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Economic feasibility of controlling tall larkspur on rangelands

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Abstract

Larkspur (*Delphinium spp.*) poisoning of cattle poses a serious economic problem on many western rangelands. Losses varied from 1.5% to 12.3% of the grazing cattle over a 15-year period on the Manti Canyon grazing allotment. Three herbicides and different application methods were compared for control of tall larkspur. The 3 herbicides were: glyphosate [N-(phosphonmethyl) glycine]; picloram (4-amino-3,5,6- trichloro-2-pyridine carboxylic acid); and metsulfuron 2[[[[(4-methyoxy-6-methly-1,3,5-triaxin-2-yl) amino] carbonyl] amino] sulfonyl] benzoic acid. A boom type sprayer and a carpeted roller applicator were tested for the selective herbicides. Spot treatment and backpack sprayers were tested for the nonselective herbicide (metsulfuron). The internal rate of return was used to evaluate the economic feasibility of each alternative control method. A treatment was considered economically feasible if the internal rate of return was equal to or higher than the cost of borrowing money. Each treatment was evaluated for an assumed cattle death loss of 4.5% and 2.25%. A 10-year life was considered for each treatment. All of the herbicides and application methods tested were economically feasible. The internal rates of return varied from 14.23% to 133.38%. An internal rate of return above 100% occurs when the benefits in a single year exceeds the total cost of control. The cost of herbicides have increased considerably over the past few years, but they can still be used economically if treatment results in death loss reductions described in this study.

Key Words: herbicides, picloram, metsulfuron, glyphosate, *Delphinium barbeyi*, D. *accidentale*

Cattle losses from larkspur (*Delphinium* spp.) poisonings are serious problems on many rangelands in the West. An average of 5,500 cattle died annually from poisonous plants grazed on national forest lands between 1913 and 1916, about 90% of which were caused by tall larkspur; this was 3-5% of the cattle grazing tall larkspur-infested ranges (Aldous 1917). In 1986, every U.S. Forest Service district in Region 4 (Montana, Idaho, western Wyoming, Utah, and Nevada) reported losses to tall larkspur (Nielsen and Ralphs 1989). This represented a total of 532 head for the region; however, Forest Service officials estimated that permittees reported only about half the losses. Thus, losses probably exceeded 1,000 head for 1986.

On the Manti Canyon Cattle Allotment, Manti-La Sal National Forest, near Manti, Utah, annual losses between 1956 and 1970 due to larkspur consumption varied from 13 to 103 head with an annual average of 36 head (Cronin and Nielsen 1979). About 837 cows graze this allotment each year. The percentage of the herd lost while on the allotment varied from 1.5% to 12.3%, with an average of 4.3% annually. Herbicide control of larkspur on this allotment using 2,4,5-T[(2,4,5-trichlorophenoxy) acetic acid] reduced cattle deaths by 94% (Cronin and Nielsen 1972, Nielsen and Cronin 1977). Several herbicides and application techniques have been tested for controlling larkspur on mountain rangelands (Ralphs et al. 1992, Bunderson et al. 1994). The objective of this study was to compare the economic efficiency of 3 herbicides and different application methods for control of tall larkspur.

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Site Description

The elevation of the Manti Canyon Cattle Allotment increases from 1,768 m (5,800 ft) on the west at the mouth of the canyon, to more than 3,109 m (10,200 ft) on the east along the crest of the plateau. The allotment is separated into 3 main divisions, which are subdivided to facilitate a rest-rotation grazing system. About two-thirds of the annual 72 cm (30 in) precipitation falls as snow, which is blown into drifts that influence the distribution of larkspur and the grazing pattern of cattle. Vegetation at the higher elevation is dominated by extensive herbaceous communities with small groves of Engelman spruce (*Picea engelmannii*). Quaking aspen also extends into the subalpine zone of the upper division in small stands on some south-facing slopes (Ellison 1954).

The upper division contains only 40% of the area of the allotment but furnishes over 60% of the forage. It is also the source of most of the water for the canyon. Cattle losses often occur on the upper division, which is grazed from about the middle of July until late September.

Barbey larkspur (*D. barbeyi* (L.) Huth) grows in the groves of trees, along the permanent streams, around springs and seeps, and on sites where huge snow drifts tend to persist. These drifts form on the lee side of the groves of trees, behind ridges, in swales, and in the erosion gullies. The tall-forb communities that grow here are dominated by barbey larkspur.

The upper end (high elevation) of the Manti Canyon Allotment, about 3,238 ha, had an estimated 139 ha of dense stands of tall larkspur. Tall larkspur was controlled by applying 4.5 kg a.e./ha of 2,4,5-T (Cronin and Nielsen 1972) for 2 consecutive years. Controlling these dense patches of larkspur reduced the number of cattle killed by 94% annually (Cronin and Nielsen 1979), which would mean saving 33 of the 36 cows lost to larkspur poisoning per year. In other words, before treatment, 36 cows died; after treatment, only 3 cows died annually. Each cow was worth about $500 in 1992, so 33 cows saved would be worth $16,500. The value of cows saved is the estimated returns from controlling larkspur. The benefits from controlling larkspur in Manti Canyon would be $118.70/ha ($16,500 ÷ 139 ha), based on an average annual death loss of about 4.5%. If losses were only 2.25%, or if herbicide control only resulted in a 50% reduction in loss-

Table 1. Chemical costs for alternative treatments

	Metsulfuron	Picloram	Glyphosate
Chemical cost	\$141.60/.226 kg 60.0% ai* \$1,044/kg ai	\$25.52/l 239.6 g ae/ℓ** \$106.51 kg	\$10.80/l 480 g ai/ℓ \$26.34/kg
Carrier volume	140.0 ℓ/ha	140.0ℓ/ha	—
Sprayer application rate (kg/ha)	.140	2.2	—
Cost/ha	\$146.16	\$234.36	—
Carrier volume	49.0 ℓ/ha	49.0 ℓ/ha	49.0 ℓ/ha
Roller application concentration rate	2.0 g ai/ℓ	32.0 g ae/ℓ	32.0 g ai/ℓ
Cost/ha	\$102.05	\$167.09	\$35.34
Spot treatment retractable hose or backpack concentration rate	—	—	16.0 g ai/ℓ
Cost/ha			\$50.50

*ai = active ingredient
**ae = acid equivalent.

es, the corresponding returns would be \$59.35/hectare.

Estimated Costs of Control

The costs for chemicals, equipment, and labor for each of the herbicides and application methods are given in Tables 1 and 2. Cost data were indexed up from earlier studies or calculated for current equipment used.

Description of Herbicides

Efficacy data and application methods were taken from recent studies (Ralphs et al. 1992, and Bunderson et al. 1994). Three herbicides were applied with the appropriate application method for the herbicide: glyphosate [N-(phosphonomethyl)glycine]; picloram (4-amino-3,5,6- trichloro-2-pyridine carboxylic acid); and metsulfuron 2[[[[(4-methyoxy-6-methyl-1,3,5-triaxin-2yl) amino] carbonyl] amino] sulfonyl] benzoic acid. Application methods, rates, and costs of herbicides are contained in Table 1. The boom sprayer and carpeted roller application methods were described by Bunderson et al. (1994). The spot spray treatment using backpack sprayers was described by Ralphs et al. (1991).

Boom Type Sprayer

A boom sprayer was used to apply the selective herbicides (metsulfuron and picloram). A five-nozzle sprayer with a 3-m (10-foot) spray width traveling at 4.0 km per hour (2.5 miles per hour) covered about 7.2 hectares in 6 hrs. A sprayer could either be mounted behind a farm tractor or in the back of a 4 x 4 pickup truck. Estimated cost to treat the plots with the boom sprayer were about the same as the sprayer used in the 1979 Manti study (Cronin and Nielsen 1979, and Nielsen and Cronin 1977), so we updated costs from this study.

Data from USDA (1990) indicated that labor cost increased by 1.79 times, while auto and truck, fuel, and energy costs increased 2.13 times from 1977 to 1990, so we doubled costs in the Manti study.

Carpeted Roller Application

The carpeted roller applicator selectively applied the herbicide to the taller growing larkspur without harming the desirable understory vegetation. The roller was mounted on the arms of a front-end loader on a farm tractor. In the test plots, the applicator could be operated at a speed of 2.4 km/hour (1.5 miles/hour) at a 2.4 m (8.0 ft) swath and would cover 0.58 ha/hour or 3.48 ha/day if operated for 6 hours. The estimated cost of the roller is \$1,500 and has a salvage value of \$500 and an expected life of 750 hours. We also calculated interest on investment. Estimated maintenance cost of the roller is \$.20/hour. The tractor used to operate the roller was a 40 hp unit operated for 750 hours/year, and we assumed that it would also be used for other purposes. The cost of tractor use was estimated at \$7.44/hour.

The amount of herbicide applied with the roller is substantially less than that applied with a boom sprayer. The experience of treating the plots showed the roller applied on an average of 35% of the amount applied with the boom sprayer.

Spot Treatment Application

Glyphosate is not a selective herbicide, and broadcast spraying would not be acceptable. The cost estimates are for treating individual plants with hand-held spray nozzles. The spraying configuration used was 2 hand-held nozzles with hoses mounted on self-winding reels with a tank and a pump mounted in the back of a pickup truck (Nielsen and Cronin 1977). This sprayer cost twice as much as that used in the 1979 study. Much more time is required to treat a hectare with spot treatment than for broadcast spraying. An individual could spot treat about .16 ha/hour, which meant that 2 people could treat 1.92 ha in a 6-hour day.

Backpack Sprayers

The value of 3 backpack sprayers used with this method was estimated at \$100 per unit with no salvage value and an expected life of 3 years. The sprayers will be used an average of 10 days per year, 6 hours per day, or 60 hours per year, or an expected lifetime use (60 hours/year x 3 years) = 180 hours. The per-hour cost would be \$.56 (\$100 ÷ 180 hrs). Using 3 sprayers for a 6-hour day would cost \$10.08 (\$.56 x 3 = \$1.68/hour x 6 hour/day). The cost of a truck to travel to and from the site to haul water and other materials at the site was estimated at \$90.80 per day. The cost of labor for 3 backpack sprayers and for one person to move materials is estimated at \$200/day.

Based on experience using backpack sprayers for individual plant treatment, one sprayer could treat .96 ha in a 6-hour day, which meant that a 3-person crew could treat 2.88 ha/day.

Table 2. Labor and equipment costs per day and per acre for alternative treatment methods

	Boom sprayer	Carpeted roller	Spot treatment	Backpack sprayer
Area Sprayed				
Spray time:	1.2 ha/hr 6 hr/day 7.2 ha/day	.56 ha/hr 6 hr/day 3.36 ha/day	.32 ha/hr 6 hr/day 1.92 ha/day	.48 ha/hr 6 hr/day 2.88
ha/day				
Labor	---------------(\$/day)---------------			
1 permittee	\$50	\$50	\$50	\$50[1]
2 laborers	80	80	80	\$150[1]
	\$130	\$130	\$130	\$200
Equipment Costs	---------------(\$/day)---------------			
Application equipment	\$46.80	\$13.98	\$46.80	\$10.08
Spray truck	88.40	—	88.40	90.80
Tractor	—	44.64	—	—
Water truck	10.80	—	10.80	—
	\$146.00	\$58.62	\$146.00	\$100.88
Total cost/day	\$276.00	\$188.62	\$276.00	\$300.88
Cost/hectare	\$38.88	\$53.57	\$142.08	\$103.26

[1]Three permittees with sprayers and 1 back-up person to service them.

Table 3. Economics of Larkspur Control on Rangelands

Chemical	Application Method		Cost of Treatment	Value of Cattle Saved	Life of Treatment	Internal Rate of Return
			($/ha)	($/ha)	(yr)	(%)
Metsulfuron	Boom sprayer (1-yr	applic	$38.88	$118.70 (4.5% loss)	10	63.67
	treatment)	chem	146.16	$59.35 (2.25% loss)	10	29.69
			$185.07			
	Boom sprayer (2-yr	1st yr	$185.07	$118.70 (4.5% loss)	10	37.04
	treatment)	2nd yr	121.69	$59.35 (2.25% loss)	10	14.23
			$306.76			
Picloram	Boom sprayer (1-yr	applic	$38.88	$118.70 (4.5% loss)	10	42.15
	treatment)	chem	234.36	$59.35 (2.25% loss)	10	17.33
			$273.24			
	Boom sprayer (1-yr	applic	$38.88	$118.70 (4.5% loss)	5	33.00
	treatment)	chem	234.36			
			$273.24			
Glyphosate	Spot treatment	applic	$142.08	$118.70 (4.5% loss)	10	61.11
	retractable hoses	chem	50.50	$59.35 (2.25% loss)	10	28.26
	Manti, UT		$192.58			
Metsulfuron	Roller	applic	$53.59	$118.70 (4.5% loss)	10	76.00
		chem	102.05	$59.35 (2.25% loss)	10	36.43
			$155.64			
Picloram	Roller	applic	$53.59	$118.70 (4.5% loss)	10	53.02
		chem	167.09	$59.35 (2.25% loss)	10	23.68
			$220.68			
Glyphosate	Roller	applic	$53.59	$118.70 (4.5% loss)	10	133.45
		chem	35.34	$59.35 (2.25% loss)	10	66.33
			$88.93			
Glyphosate	Backpack (6-hr day	applic	$103.26	$118.70 (4.5% loss)	10	76.94
		chem	50.50	$59.35 (2.25% loss)	10	36.93
			$153.76			

We assumed that larkspur would be treated during the rest year of a regular rest-rotation grazing system. If the cattle have to be taken off the range during the grazing season of the treatment year, there will be a significant nonuse cost that must be added to the cost of control. Experience at Manti showed that grazing a pasture the year that it had been treated with 2,4,5-T caused high cattle death losses, due to larkspur consumption, even when grazing was delayed until the treated plants were wilted and appeared to be dry. The larkspur plants were still toxic and were readily consumed by free-ranging cattle. Nonuse costs are especially important on treatments that require spraying for two consecutive years, which is not compatible with the usual rest-rotation grazing system.

We used the internal rate of return to evaluate the economic feasibility of each alternative control method (Cronin and Nielsen 1979). The internal rate of return is the interest rate (discount rate) such that the net income stream (benefits from larkspur control) over the life of the control equals the initial cost of the project. The internal rate of return can be compared to the cost of borrowing money or to expected rates of return from alternative investments.

Results

Metsulfuron

Metsulfuron was applied with a boom type sprayer and with the roller applicator. The boom type sprayer application was analyzed where a single year's treatment was assumed adequate for control and also where adequate control required treatment for 2 consecutive years (based on the earlier Manti study).

The first year it cost $38.88/ha, spraying 7.2 ha/day and the recommended application of chemical was .14 kg/ha. Metsulfuron cost (1992) $1,044/kg ($141.60/8 oz container), which meant that the cost of metsulfuron per hectare was $146.16.

The internal rate of return (IRR) was 63.67% (Table 3). If cattle losses were only reduced 50% of what was expected, the IRR was 29.69%. It would be rational to invest in larkspur control as long as the IRR is higher that the interest rate on borrowed money.

If adequate control requires treatment for 2 consecutive years, application costs during the second year would be 1.25 times the cost of original treatment because more time would be required to locate small scattered plants. Chemical costs would be reduced by half because there would be fewer larkspur plants to treat. Based on a project life of 10 years and if the treated range was grazed, the year after the second year of treatment and the value of reduced cattle losses was $118.70/ha treated, the IRR was 37.04% (Table 3). One would invest in the project as long as the IRR exceeded the cost of capital (interest rate). If cattle losses were reduced by one-half annually and the expected benefit was $59.35/ha sprayed, the IRR was 14.23%.

Melsulfuron can also be applied with a carpeted roller. It was not determined if a two-year treatment was desirable using the roller application, so only a single year treatment will be analyzed.

The IRR with an annual benefit of $118.70 per hectare treated and a 10-year life is 76.00%. The IRR was 36.43% when the reduction in cattle losses was only 50%.

The returns for the carpeted roller were similar to those with the boom-type sprayer. Chemical costs were lower, but application costs were higher with the carpeted roller due to the slower speed of application.

Picloram

The factors used to determine application costs and annual returns for metsulfuron treatments were also applied to picloram treatments. Picloram was \$25.52/ℓ, (\$96.60/gal) in 1992 and was applied at 2.2 kg/ha.

The IRR was 42.15% when the value of reduced cattle losses was \$118.70/ha treated and treatment life was 10 years (Table 3). If the effective life of the treatment was reduced to 5 years, the IRR was 33.00%. The IRR was 17.33% if half the number of cows were saved (annual loss of 2.25%), and treatment life was 10 years.

When picloram was applied with the roller, the treatment cost was \$220.68/ha (Table 3), resulting in an IRR of 53.02% when the reduction in cattle losses were worth \$118.70/ha; the IRR was 23.86% when the reduction in cattle losses was valued at \$59.35/ha.

Glyphosate

Glyphosate is a nonselective herbicide, which precluded the use of broadcast treatment methods. Spot spraying or individual plant control and roller application are considered as alternative treatment methods. These methods were used in an attempt to minimize the damage to nontarget plants species.

At the Manti, Utah, location, there were 11,130 larkspur plants per hectare. It required 2.0 sec/plant to spot spray. Herbicide cost was \$10.80 (\$102.20/2.5 gal container). It is estimated that it would require about 3.125 hr/ha to spot control larkspur, resulting in a total cost of treatment of \$192.58/ha (Table 3).

The resulting IRRs were 61.11%, with a 10-year project life and the value of cattle saved of \$118.70/ ha, or 28.26% when the reduction in cattle losses was \$59.35 /ha.

Glyphosate was also applied with carpeted rollers. The larkspur were the tallest plants in the community at the time of treatment and the height of the roller could be adjusted so it applied herbicide only to the larkspur plants.

The cost of roller application was \$88.93/ ha, and the IRR was 133.45% when project life was 10 years and the value of reduced cattle losses was \$118.70/ ha; and the IRR was 66.33% when the value of reduced cattle losses was \$59.35/ha treated.

Glyphosate was also applied with backpack sprayers for individual plant treatment. The treatment costs for 3 backpack sprayers working 6-hr days was \$153.76/ ha. The IRR for this treatment was 76.94% when it reduced cattle losses by \$118.70/ ha, and 36.93% when treatment reduced losses by \$59.35/ha.

Conclusions

Each of the appropriate application methods for the various herbicides were economically feasible as were the herbicides tested in this study. The costs of these chemicals have increased markedly in recent years, but ranchers can still afford to use them if treatment results in the savings described in this study.

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