PINYON-JUNIPER CONTROL:

Where?

Why?

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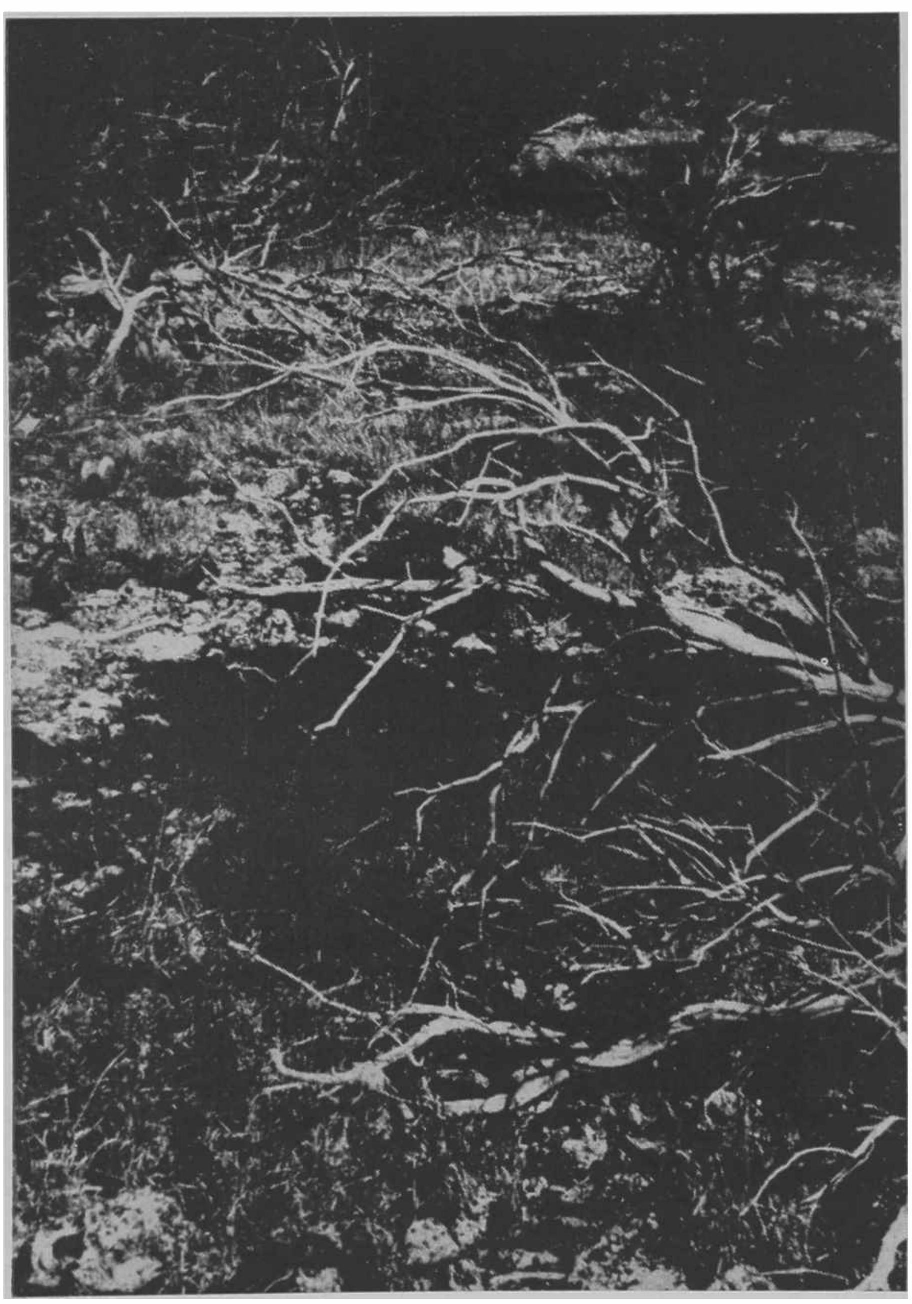

Figure 1. The lack of forage is shown in the above photo where twigs and rocky ground predominate on the Chevelon site before initiating controls on pinyon-juniper.

Figure 2. Following pinyon-juniper controls the forage production at the Chevelon site develops the grasses shown above.

Essentials in pinyon-juniper control:

1. **Control in areas of:**
   - a. **dense pinyon-juniper overstory**
   - b. **high precipitation**
   - c. **low calcium carbonate percentage**
   - d. **near neutral pH**
   - e. **high available phosphates**
   - f. **medium textured soils**
2. **Market for wood products removed.**
3. **Care in the extrapolation of data collected from one area and applied to another area.**

From the New Mexico-Arizona state line westward toward Nevada and California and from the Mogollon Rim north in Arizona lies a broad, discontinuous belt of pinyon-juniper. This area helps account for the fourteen million acres of this vegetative type in the state of Arizona. Recent studies have shown that what this area needs is a market for this low-growing, gnarled, twisted and dense growth form to make control more immediately economical, feasible, and to prevent waste. Apparently it has everything else it needs to produce excellent grazing land. However, since the biological balance is very delicately adjusted in the pinyon-juniper type, excessive grazing, clearing of lands, cutting, and fire, coupled with heavy storms, have perhaps a greater effect than in any of the other zones in causing serious erosion. It is, therefore, important to be able to select sites for pinyon-juniper control which can be successfully revegetated to minimize the erosion hazard and provide an economic return on the control investment. The objective of this study was to measure soil characteristics, precipitation, and vegetation characteristics and determine the influence of each of these on the production and density of desirable forage species following pinyon-juniper control.

In the spring of 1961 and again in the spring of 1962 clearing operations were carried on to remove the pinyon-juniper overstory on the southeast side and the northwest side, respectively, for a powerline right-of-way running northeast to southwest through Navajo and Coconino Counties and cutting perpendicularly through the pinyon-juniper belt which borders the Ponderosa pine zone located north of the Mogollon Rim. Following control, the area was rested from grazing by domestic stock for two growing seasons and then returned to grazing use with the start of the 1965 growing season. Grazing was by sheep from the first week in July until mid-August of 1965 and 1966 and use was estimated at between 45 and 50 per cent utilization of the current seasons growth by the U. S. Forest Service.

Four study sites were established on the powerline right-of-way in the summer of 1966 which had been cleared by bulldozing and handchopping resulting in 100 per cent removal of the overstory vegetation. Located on the Heber Ranger District of the Sitgreaves National Forest, the sites were selected to minimize the effects of slope and aspect and, therefore,

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Table 1. Elevation, vegetative cover, precipitation and mean soil characteristics for the surface foot of soil as measured at four comparison sites in north-central Arizona.

Characteristic		*Site Name*			
		Boundary	*Ryan*	*Second*	*Chevelon*
Elevation	ft.	6200	6300	6500	6600
Pinyon-juniper overstory on uncontrolled areas	%	13	26	36	44
Perennial grass cover on uncontrolled areas	%	22	16	16	8
Perennial grass cover on controlled areas	%	20	13	23	24
Annual grass cover on controlled areas	%	1	.5	13	14
Forb cover on controlled areas	%	1.6	2.6	3.4	1.5
Shrub and half-shrub cover at site	%	2.1	1.7	0.5	0.3
Soil Texture					
Sand	%	48	72	59	57
Silt	%	30	10	20	24
Clay	%	22	19	21	18
Water held at 1/3 atm	%	19.8	16.1	14.6	16.0
Water held at 15 atm	%	11.6	9.5	9.1	9.1
Difference		8.2	6.6	5.5	6.9
June to November 1966 precipitation	inch	5.04	5.52	6.58	9.32
Calcium carbonate	%	13.2	12.5	4.4	6.9
Soil reaction	pH	7.8	7.7	7.5	7.5
Phosphate	ppm	4.3	3.8	5.0	5.0
Nitrate	%	.19	.16	.15	.14
Nitrates	ppm	20	29	17	11
Potassium	ppm	45	48	57	32
Soluble salts	ppm	375	405	447	355

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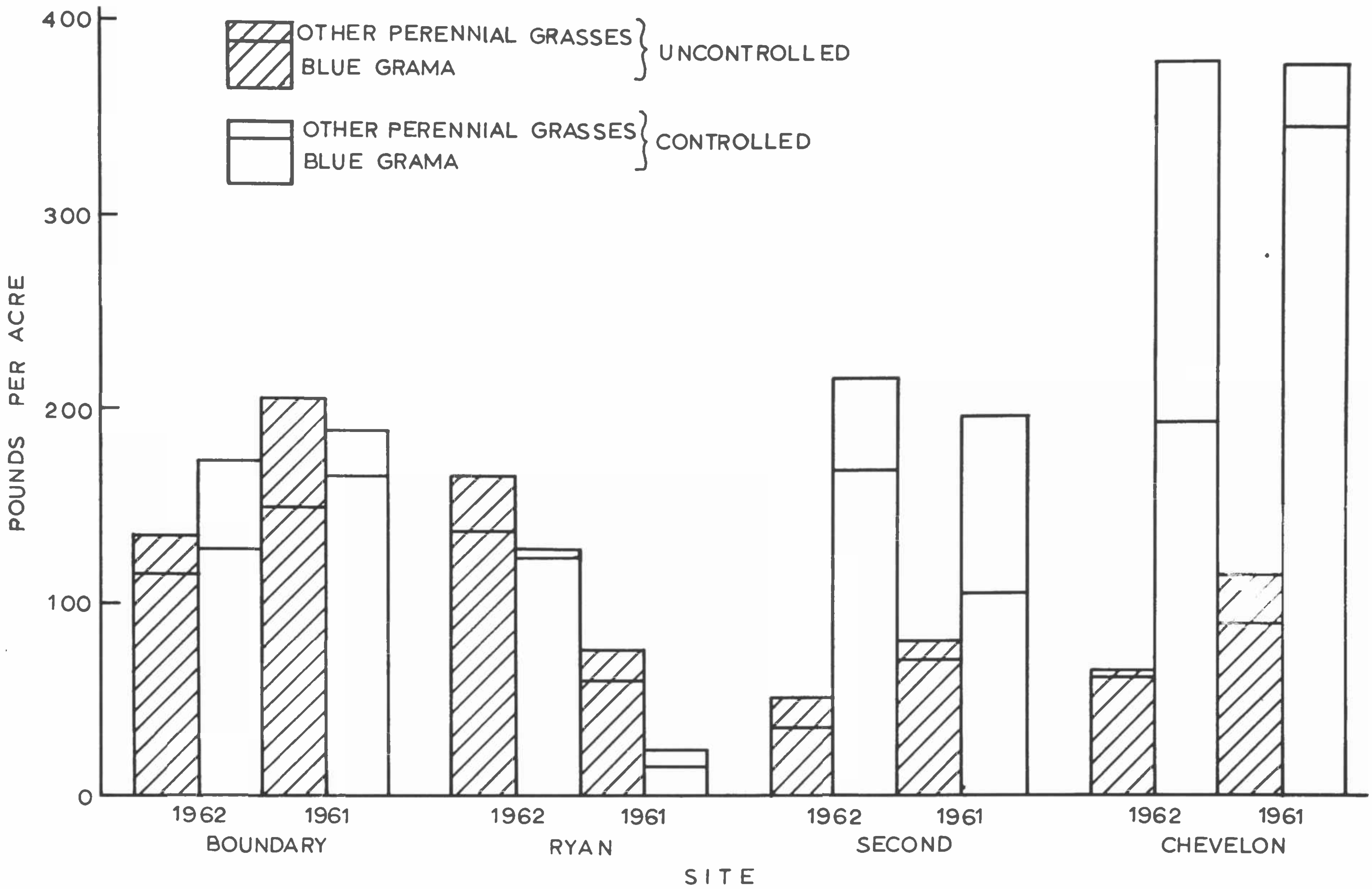

Figure 3. Perennial grass and blue grama production on controlled and uncontrolled areas within four pinyon-juniper sites.

were chosen on level to slightly rolling topography. The shallow soils occur on limestone parent material. Elevation differed approximately four hundred feet between the highest and lowest sites. Site names and elevations are: Chevelon, 6600 ft.; Second, 6500 ft.; Ryan, 6300 ft.; and Boundary, 6200 ft.

One seed juniper (*Juniperus monosperma*), Utah juniper (*J. osteosperma*) and pinyon pine (*Pinus edulis*) were the abundant tree species. Among the dominant shrubs were cliff-rose (*Cowania stansburiana*), snakeweed (*Gutierrezia sarothrae*), and senecio (*Senecio longilobus*). Besides the important annual grasses of annual lovegrasses (*Erogrostis diffusa* and *Eragrostis mexicana*) and false buffalo grass (*Munroa squarrosa*), the principal perennial forage grasses were blue grama (*Bouteloua gracilis*), Texas-timothy (*Lycurus phleoides*), red three-awn (*Aristida longiseta*), Arizona three-awn (*Aristida arizonica*) and squirrel-tail (*Sitanion hystrix*).

Within each year of control at each site, two clusters of five 100-step pace transects were established, and a corresponding number of transects were located in each adjacent uncontrolled area. Thus, the two years of control, each with an adjacent uncleared area, were compared as four treatments at each of the four sites. Basal cover of vegetation by species was recorded along the transects, and pinyon and juniper overstory was also determined along transects in the uncleared areas. At the last pace of each transect, a 9.6 ft.^{2} herbage production plot was established. Herbage production was determined by species for all grasses by weight estimate. The design of sampling was hierarchal, but the treatment within sites mean square was partitioned into the treatment and treatment times site components and analyzed as a factorial design. The cluster within treatment mean square with 16 degrees of freedom was utilized as the error term for testing significance of the treatment and site effects.

Soil was sampled at the 0- to 6-inch depth and the 6- to 12-inch depth and these held separate for analyses. Soil samples were collected from two locations within each cluster of transects. The four samples for each depth within each treatment at each treatment date were composited for laboratory analyses. Laboratory analyses on soil samples were made for texture, moisture holding capacity at ⅓ atm and 15 atm tension, soil reaction, calcium carbonate, total soluble salts, potassium, nitrate-nitrogen, total nitrogen, and phosphate. The means of the analyses are given in Table 1. The sampling was hierarchal but the treatment within sites mean square was partitioned into its factorial components and analyzed as a split-plot factorial design. The year within treatment mean square was utilized as th error term for testing treatment effects, and the site times depth mean square was used to test depth and sites.

Precipitation from June to November of 1966 was collected in three Tru-Chek rain gauges at each of the four sites and presented in Table 1.

From the standpoint of practical application of pinyon-juniper control in this area, it seems only reasonable that action would be taken on those areas from which the greatest gain in forage cover and production could be derived. Large application of funds is unreasonable on areas which will show no increase in gain of forage species, which risk erosion damage, and which bring no monetary gain to the landowner, either through increased livestock gains or through sale of the overstory scrub timber.

As can be seen from Table 1, precipitation increased with increasing elevation. It was at these upper, more moist sites that perennial grass production and basal cover showed the greatest gains from control operations. Perennial grass cover was increased 3 times on the Chevelon site and nearly 1½ times on the Second site, while cover was decreased on both the Ryan and Boundary sites (Table 1). These cover responses are reflected in the herbage production data shown in Figure 3. Perennial grass production along the cleared right-of-way was very nearly the same as for adjacent pinyon-juniper at the Boundary site. Clearing pinyon-juniper decreased perennial grass production at the Ryan site but resulted in over twice the production at the Second site and nearly four times the production of adjacent noncleared areas at the Chevelon site.

Annual grass basal cover averaged 1% to 2% on the uncontrolled areas of all sites and was little different from this after control for the Boundary and Ryan sites but averaged 13% and 14% on the Second and Chevelon sites after control (Table 1). Basal area of forbs ranged from 0.0% to 0.3% of uncontrolled areas but increased to as much as 3.4% after control.

Although not statistically significant, shrubs and half shrubs showed a slightly higher cover on the cleared areas with snakeweed being the dominant half shrub. Again the upper two sites showed the desirable characteristics for grass production capabilities with the lowest percentages of shrub and half shrubs occurring at these two sites (Table 1).

Since great care must be taken in the extrapolation of data collected from one area and applied to another area, the soil characteristics have been analyzed and presented, not only to provide an explanation for the responses noted but as guidelines for future control operations in this area. Perhaps the most obvious factor associated with poor understory herbage increase is the high calcium carbonate percentage of the soils at the Boundary and Ryan sites. Since phosphorus availability is decreased and soil reaction is increased with an increase in the calcium carbonate content in the soil, these characteristics were also correlated with response. Not only is the amount of water soluble phosphorus in calcareous soils very low, but the rate at which it becomes soluble is extremely slow. The calcium carbonate percentage of the surface foot of soil was about 13% for the poor sites and averaged near 5% for the two better sites. Phosphates averaged 4.1% ppm for the two poor sites and 5.0 ppm at the two better sites. This level of available phosphates indicates this nutrient could have been limiting at all sites. Soil reaction averaged a pH of 7.75 for the two lower sites and 7.52 at the higher elevations.

Higher percentage calcium carbonate, higher pH, and a lower phosphate level were found for the 6- to 12-inch depth than for the 0- to 6-inch depth at all sites. Because of the mechanical disturbance of the soil profile with control operations, calcium carbonate and pH were slightly higher and phosphorus lower in the surface soil of treated areas compared to the check areas. These measurements seem to indicate that clearing operations tend to decrease production potential of the sites by severe soil disturbances.

Although there was a greater percent of moisture available to the plants between the wilting point and the field capacity on the soils of the Boundary site, there was also a greater amount of clay at this site which would decrease the infiltration capacity of the soil and provide more runoff with a further decrease in the amount of water available to the plant. In addition to this, there is less total precipitation received at these lower sites which results in an overall more favorable total moisture regime for the plant at the upper sites (Table 1). The Ryan site, with a higher percentage sand and a lower level of available soil moisture than the Boundary site, was an even poorer site than Boundary in terms of perennial grass response. These superior water relationships at the upper sites intensify the leaching that occurs and add to the fact that a lower calcium carbonate percentage, lower pH, and a higher phosphorus availability occurs on these soils.

Total nitrogen and nitrates were found to be more associated with the understory vegetation prior to control and therefore were higher on the lower sites where a greater cover of understory was observed prior to control. Following control the controlled areas exhibited a higher nitrate content due to the addition of litter and more rapid decay. Due to evaporation processes, total soluble salts and potassium were brought up from the subsurface soil and show a greater concentration in the surface 6 inches of soil than in the 6- to 12-inch depth. Since potassium, total soluble salts, nitrates and nitrogen were lowest at favorable total moisture regime for the the Chevelon site, these nutrients could be limiting factors on this site, but apparently were not limiting on the lower sites.

Now that we have seen which sites can be recommended for increased forage production, we need to turn our attention to what the overstory cover is that we must control. As can be seen from Table 1 and Figures 1 and 2, it is our productive forage producing sites which also produce the heavier overstory canopy. Perhaps this is a disadvantage, and perhaps this is an advantage. Again, we have everything else we need for forage production at these sites. Now we need a market for the overstory growth to increase the benefits from this control operation. If this market can be developed, we have an advantage in having our denser overstory at these sites in that harvesting of this growth can be more economically carried on when the product is centralized.