT per day is too low for a wild deer in rough country or cold weather. However, at this minimum level a mature doe weighing 130 lbs. would require 1430 grams of feed per day. At a mean rate of 66.4 grams per hour she would have to spend 21.5 hours per day in feeding. Obviously, the field trials included much time spent on activity other than eating. The highest rate of intake ever observed in a single feeding trial was 248 grams per hour. At this rate the 130 lb. doe would have to forage for only 5.7 hours a day, but this rate could be maintained only where forage was luxuriously abundant.

If a wild deer spends about half its day resting and ruminating and the other half moving about and feeding, as observed by Linsdale and Tomich (1953), then the 130 lb. doe would have to feed at a rate of 119 grams per hour during its active hours. This rate of intake is almost twice the tame deer mean rate, but less than half the maximum observed rate.

Forage Plant Refusal

A negative reaction on a field trial, the refusal of a deer to feed on a plant, was much more difficult to evaluate than the positive act of taking a bite. Only very

Table 4. Percent composition of diet of tame trained deer on field feeding trials, Beaver Creek Watershed, 1966-70, based on estimated weight consumption. Highest ten taxa in each vegetation type and season are listed.

Utah and Alligator Juniper

Winter	Percent	Spring	Percent
Cercocarpus breviflorus	29.2	Cercocarpus breviflorus	31.2
Quercus turbinella	16.4	Eriogonum wrightii	6.7
Eriogonum wrightii	11.2	Sitanion hystrix	6.3
Ceanothus greggii	6.3	Quercus turbinella	5.8
Rhamnus crocea	6.1	Koeleria cristata	5.0
Pinus ponderosa	4.8	Poa sp.	4.4
Agropyron cristatum	3.6	Lactuca serriola	4.3
Sitanion hystrix	3.0	Bromus rubens	3.9
Cordylanthus tenuifolius	2.4	Lotus wrightii	2.6
Eriogonum cognatum	2.1	Ceanothus greggii	2.5
	85.3		72.7

Summer	Percent	Fall	Percent
Cercocarpus breviflorus	14.8	Eriogonum wrightii	20.0
Cowania mexicana	11.8	Trifolium sp.	11.8
Trifolium sp.	10.8	Cercocarpus breviflorus	9.5
Lactuca serriola	6.7	Cowania mexicana	8.4
Ceanothus greggii	5.7	Agropyron cristatum	6.6
Melilotus officinalis	3.9	Euphorbia capitellatum	4.9
Erigeron sp.	3.5	Eriogonum racemosum	4.7
Desmanthus cooleyi	3.3	Quercus gambelli	3.9
Quercus gambelii	3.2	Physalis sp.	3.4
Epilobium paniculatum	3.1	Desmanthus cooleyi	3.0
	66.8		76.2

Table 4. (Continued)

Ponderosa Pine

Winter	Percent	Spring	Percent
Quercus gambelii	25.4	Quercus gambelii	22.1
Pinus ponderosa	18.0	Unident. grasses	15.7
Unident. grasses	12.9	Dactylis glomerata	10.5
Agropyron cristatum	11.2	Trifolium sp.	8.8
Geranium sp.	8.6	Geranium sp.	5.5
Cercocarpus breviflorus	5.3	Pinus ponderosa	3.1
Aster commutatus	5.1	Poa sp.	2.5
Eriogonum racemosum	2.4	Lathyrus sp.	2.1
Quercus undulata	2.2	Melilotus officinale	1.9
Sitanion hystrix	1.7	Cercocarpus breviflorus	1.8
	92.8		74.0

Summer	Percent	Fall	Percent
Quercus gambelii	46.3	Quercus gambelii	58.1
Astragalus recurvus	6.9	Eriogonum racemosum	8.1
Lotus wrightii	6.3	Sanguisorba annua	7.7
Eriogonum racemosum	4.5	Epilobium paniculatum	4.7
Trifolium sp.	4.1	Lactuca serriola	4.5
Geranium sp.	2.7	Lathyrus sp.	3.3
Melilotus officinale	2.5	Senecio neomexicana	2.9
Cercocarpus breviflorus	1.9	Aster commutatus	2.3
Lathyrus sp.	1.8	Unident. grasses	2.0
Taraxacum sp.	1.7	Polygonum sp.	1.9
	78.7		95.5

rarely did a deer take a bite and then spit it out. The normal refusal reaction was much more subtle, and it was often not possible to tell whether the deer was even aware of a plant that was passed over. The total list of plants "rejected" at some time includes 134 taxa in the pinyon-juniper types and 113 taxa in the ponderosa pine. However, only five taxa were never taken at any time and hence are not listed and rated in Appendix III:

Hoarhound — *Marrubium vulgare*
Cactus — *Cactaceae* sp.
Agave — *Agave* sp.
Yucca — *Yucca* sp.
Sedge — *Cyperaceae* sp.

Discussion

The validity of the methods used in this study depends upon the relative importance of instinct vs. experience in the choice of forage by deer. The tame deer shared the hereditary instincts of the wild deer but had very different experiences with foods. One clue to this question is the means by which deer are able to recognize palatable plant materials. Nichol (1938:29) described a mouthing and moistening process by which his penned Kaibab mule deer taste-tested new species of forage plants. However, the sense of smell is emphasized in most reports. Dixon (1934:126-127) observed mule deer selecting good acorns without ever touching blank acorns of identical appearance. Dunkeson (1955) concluded that his semi-tame white-tailed doe tested forage by smelling, not by tasting. Recent field and laboratory studies in California have pointed to the sense of smell as the primary means of testing palatability, with visual and taste clues secondary (Longhurst, et al, 1968).

In the present study five years of close observation of tame trained deer feeding in the field and pen led to the strong conclusion that these deer relied primarily on the sense of smell. The decision of palatability was made before the deer took a bite, since only twice in 145,000 recorded bites of forage was a deer seen to spit out a bite. Choices of new plant species were made just as unerringly as were choices of old familiar plants. None of the four Kaibab mule deer does in this study were observed to take any action resembling Nichol's tasting process.

Experience with a feeding area appeared to increase the efficiency of the foraging process, as the tame deer became accustomed to the terrain and to the choice of forage plants available there. With repeated trials in the same area often a greater number of bites per trial were taken. It sometimes appeared that the deer acquired a taste for a species, feeding after several trials on material that was not taken at first. However, it appears that deer forage choices are basically instinctive responses to chemical olfactory stimuli; responses which are refined by the individual experience of the animal.

If this proposition is true, then the principal difference between wild and tame deer on a Beaver Creek sampling area was that the wild deer have much more time to explore and to test rare or obscure plants, and have time to grow accustomed to some species which were at first unattractive. Also, the wild deer would be under much greater nutritional stress during periods of severe cold, deep snow, or prolonged drouth, and at such times would take forage items not acceptable to the tame deer. The food habits data provided by the tame deer, then, represent the minimum range of forage choices: Anything a tame deer ate would also be accepted by a wild deer, but the tame deer refused items which under some circumstances would be taken by wild deer.

Overstory Removal and Deer Forage Production

Posttreatment data are now available from six Beaver Creek pilot watersheds (1, 3, 6, 9, 11, and 12). Portions of these data have been published by Brown (1971) and Clary (1972). The removal or killing in place of juniper or ponderosa pine overstory on these watersheds has invariably resulted in an increase in grass and forb production. The magnitude of this increase and the species composition has varied greatly depending upon the type of treatment, soil disturbance, reseeding, and site conditions.

The tame trained deer field feeding trials were designed to obtain information on the effects of various watershed treatments on deer forage supplies. The feeding trials successfully identified the important taxa of deer forage plants, but provided only a subjective estimate of the availability of these taxa. The impact of overstory removal treatments on deer forage supply can be evaluated, however, by reference to the forage production

measurements[1] made by Beaver Creek Project personnel on vegetation plot clusters on each watershed.

Utah Juniper Type

Herbage production for all species for the years 1965, 1966, 1968 and 1969 (2 to 6 years after cabling) was about three times greater on cabled and reseeded WS-1 than on untreated WS-2. For the four-year posttreatment period from 1969 to 1972 production of forbs on WS-3 was also about three times greater than on WS-2, but grass production was about the same on both areas. These data suggest significant improvement in grazing capacity as a result of treatment. Unfortunately, a sizeable portion of the herbage crop is not palatable to deer. In order to more closely approximate the deer forage supply, the data were revised to include only the cool season grasses which are available in late winter and spring (chiefly these are bluegrass, junegrass, squirreltail, and seeded wheatgrasses). Forb and half-shrub data were revised to exclude the most obvious unpalatable species (snakeweed, sunflower, and goldeneye). The mean annual forage crop (lbs/acre) for deer then appears as follows:

1965 to 1969	WS-1 Cabled	WS-2 Untreated
Cool season grasses	17	1
Forbs and half-shrubs	135	94
Total	152	95

1969 to 1972	WS-3 Herbicide	WS-2 Untreated
Cool season grasses	88	3
Forbs and half-shrubs	333	111
Total	421	114

According to these measurements cleared or herbicide treated Utah juniper woodland is considerably more productive of herbaceous deer food than is standing juniper. Tame deer on these three watersheds consistently selected more forbs and grass on the treated areas than on the untreated areas (Fig. 12).

[1]Data on file, Beaver Creek Project, Rocky Mountain Forest and Range Experiment Station, Flagstaff.

Alligator Juniper Type

The Beaver Creek Project has prepared a detailed statistical analysis of the pre- and posttreatment forage production on WS-6 as compared to WS-5 (Clary, 1972). Felling the overstory on WS-6 resulted in a 36 percent mean increase in total herbage yields. The largest increases were in squirreltail and ragweed. Major increases also occurred in showy aster and goldeneye. Measurements were taken in 3 of 6 years pretreatment (1960-65) and each year after treatment (1966-72). If the cool season grasses and the more palatable forbs and half-shrubs (excluding snakeweed, sunflower, goldeneye, and ragweed) are extracted from these data, the mean annual deer forage production (lbs./acre) appears as follows:

	WS-6 Felled		WS-5 Untreated	
	Pre	Post	Pre	Post
Cool season grasses	47	160	56	94
Forbs and half-shrubs	113	174	106	151
Totals	160	334	162	245
Percent increase		+109%		+51%

Production increased on both watersheds during the posttreatment years, but much more so on the treated area. The increase in total preferred forage after treatment is clearly reflected in the greater consumption of grass and forbs on WS-6 by the tame deer (Fig. 13). Changes in composition during the posttreatment period on WS-6 were only partly favorable to deer. Cool season perennials were 23 percent of the total grass yield before treatment and 40 percent after treatment; preferred forbs and half-shrubs were 40 percent of the total before treatment but only 36 percent after.

Ponderosa Pine Type—WS10 and 11

The clear-cutting treatment on WS-11 in 1958 was accompanied by seeding of crested, intermediate, and western wheatgrasses. The seed mix also included clover, sweetclover, and some alfalfa. Spring production and utilization, and summer production were measured annually on WS-11, and summer production was measured in 1961, 1962 and 1965 on WS-10. Mean annual yields (lbs./acre) of cool season grasses and preferred forbs (excluding snakeweed, goldeneye, and ragweed) for the three years were as follows:

	WS-11 Clearcut	WS-10 Untreated
Cool season grasses	435	61
Forbs and half-shrubs	144	22
Totals	579	83

One result of clear cutting and reseeding thus was a sixfold increase in palatable herbaceous forage. This probably explains why mean annual elk use on WS-11 reached 30 pellet groups/acre/month in 1961 (or an average density of 45 elk per section).

The spring-fall cattle grazing treatment on WS-11 was initiated in the fall of 1967 and continued through the fall of 1972. Mean annual deer forage production (lbs./acre) for this five-year period was as follows:

	WS-11 Clearcut	WS-10 Untreated
Cool season grasses	350	156
Forbs and half-shrubs	134	32
Totals	484	88

These results show a slight decrease in grass yield but a somewhat greater forb yield on WS-10 compared to the 1961-65 data. On the grazed area in WS-11 decreases were shown in both grass and forb yields, apparently due to the moderate to heavy grazing pressure. Statistical analysis of yield trends on both watersheds for a selected list of preferred forbs showed a decline on WS-11 from 108 lbs/acre before grazing to a mean annual yield of 83 lbs/acre during the grazing period (Warren Clary, pers. comm., 1972). While the bulk of the cattle forage came from grasses, there was also a significant impact upon the more palatable forbs.

In brief, the original overstory removal treatment (plus soil scarification and reseeding) was highly beneficial to the production of late winter and spring forage for deer and elk. This was reflected in the heavy use of grasses by the tame deer (Appendix II, Tables 5, 6). However, the spring-fall cattle grazing treatment resulted in a decline in quantity of spring grasses and the best forbs as well, and deer and elk use declined markedly in response to this competition (Neff, 1972).

Ponderosa Pine Type—WS-12 and 13

The 1967 clear-cutting treatment on WS-12 differed from that on WS-11 principally in that the windrowed slash was left in place and no seeding was done. Mean annual deer forage production (lbs./acre) for the 5 years from 1968 to 1972 was as follows:

	WS-12 Clearcut	WS-13 Untreated
Cool season grasses	314	86
Forbs and half-shrubs	214	54
Totals	528	140

In this case there was approximately a fourfold increase in forage yield due to the treatment effects. The general level of production on both WS-12 and 13 was slightly greater than on WS-10 and 11, probably because of the slightly higher elevation and greater mean annual precipitation (Brown, 1971). For the 1968-72 period, treated Watersheds 11 and 12 had similar total forage yield characteristics, but WS-11 had more grass and WS-12 had more forbs. The seeding operations on WS-11 apparently did not increase the total herbage yield, but may have improved the overall value for cattle and elk by increasing the composition of perennial grasses. The addition of highly palatable wheatgrasses to the winter and spring forage supply on WS-11 was also of obvious interest to the tame deer (Appendix II, Tables 5,6).

Rumen Content Analyses

During the course of the tame deer field feeding study mule deer rumen samples were obtained from 16 hunter-kills and 23 road-kills and special collections in the ponderosa pine and pinyon-juniper types in southern Coconino and northern Yavapai counties. These rumen samples were analyzed under the supervision of

Clay McCulloch (personal communication).

Almost all the items found in the wild mule deer rumens were taxa which were also taken by the tame deer. Most food items were highly predictable taxa such as astragalus, sweetclover, eriogonum, prickly lettuce, bluegrass, annual brome, cliffrose, Gambel oak, and mountain-mahogany.

The single major exception, juniper foliage, was found in 13 of 16 hunter-kills and 12 of 23 road-kills and collections. In both series juniper made up an average of 14 percent of the sample volume, with some samples only 1 or 2 percent and a few which were predominantly juniper (maximum 82 percent). The juniper material was not identified to species. Some of it, judging from location of kill, must have been alligator juniper which the tame deer found to be much more palatable than Utah juniper. However, there is no question that Utah juniper is taken by wild deer to a much greater extent than the tame deer data would indicate, and such use is not always forced by dire necessity. Utah juniper may be a classic example of an acquired taste in deer forage.

Review of Deer Food Habits Studies

A number of deer food habits studies have been carried out in Arizona and in Utah in vegetation types comparable to those on Beaver Creek. A review of some of these studies offers some basis for judging the results of the tame deer field feeding trials.

Dayton (1931:21) concluded from Forest Service reports that Gambel oak was foremost among forage-producing plants in many parts of its range due to great abundance, large leaf size, and resistance to heavy grazing. According to the tame deer it also would rank near the top in palatability.

On the North Kaibab a listing of palatability ratings for deer was based on observation of forage plant utilization on the open range (Julander, 1937). This list agrees fairly well with the tame deer choices in that the prime browse species were cliffrose, aspen, and mountain-mahogany, and the top forbs were clover, and red-and-yellow pea. But Gambel oak, desert ceanothus and Wright eriogonum were rated very highly by the tame deer on Beaver Creek, while locust, rose, and fourwing saltbush were rated very low—all contrary to Julander's findings. Julander also rated paintbrush very high, while on Beaver Creek it was rated well down below geranium, dandelion, vetch and others. Blue and sideoats grama were rated equal to junegrass and squirreltail on Julander's list, but on Beaver Creek the grama grasses were much less used than were the cool-season grasses.

Hungerford (1970) observed the feeding habits of wild deer on the North Kaibab for seven summers (1962-68). He found that use of grass was greatest in early growth stages in June, and seeded species were preferred over natives. The first choice was orchardgrass. Mountain-dandelion, clover and dandelion were also important. By mid-July the grasses were maturing and the deer turned increasingly to daisy, knotweed, and other forbs. In later summer seed pods of lupine and paintbrush were taken. Aspen was the most important browse species, especially the mature leaves. Spruce, fir, Douglas fir, and ponderosa pine were browsed lightly but regularly even though there was a good supply of choice forage. These findings are generally consistent with the tame deer forage choices on Beaver Creek.

Extensive pen-feeding trials at Santa Rita, near Tucson, with Kaibab mule deer gave palatability ratings which closely correspond to the Beaver Creek tame deer choices (Nichol, 1938: Tables 2 and 3). The tame deer would require a higher rating for cliff-rose and a lower rating for fourwing saltbush and filaree, but serious disagreements are few for the taxa tested in both studies.

J. G. Smith (1952) concluded from field plot studies in Utah that abundance of a species has a great deal to do with its preference rating, and because species composition of the forage varies so widely, deer food habits data may have only local application. Smith's top ten summer range forage species included aspen, Gambel oak, clover, lupine, penstemon, chokecherry, elderberry, snowberry, and paintbrush. Rare but highly palatable species included geranium, mountain-dandelion, and phacelia. The Flagstaff tame deer agreed on at least nine of these twelve species, indicating that deer food habits may not be so variable after all. On the winter range Smith found that big sage, cliffrose, and bitterbrush were the principle components of the diet, with little use on bare twigs of Gamebl oak. On occasion one or two species made up a large part of the deer diet, as in winter when nearly half the diet was cliffrose and bitterbrush, and in spring when 82 percent of the estimated forage consumption was bluegrass (*Poa fendleriana*).

In another Utah study (Robinette, et al, 1952), winter deer browse was rated as follows:

Good — Bitterbrush, cliffrose, curlleaf mountain-mahogany, true mountain-mahogany
Fair — Big sage, Gambel oak
Poor — Utah juniper, snakeweed, rabbitbrush

On Oak Creek range in south-central Utah (Julander, 1955; Julander and Robinette, 1950) grass was used mostly in the spring when it was young and tender, while forbs and deciduous browse (true mountain-mahogany and Gambel oak) were the primary summer forage plants. The Beaver Creek tame deer would not agree with the listing of goldeneye (*Viguiera multiflora*) as a preferred forb, however; they waded knee-deep in the stuff in summer and fall on the juniper watersheds and made very little use of it. Julander (1955) reported that Utah juniper was important winter cover for deer but was important as forage mainly in periods of deep snow and severe weather. Identical conclusions have been reported from the Beaver Creek winter range (Neff, 1968; Neff, 1971).

In a preliminary report on the use of moveable paddocks for field feeding trials, Smith and Gaufin (1950) reported heavy deer utilization on geranium, dandelion, and eriogonum. Bluegrass was the most palatable grass species and aspen and serviceberry were the preferred browse plants. Species which were lightly utilized included Oregon grape, rabbitbrush, yarrow, and elderberry. So far the tame deer would agree. However, moderate to heavy use was made by the Utah deer on currant, rose, and meadowrue, none of which was acceptable to the tame deer.

CONCLUSIONS

Based on the tame deer forage preferences observed in field trials on the Beaver Creek watershed the following conclusions are offered:

1. Forage choices are made by deer primarily by the sense of smell, secondarily by sight, taste and texture. Food choice by deer is basically instinctive. The tame fawns were able to make accurate forage preference decisions at their first encounter with a species.
2. The use of tame trained deer for field feeding trials is a valid research technique since the artificial environment of rearing and training does not appear to significantly alter their instinctive forage preference behavior.
3. Forage selections of tame trained deer represent a minimum range of choice. A wild deer may be expected to eat anything the tame deer will eat. But the wild deer may also take a wider range of rare or obscure species, will probably acquire a taste for some species of marginal palatability, and will be forced by drouth or storm to feed on items of low palatability.
4. The bulk of forage consumed by deer at any season or location consists of a few abundant and palatable species. But a wide variety of other species are taken in small amounts and may contribute significantly to a nutritionally balanced diet.
5. Forbs are a major source of green forage for deer at all seasons, including winter. Such green herbaceous material has been found to be relatively high in nutritional value.
6. Native and seeded cool season grasses in their early growth stages are heavily utilized by deer in late winter and early spring. Grasses are used very little in midsummer and fall.
7. Cliffrose and mountain-mahogany are the preferred winter range browse species. But shrub liveoak, at best only moderately palatable, may be just as important in the total diet of the deer because of its superabundance.
8. Gambel oak was the most important summer range forage species for the tame deer. Leaves were highly palatable at all stages of maturity and dead leaves still hanging on the trees were taken readily. The tame deer eagerly accepted acorns offered by the observers, but they apparently never learned to seek them out on the ground or on the trees. Gambel oak is the most important single plant species for deer in the ponderosa pine type of Beaver Creek.
9. Where pinyon-juniper treatments resulted in increased forb and grass production, this was reflected in the tame deer feeding choices. In the pine type, however, treatment status did not markedly affect the relative amounts of browse, forbs and grassses taken.
10. A review of some deer food habits studies conducted on the North Kaibab and in Utah pinyon-juniper and ponderosa pine types showed many areas of close agreement with the present study. Variability in mule deer forage preferences is less than might be expected from the almost infinite variability of the soil-vegetation-animal complex.

SUMMARY

Deer forage preferences were studied in relation to experimental vegetation treatments in the ponderosa pine and pinyon-juniper types on the Beaver Creek Watersheds.

Mule deer fawns from the North Kaibab and Mogollon Rim were tamed and trained for field feeding trials in which the deer were restrained by harness and leash but had free choice of forage. In five years 337 trials were conducted, totaling 431 hours of observations of deer feeding behavior. Data were collected on numbers of bites taken, plant parts taken, phenology and relative abundance for each species utilized. Rejected species were also noted. Weight per bite was estimated from hand-picked samples. Results are reported in terms of estimated weight consumption since weight per bite varied widely with species and plant parts taken.

A total of 203 plant taxa were tested in the field in the Utah juniper, alligator juniper, and ponderosa pine vegetation types. Watershed treatments in the sample areas included juniper cabling, pushing, felling, and aerial herbicide application; ponderosa pine clear-cutting, strip-cutting, and wildfire burn.

It was concluded that the forage choices of the tame trained mule deer were very similar to those of wild deer, since preference appeared to be basically an instinctive response. The sense of smell was believed to be the chief means of testing palatability.

The preferred browse species were mountain-mahogany, cliffrose, hollyleaf buckthorn, and Gambel oak. Ponderosa pine and shrub liveoak also contributed significant amounts of browse. Wright eriogonum, showy aster, geranium, prickly lettuce, slender astragalus, and red-and-yellow pea were the most heavily used native forbs, along with seeded clover and sweetclover. Cool season grasses were an important part of the diet in late winter and spring, including bluegrasses, squirreltail, junegrass, crested wheatgrass, and orchardgrass. While the species listed above contributed half or more of the total diet, there was at least occasional use on almost all of the available species. Only a few species were never taken at any time.

Under present conditions, with moderate cattle grazing and a low density deer herd, the Beaver Creek watershed study area offers an abundance of high quality forage. Deer in this area have access to at least some green herbaceous feed throughout the year, and the most palatable winter browse plants are adequate though not abundant in supply. Gambel oak browse and herbaceous forage species are common to abundant throughout the ponderosa pine summer ranges. The experimental watershed treatments which have produced the best forage crops have combined thinning or clearing of overstory with soil disturbance from skidding or slash-piling machinery. Reseeding (on WS-1 and 11) has not greatly increased the total understory forage crop but may have improved total forage quality by improving species composition.

The best diversity of forage plant species on Beaver Creek was provided by an interspersion of treated and untreated vegetation. Large uniform blocks of any one type of vegetation are likely to provide less attractive deer range. Present trends in Forest Service management practices, toward more intensive timber management and more landscape-oriented juniper clearance projects, appear to be in accordance with the principle of greater vegetation interspersion and diversity.

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Appendix I

Checklist of plant taxa utilized by tame trained mule deer on the Beaver Creek Watershed sampling areas. Taxa are listed by scientific name, common name, and four-letter code. Taxa are listed in the form in which they were recognized in the field; species where possible, or by genus or family. Technical nomenclature follows Kearney and Peebles (1960) and Hitchcock (1951).

Trees and Shrubs

Acgr	*Acacia greggii* Gray	Catclaw
Amut	*Amelanchier utahensis* Koehne	Serviceberry
Arva	*Arceuthobium vaginatum* (HBK) Eichler	Mistletoe
Arpu	*Arctostaphylos pungens* HBK	Manzanita
Bere	*Berberis repens* Lindl.	Oregon grape
Cebr	*Cercocarpus breviflorus* Gray	Mountain-mahogany
Cegr	*Ceanothus greggii* Gray	Desert ceanothus
Cefe	*Ceanothus fendleri* Gray	Fendler ceanothus
Come	*Cowania mexicana* D. Don	Cliffrose
Feru	*Fendlera rupicola* Gray	Cliff fendlerbush
Fone	*Forestiera neomexicana* Gray	Desert-olive
Gawr	*Garrya wrightii* Torr.	Silktassel
Jude	*Juniperus deppeana* Steud.	Alligator juniper
Juos	*Juniperus osteosperma* (Torr.)Little	Utah juniper
Phco	*Phoradendron coryae* Trel.	Mistletoe
Pied	*Pinus edulis* Engelm.	Pinyon pine
Pipo	*Pinus ponderosa* Lawson	Ponderosa pine
Pofr	*Potentilla fruticosa* L.	Shrubby cinquefoil
Potr	*Populus tremuloides* Michx.	Aspen
Prju	*Prosopis juliflora* (Schwartz) DC.	Mesquite
PRUN	*Prunus* sp.	Chokecherry
PTEL	*Ptelea* sp.	Hoptree
Quga	*Quercus gambelii* Nutt.	Gambel oak
Qutu	*Quercus turbinella* Greene	Shrub live oak
Quun	*Quercus undulata* Torr.	Wavyleaf oak
Rhcr	*Rhamnus crocea* Nutt.	Hollyleaf buckthorn
Rhtr	*Rhus trilobata* Nutt.	Skunkbush
RIBE	*Ribes* sp.	Currant
Rone	*Robinia neomexicana* Gray	New Mexican locust
ROSA	*Rosa* sp.	Rose
SALX	*Salix* sp.	Willow
Teca	*Tetradymia canescens* DC.	Horsebrush
Viar	*Vitis arizonica* Engelm.	Canyon grape

Forbs and Half-Shrubs

Acla	*Achillea lanulosa* Nutt.	Yarrow
AGAV	*Agave* sp.	Centuryplant
AGOS	*Agoseris* sp.	Mountain-dandelion
ALLI	Allium sp.	Onion
AMAR	*Amaranthus* sp.	Amaranth, pigweed
Amps	*Ambrosia psilostachya* DC.	Ragweed
Anbr	*Androstephium breviflorum* Wats.	Funnel lily
ANTE	*Antennaria* sp.	Pussytoes
Arcr	*Artemisia carruthii* Wood	Flat sagebrush
Arcw	*Artemisia carruthii v. Wrightii* (Gray) Blake	Sagebrush
Ardr	*Artemisia dracunculoides* Pursh	False tarragon
Arlu	*Artemisia ludoviciana* Nutt.	Louisiana wormwood
Arpe	*Arabis perennans* Wats.	Rockcress
ASTE	*Aster* sp.	Aster
Ascn	*Aster canescens* Pursh	Hoary aster
Asco	*Aster commutatus* (Torr. & Gray) Gray	Showy aster
ASTR	*Astragalus* sp.	Milkvetch, loco
Asre	*Astragalus recurvus* Greene	Slender milkvetch
Astp	*Astragalus tephrodes* Gray	Spadeleaf milkvetch
Badi	*Bahia dissecta* (Gray) Britton	Ragleaf bahia
Cabu	*Capsella bursa-pastoris* (L.) Medic.	Shepherds purse
CAST	*Castilleja* sp.	Paintbrush
CHEN	*Chenopodium* sp.	Goosefoot
Chal	*Chenopodium album* L.	Lambsquarter
CIRS	*Cirsium* sp.	Thistle
Codi	*Commelina dianthifolia* Delile	Dayflower
COMP	*Compositae* sp.	Sunflower family
Copa	*Comandra pallida* A.DC.	Bastard toadflax
Cote	*Cordylanthus tenuifolius* Pennell	Birdbeak
CYMO	*Cymopterus* sp.	Wafer-parsnip
Daal	*Dalea albiflora* Gray	Indigobush
Deco	*Desmanthus cooleyi* (Eaton) Trel.	Bundleflower
DELP	*Delphinium* sp.	Larkspur
DESC	*Descurainia* sp.	Tansymustard
Dipu	*Dichelostemma pulchellum* (Sals.) Heller	Bluedicks
Drcu	*Draba cuneifolia* Nutt.	Draba
Eppa	*Epilobium paniculatum* Nutt.	Willowweed
Erci	*Erodium cicutarium* (L.) L'Her	Filaree
ERIG	*Erigeron sp.*	Daisy
Erca	*Erigeron canadensis* L.	Horseweed
Erma	*Erigeron macranthus* Nutt.	Aspen fleabane
ERIO	*Eriogonum* sp.	Eriogonum
Erco	*Eriogonum cognatum* Greene	Sulphur eriogonum
Erra	*Eriogonum racemosum* Nutt.	Redroot eriogonum
Erwr	*Eriogonum wrightii* Torr.	Wright eriogonum
Ercp	*Erysimum capitatum* (Dougl.) Greene	Western wallflower
Erre	*Erysimum repandum L.*	Spreading erysimum
EUPH	*Euphorbia* sp.	Spurge
Eual	*Euphorbia albomarginata* Torr. & Gray	Rattlesnakeweed
Euca	*Euphorbia capitellata* Engelm.	Head euphorbia
Euch	*Euphorbia chamaesula* Boiss.	Spurge
Eude	*Euphorbia dentata* Michx.	Toothed spurge
Eufe	*Euphorbia fendleri* Torr. & Gray	Spurge
GALI	*Galium* sp.	Bedstraw
Gagr	*Gaura gracilis* Woot. & Standl.	Gaura

GERA	*Geranium* sp.	Geranium
Getr	*Geum trifolium* Pursh	Avens
Gimu	*Gilia multiflora* Nutt.	Woody gilia
GRIN	*Grindelia* sp.	Gumweed
GUTI	*Gutierrezia* sp.	Snakeweed
Hean	*Helianthus annuus* L.	Sunflower
Heob	*Hedeoma oblongifolium* (Gray)Heller	Mock-pennyroyal
HIER	*Hieracium* sp.	Hawkweed
Howr	*Houstonia wrightii* Gray	Houstonia
Hylu	*Hymenopappus lugens* Greene	White ragweed
Hywr	*Hymenothrix wrightii* Gray	Hymenothrix
IPOM	*Ipomoea* sp.	Morningglory
Ipcc	*Ipomoea coccinea* L.	Redstar morning glory
Ipcs	*Ipomoea costellata* Torr.	Morning glory
Irmi	*Iris missouriensis* Nutt.	Flag
Lase	*Lactuca serriola* L.	Prickly lettuce
LATH	*Lathyrus* sp.	Peavine
Lare	*Lappula redowskii* (Hornem.) Greene	Stickseed
LEPI	*Lepidium* sp.	Peppergrass
LESQ	*Lesquerella* sp.	Bladderpod
Lohu	*Lotus humistratus* Greene	Deervetch
Lowr	*Lotus wrightii* (Gray) Greene	Red-and-yellow pea
LOMA	*Lomatium* sp.	Biscuitroot
LUPI	*Lupinus* sp.	Lupine
Luar	*Lupinus argenteus* Pursh	Silvery lupine
Luki	*Lupinus kingii* Wats.	Lupine
Meal	*Melilotus albus* Desr.	White sweetclover
Meof	*Melilotus officinalis* (L.) Lam.	Yellow sweetclover
MENO	*Menodora* sp.	Menodora
Mesa	*Medicago sativa* L.	Alfalfa
Migr	*Microsteris gracilis* (Hook) Greene	Microsteris
Mood	*Monardella odoratissima* Benth.	Monardella
Nomi	*Nolina microcarpa* Wats.	Beargrass
OENO	*Oenothera* sp.	Evening-primrose
ORTH	*Orthocarpus* sp.	Owlclover
OXAL	*Oxalis* sp.	Woodsorrel
Oxgr	*Oxalis grayi* (Rose) Knuth.	Woodsorrel
Oxli	*Oxybaphus linearis* (Pursh) Robins	Oxybaphus
PEDI	*Pedicularis* sp.	Woodbetony
PELL	*Pellaea* sp.	Cliffbrake
PENS	*Penstemon* sp.	Beardtongue
Peli	*Penstemon linarioides* Gray	Toadflax penstemon
Phan	*Phaseolus angustissimus* Gray	Slimleaf bean
Phcr	*Phacelia cryptantha* Greene	Phacelia
Phwo	*Phlox woodhousei* (Gray) E.Nels.	Phlox
PHYS	*Physalis* sp.	Groundcherry
Plpu	*Plantago purshii* Roem. & Schult.	Plantain
POLY	*Polygonum* sp.	Knotweed
Poav	*Polygonum aviculare* L.	Knotweed
Pool	*Portulaca oleracea* L.	Purslane

POTE	*Potentilla* sp.	Cinquefoil
Pocr	*Potentilla crinita* Gray	Cinquefoil
Psmo	*Pseudocymopterus montanus* (Gray) Coulter & Rose	Pismo
Pste	*Psoralea tenuiflora* Pursh	Slender scurfpea
Ptan	*Pterospora andromedea* Nutt.	Pinedrops
Ptaq	*Pteridium aquilinum* (L.) Kuhn	Bracken
RANC	*Ranunculus* sp.	Buttercup
Rhra	*Rhus radicans* L.	Poison ivy
RUMX	*Rumex* sp.	Dock
Sami	*Sanguisorba minor* Scop.	Burnet
Saka	*Salsola kali* L.	Russian thistle
Sene	*Senecio neomexicanus* Gray	Groundsel
Sial	*Sisymbrium altissimum* L.	Tumblemustard
SOLI	*Solidago* sp.	Goldenrod
SPHA	*Sphaeralcea* sp.	Globemallow
Spgr	*Sphaeralcea grossulariaefolia* (Hook. & Arn.) Rydb.	Globemallow
Swra	*Swertia radiata* (Kellogg) Kuntze	Deers-ears, green gentian
TARA	*Taraxacum* sp.	Dandelion
Thfe	*Thalictrum fendleri* Engelm.	Meadowrue
THEL	*Thelypodium* sp.	Thelypodium
Thlf	*Thlaspi fendleri* Gray	Wild candytuft
Thpi	*Thermopsis pinetorum* Greene	Goldenpea
Toex	*Townsendia exscapa (Richards.)* Porter	Townsendia
TRAG	*Tragopogon* sp.	Salsify
Trdu	*Tragopogon dubius* Scop.	Goatsbeard
TRIF	*Trifolium* sp.	Clover
Trst	*Tragia stylaris* Muell. Arg.	Noseburn
UMBL	*Umbelliferae* sp.	Parsley family
Veth	*Verbascum thapsis* L.	Mullein
VICI	*Vicia* sp.	Vetch
Viam	*Vicia americana* Muhl.	American vetch
Vipu	*Vicia pulchella* HBK	Sweetclover vetch
VIGU	*Viguiera* sp.	Goldeneye
UNWE	Unidentified Forb	
Grasses		
AGRO	*Agropyron* sp.	Wheatgrasses
Agcr	*Agropyron cristatum* (L.) Gaertn.	Crested wheatgrass
Agin	*Agropyron intermedium* (Host) Beauv.	Intermediate wheatgrass
Anba	*Andropogon barbinodis* Lag. ex Steud.	Cane beardgrass
ARIS	*Aristida* sp.	Three-awn
Bogr	*Bouteloua gracilis* (HBK) Lag.	Blue grama
Bocu	*Bouteloua curtipendula* (Michx.) Torr	Sideoats grama
Brru	*Bromus rubens* L.	Red brome
Brte	*Bromus tectorum* L.	Cheatgrass brome
Dagl	*Dactylis glomerata* L.	Orchard grass
Eccr	*Echinochloa crusgalli* (L.) Beauv.	Barnyard grass
ERAG	*Eragrostis* sp.	Lovegrass

Fear	*Festuca arizonica* Vasey	Arizona fescue
Hoju	*Hordeum jubatum* L.	Foxtail barley
Kocr	*Koeleria cristata* (L.) Pers.	Junegrass
Lefi	*Leptochloa filiformis* (Lam.) Beauv.	Red sprangletop
Mumi	*Muhlenbergia minutissima* (Steud.)Swallen	Annual muhly
Mumo	*Muhlenbergia montana* (Nutt.) Hitchc.	Mountain muhly
Muri	*Muhlenbergia rigens* (Benth.) Hitchc.	Deergrass
Paob	*Panicum obtusum* HBK	Vine-mesquite
Pavi	*Panicum virgatum* L.	Switchgrass
POAS	*Poa* sp.	Bluegrass
Sihy	*Sitanion hystrix* (Nutt.) JG Smith	Squirreltail
Soha	*Sorghum halepense* (L.) Pers.	Johnsongrass
SPOR	*Sporobolus* sp.	Dropseed
UNGR	Unidentified grass	

Appendix II

Table 1. Winter diet of mule deer in Utah and alligator juniper types. Tame trained deer field feeding trials, Beaver Creek Watersheds, 1966-70. Estimated weight in grams and percent composition by species.

Plant Name Code	Utah Juniper			Alligator Juniper			All Areas
	WS-1 Cabled	Other Treated	Other Untreated	WS-4 Untreated	WS-5 Untreated	WS-6 Clearcut	
	%	%	%	%	%	%	%
Number Trials	4	10	16	3	8	10	51
Hours Obsv'd	6:27	12:40	20:38	2:22	9:44	12:24	64:15
Total Grams	81.30	355.95	1054.90	106.29	349.46	752.30	2700.20
Browse							
Acgr			0.1				0.05
Amut			0.2				0.09
Arpu	0.2	2.1					0.28
Cebr			23.5		42.7	51.9	29.16
Cegr	22.8	0.3	14.3				6.32
Come						2.6	0.73
Gawr		0.3	0.1				0.08
Jude				16.7	2.4	0.5	1.12
Juos	0.1	T	0.7				0.27
Pied	0.6	0.3					0.05
Pipo			1.5	43.7	16.0	1.4	4.78
Quga			0.2	0.1	1.6		0.29
Qutu	32.8	41.1	7.1	10.5	26.5	12.0	16.36
Quun			T	24.9	0.1	0.9	1.25
Rhcr		26.3	5.5		4.2		6.14
Rhtr		0.2	T	0.4			0.05
	56.5	70.4	53.3	96.3	93.5	69.4	67.01
Forbs and Half-Shrubs							
AGAV						0.1	0.03
Ampa			T			0.6	0.16
Arlu			0.2	0.1		0.5	0.21
Asco		0.1	0.9			3.6	1.36
Astp			0.1				0.02
Calu						0.2	0.04
CIRS		0.1	T			0.2	0.06
Codi			0.1				0.04
Cote			3.7		0.3	3.3	2.42
CYMO			0.8				0.30
Daal					1.1	0.7	0.33
Eppa		0.1	T				0.02
Erci		0.3					0.04
Erma			0.3				0.13
Erco	31.8	7.8		0.3	0.5	T	2.07
Erra			0.2	0.7		0.4	0.18
Erwr		0.2	27.0		3.5	0.5	11.17
GALI						0.3	0.09
GERA			1.1				0.42
Gimu						0.3	0.07
GUTI	0.7	T	0.1			T	0.06
Hean			0.2			T	0.07
Heob			0.1			0.2	0.07
Hylu				0.2			0.01
Hywr						0.1	0.02
Lase		0.5	T				0.07
Lowr						0.1	0.03
Meof		0.1	0.1				0.04
MENO		1.0	0.2			0.1	0.23
Mood			T				0.01
ORTH			0.3				0.10
PELL			T				0.01
Peli	10.1	1.3	0.1	0.2		0.1	0.55
Phcr		3.4	0.1				0.47
POLY						0.1	0.02
RANC			0.9				0.35
RUMX			0.4				0.16
Sene		0.6	0.5				0.27
Thpi			0.3				0.10
TRIF			0.5				0.19
UMBL			0.3				0.11
Veth					0.2		0.02
VIGU			T				0.01
Unwe		1.4	0.3	1.7		0.3	0.46
	42.4	16.8	38.5	3.0	5.6	11.5	22.59
Grasses							
Agcr						12.8	3.57
ARIS		T					T
Bogr	0.6			0.1	T		0.02
Bocu	0.2				0.2		0.03
ERAG	0.2				0.3	0.2	0.09
Kocr			0.9		0.1	0.9	0.61
Muri						0.6	0.16
POA		0.2	4.7			0.1	1.90
Sihy		9.2	2.3			3.2	2.99
Soha		0.5					0.06
Ungr		2.9	0.3	0.6	0.4	1.4	0.96
	1.0	12.8	8.2	0.6	1.0	19.1	10.39

Table 2. Spring diet of mule deer in Utah and alligator juniper types. Tame trained deer field feeding trials, Beaver Creek Watersheds, 1966-70. Estimated weight in grams and percent composition by species.

Plant Name Code	Utah Juniper			Alligator Juniper		All Areas
	Other Treated	Other Untreated	WS-3 Herbicide	WS-5 Untreated	WS-6 Clearcut	
	%	%	%	%	%	%
Number Trials	10	14	10	14	14	62
Hours Obsvd.	11:02	22:26	11:00	16:40	16:46	77:54
Total Grams	366.84	1032.51	730.72	854.19	1115.48	3925.35
Browse						
Amut		0.2				0.04
Arce		0.4				0.09
Arpu	0.1	0.1				0.04
Cebr		37.6		53.3	39.1	31.22
Cegr		9.9				2.50
Come				2.6		0.54
Foru		0.3				0.07
Fone	0.2	0.1				0.04
Gawr	0.7	0.5				0.21
Jude				1.0	1.5	0.61
Juos		0.1				0.02
Phco		4.7				1.20
Pied				0.1	T	0.02
Pipo				5.8	2.7	1.94
PRUN				0.3		0.06
PTEL		0.2				0.05
Qutu	17.8	13.5	0.5	1.0	1.7	5.75
Rher	2.4	1.5	1.4	1.7		1.17
Rhtr	0.1	0.1			0.1	0.07
Teca			0.1			0.01
	21.3	69.2	2.0	65.6	45.1	45.64
Forbs and Half-Shrubs						
AGOS				6.8		1.41
ALLI		0.1		0.1	T	0.06
Arcr				T	T	0.02
Arlu	0.2	0.4		0.1	0.7	0.32
Arpe		3.6	0.2	2.8		1.51
ASTE		0.1			T	0.04
Asco				0.4		0.09
ASTR				1.2	0.1	0.30
Asre					2.8	0.77
Astp		0.3	6.7		0.9	1.50
CAST				0.1	0.2	0.09
COMP				0.3		0.06
Cota		2.8				0.72
CYMO		T				0.01
DELP		0.1	0.1	0.5		0.15
DESC	5.8	0.3	0.6			0.70
Dipu		0.1	T	0.2		0.08
Drcu			2.3			0.41
Eppa				0.5		0.10
ERIG		0.3	0.4			0.14
Erco	0.5	0.1	0.1	0.7	1.6	0.62
Erra				1.9	0.7	0.56
Erwr	1.7	9.3	22.1	0.3	0.7	6.69
Ercp	0.1					0.01
Erre	0.1					0.01
Euch	1.9		3.6			0.81
GALI			0.6			0.10
GERA				0.1		0.01
Gimu				0.1		0.01
GUTI	1.3	T		0.1	0.1	0.18
Hean	5.4		0.1			0.48
Heob		T				T
Howr					0.5	0.12
Hylu		0.3		0.2		0.13
Lase	0.1		23.9			4.27
Lare			T			T
LESQ		T	0.3			0.05
Lohu		0.5	0.8			0.26
Lowr		2.0	8.6	2.0	0.5	2.58
LOMA		0.1				0.02
Luki		0.3	T	T		0.09
Meof	3.6				0.2	0.37
MENO	0.2	0.3	0.2	0.1		0.13
Migr			0.6	T		0.12
OENO	0.6		0.3		T	0.12
OXAL		0.1				0.02
PELL		0.1				0.02
Peli	2.6	0.5		T		0.36
Phwo				1.2	0.5	0.39
Pipu			2.1			0.38
Posv			0.3			0.06

Table 2. Continued.

Plant Name Code	Utah Juniper			Alligator Juniper		All Areas
	Other Treated	Other Untreated	WS-3 Herbicide	WS-5 Untreated	WS-6 Clearcut	
	%	%	%	%	%	%
Forbs and Half Shrubs (continued)						
Psmo			0.1			0.02
RANC		0.8				0.21
Saka					T	0.01
Sene	4.1	1.1	0.6	0.1	1.1	1.05
SPHA				0.2		0.04
Spgr	0.3	0.1	1.8	0.1	0.1	0.41
TARA	0.3			T	0.1	0.06
TRIF	4.3		5.6	0.3	2.4	2.11
UMBL	0.1		0.3			0.07
Veth				T		T
Vipu			0.1			0.02
VIGU			T			0.01
Unwe	0.2	0.4	0.7	0.8	1.7	0.89
	33.3	24.0	83.0	21.1	14.7	32.19
Grasses						
Agcr				0.3	0.4	0.16
Bocu			0.6			0.10
Brru	31.2	6.5				3.93
ERAG	0.1					0.01
Kocr		1.0		1.0	16.7	4.99
Mumi				T		0.01
POA		4.7	0.3	4.4	8.2	4.36
Sihy	13.8	1.1	0.8	6.3	12.5	6.34
SPOR					T	0.01
Ungr	0.5	0.1	7.0	1.4	2.4	2.26
	45.4	6.8	15.0	13.3	40.2	22.17

Table 3. Summer diet of mule deer in Utah and alligator juniper types. Tame trained deer field feeding trials, Beaver Creek Watersheds, 1966-70. Estimated weight in grams and percent composition by species.

Plant Name Code	Utah Juniper WS-1 Cabled %	Utah Juniper WS-2 Untreated %	Utah Juniper WS-3 Herbicide %	Alligator Juniper WS-5 Untreated %	Alligator Juniper WS-6 Felled %	All Areas %
Number Trials	20	4	20	8	8	60
Hours Obsv'd	25:46	4:38	24:40	8:46	10:32	74:22
Total Grams	1661.20	515.61	853.24	826.00	902.09	4758.14
Browse						
Acgr		0.1	0.1			0.04
Arpu		0.1				0.01
Cebr	14.5	5.6	6.8	33.2	11.6	14.88
Cegr		49.7	1.2		0.6	5.72
Come	23.3	8.2	14.6	1.0		11.83
Fone	0.5	0.6	0.5			0.34
Gawr	0.1	0.2				0.05
June				0.6	0.7	0.23
Juos	0.1		T			0.04
Pied		0.4			0.1	0.07
Pipo				1.0	0.1	0.20
Prju		0.8	1.6			0.38
PRUN				T		T
PTEL		0.6				0.07
Quga				12.1	5.7	3.19
Qutu	2.7	3.9	1.5	1.8	2.5	2.41
Rhcr	4.0	4.4	0.8	0.7		2.15
Rhtr	0.1	0.3	0.6	0.9	0.7	0.48
	45.3	75.1	28.0	51.3	22.0	42.02
Forbs and Half-Shrubs						
AGAV					0.1	0.02
AMAR	2.1			0.6		0.86
Ampe				T		T
Ardr	T					T
Arlu					0.1	0.01
Asco				1.8	1.2	0.53
Aste	0.1					0.04
Astp			0.1		0.4	0.09
Badi					0.6	0.11
CAST				0.2	0.1	0.05
Chal	0.2		0.1	0.1	T	0.13
CIRS					0.2	0.03
Copa	0.4	0.6				0.21
Cote		0.1		0.2	T	0.05
Daal	0.1		0.7	0.7	4.7	1.17
Deco	4.1	0.2	5.1	1.0	4.1	3.32
Eppa	6.1		0.1	0.9	4.1	3.08
Erci			T			T
ERIG				4.8	13.9	3.47
Erco	2.0	10.8	0.6	0.7	0.4	2.15
Erra				4.3	9.8	2.61
Erwr	0.6	5.8	10.4		0.8	2.78
EUPH	0.2	0.2				0.10
Eual			T			0.01
Euca	T		7.5			1.36
Euch			0.5			0.09
Eufe	0.2		0.4			0.15
GALI					1.3	0.24
Gimu				1.2	0.1	0.23
GUTI	T			0.1	0.1	0.04
Hean	0.4	0.2	0.2	1.4	2.2	0.86
Heob				0.3	1.0	0.22
Hylu	0.1	0.1				0.03
Hywr					0.4	0.07
Lase	6.7	0.7	23.5	0.1	0.4	6.71
LATH				0.1		0.02
Lowr	4.4	1.4	1.9	4.1	1.0	2.92
Meof	7.6	2.6	1.2	1.7	2.7	3.94
MENO	0.1		T			0.05
Nomi					0.1	0.01
OENO			0.9			0.16
Oxli			0.3			0.06
PENS		0.1				T
Pelt	0.1	T		0.1		0.05
PHYS	T				0.3	0.06
Pipu	0.1	1.1	1.9			0.51
POLY	0.1		0.2		0.1	0.09

Table 3. Continued

Plant Name Code	Utah Juniper WS-1 Cabled %	Utah Juniper WS-2 Untreated %	Utah Juniper WS-3 Herbicide %	Alligator Juniper WS-5 Untreated %	Alligator Juniper WS-6 Felled %	All Areas %
Forbs and Half-Shrubs (continued)						
Poav	1.1		1.2	9.9	0.1	2.35
Pool			T			T
Pote	T			T		T
Sahe	T					0.01
Sene		0.1	1.0			0.22
SPHA				2.4		0.41
Spgr	0.5	0.1	1.1	T	0.9	0.58
TARA			0.1			0.03
TRAG	0.1		0.1			0.05
TRIF	15.8		2.6	9.3	16.8	10.75
Trst				0.1		0.02
Veth				T		T
VIGU				0.5	0.7	0.22
Unwe	0.2	0.3	0.5	0.2	0.4	0.28
	33.5	24.3	62.3	46.6	68.8	53.62
Grasses						
Bogr	0.1	T		T	0.1	0.04
Bocu	0.8	T	7.8	0.5	1.2	1.99
Brte	T					T
ERAG	0.2	0.5		0.9	0.1	0.30
Koer				0.3	1.2	0.26
Lefl			0.1			0.01
Munl				T		T
Munn				0.2		0.03
POA					4.2	0.78
Sthy	0.2		0.5		1.3	0.40
Ungr	0.1		1.3	0.3	1.3	0.55
	1.3	0.6	9.7	2.1	9.2	4.36

Table 4. Fall diet of mule deer in Utah and alligator juniper types. Tame trained deer field feeding trials, Beaver Creek Watersheds, 1966-70. Estimated weight in grams and percent composition by species.

	Utah Juniper		Alligator Juniper		
	WS-1 Cabled	WS-3 Herbicide	WS-5 Untreated	WS-6 Felled	All Areas
	%	%	%	%	%
Number Trials	3	8	2	4	18
Hours Obsv'd.	5:10	10:20	2:16	5:46	23:32
Total Grams	366.55	467.72	260.63	354.66	1449.56
Browse					
Amut				0.6	0.15
Cebr			40.1	9.6	9.55
Come	33.1				8.38
Fone		0.1			0.03
Juos		T			0.01
Prju		0.5			0.17
PRUN			2.4		0.43
Quga			17.5	3.3	3.94
Qutu	0.2	0.1		0.2	0.14
Quun				0.3	0.08
Rhtr		T			0.01
	33.3	0.8	59.9	14.0	22.89
Forbs and Half-Shrubs					
AMAR				0.3	0.08
Ampe			2.0	0.7	0.54
Arlu				2.3	0.56
Ascn			0.3	1.0	0.28
Asco			1.2	8.7	2.34
Astp				T	0.01
CAST			3.0	0.1	0.59
Chal	0.2	0.3			0.13
Daal				1.1	0.26
Deco		7.8		2.0	3.00
Eppa	0.1		0.5	0.5	0.24
Erci		0.3	0.1		0.10
Erco	T		0.3	T	0.07
Erra			9.1	12.5	4.69
Erwr	9.5	52.0	3.5	0.6	19.97
EUPH				0.8	0.20
Euca		15.0			4.86
Euch		0.1			0.02
Eude				0.9	0.22
Eufe	0.2				0.06
Gimu			0.2	0.4	0.14
GUTI	T				0.01
Hean	0.3				0.07
Heob				0.1	0.02
Ipcc		0.2			0.06
Ipca		0.4		0.1	0.16
Lase	0.9	2.8			1.13
LEPI				1.4	0.34
Lowr		3.8	0.8	2.9	2.04
Meof		0.2	2.8	1.3	0.86
MENO	6.7	1.2			2.06
Mesa			7.0		1.25
Oxpu				0.2	0.04
Peli	0.7				0.18
Phcr		0.7			0.21
PHYS	13.4				3.39
Pool		0.1		1.6	0.42
Sene		T			0.01
Spgr	0.1	1.0	2.0	2.8	1.37
TARA		0.1			0.03
Toex				0.7	0.18
TRIF	33.7	1.2	6.2	7.3	11.79
VIGU				2.6	0.64
Unwe	0.2	0.9			0.32
	66.0	87.7	38.8	52.8	64.89
Grasses					
AGRO	T				0.01
Agcr				27.0	6.61
Agin				T	0.01
Bogr	T		T	0.1	0.04
Bocu				0.5	0.12
Eccr				0.5	0.67
ERAG	0.6		1.1	2.9	1.07
Kocr		1.0		0.5	0.44
Lefi		4.4			1.41
Paob		T			0.01
Pavi			0.1	1.9	0.47
POA		3.1			0.99
Sihy		2.9			0.92
Ungr		0.2			0.06
	0.7	11.5	1.3	33.3	12.22

Table 5. Winter diet of mule deer in ponderosa pine type. Tame trained deer field feeding trials, Beaver Creek Watersheds, 1966-70. Estimated weight in grams and percent composition by species.

Plant Name Code	WS-11 Clearcut	WS-12 Clearcut	WS-14 Untreated	All Areas
	%	%	%	%
Number Trials	12	6	6	24
Hours Obsv'd.	16:52	8:00	6:56	31:48
Total Grams	701.40	478.88	271.78	1452.06
Browse				
Amut			0.1	0.02
Cebr	11.0			5.30
Cefe			0.2	0.03
Jude		0.2	0.3	0.13
Pipo	7.8	24.7	26.9	18.02
Quga	13.4	32.3	36.8	25.43
Qutu	0.5			0.25
Quun	4.6			2.20
	37.2	57.2	64.3	51.38
Forbs and Half-Shrubs				
Acla			T	0.01
Ampe	0.1	T	0.3	0.13
ANTE		0.1	0.1	0.06
Arcr	0.1			0.03
Arlu	0.1		0.1	0.09
ASTE	0.1		0.2	0.09
Asco	0.6	0.4	25.0	5.12
CIRS	0.1	0.2	0.7	0.26
COMP		1.2		0.43
Daal	1.3			0.61
Eppa	0.2		0.1	0.14
ERIG	0.1		0.1	0.05
Erco	0.1			0.07
Erra	3.1	1.2	2.1	2.36
GERA	11.5	7.7	0.8	8.55
Gimu	T	0.1	1.4	0.31
Heob		0.1		0.02
IPOM		0.1		0.04
Lase		0.6		0.22
Lowr	1.2		0.2	0.62
Meof	0.1			0.04
Mesa	0.1			0.02
OENA	0.1			0.03
Peli	T			0.01
Posy		0.1		0.05
Sene	0.1		0.8	0.18
SOLI		0.1	0.5	0.13
SPHA	0.1			0.05
TRIF	0.4			0.17
Veth	0.3	T	0.1	0.14
VIGU			T	0.01
Unwe	1.8	0.1	0.9	1.11
	21.6	12.0	33.4	21.13
Grasses				
Agcr	23.1			11.15
Agin		2.7		1.00
Bogr	T		T	0.01
ERIG	0.1			0.03
POA	1.4			0.68
Sihy	3.5			1.71
Ungr	13.1	16.3	2.4	12.91
	41.3	19.0	2.4	27.49

Table 6. Spring diet of mule deer in ponderosa pine type. Tame trained deer field feeding trials, Beaver Creek Watersheds, 1966-70. Estimated weight in grams and percent composition by species.

Plant Name Code	WS-8 Untreated %	WS-9 Stripcut %	WS-11 Clearcut %	WS-12 Clearcut %	All Areas %
Number Trials	16	8	14	10	48
Hours Obsv'd.	20:30	9:40	16:54	16:38	63:42
Total Grams	1837.22	639.31	1124.60	1091.27	4692.40
Browse					
Acgr			0.8		0.20
Arva	0.2				0.06
Bere	0.1				0.03
Cebr			7.4		1.77
Cefe	2.8	0.2		0.1	1.15
Jude			T		0.01
Pipo	6.4	0.6	2.0	0.1	3.07
Pofr	1.2				0.46
Potr	0.1				0.03
Quga	11.8	18.6	14.4	49.4	22.07
Qutu			0.4		0.08
Quun			0.3		0.08
Rone	0.2				0.07
ROSA				T	0.01
SALX	0.4				0.15
	23.0	19.4	25.3	50.8	29.23
Forbs and Half-Shrubs					
Acla	T				T
AMAR			0.4	T	0.09
ANTE	T				T
Arpe		T			0.01
Arcr			0.1	T	0.03
Arlu	0.1		T		0.04
ASTE	T				0.01
Asco	0.2		0.2	0.1	0.15
ASTR	T				0.01
Asre	13.0	3.5	1.0	12.6	8.72
Astp	0.2		0.4		0.17
CAST				0.9	0.22
CIRS	T		0.1		0.04
Copa				0.1	0.03
Dasl			T		0.01
DELP		1.4		0.3	0.25
Eppa		0.1	T		0.02
Erci				T	0.01
ERIG	T			2.5	0.59
Erco			T		0.01
Erra		0.1	0.1	4.9	1.18
Gagr				0.8	0.19
GERA	7.0	3.2	4.7	5.2	5.48
Getr	0.9				0.35
Gimu			0.1		0.01
GUTI			T		T
Heob				T	T
HIER				T	0.01
Howr				0.4	0.08
Hylu				T	T
Lase				3.5	0.81
LATH	4.1	3.6			2.08
Lowr	T				0.01
LUPI	0.1				0.06
Meof		14.1			1.92
Migr		T			T
OENO				3.7	0.87
PEDI	0.2				0.07
PENS		0.1			0.01
Phan				T	T
Phwo	0.1			3.5	0.87
POLY	0.1	0.6		0.2	0.17
Poav		0.4		1.8	0.47
POTE	T				T
Ptan	T				0.01
Ptaq		0.3			0.04
RUMX	0.1	0.4			0.09
Saan		9.2			1.25
Sene	0.1	7.2		2.1	0.62
SOLI				0.7	0.15
Swra	T				T

Table 6. Continued

Plant Name Code	WS-8 Untreated %	WS-9 Stripcut %	WS-11 Clearcut %	WS-12 Clearcut %	All Areas %
Forbs and Half-Shrubs (continued)					
TARA	0.9	5.1		2.2	1.54
THAL	T				0.01
THLA			0.2	0.2	0.10
Thpi	T	0.1			0.02
TRAG			T	0.5	0.13
TRIF	15.4	20.2	0.2	0.1	8.82
Veth	T	0.4			0.06
VICI	2.2	0.3		0.4	1.01
Unwe	0.1	0.2	0.7	2.0	0.70
	44.8	64.0	8.3	48.9	39.63
Grasses					
Agcr	0.6		2.5		0.82
Anba			T		T
Brte			T		T
Dagl	26.7	0.8			10.51
ERAG			T		T
Fear	0.1			0.3	0.12
POA	3.8	4.4	1.7	T	2.50
Sihy	0.9	4.3	1.7	0.7	1.50
Ungr	0.4	7.1	60.5	0.3	15.68
	32.3	16.6	66.4	1.4	31.15

Table 7. Summer diet of mule deer in ponderosa pine type. Tame trained deer field feeding trials, Beaver Creek Watersheds, 1966-70. Estimated weight in grams and percent composition by species.

Plant Name Code	WS-8 Untreated %	WS-9 Stripcut %	WS-10 Untreated %	WS-11 Clearcut %	WS-12 Clearcut %	WS-14 Untreated %	All Areas %
Number Trials	12	16	8	16	4	16	72
Hours Obsv'd.	15:20	19:44	10:02	19:44	5:24	22:28	92:42
Total Grams	2369.21	2034.07	911.63	2316.32	531.41	2376.81	10,539.45
Browse							
Amut		0.1	4.0				0.38
Arva		0.4				0.7	0.23
Bere	0.1	0.1					0.04
Cebr			14.1	3.0			1.87
Cefe	5.0	1.4		T	0.1	1.1	1.64
Come			0.1				0.01
Jude			T			T	0.01
Pipo	0.8	0.3	0.3	0.2	0.2	0.1	0.33
PRUN		0.2					0.05
Quga	38.8	56.4	16.0	37.9	51.8	63.8	46.33
Qutu				0.1			0.02
Quun		T	0.6	0.1			0.08
RIBE				T			T
Rone	1.1	3.8					0.97
ROSA	0.1						0.01
SALX		0.2					0.04
Viar		0.7					0.13
	45.6	63.6	35.0	41.3	52.1	65.8	52.12
Forbs and Half-Shrubs							
Acla	T					T	T
AGOS	T		0.3				0.03
ALLI				0.1		0.2	0.06
AMAR	0.3		8.4	T		0.1	0.83
Amps			0.1	T		0.1	0.02
ANDR	0.1						0.01
ANTE		0.3					0.06
Arcw						T	T
Arlu	T		T	0.1		T	0.03
ASTE	T	0.1		T		0.2	0.06
Asco	0.7	0.1	0.3	0.6	0.7	1.0	0.59
ASTR	0.1	0.1		1.1			0.27
Asre	11.7	8.6	11.3	2.1	0.3	5.0	6.85
Astp		0.1					0.01
CAST		0.1	0.5	0.5	0.2		0.18
Chal				0.1			0.03
CIRS	T	0.1		0.1	0.7		0.04
Copa					0.2		0.01
Daal		0.4	2.2	0.9			0.46
Deco		T	2.3	2.1		0.1	0.67
DELP		T	T		0.2	T	0.02
Eppa	0.9	0.2	1.2	0.2	1.6		0.48
ERIG	0.2	0.4	0.2	3.1	2.2	2.9	1.60
Erca				T			0.01
ERIO				0.3			0.06
Erco			0.3	0.4		0.1	0.13
Erra	0.8	1.8	11.3	5.9	2.9	7.1	4.54
EUPH					0.1	T	T
Euch	0.1	T					0.02
Eufe				T		0.8	0.18
Galw				0.1			0.02
Gagr		T			1.9		0.10
GERA	1.4	2.5	0.6	5.5	7.5	1.1	2.66
Gimu		0.1		0.5	0.7	3.2	0.89
GRIN				T			0.01
Hean				0.5			0.12
HIER	0.1		T		0.3	0.1	0.05
Howr	0.1	0.5		0.1	1.7	1.8	0.61
Hylu			T			0.1	0.03
Hylo				0.2			0.03
IPOM						T	0.01
Irmi		T			0.1	0.5	0.11
Lase		0.3	6.6		7.2	0.1	1.00
LATH	4.3	4.0			0.1	0.1	1.75
Lowr	7.2	5.9	6.4	12.3	1.0	0.9	6.25
LUPI	0.5	0.4	0.1	0.1		0.1	0.25
Luki	T						T
Meof	0.9	0.1	6.1	8.0			2.51
Mesa				2.3			0.50
Mood			0.2				0.02

Table 7. Continued

Plant Name Code	WS-8 Untreated %	WS-9 Stripcut %	WS-10 Untreated %	WS-11 Clearcut %	WS-12 Clearcut %	WS-14 Untreated %	All Areas %
Forbs and Half-Shrubs (continued)							
OENO		0.7	0.1		10.5	0.4	0.78
Osgr				T		0.1	0.03
PEDI	T	T	0.1				0.01
Peli			T				T
Phan			0.3			0.1	0.04
Phwo	0.3	0.1	0.3		0.4	0.1	0.16
POLY	0.1	4.0	1.0	T	2.4		1.00
Poav	T	0.2	1.9	0.3	0.5	0.5	0.40
POTE	T					0.3	0.07
Pocr						0.1	0.03
Pete				T		T	T
Ptan	T	T					0.01
Ptaq		0.4					0.08
Rhra		T					0.01
RUMX		0.1					0.01
Saan						0.4	0.08
Sene		0.1	0.1		0.4	1.2	0.30
Sial				0.1			0.02
SOLI					T	0.3	0.07
SPHA		0.2		1.6			0.37
TARA	4.5	0.1	0.1		1.8	2.4	1.68
THAL		T				T	0.01
Thpi	0.1						0.03
TRAG	0.1	0.1	2.9			0.1	0.22
TRIF	12.0	0.2	0.3	5.9		0.1	4.07
Veth		0.4					0.07
VICI	0.5	1.1				0.1	0.34
Viam	0.5	0.1	0.1	T		0.3	0.20
Vipu	0.4	0.1				0.1	0.13
VIGU		0.1		T	0.2		0.04
Unwe	0.2	0.3	2.6	1.6	1.1	1.1	0.77
	48.1	34.2	64.5	56.4	46.1	33.2	45.19
Grasses							
AGRO					0.1		0.01
Agcr		T		0.7			0.16
Agin				0.1			0.01
Bogr			T	T		0.1	0.03
Bocu				T			T
Dagl	5.8	T					1.30
ERAG				T			0.01
Fear		0.1			0.1	0.3	0.10
Hoju	T			T			T
Kocr		0.1			0.2		0.02
POA	T	1.0		T	0.1		0.21
Sihy		0.6	0.2	0.1	0.6	T	0.17
Ungr	0.3	0.5	0.3	1.4	0.8	0.6	0.67
	6.2	2.3	0.5	2.3	1.7	1.0	2.69

Table 8. Fall diet of mule deer in ponderosa pine type. Tame trained deer field feeding trials, Beaver Creek Watersheds, 1966-1970. Estimated weight in grams and percent composition by species.

Plant Name Code	WS-9 (Stripcut) %
Number of Trials	2
Hours Observed	2:52
Total Grams	274.05
Browse:	
Quga	58.06
Forbs:	
Asco	2.28
CHEN	0.66
Eppa	4.71
ERIG	0.24
Erra	8.07
Gimu	0.14
Lase	4.47
LATH	3.27
Lowr	0.84
Meof	0.13
Phan	0.31
POLY	1.86
Sami	7.69
Sere	2.92
TARA	0.11
THEL	0.46
TRAG	0.63
Viam	1.09
	39.89
Grasses:	
Ungr	2.04

Appendix III

Key to sites where taxa were encountered:

U— Utah juniper type
A— Alligator juniper type
P— Ponderosa pine type
B— Brushy areas within the major vegetation types
R— Riparian zones in ravines and canyons

Key to Availablity Ratings:

1— Rare
2— Locally common
3— Common
4— Locally abundant
5— Abundant

Key to Seasonal Palatability Ratings:

H— High
M— Medium
L— Low

Key to Plant Parts taken by deer:

L— Leaves
F— Flowers and flower buds
S— Seeds and fruits
T— Twigs of browse plants
d— Dead parts (e.g., dL indicates dead leaves)

Table 1. Summary of availability and seasonal palatability of forage plant taxa tested on tame deer field feeding trials, Beaver Creek Watershed.

Plant Name	Site	Availability Rating	Seasonal palatability rating and plant parts taken			
			Winter	Spring	Summer	Fall
Trees and Shrubs:						
Acacia greggii	U	1-2	M-S	M-L	M-L	--
Amelanchier utahensis	RB	1-5	M-TS	M-TLF	H-TL	M-TL
Arceuthobium vaginatum	P	1-4	--	M-L	H-TL	--
Arctostaphylos pungens	UB	1-5	L-LS	L-L	L-TL	--
Berberis repens	P	2-4	--	L-L	L-TL	--
Cercocarpus breviflorus	B	1-5	H-TL	H-TL	H-TL	H-TL
Ceanothus greggii	UB	1-5	H-TL	H-TLF	H-TL	--
Ceanothus fendleri	P	1-5	L-TdL	M-TL	M-TL	--
Cowania mexicana	B	1-4	H-TL	H-TL	H-TL	H-TL
Fendlera rupicola	UB	1-4	--	M-TL	--	--
Forestiera neomexicana	UB	1-4	--	L-TL	M-TL	L-TL
Garrya wrightii	UB	1-5	M-TL	M-TL	M-TL	--
Juniperus deppeana	AP	1-5	L-L	M-L	M-L	--
Juniperus osteosperma	U	1-5	L-LS	L-L	L-LS	L-L
Phoradendron coryae	U	2-3	--	H-L	--	--
Pinus edulis	U	1-5	L-L	L-L	L-L	--
Pinus ponderosa	PA	1-5	H-L	H-L	M-L	--
Potentilla fruticosa	PR	1	--	H-TL	--	--
Populus tremuloides	P	1-2	--	M-TL	--	--
Prosopis juliflora	U	1-2	--	--	M-L	H-L
Prunus sp.	A	1-2	--	M-TL	L-L	H-L
Quercus gambelii	P	1-5	H-TdL	H-TL	H-L	H-LS
Quercus turbinella	UAB	3-5	M-TL	M-TL	M-TL	L-LS
Quercus undulata	P	1-4	M-TdL	--	M-TL	M-L
Rhamnus crocea	UB	1-4	H-TL	H-TL	H-TL	--
Rhus trilobata	UB	1-4	L-TdL	L-TLF	M-TL	L-TL
Ribes sp.	P	1	--	--	L-L	--
Robinia neomexicana	P	3-5	--	L-L	M-L	--
Rosa sp.	P	2-4	--	L-L	L-L	--
Salix sp.	RP	2-4	--	M-TL	M-TL	--
Tetradymia canescens	U	1	--	M-TL	--	--
Vitis arizonica	RP	2-4	--	--	M-L	--
Forbs:						
Achillea lanulosa	UAP	1-5	L-S	L-L	--	--
Agave sp.	UA	1-2	M-S	--	M-S	--
Agoseris sp.	P	1-5	--	H-L	--	--

Table 1. (Continued)

Plant Name	Site	Availability Rating	Seasonal palatability rating and plant parts taken			
			Winter	Spring	Summer	Fall
Forbs (continued)						
Allium sp.	UAP	1-3	--	M-L	--	--
Amaranthus sp.	UAP	1-5	--	H-S	H-LS	M-LS
Ambrosia psilostachya	UAP	3-5	L-S	--	L-LF	M-LFS
Androstephium breviflorum	U	2	--	--	M-LF	--
Antennaria sp.	P	2-4	L-L	L-L	--	--
Artemisia carruthii	AP	1-5	L-LS	L-L	--	--
A. c. var. wrightii	P	3	--	--	L-L	--
Artemisia dracunculoides	U	2	--	--	L-LF	--
Artemisia ludoviciana	PA	1-5	L-L	L-L	L-LF	M-LS
Arabis perennans	U	1-2	--	H-FL	M-LF	--
Aster sp.	UAP	1-5	L-S	L-L	L-L	--
Aster canescens	A	2	--	--	--	M-LFS
Aster commutatus	UAP	1-5	M-S	M-L	M-LF	M-FS
Astragalus sp.	AP	1-3	--	M-L	M-LS	--
Astragalus recurvus	AP	1-5	--	H-LF	H-LFS	--
Astragalus tephrodes	UAP	1-4	M-L	M-LF	H-LFS	L-L
Bahia dissecta	A	2	--	--	M-F	--
Capsella bursa-pastoris	A	2	M-S	--	--	--
Castilleja sp.	PA	1-3	--	M-LF	M-LF	M-F
Chenopodium sp.	P	2	--	--	--	M-S
Chenopodium album	UA	1-5	--	--	M-LFS	M-dLS
Cirsium sp.	UAP	1-5	M-LdL	L-L	L-L	--
Commelina dianthifolia	U	2	L-dL	--	--	--
Compositae sp.	U	1-3	M-S	L-L	--	--
Comandra pallida	U	1-4	--	M-LF	M-L	--
Cordylanthus tenuifolius	UA	1-5	M-S	--	L-LF	--
Cymopterus sp.	U	1-2	H-L	M-L	--	--
Dalea albiflora	UAP	1-5	M-S	L-LF	H-LF	M-FS
Desmanthus cooleyi	UAP	1-5	--	--	H-L	H-L
Delphinium sp.	UAP	1-2	--	M-L	L-F	--
Descurainia sp.	U	3-5	--	M-LF	--	--
Dichelostemma pulchellum	UA	1-3	--	L-LF	--	--
Draba cuneifolia	U	4-5	--	M-LFS	--	--
Epilobium paniculatum	UAP	1-5	L-S	M-L	H-LFS	H-LS
Erodium cicutarium	UA	1-5	L-L	L-LFS	L-LS	M-L
Erigeron sp.	UAP	2-5	--	M-L	M-LFS	--
Erigeron canadensis	U	2-3	--	--	L-L	--

Table 1. (Continued)

Plant Name	Site	Availability Rating	Seasonal palatability rating and plant parts taken			
			Winter	Spring	Summer	Fall
Forbs (continued)						
Erigeron macranthus	AP	1-3	M-dLS	--	--	--
Eriogonum sp.	P	1-3	--	--	--	--
Eriogonum cognatum	UAP	1-5	M-LS	M-L	M-LF	L-L
Eriogonum racemosum	AP	1-5	M-LS	M-L	H-LF	H-LF
Eriogonum wrightii	UA	1-5	H-LS	H-L	H-LF	H-LF
Erysimum capitatum	U	4	--	L-LF	--	--
Erysimum repandum	U	5	--	L-LF	--	--
Euphorbia sp.	UAP	1-5	--	---	M-LS	M-LS
Euphorbia albomarginata	U	2	--	---	L-LF	--
Euphorbia capitellata	U	2-5	--	--	M-LF	M-LFS
Euphorbia chamaesula	UP	1-5	--	M-LF	M-LS	L-dLS
Euphorbia dentata	UA	2	--	--	--	M-LS
Euphorbia fendleri	UP	1-5	--	--	M-LS	L-dLS
Galium sp.	UAP	1-3	M-dL	M-LF	H-LFS	--
Galium wrightii	P	2	--	--	M-LFS	--
Gaura gracilis	P	1-2	--	H-LF	M-LF	--
Geranium sp.	P	1-5	M-L	M-L	H-LF	--
Geum triflorum	P	1	--	H-LF	--	--
Gilia multiflora	AP	1-5	M-dL	L-L	M-L	M-LFS
Grindelia sp.	P	1	--	--	L-F	--
Gutierrezia sp.	UAP	3-5	L-L	L-L	L-LF	L-L
Helianthus annuus	UAP	2-5	L-S	M-dLS	M-LF	L-dL
Hedeoma oblongifolium	RUAP	1-3	L-LS	L-L	M-LF	L-FS
Hieracium fendleri	P	1-3	--	L-LF	M-LF	--
Houstonia wrightii	AP	1-3	--	H-LF	M-LF	--
Hymenopappus lugens	UAP	1-4	L-S	M-L	M-L	--
Hymenothrix wrightii	A	1-5	L-S	--	L-F	--
Ipomoea sp.	P	1	--	--	M-LF	--
Ipomoea coccinea	U	1	--	--	--	M-L
Ipomoea costellata	UA	1-2	--	--	--	M-L
Iris missouriensis	RP	1-4	--	--	L-FS	--
Lactuca serriola	UP	1-5	L-dLS	H-LF	H-LFS	M-LS
Lathyrus sp.	P	1-5	--	--	M-LFS	--
Lappula redowskii	U	2	--	L-LF	--	--
Lepidium sp.	A	2	--	--	--	M-S
Lesquerella sp.	U	3	--	L-LF	--	--
Lotus humistratus	U	2-5	--	M-LF	--	--

Table 1. (Continued)

Plant Name	Site	Availability Rating	Seasonal palatability rating and plant parts taken			
			Winter	Spring	Summer	Fall
Forbs (continued)						
Lotus wrightii	UAP	1-5	M-LS	H-LF	H-LFS	H-LS
Lomatium sp.	U	3-5	--	L-L	--	--
Lupinus sp.	P	1-5	--	M-L	M-L	--
Lupinus kingii	U	2-5	--	L-LF	--	--
Melilotus officinalis	UAP	1-5	M-L	H-LF	H-LFS	M-LS
Menodora sp.	UA	1-5	L-LS	L-LF	L-S	M-L
Medicago sativa	P	1-2	M-L	--	H-L	H-LF
Microsteris gracilis	UAP	2-3	--	M-L	--	--
Monardella odoratissima	RP	2-5	L-S	--	L-LF	--
Nolina microcarpa	A	1-3	--	--	L-L	--
Oenothera sp.	UAP	1-4	--	H-LF	H-LF	--
Orthocarpus sp.	U	1-2	M-S	--	--	--
Oxalis sp.	U	2	--	L-L	--	--
Oxalis grayi	P	2	--	--	M-L	--
Oxybaphus linearis	U	2-4	--	--	M-LF	--
Oxybaphus pumilus	A	1	--	--	--	M-L
Pedicularis sp.	P	1-5	--	M-L	L-L	--
Pellaea sp.	U	1	M-L	M-L	--	--
Penstemon sp.	UP	1-3	--	M-L	L-S	--
Penstemon linarioides	UA	1-5	M-LS	M-L	L-LF	M-L
Phaseolus angustissimus	P	1-2	--	L-LF	M-LF	L-L
Phacelia cryptantha	U	1-4	L-dLS	--	--	M-S
Phlox woodhousei	AP	1-5	--	M-LF	M-LF	--
Physalis sp.	UA	1	--	--	M-LS	H-S
Plantago purshii	U	2-5	--	H-LF	M-LS	--
Polygonum sp.	UAP	1-5	M-L	H-L	M-L	M-LS
Polygonum aviculare	UAP	1-4	M-L	H-LF	M-L	--
Portulaca oleracea	UA	1-2	--	--	M-L	H-LS
Potentilla sp.	P	1	--	L-L	H-L	--
Potentilla crinita	P	1	--	--	H-L	--
Pseudocymopterus montanus	U	3	--	L-LF	--	--
Psoralea tenuiflora	UAP	1-5	--	--	L-LS	--
Pterospora andromedea	P	1	--	M-dLS	M-S	--
Pteridium aquilinum	P	2-5	--	M-L	L-L	--
Ranunculus sp.	U	1-5	M-L	M-L	--	--
Rhus radicans	RP	2	--	--	L-L	--
Rumex sp.	AP	1-4	M-S	M-L	L-L	--
Sanguisorba annua	P	2-4	--	H-LF	H-LF	H-L

Table 1. (Continued)

Plant Name	Site	Availability Rating	Seasonal palatability rating and plant parts taken			
			Winter	Spring	Summer	Fall
Forbs (continued)						
Salsola kali	UA	3-4	--	L-L	L-L	--
Senecio neomexicanus	UAP	1-5	M-L	M-LF	M-L	M-L
Sisymbrium altissimum	P	2-3	--	--	M-LFS	--
Solidago sp.	P	3-4	L-LS	L-L	M-L	--
Sphaeralcea sp.	AP	1-5	M-S	M-L	H-LF	--
Sphaeralcea grossulariaefolia	UA	1-5	--	M-LF	H-LFS	H-LS
Swertia radiata	P	1	--	L-dL	--	--
Taraxacum sp.	UAP	1-5	--	H-LFS	H-LFS	L-L
Thalictrum fendleri	P	1-3	--	L-L	L-L	--
Thelypodium sp.	P	2	--	--	--	M-S
Thlaspi fendleri	P	1-4	--	M-LFS	--	--
Thermopsis pinetorum	P	2-5	L-dL	L-L	L-L	--
Townsendia exscapa	P	2	--	--	--	M-L
Tragopogon sp.	UP	1-3	--	M-LF	H-LF	M-LS
Trifolium sp.	UAP	1-5	M-L	H-LF	H-L	H-L
Tragis stylaris	A	3	--	--	L-L	--
Umbelliferae sp.	U	3-4	L-L	M-LF	--	--
Verbascum thapsis	AP	2-5	M-LS	L-dL	M-dL	--
Vicia sp.	P	1-5	--	H-L	H-LF	--
Vicia americana	P	1-5	--	M-LF	H-LF	M-L
Vicia puchella	P	1-4	--	M-LF	H-LF	--
Viguiera sp.	UAP	2-5	L-L	L-L	M-LF	M-FS
Grasses:						
Agropyron sp.	UP	4-5	--	--	M-L	L-L
Agropyron cristatum	AP	2-5	H-L	H-L	H-L	H-L
Agropyron intermedium	AP	3-5	H-L	--	H-L	L-L
Andropogon barbinodis	P	2-3	--	L-S	--	--
Aristida sp.	U	1-5	L-S	--	--	--
Bouteloua curtipendula	UAP	2-5	L-L	L-L	H-L	L-LS
Bouteloua gracilis	UAP	4-5	L-L	--	L-L	L-LS
Bromus rubens	U	1-5	--	H-LFS	--	--
Bromus tectorum	UP	2-4	--	L-LF	L-dL	--
Dactylis glomerata	P	5	--	H-L	H-LF	--
Echinochloa crusgalli	A	2	--	--	--	M-LF
Eragrostis sp.	UAP	1-5	M-S	L-S	M-LF	M-S
Festuca arizonica	P	1-3	--	M-L	M-L	--
Hordeum jubatum	P	3	--	--	L-L	--
Koeleria cristata	UAP	1-5	M-L	H-L	M-L	M-L

Table 1. (Continued)

Plant Name	Site	Availability Rating	Seasonal palatability rating and plant parts taken			
			Winter	Spring	Summer	Fall
Grasses (continued)						
Leptochloa filiformis	U	5	--	--	M-L	H-LS
Muhlenbergia minutissima	A	4	--	L-LF	M-LF	--
Muhlenbergia montana	A	2-3	--	--	M-LF	--
Muhlenbergia rigens	A	2-4	H-S	--	--	--
Panicum virgatum	A	2-4	--	--	--	H-S
Panicum obtusum	U	4	--	--	--	L-LS
Poa sp.	UAP	2-5	H-L	H-LF	H-LS	H-L
Sitanion hystrix	UAP	1-5	H-L	H-L	M-L	H-L
Sorghum halepense	U	1	M-LS	--	--	--
Sporobolus sp.	A	3	--	L-dL	--	--