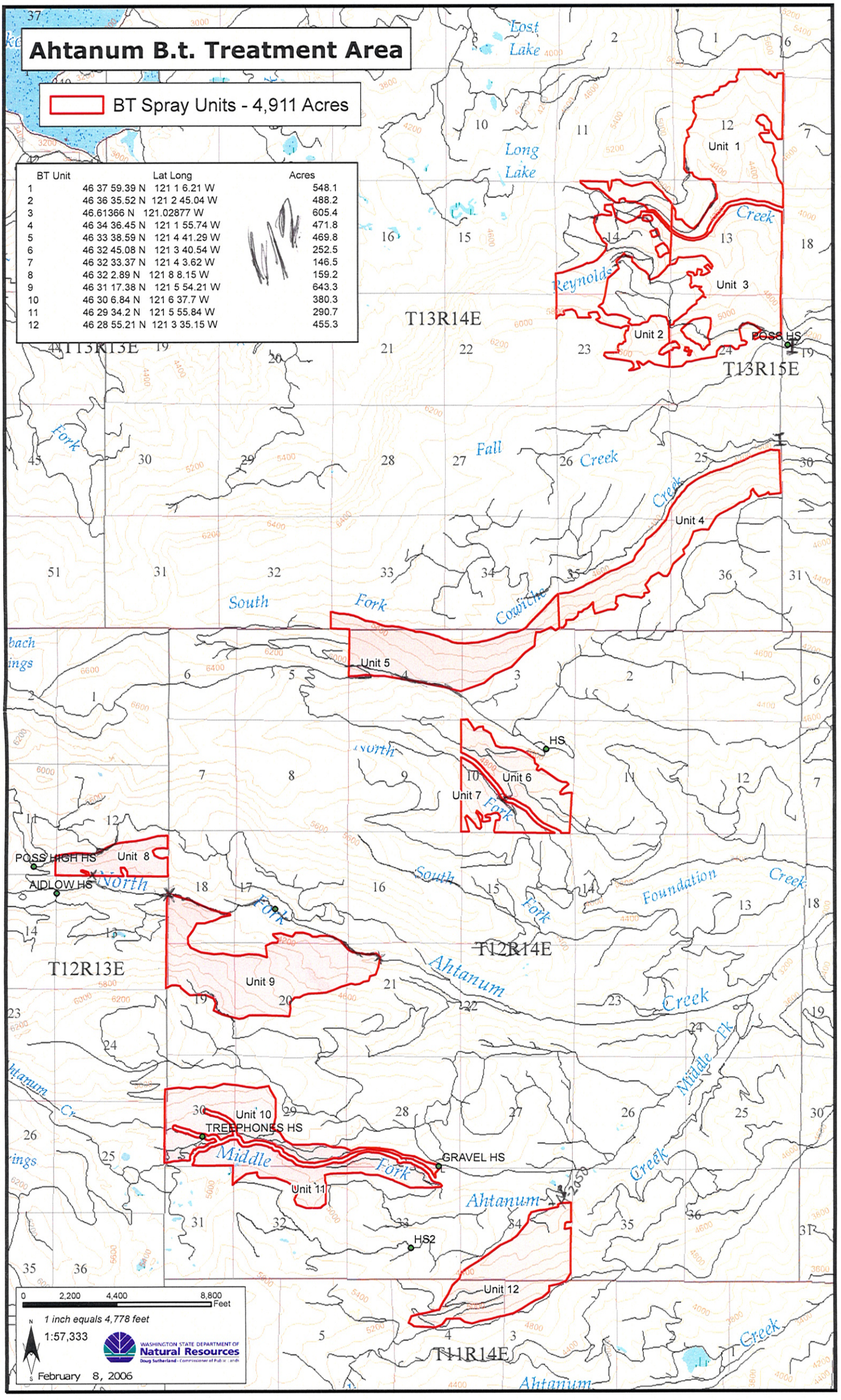
Email message from Karen Ripley (WA DNR), April 22, 2008:

> Here's the "report" on the 2006 budworm treatment in the Ahtanum State Forest. It's made up of a map (sprayblocks.pdf), Evaluation Report (word document), and July2007report (Excel) which are all attached.
>
> Sorry these aren't in a more orderly, combined format.
> This project was run in a pretty low-budget, bare bones fashion. Moreover, the 2006 weather was very cool and it ran much later than we'd planned on. Jeff Moore had to start aerial survey and I left for a vacation trip to Norway on July 1 with instructions for the local folks, "You can't spray the last block for 2 more days!". I then did follow up evaluations one year later (rather than the more desirable 14 days later). So these reports may not hang together really well ... but they are the best that was produced.
>
> If you have questions or note some gaps in the reports, let me know and I'll try to address them.
> Karen

Ahtanum B.t. Treatment Area

BT Spray Units - 4,911 Acres

BT Unit	Lat Long	Acres
1	46 37 59.39 N 121 1 6.21 W	548.1
2	46 36 35.52 N 121 2 45.04 W	488.2
3	46.61366 N 121.02877 W	605.4
4	46 34 36.45 N 121 1 55.74 W	471.8
5	46 33 38.59 N 121 4 41.29 W	469.8
6	46 32 45.08 N 121 3 40.54 W	252.5
7	46 32 33.37 N 121 4 3.62 W	146.5
8	46 32 2.89 N 121 8 8.15 W	159.2
9	46 31 17.38 N 121 5 54.21 W	643.3
10	46 30 6.84 N 121 6 37.7 W	380.3
11	46 29 34.2 N 121 5 55.84 W	290.7
12	46 28 55.21 N 121 3 35.15 W	455.3



Date: July 18, 2007
Subject: Western Spruce Budworm Ahtanum B.t. Treatment Evaluation
To: Eric Watrud
From: Karen Ripley

In mid- to late-June 2007, Jeff Hubert (Research Technician) and I evaluated western spruce budworm populations in the Ahtanum State Forest in order to gain insight into the efficacy of the 5,000 acre B.t. treatment that occurred in 2006. We collected mid-crown branch samples (2 per tree) from two host trees (usually Douglas-fir and grand fir) on 16 plots within treatment areas and 7 plots untreated "control" areas. The data were evaluated separately based on general basin (Reynolds Creek, Foundation Creek, North Fork, and Middle Fork). No samples were collected in the Cowiche Creek area (Spray units 4 and 5) in 2007 due to time limitations and relative inaccessibility of the treated stands.

Cautions:

- This is not an extremely high number of samples.
- A one-year delay between the B.t. application and the evaluation sampling increases the chance that outside factors (weather, budworm immigration, predator movements) are contributing to population changes in addition to the effects of treatment. (On the bright side, the one year delay does reduce underestimation of the B.t. efficacy potentially caused by sub-lethal effects of B.t. that ultimately prevent successful budworm reproduction).
- The 2007 evaluation branches were not taken from exactly the same trees as the 2006 population estimates were derived from. The 2006 pre-spray population estimates were based on approximately 3-4 times as many samples as the 2007 post-treatment and untreated "control" population estimates.
- Budworm population data were not collected on untreated "control" sites in 2006.
- Assuming that the untreated "control" sites had the exact same budworm populations in 2006 as the treated sites isn't iron-clad. Although effort was made to select "control" sites that were similar to the treated sites, in many cases the structure and composition between treated and untreated "control" sites was not uniform and could cause inequality in budworm populations.
- The untreated "control" sites were in close proximity to treated sites, but were hopefully not so close that B.t. drift was likely a factor in budworm population changes.

Results:
An Excel spreadsheet (different document) is provided with evaluation plot data. Latitude and longitude of plot locations are available, but not included in this spreadsheet in order to make it fit on one legal-size page.

In all four treatment areas, budworm populations on the treated sites declined significantly (from 76% to 90%) between 2006 (pre-B.t. application) and 2007. Many years ago, forest entomologists established 4.0 larvae per 17-inch branch as the western spruce budworm "treatment threshold". This is an estimate of the lowest population level

that is worth treating, i.e. enough damage can be prevented to equal or exceed cost of the treatment.

In three of four treatment areas (Foundation Creek, North Fork, Middle Fork), budworm populations in 2007 were below the treatment threshold of 4 larvae per 17 inch branch (down from 18.86, 27.18, and 16.39 larvae per 17-inch branch respectively in 2006). At one site (Reynolds Creek) the 2007 population was near the treatment threshold (4.7 larvae per 17-inch branch, down from 19.84 larvae per 17-inch branch in 2006).

Budworm populations on all four areas were lower on treated plots than nearby untreated "control" plots. Budworm populations on untreated "control" plots in two areas (Reynolds Creek, Middle Fork) declined significantly (62% or 77%, respectively) between 2006 and 2007. In the North Fork and Foundation Creek, budworm populations on untreated "control" plots increased by 13% or 35%, respectively, between 2006 and 2007.

Conclusions:
The B.t. spray project contributed to budworm declines in the Ahtanum State Forest between 2006 and 2007. During the June visits, in most areas tree crowns appeared green with lush, long new growth. Grand fir and subalpine fir severely affected by balsam woolly adelgid often did not re-foliate well in 2007.

The most notable effects of B.t. application were observed in Foundation Creek and the North Fork of Ahtanum Creek where budworm populations were greatly reduced on treated areas but increased on nearby untreated "control" areas. This is consistent with pheromone trapping trends for the North Fork (rising budworm populations predicted in 2007, see Figure 1 Dan Omdal's chart, at the end of this document). No pheromone trapping data are available for Foundation Creek.

In Reynolds Creek and Middle Fork, population changes were not so readily attributable to the B.t. treatment. There could be several causes for these observations:

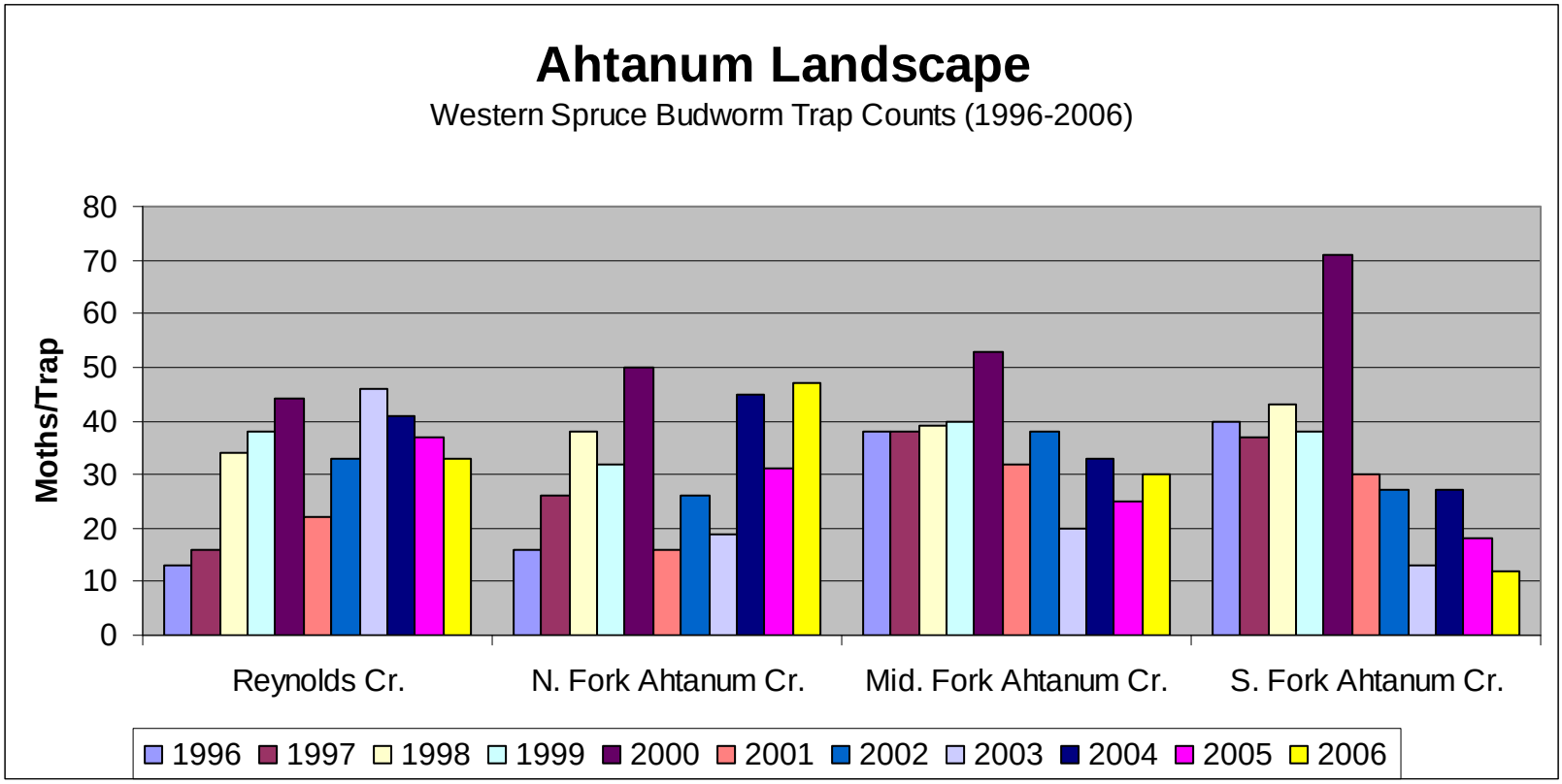
- Insufficient data were collected to accurately identify true patterns between treated and untreated control sites.
- A general budworm decline was occurring, masking the effects of the B.t. treatment. In Reynolds Creek, this is consistent with the last 4 years of annual pheromone trapping conducted by Dan Omdal. He attributes declining budworm populations there to loss of hosts (Douglas-fir and grand fir) due to other pests such as root disease, dwarf mistletoe, balsam woolly adelgid, and bark beetles. The pheromone traps do not indicate a clear budworm population trend in the Middle Fork.
- The untreated "control" plots were poorer quality budworm habitat, always supporting a lower budworm population than nearby treated sites. (That may have been why they were not selected for treatment).
- The untreated "control" plots were influenced by B.t. drift or other unknown factors such as predator immigration when budworm populations were quickly killed on the treated sites.

I believe that the 2006 application of B.t. successfully contributed to reduced budworm populations in treated and adjacent areas. This is a temporary effect on a native insect that will return to defoliate susceptible stands. Although progress is being made, work to alter forest structures, reducing host availability, canopy connectivity for budworm, and the stresses caused by competition, root disease, dwarf mistletoe, and drought must be continued and expanded to provide more durable, sustainable forests throughout the Ahtanum area.

Thanks to the Ahtanum Work Center staff for providing work space to process samples quickly.

Please let me know if you have questions or concerns regarding this report.

Figure 1: Western spruce budworm pheromone trapping data collected by Dan Omdal between 1996 and 2006.



WSB follow-up sampling in Ahtanum June 2007 Karen Ripley July, 2007

Area	Spray Block #	Plot #	Sampled on:	Larvae on GF	Larvae on GF	Larvae on DF	Larvae on both hosts	Average in spray areas	Average in Control	2006 Average in spray areas	% Change from 2006	Notes
Reynolds Creek	1	1	27-Jun-07	3.40		8.70	6.05					
Reynolds Creek	1	2	27-Jun-07	6.18		5.00	5.59	4.70		19.84	-76%	Lower than 2006
Reynolds Creek	2	1	27-Jun-07	4.45		0	2.23					Lower than control areas
Reynolds Creek	3	1	27-Jun-07	4.61		5.2	4.91					Decline in both sprayed and control areas
Reynolds Creek	Between blocks 1 and 2	Control 1	27-Jun-07	6.54		3.44	4.99		7.52		-62%	
Reynolds Creek	Near block 2	Control 2	27-Jun-07	8.02		12.06	10.04					
Cowiche Creek	4, 5			no data		no data	no data		no data	7.4		No data collected in 2007
Foundation Creek	6	1	12-Jun-07	3.23		1.05	2.14					Much lower than 2006
Foundation Creek	6	2	12-Jun-07	4.08		0.96	2.08	1.87		18.86	-90%	Much lower than control areas
Foundation Creek	7	1	12-Jun-07	2.91		1.81	2.36					Population in control areas increased
Foundation Creek	7	2	12-Jun-07	1.06		0.72	0.89					
Foundation Creek	Near block 7	Control 1	12-Jun-07	25.28		25.64	25.46		25.46		35%	
North Fork	8	1	13-Jun-07	6.26		4.00	5.13					Much lower than 2006
North Fork	8	2	13-Jun-07	3		0.88	1.94	2.62		27.18	-90%	Much lower than control areas
North Fork	9	1	13-Jun-07	1.58		0.00	0.79					Population in control areas increased
North Fork	Near block 8	Control 1	13-Jun-07	23.29		62.80	43.04		30.73		13%	
North Fork	Between blocks 8 and 9	Control 2	13-Jun-07	25.79		11.07	18.43					
Middle Fork	10	1	26-Jun-07	5.48	4.38		4.93					
Middle Fork	10	2	26-Jun-07	3.09		1.15	2.12	2.92		16.39	-82%	Lower than 2006
Middle Fork	11	1	26-Jun-07	0		0.00	0.00					Lower than control areas
Middle Fork	11	2	26-Jun-07	5.51		6.18	5.84					Decline in both sprayed and control areas
Middle Fork	12	1	26-Jun-07	3.4		0.00	1.70					
Middle Fork	Near block 10	Control 1	26-Jun-07	7.42		3.73	5.58		3.82		-77%	
Middle Fork	Near block 12 (Red Saddle	Control 2	26-Jun-07	0		4.12	2.06					