

Budworm Tracker: A Citizen Science Program



3rd Annual Program Report 2017

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PROGRAM OVERVIEW

As expected, spruce budworm pheromone trap captures increased during the past year. This is not that surprising given that the overall outbreak grew from 4.3 million hectares in 2014 to nearly 7.1 million hectares in 2017. To give a little perspective on the current scale of the outbreak, New Brunswick forests cover only about 6 million hectares and the previous outbreak of the 1970s through early 1990s caused moderate to severe defoliation of over 50 million hectares of forest across Eastern Canada. Monitoring and understanding the rise and spread of the current outbreak is a priority for developing an effective and efficient management program for the budworm, as well as for gaining a better understanding of its dispersal ecology – our Budworm Trackers are a huge part of this effort!

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WHAT IS SPRUCE BUDWORM?

Spruce budworm is the major defoliating insect of spruce and balsam fir trees throughout the North American boreal forest. Budworm outbreaks have occurred periodically for centuries (every 25-40 years) and there is fossil evidence from old peat bogs that suggests outbreaks have occurred at least ~6,800 years into the past. Recent outbreaks in budworm's eastern range have been especially intense – the previous outbreak damaged trees throughout much of northeastern North America (~50 million hectares or ~123 million acres) and persisted from 1972 to 1992.

Economic losses caused by budworm outbreaks can reach well into the tens of billions of dollars, with especially large impacts on sectors reliant on softwood for pulp and paper or lumber. The most recent budworm outbreak began around 2006 and has continued to expand ever since then. As of 2017 the outbreak covered approximately 7.1 million hectares (~17 million acres) and has started to spread into Atlantic Canada through the northern New Brunswick border. To date, no appreciable defoliation has occurred outside of Québec and Ontario (where there are also some patches of outbreaks brewing).

HOW DO WE MONITOR SPRUCE BUDWORM?

The first priority in managing insect pests is devising methods to monitor where they are and what damage they are causing.

There are three ways that we monitor spruce budworm:

1. Pheromone trap surveys to monitor the moth stage.
2. 'L2' surveys to monitor the hibernating caterpillars on branches.
3. Defoliation surveys to determine how much feeding damage they've caused to trees.

Budworm Tracker engages citizen scientists to help with the first method, pheromone trapping. Data collected from pheromone traps are of course useful for monitoring where the moths are active and can help guide follow-up 'L2' surveys. But, pheromone trapping can also tell us many things about budworm ecology.

For example, the moths collected from pheromone traps can also tell us important things about budworm dispersal. Our Trackers check the traps repeatedly through the flight season, so we are better able to identify areas that have moth immigrants from Québec. This is because Québec is colder and the budworm develop a bit later, so any late arrivals in southern areas is pretty strong evidence that they come from the north. The collected moths themselves can also be analysed for their DNA to confirm where they come from. We also use Tracker results to help plan our search for new rising populations beyond the leading edge of the outbreak. As you can see, the work you do is essential for budworm management and ecological research!



WHAT HAVE WE LEARNED TO DATE?

You might be wondering: How do we use the data and samples collected by you, our Budworm Trackers? Firstly, it tells us in general where the highest densities of moths are in the region. This is essential for helping us to better plan more detailed surveys of overwintering 'L2' larvae in the fall. Secondly, we use your data to help us better understand where the moths that were captured in your trap came from. One way we do this is by looking at what day they were caught. Like all insects, budworm is cold-blooded and their development depends on how warm the climate is where they develop. Using regional temperature and climate, we can predict with fair accuracy when the moths should be flying in your area. Thus, if moths are captured much earlier or later in the season than predicted (for example), we become very suspicious that those moths might be immigrants from other areas where the climate differs. We can also take measurements from the moths to see how healthy or old they are and in some cases, whether they've mated. We can also take the moths you collect and send them away for DNA analyses to further confirm whether they came from Québec or are more likely from your area. By the way, if you catch nothing in your trap, that's just fine! Knowing where budworm are not is just as important to us as knowing where they are: zeros count!

In a nutshell, your efforts and the samples you collect are helping us unravel some of the most poorly understood aspects of spruce budworm outbreaks!

WHAT DO YOUR TRAP CATCHES MEAN?

The number of moths in a trap that might result in visible defoliation on nearby balsam fir and spruce trees is about 100+ total moths. You can be sure that if your trap catch was 100+ total moths, we or a collaborator are looking for defoliation in your area. However, there are exceptions. We had several traps this past year in PEI and parts of middle to southern NB that had much more than 100 moths but no visible defoliation. Although we are still examining these samples, we suspect that many of these were late arrivals having immigrated from the cooler Québec climate.

For reasons we are still trying to understand, there are instances away from the main bulk of the outbreak where having a large number of moths show up doesn't seem to lead to a large number of budworm eggs being laid in the area. We had one of our own traps in northern NB that had nearly 700 moths in it and surprisingly, not a single spruce budworm egg mass was found in the entire site! This is one of the many mysteries we are still hoping to solve with the help of our Budworm Trackers.

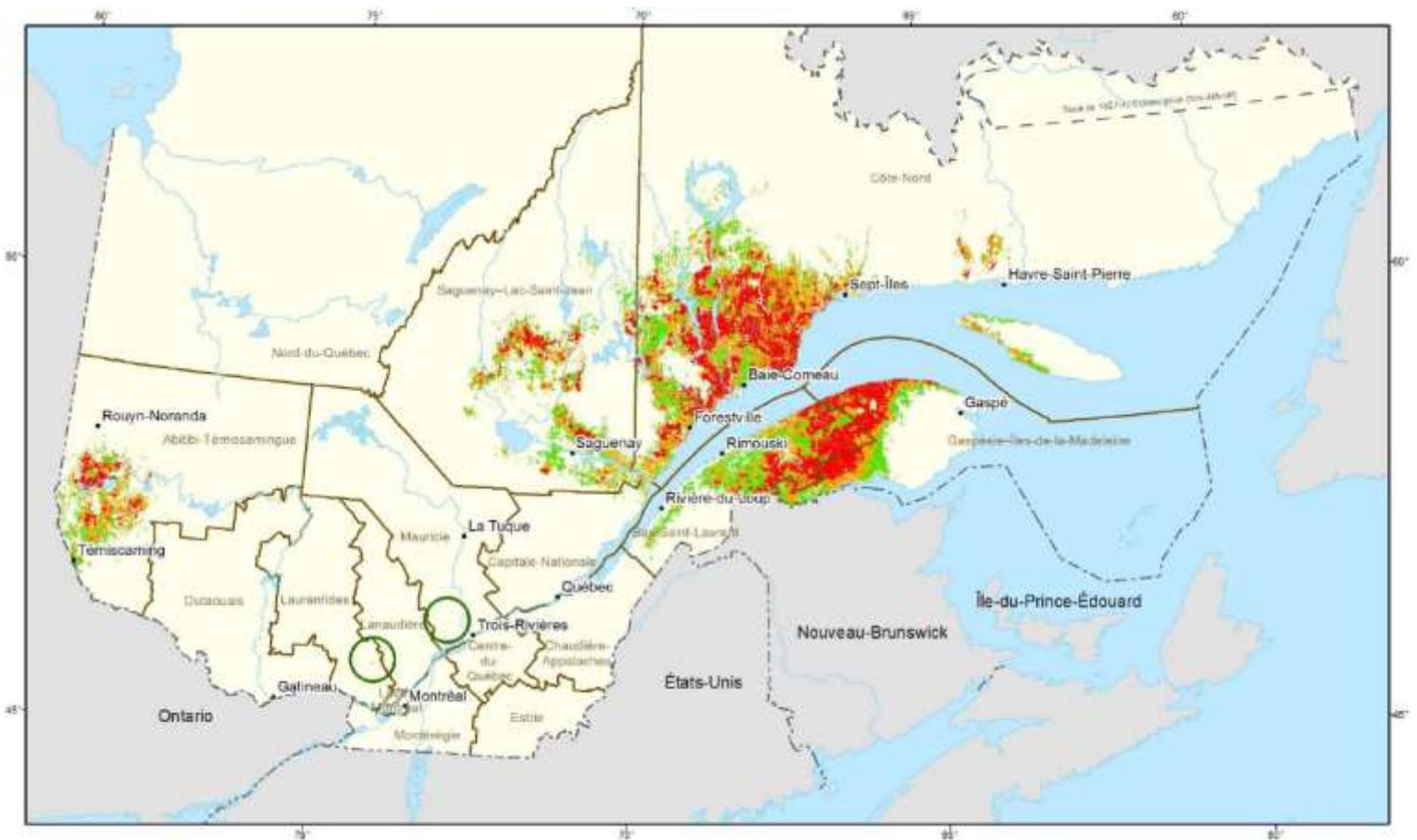
WHERE IS THIS ALL HEADING?

One of the greatest benefits of Citizen Science is its value as an educational and outreach tool, and we are in part trying to use Budworm Tracker to improve science literacy on one of the most ecologically and economically important insect pests in Eastern Canada. However, equally important, a good Citizen Science program should eventually lead to peer-reviewed scientific publications that shed light on the topic of interest. As of now, we have several early publications in development and will share these as they are published. In all likelihood, the data you are helping us collect will appear in publications for years to come and may very well change the way that we monitor insect pests in our region.

We have also been discussing with various groups how we might harness this approach to help improve pest monitoring (and associated decision-making) in other forestry or agricultural systems. In many ways, Atlantic Canada with its small size and tight knit communities is uniquely suited to developing these types of programs and we see it as an ideal platform for developing citizen-based programs. While this program is currently planned to last through 2018, we suspect that its use and impact will continue beyond that. We applaud our many participants for their efforts on this project and hope they will continue to find it as interesting and enlightening as we have.

UPDATE ON THE CURRENT OUTBREAK

Total defoliation by spruce budworm remained roughly the same in 2017 compared with 2016 (~7 million hectares or ~17 million acres of moderate to severe defoliation). Even still, there was a shift in where defoliation was expanding. On the north shore of the St. Lawrence river, defoliation declined by about 360,000 hectares. As you'll see in the figure below, on the south shore, there was an increase of over 700,000 hectares, with most of this increase occurring towards the west of the Gaspé. In the figure, the red represents areas with severe defoliation, whereas the green represents more modest levels from 2017. In New Brunswick, we're starting to see some signs of defoliation along the northern border with Québec, but so far there's nothing too severe. There is no detectable budworm defoliation (so far) in Maine, Prince Edward Island, Nova Scotia, or Newfoundland.



WHAT'S NEW FOR THE RESEARCH PROGRAM FOR 2018?

You may have noticed the announcement in the federal budget this year that the Healthy Forest Partnership's Early Intervention Strategy Program received funding for four more years totalling nearly \$75 million dollars. A small portion of this funding will continue to support the Budworm Tracker program. If you'd like more information on what this all means, please check out www.healthyforestpartnership.ca.

OVERVIEW OF THE TRACKING SEASON

2015

We were very grateful for the support we received from the Budworm Trackers in 2015. A total of 284 traps were given out in the spring and we received data back from 259, for an impressive return rate. We were impressed and gratified by the consistent and dedicated efforts of our volunteers. There were a total of 2,996 days on which data were collected and over 28,000 moths sent in!

2016

We continue to be impressed and gratified by the consistent and dedicated efforts of our volunteers! A total of 405 traps were given out in 2016 (up from 284 in 2015) and we received data back from 352. From the efforts of our Budworm Trackers there were a total of 5,328 days on which data were collected and over 16,000 moths sent in. From our end, we counted and identified every single one of your moths. Many of them are having their DNA analysed to see if we can figure out whether they were locals or immigrants from Québec!

2017

We are very grateful for the support we receive from our budworm trackers. A total of 421 traps were given out in the spring of 2017 (up from 405 in 2016) and we received data back from 340. From the efforts of our Budworm Trackers there were a total of 4,191 days on which data were collected and over 48,000 moths sent in. We're always working to improve the Budworm Tracker Program and we appreciate your help in doing so! One of the best ways that you can get the most from your trap is to check it as often as possible. If checked often enough, many of your traps will have multiple spikes in moth numbers. Some of these spikes may represent local moths or could actually be moths arriving from distant stands as part of a moth dispersal events.

While we ask you to do at least one trap check per week, it is incredibly valuable when you are able to check your traps more often (daily or every couple of days). So the more often you check your traps the better able we are to identify when budworm moths are flying into your area!

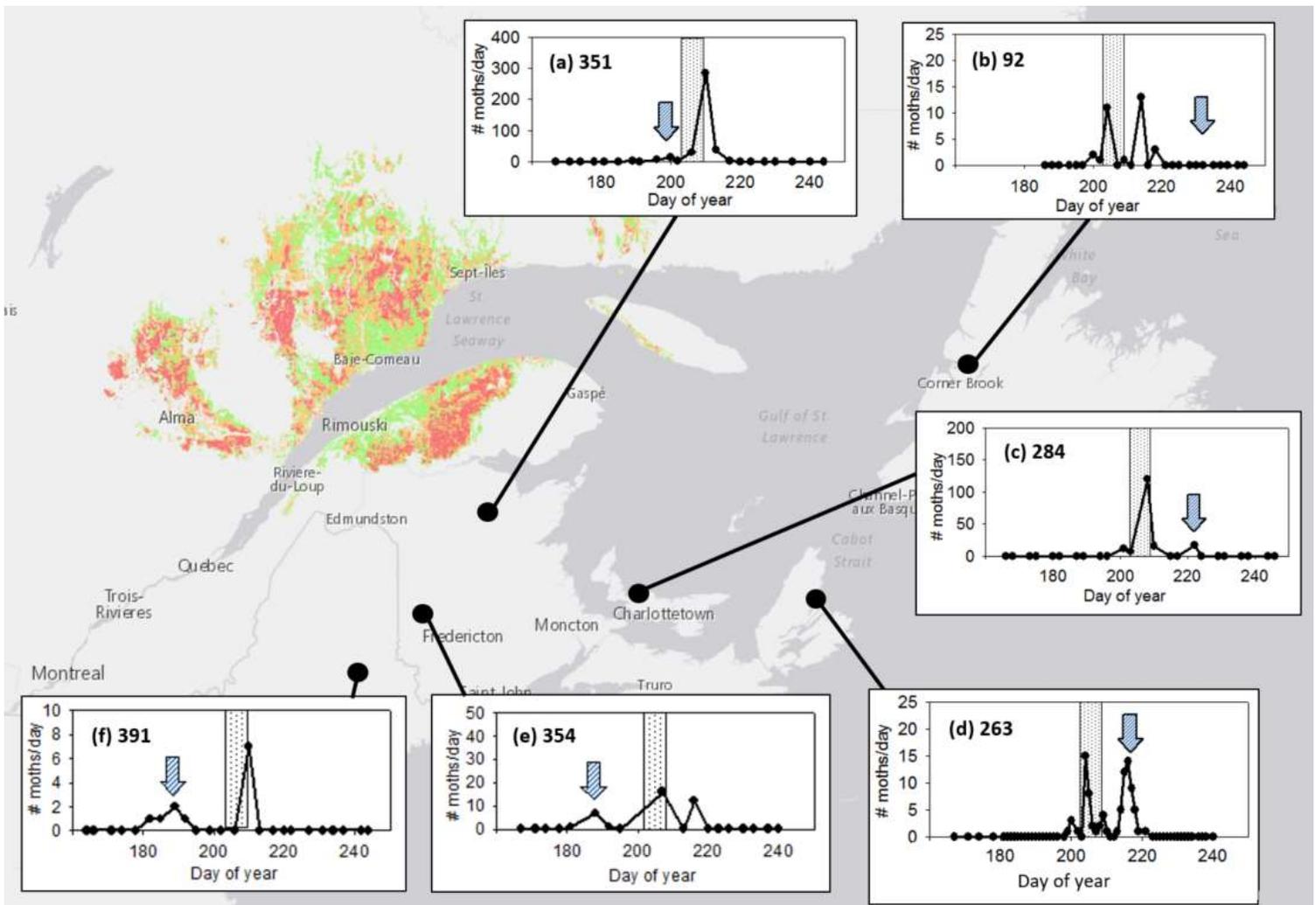
MASS DISPERSAL EVENT OF 2016!

The highest densities of moths were found in Québec traps, which wasn't a big surprise given the huge outbreak ongoing there. Lower levels were noted in all of the Maritime Provinces and Maine. It was interesting to note, however, that our Trackers collected moths well into Nova Scotia where there is no visible activity of feeding budworm. We suspect that these may have been immigrants from Québec.

We've also been giving a number of talks using the Budworm Tracker data to highlight how the timing of moth collection in an area can offer hints at whether or not there has been immigration. The figure below shows the number of moths captured vs. the day of the year (and we can look at this because you collect moths for us periodically). In the figure below, we have excellent examples of collections done by some of our Trackers (do you recognize your trap number?). The yellow arrow represents the timing of the mass dispersal event (about July 24).

'NB 551' is an example of northern New Brunswick. It is hard to distinguish if those numbers are locals or immigrants from Québec because they are developing very close to the source of moths. However, the other three examples are more interesting in that regard. 'ME 391' has an initial subset of moths captured (probably locals) and then a second blip that occurs just after the mass dispersal event. We would guess that this second group comes from the north (and are trying to confirm this with some DNA analyses). 'NS 263' has two blips that occur after the dispersal event. Is this evidence of two groups of immigrants coming into the province (again, we hope DNA analyses will help to clarify)? 'NL 92' is also interesting, but for a different reason. In this example, the first blip is perhaps evidence of dispersers from Québec, whereas the second blip is most likely locals...Newfoundland is even colder than Québec and the budworm there develop later! This is just an example of some of the ways we can use the data collected by Trackers.

So, what is the moral of this story? The more often you check your traps, the better data we have to determine if the moths you capture are immigrants!



Certainly the most noteworthy budworm event of 2016 was the mass dispersal event that occurred in the late summer. On several cloudless evenings from July 20-25 weather radar detected moving plumes of spruce budworm moths coming from Québec into New Brunswick.

Moths are attracted to bright lights, and as a result, these plumes tended to descend upon well-lit areas. In the aftermath we were left with many concerning images of parking lots and cars covered in dense carpets of fluttering moths, especially in areas to the north of New Brunswick such as Campbellton.

Trillions of budworm moths were estimated to have dispersed during this mass dispersal event. Certainly the sheer spectacle and aftermath garnered a fairly high level of public interest and media coverage. Yet, although the event was certainly striking in its imagery it was the practical implications of the event that raised the most concerns: Could these mass dispersal events completely overwhelm our ongoing efforts to slow the spread of budworm through Atlantic Canada?

A large part of our effort during the late summer was focused on this question – so, what did we learn? First of all, with the help of you, our dedicated Budworm Trackers we determined that the dispersal event was likely quite extensive, perhaps reaching as far as Cape Breton and deep into Maine. From the moths we scooped up from parking lots and from around trees in Campbellton, we discovered that nearly 80% of the moths were females, potentially carrying as

many as 200 eggs each! However, on-the-ground surveys conducted immediately after the event suggested that high densities of eggs were laid mainly in the area within 30-50 km of Campbellton, though there was evidence of some sparse egg deposits reaching as far as Nova Scotia.

From these results we were able to draw a few tentative conclusions. Even with the impressive scale of the mass dispersal event our evidence to date suggests that whatever impact it had was fairly local to northern New Brunswick, where densities rose somewhat this past summer. Research in upcoming years will address this event and other questions as we continue our ongoing research to understand how budworm outbreaks advance over the landscape and whether we might be able to slow its spread.

UPCOMING BUDWORM TRACKER ARTICLES IN SCIENTIFIC JOURNALS

As researchers, one of the ways we share our findings is through peer-reviewed scientific journals. In general, we usually like to have at least 3 years of data before publishing about a topic so that we can provide a more accurate conclusion.

As this is the third year of the project, we're in the process of preparing our first publication, which will lay out the program with a particular emphasis on how we set it up and how successful it has been. This article will lay the ground work for several more publications expected for future years.

PLANS FOR THE UPCOMING SEASON

Most aspects of the Budworm Tracker will continue this year, however, there will be one significant change. We have decided to move away from the 'kill strip' used in the trap to kill the captured moths and substitute it for a bit of dish soap and water in the bottom of your traps. Adding a bit of soap to water breaks up the surface tension so that as soon as the insect touches the water it gets sucked in. Simple, clean, and your moths will have the sweet scent of dish soap! Details will follow in in your kits, stay tuned.

QUESTIONS ABOUT THE REPORT?

Do you have some questions about the report? Would you like to see the final results for your particular trap? Feel free to contact us at:

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