2006 JACK PINE BUDWORM SUPPRESSION PROJECT DATA REVIEW

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From June 1 to June 10, the Ontario Ministry of Natural Resources under the direction of Bill Moody, conducted a suppression project on 105,426 hectares. Foray 76B was applied at a rate of either 1.5 liters per hectare (dose of 30 billion international units (BIU)) or 3 liters per hectare (60 BIU) based on insect population levels. The primary contractor was Supermarine Aircraft Inc. (Port Burwell, Ontario) providing twelve Dromader M-18, each equipped with eight Micronair AU-5000 rotary atomizers. Forest Protection Limited (Lincoln, New Burnswick) provided two Air Tractor 802, equipped with ten Micronair AU-4000 rotary atomizers. The base of operations was the Fort Frances Airport.

One of the biggest problem associated with projects of this size is management and review of operational data in a timely manner. There is so much data generated in a short time that it can be over whelming. The following is a review of just some of the data collected during the project. This includes some personnel interpretation of the data and suggestions for the future.

PROJECT EQUIPMENT AND DESIGN

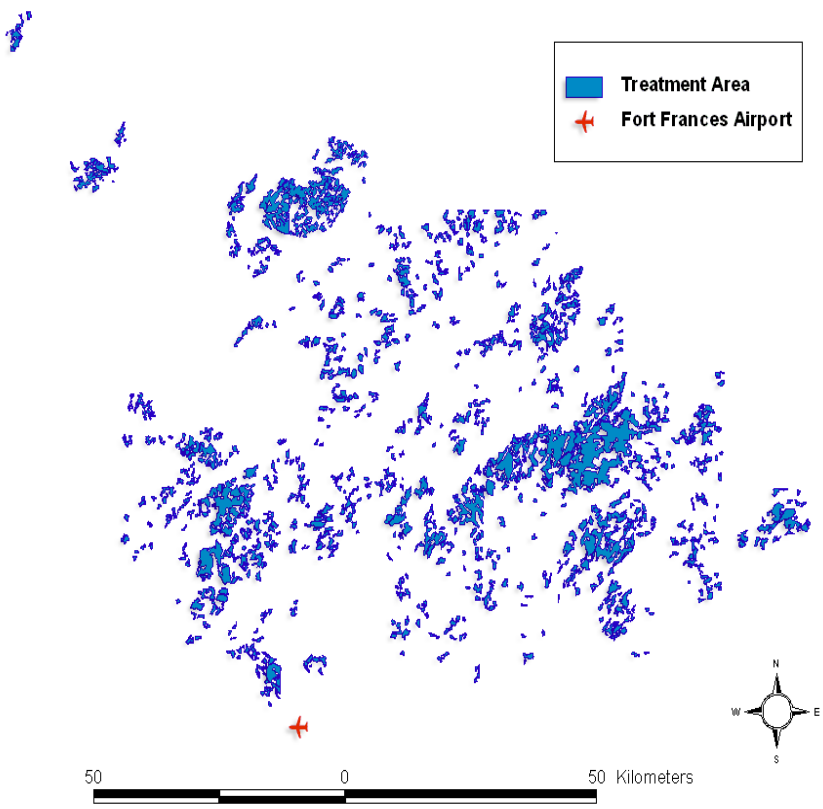
A total of fourteen aircraft were used, each generating flight files and load records often during multiple flights each day. All aircraft were outfitted with Ag-Nav GPS flight guidance and recording systems. The M-18's were calibrated at a swath width of 76 meters and an application speed of 193 KPH for both application rates. The 802 were calibrated at a 100 meter swath width and an application speed of 240 KPH. Six of the M-18's and both of the AT-802's were equipped with auto-flow control that maintained application rates regardless of airspeed.

Treatment blocks were selected from forest stand inventory and a corporate GIS. Selection was based on jack pine stocking and the risk of economic loss from defoliation. The stand boundaries were used to establish treatment block boundaries.

The use of meticulously digitized stand boundaries and the limitations of the GPS guidance systems created problems in operations. Ag-Nav treatment blocks were limited in the number of vertices they could contain. When blocks were grouped as projects for efficiency of treatment, even fewer vertices per block were allowed.

Small exclusion areas, such as open water were included. It is difficult for pilots to turn on and off over small openings. An aircraft traveling at 193 kph, covers 54 meter per second. The ability of the pilot to turn on and off based on GPS guidance signal, spray equipment, and human reaction time is not practical. That plus the fact that the spray does not fall directly below the application aircraft makes small exclusion areas impractical. Pilots can also be instructed to shut off over water or non-host type.

Suggestion: ***Determine what is a realistic reaction time for pilot and spray equipment. Convert airspeed (KPH) to meters per second and limit the minimum diameter of exclusion areas to this distance. Three seconds (60 meters for 193 KPH) would be minimal. Auto-booms could also be required for all aircraft.***



Location of treatment areas and relationship to airport.

Blocks should be designed with fewer vertices to accomadate the limitations with some GPS guidance systems. Problems between the new Ag-Nav systems and the older NavView software created problems in producing efficient treatment block design. This often resulted in pilots flying and turning over areas that would later have to be sprayed or only part of the project file being loaded in the aircraft GPS system.

The lengthy ferry distance from the airport to the treatment areas reduced productivity of the aircraft; ferry flights in excess of one hour per load were common. This was one of the reasons for the low production rate for the project. The average daily production rate for all fourteen aircraft was only 1025 hectares per hour, or an average of 73 hectares per hour per aircraft.

Average Aircraft Daily Production Rate by Team - Ha/hr				
	Team 1	Team 2	Team 3	Team 4
June 1	0	220	0	0
June 2	274	576	291	309
June 3	254	320	178	283
June 4	172	429	152	285
June 5	157	215	187	375
June 6	100	175	178	321
June 7	269	229	235	324
June 8	200	128	106	295
June 9	142	157	137	216
Average	192	322	197	314

The adjacent table shows daily production rates by Team and their daily average. Teams 1 - 3 were groups of four Dromader from Supermarine, and Team 4 consisted of the two AT-802's from Forest Protection Limited. Data presented was taken from load record sheets provided by pilots. Some of these data had discrepancies from flight logs and may not be accurate.

Suggestion: ***Projects as large as this should use a full function GIS program at base to manage data. Vendor GPS software should be used to assist daily planning and up-loading treatment areas into aircraft as needed.***

DATA MANAGEMENT

Unreliable load records lead to problems in operation planning. Delays in delivery post-session aircraft flight data resulted in delays in planning for the next day's spray mission. Some of this was due to late evening finishing times.

Pilots for Supermarine were responsible for filling out daily production sheets with liters sprayed and acreage treatment. Often acreage treated, liters applied, and liters remaining were estimates, while some were copies from team members. Comparison of these load records with flight log data showed as much as 10 percent error in recorded liters to actual application. Towards the end of the project, the reported completion hectares from manually recorded load sheets differed by approximately 10,000 hectares from GIS/flight file completion records. These discrepancies were sorted out during the program and records of liters applied versus area treated are accurate and consistent.

Some of the discrepancies arose out of the fact that most of the M-18's returned to the airport with partial loads on-board, especially when they were treating small blocks

in remote locations. The ground crew used a large "dipstick" to estimate the product remaining in the hopper. These estimates were provided to the pilot to adjust his load sheets.

Forest Protection Limited load records for their two aircraft was collected and reported via their loading manager. This reduced the workload of the pilots and was more accurate when compared to actual flight logs.

Suggestion: Daily loading manifest should be collected by Ministry personnel. Loads should be verified from the metered pumps, and completed hectares from aircraft GPS prior to any reloading. Pilots should sign daily load sheets on site and deliver flight data storage media.

Some blocks were left uncompleted and were not finished the following load. Due to the long ferry distances involved it was not cost effective to return to complete the small remaining amount of area.

These incomplete blocks made estimates of remaining untreated areas difficult to calculate. Delays in application may also lead to problems in evaluating effectiveness of the project as some post-treatment sample points may not have been treated.

Management must ensure that this information is shared with the efficacy assessment crews. Large scale individual block maps with flight line overlays would be of value for field crews.

Suggestion: Once started, treatment blocks should be completed prior to aircraft being released to begin new blocks.

OPERATIONS

Pilot performance varied with respect to proficiency in the use of GPS guidance systems. The use of aircraft flight records was used to produce the table below. Cross track error (x-track, measure in meters), the ability to fly the designated track across the block, was collected for individual aircraft for each day and averaged for the

project. Since the swath width for the aircraft, in my opinion, was at a maximum, deviation from the desired flight line would result in poor coverage between flight lines.

Aircraft are listed by order of proficiency in using GPS guidance. Some pilots reported problems in Ag-Nav light-bar function. This may have affected guidance and increased average x-track error.

	Average		
Aircraft	X-Track	KPH	Application Error
FFPL *	3.1	244.8	
GZUE *	3.6	247.5	
GJGH *	3.7	204.9	
GMQK *	4.1	197.1	
GHVZ	4.7	202.1	-4.49
FJGB *	4.8	199.3	
GRBM *	6.2	198.8	
GMVL	6.4	201.5	-4.24
FYSU *	7.6	203.3	
FVYQ	8.4	200.0	-3.51
FYST	8.6	196.4	-1.71
GIZR *	9.4	201.0	
GMVK	12.2	200.7	-3.85
GDEM	12.3	195.4	-1.22

Aircraft with marked with an * had auto flow control installed. Auto flow adjusted applied volume to the desired rate based on groundspeed. These were assumed to work properly. Six aircraft did not have flow control. Based on their average application speed for all blocks and their calibrated airspeed of 193 KPH, an average application error was computed. The negative sign indicates a light application due to higher than calibrated airspeed.

The adjacent table incorporates flight data from the six M-18 aircraft not equipped with the AutoFlow control feature.

Aircraft	Application Error	Total Liters Applied	Surplus Liters
FYST	-1.71	13,400	229
GDEM	-1.22	13,869	169
GMVL	-4.24	11,761	499
GMVK	-3.85	15,235	587
FVYQ	-3.51	12,637	444
GHVZ	-4.49	15,539	698
Total			2,625

Based on the reported liters loaded for these six aircraft, the total surplus in liter was calculated. It is estimated that 2,625 liters were not applied by these aircraft, resulting in an under-application of Foray. In consideration of the total volume of Btk applied, this volume represents a small deviation of less than 0.01 percent. It does however underscore the benefits of flow controllers, even over relatively flat terrain.

Suggestion: ***For aircraft not using flow control, flight records should be examined during operations to insure that aircraft are maintaining calibrated airspeeds. If airspeed is consistently off, the aircraft should be recalibrated.***

Operations often experienced frequent delays due to congestion in the loading area as aircraft waited to be loaded, an additional loading area would have helped. The use of formation flying (in teams of four) also lead to congestion in the loading area as all four aircraft would return at the same time to be refueled and reloaded. With the use of GPS in each aircraft, the need for formation flying should be reviewed.

SAFETY

The only injury reported was a dislocated finger from a loader slipping off a wing. One aircraft was temporarily out of service due to hitting obstacles on the airfield. The operations area was guarded and access to the loading area was controlled. One aircraft had to jettison part of a load during takeoff due to engine performance problems resulting from a bird nest being built in the exhaust manifold. For a project of this size and complexity these were minor occurrences; this speaks well to the emphasis on project safety.

Problems with the recently installed Ag-Nav systems caused some frustration with pilots. On several occasions, aircraft had to return to the airport and land with full loads after flying to the blocks and not being able to load block files. These issues were resolved later in the project, but did create a safety issue.

Fatigue is a leading cause of aircraft accidents. In OMNR's Jack Pine Budworm program spray missions were conducted every day for 11 consecutive days. Based on my experiences in other forest protection programs, it seemed that the duration of this project and length of duty time for all personnel was excessive.

Pilots reported to airfield at 04:30 for the morning session and then again at 17:00 for the evening sessions, often not returning to the hotel until 23:00 hrs. This made for

very short rest periods. The table below show the earliest takeoff and latest landings for each day of the project. Data is missing for June 10 evening session and June 11 final morning session. Additionally, due to accommodation problems from week-end vacation bookings, some of the contractor's personnel had to relocate to other facilities during the program. All of this added to fatigue and posed a possible safety concern.

Starting and Stopping TImes by Project Dates										
SESSIONS	June 1	June 2	June 3	June 4	June 5	June 6	June 7	June 8	June 9	June 10
AM Start		06:13	05:08	04:59	04:53		04:53	04:45	04:46	04:51
AM Stop		10:45	10:25	07:45	09:50		10:55	09:08	08:45	07:55
PM Start	19:00		19:30	19:05		18:54	19:00	17:05	19:00	
PM Stop	20:20		21:30	21:20		21:49	21:55	21:25	21:00	

Suggestion: ***Implement pilot duty time limitations. No pilot should work longer than 6 consecutive days without a day off. Rest days can be staggered among aircraft to avoid closing the project during good spray conditions.***

SUMMARY

This by far has been the largest project I've experienced. Project planning under Dr. Taylor Scarr and project operations under Mr. Bill Moody, provided for a safe, and in my view a successful project. Problems that did occur were minor and primarily associated with the project's size and complexity and newly installed GPS equipment.

Approximately 105,426 hectares, composed of 1323 blocks were treated with approximately 245,000 liters of Foray 76B at two different application rates, within a treatment window of approximately 55 hours, spread out over 11 days by 14 aircraft. The most serious aircraft mishap was partial dump at the end of the runway, and only accident was a dislocated finger. That's pretty impressive.