Improving Gambel Oak Ranges for Elk and Mule Deer by Spraying with 2,4,5-TP

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Highlight: Areas of Gambel oak vegetation in northwestern Colorado were sprayed with 2,4,5-TP to evaluate effects on plant abundance and deer and elk use 2 and 5 years after treatment. Grasses increased in abundance 44% after 2 years; shrubs and forbs decreased 29 and 15%, respectively. After 5 years, grasses and shrubs were 17 and 7% , respectively, above pretreatment levels of abundance; forbs were 4% below. Total vegetation on the treated area decreased 4% after 2 years, while a 5% increase was recorded after 5 years. Elk and deer use on the sprayed area increased 73 and 16%, respectively, 2 years after spraying. After 5 years elk use was 11% above pretreatment levels and deer use was 21% below. If 2,4,5-TP is used to spray Gambel oak to modify plant composition and increase elk or deer use, the area should be resprayed at 3-year intervals, indefinitely, if the improved situation is to be maintained.

Gambel oak (*Quercus gambellii*) is an important elk (*Cervus canadensis*) and mule deer (*Odocoileus hemionus*) winter browse plant in Colorado (Kufeld 1973; Kufeld et al. 1973). Extensive stands of Gambel oak are found on some big game winter ranges throughout the western slope of Colorado (Brown 1958). As oakbrush becomes older, however, it grows beyond the reach of elk and deer and much of it is unavailable as game forage. Oak stands also become extremely dense, suppressing grass and forb production, and often precluding access by cattle; very dense stands will exclude elk. Boyd (1970) found that oakbrush in densities exceeding 51% appeared to exclude elk physically.

This study was conducted to determine if forage production and elk and deer use can be increased on Gambel oak game ranges by spraying with 2,4,5-TP (2-(2,4,5-trichlorophenoxy) propionic acid) to induce shrub sprouting and alter vegetation composition. It was a cooperative project involving the Colorado Division of Wildlife and the U.S. Forest Service, Routt National Forest.

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Study Area and Methods

The study was conducted along Beaver Creek on the Routt National Forest about 28 miles southwest of Hayden, Colo., at an elevation of 8,000 to 8,500 feet. Dominant plants are Gambel oak, snowberry (*Symphoricarpos* sp.), serviceberry (*Amelanchier alnifolia*), and common chokecherry (*Prunus virginiana*). Slopes generally face southwest and are relatively steep, ranging from 30 to 90%. Annual precipitation averages 23 inches.

The area is used by elk during fall, winter, and spring, and yearlong by deer. Most deer use, however, occurs during spring, summer, and fall. The area has been set aside for wildlife by the U.S. Forest Service and is closed to livestock grazing.

Two adjacent 67-acre areas were studied. One area was treated with herbicide and the other was a control. On July 10, 1969, the treated area was sprayed by helicopter with 2 lb of 2,4,5-TP in 10½ gallons of water per acre. The large volume of water was used to achieve adequate wetting of vegetation. Winds during spraying remained below 5 mph. Three-fourths of the spraying was completed during the early morning hours. Due to rising winds, however, the remaining one-fourth was delayed until midafternoon, when winds again dropped below 5 mph. Temperatures ranged in the 60°s and 70°s and no precipitation occurred on spraying day.

Vegetation measurements were made on 111 permanent plots in the treated area and 114 in the control. Vegetation was measured during summer (1968), 1 year before spraying, and in 1971 and 1974, 2 and 5 years after spraying, using the vertical point quadrat method originated by Levy and Madden (1933). The equipment consisted of a tubular 7/8-inch aluminum conduit horizontal frame, 12 inches by 68 inches, mounted on 5/8-inch steel rod uprights fastened to permanent steel stakes. The frame could be set any desired height up to 5½ feet. Two attached line levels permitted the frame to be set level and plumb. Ten guide holes 6 inches apart were drilled through the horizontal conduit frame to support and guide the point quadrat pins. Pins were made of 3/16-inch carbon-tested drill rod. Each was 6 feet long, with one end sharpened to a needle point. One plot consisted of 10 pin drops. The number of hits (point contacts) with vegetation were recorded, by plant species, between a height of 5½ feet and ground level. Changes in plant abundance are reflected by changes in frequency of occurrence. All vegetation change data have been adjusted for normal year-to-year fluctuations in plant growth as measured on the control area.

Identification of study area plants was verified by Colorado State University Botany Department personnel. Scientific names are according to Harrington (1952). Common names are according to Kelsey and Dayton (1942).

Photographs showing vegetation conditions were taken at 67 permanent photo points 1 year before and 1, 2, and 5 years after spraying.

Deer and elk use during the fall-winter-spring period as indicated by fecal pellet accumulation was measured on 58 .001-acre circular pellet group plots located in the spray area and 57 plots in the control. Fecal counts were made 1 year before and 2 and 5 years after spraying. Plots were cleared of pellets about the first of September, and accumulated deer and elk pellet groups counted the following May.

Results

Vegetation Changes 2 and 5 Years after Spraying

Total vegetation abundance changed very little following spraying. After 2 years, adjusted total vegetation on the sprayed area decreased 4%, while an increase of 5% was recorded after 5 years (Table 1). However, relatively large changes in abundance of forbs, grasses, and shrubs occurred after spraying. Although vegetation measurements were not made until the second year, substantial increases in abundance of grasses and decreases in shrubs were observed after the first year following spraying. After 2 years, grass abundance had declined somewhat and shrub regrowth was underway (Fig. 1). Despite the decline of grasses and regrowth of shrubs between the first and second post-treatment years, grasses had still increased 44% and shrubs had decreased 29% 2 years after spraying. After 2 years forbs decreased 15% from spraying (Table 1).

Between 2 and 5 years after spraying, grass abundance continued to decline toward pretreatment levels and shrub and forb abundance continued to rise (Fig. 1, Table 1). Grass abundance after 5 years was still higher than adjusted control area values, but only by 17%. This increase during the 5-year post-treatment period was significant ($P<.05$), but most of the significance was attributable to the large increase in grass yields measured after 2 years. Shrub abundance after 5 years was 7% higher than before spraying, and forb abundance was 4% below pre-treatment levels. The change in shrubs during the 5-year post-treatment period was significant at the α (confidence) .05 level primarily due to the large decrease in shrubs observed after 2 years. The post-treatment forb decline was significant at the α .15 level, again due primarily to the decrease in forbs after 2 years.

The principal grass and grasslike plants on the study area are nodding brome (*Bromus anomalus*), blue wildrye (*Elymus glaucus*), Kentucky bluegrass (*Poa pratensis*), and elk sedge (*Carex geyeri*). Kentucky bluegrass and elk sedge were lumped together in this study because it was often difficult to distinguish between them when making vegetation measurements. Nodding

Table 1. Abundance of summer vegetation on control and sprayed areas before and 2 and 5 years after spraying.

	Control area						Spray area									Percent change due to spraying		Significance of change over 5 year period[3]
	1968		1971		1974		1968		1971			1974					
Species	Hits	Percent comp.	Hits	Percent comp.	Hits	Percent comp.	Hits	Percent comp.	Hits	Percent comp.	Expected 71 hits[1]	Hits	Percent comp.	Expected 74 hits	After 2 years	After 5 years	
Achillea lanulosa	86	6.0	152	6.4	89	4.7	77	5.6	152	6.8	143	74	3.8	86	+ 6	− 14	
Agastache urticifolia	40	2.8	58	2.4	80	4.2	42	3.0	49	2.2	57	54	2.8	78	− 15	− 31	
Erigeron sp.	22	1.5	32	1.3	28	1.5	43	3.1	28	1.3	38	35	1.8	31	− 27	+ 12	
Galium boreale	42	2.9	56	2.3	22	1.2	42	3.0	64	2.9	55	30	1.5	21	+ 16	+ 39	
Lathyrus leucanthus	32	2.2	155	6.5	98	5.1	71	5.1	131	5.9	193	149	7.6	115	− 32	+ 29	.05
Lupinus argenteus	34	2.4	69	2.9	56	2.9	21	1.5	35	1.6	59	38	1.9	49	− 41	− 24	
Mertensia franciscana	49	3.4	72	3.0	63	3.3	49	3.5	48	2.2	71	33	1.7	62	− 33	− 47	
Thalictrum fendleri	21	1.5	38	1.6	26	1.4	29	2.1	72	3.2	45	59	3.0	29	+ 59	+100	
Minor forbs (37 species)	140	9.9	236	9.9	247	12.9	126	9.1	179	7.9	227	222	11.4	251			
Total forbs	466	32.6	868	36.3	709	37.2	500	36.0	758	34.0	888	694	35.5	722	− 15	− 4	.15
Agropyron spp.	29	2.0	101	4.2	47	2.5	28	2.0	101	4.5	98	38	1.9	45	+ 3	− 17	
Bromus anomalus	15	1.1	31	1.3	33	1.7	41	3.0	58	2.6	32	94	4.8	31	+ 81	+196	
Elymus glaucus	21	1.5	93	3.9	53	2.8	57	4.1	313	14.0	107	97	5.0	75	+191	+ 28	.05
Poa-Carex geyeri	249	17.4	390	16.3	249	13.1	142	10.2	323	14.5	326	178	9.1	210	− 1	− 16	
Minor grasses (5 grasses)	23	1.6	24	1.1	32	1.6	26	1.9	77	3.5	42	48	2.5	27			
Total grasses	337	23.6	639	26.8	414	21.7	294	21.2	872	39.1	605	455	23.3	388	+ 44	+ 17	.05
Amelanchier alnifolia	33	2.3	45	1.9	33	1.7	64	4.6	23	1.0	70	46	2.4	52	− 67	− 12	.05
Prunus virginiana	103	7.2	151	6.3	100	5.2	65	4.7	62	2.8	122	59	3.0	74	− 49	− 21	
Quercus gambellii	136	9.5	247	10.3	216	11.3	97	7.0	173	7.8	198	231	11.8	172	− 13	+ 34	
Symphoricarpos sp.	328	23.0	394	16.5	402	21.1	324	23.3	315	14.1	387	442	22.6	394	− 19	+ 12	.10
Minor shrubs (4 species)	23	1.6	39	1.7	33	1.8	37	2.7	27	1.2	62	24	1.2	58			
Total shrubs	623	43.6	876	36.7	784	41.1	587	42.3	600	26.9	839	802	41.0	750	− 29	+ 7	.05
Total all plants	1426	99.8	2383	99.8	1907	100.0	1381	99.5	2230	99.9	2318	1951	99.7	1856	− 4	+ 5	

[1] Value reflects the number of hits expected on the sprayed area following spraying assuming that normal year-to-year plant abundance changes occurred there in the same proportion as on the control. This value forms the basis for determining percent change due to spraying. It was derived by applying the number of pretreatment spray area hits to a regression of pre- and post-treatment control area hits for each plant species.

[2] Indicates the highest confidence level at which changes due to spraying during the 5-year period following spraying are significant. Data in the preceding column show whether most of the significant change occurred after 2 or 5 years. Only changes that are significant at the ϵ .05, .10, or .15 level are shown.

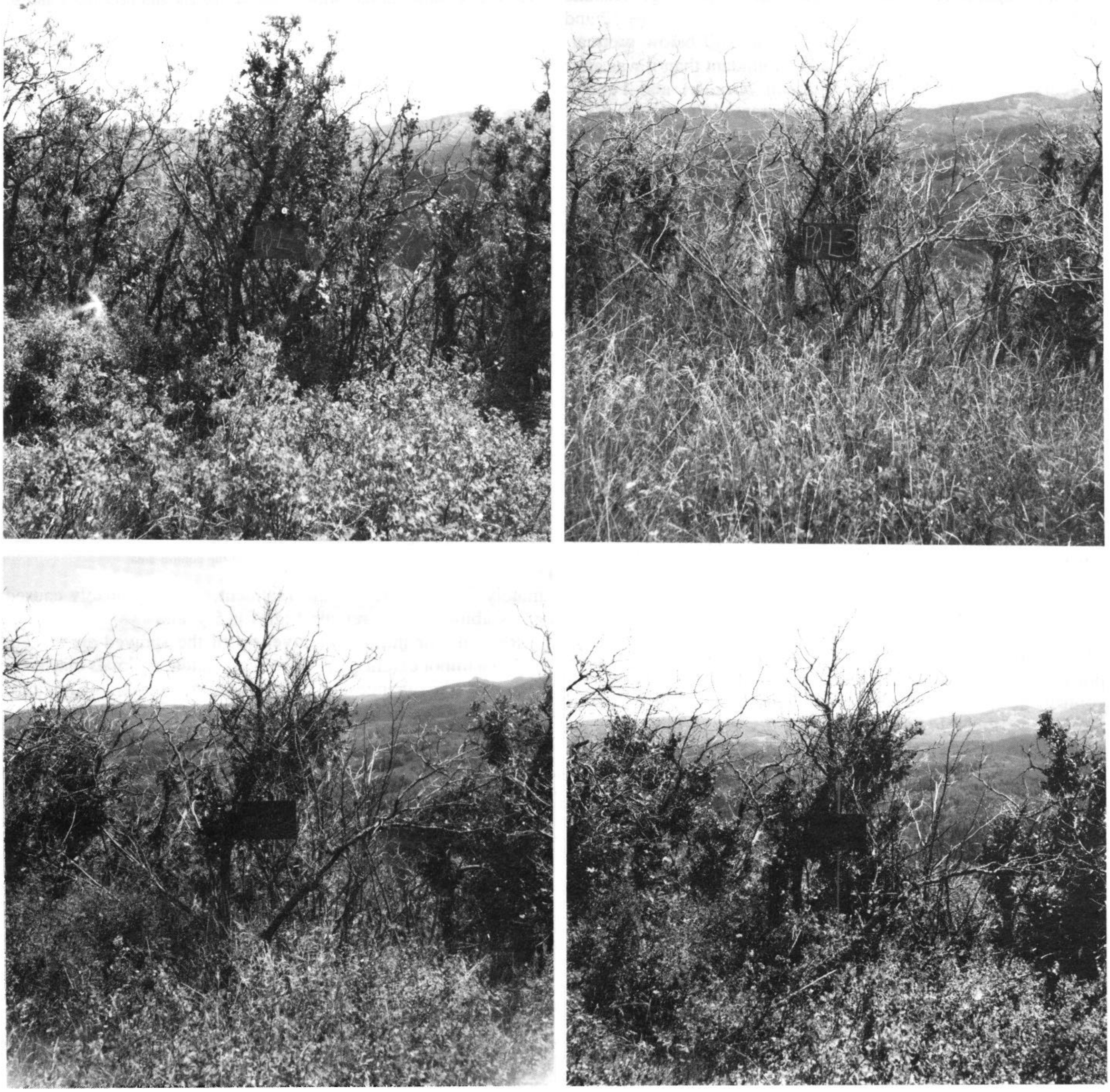

Fig. 1. *Vegetation conditions at a permanent photo point on the Beaver Creek oak study area 1 year before (1968, upper left), 1 year after (1970, upper right), 2 years after (1971, lower left), and 5 years after (1974, lower right) spraying.*

brome and blue wildrye accounted for most of the large increase in grass abundance after 2 years. These species increased 81 and 191%, respectively. Abundance of nodding brome continued to rise, and after 5 years it had increased 196%. Five years after treatment, abundance of blue wildrye was only 28% above pretreatment levels. Bluegrass-elk sedge declined by 1% after 2 years and by 16% after 5 years (Table 1).

Abundance of primary shrubs declined substantially after 2 years. Serviceberry, chokecherry, Gambel oak, and snowberry declined 67, 49, 13, and 19%, respectively. The decreases in these shrubs were probably even greater the first year following spraying than after the second (Fig. 1). As a result of sprouting and regrowth, abundance of serviceberry and chokecherry after 5 years was only 12 and 21%, respectively, below pre-spray levels; Gambel oak and snowberry were 34 and 12%, respectively, above levels recorded before spraying (Table 1).

Two of the primary forbs on the study area, nettleleaf gianthyssop (*Agastache urticifolia*) and Franciscan bluebell (*Mertensia franciscana*), showed continued decline throughout the 5-year post-spraying period. These were down 15 and 33%, respectively, after 2 years and down 31 and 47%, respectively, after 5 years. Three others, fleabane (*Erigeron* sp.), aspen peavine (*Lathyrus leucanthus*), and silvery lupine (*Lupinus argenteus*), showed decreases after 2 years (−27, −32, and

−41%, respectively), but by 5 years after spraying, fleabane and aspen peavine were more abundant than before (+12 and +29%, respectively); silvery lupine was still below pretreatment levels (−24%), although more abundant than it was after 2 years. Northern bedstraw (*Galium boreale*) and Fendler meadowrue (*Thalictrum fendleri*) increased in abundance 2 years after treatment (+16 and +59%, respectively), and these continued to become more abundant until 5 years, when their production was +39 and +100%, respectively, above pretreatment levels. Western yarrow (*Achillea lanulosa*) was 6% more abundant after 2 years, but 14% less abundant after 5 years (Table 1).

Elk and Deer Use Changes 2 and 5 Years after Spraying

Elk use in the study area vicinity during fall, winter, and spring remained relatively high throughout the duration of the study. Pellet count data from the control area showed elk use fluctuated from 136 elk per square mile in 1969 to 162 in 1972 and 114 in 1975 (Table 2).

Two years after spraying, elk per square mile on the spray area increased 106%, while a 19% increase was recorded for the control area. Comparison of ratios of elk use intensity measured before (1969) and 2 years after (1972) spraying on the control plot with the same ratios on the spray area indicates the increase attributable to spraying after 2 years is 73%, or 67 elk per square mile.

Five years after spraying, elk density per square mile on the spray and control areas was lower than before spraying, by 6 and 16%, respectively. Since elk use declined less on the sprayed portion than on the control, comparison of ratios of elk use on control and sprayed areas before and after spraying indicates an increase attributable to spraying after 5 years of 11%, or 7 elk per square mile (Table 2). A *t* test showed that neither the 2- or 5-year elk use increase is statistically significant at the α .10 level.

Fall, winter, and spring deer use in the study area vicinity declined steadily throughout the duration of the study. Deer use on the control area was measured at 198 deer per square mile in 1969, 108 in 1972, and 54 in 1975 (Table 2). This decline was not related to spraying, but occurred throughout western Colorado and was reflected by declining deer harvest figures.

Pellet counts show deer use 2 years after spraying (1972) declined 45% on the control area and 37% on the spray area from levels recorded before the 1969 treatment. Since deer use declined less on the sprayed portion than on the control, comparison of ratios of deer use intensity before and after treatment on the two areas suggests spraying, in effect, prompted an increase of 16% or 12 deer per square mile.

Five years after spraying (1975), deer use was 73% below pretreatment (1969) levels on the control area and 78% below on the spray area. Comparison of ratios of deer use on control and sprayed areas before and after spraying reflects a decrease attributable to spraying after 5 years of 21%, or 8 deer per square mile (Table 2). A *t* test showed that neither the 1972 or 1975 change is statistically significant at the α .10 level.

Table 2. Changes in fall, winter, and spring elk and deer use 2 and 5 years following spraying of Gambel oak with 2,4,5-TP.[1]

			Animals per square mile			
					Change due to spraying[3]	
Animal	Area	Year	Actual no.	Expected no.[2]	no.	%
Elk	Control	1969 (pre-spray)	136			
		1972 (2 years after)	162			
		1975 (5 years after)	114			
	Spray	1969 (pre-spray)	77			
		1972 (2 years after)	159	92	+67	+73
		1975 (5 years after)	72	65	+ 7	+11
Deer	Control	1969 (pre-spray)	198			
		1972 (2 years after)	108			
		1975 (5 years after)	54			
	Spray	1969 (pre-spray)	138			
		1972 (2 years after)	87	75	+12	+16
		1975 (5 years after)	30	38	− 8	−21

[1]Data are derived from pellet group counts. Pretreatment period of use was 8-19-68 to 5-5-69. Two- and 5-year post-treatment periods of use were 9-1-71 to 5-8-72 and 8-25-74 to 5-28-75, respectively.

[2]The number of animals per square mile expected on the sprayed area following spraying assuming that normal year-to-year animal use changes occurred there in the same proportion as on the control. This value forms the basis for determining percent change due to spraying.

[3]The change in animals per square mile which can be attributed to spraying. This has been adjusted to consider animal use changes on the control area.

Discussion

The response of grasses and shrubs to spraying is similar to that described by Marquiss (1972) after spraying Gambel oak with 2,4,5-TP mixed with picloram. He reported an 80% kill of oak and large increases in forage abundance, presumably grasses, over a 5-year period. His area was resprayed approximately 3 years after initial treatment, which probably caused grass abundance to remain high for 5 years.

Reasons for initial attractiveness of the sprayed area to elk and to a minor extent deer, were not isolated. Animals may have responded to changes in plant moisture or nutrient content. Kufeld (1975), however, working in a Gambel oakbrush area near Collbran, Colo., which had been sprayed with the same chemical (2,4,5-TP), found no significant differences after 2 years between sprayed and control areas in plant moisture content and the following nutrients and minerals: total cell contents, protein, ether extract, soluble carbohydrate, soluble ash, insoluble ash, lignin, holocellulose, nitrogen, calcium, phosphorus, calcium/phosphorus ratio, iron, zinc, copper, magnesium, manganese, and potassium. Kufeld (1975) found sodium content of forbs significantly higher on the sprayed area, but this was during the summer; elk and deer use measurements on the Beaver Creek study area were made during fall, winter, and spring when forbs were not available.

The trend of elk and deer use, particularly elk use, for 5 years after spraying roughly follows the same pattern as the trend in production of grasses, which was 44% higher than adjusted pretreatment levels after 2 years and 17% higher after 5 years. The grass increase, in effect, changed the forage composition, creating a greater variety of forages compared to surrounding oakbrush type areas and may have been a major factor attracting elk and deer.

Reasons for the observed decline of 21% in deer use attributable to spraying after 5 years are not known and may have been the result of sampling variation. Deer may have exhibited a more positive response to the sprayed area following spraying had the area not been so heavily used by elk.

Conclusions

Based on results of this study, spraying Gambel oak type vegetation with 2,4,5-TP herbicide can be expected to cause substantial initial reductions in shrub abundance and increases in the quantity of grasses. This is most pronounced during the first and second year following spraying. Effects of spraying are relatively short-lived, however, and after 5 years plant composition can be expected to return to its pretreatment condition.

Although not significant statistically, the relatively large increase in elk use 2 years after spraying suggests that initial increase in elk use may be expected after spraying Gambel oak. Attractiveness of the area to elk may be due to increased grass abundance and the resulting change in plant composition compared with surrounding untreated areas. Elk appear to lose their affinity for the area as plant composition reverts to its pretreatment state. Elk use approached pre-spray levels 5 years after treatment.

In this study deer exhibited only a minor response to the sprayed area. Their response may have been more positive had the area not been so heavily used by elk.

If Gambel oak vegetation is sprayed with 2,4,5-TP for the purpose of modifying plant composition and increasing elk or deer use, it is recommended that a program be established involving respraying at 3-year intervals for as long as the improved situation is to be maintained.

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