Impact on Associated Vegetation of Controlling Tall Larkspur

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Highlight: *Herbicide treatments that effectively control tall larkspur also convert the tall-forb community to a grass-dominated community. The composition of the grass community is determined more by the grazing system imposed on the treated area than by the herbicide treatments. Early grazing reduces mountain brome and increases letterman needlegrass. With protection from grazing, the converted grass community can produce abundant high-quality forage and watershed cover superior to that of the former larkspur-dominated tall-forb community.*

Stagger weed, poison weed, and cow poison were names applied to the larkspurs by pioneer livestockmen in the western states (Chesnut, 1898; Chesnut and Wilcox, 1901). Early recognition of the poisonous properties of larkspur, however, has not altered its importance as a cattle killer (Cronin, 1971). The economic impact on ranchers as well as the increasing demand for red meat emphasizes the necessity of eliminating this needlessly destructive poisoning.

Cattle losses can be reduced via control of tall larkspur (*Delphinium barbeyi* Huth) with herbicides. Recent research has demonstrated that tall larkspur and duncecap larkspur (*D. occidentale* S. Wats) can be controlled with herbicide treatments (Torrel and Haas, 1963; Cronin and Nielsen, 1972; Cronin, 1974). Reinvasion and reestablishment of tall larkspur proceed slowly due to the dawdling growth and development of the seedlings and juvenile stages (Holman, 1973). It appears reasonable and conservative to estimate a period of 15 years before tall larkspur on effectively controlled areas would again reach potentially dangerous levels.

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It is a report on the current status of research involving use of certain chemicals that require registration under the Federal Insecticide, Fungicide, and Rodenticide Act. It does not contain recommendations for the use of such chemicals, nor does it imply that the uses discussed have been registered. All uses of these chemicals must be registered by the appropriate State and Federal agencies before they can be recommended.

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The multiple-use concept in management of public lands requires that control of larkspur to avert cattle losses must not diminish the value of the land for other uses. History adequately forewarns us of the dangers and consequences of damaging the subalpine zone (Reynold, 1911; Sampson and Weyl, 1918; Ellison, 1954). Damage may vary from simple but undesirable alterations of the vegetation up through extensive changes affecting both water and grazing resources, and finally, monumental depletion of the vegetation that can result in mud and rock flooding of the farmlands and communities in the valleys below the watershed (Reynold, 1911).

The value of the Wasatch Plateau as a watershed, in fact, exceeds its value for grazing, recreation, or timber production (Ellison, 1954). Proper management of grazing should enhance its value and productivity as a watershed. Other uses should be managed to be compatible with maintenance of the watershed.

The purpose of this paper is to report changes in the densities of associated species following application of herbicides to control tall larkspur. Hopefully, these data will provide a basis for evaluating the impact of controlling tall larkspur on existing uses, as well as future uses, of these subalpine grazing lands.

Materials and Methods

Data presented and discussed here were compiled simultaneously from the same experiments as data presented earlier on the response of tall larkspur to various herbicide treatments (Cronin and Nielsen, 1972; Cronin, 1974).

Experimental sites were in the subalpine zone on the Wasatch Plateau in central Utah. All of the study plots were in the tall-forb communities on persistent or late-melting snowdrift areas supporting dense stands of tall larkspur.

An ocular point frame was used to estimate changes in the vegetation as a result of herbicides applied and grazing (Cronin and Nielsen, 1972). Ten samples of 10 points each (100 points/plot/year), spaced 3 feet apart along the axis of the 8- by 33-foot plots, were obtained on each plot before treatment and annually for 4 or more years after treatment. The first species or object intercepted by the line of sight was recorded for each point. The exception was in the 1965 experiment, when (20 points/sample) 200 points were recorded annually for each plot.

Data were subjected to analysis of variance.

Herbicide treatments applied in the 1961 study included the dimethylamine salt of 2,4,5-T [2-(2,4,5-trichlorophenoxy) acetic acid], the butoxy ethanol ester of 2,4,5-T and the butoxy ethanol ester of silvex [2-(2,4,5-trichlorophenoxy) propionic acid] applied at rates of 2, 4, and 8 lb/acre. Four additional treatments consisted of two series of repeated or split applications of the ester formulations of 2,4,5-T or silvex. One repeated or split treatment consisted of an application of a 2 lb/acre treatment the first summer and a 4 lb/acre application for each of the next two summers. A total of 14 treatments, including untreated checks, were replicated three times on an area open to grazing and three times on an adjacent ungrazed area in an exclosure.

No split application treatments were used in the 1964 study. The propylene glycol butyl ether ester of 2,4,5-T was applied at 4, 8, and 16 lb/acre. The diethylamine salt of dicamba (3,6-dichloro-*o*-anisic acid), picloram (4-amino-3,5,6-trichloropicolinic acid) and mixtures of 2,4-D [(2,4-dichlorophenoxy) acetic acid] and 2,4,5-T were applied at rates of 2, 4, and 8 lb/acre.

The 1965 study was designed to evaluate various split treatments with 2,4,5-T, silvex, dicamba, picloram, 2,4-D and mixtures of 2,4-D and 2,4,5-T (Table 1). Each treatment and the untreated check were replicated four times in a stratified block. Plots were grazed by cattle.

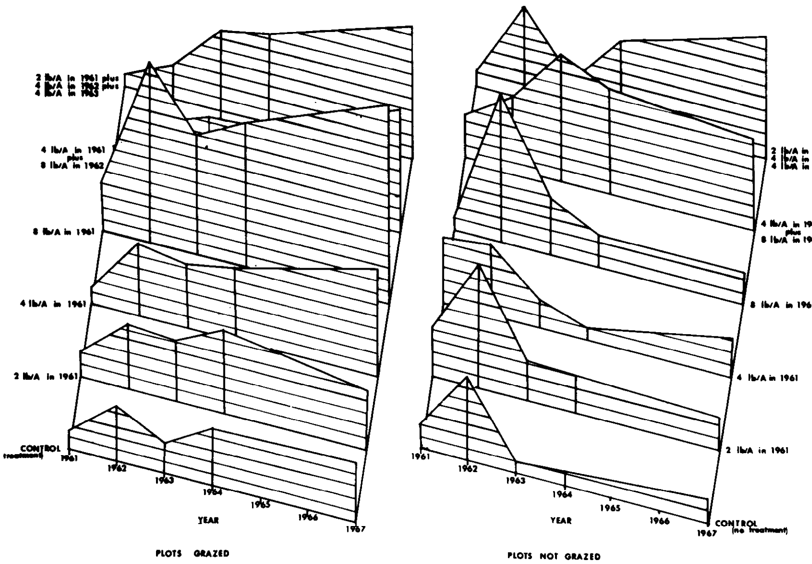

Fig. 1. *Percent aerial cover, in 1% increments (horizontal lines), of slender wheatgrass (*Agropyron trachycaulum*) on grazed plots and on plots in an exclosure as influenced by various herbicide treatments. The vegetation was sampled prior to treatment in 1961 and in 1962, 1963, 1964, and 1967 (L.S.D.$_{.05}$ = 8.2).*

Table 1. Treatments applied to the 1965 study plots.

Herbicide applied	Rate applied in[1] 1965	1966	1967
Check – no treatment applied			
2,4,5-T	8	0	0
2,4,5-T	4	4	0
2,4,5-T	4	8	0
2,4,5-T	8	8	0
2,4,5-T	2	4	4
2,4,5-T	4	4	4
2,4,5-T	2	4	8
Silvex	2	4	4
2,4-D	8	8	8
Dicamba	1	1	1
Dicamba	2	2	2
Picloram	¼	¼	¼
Picloram	½	½	½
2,4,5-T plus 2,4-D	2 + 2	2 + 2	2 + 2
2,4,5-T plus 2,4-D	4 + 2	4 + 2	4 + 2

[1] Rate of herbicide application indicates amount (lb/acre) of active ingredient applied.

Results and Discussion

Generally, herbicide treatments richly enhanced grass production and drastically reduced forbs without any obvious intensification of erosion, although a temporary increase in percentage of bare ground followed applications of the treatments. Gains in forage production were enhanced or abrogated by grazing practices following application of the herbicide.[1]

Grass

The effects of herbicide treatments, grazing, and their interactions are best illustrated by the data from the 1961 study. Grasses found on the study areas included slender wheatgrass (*Agropyron trachycaulum*), mountain brome (*Bromus carinatus*), meadow barley (*Hordeum brachyantherum*), alpine timothy (*Phleum alpinum*), arctic bluegrass (*Poa arctica*), subalpine needlegrass (*Stipa columbiana*), letterman needlegrass (*S. lettermanii*), spike trisetum (*Trisetum spicatum*), oniongrass (*Melica bulbosa*), Raynolds sedge (*Carex raynoldsii*), and blister sedge (*Carex vernacula*).

While slender wheatgrass, mountain brome, and letterman needlegrass responded dramatically to the treatments, the remaining species of grasses and sedges were scarcely affected. The aerial cover data for this group of miscellaneous species were consolidated for analysis, since none of them were evenly distributed over the study area. Analyses of variance of the consolidated data indicate differences due to herbicide applications and to grazing were not significant. The consolidated data suggest a trend of increased production by these miscellaneous species, especially on plots where tall larkspur and other broadleaf species were effectively removed. Data from both the 1964 and 1965 studies are similar to the data from the 1961 study.

Initially on the 1961 study plots, slender wheatgrass tended to increase, sometimes significantly, following applications of herbicides on both the grazed and the ungrazed plots (Fig. 1). During the 6 years spanned by this study, the largest increases in aerial cover of slender wheatgrass occurred on the grazed plots. Differences in aerial cover between the grazed and ungrazed plots were highly significant. With the exception of the split treatments, the aerial cover of slender wheatgrass decreased on plots in exclosure, while all herbicide treatments on the grazed plots produced an increase in the aerial cover of slender wheatgrass. Although grazing produced the most profound effect on the study plots, the herbicide treatments significantly increased the aerial cover of slender wheatgrass, especially the split treatments. The interaction between the herbicide treatment and the grazing was also statistically significant.

On the 1964 study plots, which were all grazed, the slender wheatgrass increased only on plots treated with 2 and 4 lb/acre of picloram and 8 and 16 lb/acre of 2,4,5-T. The aerial cover decreased on the untreated control plots and the remaining treated plots. The differences between these two groups of plots in the 1964 study were highly significant.

Treatments applied in the 1964 study produced changes in the aerial cover of slender wheatgrass similar to those recorded for the split treatments on the grazed areas in the 1961 study. Differences due to treatment in the

[1] Cattle should not be permitted to graze treated areas following application of herbicides until the leaves of larkspur are dry. Treated plants may increase in palatability following application of the herbicides resulting in heavier use of the poisonous plant.

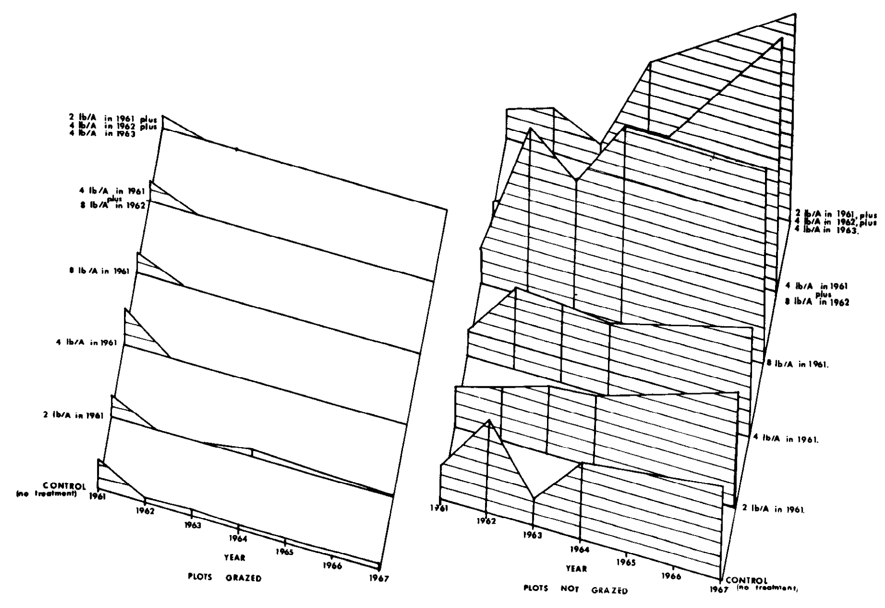

Fig. 2. *Percent aerial cover, in 1% increments (horizontal lines), of mountain brome on grazed plots and plots in an exclosure as influenced by various herbicide treatments. The vegetation was sampled before treatments were applied in 1961 and in 1962, 1963, 1964, and 1967. Differences between grazed plots and ungrazed plots were highly significant but differences between treatments on the ungrazed plots were not significant (L.S.D.$_{.05}$ = 8.89).*

1965 study, however, were not significant.

The results of these three studies indicate that slender wheatgrass responds well to early spring grazing. The split treatments with 2,4,5-T, which were found best for controlling tall larkspur (Cronin, 1974), combined with grazing also generally produced the greatest increases in aerial cover of slender wheatgrass.

Mountain brome's response to the removal of the susceptible broadleaf species was quite different on the grazed plots and on the ungrazed plots (Fig. 2). With protection from grazing cattle, the reduced competition following herbicide applications produced a dramatic increase in mountain brome. Without protection from cattle, the removal of the competing broadleaf species only served to expose this grass to the grazing cattle, and the plants were nearly eradicated. Other factors, such as their increased succulence and their innate susceptibility to injury by early grazing, probably contributed to their destruction. Statistical analyses of these data indicate that differences between grazed and ungrazed plots were highly significant but no differences due to herbicide treatment were measured.

Although both the 1964 study plots and the 1965 study plots were grazed, the aerial cover of mountain brome remained statistically unchanged for the period of 5 years during which the vegetation on these plots was measured. In the 1964 study, a difference in cover occurred due to the excessively high rates of picloram applied (4 and 8 lb/acre), which temporarily sterilized the plots. The split treatments with picloram applied in the 1965 study resulted in nonsignificant reduction in mountain brome cover.

Letterman needlegrass increased in response to herbicide treatments and grazing in the 1961 study. Differences due to herbicide treatments applied, to grazing, and to their interactions were highly significant (Fig. 3). The pretreatment cover percentages of letterman needlegrass were significantly higher on the grazed plots than on plots in the exclosure and may have contributed to the highly significant differences that developed between the grazed and the ungrazed plots.

Application of split treatments with 2,4,5-T or silvex to grazed plots resulted in vegetation dominated by letterman needlegrass. The vegetative cover on these plots was similar to the vegetation described by Ellison (1954) resulting from overgrazing by sheep.

The initial aerial cover of letterman needlegrass on both the 1964 and 1965 plots was relatively low. In neither study did the changes in cover of letterman needlegrass become significant. Observations of the 1964 plots indicate that it is the most resistant of the grasses to injury from high concentrations of picloram. It was the first grass to reestablish on plots temporarily sterilized by picloram.

Forbs

Herbicides selective against broadleaf species destroyed most forbs on treated plots. A few survived and some reinvaded the treated plots. Two forbs that were destroyed by herbicide treatments were tall bluebell (*Mertensia arizonica*) and porter ligusticum (*Ligusticum porteri*).

A preferred forage of almost all classes of grazing animals, tall bluebell was drastically reduced by pandemic overgrazing near the turn of the century (Ellison, 1954). Growing on only a few plots in these studies, it was readily killed by herbicide treatments. Removal of this desirable component of the tall-forb community appears to be an enduring result due to its sluggish regenerative capacity (Matthews and Conrad, 1968).

Porter ligusticum appears to be a palatable forb that is utilized for a short period early in the grazing season. Its tolerance to herbicide injury appears to be slightly less than tall larkspur's. Highly significant reductions followed application of herbicide treatments, but no changes related to grazing were detected. Porter ligusticum has gradually reestablished itself even on plots where it has been eradicated.

Ellison (1954) wrote, "Some forbs increase with increasing cattle grazing. The most clear-cut examples of those that increase are *Artemisia discolor* and *Delphinium nelsonii.* Others that are rather abundant and have similar tendency are *Geranium richardsonii, Agoseris pumila, Gilia pulchella, Lupinus alpestris, Solidago ciliosa, Taraxacum officinale,* and *Viola nuttallii.* Several of these species are ephemeral or are notably abundant on accelerated erosion pavement: *Delphinium, Agoseris, Gilia, Taraxacum,* and *Viola.*"

Most of these species are present in our study plots, but with the exception of *Artemisia, Taraxacum, Lupinus,* and *Viola* they are infrequent. Their cover values varied with year but without evidencing a trend. Plants listed as exceptions were impor-

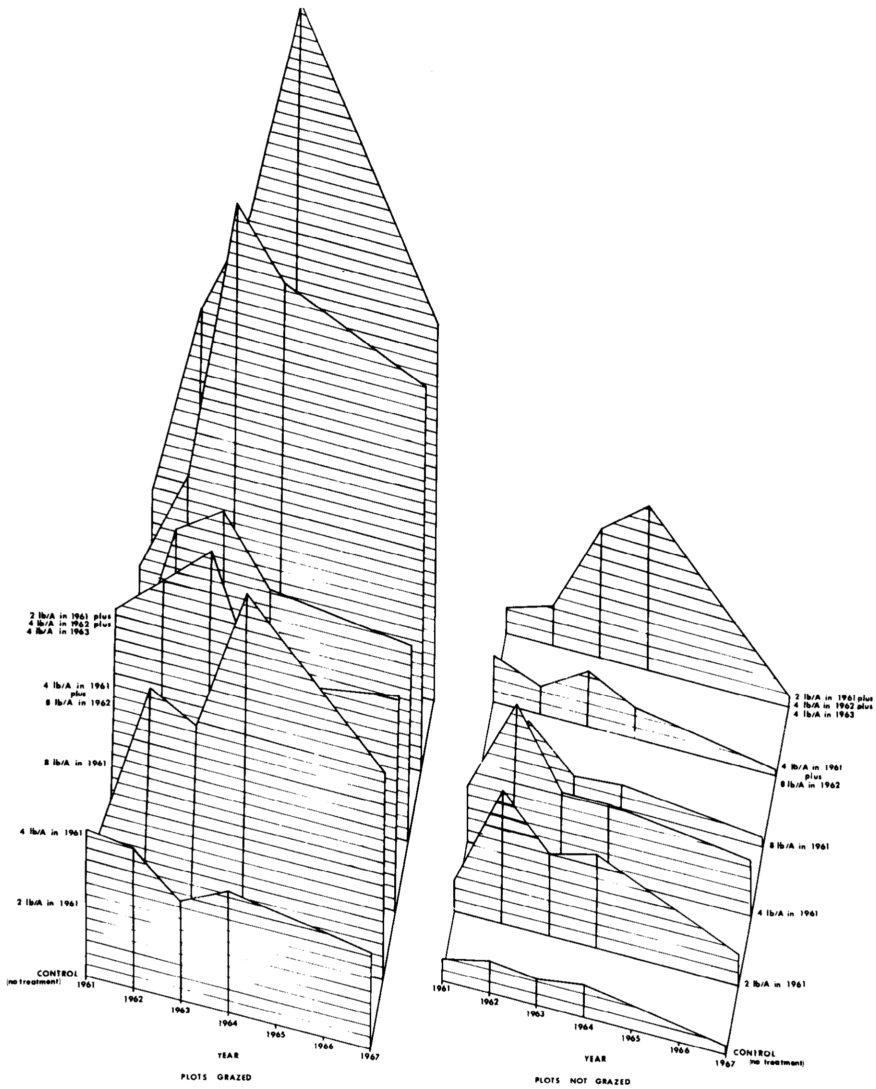

Fig. 3. *Percent aerial cover, in 1% increments (horizontal lines), of letterman needlegrass on grazed and ungrazed plots as influenced by various herbicide treatments. The vegetation was sampled prior to treatment in 1961 and in 1962, 1963, 1964, and 1967. Differences due to treatments, to grazing, and to their interaction were highly significant (L.S.D.$_{.05}$ = 10.19).*

tant on our plots and trends did become evident while the plots were studied.

Artemisia discolor, now generally accepted as Michaux sage (*Artemisia michauxiana*) furnishes no forage for cattle and aggressively invaded unoccupied territory. Applications of 2,4,5-T or silvex produced severe injury to Michaux sage and the split application treatments rigorously reduced both its cover and distribution. However, the cover of this species increased significantly following single application treatments with these herbicides, especially when early grazing followed the treatments. Applications of as little as ¼ lb/acre of picloram eradicated Michaux sage from treated areas. On the other hand, application of as much as 8 lb/acre of 2,4-D favored the spread and dominance of the sage.

Even low rates of 2,4,5-T and silvex killed silky lupine (*Lupinus sericeus*) growing in the 1961 study plots, however, it is already reestablishing itself on these plots. This plant furnishes little or no forage to grazing cattle and eradication of silky lupine would be desirable because of its potential danger as a poisonous plant.

Both dandelion (*Taraxacum officinale*) and nuttal viola (*Viola nuttallii*) increased immediately following treatment unless a second application of herbicide was included as part of the treatment. These plants tended to maintain their high cover on plots treated with 2,4-D or with single applications of low rates (2 or 4 lb/acre) of 2,4,5-T or silvex. Increases were greater on treated plots that were grazed than on treated plots in the enclosure.

Alpine aster (*Aster foliaceus*), a conspicuous species of the pristine vegetation usually decreases under heavy grazing (Ellison, 1954). But on the grazed plots receiving single applications of herbicides it tended to increase, sometimes manyfold. This increase was not significant, probably because of the variation between replications.

Changes in the composition of the vegetation of the 1961 grazed plots, indicative of overgrazing, may have been due to close proximity of these plots to shade, shelter, and water. Changes in cover of key species did not occur on the 1964 or 1965 study plots that were not near water and only the 1964 plot was near shade and shelter. However, cattle infrequently utilized the trees adjacent to the 1964 plots for shade or shelter.

Conclusions

Split application treatments with silvex or 2,4,5-T effectively converted the tall forb communities, dominated by tall larkspur on snowdrift areas, to grass communities. However, grazing influenced the vegetation, especially the grasses, as much as the herbicide treatments. While these studies failed to address the question of proper grazing management during and following herbicide treatments, they demonstrated that early season grazing should be avoided following application of treatments. The studies suggested that proper grazing may enhance forage production of the highly palatable grass species.

The overall degradation caused by early season grazing during the season of herbicide applications was emphasized by results from the 1961 study. Early season grazing tended to sacrifice mountain brome while selectively favoring letterman needlegrass. The latter is, unfortunately, a grass of low palatability and a relatively poor forage producer. Slender wheatgrass was the only grass to increase when subjected to early season grazing. It increased moderately on grazed plots treated with single applications of herbicides.

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