

Budworm Tracker: A Citizen Science Program



2nd Annual Program Report 2016

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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 (Fig. 1). 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 (~52 million hectares or ~128 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 2016 the outbreak covered approximately 7.1 million hectares (~18 million acres) and has started to spread into Atlantic Canada through the northern New Brunswick border (Fig. 2). To date, no appreciable defoliation has occurred outside of Quebec and Ontario (where there are also some patches of outbreaks brewing).

If you are interested in learning more about spruce budworm and some of the great research that has gone into understanding its outbreaks, we would draw your attention to the following resources:

(1) A website dedicated to all things budworm: www.healthyforestpartnership.ca

(2) A recent review article that discusses why budworm outbreaks (a bit more technical!):

<https://www.researchgate.net/publication/307560648> Paradigms in Eastern Spruce Budworm Lepidoptera Tortricidae Population Ecology A Century of Debate



Figure 1. A pair of budworm caterpillar munching away on the fresh new needles of a balsam fir twig.

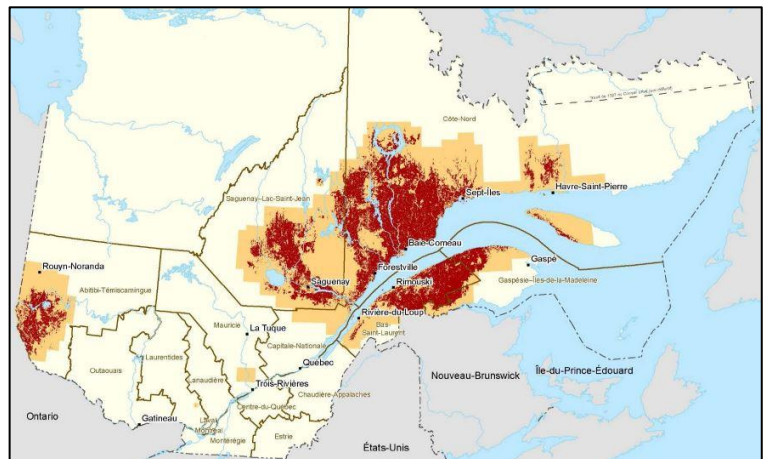


Figure 2. The spruce budworm outbreak range as of spring 2017. Orange areas are where surveying has been done for defoliation. Red areas are those with moderate to severe defoliation.



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 (Fig. 3)
2. 'L2' surveys to monitor the hibernating caterpillars on branches (Fig. 4).
3. Tree defoliation surveys to determine how much feeding damage they've caused to trees (Fig. 5).



Figure 3. An attentive Tracker checking her trap for budworm moths.



Figure 4. Our technician reaching into the snowy tree-tops with a pruner to collect a branch for 'L2'.



Figure 5. Left: a budworm damaged branch (note the eaten tips); right: a healthy branch.

Budworm Tracker engages citizen scientists to help with the first method, pheromone trapping (Fig. 3). Data collected from pheromone traps are of course useful for monitoring where the moths are active and can help guide follow-up 'L2' surveys (Fig. 4). 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. Because our Trackers check the traps repeatedly through the flight season, we are better able to identify areas that have moth immigrants from Quebec. This is because Quebec 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!



OVERVIEW OF 2016 TRACKING SEASON

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, for an impressive 87% return rate. Citizen Science programs, in general, are lucky to receive even half of this level of return! 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 Quebec!

The highest densities of moths were found in Quebec traps (Fig. 6), 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 Quebec.

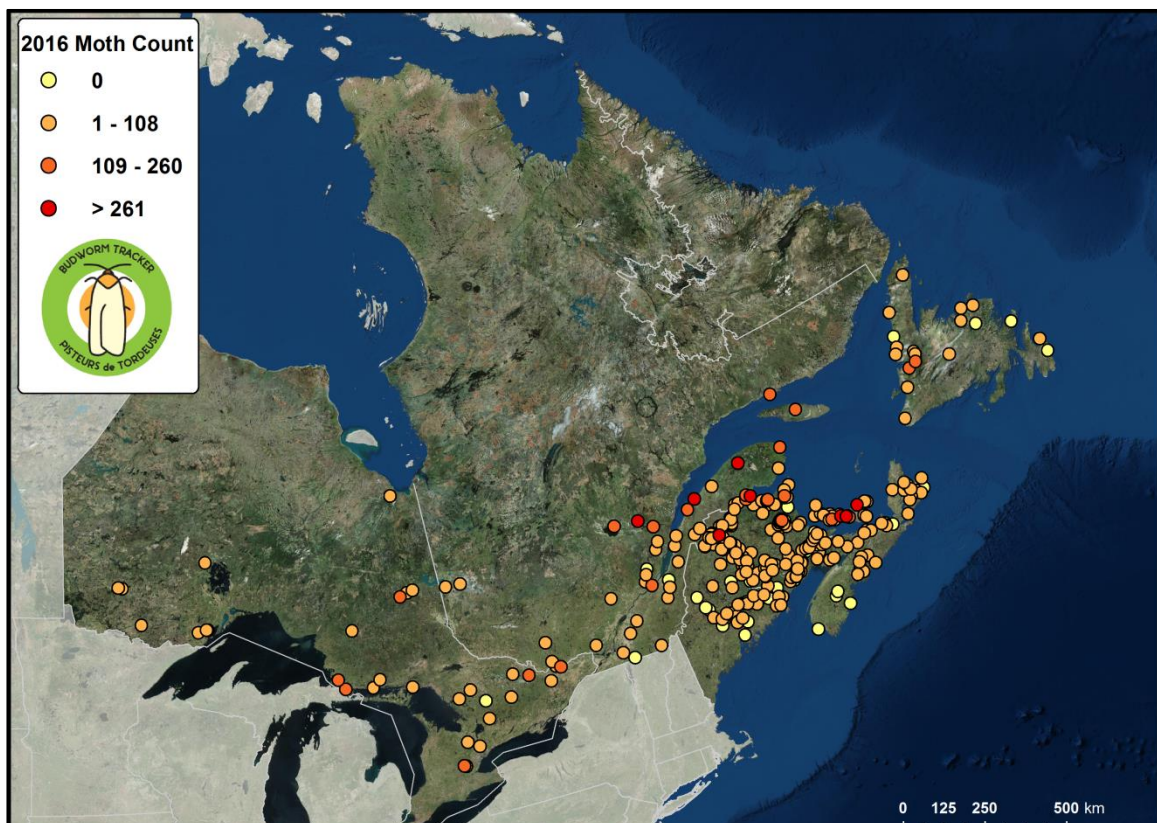


Figure 6. Moth captures in the Budworm Tracker program from 2016. Note the especially high densities in Quebec, but also the fact that there were moths found in traps throughout the region. We believe that many of the moths captured outside of Quebec and northern New Brunswick might have been immigrants from a mass dispersal event in late July (explained on page 7).



(CONTINUED) OVERVIEW OF 2016 TRACKING SEASON

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 figures 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 Fig. 7 below, we have four 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 251' is an example of northern New Brunswick. It is hard to distinguish if those numbers are locals or immigrants from Quebec 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 Quebec, whereas the second blip is most likely locals...Newfoundland is even colder than Quebec and the budworm there develop later! This is just an example of some of the ways we can use the data collected by Trackers.

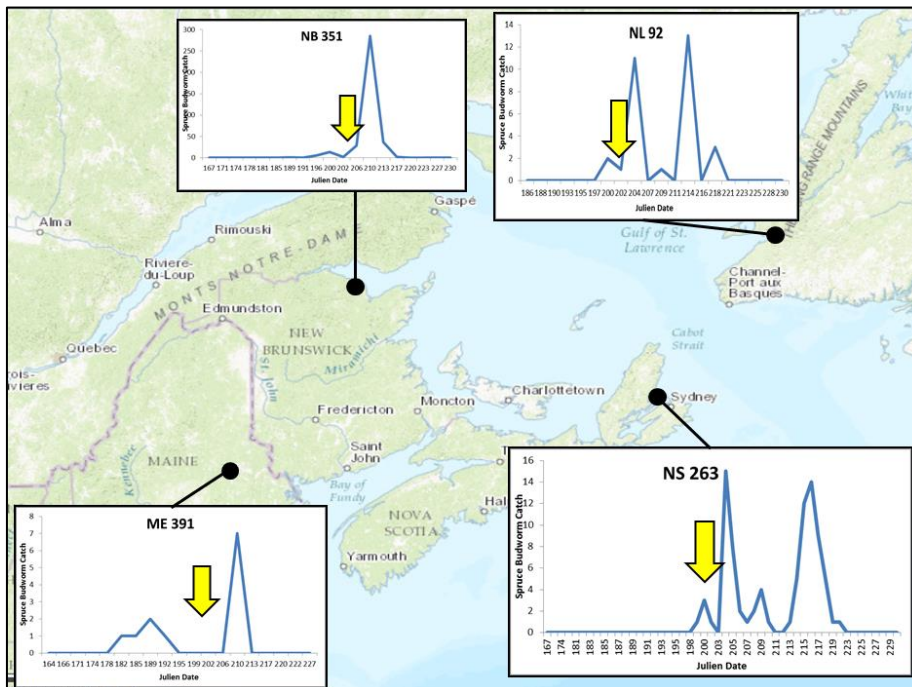


Figure 7. Actual results from our Budworm Trackers from 2016. The yellow arrow indicates when the mass dispersal event occurred. This data offers strong evidence for the range of budworm dispersal, which appears to be quite substantial!

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!



MASS DISPERSAL EVENT OF 2016: BUDWORMAGEDDON!

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 Quebec into New Brunswick (Fig. 8).

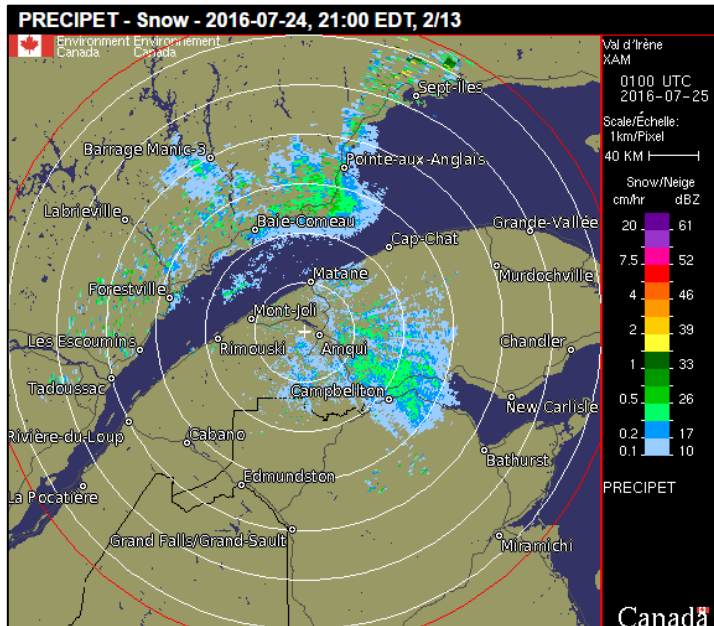


Figure 8. A snapshot from the weather radar at 9pm on July 24 centered over northern New Brunswick and Québec's North Shore and Gaspé Peninsula. This was a cloudless night with no rain – the blue and green represents a giant plume of budworm moths moving south!

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 (Fig. 9).



Figure 9. The aftermath. This is one of many Campbellton, New Brunswick parking lots that woke up to a dense carpet of fluttering budworm moths.



(CONTINUED) BUDWORMAGEDDON!

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, USA. From the moths we scooped up from parking lots and from around trees in Campbellton (Fig. 9), we discovered that nearly 80% of the moths were females, potentially carrying as many as 180-200 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 (e.g., Fig. 10), though there was evidence of some sparse egg deposits reaching as far as Nova Scotia.



Figure 10. Budworm moths covering a bush in Campbellton. These particular bushes, which were right in the eye of the storm, had nearly 10,000 eggs on a single 10 cm branch tip!

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 this year 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 2018.

Stay tuned for blog posts (and links) on our Twitter and Facebook pages where you can read about any new findings or publications and where you can see the fruits of your efforts.

SOME BUDWORM TRACKER AWARDS AND HONORS FOR 2016!

During the past year, Budworm Tracker was nominated for and received several science innovation awards! In April, we were finalists for the New Brunswick Knowledge and Innovation Recognition Awards (KIRA) in the "Innovation Champion" category (Fig. 11) and were nominated for the "Technological Advancement and Innovation in the Public Sector" category. The program also received a "Dedication and Exceptional Achievement Award" from the Canadian Forest Service and a departmental achievement award "Excellence in Science" from Natural Resources Canada. We share this award with you our exceptionally dedicated Budworm Trackers.



Figure 11. Some of the many "behind-the-scenes" characters from New Brunswick, representing the Budworm Tracker program at KIRA 2017.

From left to right, Allyson Heustis, Evan Shanks, Brigitte Richard, Ian DeMerchant, Kevin Porter, Emily Owens, Bernard Daigle, Rob Johns.



PLANS FOR THE UPCOMING 2017 SEASON

We're not making any changes to the program. Everything will stay the same! We do encourage you all to join in the conversation on social networks such as Facebook and Twitter. Post your catches, share your pictures, and feel free to ask us any questions. You can find us on twitter at #budwormtracker or on our Facebook page called...you guessed it..."Budworm Tracker"!

As the spruce budworm outbreak increases in both size and density, more moths may be moving from area to area so we highly encourage you to check your trap as often as possible. Although we already have good coverage of approximately 400 citizens scientists across northeastern America, we are still looking to "fill in the gaps" where we don't have any trackers. On our website, under the "resources" tab you'll find maps outlining some of the areas we're still trying to fill.

We have also provided a short survey for this year for Budworm Tracker participants willing to fill it out. These types of surveys are extremely helpful for refining and developing Citizen Science programs as they help us to understand something of the people that are participants in the program. We would emphasize that these are completely confidential and are only used for the purpose of science!

As always, if you have any questions, comments, or concerns, don't hesitate to contact us! We will get back to you as soon as humanly possible. In the meantime...
Happy Tracking!!

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:

Website: budwormtracker.ca

Email: info@budwormtracker.ca

Phone: (506) 452-3507 or (506) 292-5861

Facebook: facebook.com/budwormtracker

Twitter: #budwormtracker

YouTube: www.youtube.com/channel/UCkjymF5lIKu12efTrkrULIA

NB, NS, PEI	NFLD	QC	ON	ME
1350 Regent St.	26 University Dr	1055 PEPS	1219 Queen St.	168 State House Station
Fredericton	Corner Brook	Québec City	Sault Ste. Marie	Augusta
New Brunswick	Newfoundland	Québec	Ontario	Maine
E3B 5P7	A2H 6J3	G1V 4C7	P6A 2E5	04333-0168

