Results of the Aerial Application of 2,4-D Amine for Control of Red Alder: Effingham, 1983

by

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Introduction

The objective of this project was to gather additional efficacy information to support the continued registration of 2,4-D amine for the aerial control of red alder (Alnus rubra Bong.) This objective was considered very important in 1983, as at this time, 2,4-D had only a temporary registration leaving only 2,4-D Ester registered if the amine formulation's registration was withdrawn. The amine formulation was considered less toxic to fish and aquatic organisms than the ester formulation, making it a more desirable product from an environmental point of view. (Davis and Hardcastle, 1959), (Hughes and Davies, 1963).

To achieve this objective, 20 hectares of a 185 hectare spray project were treated with 2,4-D amine while the remaining area was treated with 2,4-D ester. Study plots were established one week prior to treatment and were re-examined one year later. This report describes the efficacy of these treatments and makes recommendations based on the results. The reader is referred to an earlier report "Aerial Applications of 2,4-D to Control Alder: Effingham, 1983" (Taylor, 1983) for additional details on the treatment site and the operational aspects of this project.

Methods

Treatment Site Description

The treatment site was located approximately 40 kilometers east of Ucluelet in the Port Alberni Forest District. (Figure 1). It was located in the Coastal Western Hemlock - wet zone (Reichenback[1], personal communication) in the Effingham River drainage system, which consists of valleys with slopes frequently in excess of 30 percent. Numerous runoff creeks were found in most of the spray blocks, but at the time of treatment only major creeks had running water.

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1) Silviculture Officer, British Columbia Forest Service, Port Alberni Forest District.

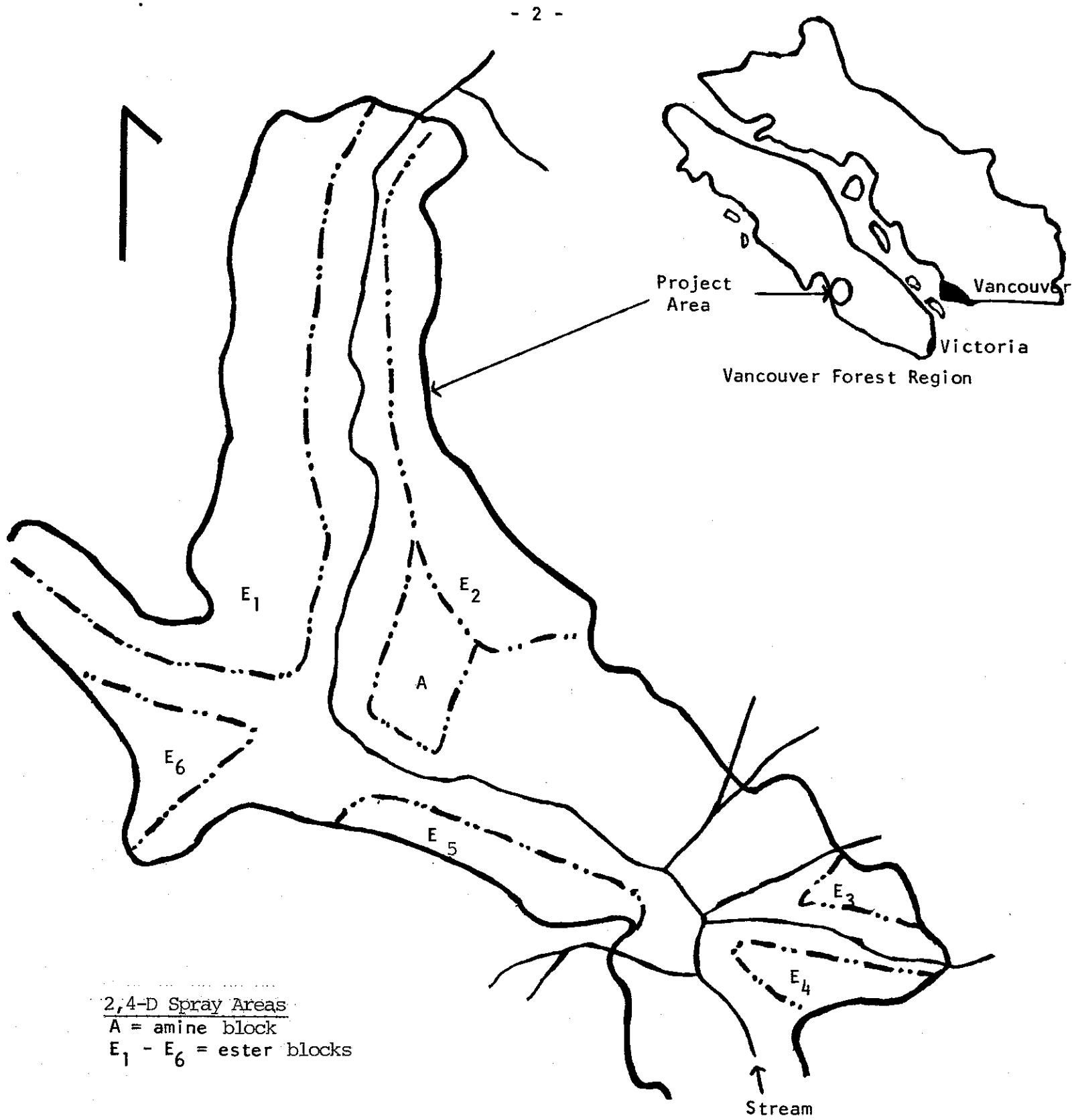

Figure 1 The 1983 Effingham Project Area located on the west side of Vancouver Island.

The treatment area was divided into seven distinct spray blocks, with the amine block being located adjacent to ester block #2. (Figure 1). A swamp was present east of the amine block and fish were observed in the major creeks.

This drainage area was logged from 1965 to 1970. It was burned immediately after being logged and then planted with Douglas-fir. The estimated stocking on site in 1983 was:

	Stems per Hectare
Douglas-fir[1]	183
Hemlock	1159
Cedar	1651
Balsam	429
Alder	278
Totals	> 3700

Cedar heights ranged from .5 - 16 m with an average of 1.9 m. The height range for the alder was 3 - 17 m with an average of 8 m. Alder cover was scattered and dense along creek beds and old logging roads. Other brush species found in the area included deer fern (Struthiopteris spicant), huckleberry (Vaccinium spp.), salal (Gaultheria shallon), salmonberry (Rubus spectabilis), and thimbleberry (Rubus parviflorus). There were numerous standing snags present.

As there was no road access into this area, transportation onto the site involved a 5 km helicopter trip from the Ucluelet Highway.

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1 Douglas-fir seedlings were underestimated as not all seedlings were tallied during the regeneration surveys.

Application Methods

A brief discussion of treatment methods is necessary to provide a complete background for this project.

The products used were Esteron 600 (P.C.P. #15,981) and 2,4-D Amine 80 (P.C.P. #9,033), applied at 3.0 and 3.8 kg a.i. per hectare, respectively. The spray boom output was 100 litres per hectare.

A Bell 206 helicopter with a Simplex 2700 boom system and Rain Drop #10 nozzles, were used under the following conditions:

Flying Speed 89 kph
Flying Height 9.1 m
Boom Pressure 124 - 138 kPa
Nozzle Orientation 45^{o} back from the airstream
Useable Boom Length/Total Rotor Length .75

Three day spray operations commenced on August 17th. The daily startup and shutdown times were as follows:

	Morning		Afternoon	
	Start Up	Shut Down	Start Up	Shut Down
August 17th	07:15	11:25	18:30	Dusk
August 18th	06:30	11:15	16:45	Dusk
August 19th	06:45	12:00	17:20	Till Finished

Operations commenced the first day with no measurable wind and a relative humidity (R.H.) of 94%, by 11:25 the wind had increased to greater than 8 kph and the R.H. was 57%. Spraying was then halted but commenced again at 18:30 and continued until dusk. Weather records for this project are found in the Appendices.

Spray deposit cards were laid out in the amine block (figure 2). The spray deposit pattern obtained was similar to that found at the calibration trials with the droplet density being 10 droplets per cm^2 and an average stain diameter[1] of 813 μ with a range of 160 - 5,120 μ. The spray flight lines were parallel to contours and are shown in figure 2.

Assessment Techniques

Efficacy measurement plots were established in August prior to the commencement of spray operations. Nine sample plots were randomly established in the following locations; three in the 2,4-D amine spray block (Aspect 194^{O}, 200^{O}, 154^{O}), three in the 2,4-D ester spray block (Aspect 178^{O}, 160^{O}, 162^{O}) and three in untreated areas between the amine block and ester block #1 (Aspect 130^{O}, 134^{O}, N/A).

Each plot consisted of a 5 meter square area established, using corner posts, in areas where alder was the principle brush problem. The percentage of the area occupied by brush in each plot was recorded. This information was gathered by height classes and was broken down into three height categories $<$ 0.5 m, 0.5 m - 1.0 m and $>$ 1.0 m. Brush species other than alder were identified and data was collected on the height, leader growth and bud development of conifer seedlings. Finally, photographs were taken of each plot.

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1 Note: The spread factors are unknown so an accurate determination of the volume mean diameter is not possible.

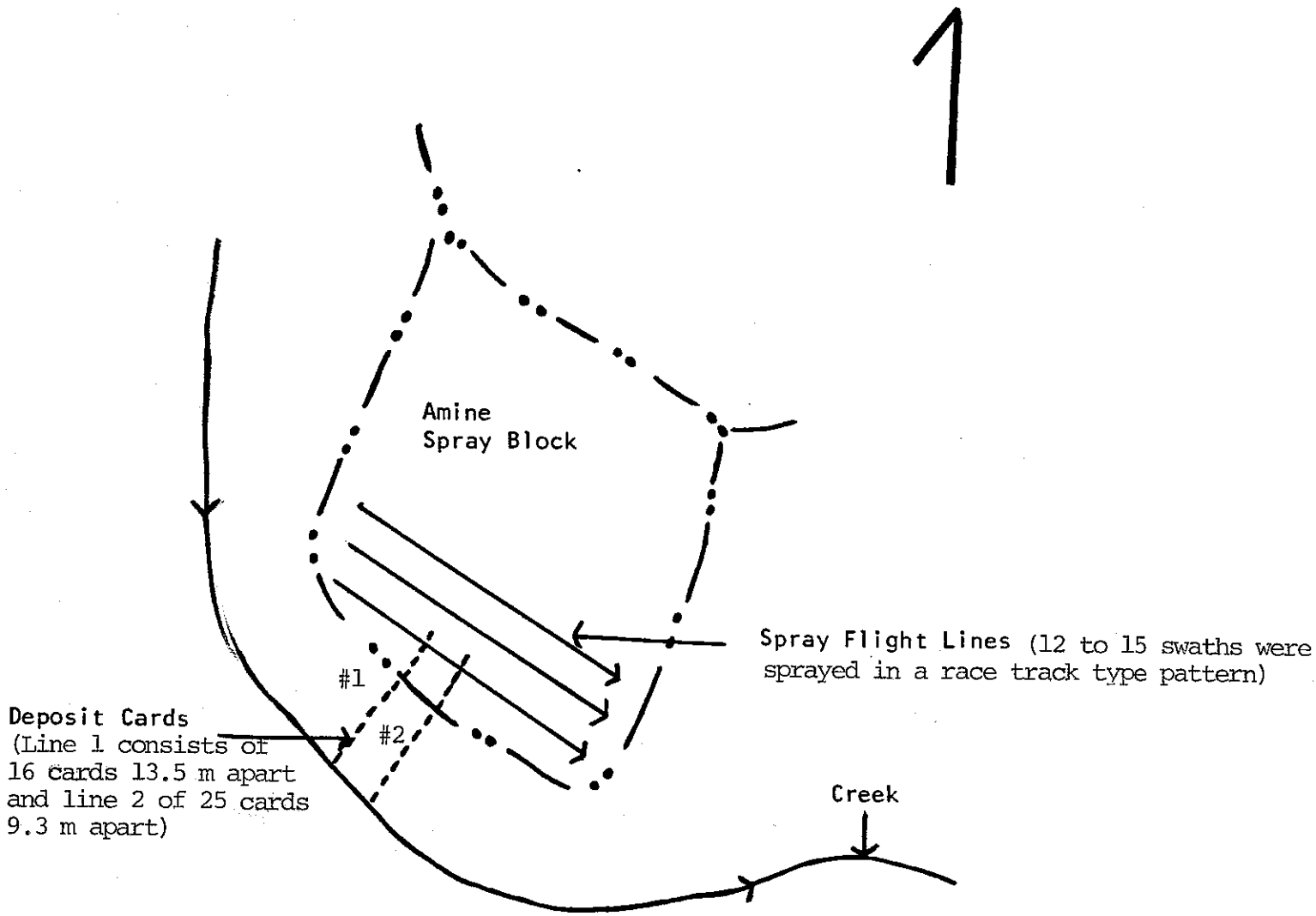


Figure 2 Placement of Deposit Cards and Alignment of Swaths on the amine Spray Block

The plots were remeasured on September 18th and 19th, 1984, one year after treatment. At this time, repeat observations were made on brush coverage, seedling condition, leader growth, brush condition and plots were re-photographed.

Results

No alder tree mortality was observed in any of the measurement plots. Outside the ester measurements plots, but still in the ester treatment area, slight, scattered mortality was observed on alder less than 3.0 m in height and no mortality was observed outside the amine measurement plots on trees of any size. The result of both treatments was to defoliate the outer 1 meter of the alder crown (completely on most trees) and to reduce the amount of foliage in the inner crown. When the spray area was observed from the air it was difficult to distinguish between treated and untreated areas and differences only became obvious when viewed from the ground.

Table 1 illustrates the differences in defoliation as measured by the area occupied by brush in each of the measurement plots. Results indicate that the ester treatment reduced alder cover by 53% while the amine treatment reduced cover by only 23%. On untreated check plots, as expected, alder cover increased by 55%. The undergrowth species salal, thimbleberry and salmonberry, all appeared to increase their respective coverages after treatment. However, only salal appeared on a sufficient number of plots to establish reliable trends. Salal coverage increased by 167% on the amine treatment plots, 189% on the ester treatment plots and 64% on the untreated plots. Refer to tables 2 through 5 for information on plot coverage by brush species before and after treatment.

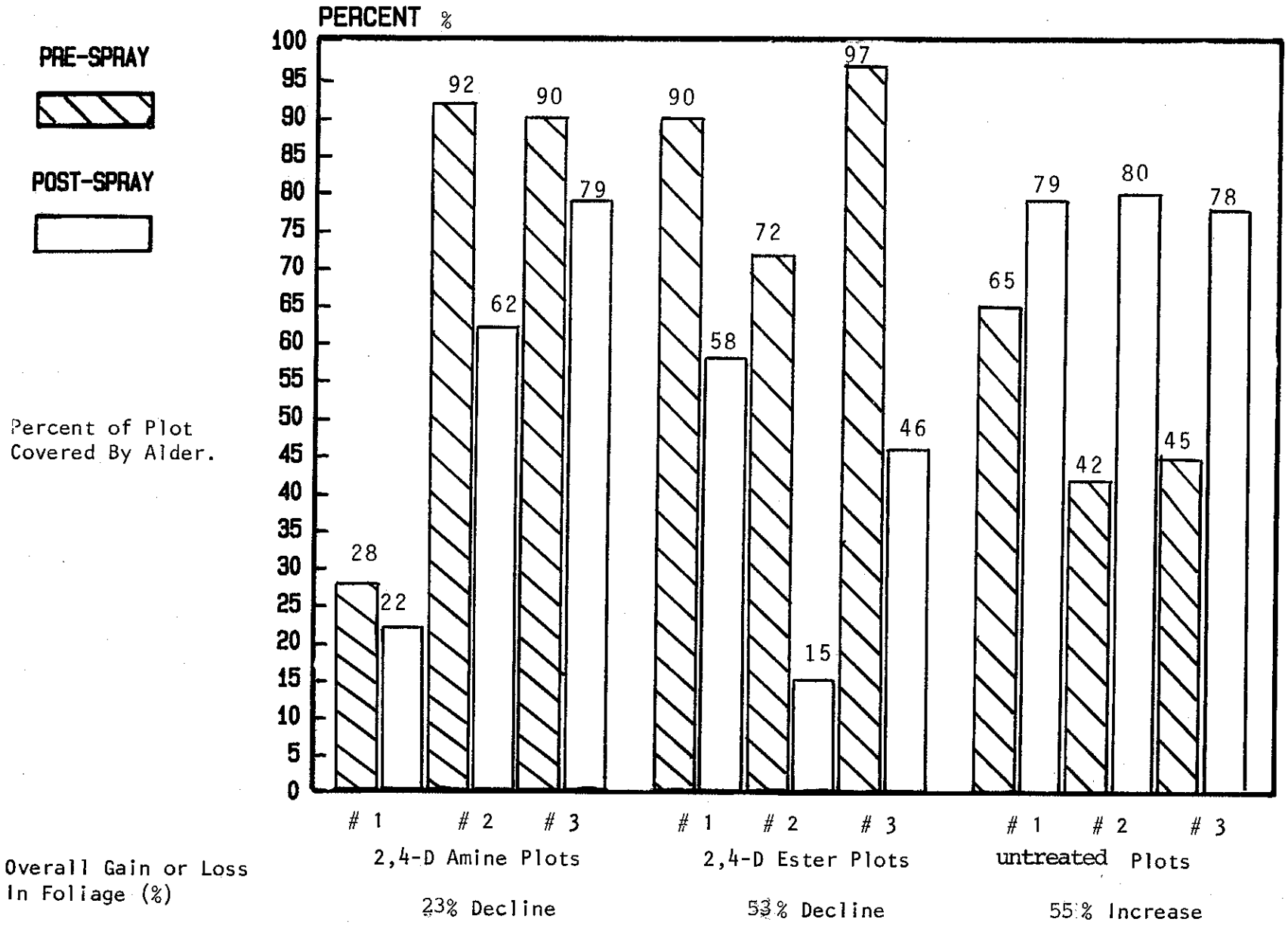
The cedar, hemlock and douglas-fir seedlings were unaffected by the treatments, that is, there was no change in plant vigor, needle color or leader growth before or after treatment. Increased leader growth was not

Table 1 The Efficacy of 2,4-D Amine and Ester as compared to an Untreated Area. (measured as the percentage of the area occupied by brush in each measurement plot pre and post treatment).

Brush Species[1]	2,4-D Amine Plots			2,4-D Ester Plots			Untreated Plots		
	Pre (%)	Post (%)	Difference (%)	Pre (%)	Post (%)	Difference (%)	Pre (%)	Post (%)	Difference (%)
Alder	70	54	-23	86	40	-53	51	79	+55
Salal	15	40	+167	9	26	+189	11	18	+64

1) Salmonberry and Thimbleberry were not present on a sufficient number of plots to establish reliable trends.

Table 2 The Efficacy of 2,4-D Amine + Ester on Alder (Alnus rubra)



Percent of Plot Covered By Alder.

Overall Gain or Loss In Foliage (%)

Table 3 The Efficacy of 2,4-D Amine + Ester on Salal (Gaultheria shallon)

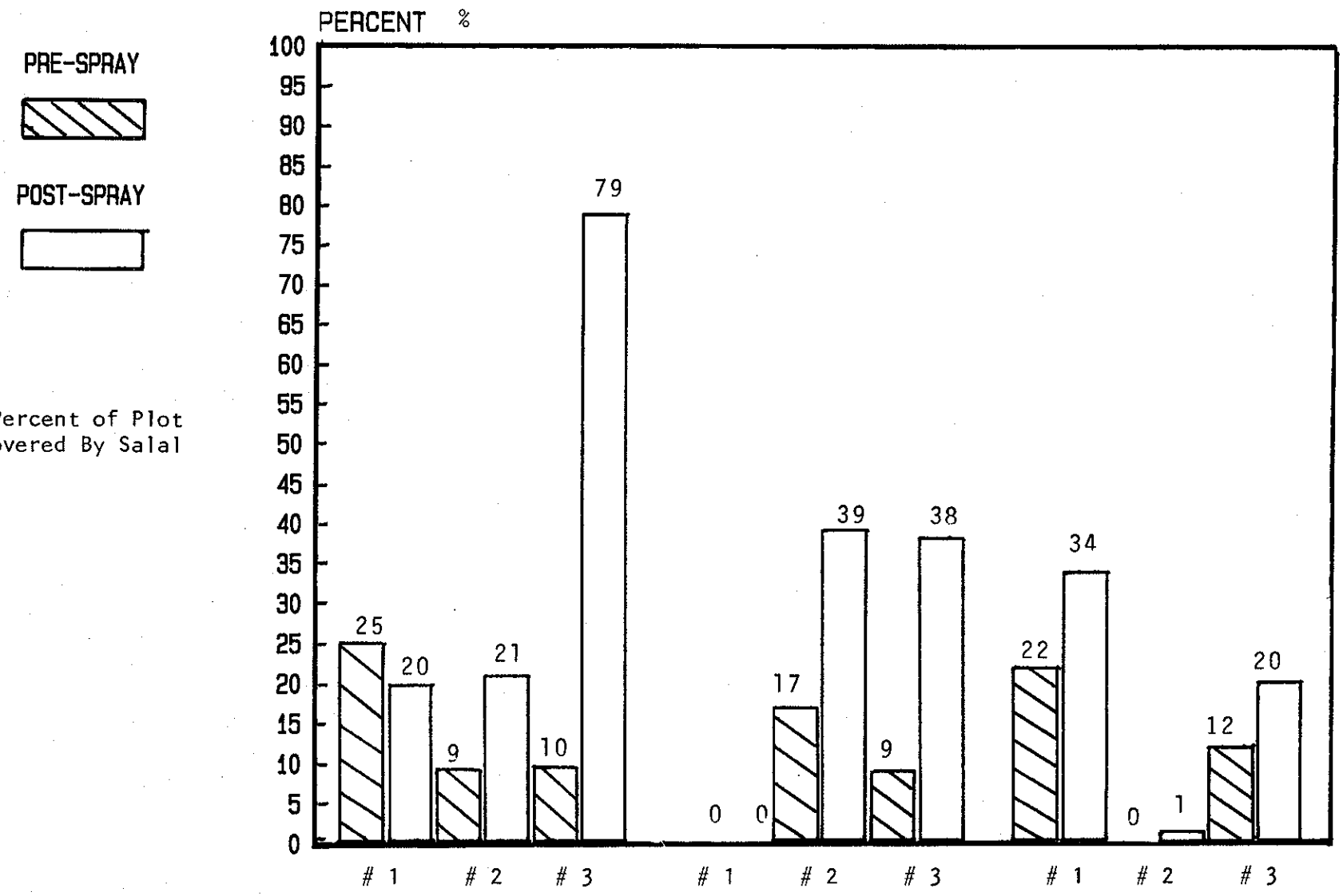


Table 4

The Efficacy of 2,4-D Amine + Ester on Thimbleberry (Rubus parviflorus)

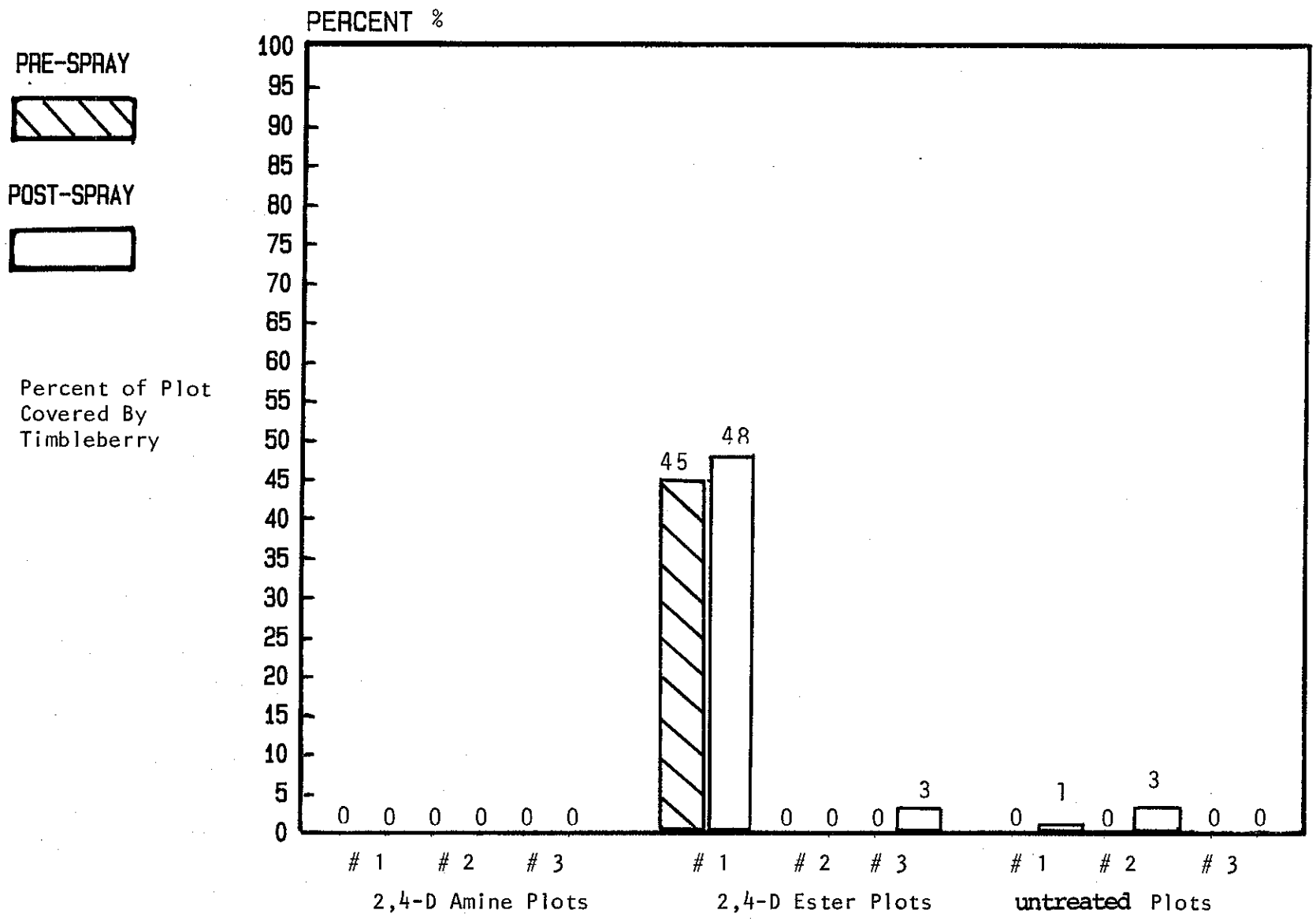
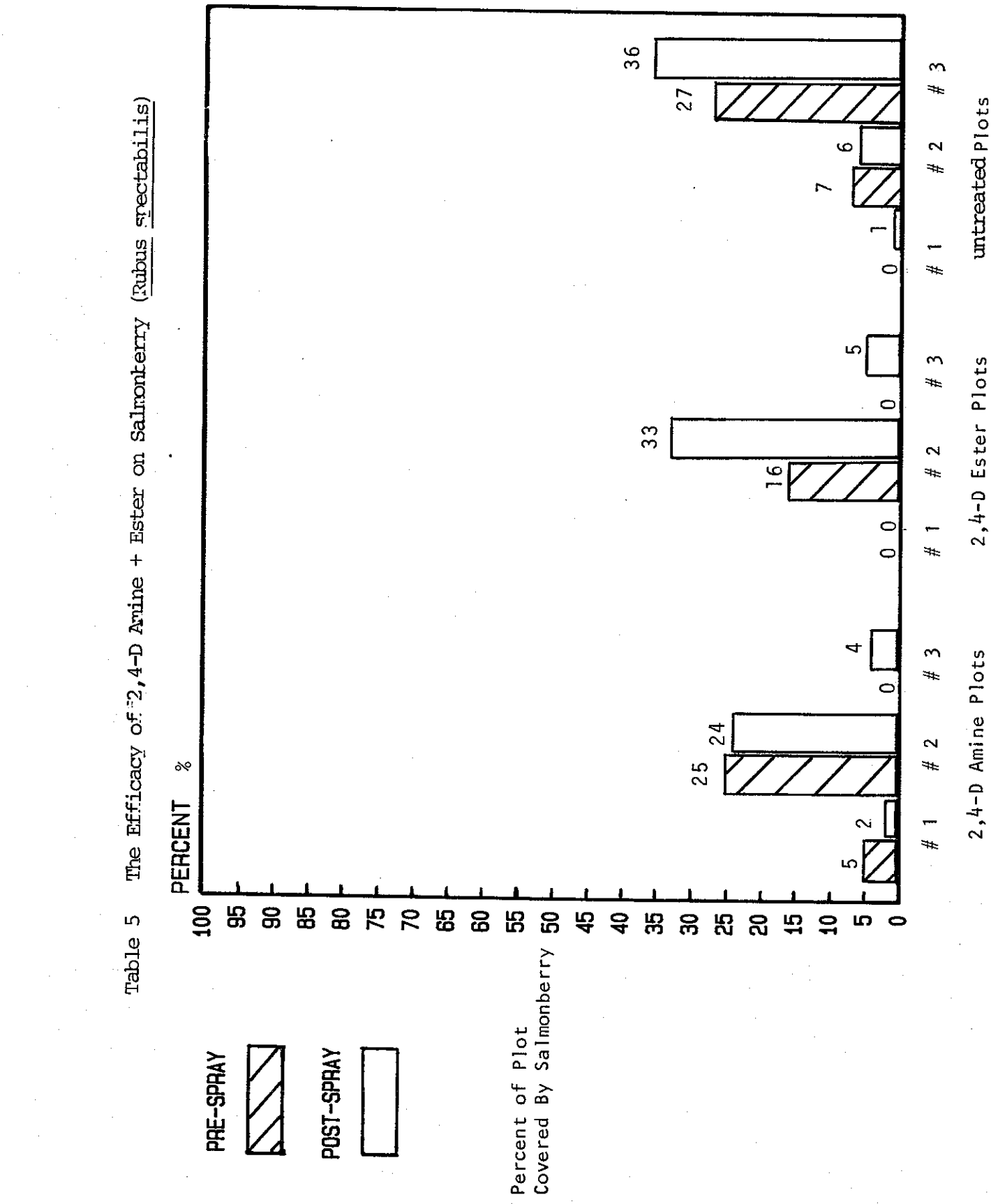


Table 5 The Efficacy of 2,4-D Amine + Ester on Salmonberry (Rubus spectabilis)



expected this soon after treatment. Douglas-fir buds appeared hardened off at remeasurement as they were at the time of plot establishment.

Refer to figures 3 through 8 for photographic evidence of the treatment effects. A number of general observations can be made from these photographs:

= 2,4-D Amine (Figure 3 and 4)
- cedar seedlings were unaffected by treatment
- no alder mortality was observed within the measurement plot
- the outer fringe of the alder was completely defoliated with a noticeable defoliation or thinning of leaves in the inner crown

= 2,4-D Ester (Figures 5 and 6)
- douglas-fir seedlings were unaffected by the treatment
- no alder mortality was observed within the measurement plot
- defoliation was more noticeable than in the amine plots however, like the amine plots only the outer fringe of the alder was completely defoliated with a noticeable defoliation or thinning of leaves in the inner crown

= Control (Figures 7 and 8)
- the photographs appeared similar as expected

No defoliation or treatment effects were observed in any untreated areas including those near creeks.

Figure 3 2,4-D Amine Plot #2, Pre-Spray

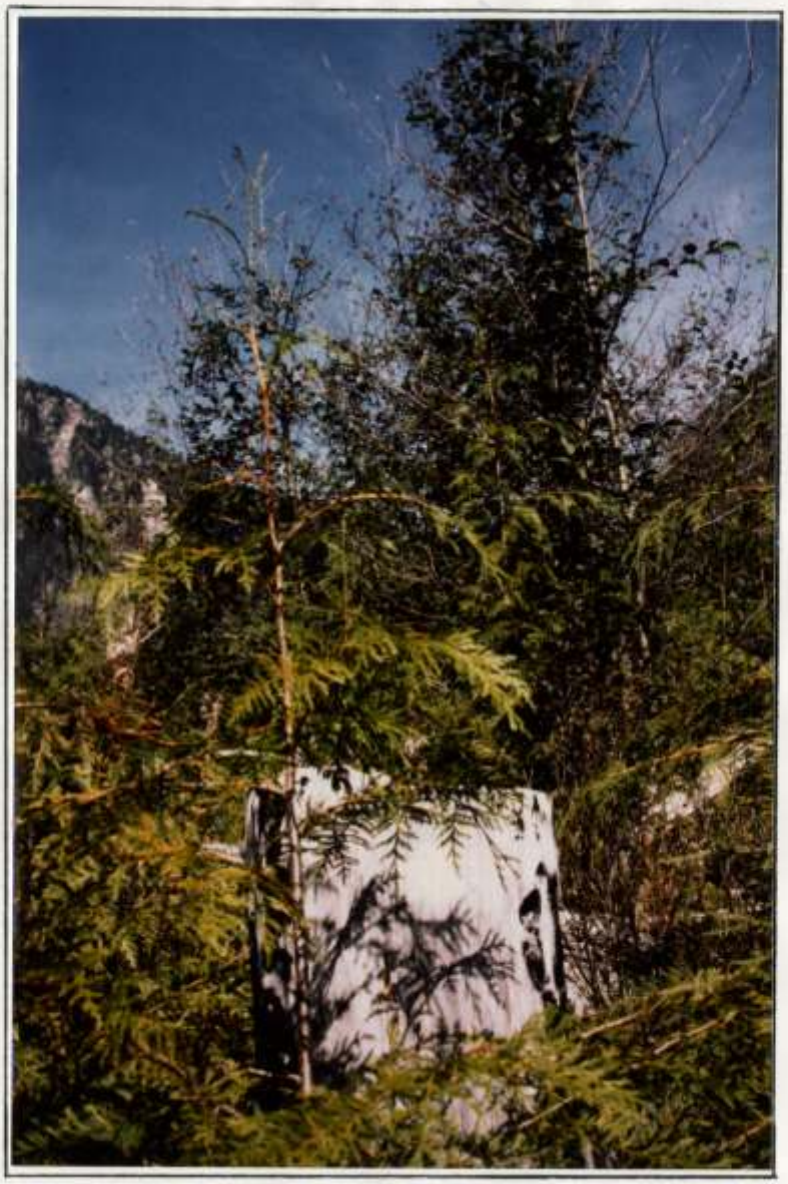


Figure 4 2,4-D Amine Plot #2, Post Spray 1 year

Figure 5 2,4-D Ester Plot #3, Pre-Spray

Figure 6 2,4-D Ester Plot #3, Post-Spray 1 year

Figure 7 Untreated Plot #1, August 16, 1983

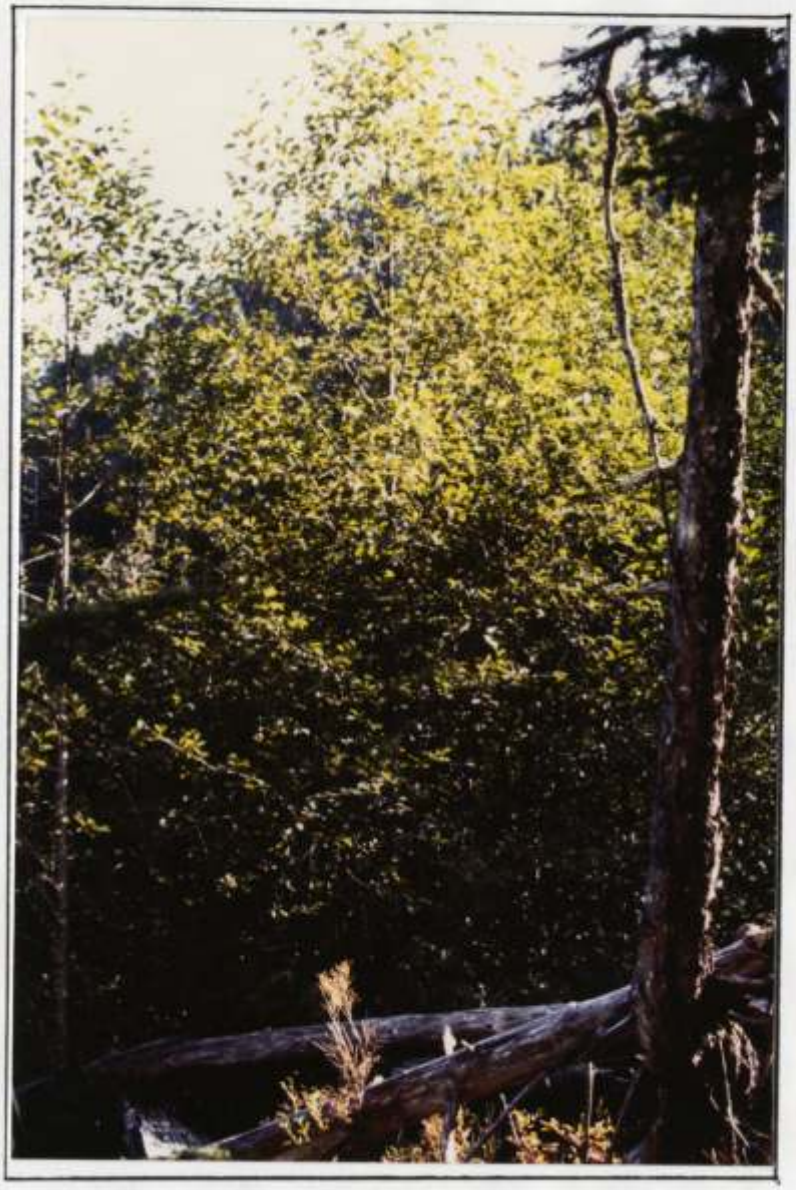


Figure 8 Untreated Plot #1, September 19, 1984

Discussion and Recommendations

Results indicate that the ester treatment was more effective than the amine in reducing alder cover (i.e. 53% reduction versus 23%). Photographic evidence confirms this finding. Overall results however, were poorer than expected with more alder defoliation and mortality being anticipated. Nonetheless, it is difficult at this stage to describe the project as a failure and in the opinion of the Managing Forester, these treatments will at least suppress alder growth for 2 to 3 years which will allow the conifers to increase their competitive margin. However, given average heights of 1.9 m for cedar and 8 m for alder, an additional treatment may be required.

Four factors may have influenced treatment efficacy:

1. Timing - an earlier treatment (by two to three weeks) might have produced better efficacy, as the alder would have been translocating more actively.
2. Droplet Size - the use of Rain Drop #7 nozzles instead of Rain Drop #10's, would have produced droplets closer to the desired herbicide size range (Newton and Yates, 1981). Other desirable nozzle types can be found in Yates and AKesson, 1984. Smaller droplets would have provided more effective coverage, although on this project environmental concerns made larger droplets desirable.
3. Oil Additive - the addition of oil to the ester formulation increased the ester's efficacy, as at this time of the year the alder leaves would have had a thick waxy cuticle and the oil would have dissolved this surface and increased ester solubility and penetration into the plant.
4. Weather Conditions - Some spray swaths were applied under less than ideal conditions, with relative humidity $< 70\%$ and temperatures $> 21^{o}$ C. Under these conditions increased evaporation of water from the spray droplets would have occurred resulting in fewer fine droplets ($< 200 \mu$) reaching the target plants.

Results also indicate a negative effect of the treatments on the minor brush species, salal, salmonberry and thimbleberry. One reason for this is that as the alder overstory opened up after treatment it allowed the lower brush species to thrive. In addition, 2,4-D is reported to have no effect on these brush species.

Future stand entries will be required for surveys and additional conifer release. These entries should be made 4-6 years after the initial release program (August, 1983). At this time it is recommended that silvicultural staff measure leader growth, for the past 4-6 years, to arrive at a better estimation of the 1983 amine and ester's treatment efficacy.

Based on this preliminary evaluation of the efficacy of the 1983 2,4-D Amine application, it is not possible to recommend its use at this time. Repetition of the Effingham work is required to accomplish this and it is recommended that this work be conducted 2-3 weeks earlier, using smaller droplets and never applying at relative humidities $< 70\%$ or temperatures $> 21^{o}$ C.

Acknowledgements

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The Port Alberni District Staff for providing transportation on the project site and for assistance in obtaining information.

J. Boatneg, J. Henigman, G. Ackerman, M. Scott, P. Humphreys and R. DeBoo for providing information, advice and manuscript review.

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Appendices

Weather Information

Weather information was collected on site near where the spraying was being conducted. When the 2,4-D amine block was being sprayed this information was collected from an observation point located in the middle of the block and measurements were taken at a height of 1.5 m above ground level. For the ester block, two observations points served several blocks and measurements were taken at these points. These points were located in the northern end of the 2,4-D ester blocks (E_1) and in the 2,4-D amine block (figure 1).

August 17, 1983

Time	Wind (km/hr)	Temp (°C)	RH (%)	Number of Loads
7:15	0	12.5	94	
7:30	0	13	95	
7:45	0	13.5	95	no data available
8:00	0	13	94	for August 17
8:15	0	15	90	
8:35	0	16	90	
9:00	0 < 1	17	86	
9:25	1	18	87	
11:00	5	22	68	
11:25	gusts < 6	25	50	
11:40	gusts to 8	25	57	shut down
12:00	10	26	46	
12:20	10	26	51	
12:40	10	26	58	
13:00	10	28.5	56	
13:20	13	25	70	
13:40	8	26	64	
14:00	12	27	58	
14:20	12	25	63	
14:40	13	23	62	
15:00	10	21	67	
15:20	0 gusts to 8	20	74	
18:30	0	21	91	
19:30	0	15.5	95	
20:30	0	14	100	

August 18, 1983

Time	Wind (km/hr)	Temp (^{o}C)	RH (%)	Number of Loads
06:30	<1	12.5	100	Clear
07:00	<1	12.5	94	
07:30	<1	12.0	100	
08:30	<1	13.0	95	
09:00	<1	13.0	95	10?
10:15	<1	21.0	53	
10:30	3	21.0	53	
10:45	5	21.0	67	
11:00	4	21.0	67	
11:15	5	20.5	63	
16:30	5	23.0	62	
16:45	5	23.0	65	1
17:00	3	21.5	71	
17:25	0	19.5	70	1
17:50	<1	19.0	74	1
18:30	<1	18.0	86	1
19:15	<1	18.0	77	2
19:45	<1	18.0	77	2
20:45	<1			

August 19, 1983

Time	Wind (km/hr)	Temp (^{O})	RH (%)	Number of Loads
06:45	<1	13.5	95	1
07:00	<1	12.5	94	1
07:15	<1	12.5	94	1
08:25	0	14.0	90	1
09:00	<1	16.0	85	1
09:15	1	17.0	81	1
09:45	2	19.5	78	1
10:05	4	19.5	74	1
10:35	1	19.5	70	1
11:00	3	21.0	67	1
11:30	6	22.0	65	1
12:00	8	22.0	65	1
17:20	8	22.0	64	gusts 15
17:40	4	22.0	61	Restart