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Spruce Budworm in Maine 2020 Annual Report

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Spruce Budworm in Maine 2020

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Introduction

As growing spruce budworm populations continue to fluctuate in Maine, the Maine Forest Service, University of Maine Cooperative Forestry Research Unit (CFRU), and our cooperator network are tracking populations carefully in anticipation of an approaching outbreak.

A comprehensive spruce budworm (SBW) monitoring program requires a multi-pronged approach. It relies on using methods such as pheromone trapping, light trapping, overwintering L2 larval sampling, and both ground and aerial survey. At the core of the Maine Forest Service (MFS) monitoring program lies the extensive pheromone trap network throughout western and northern Maine's spruce-fir forests. A permanent pheromone trap network was first established in 1992. It was made up of 80 sites operated by MFS, J.D. Irving Ltd, Penobscot Nation Department of Natural Resources, and the USDA Forest Service. The program grew substantially in 2014, and since then, with the support of a large team of stakeholders, the pheromone trap network now consists of hundreds of sites.

SBW is a native insect whose outbreaks cover vast regions and spread through massive dispersal events as moths undergo atmospheric transport from impacted areas to new ones. In northeastern North America, SBW outbreaks tend to return on a 30-60 year interval, and the last major SBW outbreak to directly affect Maine occurred during the 1970s-80s. Historical data tells us that Maine is due for another SBW outbreak and monitoring efforts illustrate that over the last several years, SBW populations appear to have risen above endemic levels experienced between outbreak events. For several years now in Maine, both pheromone trap and light trap catches have been above numbers expected during the endemic period. Millions of acres of defoliation in neighboring Canadian provinces continue to encroach on the Maine border. From this outbreak area to the north, large in-flights of moths into northern Maine were well-documented in 2019. Atmospheric transport events of any appreciable scale largely lacked in 2020, however, meaning the majority of those moths recovered in 2020 have completed their life cycle here in Maine's forests. Now that all major portions of the 2020 SBW monitoring season are complete, the first glimpses of how these 2019 mass migration events might impact Maine's forests are being seen.

Spruce Budworm Pheromone Trap Survey Cooperator Network

American Forest Management	***Maine Bureau of Public Lands***
Appalachian Mountain Club	***Maine Forest Service***
Baskahegan Company	***Passamaquoddy Tribal Forestry Department***
Baxter State Park	***Penobscot Indian Nation***
Forest Society of Maine	***Prentiss & Carlisle***
Hilton Timberlands, LLC	***Rangeley Lakes Heritage Trust***
Houlton Band of Maliseet Indians	***Seven Islands Land Company***
J.M. Huber Corporation	***The Nature Conservancy***
J. D. Irving Ltd.	***USDA Forest Service***
Katahdin Forest Management, LLC	***Wagner Forest Management, Ltd.***
LandVest	***Weyerhaeuser***

Pheromone Trapping

Pheromone trapping methods follow a standardized protocol used by both Canadians and Americans since 1986 (http://phero.net/iobc/montpellier/sanders.html). Pheromone trapping efforts are concentrated in northern and western Maine, where the spruce-fir resource is greatest. Cooperators are asked to locate pheromone trap sites in spruce-fir-dominated stands greater than 25 acres at a density of one site per township or roughly every six miles along forest roads. Stands vary in tree size and degree of management, but as a minimum requirement, at least half the trees should be pole-sized or larger. Once established, cooperators tend to reuse sites annually, but sites are dropped or established due to active management, change in access, or other reasons.

The trap network employs re-usable Multipher traps baited with SBW pheromone lures made by ISCA Technologies and distributed by Solida and equipped with Vaportape II insecticide strips (1" x 4", 10% DDVP) made by Hercon Environmental. These high-capacity traps can monitor SBW moth numbers over a wide range of population densities ranging from 0–20 at low population densities to over l,000 per trap at high densities. Each site consists of three traps arranged in a triangle with ~130 feet between traps. Traps are deployed during the first three weeks of June and retrieved in mid-August or later. Once collected, the bulk of these samples are typically processed at the entomology lab in Augusta; however, we relied on additional counters at several satellite locations in 2020.

In 2019, a total of 383 usable SBW pheromone trap samples were collected throughout Maine (Figure 1). In 2020, a reduced target of 350 pheromone trap sites yielded a total of 345 usable samples from roughly the same geographic area, with fewer sites operated in western Maine (Figure 2). Overall, the statewide average pheromone trap catches fell substantially from 67 in 2019 to around 36 moths per trap in 2020 (Figure 3). The maximum average experienced for any site also fell from 534 in 2019 to 397 in 2020, and fewer sites averaging more than 50 moths per trap were recorded (Figure 4). Despite this drop in average trap catch, pheromone trap results for 2020 show that spruce budworm remains widespread across the state. The greatest population densities appear to be concentrated in northernmost Maine. This pattern reflects locations where 2019 mass transport events from Canadian forests with outbreak conditions terminated.

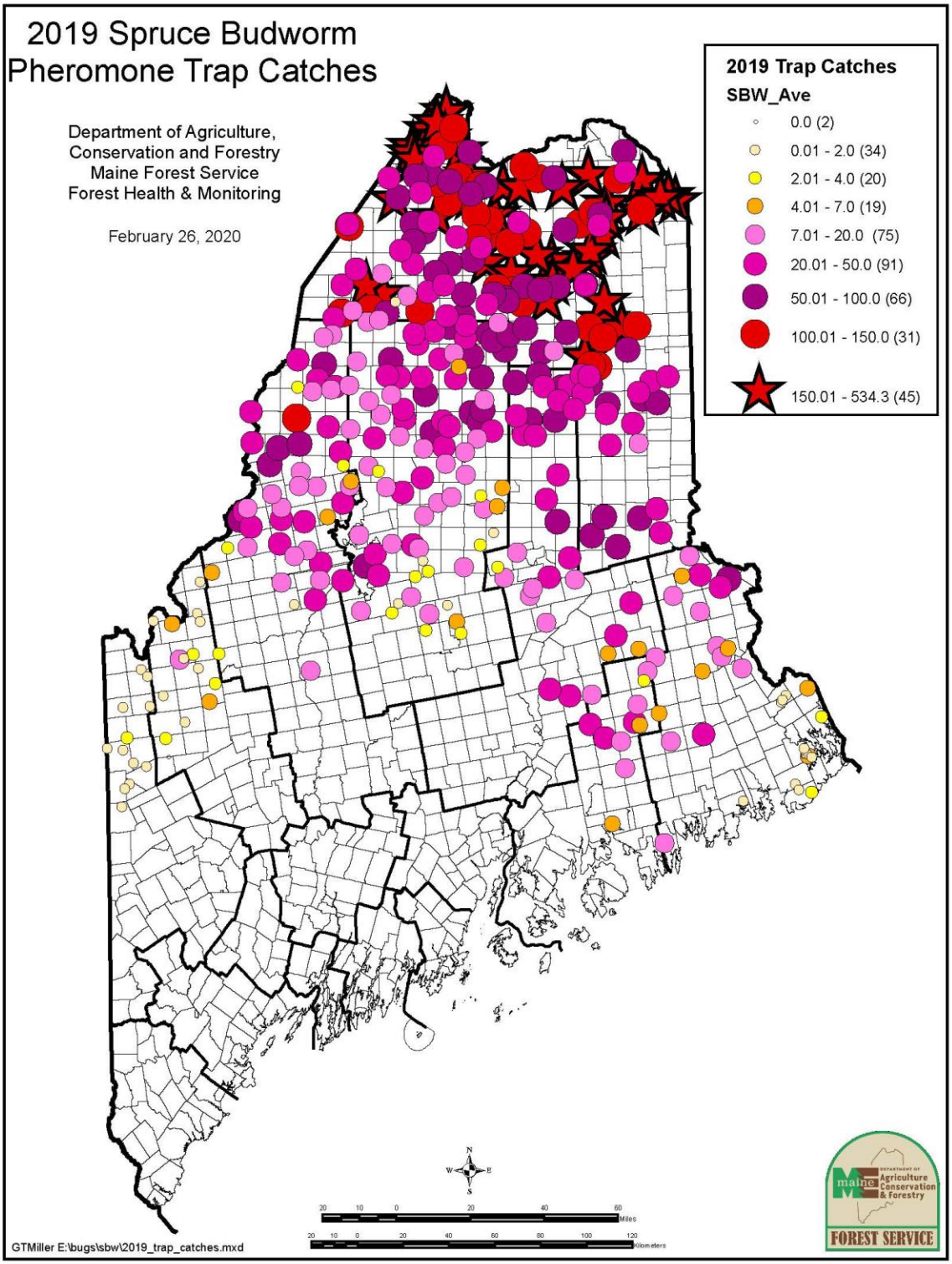

Figure 1. Map of statewide spruce budworm pheromone trap average catches, 2019.

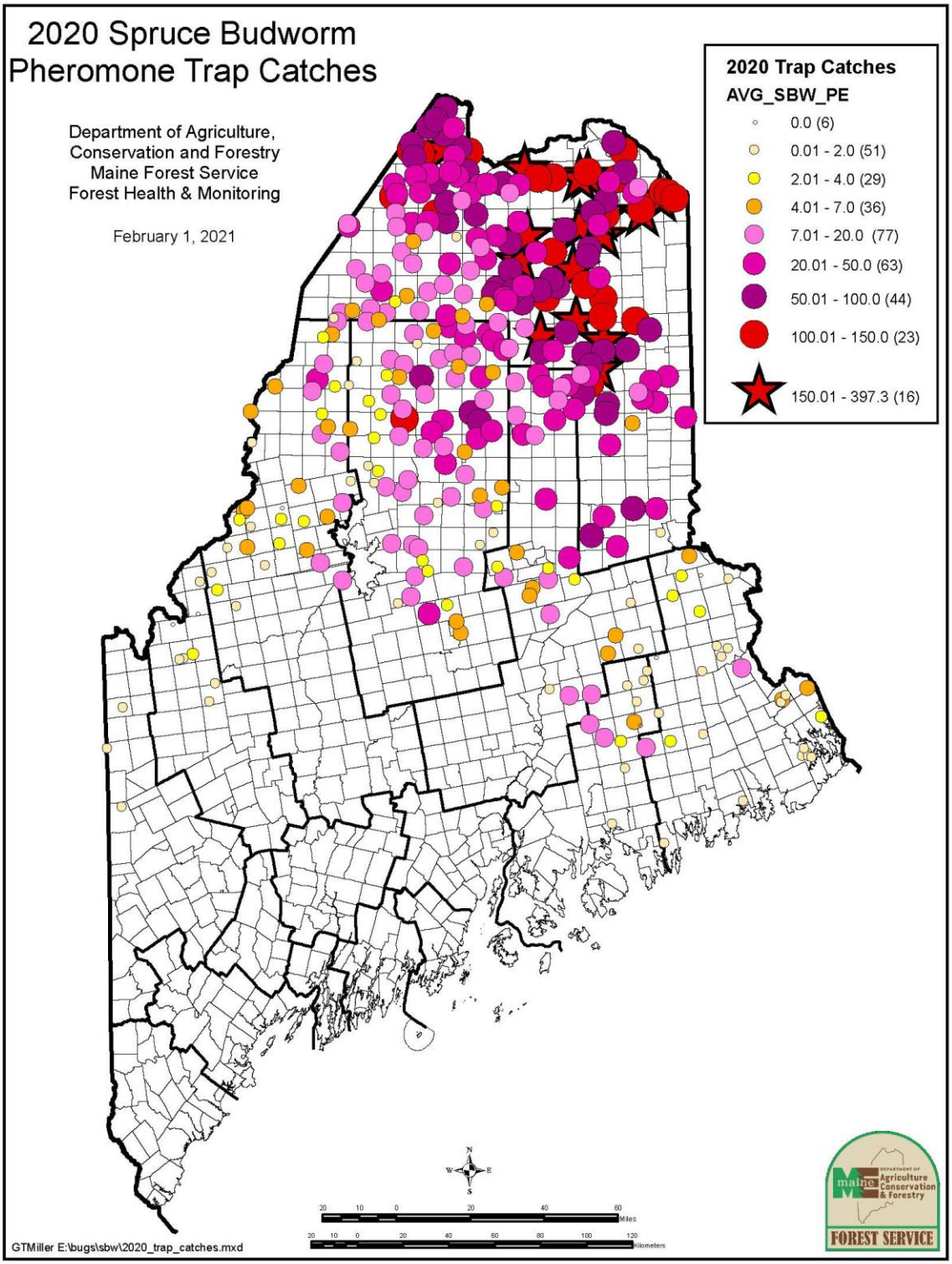

Figure 2. Map of statewide spruce budworm pheromone trap average catches, 2020.

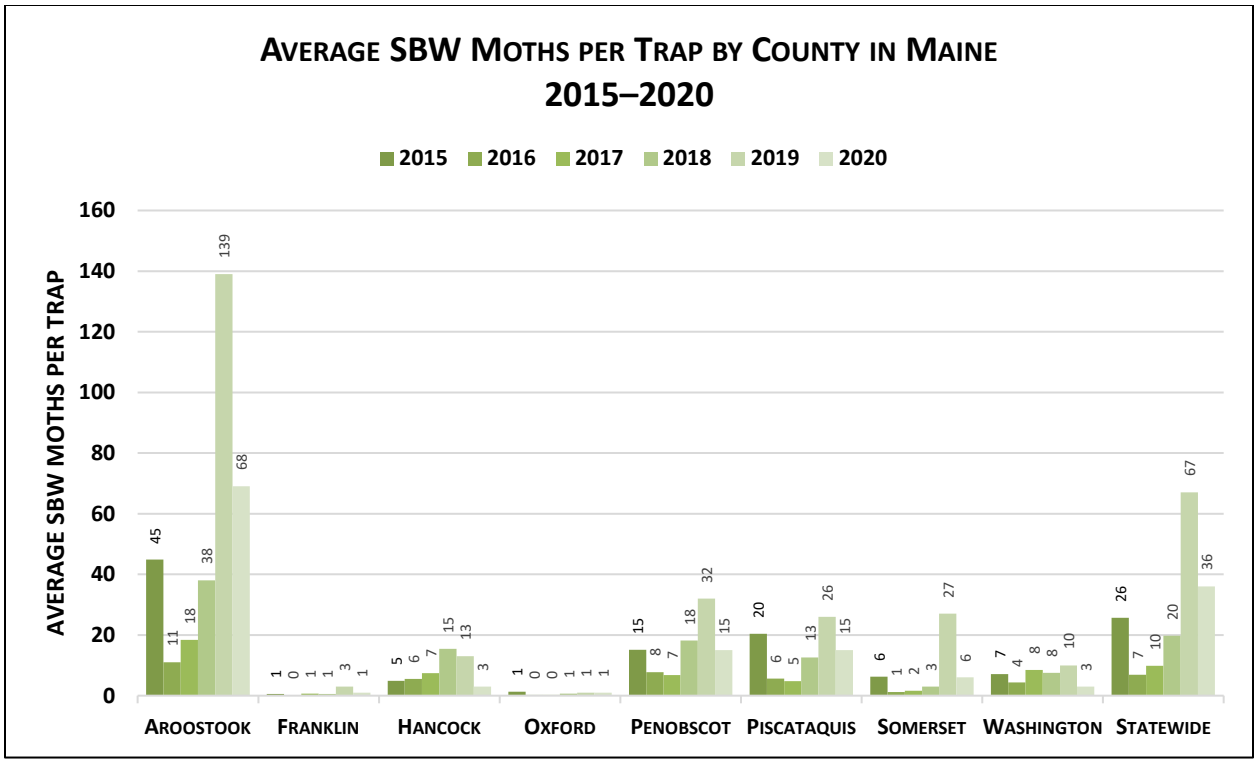

Figure 3. Average number of SBW moths in pheromone traps by county in Maine 2015–2020.

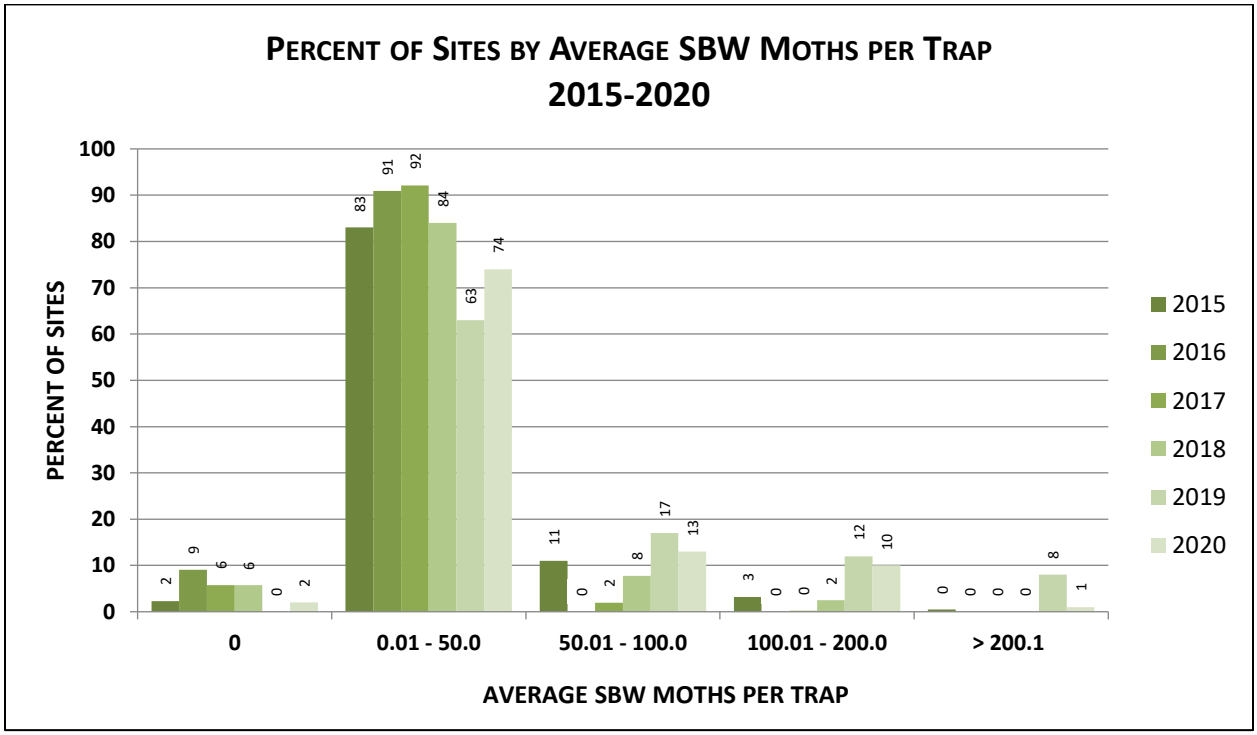

Figure 4. Percent of SBW pheromone trapping sites by average trap capture, 2015–2020.

As noted earlier, the Maine Forest Service has been monitoring a core set of long-term pheromone trap sites since 1992. Across these long-term sites, from 1992 to 2012, the average number of moths per trap remained well below 10. That average jumped to 18 in 2013, followed by a further increase in 2014 and 2015 to more than 20 moths per trap. Average catches fell to just seven moths per trap in 2016 and 2017, but once again returned to double digits in 2018 with an increase to 15 moths per trap. In 2019, we observed a dramatic increase as the average grew to about 55 moths per trap. Again, we suspect this 2019 statistic was largely influenced by mass migrations of SBW moths from outbreak areas in Canada. In 2020, the number remains elevated but has fallen to an average of 30 versus 55 in 2019 (Figure 5).

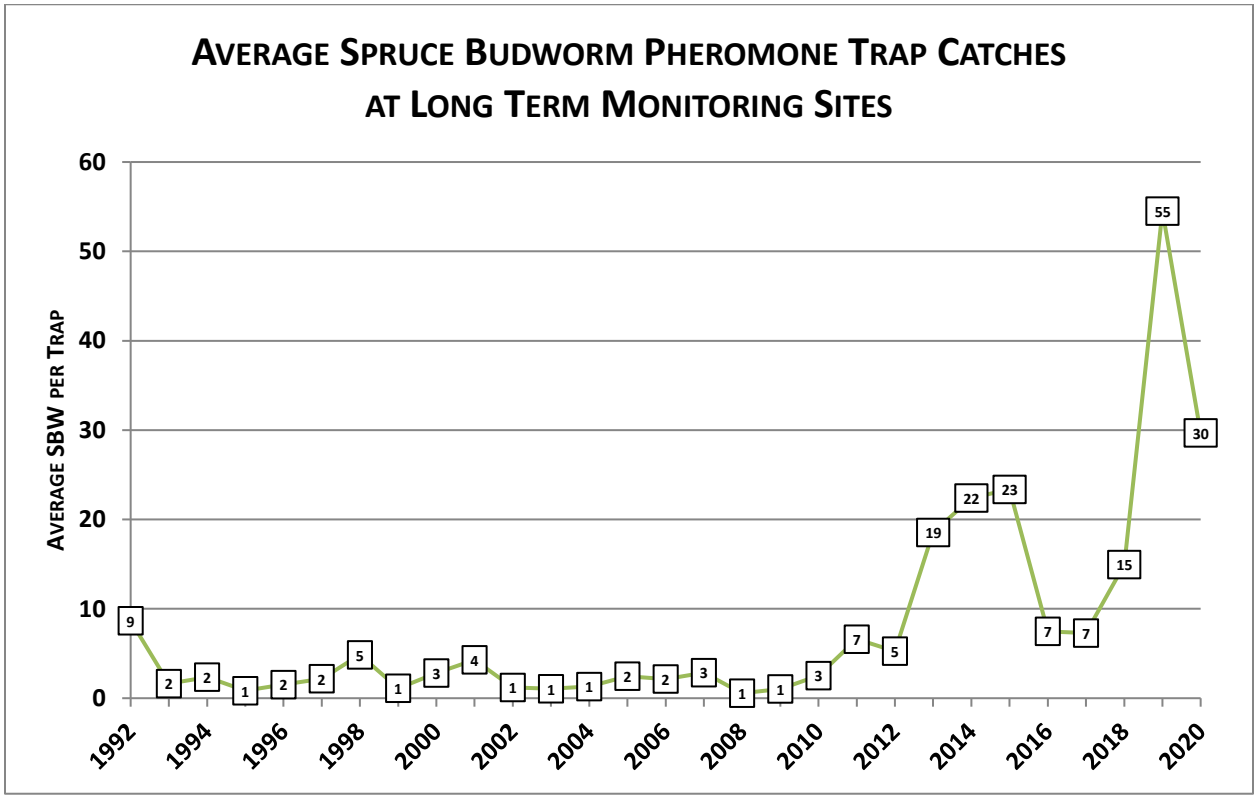

Figure 5. Average SBW pheromone trap catches at long term sites operated since 1992 by the Maine Forest Service, J.D. Irving Ltd., Penobscot Nation DNR, and USDA Forest Service.

Additionally, other volunteers in Maine are committed to collecting moths on a weekly or more frequent basis in pheromone traps. Data from these particular sample locations are included in the Healthy Forest Partnership's Budworm Tracker Program. This project is managed by the Healthy Forest Partnership and results can be requested at www.budwormtracker.ca.

Light Trapping

Light trapping has been used in Maine for more than seven decades to monitor forest defoliators and remains a useful tool for monitoring SBW moths. In 2018, 18 traps were operated by volunteers in Maine, and 12 of these sites caught a total of 202 SBW moths. In 2019, 17 light traps were operated statewide, and we witnessed a dramatic increase in SBW light trap catches, with 507 moths captured at 14 sites (Table 1, Figure 6). In 2019, most moths were recovered from just five sites in Aroostook County (135 in Garfield, 127 in Crystal, 89 in St. Pamphile (T15 R15 WELS), 65 in Clayton Lake Twp, 44 in Allagash, and 27 in New Sweden). Overall, there was a substantial decrease in capture to just 107 moths from all 18 light traps operated statewide in 2020. Unfortunately, several of the locations that proved to be the biggest producers in 2019, such as Crystal and St. Pamphile (T15 R15 WELS), were unable to be operated in 2020. We believe many of the moths captured in 2019 were Canadian-origin and those captured in 2020 to be moths that completed their life cycles in Maine. Regardless, notable decreases were still observed however in Allagash, Clayton Lake Twp, and Garfield.

Table 1. Spruce budworm moth capture in light traps from 2015 through 2020.

TOWN	COUNTY	2015	2016	2017	2018	2019	2020
Allagash	Aroostook	3	25	N/A	23	44	9
Ashland*	Aroostook	0	3	0	29	N/A	N/A
Big Twenty Twp	Aroostook	N/A	N/A	N/A	54	N/A	0
Bowerbank	Piscataquis	1	0	0	2	1	0
Calais	Washington	2	0	6	2	1	1
Cape Elizabeth	Cumberland	0	0	0	1	0	4
Clayton Lake Twp	Aroostook	N/A	N/A	N/A	10	65	2
Crystal	Aroostook	5	53	7	42	127	N/A
Exeter	Penobscot	0	0	0	2	0	0
Garfield	Aroostook	N/A	N/A	N/A	N/A	135	82
Jackman	Somerset	N/A	0	0	0	0	N/A
Madison**	Somerset	N/A	N/A	N/A	N/A	N/A	0
Millinocket	Penobscot	1	1	0	0	8	0
Monson	Piscataquis	N/A	N/A	N/A	0	3	0
Mount Desert	Hancock	N/A	4	N/A	0	N/A	0
New Sweden	Aroostook	2	3	0	12	27	7
Northport**	Waldo	N/A	N/A	N/A	N/A	N/A	0
Rangeley	Franklin	1	0	0	0	1	1
Salem	Franklin	N/A	N/A	0	0	4	0
South Berwick	York	0	0	0	0	1	1
Topsfield	Washington	0	44	18	22	1	0
T3 R11 WELS	Aroostook	2	13	0	0	N/A	N/A
T15 R15 WELS	Aroostook	17	0	10	3	89	N/A
TOTAL NUMBER OF SBW MOTHS		**34**	**146**	**41**	**202**	**507**	**107**

* Site retired in 2019

** New site in 2020

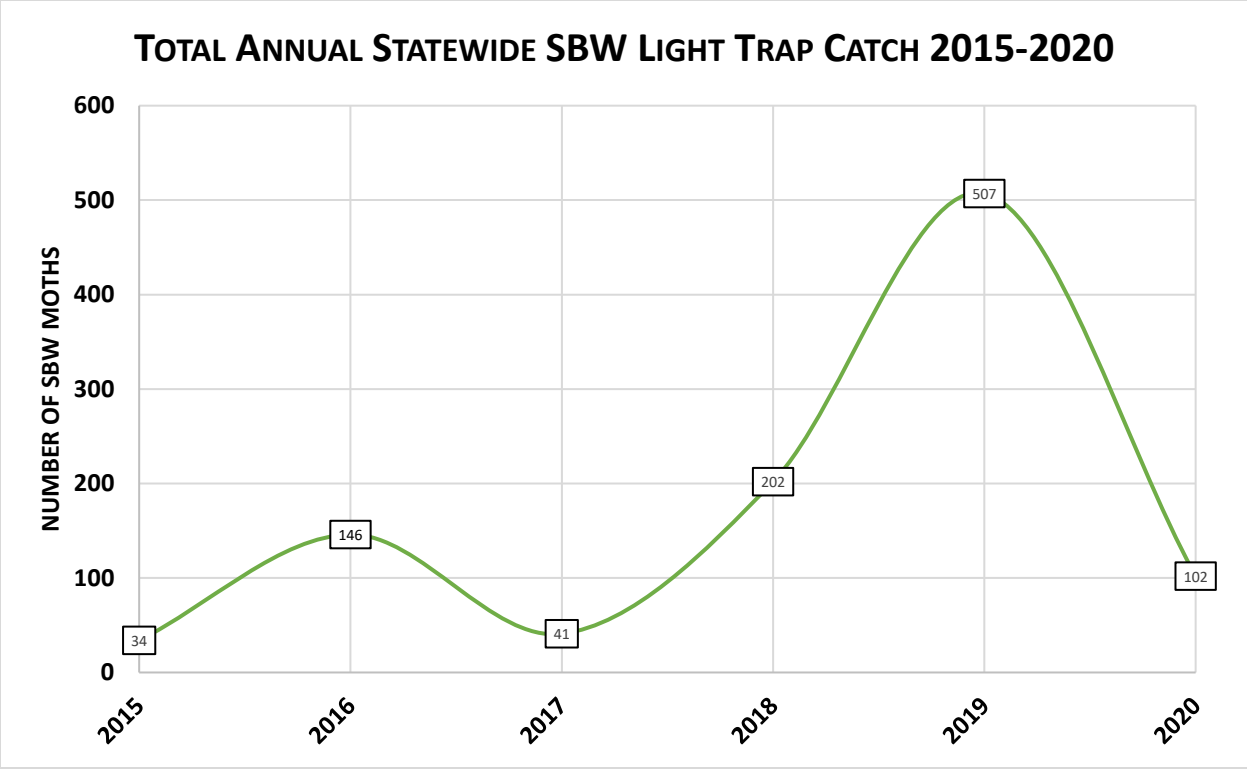

Figure 6. Total annual statewide light trap catches of SBW moths 2015–2020.

Overwintering L2 Larval Sampling

The University of Maine Cooperative Forestry Research Unit (CFRU) continues to lead the overwintering larval sampling portion of the monitoring program, targeting second instar (L2) larvae, in conjunction with the Canadian Forest Service as part of the Healthy Forest Partnership. The L2 project goals are to: (1) assemble a broadly distributed, long-term time series of budworm population monitoring data (2) enhance opportunities for management planning by identifying incipient local populations as early as possible (3) add to a database that can be linked with vegetation data and information about natural enemies in the future to fill important knowledge gaps about how landscape conditions influence local outbreak dynamics.

Since 2014, branch samples from SBW host species, primarily balsam fir, have been collected during the fall or winter in areas where pheromone trap catches were high, where modeling has predicted at-risk stands, or where previous samples had been collected. At each sample site, one 30-inch-long branch is cut from the mid-crown of each of three trees. Branch samples are sent to Canada for processing at the Canadian Forest Service lab in Fredericton, NB. Results of the 2019 and 2020 statewide overwintering L2 larval survey can be seen on the following maps (Figures 7 and 8). Please note that the 2019 map below appears differently from the 2019 report, as its scale and symbology have been converted to mirror that of the new 2020 map for ease of direct comparison.

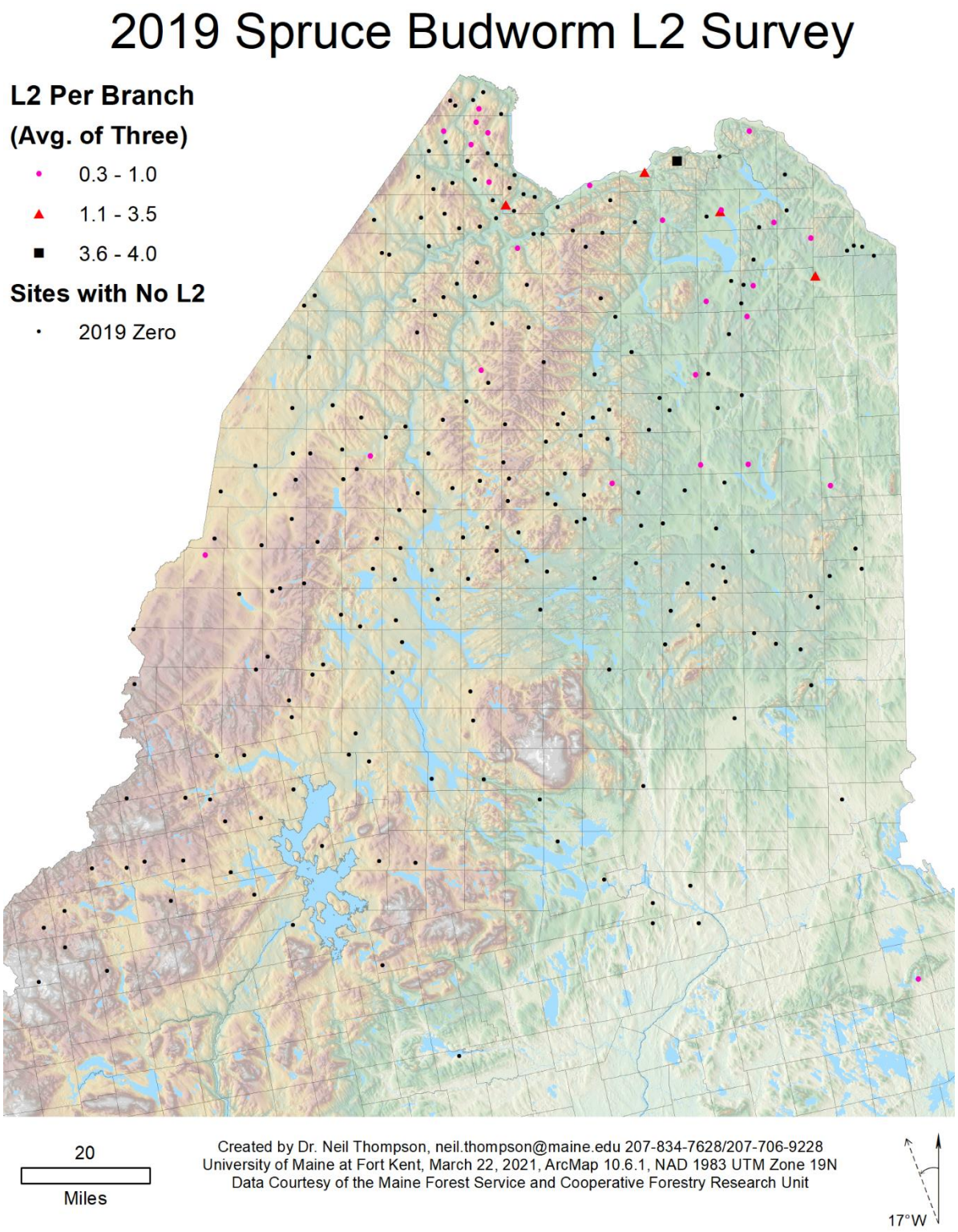

Figure 7. Map of statewide results for 2019 overwintering spruce budworm L2 larvae survey.

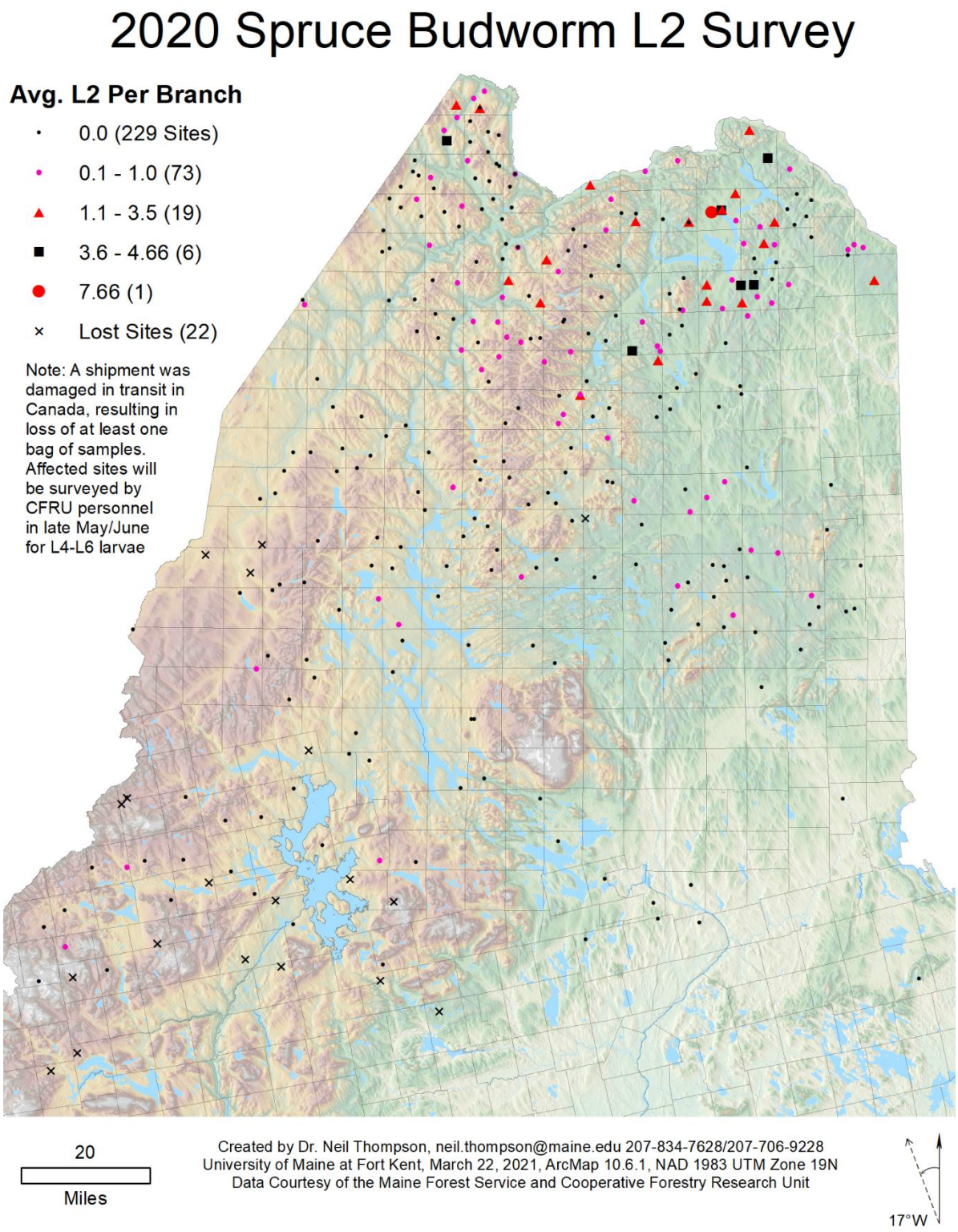

Figure 8. Map of statewide results for 2020 overwintering spruce budworm L2 larvae survey.

The final results of the 2020 overwintering L2 larval survey serve as yet another piece of evidence supporting observations of a rise of SBW activity in Maine and demonstrate a clear increase in the number of larvae recovered compared to 2019. A total of 309 larvae were collected from branch samples taken at 328 sites across the state in 2020, versus only 70 larvae recovered from 317 sites in 2019. The larvae collected in 2020 came from a total of 99 independent sampling sites compared to just 29 sites in 2019, indicating a more widespread distribution of growing SBW populations. The greatest average recorded at any site in 2019 was 3.1 - 4.0 larvae per branch and was documented at just one site. In 2020, six sites averaged from 3.6 to 4.66 larvae per branch, and most notably, a single site in Cross Lake Township that averaged 7.66 larvae per branch. Also of note for this general area, large populations of mature SBW larvae were observed during summer 2020 on a tree plantation in neighboring New Canada Township, as well as during mid-season defoliation survey at another location in New Canada Township.

The sampling site in Cross Lake Township marks the first time since L2 sampling resumed that the samples have uncovered a population above the management threshold of the SBW Early Intervention Strategy (EIS) threshold being employed in Atlantic Canada. The result has triggered additional L2 sampling by cooperators to help inform management response. More information on the Canadian EIS program can be found online at https://healthyforestpartnership.ca/what-we-do/targeting-and-treating/ or by reading the suggested articles referenced at the end of this report.

Even though this clear increase appears to be significant, there remains some doubt as to whether branch samples collected during the 2019 survey were of sufficient quality to provide a representative estimate of 2019 larval populations. Reports from staff at the lab where these branch samples were processed indicated that many may have come from too low in the canopy, rather than mid-canopy positions specified in sampling protocols, which in turn may have affected larval counts. This suspicion was somewhat supported by follow-up surveying in 2019 where samples at sites initially with trace L2 counts were re-sampled at mid-canopy positions in response to this feedback. At some sites the difference was minimal, while at others the follow-up was several times higher than the original count. Therefore, it is possible that the overall overwintering L2 larval population was underestimated originally in 2019 and already at elevated levels at that point. Lab staff reported that all but a few 2020 samples appear to have come from the proper mid-canopy positions, giving a higher degree of confidence in the current year's population estimate.

Statewide Defoliation Survey

Prior to being submitted for L2 assessment, all branch samples collected undergo defoliation assessment by CFRU student employees using the Fettes Method, which systematically quantifies missing foliage on current-year growth. It was used during the last budworm outbreak in Maine and is currently being used in the Canadian provinces. The Fettes Method captures defoliation from all causes and can be used to estimate both current-year defoliation and cumulative defoliation. A brief introduction to the Fettes Method is provided in this document: http://www.sampforestpest.ento.vt.edu/defoliating/spruce-budworm/pdf/montgomery-etal1982-sbw.pdf. Results of the 2019 and 2020 Fettes defoliation assessment survey performed by CFRU are displayed on the maps below and each point represents the average defoliation of three branch samples taken at each site (Figures 9 and 10).

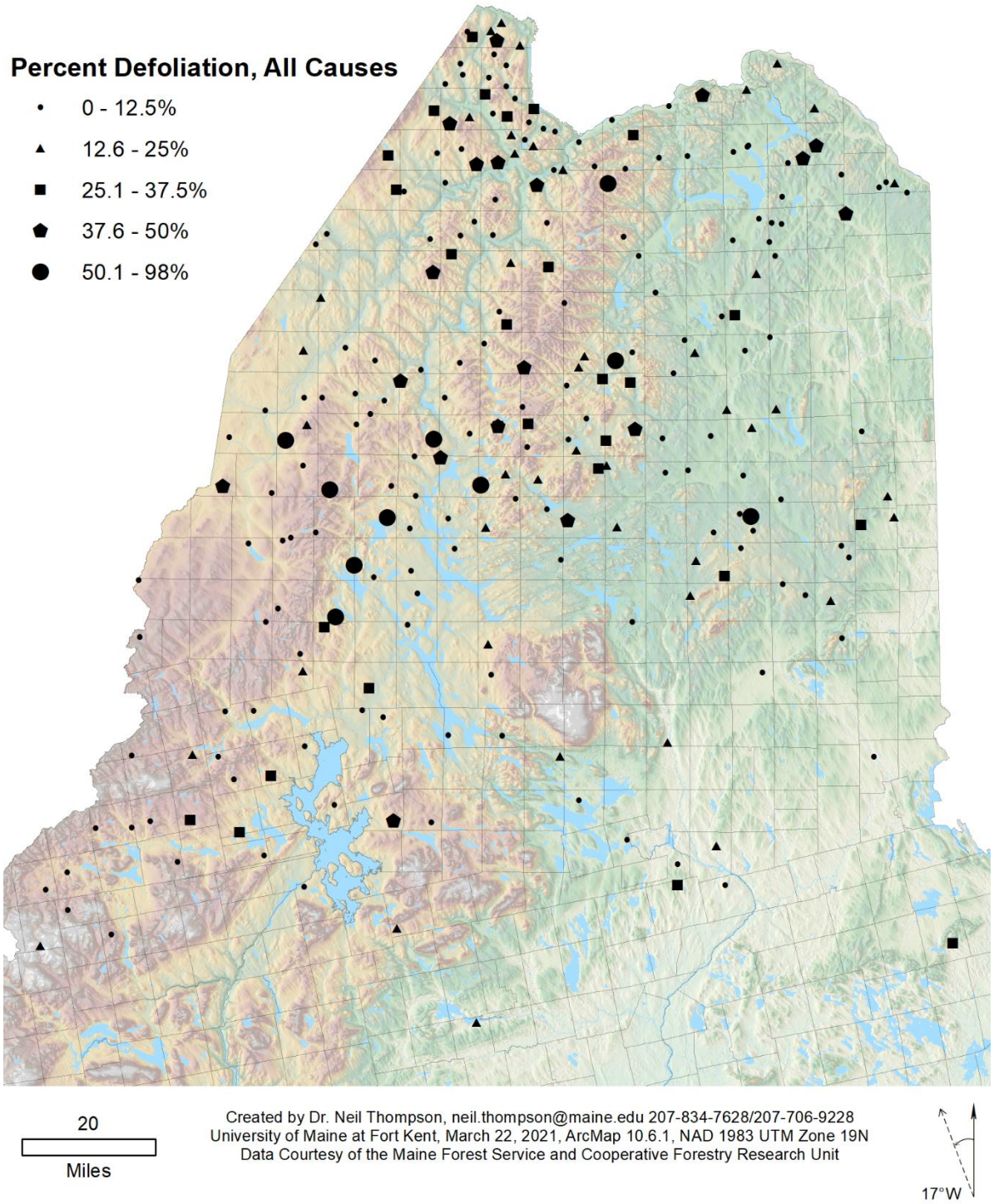

Figure 9. Map of statewide results for 2019 Fettes defoliation survey.

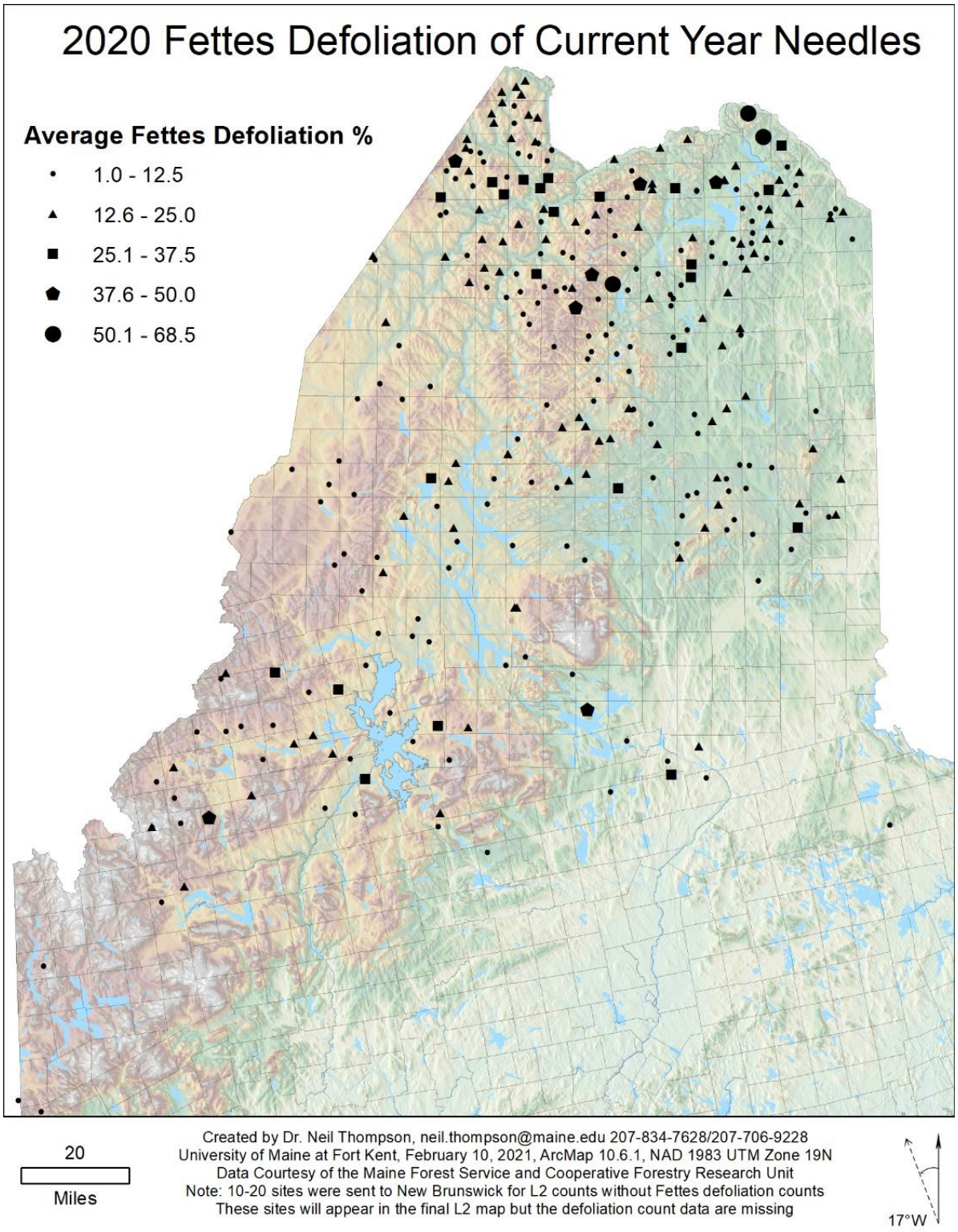

Figure 10. Map of statewide results for 2020 Fettes defoliation survey.

Results of the 2020 Fettes defoliation assessment survey appear to support other observations of a slight increase in larval feeding activity concentrated in northernmost Maine. The trend from 2019 to 2020 does not appear dramatic, as only a small percentage of sites were designated as having moderate or high defoliation levels, with again no sites designated as severe in 2020. More noticeable is the shift from a larger percentage of sites from the trace category and into the low category (Figure 11), potentially indicating a slow and steady buildup of populations despite an apparent drop in pheromone trap catches from 2019 to 2020.

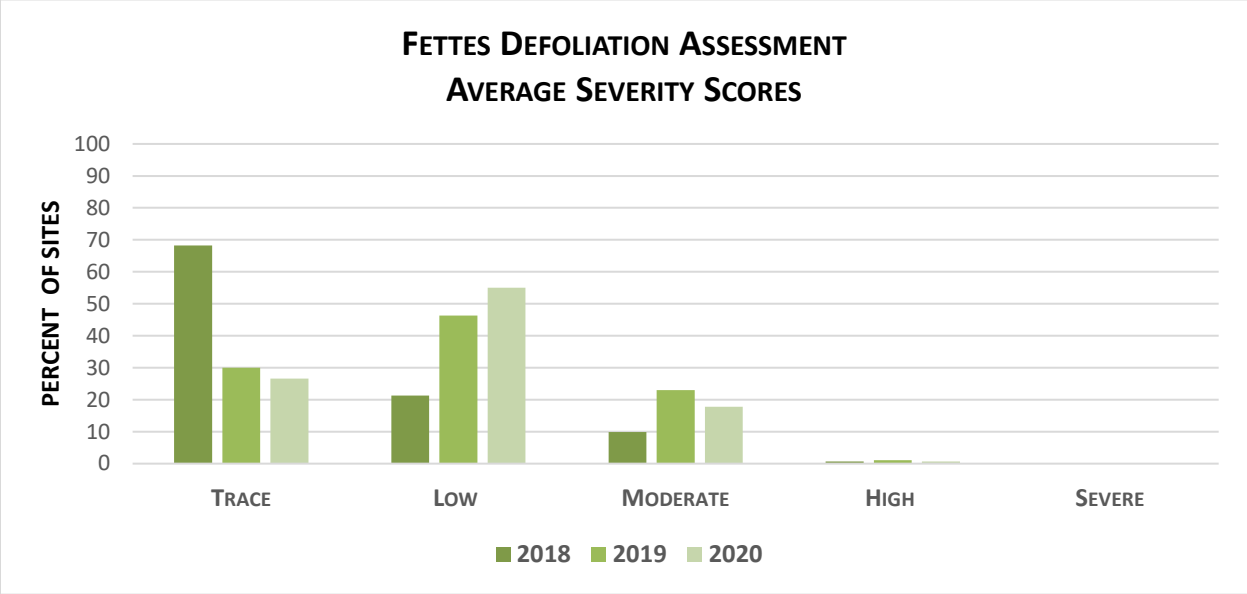

Figure 11. Percentage of sites by defoliation severity as categorized using the Fettes defoliation assessment protocol.

Aroostook County Mid-season Defoliation Surveys

Both ground and aerial surveys were conducted in 2020, looking specifically for spruce budworm in northern Maine where damage would be expected to first appear. For the first time since the end of the last major SBW outbreak in Maine, mature SBW larvae were easily found at survey sites in northern Penobscot and Aroostook Counties (Figure 12). Despite this, aerial survey efforts still detected no visible defoliation even when flown over areas known to have elevated larval populations. A mid-season defoliation survey at 60 sites in Aroostook County found widespread, low-level defoliation from SBW (Figure 13). Of these, 39 were characterized as trace, 19 as low, and two as moderate. No sites were characterized as high or severe. These sites will be re-evaluated in 2021 for comparison.

Figure 12. Defoliation and mature spruce budworm larva from northern Maine, 2020.

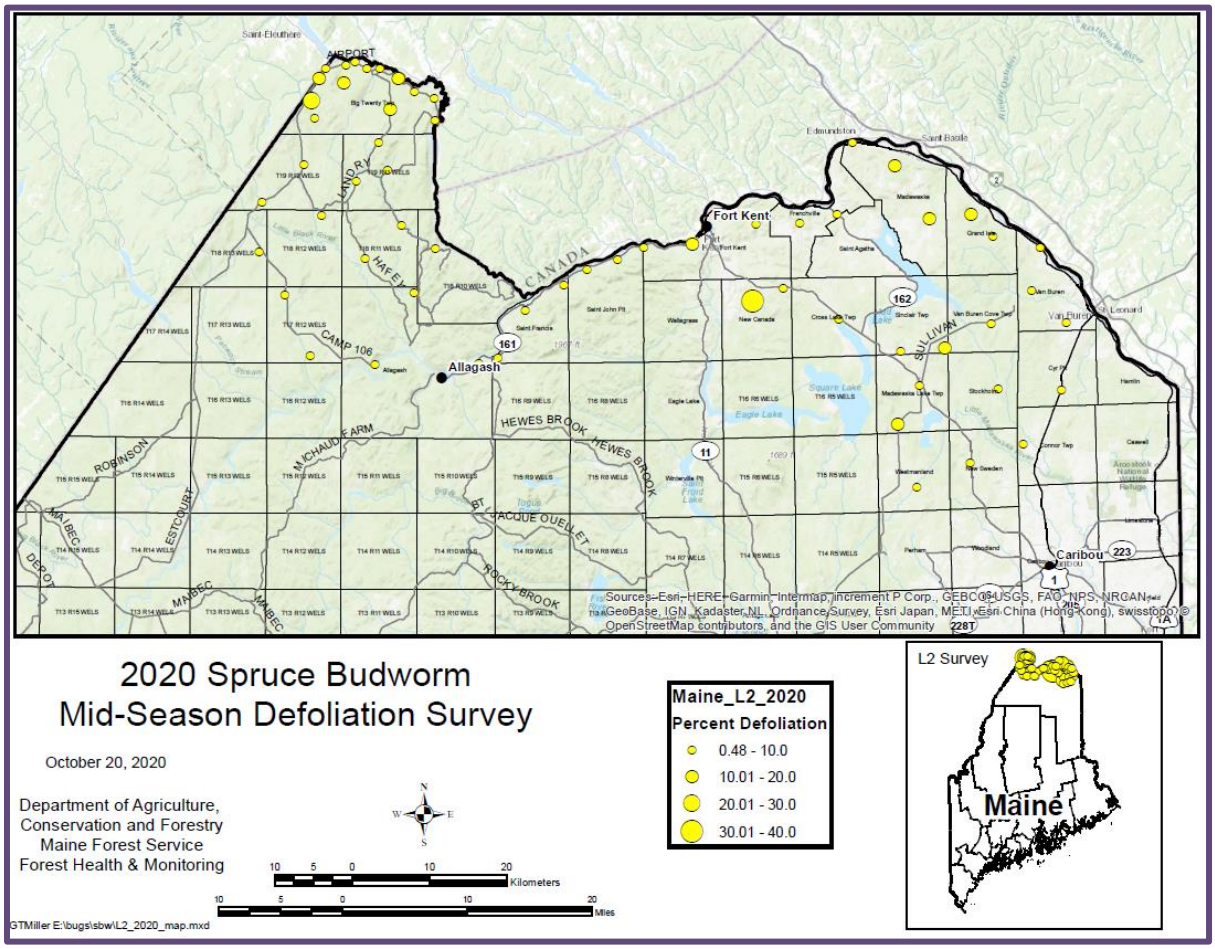

Figure 13. Map of sites evaluated during 2020 SBW mid-season defoliation survey and corresponding defoliation intensity.

Closing Remarks

Although this story will continue to evolve quickly, the results of Maine's spruce budworm monitoring program over the past several years highlight how important these monitoring activities are in order to ensure a full suite of management approaches are available. Pheromone trap and light trap catches over nearly the past decade now have fluctuated, often frustratingly for managers, without necessarily confirming any clear trajectory for Maine's SBW population trend. The story now appears to be unfolding more clearly now, with a well-documented beginning in the form of mass transport of SBW moths into Maine in 2019. As we continue to collect information, the data continue to point to an expansion of spruce budworm populations here in Maine's forests. As always, it is our hope that this information will provide managers with insight on what might lie ahead, and that adequate preparations and responses are made. We encourage all stakeholders to pay close attention to this situation. We will continue to provide updates in our Conditions Reports and through Spruce Budworm Task Force communications during the 2021 season as information becomes available.

Recommended Readings

Johns, R.C.; Bowden, J.J.; Carleton, D.R.; Cooke, B.J.; Edwards, S.; Emilson, E.J.S.; James, P.M.A.; Kneeshaw, D.; MacLean, D.A.; Martel, V.; Moise, E.R.D.; Mott, G.D.; Norfolk, C.J.; Owens, E.; Pureswaran, D.S.; Quiring, D.T.; Régnière, J.; Richard, B.; Stastny, M. ***A Conceptual Framework for the Spruce Budworm Early Intervention Strategy: Can Outbreaks be Stopped?*** Forests *2019,* 10*, 910.* *https://doi.org/10.3390/f10100910*

MacLean, D.A.; Amirault, P.; Amos-Binks, L.; Carleton, D.; Hennigar, C.; Johns, R.; Régnière, J. Positive ***Results of an Early Intervention Strategy to Suppress a Spruce Budworm Outbreak after Five Years of Trials.*** Forests *2019,* 10*, 448. https://doi.org/10.3390/f10050448*

Acknowledgements

On behalf of the Maine Forest Service, we wish to thank our cooperators for their continued participation and dedication to this large-scale and long-term project. The overall success of this program would not be possible without them. This was especially true in a field season plagued with countless logistics issues for all parties stemming from the ongoing COVID-19 pandemic.

Special thanks are due to our partners at the University of Maine Cooperative Forestry Research Unit, especially Dr. Neil Thompson and his staff, who continue to coordinate the ever important overwintering L2 larval survey. It is remarkable that the L2 survey results were available with little delay despite the new challenge of international shipping when border closings prevented in-person delivery of samples. Note that the maps for both the statewide Fettes defoliation assessments and L2 surveys are prepared and provided by Dr. Neil Thompson as well.

That impressive feat also owes to all the hard work of the staff at the Canadian Forest Service Lab where these samples are processed, to whom we are also extremely grateful. On that note, thanks to each and every one of our other SBW colleagues in Canada as well, who provide constant guidance on many aspects of our SBW monitoring and management activities.

Another special thanks is due to all of those Maine Forest Service staff who participated in receiving and counting SBW samples as they came in from the field this season. Counting duties usually fall on the shoulders of a few select staff, however the team was much larger in 2020 to help overcome issues with moving samples around when the usual options of in-person drop-offs and routine hand-offs of samples were simply not available.

This program would not be able to function as well as it does without the assistance and experience our Senior Entomology Technician in northern Maine, Joe Bither. In addition to other SBW tasks, he alone performed the 2020 mid-season defoliation survey across northern Aroostook County. Finally, thanks to Greg Miller for mapping these and all the rest of our SBW survey results for us.

We are looking forward to the upcoming monitoring season and working with all of you once again.

Best,

Mike Parisio