Response of Herbaceous Vegetation to Felling of Alligator Juniper

WARREN P. CLARY

Highlight: *Felling of a 13% cover of alligator juniper in northcentral Arizona resulted in a 38% increase in total herbage production and a 45% increase in forage plant production. These increases were highly variable relative to the control. There was little or no apparent response in three of the seven postfelling years.*

Management of the southwestern pinyon-juniper is of interest to many because of its contributions to livestock grazing, wildlife habitat, and domestic and agricultural water supplies. Most attempts at improving these values consist of reducing pinyon-juniper stands by cabling or pushing, burning, or by chemical control (Aro, 1971; Arnold et al., 1964).

This paper reports the response of herbage to the felling of alligator juniper (*Juniperus deppeana*). The trees were felled with power saws to eliminate soil pits which are created when trees are uprooted through cabling or pushing. These pits were considered undesirable because they retain surface water, thereby reducing runoff yield (Skau, 1961), they are a potential source of sediment, and when the trees are uprooted much of the cool-season grass is destroyed which normally grows under larger alligator juniper crowns (Clary and Morrison, 1973).

Study Area and Methods

The study was conducted in north-central Arizona on a 100-acre experimental watershed at an elevation of approximately 6,400 ft. The soils are a complex of the Gem clay loam and Springerville very stony clay series. These soils, formed over basalt and volcanic cinders, have an average profile depth of 44 inches (Williams and Anderson, 1967).

Average annual precipitation on the area during the study was 20 inches. Crown cover of the tree vegetation was approximately 13%. The tree basal areas per acre were alligator juniper, 22.3 ft^2; others, 1.6.

The tree overstory was felled with power saws in the fall of 1965. Chemicals were used to control the sprouting of alligator juniper and to remove most other minor woody vegetation, primarily shrub live oak.[1] Stumps of alligator juniper were treated with polychlorinated benzoic acid to reduce sprouting, shrub live oak clumps were treated with pelleted fenuron, and the few Gambel oak sprouts were treated with a dormant-season basal spray of 2,4,5-T.

About half of the alligator juniper sprouts were killed, but little damage was evident on shrub live oak. Poor herbicide distribution was apparent in both cases. The residual juniper sprouts, shrub live oak, and Gambel oak sprouts were treated with picloram and 2,4-D in 1968. Most alligator juniper sprouts were killed, but kill of the oaks was variable.[2] Miller (1971) made a cost analysis of this treatment.

No forage plants were seeded because of the good cover of native species (Fig. 1).

The study area had been paired with an adjacent control area 6 years previous to treatment. Sampling on both the control and the treated areas consisted of ten 100- by 300-ft plot clusters. Each contained five 9.6 ft^2 plots used to determine herbage production by species via the weight estimate method (Pechanec and Pickford, 1937), and two 3-step transects (Parker, 1954). During herbage sampling, a sixth plot at each cluster was estimated, clipped, ovendried, and weighed to determine the conversion from estimated green weight to ovendry weight.

Data on herbage production were collected for 3 of the 6 pretreatment years. Data were collected each year of the posttreatment evaluation period, 1966 to 1972. The transects, used to determine ground cover and plant frequency, were read in 1960, 1965, 1966, and 1971.

The study area was grazed by beef cattle during spring and fall. Utilization averaged 15% for all forage grasses combined, but was about double the average for cool-season grasses alone. Grazing was not deferred following the felling treatment, but was changed to alternate-year use.

The statistical analysis was based on a comparison of ratio estimates utilizing pretreatment and posttreatment data for both treated and control areas (Cochran, 1963, p. 181).

Herbage Response

Felling the alligator junipers resulted in a 38% average increase in herbage yields. The treated watershed would have had an estimated mean production for the posttreatment period of 635 lb/acre if left untreated, while the actual production was 877 lb/acre. This is a 242-lb/acre difference or about a 38% increase. Production increases were largest in bottlebrush squirreltail and western ragweed (Table 1). Plumeweed birdbeak, which is partially root parasitic on juniper, declined.

Forage plant (U. S. Forest Service, 1970) yields on untreated and treated plots were estimated to be 292 and 423 lb/acre, respectively, or an increase of 45% as a result of tree removal. Based on 40% utilization and 750 lb of forage per animal unit month (AUM), the potential livestock carrying capacity has increased from 0.16 AUM/acre before treatment to 0.23 AUM/acre after treatment.

The herbage production increase was not consistent from year to year (Fig. 2). Herbage production increased for 2 years after the juniper felling, then became variable in relation to the

The author is principal plant ecologist, Rocky Mountain Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture. Research reported here was conducted at Station's Research Work Unit at Flagstaff, in cooperation with Northern Arizona University. Station's central headquarters is maintained at Fort Collins, in cooperation with Colorado State University.

Manuscript received December 27, 1973.

[1] Botanical names of understory plants are given in Table 1.

[2] Johnsen, Thomas N., Jr. 1972. Personal communication.

Fig. 1. *Views from a photo point: (A) In 1960, 5 years before trees were felled. (B) In 1971, 6 years after felling.*

control area. This variation in treatment response may have two independent causes. One is time related: a stimulation effect, related possibly to nutrients, etc., is often apparent for up to several years after overstory removal. Thereafter, however, the response of herbage production appears to be primarily affected by climatic variation.

Grasses respond somewhat differently to the timing and amount of precipitation than do forbs, and therefore often attain peak yields in different years than do forbs. Of the 7 posttreatment years, perennial grass production was significantly higher than pretreatment levels in 3 years, and total herbage production was significantly higher in 4. When all posttreatment years are combined, average herbage yields were significantly higher as a result of treatment.

The response of herbaceous vegetation to the felling of alligator juniper differs from the response suggested by some. It has been suggested that herbage yields will steadily increase after juniper removal until a maximum level is reached, perhaps 10 years later (Arnold and Schroeder, 1955; Arnold et al., 1964). In most cases on the Beaver Creek watersheds, however, herbage production after treatment appears to more closely follow the pattern suggested by Odum (1960): Total herbage production reaches essentially a steady state within a year or two, and does not tend to increase measurably through time, even though plant composition is changing, so long as the plants are of the same major life form. If this is true, then grazing capacity will increase due to increases in total herbage production only in the first few years after treatment. Further

Table 1. Average production (lb/acre) of understory plants.

Species	Control area		Treatment area	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Grasses				
Blue grama (*Bouteloua gracilis*)	82.5	98.7	109.6	158.9
Side-oats grama (*Bouteloua curtipendula*)	45.9	59.0	38.7	51.6
Prairie junegrass (*Koeleria cristata*)	19.6	23.8	9.1	19.7
Bottlebrush squirreltail (*Sitanion hystrix*)	18.5	40.0	23.8	118.4
Mutton bluegrass (*Poa fendleriana*)	18.1	30.2	12.0	11.3
Black dropseed (*Sporobolus interruptus*)	17.8	23.9	8.4	18.6
Spike muhly (*Muhlenbergia wrightii*)	1.0	.5	1.7	2.9
Fendler three-awn (*Aristida fendleriana*)	.3	.8	1.4	3.6
Western wheatgrass (*Agropyron smithii*)	.0	.0	2.5	10.2
Total grasses	203.7	276.9	207.2	395.2
Forbs and half-shrubs				
Broom snakeweed (*Gutierrezia sarothrae*)	81.3	65.4	151.2	166.3
Sulfur eriogonum (*Eriogonum cognatum*)	45.2	55.1	34.8	49.8
Plumeweed birdbeak (*Cordylanthus wrightii*)	30.8	40.6	50.3	13.2
Goldeneye (*Viguiera* spp.)	11.5	18.3	8.3	37.7
Western ragweed (*Ambrosia psilostachya*)	5.8	17.5	4.0	94.6
Showy aster (*Aster commutatus*)	5.8	13.5	2.1	29.6
Redroot eriogonum (*Eriogonum racemosum*)	5.8	6.3	10.0	17.7
Common sunflower (*Helianthus annuus*)	.5	.1	5.5	9.2
Others	18.2	35.6	15.4	63.6
Total forbs and half-shrubs	204.9	252.4	281.6	481.7
Shrubs				
Shrub live oak (*Quercus turbinella*)	26.7	48.6	.0	.0
Wavyleaf oak (*Quercus undulata*)	4.3	2.4	.0	.0
Total shrubs	31.0	51.0	.0	.0
All vegetation	439.6	580.3	488.8	876.9

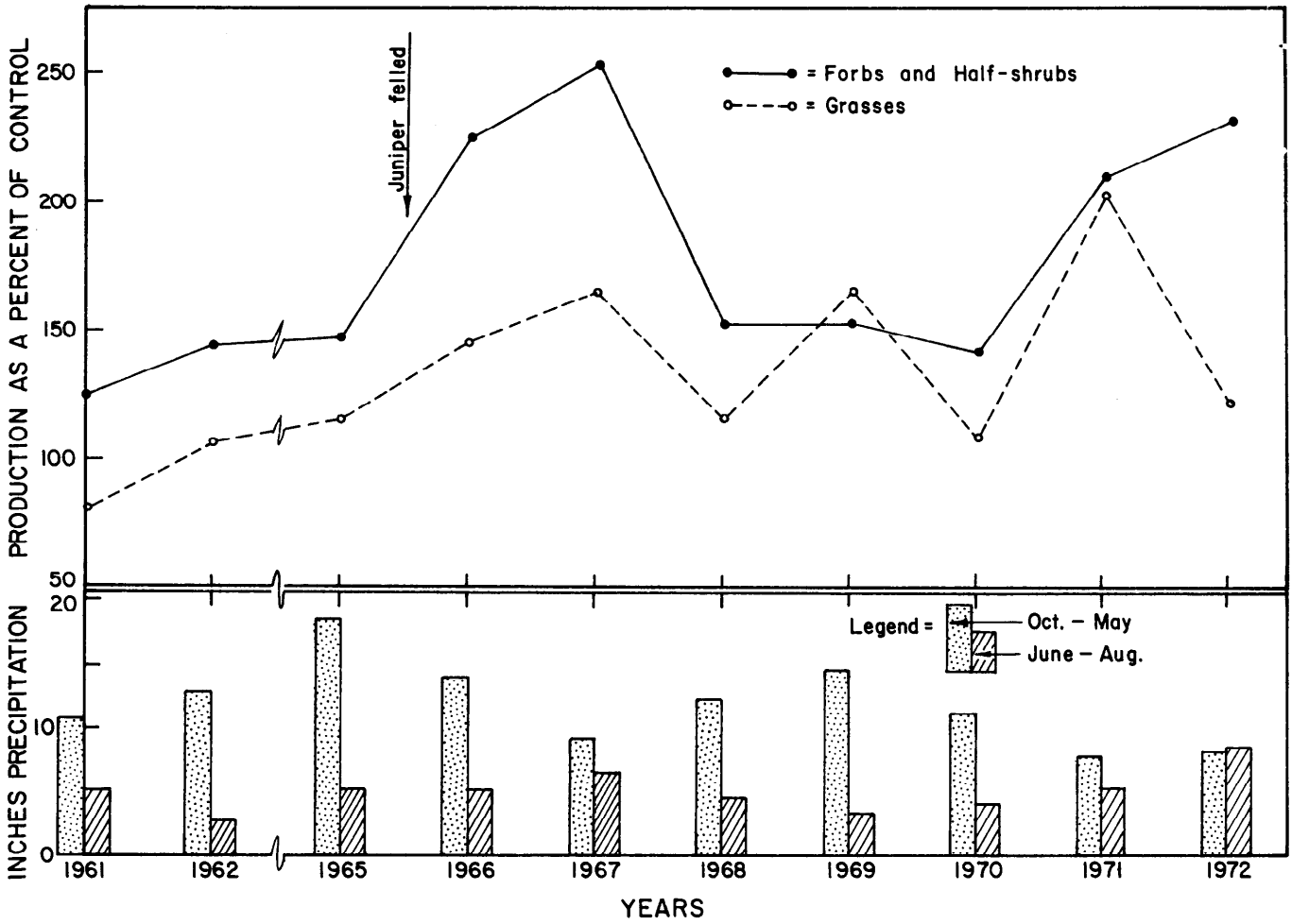

Fig. 2. *Herbage production on the treated area as a proportion of the control area.*

increases will result only as nonpalatable plants are replaced by palatable plants via plant succession, at an expected average replacement ratio of 1:1.

Measurements of ground cover and range condition on the 3-step transects were not affected by juniper removal.

Summary and Conclusions

1) The increase in total herbage yields as a result of felling a 13% cover of alligator juniper averaged 38%; the increase in forage plant yields averaged 45%.

2) The herbage increase was highly variable. There was little or no response in 3 of 7 posttreatment years.

3) Experience here and on other Beaver Creek watersheds suggests that average herbage production may reach a near steady state within several years after tree removal. If palatable forage plants then replace nonpalatable plants during successional change, it will be about at a 1:1 ratio.

4) Little effect of treatment on ground cover and range condition was detected by the 3-step transect measurements. This suggests that major changes in range condition on these sites will take long periods of time or will require major changes in grazing management in addition to the juniper control.

Literature Cited

Arnold, Joseph F., Donald A. Jameson, and Elbert H. Reid. 1964. The pinyon-juniper type of Arizona: Effects of grazing, fire, and tree control. U. S. Dep. Agr. Prod. Res. Rep. 84. 28 p.

Arnold, Joseph F., and W. L. Schroeder. 1955. Juniper control increases forage production on the Fort Apache Indian Reservation. U. S. Dep. Agr., Forest Serv., Rocky Mountain Forest and Range Exp. Sta., Sta. Pap. 18. 35 p. Ft. Collins, Colo.

Aro, Richard S. 1971. Evaluation of pinyon-juniper conversion to grassland. J. Range Manage. 24:188-197.

Clary, Warren P., and Douglas C. Morrison. 1973. Large alligator junipers benefit early-spring forage. J. Range Manage. 26:70-71.

Cochran, William G. 1963. Sampling techniques. John Wiley and Sons, New York. 413 p.

Miller, Robert L. 1971. Clearing an alligator juniper watershed with saws and chemicals: A cost analysis. Rocky Mountain Forest and Range Exp. Sta., Ft. Collins, Colo. USDA Forest Serv. Res. Note RM-183. 8 p.

Odum, Eugene P. 1960. Organic production and turnover in old field succession. Ecology 41:34-49.

Parker, Kenneth W. 1954. A method for measuring trend in range condition on National Forest ranges with supplemental instructions for measurement and observation of vigor, composition, and browse. U. S. Forest Serv., Washington, D. C. 37 p.

Pechanec, Joseph F., and G. D. Pickford. 1937. A weight estimate method for determination of range or pasture production. Amer. Soc. Agron. J. 29:894-904.

Skau, C. M. 1961. Some hydrologic influences of cabling juniper. U. S. Dep. Agr., Forest Serv., Rocky Mountain Forest and Range Exp. Sta., Res. Note 62. 2 p. Ft. Collins, Colo.

U. S. Forest Service. 1970. Range environmental analysis handbook. Region 3. Albuquerque, N. Mex.

Williams, John A., and Truman C. Anderson, Jr. 1967. Soil survey of Beaver Creek area, Arizona. U. S. Dep. Agr., Forest Serv. and Soil Conserv. Serv., in cooperation with Ariz. Agr. Exp. Sta. 75 p.