# **TECHNICAL NOTES**

# Spraying of Big Sagebrush with 2,4-D Causes Negligible **Stream Contamination**

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#### Abstract

The maximum level of 2,4-D detected in stream water was 5 ppb following aerial application of 2.2 kg/ha herbicide to a 238-ha watershed for big sagebrush control. Careful placement of the aerially applied herbicide, leaving an unsprayed buffer strip 30 m wide bordering the stream channel, and the presence of a snowdrift over the channel, prevented significant water contamination. Surface snow within the unsprayed buffer zone averaged 35 ppb of 2,4-D. Herbicide levels in a stream .5 km downwind from the sprayed watershed did not exceed 2 ppb immediately following spraying even though wind speeds exceeded 2.2 m/s during much of the spray period.

One of the most popular herbicides to control undesirable plant species on range and forests lands is 2,4 Dichlorophenoxyacetic acid. This material is sometimes applied by ground equipment, but often it is applied aerially. When applied as an aerial spray, the herbicide is subject to drift, which can contaminate surface waters with possible adverse effects on fish and other aquatic organisms.

This note describes 2,4-D levels measured in stream waters from adjacent treated and untreated big sagebrush watersheds. Treatment occurred as part of a paired watershed study being conducted to provide information about the effect of sagebrush alteration on hydrolic relations and indigenous wildlife populations.

## Area Description

The experimental site is on the Stratton sagebrush hydrology study area 9 km west of Saratoga, Wyoming, at an elevation of 2,225 m. Principal species in the vegetation consists of mountain big sagebrush (Artemisia tridentata spp. vaseyana) stands on mesic sites and Wyoming big sagebrush (A.t. spp. wyomingensis) stands on the drier slopes and ridge areas.

Annual precipitation is about 530 mm, two-thirds of which falls as snow. Average monthly wind speeds reach a maximum of 8.8 m/s in January, decreasing to 3.2 m/s in July. Wind blows much of the snow to the leeward side of ridges or into incised drainages, where it accumulates in drifts that commonly exceed 5 m depth.

The treated watershed, Sane Creek, is a 238-ha drainage; Loco Creek (663 ha) is an adjacent untreated watershed (Fig. 1). Both drainages contain small streams that begin at a perennial spring. Drainage channels extend above the springs and carry surface flow during snowmelt. Both streams are less than 1 m wide. Peak flow rates occur during snowmelt and average about  $16 \times 10^{-2}$ m<sup>3</sup>/sec/day on Loco Creek and  $4 \times 10^{-2}$  m<sup>3</sup>/sec/day on Sane Creek. Base flow during the winter months is about  $0.36 \times 10^{-2}$  and  $0.14 \times 10^{-2} \text{m}^3/\text{sec}/\text{day}$  on Loco and Sane Creeks respectively.

#### Methods

Spray was applied by standard Bureau of Land Management procedures for aerial control of big sagebrush. To minimize volatization and drift, these procedures require that spray application be confined to periods when wind speed does not exceed 2.2 m/s and the air temperature is less than 22° C. The herbicide was mixed with a diesel oil carrier and applied from helicopter at heights varying from 5-10 m. Swath widths were estimated at 30 m. Flagmen were used to help maintain proper flight lines.

Continuous meterological records were obtained from a weather station located on the ridge dividing Sane and Loco Creeks (Fig. 1). During spray application, wind speed was monitored on the treated drainage by a hand-held pith ball anemometer.

A buffer zone of live sagebrush was left along the stream course for wildlife habitat. This buffer was approximately 60 m wide and extended 300 m above the stream gage (Fig. 1). About half of the buffer strip was covered by snow at the time of spraying. Channel snow, 25 to 30 m wide, extended an additional 600 m upstream from the buffer. Snow also extended a short distance up several side channels branching westward off the main channel (Fig. 2).

Sane Creek was sprayed at an average application rate of 2.2 kg acid-equivalent of 2,4-D/ha. Chemicals' were mixed in a carrier of 28.1 of diesel oil per ha. Spray application began about 1600 MST on May 17, 1976, but was discontinued because of excessive winds. Treatment resumed on May 18, at 0445 MST and was completed at 0830 MST.

<sup>1</sup>Chemicals used for treatment included: (1) 50 gallons of "Weedone," 2,4-D butoxy ethanol ester 62.5% plus inert ingredients (43.3% ester by weight) and (2) 294 gallons of transvaal weed rhap LV-4D, 2,4,-D 2 ethelhexyl ester plus iso octyl ester, 69.9% 2,4-D plus inert ingredient, 46.3% ester by weight.



Fig. 1. Sane Creek watershed was sprayed with 2,4-D to control big sagebrush whereas Loco Creek watershed was not treated.

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Manuscript received October 24, 1978.



Fig. 2. Channel snow accumulation on the Sane Creek watershed 1 week after spraying with 2,4-D to control big sagebrush.

Four, 1-liter water samples for analysis of 2,4-D content were collected near the Sane and Loco Creek stream gages within a 15-minute time period. Water was collected from 0 to 10 cm depth at mid stream. The first samples were collected 0, 3, 6, and 12 hr after spraying was completed May 18 and 1, 2, 3, and 9 days following treatment.

To sample herbicide contamination within the buffer strip we collected four, 1-liter snow samples from the surface 1 cm of snow at 140-220 and 300 m above the gaging station. An additional sample of surface snow was obtained 880 m above the gaging station in an area where spray was applied to the edge of the snow. Snow samples were collected 1 to 2 hours following completion of spraying. Stream and water samples were analyzed for 2,4-D content by personnel of the Wyoming Department of Agriculture Laboratory, who used a gas chromotography procedure patterned after that of Goelitz and Lamar (1967). Analysis of two pooled water samples was conducted for each sampling period. The lower limit of reportable detectability was one part per billion (ppb).

# Results

During the treatment period recorded air temperatures ranged from 8 to 19° C, less than the recommended upper limit of 21° C. Prevailing SW winds recorded at the weather station exceeded the maximum recommended limit of 2.2 m/s (1.9-5.3 m/s) in all but one half-hour period. The hand-held pith-ball anemometer did not indicate winds sufficiently strong to terminate spraying until the latter stages of treatment. At that time it was decided to continue because the area remaining to be treated was located on the downwind side of the Sane Creek stream channel and no spraysensitive areas were adjacent to the watershed boundary.

Sane Creek water samples collected before spraying contained less than 1 ppb 2,4-D. The maximum 2,4-D concentration in stream water, detected after treatment, was 5 ppb upon completion of the spray operation. Three ppb of 2,4-D were present in water collected 3 to 12 hours after treatment and 2 ppb of herbicide were found in water 1, 2, and 3 days after spraying.

Herbicide levels in the surface centimeter of snow collected from within the unsprayed buffer area were greater than in creek water, but were still very low. Individual samples contained 17, 29, and 59 ppb 2,4-D and averaged 35 ppb. The single snow sample taken from the channel above the buffer area contained 90 ppb of 2,4-D. These measurements suggest that the buffer zone of unsprayed sagebrush was effective in reducing the amount of herbicide reaching the stream. The snowdrift covering the Sane Creek channel served to further reduce entry of herbicide into water. Herbicide that did reach the snow surface was retained for a period, allowing ultraviolet radiation to begin degrading the chemical.

Only 2 ppb of 2,4-D were found in Loco Creek water as a result of spray application even though average half-hourly wind speeds usually exceeded the recommended 2.2 m/s limit. Water samples collected within 12 hours after treatment contained 2 ppb or less of herbicide. Samples taken 1, 2, and 3 days after spraying contained 1 ppb of herbicide whereas the sample taken 9 days after spraying contained less than 1 ppb of herbicide. The herbicide contamination of Loco Creek reflected deposition of drifted and volatilized materials that were transported by the wind. The distance from the watershed boundary of Sane Creek to Loco Creek varied from about 550 meters at the spring to 2,050 meters at the stream gage where water samples were collected (Fig. 1). The herbicide could have entered Loco Creek at any point over the 1,600-meter distance between the spring and stream gage.

# **Discussion and Summary**

The contamination of Sane Creek with 2,4-D as a result of watershed treatment was extremely low and should have a negligible impact on stream biology. Juntunen and Norris (1972) reported that the chemical formulation used to spray Sane Creek was toxic to fish only if the concentration equaled or exceeded 1,000 ppb, far more than the 5 ppb measured in this study.

## Literature Cited

- Goerlitz, D.F., and W.L. Lamar. 1967. Determination of phenoxy acid herbicides in water by electron-capture and microcoulometric gas chromatography. U.S. Geol. Surv. Water-Supply Pap. 1817-C. 21 p.
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