Western Spruce Budworm Suppression Project
DNR, Champion, Boise Cascade

Entomology Report
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Epidemic levels of Western Spruce Budworm (*Choristoneura occidentalis* Freeman)(WSB) have been continuously affecting the Glenwood, Mt. Adams, Simcoe Mountain area since 1985. Approximately 8,200 acres of the affected area were sprayed with *Bacillus thuringiensis kurstaki (B.t.*) between June 13 and June 27, 2000. The Entomological portion of the project included establishing spray blocks, evaluating the population of larvae on each spray block, determining when the development of the larvae was appropriate for treatment, and conducting post-spray evaluation. Effort is also made to relate these entomological operations and determinations with methods and determinations made in similar WSB control projects using *B.t.* in recent years.

Actions and Results

Landowners (Boise Cascade Corporation, IP (Champion) Pacific Timberlands Inc, Washington Department of Natural Resources), determined the area that they desired to spray and completed Forest Practices Applications for the Project Area. This area was divided into twenty spray blocks, with average size of 450 acres (min. 114; max. 896). On 5 of 8 days that spraying occurred, more than one spray block was treated, resulting in average spray day activity on 1023 acres (min 370; max. 2300).

Approximately 66 Evaluation Plots were established across the treatment area. Most spray blocks were referenced to three evaluation plots. Most of these plots were in place by May 30. Additional plots were added later as snow levels retreated and spray unit changes (Block 15 was evaluated more, then dropped; Block 19 was added; Block 11-Addition was added) occurred. The spray blocks were evaluated in three phases:

1. Early Larval Density assessment used a mid-crown branch collection procedure to evaluate whether the population of insects exceeded 4 larvae per 17 inch mid-crown branch, meeting the threshold for treatment. Six mid-crown branches per plot were collected using a pole pruner and basket. They were taken back to the work center for insect removal and counting.
2. Larval Development sampling used a lower-crown branch collection procedure to gather and examine the development of the larvae. Four lower crown branches per plot were collected and taken back to the work center for insect removal and counting. The instars (developmental stages of larvae) were classified by the entomologist. The spray blocks were to be released when the WSB population had >= 85% in the 4th, 5th or 6th instar.
3. Fourteen days after treatment a lower-crown branch beating system was used to evaluate the Post-Spray Population on 74 plots, including many of the established Evaluation Plots used for previous sampling. At each plot, live budworm (including pupae) and dead budworm that were dislodged from the branch were tallied when the distal 17-18 inches of three lower crown branches of at least five trees were beaten above a cloth. A more comprehensive description of the procedure is attached in Appendix C. The desired result was to be an average of fewer than 1.0 larva per lower-crown branch, returning the

population to an endemic level for 2 or more years. Samplers likely challenged this total by using evaluation plots which were often near spray block boundaries and by selecting among the more obviously defoliated trees for beating.

Results: Early Larval Density

Project-wide, treated spray blocks qualified with an average of 19.6 larvae per mid-crown branch. See Appendix A for summary information. They ranged from 4.6 larvae per mid-crown branch on Block 17 to 59.8 larvae per mid-crown branch on Block 10. Block 15 did not qualify and was dropped from the project. At the late time it was added, Block 11-Addition obviously had sufficient population present to warrant treatment, so its early larval density was not measured.

Early larval density can vary quite a bit with the timing of sampling. Specifically, areas may not qualify if samples are taken so early that the over-wintering larvae have not fully migrated to the branch tips. Conversely, a late spring frost or disease outbreak which kills the larvae can make treatment unnecessary on blocks which had previously qualified. Those situations were not observed on this project.

Results: Larval Development

The treated blocks received an average of 2.8 visits to gather development samples. At the time release was granted, spray blocks averaged 75% >= 4th instar in samples generally collected one or two days prior to the release. The lowest level was 65% (Block 8); the highest level was 89% (Block 2). Although this generally was lower than the initial release criteria of 85% >= 4th instar, it was consistent with the appearance of 6th instar larvae, a lack of 2nd instar larvae, and judgement about the average conditions of the block, expected weather, and the likely persistence of the *B.t.* No pupae were observed in any of the samples prior to treatment. All blocks were treated within 3 days of release.

Results: Post-Spray Sampling

In order to evaluate the overall success of the project, and gain additional insight into potential areas of future concern, the data from post-spray insect sampling was divided into three analysis units (King Mountain, Bacon Creek and Simcoe). The spray blocks associated with each Analysis Unit are listed in Appendices A and C.

King Mountain. Thirty plots were evaluated on the King Mountain area. They averaged 0.87 larvae per lower crown branch examined: a lowered population level that is expected to cause endemic levels of WSB to be observed for two or more years. The post-spray populations ranged from 0 to 2.67. Only five plots had levels above 1.5. Only ten plots had levels above 1.0. There was no pattern to the higher rates; they differed by spray blocks, proximity to spray block boundaries, and the person doing the post-spray sampling.

Simcoe. Twenty-four plots were evaluated in the Simcoe area. They averaged 0.39 larvae per lower crown branch examined: a lowered population level that is expected to cause endemic levels of WSB to be observed for two or more years. The post-spray populations ranged from 0 to 5.95. The plot with 5.95 larvae was the only plot above 1.0. That plot was located on the NW corner of Spray Block 19. That location and the area immediately north and west of the spray block boundary are very heavily defoliated, without much relief apparent in 2000. On July 10,

most of the trees did not have a single new needle showing. Although the samples were taken about 100 feet inside the spray boundary (road), the area could have been missed by the spraying. There were a few dead larvae observed during the beating. This portion of spray block 19 and vicinity remain of concern into the future.

Bacon Creek. Twenty plots were evaluated in the Bacon Creek area. They averaged 2.07 larvae per lower crown branch examined. This population level is not expected to have endemic effects for two years. The post-spray populations ranged from 0.07 to 5.07. Nine plots had levels above 1.5. Eleven plots had levels above 1.0. Plots in spray blocks 14 and 4 were all below 1.0 larvae. All the plots in spray blocks 1 and 2 were above 1.0. Although data collected by Louis Halloin might have been somewhat high because of his tendency to include sickly larvae among those counted as "live," in contrast to Karen Ripley and Nina Vinyard's tendency to include sickly larvae among those counted as "dead," the observations between the collectors were not terribly different. The Bacon Creek area was likely a very challenging area to treat effectively: spray blocks were small, edges were large, evaluation plots were generally close to edges, the stand structure in this area is heavily layered, and pre-spray WSB populations were high.

Discussion: Relationships between sampling systems

Mid-crown branch collection is an excellent way to collect larvae early in the season when they are likely to be located near the tops of the trees and enclosed within needles or buds. Mid-crown sampling is very labor intensive, especially when processing samples right at the time of spray block release.

Lower-crown branch collection is a less labor intense method of collecting samples for examination than mid-crown sampling. Branches are taken to a laboratory facility for complete dissection and removal of all larvae.

As the larvae mature and are less contained within the foliage, lower crown beating produces similar results as lower crown branch collection, but much more quickly. This will not hold true if the sampling is conducted early in the growth season of WSB when the larvae are enclosed within the buds or foliage. It may not be as reliable if the weather is cold. These situations were not an issue during the times the lower crown beating procedures were used during this project.

Generally when appropriate lower crown observations are multiplied by 2.3, they equal mid-crown measurements[1]. If the post-spray measurements were converted to mid-crown measurements, they would reveal:

Analysis Unit	Post Spray Lower Crown	Post Spray Mid Crown
King Mountain	0.87	2.001
Simcoe	0.39	0.897
Bacon Creek	2.07	4.761

Bacon Creek still does not appear to have populations reduced below the 4.0 larvae per mid-crown branch set as a threshold for treatment qualification.

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[1]1994. Mason, R.R. and H.G. Paul. Monitoring Larval Populations of the Douglas-fir Tussock Moth and the Western Spruce Budworm on Permanent Plots: Sampling Methods and Statistical Properties of Data. USDA Forest Service. PNW-GTR-333.

In order to provide a reasonable estimate of the population reduction caused by spraying measurement immediately prior to the spraying and 14-days after the spraying are collected. This project did not specifically have pre-spray samples collected. However the last development samples (branch collection) were generally collected within 3 days of the treatment. Although not modified with "natural mortality" estimates from an unsprayed area, these could provide a reasonable comparison with the 14-day post spray lower crown beating samples.

Analysis Unit	Post Spray		Pre-Spray		Percent reduction
King Mountain	0.87*	n=30	21.27	n=30	96%
Simcoe	0.39	n=24	7.23	n=10	95%
Bacon Creek	2.07	n=20	16.86	n=14	88%

* Data reported are larvae per 17 inch lower crown branch.

B.t. has an excellent "track record" against western spruce budworm. The true effectiveness of this project will be measured in future years as the area treated in 2000 is examined for defoliation.

Conclusions

The 2000 Western Spruce Budworm Suppression Project was successful. The spray units were analyzed in an appropriate and efficient manner. The *B.t.* was applied during an appropriate window of effectiveness. Populations on most areas were reduced to a level below one larva per lower crown branch, causing significant budworm relief for two or more years. All areas had approximately 88-96% population reduction. The weakest areas of control included the far northwest portion of spray block 19 and the northern portions of the Bacon Creek Analysis unit. These areas may continue to have damaging levels of WSB in the next two years. Monitoring defoliation levels in the next two or more years will provide the truest test of this project's success.

Application of *B.t.* is a temporary means of protecting host tree foliage. Its effects can serve to prolong tree life, prevent top kill and reduce tree breakage during felling. The time that is purchased by *B.t.* application may provide protection until the surrounding WSB epidemic subsides or buys time for silvicultural treatments. Silvicultural treatments which reduce the volume of host foliage, reduce canopy layering and increase non-host presence are the only long term treatment for WSB relief.

Miscellaneous

- 2000 appears to be a very successful year for WSB and other defoliators. The 2000 aerial survey will likely show a significant increase in affected acres over 1999. Along with the unexpectedly high defoliation levels south of the King Mountain treated area (T6N, R11E), defoliation is apparent on the "plateau" area south of Glenwood, throughout the Ahtanum State Forest, and north of Highway 12 between White Pass and Rimrock Lake.
- The Forest Service has decided to stop providing WSB traps and baits for pheromone trapping free of charge to states and cooperating private forestry companies as of 1999. These products are now available commercially and policy interpretations demand that

the public agency not under-cut or compete with free market opportunities. In 2000 DNR paid for these materials and provided them free of charge. DNR will unlikely be able to do so into the future unless special funding is acquired.

- Beth Willhite, Forest Service Entomologist, conducted a test of two possible methods for mitigating the effects of *B.t.* application on Mardon Skipper, a state-listed butterfly whose range and life history overlap with WSB. The results of those tests will be made available to cooperators as soon as they are available.
- Many of the higher elevation portions of this spray area, on all ownerships, dominated by grand fir, are infested with an exotic insect called the Balsam Woolly Adelgid. Very little is known about how BWA populations and resulting damage will cycle in North America. It damages a variety of true firs (genus *Abies*) and has been in North America for decades. Many of the trees examined in evaluation units had signs of prior BWA infestation (branch gouting). Many of the areas will be evaluated this autumn for active infestations of branches and stems. Protecting these trees from WSB defoliation for a few years is unlikely to be a long term solution to managing these forests. Trees which are not susceptible to BWA are more likely to be capable of surviving to maturity and beyond in these forests into the future. Depending on the site, spruce, Douglas-fir, larch, ponderosa pine, lodgepole pine, or white pine may be appropriate substitutes to favor.
- This project was a cooperative, coordinated effort between DNR, IP (Champion) and Boise Cascade. All groups provided assistance to the insect crew. Special dedication was provided by Louis Halloin and Nina Vinyard. The work and good humor of the entire bug crew is well appreciated. Patrick Allen provided prompt assistance with map production and adjustments.

Appendix A:

Spray Block Summary (July, 2000)

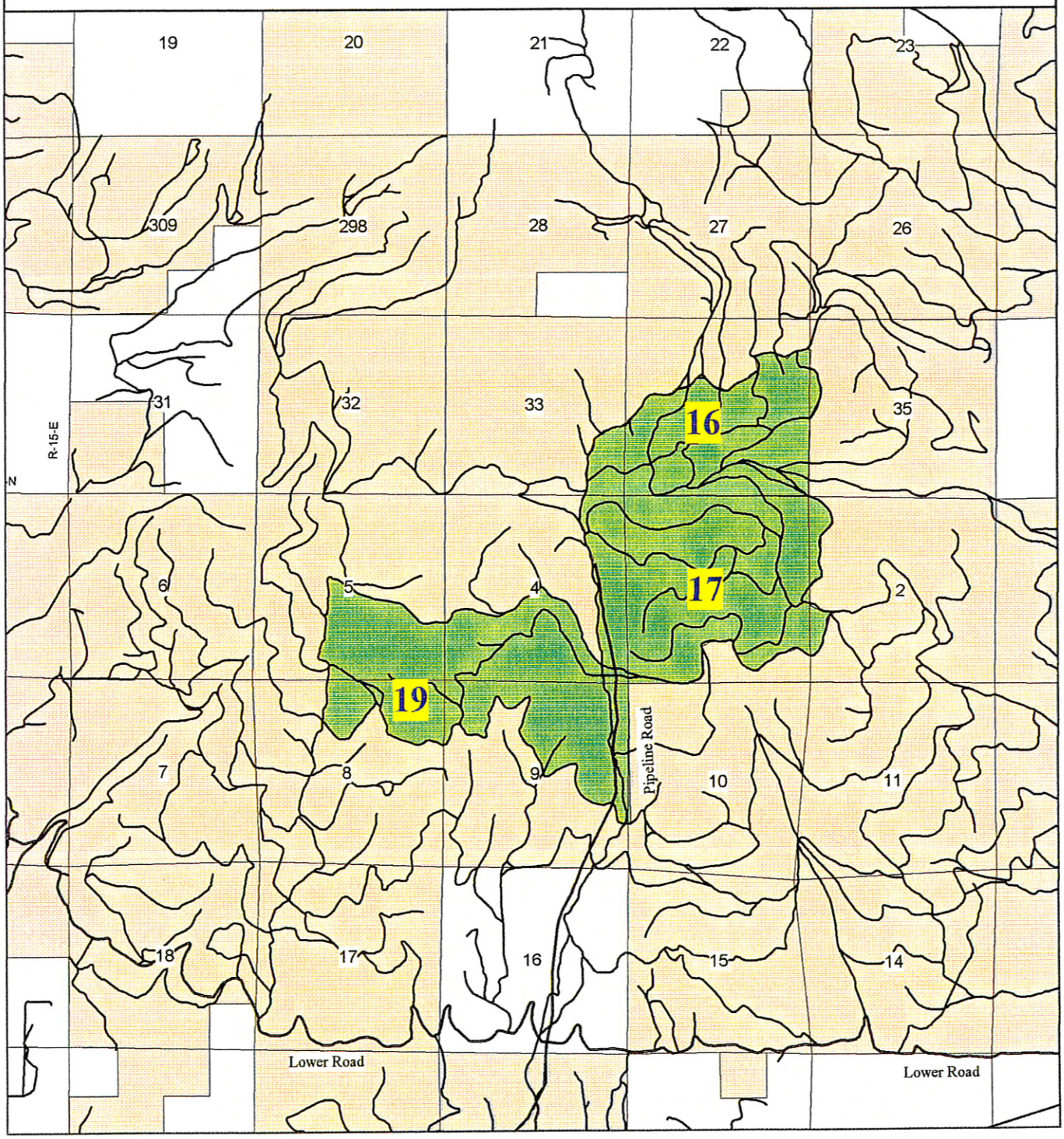
WSB Control Project 2000

#	Owner	T	R	S	Min Elev	Max Elev	Elev diff	Ave. Elev	Asp	Acres	Eval Plot #s	Last Coll.	Budworm Status	Foliage Status	Block Status	Released	Sprayed	Analysis
1	DNR	7N	11E	1,	4080	4520	440	**4200**	SSE	144	E35, E42	June 26	75% >= 4th instar	GF 1-3"; DF unk	Qualifies. 17.9	June 27	June 27	Bacon Creek
2	DNR	7N	12E	7,	3800	4080	280	**4000**	SE	114	E33, E34	June 26	89% >= 4th instar	GF 1-3"; DF .5-3"	Qualifies. 6.1	June 27	June 27	Bacon Creek
3	DNR	7N	12E	5,6	3520	4080	560	**3850**	SE	151	E31, E32	June 22	67% >= 4th instar	GF 1-3"; DF unk	Qualifies. 12.8	June 25	June 27	Bacon Creek
4	DNR	7N	12E	16, 17	2700	2970	270	**2800**	NE	385	E18, E19, E30	June 12	77% >= 4th instar	GF 1.-4"; DF 1-2"	Qualifies. 7.7	June 13	June 13	Bacon Creek
5	Champ	7N	11, 12E	7, 12	3520	4480	940	**4050**	SE	491	E36, E37 (E39)	June 22	70% >= 4th instar	GF 1-2"; DF unk	Qualilfies. 18.2	June 25	June 27	Bacon Creek
6	DNR	7N	11E	33,34	3760	4560	800	**4240**	S	557	E4, E47, E48, E49	June 26	71% >= 4th instar	GF 1-4"; DF .5-1"	Qualifies. 29.2	June 27	June 27	King Mountain
7	DNR	6N	11E	3, 4	3360	4160	800	**3840**	S	644	E3, E5, E45, E48	June 26	81% >= 4th instar	GF .5-3; DF 1-2.5"	Qualifies. 34.3	June 27	June 27	King Mountain
8	DNR	7N	11E	23,26	3520	3880	360	**3700**	ENE	662	E17, E41,E43, E51	June 22	65% >= 4th instar	GF 1-4"; DF unk	Qualifies. 24.3	June 25	June 24	King Mountain
9	DNR	7N	11E	26,35	3440	3920	480	**3720**	E	600	E9, E10, E51	June 22	67% >= 4th instar	GF 1-3; DF .5-1"	Qualifies. 37.3	June 24	June 24	King Mountain
10	DNR	7N	11E	25,36	3200	3520	320	**3380**	E	370	E10, E11, E16	June 21	79% >= 4th instar	GF 1-3"; DF .5-2"	Qualifies. 59.8	June 23	June 23	King Mountain
11	Champ	6N	11E	1,	2640	3280	640	**3000**	SE	398	E12, E13, E14, E15	June 19	88% >= 4th instar	GF 1-3"; DF 1-3"	Qualifies. 16.5	June 20	June 20	King Mountain
11Add	Champ	6N	11E	11,12	2360	3200	840	**2600**	ESE	400	E66,67,68	June 15	77% >= 6th instar	GF 1-3"; DF 1-2"	Qualifies.	June 16	June 17	King Mountain
12	Champ	6N	11E	2,	2900	3680	780	**3300**	SSE	501	E8,E44 (E12 or E13)	June 19	80% >= 4th instar	GF 1-3; DF 1-3"	Qualifies. 10.6	June 20	June 20	King Mountain
13	Champ	6N	11E	5,4	2880	3720	840	**3360**	SSW	191	E1, E2,E50	June 19	72% >= 4th instar	GF 1.5-3"; DF 1-2"	Qualifies. 12.2	June 22	June 22	King Mountain
14	Champ	6N	11E	13,14	3400	4120	720	**3800**	SE	432	E38, E39, E40	June 22	67% >= 4th instar	GF 1-2.5"; DF .5-1.5"	Qualifies. 26.9	June 25	June 26	Bacon Creek
15	Boise	6N	14E	23 to 27	2520	3400	880	**2900**	SE	896	E26, E27, E28, E29	May 23	* 0.4 Larvae		Does Not Qualify	WILL NOT SPRAY		
16	Boise	6N	16E	33,34	3800	4400	600	**4100**	ESE	451	E20, E21, E25	June 22	71% >= 4th instar	GF 1-3.5"; DF .5-2"	Qualifies. 11.5	June 24	June 26	Simcoe
17	Boise	5N	16E	2,3,4	3880	4320	440	**4100**	SE	723	E22, E23, E24	June 22	68% >= 4th instar	GF 1-3"; DF .5-3"	Qualifies. 4.6	June 24	June 26	Simcoe
18	Champ	6N	11E	3,9,10	3200	3680	480	**3360**	SSE	279	E6,E7,E46	June 19	79% >= 4th instars	GF 1-3"; DF .5-3"	Qualifies. 9.6	June 22	June 22	King Mountain
19	Boise	5N	16E	4,5,9,10	3600	4200	600	**3840**	S	700	E62,E63,E64,E65	June 22	76% >=4th instar	GF 1-4"; DF 1-3"	Qualifies. 13.9	June 24	June 26	Simcoe
									Total Acres:	9,089			* 0.4 Larvae; all 2nd instar or parasitized					

2000 Spruce Budworm Spray
CPTI - Boise Cascade - WA DNR

Boise Cascade Spray Area (1934ac)
DNR Spray Area (3620ac)
DNR Butterfly Refugia (576ac)
IPPTI Spray Area (2734)
Boise Cascade Ownership
IPPTI Ownership

Scale: 1" = 4000'



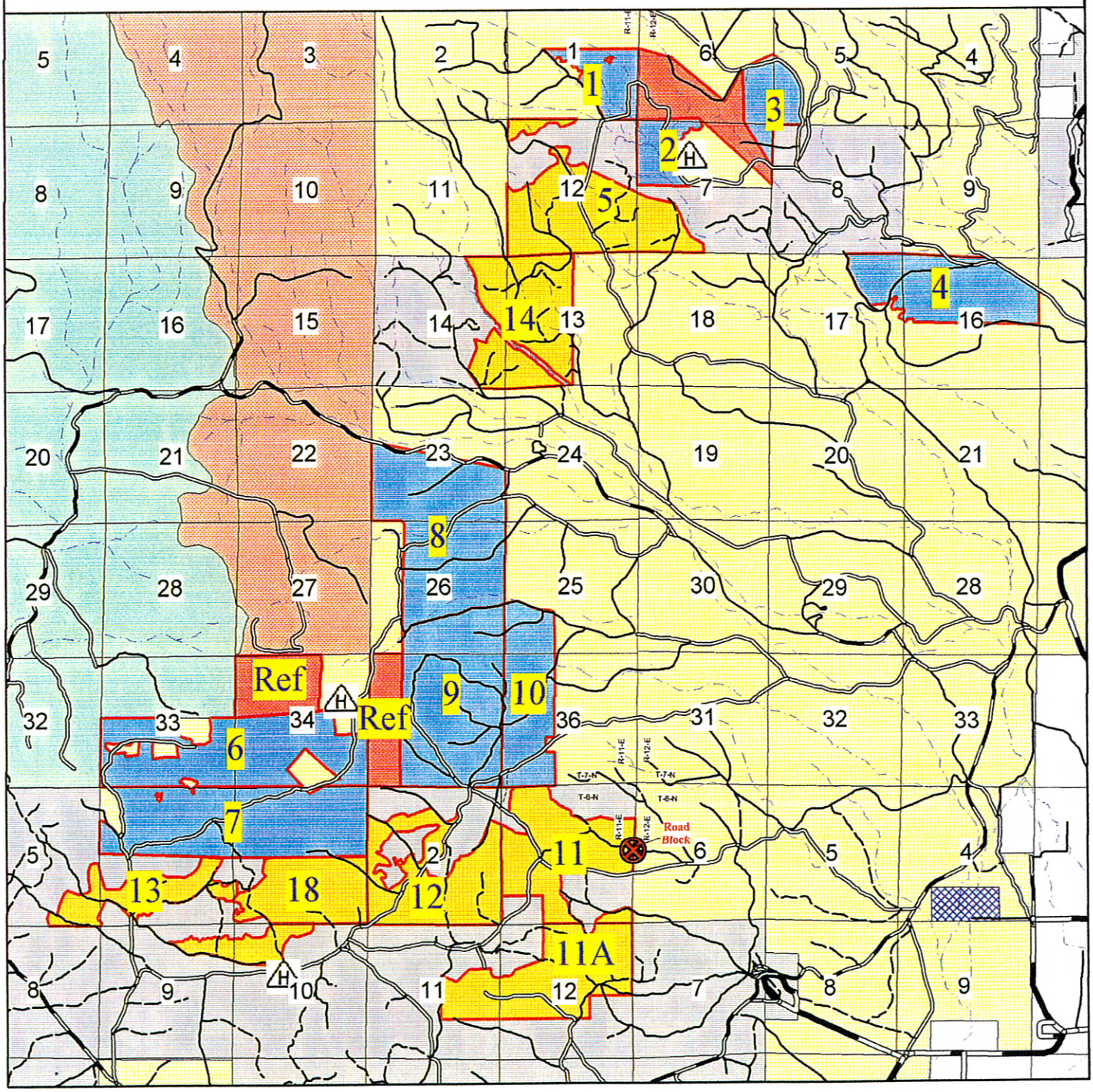
2000 Spruce Budworm Spray
CPTI - Boise Cascade - WA DNR

DNR Spray Area (3620ac)
DNR Butterfly Refugia (576ac)
IPPTI Spray Area (2734ac)

DNR Ownership
Other Ownership
USFS Ownership
YN Ownership

IPPTI Ownership

Scale: 1" = 5500'



Objective: There are many methods for measuring the success of a western spruce budworm suppression project. For the purposes of this project, finding less than an average of 1 larvae per branch in a 14 day post spray lower crown beating sample will be "Excellent" success. If the population is reduced to this level, defoliation is expected to be reduced to endemic levels the year following spraying. The second year after spraying, budworm populations could increase, but to levels less than those found the year of treatment. The third year following treatment, the population could return to epidemic levels unless the local population has collapsed or silvicultural treatments have been applied to alter stand condition.

Procedures: The 2000 western spruce budworm spray project area is divided into 3 analysis units (Simcoe, Bacon Creek, and King Mountain). These analysis units will contain the following spray blocks:

Simcoe: 16,17,19
Bacon Creek: 1,2,3,4,5,14
King Mountain: 6,7,8,9,10,11, 11-addition, 12,13,18

Each analysis unit will have at least 20-30 plots established in it. Simcoe will have at least 20. Bacon Creek and King Mountain will have at least 30. Some will be the evaluation plots where early larval density and development samples were taken, some new plots will be added.

At each plot, 5 host trees with lower crown with live buds in reach from the ground will be selected. An effort will be made to select host trees as a representation of the stand (i.e. they could all be grand fir, could be a mixture of grand fir and Douglas-fir, could be all Douglas-fir). Sampling will occur after 10 am or 60°F temperatures have been reached. A 17-18 inch length of three lower crown branches will be beaten above a hand held cloth for twelve strong strikes. The a) dead, dried or moribund western spruce budworm larvae and the b) live/vigorous western spruce budworm larvae will be counted and tallied on a plot data sheet. From these data, the number of live western spruce budworm larvae per branch will be calculated for that plot and the Analysis Unit.

Post Spray Budworm Tally Form

Analysis unit: ☐Simcoe ☐Bacon Creek ☐King Mountain

Spray Block # _____ Plot # _____ Date sampled _____

		live budworm	dead budworm	other
Tree#1	☐DF	_____	_____	_____
	☐GF	_____	_____	_____
		_____	_____	_____
Tree#2	☐DF	_____	_____	_____
	☐GF	_____	_____	_____
		_____	_____	_____
Tree#3	☐DF	_____	_____	_____
	☐GF	_____	_____	_____
		_____	_____	_____
Tree#4	☐DF	_____	_____	_____
	☐GF	_____	_____	_____
		_____	_____	_____
Tree#5	☐DF	_____	_____	_____
	☐GF	_____	_____	_____
		_____	_____	_____
Total Insects:		_____	_____	_____
Total Branches:		_____	_____	_____
Average per branch:		_____	_____	_____