

MAINE STATE LEGISLATURE

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Spruce Budworm (*Choristoneura fumiferana*) in Maine 2015

Charlene Donahue, Forest Entomologist
Maine Forest Service
Department of Agriculture, Conservation and Forestry
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Spruce budworm is being closely monitored in Maine in order to plan for another outbreak of this native defoliator. Spruce budworm populations have shown a steady rise over the past four years from almost non-existent to moths being present in most pheromone traps set out. Defoliation has not been observed in Maine yet but increasing levels of adults here and in New Brunswick indicate that noticeable feeding on fir and spruce may not be far off. Quebec's infestation now encompasses over 15.6 million acres and has spread south onto the Gaspé Peninsula from north of the Saint Lawrence Seaway. This is an insect that goes into outbreak mode over vast regions and flights of moths from heavily infested areas can migrate to new areas.

The Maine Forest Service (MFS), cooperators within and outside the state, and Canadian provinces are working together to monitor and predict the growth of the spruce budworm population and its potential impact on the Maine forests. Pheromone traps, light traps, overwintering larval samples, ground and aerial surveys are being employed to determine the trend of spruce budworm.

The most sensitive method of monitoring budworm is pheromone traps. Permanent pheromone trap locations were established in the early 1990's across the northern half of the State and have been run yearly for the past twenty years. Last year the monitoring program was significantly expanded with 21 land owners and managers participating in setting and retrieving traps at 412 sites. The pheromone trap monitoring program was run again in 2015.

In 2015 spruce budworm pheromone traps were placed at 448 sites (Appendix 1) across the northern half of Maine. Traps were placed by the following 21 land owners or managers:

Table 1. Spruce Budworm Pheromone Survey Cooperators

American Forest	North Maine Woods
Appalachian Mountain Club	Orion Timberlands
Baskahegan	Parks and Lands
Baxter State Park	Penobscot Experimental Forest
Forest Society of Maine	Penobscot Nation
Huber Corporation	Plum Creek
J. D. Irving	Prentiss and Carlisle
Katahdin Forest	Seven Islands
LandVest	University of Maine
Maine Forest Service	USDA-FS
	Wagner Forest Management

It was requested that traps be placed approximately one per township or every six miles with traps placed in stands that were 25 acres or larger and at least 50% pole-sized or larger spruce/fir. Cooperators chose the sites based on where they had an interest in monitoring for spruce budworm. The trees were mature or pole sized trees, uncut or lightly cut spruce-fir stands and could be pre-commercially thinned or shelterwood stands.

The trapping method follows standardized protocol used by both Canadians and Americans since 1986. <http://phero.net/iobc/montpellier/sanders.html>.

At most site there was a three trap cluster with traps arranged in a triangle with traps 130 feet from each other, away from the road and at an average elevation for the area. Traps were set out during the first three weeks of June and retrieved after mid-August. The catch was mailed to the MFS Entomology lab for processing.

At nine ten of the locations traps were checked twice a week (Appendix 2). This allows us to see when moth flights peak and compare it to predicted emergence for the location. Late season flights indicate in-migration from north of us i.e. the Quebec infestation. Additionally, a University of Maine graduate student was doing a bird study and he put out 129 traps in Maine (plus more in New Hampshire!!). Those trap numbers have been averaged for the townships where they were placed and added to the other data.

The expanded spruce budworm pheromone survey shows spruce budworm is widespread but at still at low numbers across the trapping range (Figure 1 & 2). Trapping effort was heaviest in the northern third of the state, light across the middle of the state, with no trapping in the south where budworm is not expected to have an impact. Of the 448 trap sites, 11 had no sample, most often due to bears, while the remaining 437 sites had at least one trap out of three intact. Only ten sites had no budworm in any of the traps which translate into 98% of the sites with budworm. The majority of the positive [?] sites (98%) have moth catches in the detectable but low range and the number are slightly higher than in 2014 (Figure 3). Once the number of moths/ pheromone trap rise above 100 moths/trap then defoliation may become detectable.

Figure 1.

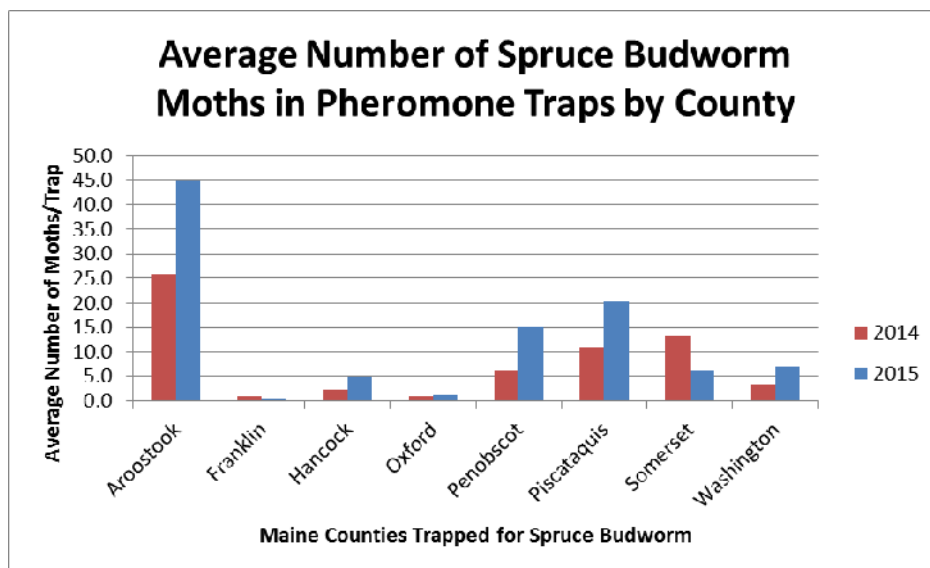
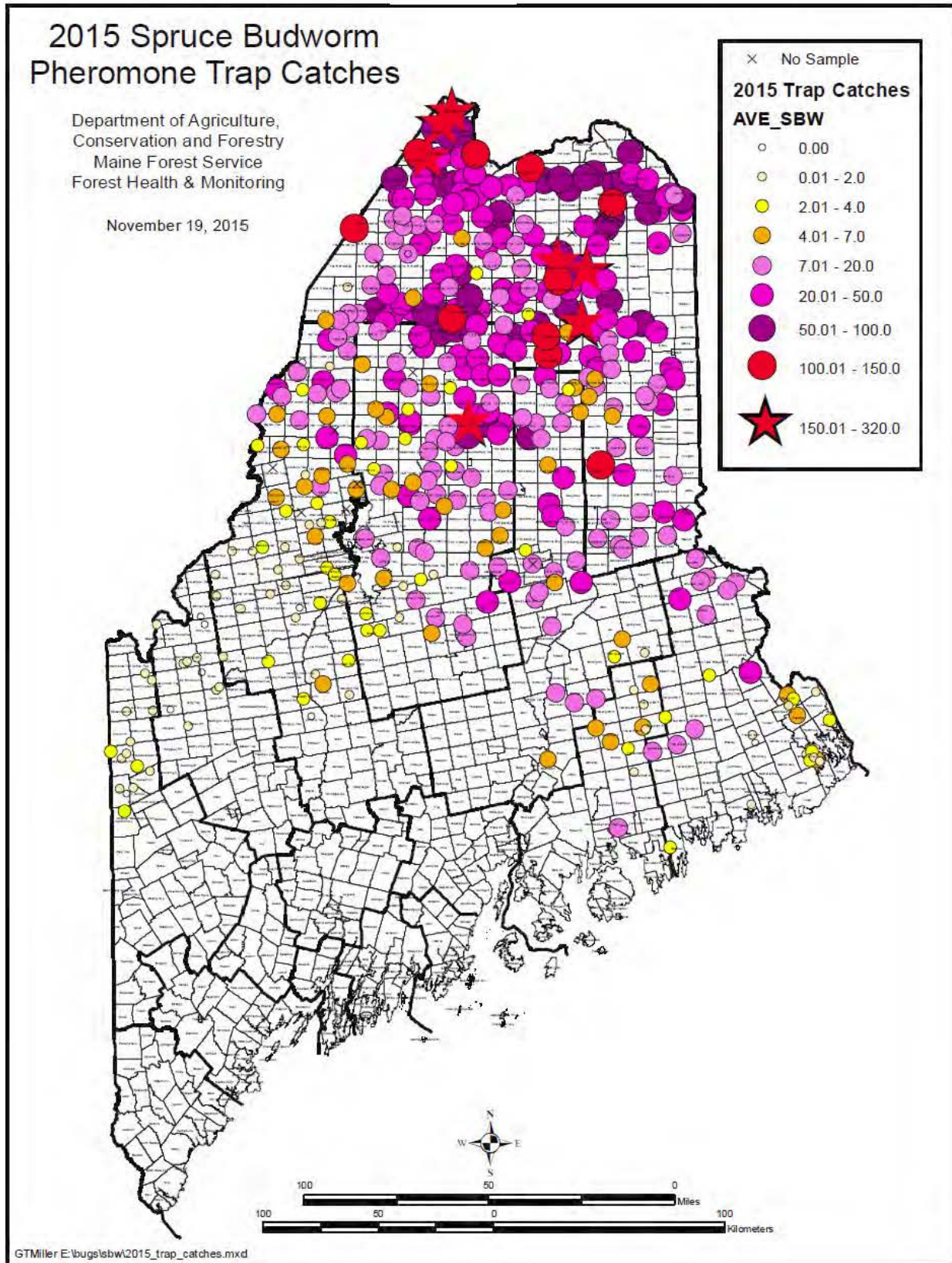
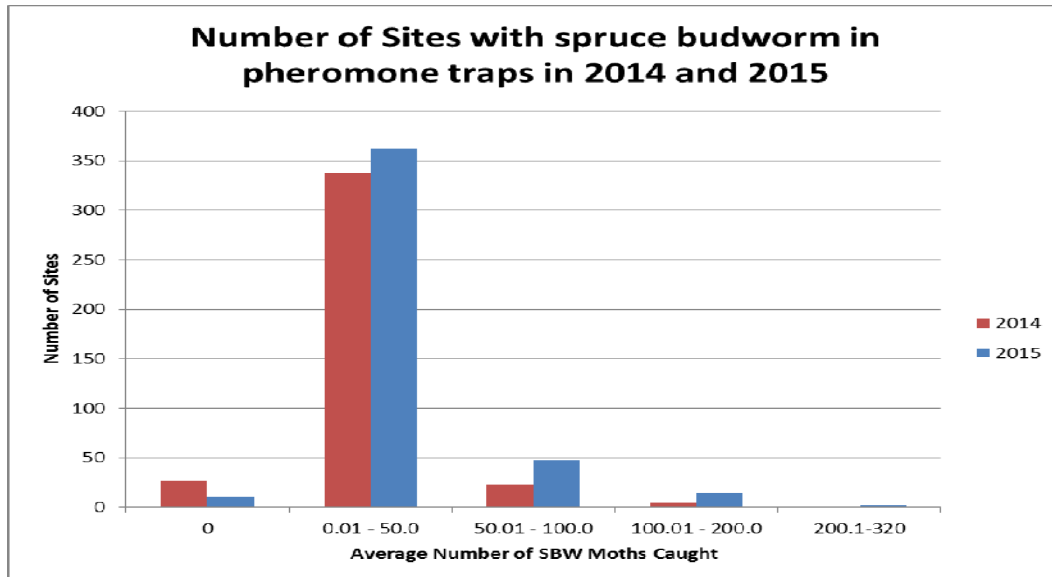


Figure 2.



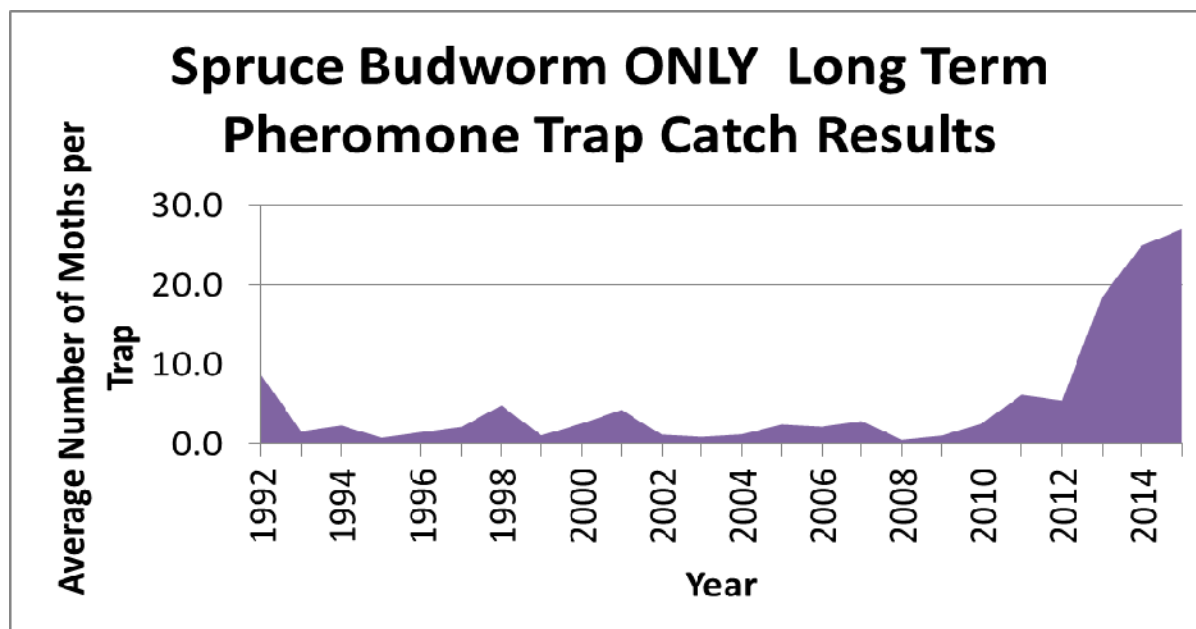
Aroostook County encompasses the most northerly part of state and was the most heavily trapped with 181 locations as compared to 164 sites in 2014. It had the highest average number of moths up from 25.8 per trap to 44.9 moths in 2015. Somerset, Piscataquis and Penobscot Counties were trapped primarily in the northern half of each county accounting for the lower number of traps in those jurisdictions. The numbers of moths in Piscataquis and Penobscot counties doubled from last year while the number in Somerset fell by half (Figure 1). One possible explanation for the 2015 decrease in moths in Somerset County may be that there was a moth flight from Quebec in 2014 that bumped up counts in a cluster of traps. The numbers of moths is still very low and fluctuations of just a few moths can make the numbers change dramatically. The other counties, Franklin, Hancock, Oxford and Washington all had less than ten moths /trap. These very low numbers in all but Aroostook County mean there is still time to plan for a spruce budworm outbreak.

Figure 3.



As noted earlier, the MFS has been running spruce budworm pheromone traps for the past 23 years. During that time the average number of moths/trap stayed well below 10 moths/trap until 2013 when the number jumped to 18 moths/trap (Figure 4.) In 2014 it went up to 25 moths/trap and this year is at 27 moths/trap.

Figure 4.



Light traps have been used in Maine for decades to monitor spruce budworm populations and other forest defoliators and continue to be used today. This year 18 traps were run by Maine residents in their backyards (Appendix 3). They are paid a small stipend for checking the traps daily.

Budworm moth counts from light traps were low with five traps catching 29 moths (Figure 5.) Last year seven traps caught 84 moths. For the past three years five to seven traps have caught spruce budworm moths but, with the exception of Allagash and T15 R15 WELS, it has been varying traps over the years (Appendix 3). In the 10 years previous to 2013 there were less than 10 spruce budworm moths caught in all the light traps combined. Therefore the past three years are a significant increase but not enough to see defoliation yet. At such low numbers apparently wide fluctuations are not surprising as there are only a few locations where the moths may happen to get caught.

Figure 5.

Spruce Budworm Caught in Light Traps in 2015		
Town	County	SBW Moths
Allagash	AROOSTOOK	3
Calais	WASHINGTON	2
Crystal	AROOSTOOK	5
New Sweden	AROOSTOOK	2
T15 R15 WELS	AROOSTOOK	17
Total number of moths		29

The University of Maine Cooperative Forestry Research Unit headed up an “L2” sample program in conjunction with the Canadian Forest Service in both 2014 and 2015. Branch samples were taken during the fall and winter in areas where pheromone trap catches had been high or modeling predicted at-risk stands. Three branches were cut from the mid-crown at 100 sites in 2014 and samples are currently being taken at 300 sites this year. Samples are sent to Canada for processing to look for overwintering larvae on the branches. Only eleven larvae were found in 2014 (Table 2.)

Table 2. Number of Overwintering Spruce Budworm Larvae (L2) in 2014

Township	Latitude	Longitude	Number of Larvae
Saint Francis	47.1092	-68.851	3
T12 R12 WELS	46.68416	-69.27611	1
T14 R13 WELS	46.87841	-69.35405	1
T14 R7 WELS	46.8369	-68.6586	3
T14 R8 WELS	46.8767	-68.8077	1
Westmanland	46.9437	-68.2978	2
Total			11

Both ground and aerial surveys were conducted in 2015 looking specifically for spruce budworm in northern Maine where damage would first appear. Due to a lack of personnel the ground surveys were limited to roadside surveys in areas where trap counts were highest.

No feeding damage from spruce budworm was apparent in either ground or aerial surveys. Feeding needs to be approaching a moderate level of damage before it is visible from the air and moth counts are not high enough anywhere in Maine to expect that level of feeding yet. Ground surveys were very limited in their extent and not expected to pick up damage yet. It will take more time on the ground looking at more trees to begin to find defoliation at this level of budworm feeding. A focused observer is needed to see trace to light damage in the forest so casual visitors to the forest usually do not notice damage until it starts to get moderate to heavy.

The pheromone survey went extremely this year and a big hand needs to go out to all those boots on the ground who paid attention to the detail and got the traps out, back in and provided the data. Companies now have the bulky traps on hand so lures, kill strips and replacement parts can be mailed. I would recommend having training sessions where updates can be provided and questions answered. Thank you to companies who send in site coordinates electronically, it reduces transcription errors.

Issues in a few cases:

Send samples in as soon as possible so they do not get dry and brittle.

Number of traps retrieved means the number still hanging. We divide the moth count by the number of traps that caught moths all season at a site. If a trap is on the ground and has some moths in it, please discard the moths.

Write clearly, I know it is difficult sitting in the truck but we get in over 400 samples to process.

Remember to put in a new lure and kill strip every year.

Appendices

Appendix 1. Pheromone Trap Locations and Average 2015 Spruce Budworm Trap Catch

town	COUNTY	ave SBW	latitude	longitude
Big Twenty Twp	Aroostook	319.3	47.40228	-69.17986
T13 R5 WELS	Aroostook	230.3	46.78336	-68.40756
Garfield Plt	Aroostook	225.3	46.58140	-68.43697
T13 R7 WELS	Aroostook	175.0	46.81740	-68.57510
T18 R12 WELS	Aroostook	168.3	47.22694	-69.32139
T6 R10 WELS	Piscataquis	167.0	46.19055	-69.07465
T19 R12 WELS	Aroostook	155.7	47.35919	-69.23206
T9 R7 WELS	Aroostook	147.0	46.44661	-68.63000
T12 R7 WELS	Aroostook	139.0	46.73299	-68.56727
T18 R10 WELS	Aroostook	132.7	47.23434	-69.04106
T16 R4 WELS	Aroostook	130.3	47.04030	-68.25430
T10 R7 WELS	Aroostook	127.0	46.52161	-68.63869
Crystal	Aroostook	118.0	46.01350	-68.33247
Saint John Plt	Aroostook	115.7	47.17780	-68.72660
T15 R15 WELS	Aroostook	114.0	46.93818	-69.73268
T18 R13 WELS	Aroostook	112.7	47.23706	-69.37111
T11 R11 WELS	Aroostook	102.0	46.58911	-69.17144
Cross Lake Twp	Aroostook	95.7	47.15318	-68.36150
T6 R10 WELS	Piscataquis	93.5	46.17489	-68.98291
T10 R3 WELS	Aroostook	92.7	46.56577	-68.09440
Connor Twp	Aroostook	92.0	47.00140	-68.05275
Grand Isle	Aroostook	90.0	47.23270	-68.15150
T6 R10 WELS	Piscataquis	89.0	46.13062	-69.08397
T19 R11 WELS	Aroostook	85.0	47.32860	-69.13100
Big Twenty Twp	Aroostook	84.7	47.33165	-69.27734
T13 R11 WELS	Aroostook	80.3	46.76742	-69.12806
T15 R9 WELS	Aroostook	77.7	46.93333	-68.91667
T11 R8 WELS	Aroostook	76.0	46.56714	-68.68653
T16 R6 WELS	Aroostook	75.5	47.09718	-68.50870
Wallagrass	Aroostook	75.3	47.12850	-68.64560
T6 R8 WELS	Penobscot	75.3	46.12419	-68.73630
T15 R15 WELS	Aroostook	74.7	46.93864	-69.73196
T12 R10 WELS	Aroostook	74.3	46.67478	-69.07211
T19 R11 WELS	Aroostook	74.3	47.30289	-69.18597
Allagash	Aroostook	74.0	47.10182	-68.97916
T11 R10 WELS	Aroostook	73.3	46.58908	-69.07847
T11 R4 WELS	Aroostook	71.7	46.65467	-68.27443
T10 R12 WELS	Piscataquis	71.5	46.53067	-69.24336

T13 R7 WELS	Aroostook	71.0	46.77953	-68.56592
T17 R5 WELS	Aroostook	68.0	47.13940	-68.40950
Garfield Plt	Aroostook	68.0	46.63580	-68.52891
Caswell	Aroostook	65.5	47.04740	-67.86080
T17 R4 WELS	Aroostook	65.3	47.11420	-68.23730
T18 R11 WELS	Aroostook	65.0	47.25219	-69.09433
T17 R14 WELS	Aroostook	60.3	47.13240	-69.50360
New Canada	Aroostook	60.0	47.13190	-68.55500
T17 R12 WELS	Aroostook	60.0	47.14760	-69.27320
T15 R9 WELS	Aroostook	60.0	47.00000	-68.90000
T18 R13 WELS	Aroostook	59.3	47.21310	-69.36210
T17 R12 WELS	Aroostook	58.7	47.11410	-69.22480
T10 R9 WELS	Piscataquis	58.7	46.48533	-68.86939
Stockholm	Aroostook	56.0	47.08850	-68.06850
T14 R6 WELS	Aroostook	55.7	46.84020	-68.56090
Westmanland	Aroostook	54.5	46.98320	-68.25900
T11 R12 WELS	Aroostook	54.0	46.62302	-69.27572
T11 R12 WELS	Aroostook	53.3	46.60939	-69.32331
T11 R15 WELS	Aroostook	53.3	46.61669	-69.60275
Westmanland	Aroostook	52.7	46.94370	-68.29780
T10 R8 WELS	Aroostook	52.0	46.51586	-68.81433
T6 R10 WELS	Piscataquis	51.8	46.17671	-69.01928
T10 R11 WELS	Piscataquis	51.7	46.54739	-69.15456
T17 R4 WELS	Aroostook	51.3	47.12440	-68.18880
Allagash	Aroostook	51.0	47.11850	-69.15540
Allagash	Aroostook	51.0	47.10192	-68.97821
Portage Lake	Aroostook	50.7	46.78210	-68.45250
Allagash	Aroostook	49.7	47.13750	-69.10320
T14 R5 WELS	Aroostook	49.0	46.87567	-68.33944
Saint John Plt	Aroostook	48.7	47.10510	-68.75360
TD R2 WELS	Aroostook	48.7	46.39047	-67.93425
T17 R3 WELS	Aroostook	48.5	47.15140	-68.14590
Allagash	Aroostook	48.0	47.08648	-69.06014
T14 R8 WELS	Aroostook	47.0	46.91570	-68.71100
T3 R7 WELS	Penobscot	47.0	45.86183	-68.62630
T6 R10 WELS	Piscataquis	46.7	46.20848	-69.03144
T13 R11 WELS	Aroostook	45.0	46.79550	-69.15220
T15 R5 WELS	Aroostook	45.0	46.94850	-68.41430
T9 R12 WELS	Piscataquis	45.0	46.47881	-69.33511
T11 R9 WELS	Aroostook	44.0	46.66142	-68.84000
T12 R7 WELS	Aroostook	41.3	46.69168	-68.63777

Saint Francis	Aroostook	41.0	47.10920	-68.85100
T10 R8 WELS	Aroostook	41.0	46.54083	-68.72417
T8 R11 WELS	Piscataquis	40.7	46.39061	-69.09994
T14 R10 WELS	Aroostook	40.3	46.86020	-68.97670
T11 R14 WELS	Aroostook	40.3	46.60307	-69.51355
T14 R7 WELS	Aroostook	40.0	46.83690	-68.65860
T16 R11 WELS	Aroostook	40.0	47.07804	-69.11976
T10 R13 WELS	Piscataquis	39.3	46.51972	-69.35656
T11 R10 WELS	Aroostook	39.3	46.62295	-69.01791
T18 R11 WELS	Aroostook	39.0	47.21810	-69.12640
T11 R13 WELS	Aroostook	39.0	46.64517	-69.46200
Patten	Penobscot	38.0	45.96472	-68.54298
Ashland	Aroostook	38.0	46.70990	-68.37790
T15 R12 WELS	Aroostook	38.0	46.99020	-69.23190
T11 R4 WELS	Aroostook	38.0	46.55188	-68.17690
T11 R9 WELS	Aroostook	37.7	46.65008	-68.82625
Allagash	Aroostook	37.3	47.06950	-69.03190
T3 R13 WELS	Piscataquis	36.7	45.89690	-69.41704
Connor Twp	Aroostook	36.5	47.00799	-67.99688
T12 R9 WELS	Aroostook	36.3	46.69860	-68.88310
T12 R8 WELS	Aroostook	36.0	46.68990	-68.78660
T2 R12 WELS	Piscataquis	36.0	45.80417	-69.29604
T4 R9 NWP	Piscataquis	35.7	45.47798	-68.97532
T12 R14 WELS	Aroostook	35.3	46.68842	-69.54169
T13 R12 WELS	Aroostook	35.0	46.75997	-69.23341
T9 R11 WELS	Piscataquis	34.3	46.44275	-69.13044
T7 R14 WELS	Piscataquis	34.0	46.21667	-69.53333
Hamlin	Aroostook	33.7	47.07070	-67.92620
Oxbow Plt	Aroostook	33.7	46.45110	-68.56020
T10 R14 WELS	Piscataquis	33.0	46.57319	-69.55561
T8 R7 WELS	Penobscot	33.0	46.36247	-68.64767
Trout Brook Twp	Piscataquis	32.7	46.13720	-68.91419
T16 R14 WELS	Aroostook	31.7	47.05887	-69.47773
T9 R5 WELS	Aroostook	31.3	46.43866	-68.38790
Nashville Plt	Aroostook	31.3	46.70444	-68.50564
T17 R13 WELS	Aroostook	31.0	47.13800	-69.34920
T10 R9 WELS	Piscataquis	30.3	46.49520	-68.90830
Saint Francis	Aroostook	29.7	47.10220	-68.94970
Westfield	Aroostook	29.5	46.53210	-68.01450
T11 R13 WELS	Aroostook	29.3	46.62360	-69.40320
T8 R14 WELS	Piscataquis	29.0	46.35000	-69.50000

Caswell	Aroostook	28.8	47.00984	-67.85977
Orient	Aroostook	28.7	45.79473	-67.87048
Hammond	Somerset	28.7	46.24650	-67.97620
T6 R11 WELS	Piscataquis	28.7	46.15595	-69.15443
Princeton	Washington	28.3	45.19415	-67.52312
Cyr Plt	Aroostook	28.0	47.05930	-67.94860
T14 R9 WELS	Aroostook	28.0	46.90380	-68.88580
Cyr Plt	Aroostook	27.0	47.12987	-68.05317
Masardis	Aroostook	27.0	46.54270	-68.35880
TC R2 WELS	Aroostook	27.0	46.34540	-67.91620
T11 R11 WELS	Aroostook	27.0	46.62274	-69.14870
Castle Hill	Aroostook	26.0	46.73830	-68.29980
T14 R12 WELS	Aroostook	26.0	46.91990	-69.30260
T8 R19 WELS	Somerset	26.0	46.30275	-70.16036
T5 R17 WELS	Somerset	26.0	46.12025	-69.87653
T9 R8 WELS	Aroostook	25.7	46.46278	-68.81306
T7 R11 WELS	Piscataquis	25.7	46.27954	-69.10018
T6 R13 WELS	Piscataquis	25.3	46.18579	-69.40520
T9 R10 WELS	Piscataquis	25.3	46.43222	-69.02806
Caribou	Aroostook	25.2	46.87804	-67.99390
Smyrna	Aroostook	25.0	46.16530	-68.11740
T15 R10 WELS	Aroostook	25.0	46.98830	-69.00200
Haynesville	Aroostook	25.0	45.82791	-67.98783
T12 R12 WELS	Aroostook	25.0	46.68417	-69.27611
Trout Brook Twp	Piscataquis	24.2	46.17643	-68.88749
T7 R10 WELS	Piscataquis	24.0	46.22020	-68.96615
T11 R4 WELS	Aroostook	23.7	46.58883	-68.29542
T8 R10 WELS	Piscataquis	23.7	46.36819	-69.00172
T15 R11 WELS	Aroostook	23.3	46.96110	-69.17170
T14 R13 WELS	Aroostook	23.0	46.87842	-69.35406
Allagash	Aroostook	22.5	47.05080	-69.08210
T16 R12 WELS	Aroostook	22.3	47.07450	-69.32420
T8 R17 WELS	Somerset	22.3	46.33692	-69.90175
T9 R5 WELS	Aroostook	22.3	46.39329	-68.34842
T10 R10 WELS	Piscataquis	22.0	46.56169	-69.03433
Long A Twp	Penobscot	21.7	45.56075	-68.84520
Russell Pond Twp	Somerset	21.7	46.05231	-69.76933
Allagash	Aroostook	21.5	47.03820	-69.16510
T16 R13 WELS	Aroostook	21.3	47.05460	-69.45480
T18 R10 WELS	Aroostook	21.0	47.15410	-69.04340
T8 R9 WELS	Piscataquis	21.0	46.36833	-68.90611

Island Falls	Aroostook	21.0	45.97442	-68.20148
T9 R3 WELS	Aroostook	20.7	46.45436	-68.14303
T10 R17 WELS	Somerset	20.5	46.50147	-69.86969
T6 R13 WELS	Piscataquis	20.5	46.17410	-69.40770
T8 R3 NBPP	Washington	20.3	45.48415	-67.90097
T2 R7 WELS	Penobscot	20.3	45.81684	-68.60485
T18 R12 WELS	Aroostook	20.3	47.21620	-69.24600
Woodville	Penobscot	20.3	45.55317	-68.45123
T8 R7 WELS	Penobscot	20.0	46.31179	-68.61920
T12 R11 WELS	Aroostook	20.0	46.71214	-69.14745
T6 R12 WELS	Piscataquis	19.7	46.11687	-69.26691
Dudley Twp	Aroostook	19.3	46.26010	-68.05900
T16 R8 WELS	Aroostook	18.7	47.07270	-68.80830
T5 R12 WELS	Piscataquis	18.7	46.06944	-69.30017
T6 R8 WELS	Penobscot	18.3	46.18074	-68.69923
T12 R11 WELS	Aroostook	18.3	46.71250	-69.18833
T3 R12 WELS	Piscataquis	18.3	45.89986	-69.25748
Oakfield	Aroostook	18.0	46.08510	-68.08420
TC R2 WELS	Aroostook	18.0	46.32780	-68.01240
T12 R7 WELS	Aroostook	18.0	46.66167	-68.60417
Mount Katahdin Twp	Piscataquis	17.7	45.91404	-68.85548
T6 R18 WELS	Somerset	17.5	46.18647	-70.02927
T7 R10 WELS	Piscataquis	17.3	46.25951	-68.95653
T4 R12 WELS	Piscataquis	17.3	45.95313	-69.30699
T12 R15 WELS	Aroostook	17.3	46.71642	-69.63567
Forest Twp	Washington	17.0	45.56692	-67.75022
T3 R10 WELS	Piscataquis	17.0	45.88460	-68.97840
T4 R14 WELS	Piscataquis	17.0	45.97853	-69.55364
T3 R13 WELS	Piscataquis	17.0	45.87176	-69.34841
T1 R13 WELS	Piscataquis	17.0	45.68922	-69.35793
T4 R12 WELS	Piscataquis	16.8	45.99351	-69.27941
T2 R8 NWP	Penobscot	16.7	45.38337	-68.61227
T7 R4 WELS	Aroostook	16.7	46.23817	-68.25794
T10 R4 WELS	Aroostook	16.7	46.50353	-68.28248
T2 R4 WELS	Aroostook	16.3	45.79705	-68.28502
Danforth	Washington	16.3	45.64007	-67.80928
T10 R9 WELS	Piscataquis	16.3	46.56361	-68.87833
Bancroft	Aroostook	16.0	45.73328	-67.96522
T15 R8 WELS	Aroostook	16.0	46.95700	-68.75980
T3 R11 WELS	Piscataquis	16.0	45.87815	-69.14022
T8 R8 WELS	Penobscot	16.0	46.32917	-68.78250

T14 R13 WELS	Aroostook	16.0	46.84237	-69.42637
TA R10 WELS	Piscataquis	16.0	45.60166	-69.07250
T1 R5 WELS	Aroostook	15.7	45.72475	-68.35555
T15 R14 WELS	Aroostook	15.7	46.97610	-69.50920
T3 R9 NWP	Penobscot	15.7	45.48879	-68.70354
Herseytown Twp	Penobscot	15.7	45.77390	-68.53468
T13 R9 WELS	Aroostook	15.5	46.81380	-68.94630
T9 R14 WELS	Piscataquis	15.5	46.41764	-69.48906
T11 R3 NBPP	Washington	15.3	45.54878	-67.59183
Codyville Plt	Washington	15.0	45.51590	-67.63573
T6 R6 WELS	Penobscot	15.0	46.17980	-68.55520
T9 R4 WELS	Aroostook	15.0	46.44910	-68.27710
Reed Plt	Aroostook	15.0	45.72843	-68.12631
T5 R14 WELS	Piscataquis	14.7	46.11020	-69.57614
T14 R14 WELS	Aroostook	14.3	46.89610	-69.50060
T4 R10 WELS	Piscataquis	14.0	45.96566	-69.06209
T12 R8 WELS	Aroostook	14.0	46.70760	-68.73370
T10 R15 WELS	Piscataquis	14.0	46.53911	-69.59456
T15 R13 WELS	Aroostook	14.0	46.95372	-69.37638
T29 MD BPP	Washington	13.7	44.88790	-68.06245
T12 R9 WELS	Aroostook	13.7	46.67420	-68.90140
T7 R12 WELS	Piscataquis	13.7	46.28220	-69.28984
Franklin	Hancock	13.7	44.59304	-68.25452
T6 R11 WELS	Piscataquis	13.7	46.16967	-69.19119
Lily Bay Twp	Piscataquis	13.7	45.65118	-69.56847
T5 R11 WELS	Piscataquis	13.3	46.10798	-69.20148
Days Academy Grant Twp	Piscataquis	13.3	45.72606	-69.65814
T5 R11 WELS	Piscataquis	13.2	46.08689	-69.15176
T15 R12 WELS	Aroostook	12.7	46.95930	-69.27510
T14 R8 WELS	Aroostook	12.5	46.87670	-68.80770
T6 R15 WELS	Piscataquis	12.5	46.11667	-69.65000
Brookton Twp	Washington	12.3	45.55460	-67.78615
T7 R6 WELS	Penobscot	12.3	46.25540	-68.53640
Big Six Twp	Somerset	12.3	46.20550	-70.27575
T2 R9 NWP	Penobscot	12.3	45.51861	-68.68559
T1 R4 WELS	Aroostook	12.0	45.68127	-68.21093
TA R7 WELS	Penobscot	12.0	45.59849	-68.59891
T8 R18 WELS	Somerset	12.0	46.37528	-70.04561
T6 R8 WELS	Penobscot	12.0	46.19778	-68.77340
Williamsburg Twp	Piscataquis	12.0	45.34214	-69.08761
Northeast Carry Twp	Piscataquis	11.7	45.93175	-69.57506

T10 R16 WELS	Somerset	11.7	46.54806	-69.75401
T7 R19 WELS	Somerset	11.3	46.27786	-70.12908
Dudley Twp	Aroostook	11.0	46.28510	-68.08180
T14 R15 WELS	Aroostook	11.0	46.84130	-69.61680
T9 R11 WELS	Piscataquis	11.0	46.41667	-69.20000
Greenbush	Penobscot	10.7	45.12286	-68.59342
T15 R13 WELS	Aroostook	10.3	46.94790	-69.45090
T9 R16 WELS	Somerset	10.3	46.46031	-69.76558
T10 R10 WELS	Piscataquis	10.3	46.50306	-69.06278
Williamsburg Twp	Piscataquis	10.3	45.38994	-69.11061
T11 R14 WELS	Aroostook	10.3	45.69729	-68.23300
T4 R11 WELS	Piscataquis	10.2	45.99359	-69.15182
Grand Falls Twp	Penobscot	10.0	45.09830	-68.37122
T31 MD BPP	Washington	10.0	44.97535	-67.83072
Hamlin	Aroostook	10.0	47.06810	-67.89910
Plymouth Twp	Somerset	10.0	45.92780	-69.91097
Summit Twp	Penobscot	9.7	45.08487	-68.49127
T8 R5 WELS	Aroostook	9.7	46.35660	-68.40480
T10 R16 WELS	Somerset	9.7	46.51503	-69.82019
T11 R15 WELS	Aroostook	9.7	46.60770	-69.70718
Bowdoin College Grant West Twp	Piscataquis	9.0	45.48535	-69.36733
T5 R7 WELS	Penobscot	9.0	46.11859	-68.67001
T15 R13 WELS	Aroostook	9.0	46.99160	-69.45590
T11 R16 WELS	Aroostook	9.0	46.60647	-69.76319
T13 R8 WELS	Aroostook	9.0	46.78597	-68.77914
Limestone	Aroostook	9.0	46.91794	-67.85885
T1 R12 WELS	Piscataquis	8.7	45.67492	-69.32470
T7 R16 WELS	Somerset	8.7	46.29689	-69.82658
T11 R17 WELS	Aroostook	8.7	46.57811	-69.81301
T13 R14 WELS	Aroostook	8.7	46.75550	-69.54544
Medway	Penobscot	8.5	45.63724	-68.47832
TA R2 WELS	Aroostook	8.3	45.96940	-67.92700
T2 R10 WELS	Piscataquis	8.3	45.83287	-68.95979
T8 R13 WELS	Piscataquis	8.3	46.31667	-69.41667
T30 MD BPP	Washington	8.0	44.91347	-67.92520
T7 R9 NWP	Piscataquis	8.0	45.41804	-69.26346
Millinocket	Penobscot	8.0	45.62723	-68.71994
T4 Indian Purchase Twp	Penobscot	8.0	45.61683	-68.91086
Glenwood Plt	Aroostook	7.7	45.82727	-68.11878
T8 R5 WELS	Aroostook	7.7	46.32000	-68.35660
T9 R4 WELS	Aroostook	7.7	46.38760	-68.26870

Topsfield	Washington	7.7	45.42133	-67.75435
T14 R10 WELS	Aroostook	7.5	46.89280	-68.99670
T8 R16 WELS	Somerset	7.5	46.31000	-69.80314
Dyer Brook	Aroostook	7.3	46.07970	-68.24590
T7 R17 WELS	Somerset	7.3	46.28970	-69.93239
T11 R17 WELS	Aroostook	7.0	46.57853	-69.88618
T9 R15 WELS	Piscataquis	7.0	46.40925	-69.68056
Bowerbank	Piscataquis	7.0	45.35510	-69.28354
Moscow	Somerset	7.0	45.15384	-69.87946
T10 R6 WELS	Aroostook	7.0	46.53447	-68.51533
T4 R17 WELS	Somerset	7.0	45.97027	-69.90250
T34 MD	Hancock	6.7	44.98384	-68.11751
T6 R19 WELS	Somerset	6.7	46.20889	-70.15867
Edmunds Twp	Washington	6.7	44.84713	-67.16991
Lobster Twp	Piscataquis	6.7	45.91711	-69.50919
Seboomook Twp	Somerset	6.7	45.91574	-69.70784
Great Pond	Hancock	6.5	44.92953	-68.29197
T1 R10 WELS	Piscataquis	6.5	45.68980	-68.98138
T32 MD	Hancock	6.3	44.98502	-68.37167
T4 R7 WELS	Penobscot	6.3	46.01435	-68.63269
Beaver Cove	Piscataquis	6.3	45.57001	-69.54986
Big Moose Twp	Piscataquis	6.3	45.54821	-69.74991
T7 R5 WELS	Aroostook	6.0	46.28260	-68.39580
T2 R9 NWP	Penobscot	6.0	45.55360	-68.59866
T6 R14 WELS	Piscataquis	6.0	46.20102	-69.54165
Pittston Academy Grant	Somerset	6.0	45.92572	-70.00018
T4 R16 WELS	Somerset	6.0	46.01480	-69.75958
Oqiton Twp	Hancock	5.7	45.15286	-68.07131
T6 R17 WELS	Somerset	5.7	46.20208	-69.87403
T8 R12 WELS	Piscataquis	5.5	46.33333	-69.30000
Merrill	Aroostook	5.3	46.20390	-68.26550
T8 R5 WELS	Aroostook	5.3	46.35170	-68.36370
T1 R9 WELS	Piscataquis	5.3	45.73773	-68.90362
T2 R9 WELS	Piscataquis	5.0	45.84066	-68.88416
Bradley	Penobscot	5.0	44.86105	-68.63692
T3 R1 NBPP	Penobscot	5.0	45.33059	-68.22337
T5 R19 WELS	Somerset	5.0	46.07083	-70.13148
Baring Plt	Washington	5.0	45.10254	-67.31606
Charlotte	Washington	4.7	45.02262	-67.26847
T14 R11 WELS	Aroostook	4.7	46.90140	-69.11530
T7 R6 WELS	Penobscot	4.7	46.22220	-68.44790

T8 R6 WELS	Penobscot	4.7	46.31690	-68.47990
T12 R13 WELS	Aroostook	4.7	46.66889	-69.39703
Sandwich Academy Grant Twp	Somerset	4.5	45.60896	-69.87993
T3 R12 WELS	Piscataquis	4.3	45.85575	-69.21616
T4 R13 WELS	Piscataquis	4.3	45.94485	-69.38757
T7 R15 WELS	Piscataquis	4.3	46.23333	-69.60000
Hammond Twp	Somerset	4.3	45.88393	-70.15842
T8 R6 WELS	Penobscot	4.0	46.30820	-68.51590
Chesuncook Twp	Piscataquis	4.0	46.11628	-69.43646
Indian Purchase T3	Penobscot	4.0	45.68189	-68.76100
Shirley	Piscataquis	4.0	45.36620	-69.64042
T5 R20 WELS	Somerset	4.0	46.08403	-70.26778
Pittston Academy Grant	Somerset	4.0	45.86207	-69.92465
Brassua Twp	Somerset	4.0	45.73351	-69.93339
Chase Stream Twp	Somerset	4.0	45.47005	-69.90179
Shirley	Piscataquis	4.0	45.36467	-69.56837
T11 R8 WELS	Aroostook	4.0	46.60580	-68.73890
T7 R13 WELS	Piscataquis	4.0	46.23333	-69.41667
Edmunds Twp	Washington	4.0	44.87693	-67.19032
Moose River	Somerset	3.7	45.68596	-70.22645
T4 R15 WELS	Piscataquis	3.7	45.99917	-69.61101
T5 R18 WELS	Somerset	3.7	46.09013	-70.00653
Sapling Twp	Somerset	3.5	45.58386	-69.82187
T4 R11 WELS	Piscataquis	3.3	46.01012	-69.17361
Bald Mountain Twp T2 R3	Somerset	3.3	45.24528	-69.74065
T28 MD	Hancock	3.0	44.90150	-68.19948
Beaver Cove	Piscataquis	3.0	45.56507	-69.34376
Alder Brook Twp	Somerset	3.0	45.83064	-70.09819
Steuben	Washington	3.0	44.51432	-67.96966
Moosehead Junction Twp	Piscataquis	3.0	45.42968	-69.64590
T13 R10 WELS	Aroostook	3.0	46.76653	-69.03192
T15 R15 WELS	Aroostook	3.0	46.96129	-69.69661
T8 R11 WELS	Piscataquis	3.0	46.31667	-69.18333
Baring Plt	Washington	3.0	45.06802	-67.30281
T36 MD BPP	Washington	2.7	45.02355	-67.98995
Magalloway Plt	Oxford	2.7	44.87314	-71.04109
Grand Lake Stream Plt	Washington	2.7	45.18528	-67.74500
West Middlesex Canal Grant	Somerset	2.7	45.78882	-69.85521
Baring Plt	Washington	2.7	45.08764	-67.28367
Pleasant Ridge Plt	Somerset	2.5	45.09728	-69.98705
Richardsontown Twp	Oxford	2.5	44.81819	-70.89447

T5 R15 WELS	Piscataquis	2.5	46.10000	-69.68333
Edmunds Twp	Washington	2.5	44.84634	-67.19995
T3 R1 NBPP	Penobscot	2.3	45.26038	-68.26808
T8 R18 WELS	Somerset	2.3	46.30625	-70.01394
Grafton Twp	Oxford	2.3	44.64448	-70.95558
Perry	Washington	2.3	44.99964	-67.08864
Pierce Pond Twp	Somerset	2.3	45.23759	-70.18492
TA R12 WELS	Piscataquis	2.0	45.58674	-69.27167
Elliottsville Twp	Piscataquis	2.0	45.41836	-69.46264
Mayfield Twp	Somerset	2.0	45.11298	-69.73379
Oxbow Twp	Oxford	2.0	45.18516	-70.86428
Upper Cupsuptic Twp	Oxford	2.0	45.15950	-70.82645
Edmunds Twp	Washington	2.0	44.85439	-67.17885
T4 R18 WELS	Somerset	2.0	45.97138	-69.99188
Edmunds Twp	Washington	2.0	44.86770	-67.22163
T22 MD	Hancock	1.7	44.80967	-68.16778
T3 ND	Hancock	1.7	45.13282	-68.16200
T35 MD	Hancock	1.7	44.97850	-68.09825
T41 MD	Hancock	1.7	45.07155	-68.11017
Calais	Washington	1.7	45.11264	-67.16159
Caratunk	Somerset	1.7	45.19275	-69.92414
Long Pond Twp	Somerset	1.7	45.64134	-70.02098
Spencer Bay Twp	Piscataquis	1.7	45.69288	-69.47423
West Forks Plt	Somerset	1.7	45.41195	-70.03585
Baring Plt	Washington	1.7	45.05957	-67.31142
Shawtown Twp	Piscataquis	1.5	45.58674	-69.27120
Alder Stream Twp	Franklin	1.5	45.22704	-70.65275
Parkertown Twp	Oxford	1.3	45.03431	-70.95995
Soldiertown Twp T2 R3 NBKP	Somerset	1.3	45.77862	-69.96951
Lincoln Plt	Oxford	1.3	44.91455	-70.93272
T9 R17 WELS	Somerset	1.0	46.39993	-69.86219
Coburn Gore	Franklin	1.0	45.37780	-70.80367
Dennistown Plt	Somerset	1.0	45.67272	-70.28333
Alder Stream Twp	Franklin	1.0	45.23233	-70.62974
Lakeville	Penobscot	1.0	45.27810	-68.09730
Flagstaff Twp	Somerset	1.0	45.25445	-70.43317
Indian Stream Twp	Somerset	1.0	45.48767	-69.78281
Thorndike Twp	Somerset	1.0	45.68907	-70.10378
T3 R3 NBKP	Somerset	1.0	45.78604	-69.90214
Lower Cupsuptic Twp	Oxford	1.0	45.04099	-70.81208
Edmunds Twp	Washington	1.0	44.83995	-67.15006

Magalloway Plt	Oxford	0.7	44.85006	-70.97944
Coplin Plt	Franklin	0.7	45.12326	-70.46665
Eustis	Franklin	0.7	45.13577	-70.45142
Holeb Twp	Somerset	0.7	45.57711	-70.48364
Alder Stream Twp	Franklin	0.7	45.24880	-70.57822
Bowdoin College Grant West Twp	Piscataquis	0.7	45.54039	-69.43922
Bradstreet Twp	Somerset	0.7	45.50294	-70.18320
Hobbstown Twp	Somerset	0.7	45.44275	-70.34206
Jackman	Somerset	0.7	45.59850	-70.14030
Parlin Pond Twp	Somerset	0.7	45.53749	-70.09436
Township C	Oxford	0.7	44.80362	-70.82217
Upton	Oxford	0.6	44.73106	-70.98566
T12 R16 WELS	Aroostook	0.5	46.70925	-69.76705
Dennistown Plt	Somerset	0.5	45.67104	-70.39467
T19 ED BPP	Washington	0.3	44.94967	-67.51735
Dallas Plt	Franklin	0.3	44.98260	-70.61673
Jonesboro	Washington	0.3	44.67498	-67.53070
Appleton Twp	Somerset	0.3	45.49149	-70.47742
C Surplus	Oxford	0.3	44.73529	-70.91313
Magalloway Plt	Oxford	0.3	44.86759	-70.95299
T19 ED BPP	Washington	0.0	44.91841	-67.50058
T9 R18 WELS	Somerset	0.0	46.41414	-70.01667
Concord Twp	Somerset	0.0	45.02761	-69.94635
Eustis	Franklin	0.0	45.19400	-70.54697
Johnson Mountain Twp	Somerset	0.0	45.45086	-70.01912
Kibby Twp	Franklin	0.0	45.37914	-70.54026
Skinner Twp	Franklin	0.0	45.41167	-70.55905
T13 R13 WELS	Aroostook	0.0	46.84081	-69.42628
Davis Twp	Franklin	0.0	45.04551	-70.72032
Upton	Oxford	0.0	44.71349	-70.94932

Appendix 2. Spruce Budworm Caught in Light Traps from 2012-15

Spruce Budworm Caught in
Light Traps

Town	County	Year				no. nights	Latitude	Longitude
		2012	2013	2014	2015			
Allagash	AROOSTOOK	0	11	29	3	30	47.08649	-69.06014
Arundel	York	0	x	x	x	45	43.46578	-70.51609
Ashland	AROOSTOOK	0	0	3	0	30	46.57856	-68.43195
Bowerbank	PISCATAQUIS	0	1	0	0	45	45.26686	-69.20419
Calais	WASHINGTON	0	12	0	2	45	45.10951	-67.16187
Cape Elizabeth	CUMBERLAND	x	x	0	0	45	43.59346	-70.2578
Crystal	AROOSTOOK	0	0	0	3	30	46.0113	-68.31942
Ellsworth	PENOBSCOT	x	x	0	x	45	44.63428	-68.54592
Exeter	PENOBSCOT	0	0	0	x	45	44.95843	-69.13738
Frost Pond	PISCATAQUIS	0	1	x	0	30	45.90114	-69.18286
Haynesville	AROOSTOOK	0	0	2	0	45	45.82285	-67.98638
Hope	KNOX	0	0	0	0	45	44.2595	-69.20692
Kingfield	FRANKLIN	0	0	0	0	30	44.96619	-70.15619
Millinocket	PENOBSCOT	0	1	0	0	45	45.65453	-68.69766
Monson	PISCATAQUIS	x	x	x	0	45	45.26971	-69.45179
Moose River	SOMERSET	0	0	x	x	30	45.645	-70.26288
Mount Desert Island	HANCOCK	0	x	x	x	45	44.36661	-68.31483
Mount Vernon	KENNEBEC	0	0	x	x	45	44.43868	-69.91379
New Sweden	AROOSTOOK	0	0	0	2	30	46.94095	-68.13014
Parlin Pond	SOMERSET	x	x	0	x	30	45.51091	-70.09371
Rangeley	FRANKLIN	0	0	2	0	45	44.96823	-70.64929
Sedgewick	HANCOCK	0	0	x	x	45	44.28903	-68.63028
Shirley	PISCATAQUIS	0	2	0	x	45	45.37876	-69.59573
South Berwick	YORK	0	0	0	0	45	43.28574	-70.70582
Big Six Twp -Ste. Aurelie	SOMERSET	0	0	3	0	30	46.20694	-70.27543
T10 R12 WELS -Churchill Dam	AROOSTOOK	x	x	0	x	30	46.49221	-69.28628
T15 R15 WELS Ste. Pamphile	AROOSTOOK	1	56	4	17	30	46.95104	-69.73135
Topsfield	WASHINGTON	0	0	0	0	45	45.42511	-67.75491
Total		1	84	43	29	30 nights = 7/3-7/31		

Total number of traps run

23 21 21 18 45 nights = 6/17-7/31

x= no trap run

Appendix 3. 2015 Pheromone traps checked two times per week

TOWN	T15 R15 WELS	Garfield Plt	T3 R13 WELS	Pittston Academy Grant	T13 R7 WELS	Allagash	Crystal	T6 R10 WELS brk	T6 R10 WELS gap
COUNTY	Aroostook	Aroostook	Piscataquis	Somerset	Aroostook	Aroostook	Aroostook	Aroostook	Aroostook
latitude	46.93818	46.6358	45.87176	45.86207	46.77953	47.08648	46.0135	46.1306	-69.08397
longitude	-69.73268	-68.52891	-69.34841	-69.92465	-68.56592	-69.06014	-68.33247	46.19055	-69.07464
set up date	6/23/2015	7/10/2015	6/20/2015	6/24/2015	6/22/2015	6/23/2015	6/22/2015	7/6/2015	7/20/2015
pick up date	8/13/2015	8/20/2015	8/15/2015	8/17/2015	8/13/2015	7/31/2015	8/17/2015	7/27/2015	8/12/2015
total SBW	114	68	17	4	71	48	118	167	89
6/22/2015			0						
6/23/2015									
6/24/2015					0				
6/25/2015	0		0	0		0	1		
6/26/2015									
6/27/2015									
6/28/2015									
6/29/2015			0	0			0		0
6/30/2015									
7/1/2015									0
7/2/2015				0	0	2	3		
7/3/2015									
7/4/2015									
7/5/2015									
7/6/2015			0	1	0	0	14	7	4
7/7/2015									
7/8/2015									
7/9/2015	0			0			14		5
7/10/2015					27				
7/11/2015									
7/12/2015									
7/13/2015		22	12	2		12	12	62	29
7/14/2015									
7/15/2015							26		
7/16/2015	66	15	4	1		23			27
7/17/2015									
7/18/2015									
7/19/2015									
7/20/2015		29		0		8	42	94	22
7/21/2015			1						
7/22/2015									
7/23/2015	47	0	0	0	44	2	4		2
7/24/2015									
7/25/2015					0				
7/26/2015									
7/27/2015		1		0			2	4	0
7/28/2015									
7/29/2015									
7/30/2015				0		1			0
7/31/2015		1					0		
8/1/2015			0		0				
8/2/2015									
8/3/2015		0		0			0		0
8/4/2015	1								

Normal dates of peak male SBW flight

