

**CONFIDENTIAL**



Town of Pelham  
**2021 LDD Moth Aerial Spray Program**  
Summary Report

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## Table of Contents

Introduction .....	1
Program Overview .....	1
Methods.....	2
Spray Timing .....	2
BioSIM Forecasts.....	2
Host Development .....	2
Weather .....	2
Spray Assessment .....	2
Spray Deposit .....	2
Defoliation Surveys .....	3
Results.....	4
Spray Timing .....	4
BioSIM Forecasts.....	4
Host Development and Egg Hatch .....	4
Weather .....	6
Post-Spray Assessment .....	8
Spray Deposit .....	8
Defoliation Surveys .....	9
Conclusion.....	9
Appendix A: Spray block wind, temperature and relative humidity records for Town of Pelham spray days .....	10

## List of Figures

Figure 1. 2021 Town of Pelham LDD moth aerial spray program overview. ....	1
Figure 2. Development plots and weather station locations, 2021.....	3
Figure 3. BioSIM prediction of 90% LDD moth egg hatch in southern Ontario, April 12 2021.....	4
Figure 4. Percent development of red and white oak in development plots, 2021. ....	5
Figure 5. Percent LDD moth egg hatch in development plots, 2021. ....	5
Figure 6. Average wind speed range (km/h) recorded during spray events. Dotted red lines represent optimal parameters.....	7
Figure 7. Average temperature range (degrees Celcius) recorded during spray events. Dotted red lines represent optimal parameters.....	7
Figure 8. Average relative humidity range (%) recorded during spray events. Dotted red lines represent optimal spray parameters. ....	8
Figure 9. ADAM Kit results - amount of Btk on branches sampled from six spray blocks, 2021. ....	8
Figure 10. Percent branches in each defoliation class from ten spray blocks and seven unsprayed sites sampled, 2021. ....	9

## List of Tables

Table 1. First and second application dates for spray blocks. ....	5
Table 2. Weather summaries for the 2021 Town of Pelham aerial spray events.....	6
Table 3. Weather summaries for 48 hours prior to and following each 2021 Town of Pelham aerial spray date. Source: Environment Canada. ....	6
Table 4. Average deposit index (ADAM Kit) after each application, 2021.....	9

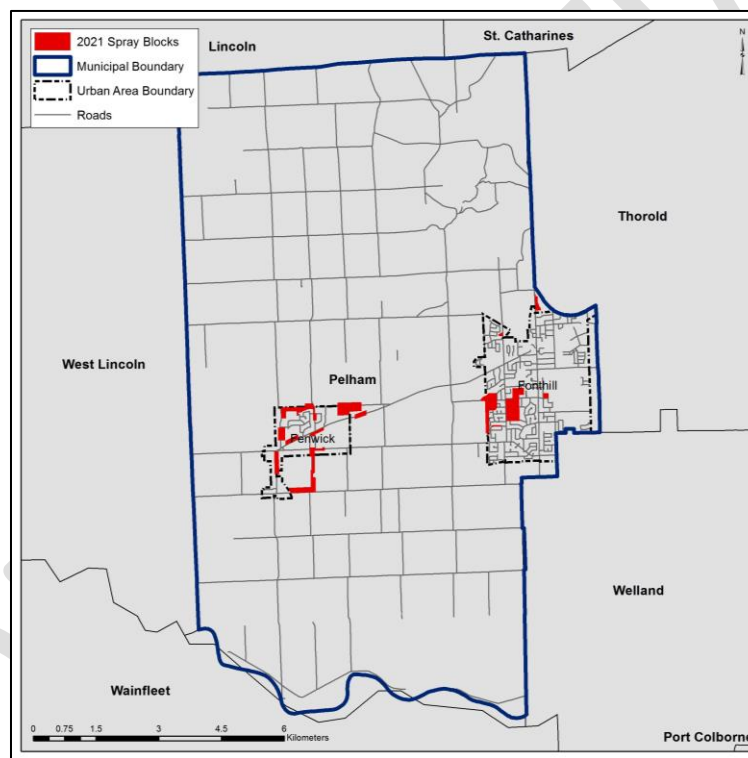
## Introduction

In May 2021, the Town of Pelham implemented an aerial spray program to treat various parts of the Town for *Lymantria dispar dispar* (“LDD moth”). The Town of Pelham’s management objective for this program, as per Policy No. S801-14 is to “...protect the tree canopy within its Municipal Boundary against tree mortality caused by defoliation by the LDD moth...”.

Lallemand Inc./BioForest (“BioForest”) was contracted by the Town to provide spray timing and assessment services. This report presents an overview of the spray program as well as the methods for, and the results of, the timing and assessment of the program.

## Program Overview

Figure 1 presents an overview of the LDD moth spraying that took place in the Town of Pelham in 2021.



**Figure 1. 2021 Town of Pelham LDD moth aerial spray program overview.**

In the Town of Pelham, a total of 113.1 hectares in areas of Fenwick and Fonthill were treated with two applications of Foray 48B (*Bacillus thuringiensis* var. *kurstaki* [Btk]), supplied by Valent BioSciences Corporation and applied at a rate of 50 BIU/4.0L/ha. The first application of Btk took place on May 20 and the second application took place on May 31. Zimmer Air Services Inc. was the aerial applicator.

## Methods

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### Spray Timing

The benefits of using Btk to control LDD moth are maximized when first applications target host leaves that are providing an optimum deposit surface. For white oak and red oak, the target level of leaf development is 30-40% and 50-60%, respectively. These stages of leaf development typically coincide with first and second instar LDD moth larvae.

BioForest monitored LDD moth development using BioSIM, a software tool for predicting larval development. Host leaf development and egg mass hatch was monitored from field measurements.

### BioSIM Forecasts

BioForest used the latest version of the BioSIM phenology model developed by the Canadian Forest Service to provide advance indication of probable program start dates based on 90% LDD moth egg hatch. BioSIM was also used to assist with the timing of field activities.

### Host Development

To monitor host development, four development plots were established across the Town – two in Fenwick and two in Fonthill (Figure 2).

Sampling in development plots took place at regular intervals between April 27 and May 20. To track host leaf expansion in each development plot on each sample date, one 40cm branch was clipped from each of 10 trees, and 10 leaves were measured and compared to mature leaf size to determine percent development. When possible, the 10 trees sampled were five red oak and five white oak. When a representative branch could not be collected due to tree height, visual ground surveys were conducted using binoculars.

Egg hatch observations were made by marking 50 egg masses at each development plot and monitoring those same 50 egg masses for the duration of the assessment period. Field crews were careful to include egg masses at various heights and at different exposures, to account for these factors that influence egg hatch timing.

### Weather

On spray days, for both applications, BioForest field crews monitored weather conditions on the ground. Temperature, relative humidity, wind speed and direction were recorded every five minutes. Any significant deviations from specified weather parameters were reported to command central.

### Spray Assessment

#### Spray Deposit

For both applications, spray deposit was assessed using the ADAM (Accurate Deposit Assessment Method) Field Kit supplied by Valent BioSciences Corporation. Following each application, foliage samples from a representative number of trees were collected from six spray blocks within 8 hours. Foliage samples were stored at 4°C until they could be processed in the lab. All samples were processed within 24 hours of collection. The amount of deposit was determined for each sample, and a deposit index was calculated for each spray block sampled. The deposit index calculations were based on the following ADAM Kit deposit categories:

- 1 = nil (0 ng Btk/ml)
- 2 = low (< 20 ng Btk/ml)
- 3 = moderate (20 – 100 ng Btk/ml)
- 4 = high (> 100 ng Btk/ml)

## Defoliation Surveys

Host defoliation rates were assessed upon completion of LDD moth larval feeding. On June 30, BioForest staff evaluated defoliation in ten spray blocks, as well as at seven sites that were not included in the spray program. These seven sites had a severe defoliation forecast from the 2020 LDD Moth Egg Mass Surveys. Evaluated trees were a combination of red, white, and bur oaks, with some alternate host such as apple, basswood, cherry, poplar, and maple when oak was not available. Twelve branches from each tree were assessed and assigned one of the following six defoliation classes: <5%, 6-25%, 26-50%, 51-75%, 76-95%, or >95%.

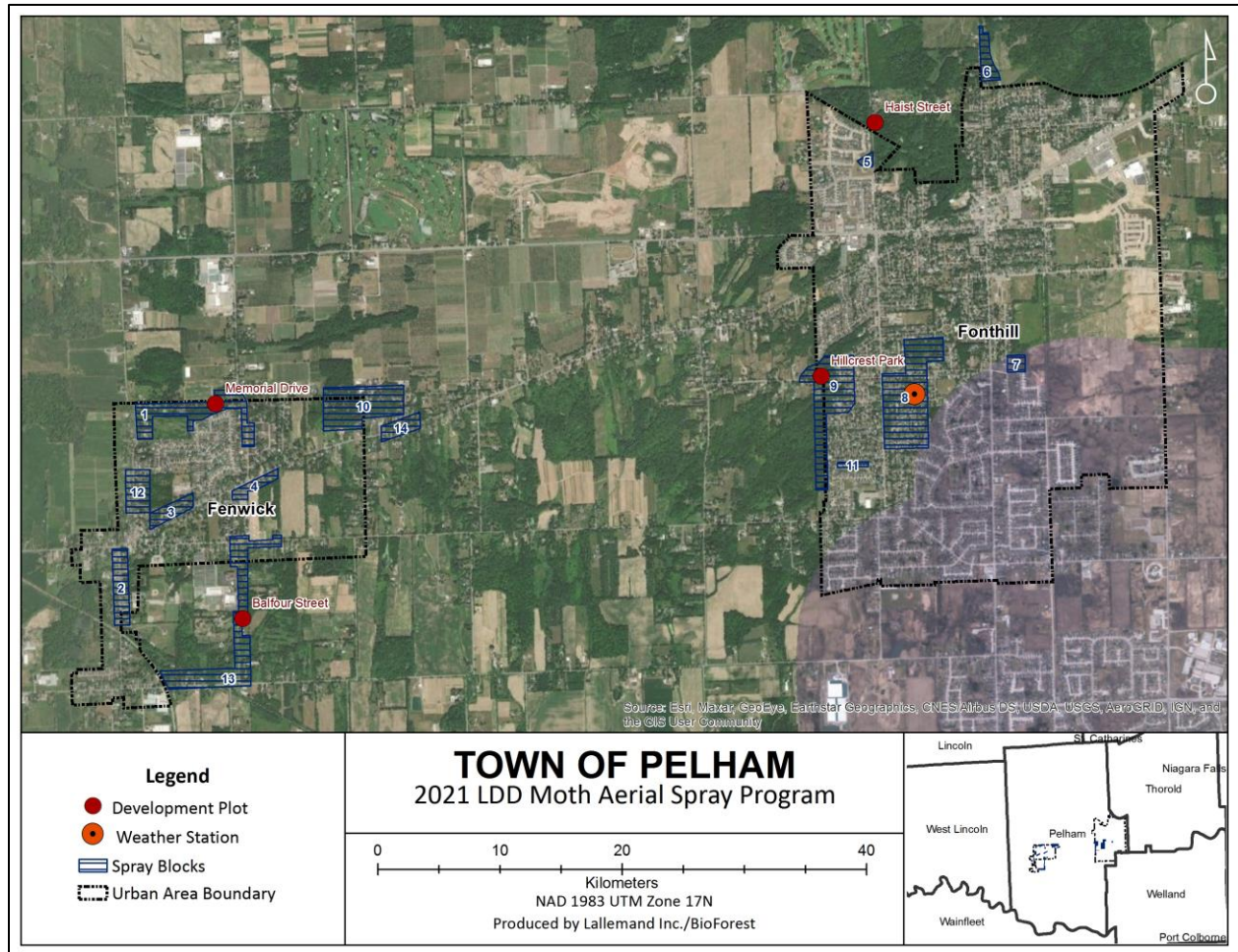


Figure 2. Development plots and weather station locations, 2021.



## Results

### Spray Timing

#### BioSIM Forecasts

The first BioSIM run on April 12, 2021 predicted that 90% egg hatch would occur in Pelham between May 11 and May 16 (Figure 3). This forecast window is early than normal for the Pelham area and was influenced by a few days of unseasonably warm temperatures during the week prior to the BioSIM run. To fine tune the model's prediction, field sampling to monitor host development and egg hatch began on April 27.

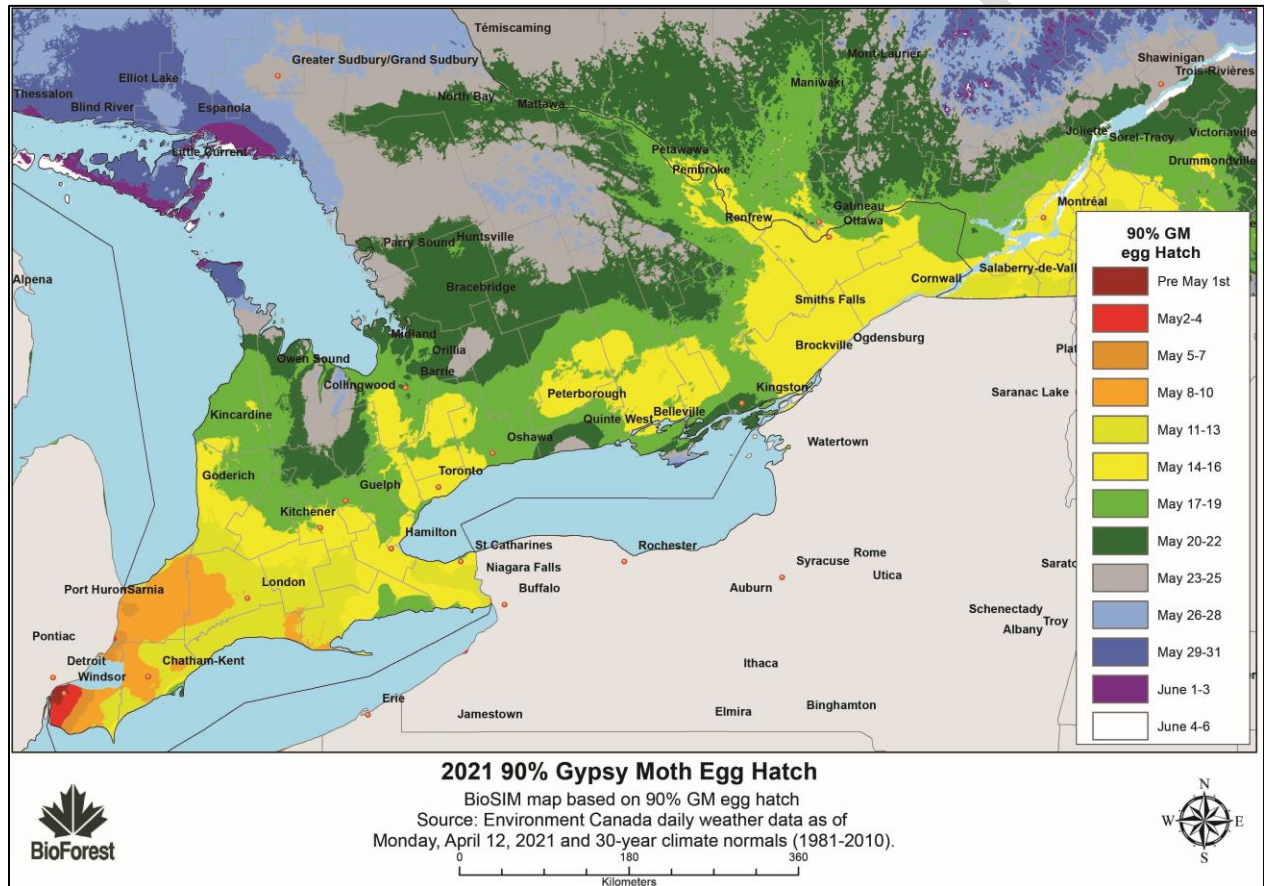


Figure 3. BioSIM prediction of 90% LDD moth egg hatch in southern Ontario, April 12 2021. Note: map title uses the old name for LDD moth, “gypsy moth”.

#### Host Development and Egg Hatch

Figure 4 presents red and white oak development from each of the development plots that were monitored. Figure 5 presents LDD moth egg hatch from each of the development plots where egg masses were monitored.

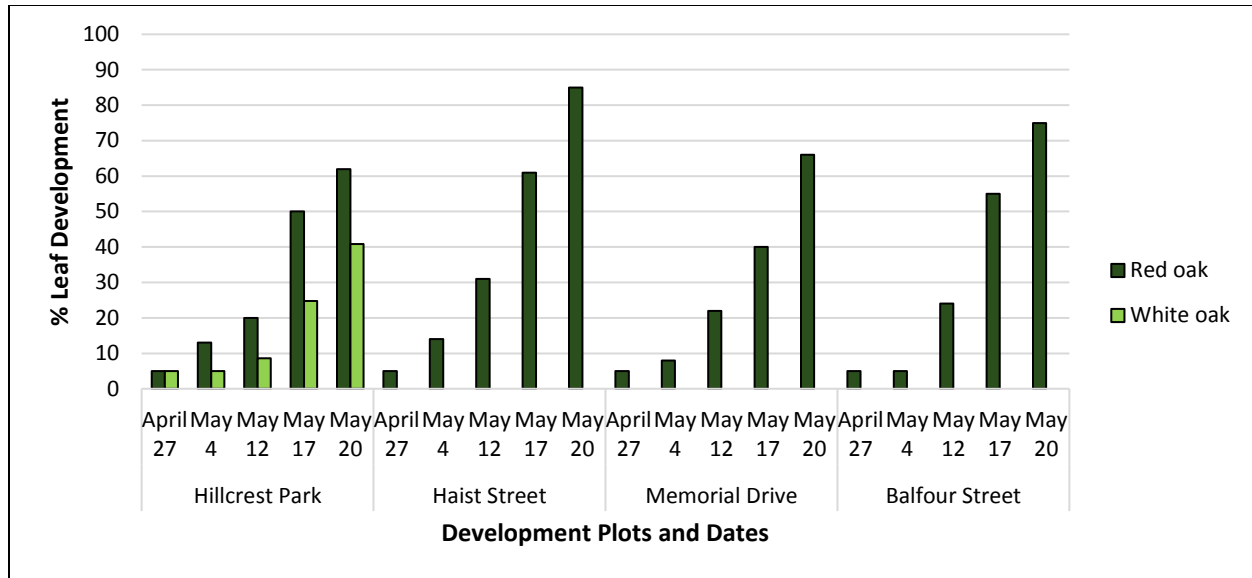


Figure 4. Percent development of red and white oak in development plots, 2021.

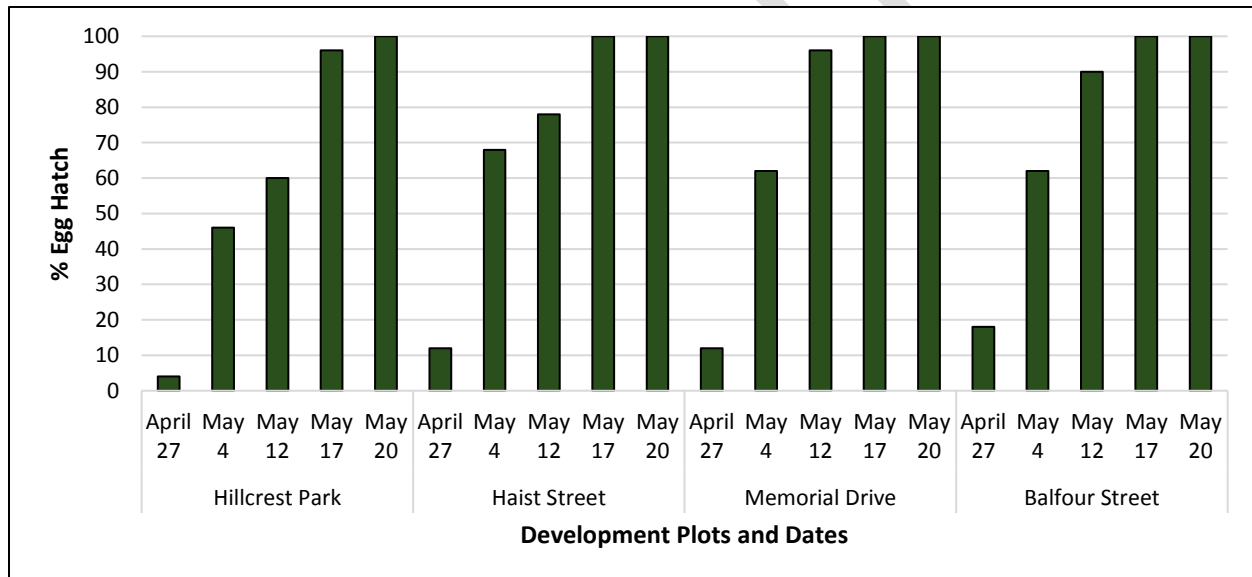


Figure 5. Percent LDD moth egg hatch in development plots, 2021.

Table 1 presents the application dates for each spray block and identifies which development plot was closest to each spray block. The first application occurred on May 20, when white oak development was at approximately 40.8%, red oak development ranged from approximately 62 to 85%, and egg hatch was observed to be 100% at all plots.

Table 1. First and second application dates for spray blocks.

Development Plot	Date of First Application	Date of Second Application	Spray Blocks Closest to Plot
Hillcrest Park	May 20	May 31	7, 8, 9, 11
Haist Street	May 20	May 31	5, 6
Memorial Drive	May 20	May 31	1, 3, 4, 10, 12, 14
Balfour Street	May 20	May 31	2, 13



## Weather

Spray weather parameters for the Town of Pelham aerial spray program were:

- Calm winds (less than 16 km/h)
- High humidity (> 40%)
- Temperatures between 2 and 25°C
- No precipitation within 24 to 48 hours

Detailed weather data collected on spray days is presented in Appendix A. Table 2 summarizes the weather data collected on each spray day, during the spray event (approximately 5:30 am to 7:30 am), and Figure 6, Figure 7, and Figure 8 graphically depict the ranges observed on the ground with the optimal spray parameters outlined.

Weather data was also collected for 48 hours prior to and following each spray event. This data is summarized in Table 3. Weather summaries for 48 hours prior to and following each 2021 Town of Pelham aerial spray date. Source: Environment Canada. Table 3.

**Table 2. Weather summaries for the 2021 Town of Pelham aerial spray events.**

Spray Date	Application	Blocks Sprayed	Weather Station	Average Wind Range (km/h)	Temperature Range (°C)	RH Range (%)
May 20	1	All	Fonthill	0 – 6.4	17.2 – 18.1	61 – 69
May 31	2	All	Fonthill	0 – 6.7	8.2 – 11.7	68 – 84

**Table 3. Weather summaries for 48 hours prior to and following each 2021 Town of Pelham aerial spray date.**  
Source: Environment Canada.

Date	Average Wind Range (km/h)	Temperature Range (°C)	RH Range (%)	Total Precipitation (mm)
May 18	12.6-16.1	6.9-24.6	61-84	0
May 19	12.6-16.0	8.4-28.0	55-72	0
May 21	12.5-15.9	13.9-29.7	75-89	0
May 22	12.4-15.8	15.0-28.0	79-93	0
May 29	12.1-15.3	5.1-15.0	41-84	0
May 30	12-15.3.0	3.2-18.3	67-78	0
June 1	11.9-15.2	9.9-23.0	61-91	0
June 2	11.9-15.1	8.3-24.9	60-97	4.2

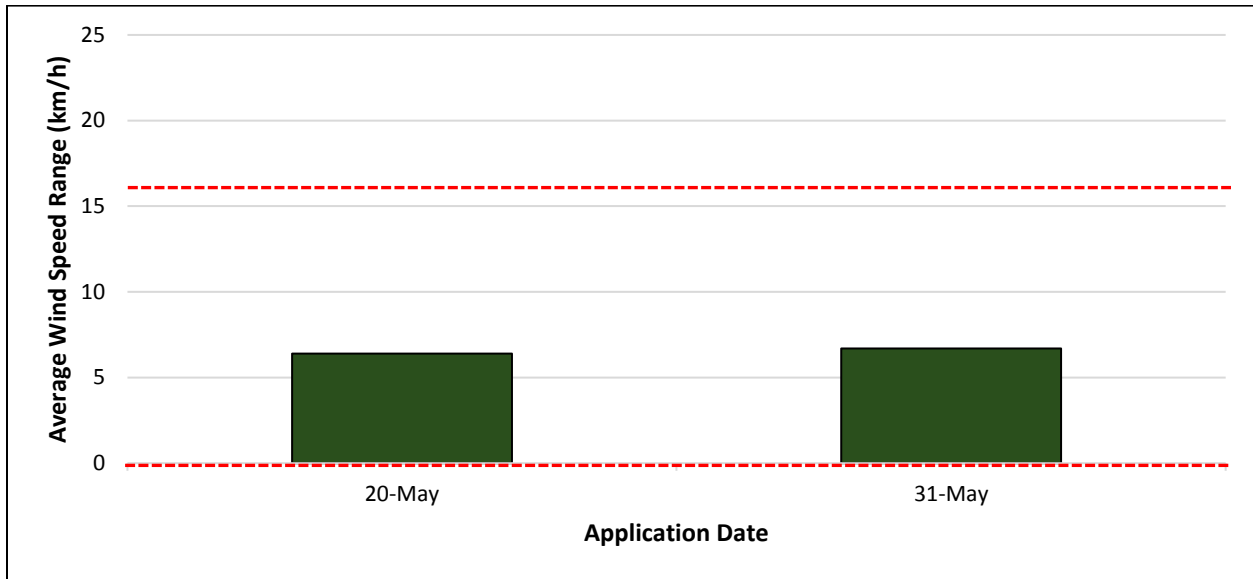


Figure 6. Average wind speed range (km/h) recorded during spray events. Dotted red lines represent optimal parameters.

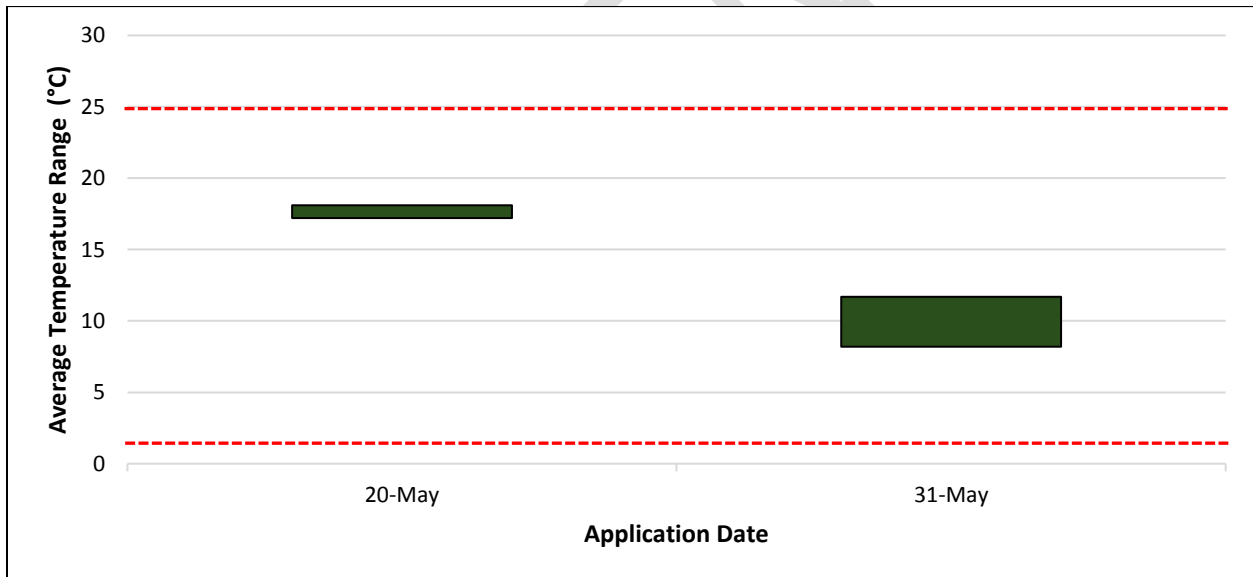


Figure 7. Average temperature range (degrees Celcius) recorded during spray events. Dotted red lines represent optimal parameters.

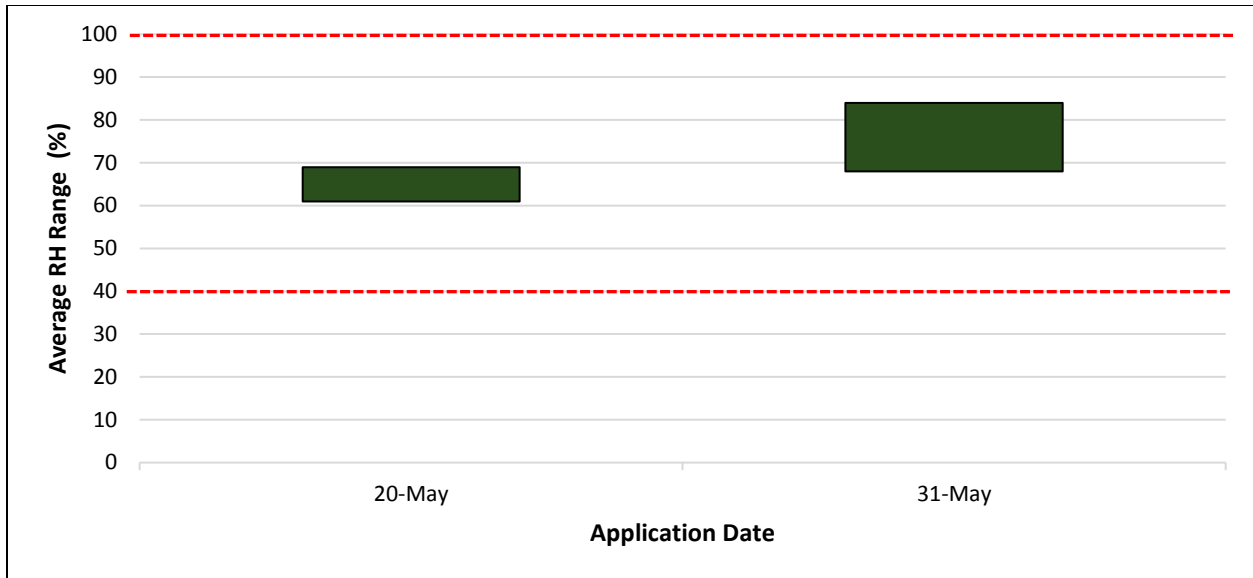


Figure 8. Average relative humidity range (%) recorded during spray events. Dotted red lines represent optimal spray parameters.

## Post-Spray Assessment

### Spray Deposit

After the first application the majority of branches sampled (94.4%), had Btk present (Figure 9). 27.8% of branches sampled had >100 ng Btk/ml (deposit index of 4), and 66.7% had 20 – 100 ng Btk/ml (deposit index of 3). After the second application, all branches sampled had Btk present. Table 4 presents the deposit index after each application for all six spray blocks sampled using the ADAM Kit methodology.

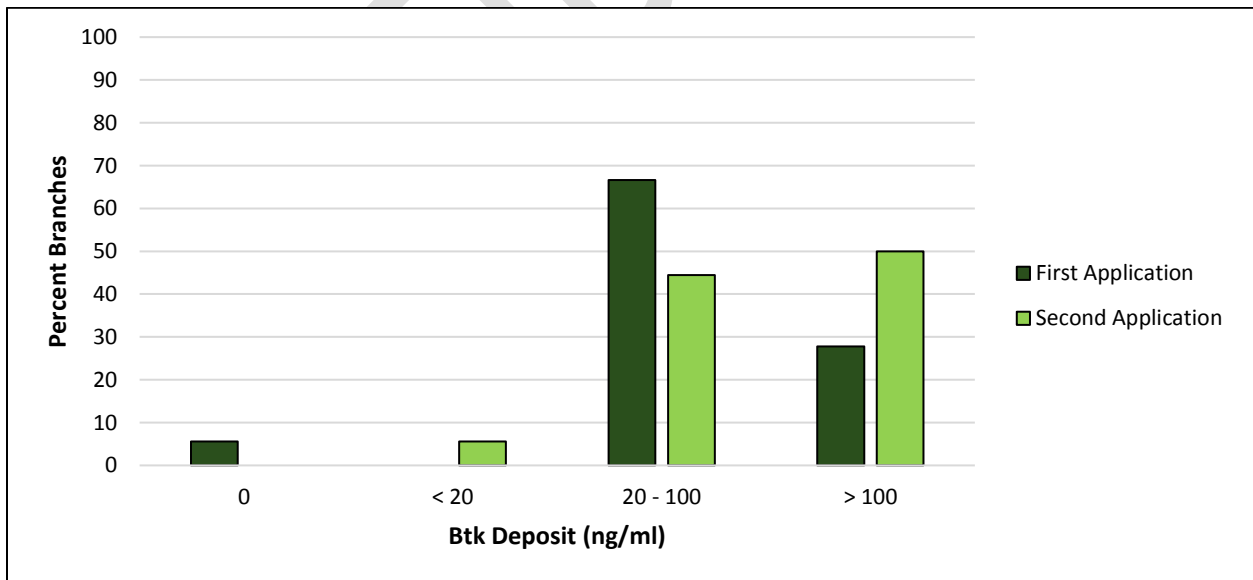


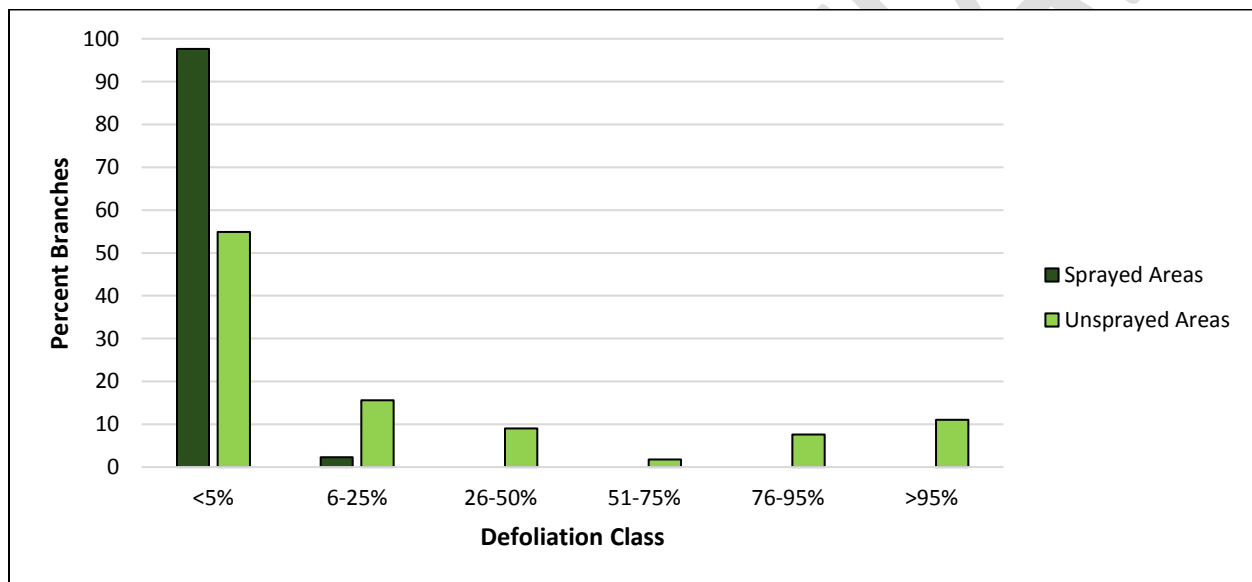
Figure 9. ADAM Kit results - amount of Btk on branches sampled from six spray blocks, 2021.

**Table 4. Average deposit index (ADAM Kit) after each application, 2021.**

Spray Block	Location	Average Deposit Index – First Application	Average Deposit Index – Second Application
1	Northwest Fenwick	3.3	3.3
4	Central Fenwick	2.7	3.3
8	East Fonthill	3.0	3.3
9	West Fonthill	3.0	3.7
10	Northeast Fenwick	3.3	3.7
13	South Fenwick	3.7	3.3

### Defoliation Surveys

Of the 120 trees that were evaluated for defoliation within the spray blocks, most branches (97.7%) had less than 5% defoliation (Figure 10). No branches had more than 25% defoliation. In unsprayed areas, almost half (45.1%) of branches had more than 25% defoliation and almost a quarter (20.5%) had more than 50% defoliation. In all unsprayed areas, larvae affected by both nuclear polyhedrosis virus (NPV) and *Entomophaga maimaiga* were observed.



**Figure 10. Percent branches in each defoliation class from ten spray blocks and seven unsprayed sites sampled, 2021.**

## Conclusion

The Town of Pelham's management objective for the aerial spray program, as per Policy No. S801-14, is to "...protect the tree canopy within its Municipal Boundary against tree mortality caused by defoliation by the LDD moth...". Assessment of the 2021 Town of Pelham aerial spray program indicates that the program was effective at achieving program goals by significantly reducing forecasted defoliation and maintaining a healthy tree canopy. Host development and egg hatch at the time of spraying were within acceptable ranges. For each of the spray dates, the average temperature and relative humidity were within acceptable spray parameters. Following the first application, the majority of branches sampled for deposit (94.4%) had Btk present and following the second application all branches sampled had Btk present. All blocks sampled had Btk present following both applications. No branches surveyed within the spray area had greater than 25% defoliation and most had less than 5% defoliation.

Appendix A: Spray block wind, temperature and relative humidity records for Town of Pelham spray days

Spray Day Weather Record											
Location: Baker Place						Date:		Thursday May 20, 2021			
GPS Coordinates:			Zone	Easting		Northing					
			17N	639141		4765905					
Crew: SC			Application:			1st	2nd				
Time	Wind					Temperature			RH		Comments
	Avg		Max			°C	↑ ↓ →	%	↑ ↓ →		
	kph	Direction	kph	Direction	Time						
5:30 AM	0	-	-	-	-	17.7	→	61	→		
5:35 AM	0	-	-	-	-	17.6	→	62	→	over Fenwick	
5:40 AM	0	-	-	-	-	17.6	→	62	→		
5:45 AM	0	-	-	-	-	17.5	→	63	→		
5:50 AM	0	-	-	-	-	17.4	→	63	→		
5:55 AM	0	-	-	-	-	17.4	→	63	→		
6:00 AM	0	-	-	-	-	17.3	→	64	→		
6:05 AM	0	-	-	-	-	17.2	→	65	→		
6:10 AM	0	-	-	-	-	17.4	→	65	→		
6:15 AM	0	-	-	-	-	17.4	→	66	→		
6:20 AM	1.3	NNW	4.9	NNW	6:25	17.4	→	66	→		
6:25 AM	1.7	NNW	2.1	NNW	6:27	17.5	→	67	→	finished Fenwick - refueling	
6:30 AM	0	-	-	-	-	17.4	→	67	→		
6:35 AM	1.5	NNW	2.1	NNW	6:36	17.5	→	67	→	hear the helicopter in Fonhill	
6:40 AM	0.7	NNW	1.5	NNW	6:44	17.5	→	68	→		
6:45 AM	1.1	NNW	2.7	NNW	6:46	17.4	→	68	→		
6:50 AM	0	-	-	-	-	17.4	→	68	→		
6:55 AM	3.1	NNW	6.4	NNW	6:57	17.5	→	68	→	helicopter overhead	
7:00 AM	0.3	NNW	1.1	NNW	7:03	17.6	→	68	↑	RH trend change	
7:05 AM	0	-	-	-	-	17.6	→	69	↑		
7:10 AM	1.4	SE	2.5	SE	7:11	17.7	→	68	↑	change in wind direction	
7:15 AM	0.3	SE	1	SE	7:18	17.8	→	69	↑		
7:20 AM	0	-	-	-	-	17.9	→	69	↑		
7:25 AM	0	-	-	-	-	18.1	→	69	↑	helicopter done	



Spray Day Weather Record											
Location: Baker Place						Date: Monday May 31, 2021					
GPS Coordinates:			Zone	Easting		Northing					
			17N	639141		4765905					
Crew: SC			Application: 1st 2nd								
Time	Wind					Temperature			RH		Comments
	Avg		Max		Time						
	kph	Direction	kph	Direction		°C	↑ ↓ →	%	↑ ↓ →		
5:30 AM	0	-	0	-	-	8.8	→	71	→	hear helicopter	
5:35 AM	0	-	0	-	-	8.6	→	71	→		
5:40 AM	0	-	0	-	-	8.5	→	73	→		
5:45 AM	0	-	0	-	-	8.5	→	74	→		
5:50 AM	0	-	0	-	-	8.5	→	75	→		
5:55 AM	0	-	0	-	-	8.4	→	76	→		
6:00 AM	0	-	0	-	-	8.5	→	77	→		
6:05 AM	0	-	0	-	-	8.2	→	78	→		
6:10 AM	0	-	0	-	-	8.2	→	80	→	wind direction changing	
6:15 AM	0.9	NW	2.3	NW	6:15 AM	8.3	→	81	→		
6:20 AM	0	-	0	-	-	8.5	→	83	→		
6:25 AM	0	-	0	-	-	8.8	→	84	→		
6:30 AM	0	-	0	-	-	9.1	→	82	↑	RH trend changing	
6:35 AM	0	-	0	-	-	10.0	→	81	↑		
6:40 AM	0	-	0	-	-	9.7	→	81	↑	helicopter in Block 8	
6:45 AM	0.5	NW	3.3	NW	6:48 AM	9.6	↑	81	↑	helicopter overhead	
6:50 AM	0	-	0	-	-	9.5	↑	81	↑		
6:55 AM	0	-	0	-	-	9.9	↑	79	↑		
7:00 AM	1.1	NW	2.4	NW	7:04 AM	10.5	↑	74	↑		
7:05 AM	2.5	NW	3.7	NW	7:05 AM	11.1	↑	74	↑		
7:10 AM	1.2	NW	4.1	NW	7:14 AM	11.0	↑	72	↑		
7:15 AM	1.5	W	4.2	W	7:15 AM	10.4	↑	72	↑	wind direction changing	
7:20 AM	2.3	W	6.7	W	7:24 AM	10.3	↑	72	↑		
7:25 AM	1.3	W	1.7	W	7:28 AM	10.3	↑	72	↑		
7:30 AM	2.3	W	3.1	W	7:31 AM	10.7	↑	72	↑		
7:35 AM	2.5	W	3.5	W	7:36 AM	11.7	↑	68	↑		