1990 Western Spruce Budworm Suppression Project
Yakima Indian Reservation

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ABSTRACT

The USDA Forest Service, USDI Bureau of Indian Affairs, and the Yakima Indian Nation Tribal Council carried out a project to suppress an outbreak of western spruce budworm on the Yakima Indian Reservation in central Washington. Thuricide 48LV, a biological insecticide using Bacillus thuringiensis variety kurstaki as the active ingredient, was applied undiluted at the rate of 1/3 gallon per acre to 70,827 acres. Application was made by helicopters and single engine airplanes. Early larval density prior to spraying averaged 27.3 budworm larvae per 45 CM mid-crown branch tip. Post-spray density averaged 1.0 budworms per branch, for a 96.5 percent population reduction. Cost for the treatment was $15.35 per acre.

INTRODUCTION

Western spruce budworm (Choristoneura occidentalis Freeman) populations have been at outbreak levels on the Yakima Indian Reservation, in south-central Washington, since 1987. The defoliation was starting to cause topkill and understory tree killing.

The Branch of Forestry of the US Department of Interior, Bureau of Indian Affairs Yakima Agency (BIA), requested the USDA Forest Service, Forest Pest Management staff of the Pacific Northwest Region (USFS) to evaluate the outbreak in 1989 to help determine if a suppression project was needed to protect threatened forest resources. Biological evaluation of the outbreak revealed populations were high enough to meet treatment thresholds historically used to warrent suppression efforts in the Pacific Northwest.

The Tribal Council of the Yakima Nation passed Resolution T-24-90 requesting and authorizing the USFS, in cooperation with the BIA, and the Tribal Council, to suppress the outbreak. The resolution specified that only water-based formulations of insecticides containing Bacillus thuringiensis variety kurstaki (BT) could be aerially applied on the reservation.

The BIA prepared a site-specific Environmental Assessment (EA), "Western Spruce Budworm Management on the Yakima Indian Reservation During 1990." The EA was tiered to the USFS programmatic Environmental Impact Statement, "Management of

Western Spruce Budworm in Oregon and Washington." The alternative selected in the EA was to suppress the outbreak with BT. A Finding of No Significant Impact was signed by the Yakima Agency Superintendent of the BIA and the USFS Regional Forester.

This report describes the objectives, location, organization, equipment and supplies, procedures, and results of the 1990 Yakima Indian Reservation western spruce budworm suppression project.

OBJECTIVE

The project objective was to safely and efficiently reduce the western spruce budworm population within the treatment areas to levels which would not cause unacceptable resource damage for a minimum of four years following insecticide application.

PROJECT AREA DESCRIPTION

The suppression project was carried out in mixed fir stands on the southern portion of the Yakima Indian Reservation (Figure 1). There were three Analysis Units (AU), Signal Peak, East Simcoe, and West Simcoe. Signal Peak AU extended approximately 13 miles east from Signal Peak. Total area was 27,418 acres. East Simcoe AU extended from the southern boundary of the reservation at Simcoe Mountain northward to McKay Butte. It contained 21,848 acres. West Simcoe AU reached from McKay Butte southward to Grayback Mountain. This AU had 22,006 acres. Total area in the analysis units was 71,272 acres.

Tree species composition in the project area included stands of nearly pure Douglas-fir, nearly pure grand fir, mixed Douglas-fir and true fir, pine and fir mixes, and nearly pure pine. Pine stands with less than 25 percent budworm host type and non-forested openings were excluded from treatment, if they were larger than 20 acres.

Elevations ranged from 2,500 to 5,500 feet above sea level. The terrain in the majority of the project area was characterized by gentle slopes and broad flat expanses. There were few deeply dissected valleys.

The majority of the area treated, 65,875 acres, was Indian-owned. The remaining 4,952 acres were held by 10 separate non-Indian owners.

The analysis units were divided into 61 spray blocks based on topography, elevation, and presence of spruce budworm host trees.

PROJECT ORGANIZATION

An Incident Command System organization, modified to fit the needs of a forest defoliator suppression project, was used to manage the project. The organization is dis-

played in Figure 2. A total of 55 USFS, BIA, Bureau of Land Management, Tribal, and Champion International personnel worked on the project. All government personnel working on the project were resource ordered through the interagency Northwest Coordination Center. Tribal employees working on entomology crews were hired by the Yakima Nation personnel department for the project. Other Tribal employees were detailed to the project from the Tribal Fire Control staff. The contractor had 20 employees on site.

CONTRACTOR

Aero Tech Incorporated from Bovina, Texas, was the prime contractor. P.J. Helicopters, from Red Bluff, California, subcontracted with Aero Tech for all helicopter services.

The USFS used a Request For Proposals (RFP) to solicit, negotiate, and award the contract. Items contracted for were application aircraft and support equipment and personnel, sufficient Bacillus thuringiensis insecticide to spray 67,000 acres, marking of project block boundaries, observation helicopters carded to transport government employees, and up to 50 hours of administrative flights in the observation helicopters.

The USFS specified that any of four commercially available BT products could be used on the project. The four products approved by the USFS were Thuricide 32LV, Thuricide 48LV, Dipel 6AF, and Foray 48B. All application was to be at the rate of 16 BIU per acre, undiluted. For all products except Thuricide 32LV this equated to a volume of 1/3 gallon per acre. Thuricide 32LV would have to be applied at 1/2 gallon per acre.

Six aerial application contractors responded to the RFP with technical and price proposals. Aero Tech was awarded the contract on the basis of the strenght of the technical approach and price. The price per acre was $10.68.

Aero Tech provided 3 Air Tractor 400 airplanes and 2 UH1B-204 helicopters for application aircraft, 2 Bell 206s and 2 Hughes 500s for observation helicopters, and support personnel and equipment. One of the 204 helicopters was badly damaged in a crash and was replaced by a Bell 206 equipped for spraying. Aero Tech used Thuricide 48LV.

FACILITIES AND EQUIPMENT

A 5,300 square foot building, located in Union Gap, Washington, was rented for four months to serve as the project headquarters. Telephones and the USFS Data General computer system were installed.

A large quantity of supplies needed to conduct the project was resource ordered from the Forest Pest Management suppression cache at the Redmond Air Center. All sup-

plies were delivered in good condition in a 40 foot trailer. Several incidental supplies were purchased locally. A radio system was ordered from the Boise Interagency Fire Center.

Aero Tech leased a privately owned airstrip and hanger at White Swan, Washington. All aerial activity was staged from this facility.

A total of 23 government vehicles was used on the project. Most were leased 4X4 pick-ups.

Geographic information system equipment owned by the Yakima Tribe and the BIA was used on the project to produce most maps and track progress. An ARC-INFO computer program was used for this purpose. This system was capable of producing maps of any scale. Data layers used for the project included legal location descriptions, USGS 7.5 minute quadrangle map designations, 1989 budworm defoliation extent and severity, forest types, ownership, roads, streams, analysis unit and spray block boundaries, plot locations, helispots, and daily spray accomplishments by type of aircraft. Maps were produced for several different activities by manipulating the data layers to include only those needed for the specific activities. It was used to calculate acreages in spray blocks. As many as four colors were used for the maps. This system was outstanding.

SPRAY OPERATIONS

Spray blocks were designated as helicopter treatment only or treatment by either helicopter or single engine airplane. This was done in the fall of 1989 before the RFP was advertised. The basis for aircraft assignment was safety, probability of successful treatment, and size of blocks.

Spray blocks were marked for treatment by placing bright orange and yellow-green streamers in snags and tall trees along the boundaries. This was done by contractor personnel tossing the markers from helicopters. Ground panels and distinctive ground features were also used to define the blocks.

Spray aircraft were calibrated and characterized at the White Swan airstrip. The Air tractor 400's were calibrated for a 150-foot swath. Their airspeed was 145 MPH. Each was equipped with 8 Micronair AU 5000 mini atomizers. Volume output was 14.6 gallons of BT per minute. Volume median diameter (VMD) for all three Air Tractors was 120 microns. The Bell 204's were also calibrated for a 150-foot swath. Their airspeed was 70 MPH. Each was equipped with 8 Beecomist 360A rotary atomizers. Volume output was 7.1 gallons per minute. VMD for the Bell 204's was 170 to 185 microns. The Bell 206, equipped with 4 Beecomist 360A atomizers, was calibrated for a 100-foot swath. It flew at 70 MPH. Volume output was 4.7 gallons per minute. VMD was approximately 180 microns. All spray aircraft used Crophawk monitors to monitor flow rate of insecticide.

Thuricide 48LV was delivered to the contractor at White Swan in bulk tanker shipments. The USFS provided 715 gallons in barrels left from a previous project. Insecticide was metered as it was off-loaded from the supplier to the contractor's storage and as it was pumped from storage tanks into batch trucks and spray aircraft. The contractor was paid on the basis of gallons of insecticide pumped into spray aircraft and then properly applied.

Application and observation pilots and USFS aerial observers reconned the spray blocks a day prior to their scheduled treatment to familiarize themselves with block features and determine spray strategy.

With only minor exceptions the three Air Tractors flew in tandem formation. They were always accompanied by two observation aircraft. The application helicopters flew both singly and in tandem. They were always accompanied by one observation helicopter.

The following criteria were used to determine if spraying could proceed: wind speed between 1 and 8 MPH; relative humidity greater than 50 percent; temperature between 33 and 70 degrees; spray settling into the trees within 2 minutes; and no rain predicted within 6 hours.

Weather forecasts were obtained for individual spray blocks the afternoon prior to their scheduled treatment. Spot forecasts were provided by the National Weather Service Office in Wenatchee, Washington.

Ground-based observers were used to monitor weather in the spray blocks the morning the blocks were scheduled for spraying. Wind speed, wind direction, temperature, and relative humidity were measured and radioed to the aircraft staging area. Weather measurements were made starting at 3:45 AM and continued for at least 30 minutes after application was completed for the block.

Ground observers placed white Kromekote cards in many of the spray blocks to monitor spray deposit. Several cards were placed in lines perpendicular to the flight paths of the application aircraft. An attempt was made to place the cards at least one full tree height away from trees. All cards were laid on the ground. The cards were examined, generally the same day, for deposit.

Spray blocks had to be sprayed within 72 hours of being released or they would be withdrawn for resampling. Only one block had to be resampled.

Application and observation pilots, and aerial observers were briefed each morning spraying was scheduled. Block assignments were reviewed. Weather conditions in the blocks were described. Schedule of departure from the airstrip and travel route for each aircraft were discussed. Radio frequency assignments were checked. An aircraft safety message was presented every day by the air operation director. All aircraft were flight-followed constantly. All aircraft were required to have their status reported to the radio dispatcher at least once every 15 minutes.

The gross acres, proposed treatment acres, gallons of insecticide applied, and actual treatment acres were determined for each spray block.

ENTOMOLOGY OPERATIONS

The entomology work was divided into three activities: early larval density sampling; larval and tree development assessment; and post-spray population sampling.

Early larval density sampling was done to determine if the western spruce budworm populations in the three analysis units were high enough to meet the treatment criteria of at least 6 larvae per 45 CM branch tip. A total of 119 sample plots were established in the project area. The sample plots were used for both early larval density and post-spray sampling. Three open grown, full crown Douglas-firs or grand firs, 20 to 35 feet tall, with bud bearing branches at mid-crown were selected for early larval density sampling. Only one tree species was selected at each plot. One 45 CM long mid-crown branch tip was clipped from each tree with a telescoping pole pruner. Sample branches were examined for budworm larvae in the laboratory. Early larval density averages for spray blocks and analysis units were calculated by using the WESTBUDS program.

Spruce budworm larval development and host tree foliage development were monitored to time release of the spray blocks for treatment. The criteria for release were less than 15 percent of the budworm larvae were to be in the 2nd and 3rd instars, and at least 95 percent of the new shoots had to be unfurled. This activity was accomplished by entomologists and crew leaders with at least 2 years of previous experience in releasing spray blocks. They travelled throughout the spray blocks, making numerous stops to monitor insect and tree development.

Post-spray population sampling did not begin until at least 13 days had passed after each block had been sprayed. Three trees with the same characteristics as those used for early larval density sampling were used at each sampling plot. The post-spray population was estimated by lower crown beating. Three branches with new shoots exposed to sunlight were sampled on each tree. A 2'X4' white canvas cloth stretched on an aluminum frame was held under the outermost 45 CM of the branch while the branch was struck repeatedly with a beating stick to dislodge larvae and pupae. Western spruce budworm larvae and pupae and larvae of other lepidopterous insects were tallied.

SPRAY ACCOMPLISHMENTS

Spray block data are displayed in Tables 1 and 2 (Appendix). All blocks scheduled for treatment got sprayed. Spraying began on June 20 and was completed on June 29. Only one day was not suitable for spraying, due to high winds.

The Air Tractors sprayed 52,572 acres. They averaged 911 acres per hour per airplane.

The helicopters sprayed 18,255 acres. The Bell 204 averaged 415 acres per hour. The Bell 206 averaged 401 acres per hour.

Thirty six spray card lines, with a total of 814 cards, were placed in 29 spray blocks. Cards were given a rating corresponding to the number of drops per square centimeter. Ratings were 0 = no drops, 1 = 1-5 drops, 2 = 6-14 drops, 3 = 15+ drops. Two of the cardlines had no deposit on any of the cards. The mode rating was 2 for all cards. Percentage of cards in the rating catagories was as follows: rating 0 = 9.2%; rating 1 = 31.2%; rating 2 = 35.6%,;and rating 3 = 24%. Deposit ratings were slightly better for cards placed in the fixed-wing treated blocks than those in the helicopter sprayed blocks.

One Bell 204 crashed and was extensively damaged while it was departing a helispot. The cause of the crash has been tentatively attributed to mechanical failure of the engine when an oil line became disconnected and the oil reservoir ran dry. The pilot was not injured in the crash. The insecticide tank ruptured in the crash and spilled 231 gallons of BT. The BT was immediately contained with dirt berms and later worked into the soil. The nearest stream was approximately 1/2 mile from the crash site. The crash was investigated by a USFS aircraft accident investigation team. There were no other aircraft accidents or insecticide spills.

ENTOMOLOGY SAMPLING RESULTS

Early larval density and post-spray western spruce budworm population averages are displayed by analysis units, spray blocks, and sample plots in Tables 3, 4, and 5 (Appendix). Budworm populations in the Yakima Indian Reservation project area were considerably higher than those encountered in other recently conducted budworm suppression projects in the Pacific Northwest.

A total of 119 sample plots were established. The early larval density averaged 29.5 budworm larvae per 45 CM branch tip for the grand fir plots and 23.4 per branch for the Douglas-fir plots. Early larval density averaged 27.3 per branch for all plots.

Early larval densities and post-spray densities were compared for helicopter and fixed-wing treated blocks to determine if one type of aircraft may have provided more effective control. Early larval density for the helicopter treated blocks averaged 30.7 larvae per mid-crown branch tip, while early larval density for the fixed wing blocks averaged 25.5 insects. Post-spray budworm density for the helicopter treated blocks averaged 1.4 insects. Post-spray density for the fixed-wing blocks averaged 1.0 insects. The population was reduced 95.6 percent in the helicopter treated blocks and 96.2 percent in the fixed wing treated blocks.

BUDGET

Cost of the project was $1,087,544. Breakdown of costs are shown in Table 6. Cost per treated acre averaged $15.35. All costs of treating Indian-owned lands were paid by the Federal government. Costs of treating 3,850 acres of industry-owned stands were cost-shared, with the Federal government paying 1/3 of the cost, the remainder being paid by the landowners.

DISCUSSION

Excellent population reduction of western spruce budworm was achieved on the project. Overall, the population declined by 96.5 percent from the early larval density sampling to the post-spray sampling. Most of this reduction is attributable to the spraying. There were no obvious indications of a natural population collapse. The Signal Peak analysis unit, in particular, showed indications of a building population, because the severity and extent of defoliation increased dramatically from 1988 to 1989.

Western spruce budworm populations in the project treatment area have been reduced to levels where recovery of the defoliated trees can begin in 1991.

There were many reasons for the successful population reduction. Spray blocks were released for treatment when the insects were at the optimum stage of vulnerability to the insecticide. Aero Tech used excellent application equipment and highly skilled pilots to achieve very good deposit of Thuricide 48LV. Thuricide 48LV worked very well. The project operations personnel were highly experienced and made sure spraying was done under proper conditions and evenly over the entire project area.

There was no substantive difference between the Air Tractors and the helicopters in the degree of population reduction achieved. The Air Tractors were more than twice as productive in acres treated per hour than the helicopters. Spray deposit appeared to be slightly better with the Air Tractors than the helicopters.

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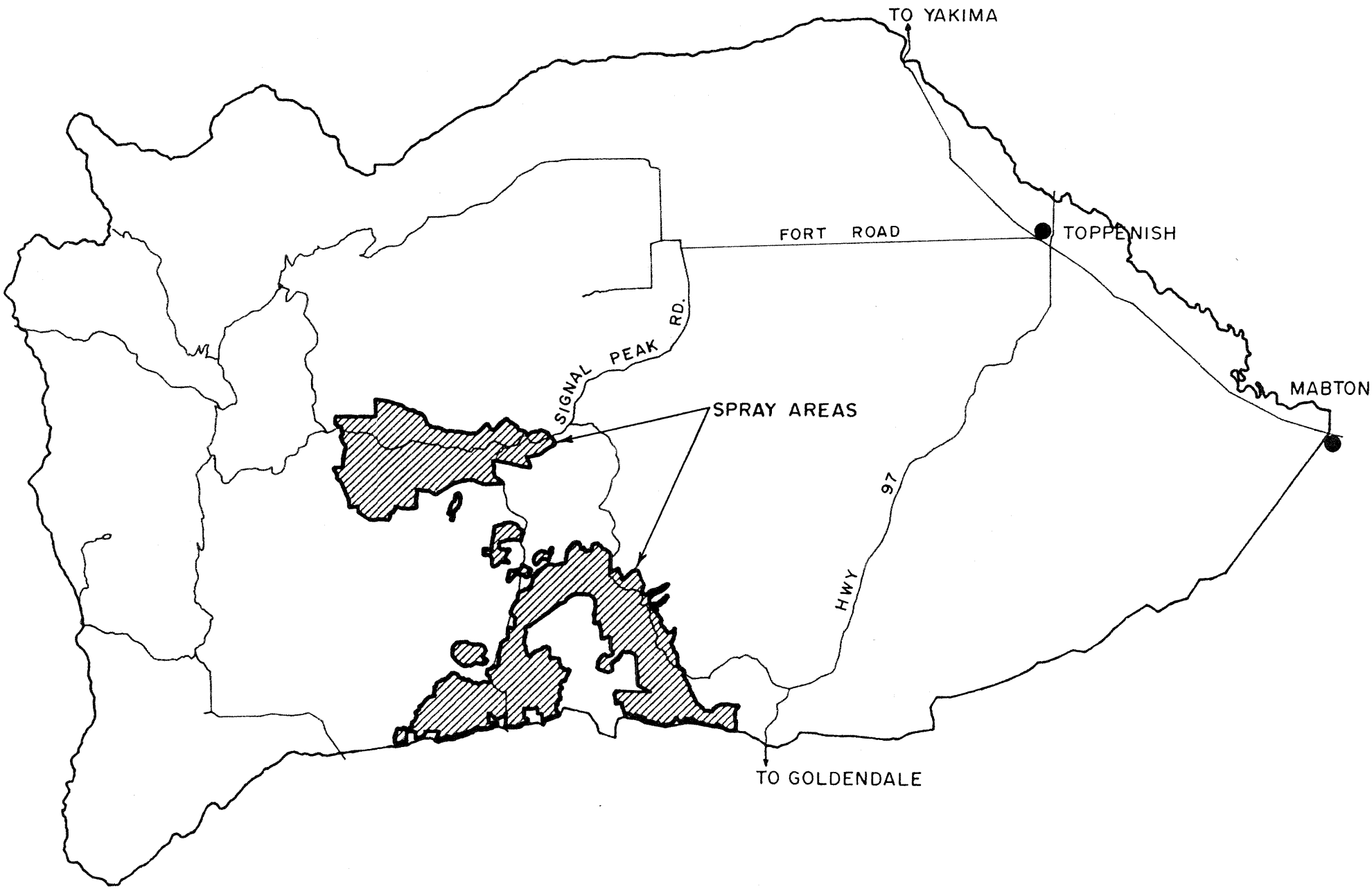

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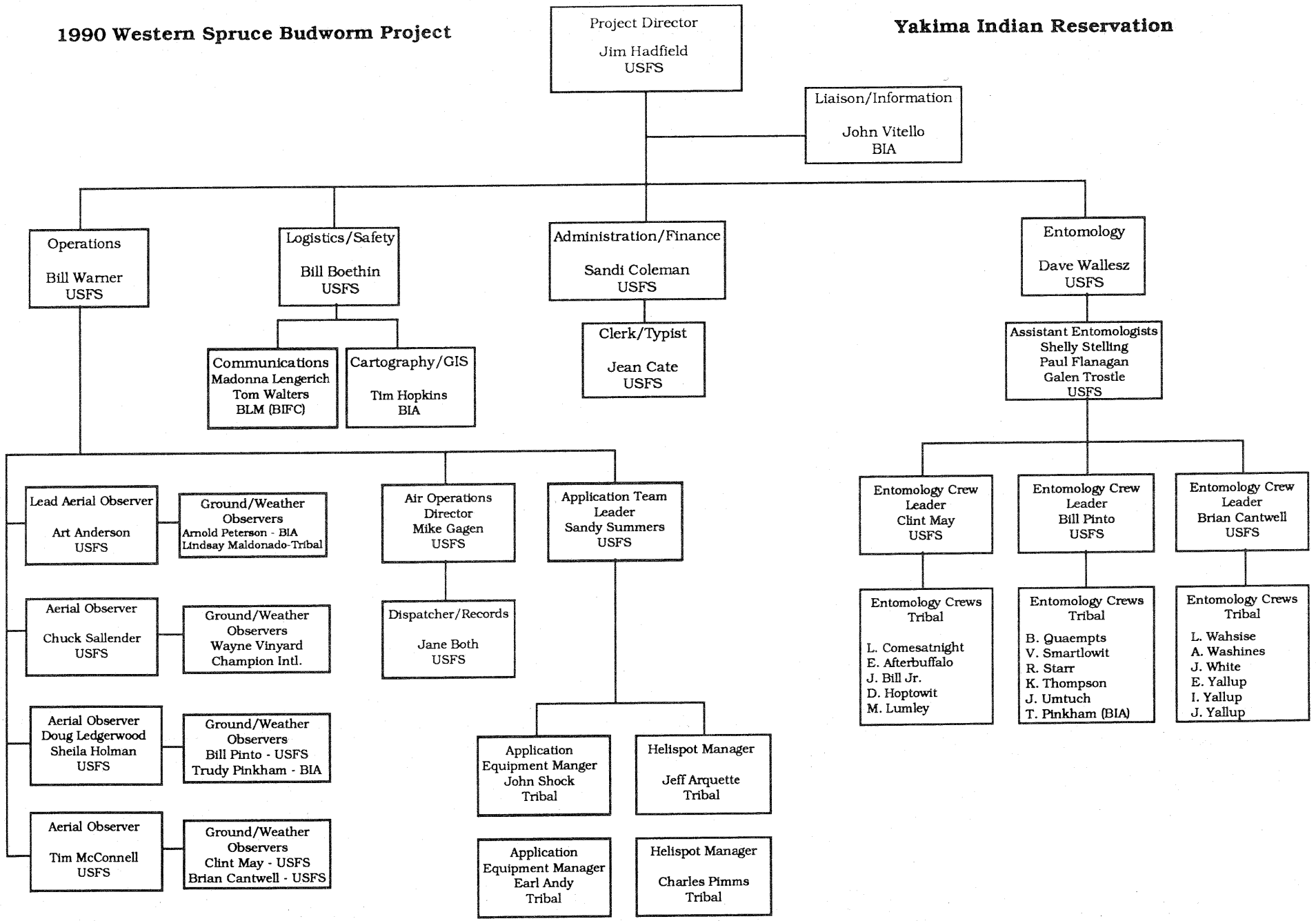

APPENDIX

Table 1:

Western Spruce Budworm Project, Yakima Indian Reservation, Signal Peak Analysis Unit, Treatment Block Information.

BLOCK NO.	GROSS ACRES	TREATMENT ACRES	GALLONS 48LV	GALLONS APPLIED	ACRES TREATED
P-H2	526	526	175	175	525
P-H4	633	633	211	211	633
P-H7	951	951	317	317	951
P-H8	533	533	178	178	534
P-H13	288	288	96	95	285
Helicopter Total acres:	2928				
P-F1	3463	3463	1154	1292	3876
P-F3	2657	2657	886	743	2229
P-F5	1378	1378	459	combined with F6	
P-F6	2247	2247	749	1100	3300
P-F9	2429	2405	802	836	2508
P-F10	2049	2024	675	651	1953
P-F11	2378	2347	782	837	2511
P-F14	2165	2165	722	752	2256
P-F15	5801	5801	1934	1949	5847
Fixed-wing Total acres:	24480				
Grand total:	27408				

Table 2:

Western Spruce Budworm Project, Yakima Indian Reservation, Simcoe East and West Analysis Units, Treatment Block Information.

BLOCK NO.	GROSS ACRES	TREATMENT ACRES	GALLONS 48LV	GALLONS APPLIED	ACRES TREATED
S-H1	1547	1547	516	480	1440
S-H2	293	293	98	120	360
S-H3	328	328	109	120	360
S-H8	501	501	167	170	510
S-H13	2624	2624	875	824	247
S-H23	412	412	137	130	390
S-H24	984	984	328	300	900
S-H25	309	309	103	75	225
S-H26	383	383	128	139	417
S-H27	90	90	30	30	90
S-H28	902	902	301	103	309
S-H29	276	276	92	100	300
S-H30	348	348	116	155	465
S-H31	784	784	261	275	825
S-H32	392	392	131	120	360
S-H33	889	889	296	293	879
S-H34	635	635	212	215	645
S-H35	598	598	199	200	600
S-H36	513	487	162	*	
S-H37	316	277	92	*	

(continued)

Table 2 (continued):

Western Spruce Budworm Project, Yakima Indian Reservation, Simcoe East and West Analysis Units, Treatment Block Information.

BLOCK NO.	GROSS ACRES	TREATMENT ACRES	GALLONS 48LV	GALLONS APPLIED	ACRES TREATED
S-H38	352	352	117	110	330
S-H39	496	496	165	160	480
S-H40	474	474	158	*	
S-H41	336	336	112	*	
S-H42	513	468	156	90	270
S-H43	705	551	184	*	
S-H44	217	165	55	*	
S-H46	313	313	104	95	285
S-H47	637	637	212	75	225

Helicopter * Satus complex total gallons = 730 2190 ac.
Total acres: 15327

BLOCK NO.	GROSS ACRES	TREATMENT ACRES	GALLONS 48LV	GALLONS APPLIED	ACRES TREATED
S-F4	3015	3015	1005	1022	3066
S-F5	844	844	281	275	825
S-F6	2171	2171	724	715	2145
S-F7	3518	3518	1173	1295	3885
S-F9	1211	1211	404	404	1212
S-F10	1087	1087	362	355	1065
S-F11	1429	1429	476	470	1410
S-F12	1341	1341	447	539	1617

(continued)

Table 2 (continued):

Western Spruce Budworm Project, Yakima Indian Reservation, Simcoe East and West Analysis Units, Treatment Block Information.

BLOCK NO.	GROSS ACRES	TREATMENT ACRES	GALLONS 48LV	GALLONS APPLIED	ACRES TREATED
S-F14	1862	1862	621	621	1863
S-F15	921	921	307	307	921
S-F16	1187	1187	396	396	1188
S-F17	958	958	319	319	957
S-F18	928	928	309	339	1017
S-F19	801	801	267	325	975
S-F20	1757	1757	586	598	1794
S-F21	1227	1227	409	409	1227
S-F22	2171	2171	724	723	2169
S-F45	575	575	192	252	756

Fixed-wing
Total acres: 28092

Simcoe acres: 43419

Signal A.U. Acres: 27408
Simcoe A.U. Acres: 43419

Grand Total Acres: 70827

Table 3:

Western Spruce Budworm Early Larval and Post-spray Population Densities for the Signal Peak Analysis Unit.

Spray Block	Plot	Early Larval Density*	Post-spray Density**
P-F1	19	18.3	1.0
	20	7.0	0.9
	21	4.0	0.2
	22	87.7	0.1
	23	55.7	0.7
	36	8.0	1.6
	37	14.7	0.4
Block Mean		27.9	0.97
P-H2	24	6.3	0.0
	25	7.3	0.6
	26	34.0	0.9
Block Mean		15.9	0.5
P-F3	27	26.7	0.8
	28	40.3	0.9
	29	39.3	NS*
	30	8.7	0.0
	31	11.0	0.6
	40	27.3	NS
Block Mean		25.6	0.6
P-F6	11	62.3	0.3
Block Mean		62.3	0.3
P-H7	7	6.3	0.2
Block Mean		6.3	0.2
P-F9	3	16.3	0.1
	5	111.7	1.1
	6	67.7	3.7
Block Mean		65.2	1.6
P-F10	1	0.0	0.1
	2	1.7	0.4
	4	13.0	NS
Block Mean		4.9	0.25

(continued)

Table 3 (continued):

Western Spruce Budworm Early Larval and Post-spray Population Densities for the Signal Peak Analysis Unit.

Spray Block	Plot	Early Larval Density*	Post-spray Density**
P-F11	9	70.3	0.2
	10	56.0	0.4
	32	14.3	1.9
Block Mean		46.9	0.9
P-H13	35	9.3	0.1
Block Mean		9.3	0.1
P-F14	12	52.3	0.0
	13	9.7	0.3
	14	10.3	0.4
	15	41.0	0.0
	39	9.7	0.6
Block Mean		24.6	0.3
P-F15	16	19.3	0.2
	17	9.7	0.1
	18	41.7	0.8
	33	8.3	0.1
	38	31.3	0.0
Block Mean		22.1	0.2
Analysis Unit Mean		27.2	0.56

* Average of 1 branch for each of 3 trees
** Average of 3 branches for each of 3 trees

Table 4:

Western Spruce Budworm Early Larval and Post-spray Densities for the Simcoe West Analysis Unit.

Spray Block	Plot	Early Larval Density*	Post-spray Density**
S-H1	6	23.0	0.9
	7	41.7	0.7
Block Mean		32.3	0.8
S-H2	8	25.3	0.6
Block Mean		25.3	0.6
S-H3	10	10.3	2.4
Block Mean		10.3	2.4
S-F5	40	38.0	0.7
Block Mean		38.0	0.7
S-F6	9	9.7	0.3
	39	20.0	0.6
Block Mean		14.8	0.4
S-F10	1	18.0	0.6
	2	26.3	8.6
Block Mean		22.2	4.6
S-F11	3	14.7	2.8
	4	33.0	2.0
	5	29.0	1.8
Block Mean		25.6	2.2
S-F12	11	54.0	0.3
	16	14.7	0.7
Block Mean		34.3	0.5
S-F18	15	6.7	1.8
	17	10.0	2.6
Block Mean		8.3	2.2

(continued)

Table 4 (continued):

Western Spruce Budworm Early Larval and Post-spray Densities for the Simcoe West Analysis Unit.

Spray Block	Plot	Early Larval Density*	Post-spray Density**
S-F19	14	10.7	0.2
	20	12.7	1.8
Block Mean		11.7	1.0
S-F20	12	15.3	1.2
	13	9.0	0.6
Block Mean		12.2	0.9
S-F21	23	4.7	0.8
	24	37.3	1.3
	25	8.7	1.2
Block Mean		16.9	1.1
S-F22	27	58.3	4.4
	28	48.3	1.2
	36	18.3	0.7
Block Mean		41.7	2.1
S-H23	37	53.0	6.3
Block Mean		53.0	6.3
S-H24	19	19.3	2.4
	29	4.3	1.2
	30	94.3	2.8
Block Mean		39.3	2.1
S-H26	26	7.0	0.1
Block Mean		7.0	0.1
S-H28	38	48.3	NS
Block Mean		48.3	NS
S-H29	33	45.7	0.4
	35	61.0	1.0
Block Mean		53.3	0.7

(continued)

Table 4 (continued):

Western Spruce Budworm Early Larval and Post-spray Densities for the Simcoe West Analysis Unit.

Spray Block	Plot	Early Larval Density*	Post-spray Density**
S-H30	21	74.3	1.0
	22	80.3	2.6
Block Mean		77.3	1.8
S-H31	34	44.0	0.7
Block Mean		44.0	0.7
S-H33	18	15.3	0.9
	31	17.3	2.9
	32	10.0	2.4
Block Mean		14.2	2.1
Analysis Unit Mean		29.3	1.7

* Average of 1 branch for each of 3 trees
** Average of 3 branches for each of 3 trees

Table 5:

Western Spruce Budworm Early Larval and Post-spray Densities for the Simcoe East Analysis Unit.

Spray Block	Plot	Early Larval Density*	Post-spray Density**
S-F4	2	9.7	0.0
	6	18.3	0.6
	16	26.0	0.6
	17	50.7	0.0
	18	45.3	0.1
Block Mean		30.0	0.2
S-F7	1	13.7	0.1
	3	18.7	0.7
	4	5.3	
	5	44.7	
	37	7.7	0.4
Block Mean		18.0	0.3
S-F9	26	17.0	0.0
Block Mean		17.0	0.0
S-H13	29	34.0	0.0
	31	14.3	0.0
Block Mean		24.2	0.0
S-F14	7	25.0	0.2
	32	11.0	0.1
	36	14.7	0.4
Block Mean		16.9	0.3
S-F15	27	36.3	0.0
	28	57.3	0.1
	30	36.0	0.3
	34	10.0	0.3
Block Mean		34.9	0.2
S-F16	8	3.0	2.0
	12	4.3	2.0
	35	5.7	0.2
Block Mean		4.3	1.4

(continued)

Table 5 (countinued):

Western Spruce Budworm Early Larval and Post-spray Densities for the Simcoe East Analysis Unit.

Spray Block	Plot	Early Larval Density*	Post-spray Density**
S-F17	9	15.0	1.6
	11	4.7	1.6
	15	17.3	1.0
Block Mean		12.3	1.4
S-H35	38	13.0	NS
	39	9.0	0.2
Block Mean		11.0	0.2
S-H36	24	41.0	4.0
Block Mean		41.0	4.0
S-H37	14	27.3	2.0
	25	42.7	0.0
Block Mean		35.0	1.0
S-H38	20	32.3	1.2
	21	20.7	1.0
Block Mean		26.5	1.1
S-H39	10	77.7	3.7
	13	26.3	0.9
	33	21.7	0.7
Block Mean		41.9	1.7
S-H41	22	12.7	0.0
	40	38.3	0.0
Block Mean		25.5	0.0
S-H42	19	24.5	1.1
Block Mean		24.5	1.1
S-H43	23	40.7	4.2
Block Mean		40.7	4.2
Analysis Unit Mean		24.3	0.8

* Average of 1 branch for each of 3 trees
** Average of 3 branches for each of 3 trees

Table 6:

Budget for the 1990 Yakima Indian Reservation Western Spruce Budworm Suppression Project.

Salary USFS	$120,000
Travel USFS	48,000
Tribal and BIA Expenses	60,000
Vehicle Rental	35,000
Fuel	6,400
Project Office	5,800
Application Contract	760,344
Cache Supplies	30,000
Data General	7,500
Telephone	2,500
Miscellaneous Supplies	12,000
TOTAL	$1,087,544