Cover Page

Final Report (2023, 6th Report)

Crowland Mitigation through Restoration of the Tamarack Bog, Bath Nature Preserve. Summit County Ohio.

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ABSTRACT

This document describes the successful restoration of wetland conditions for the Tamarack Bog in the Bath Nature Preserve. The primary restoration action has been to increase water depth through the late winter and spring seasons due to the installation of an AGRI Drain at the exit point of water flow from the wetland. This change enhanced growth of wetland plant species. In addition, removal of undesirable plant species has created opportunities for desirable wetland plant cover to increase. In order to maintain the restoration success, Bath Township will continue to maintain the AGRI Drain and the removal of invasive and undesirable upland species in the future. They will also maintain the boardwalk and signage that has been installed to invite the public to see and learn about this rare habitat type.

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Appendices and digital copies of this and prior reports are available online at https://fieldstation.uakron.edu/permits-and-reports/bath-tamarack-bog-restoration/

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EXECUTIVE SUMMARY 2023

Wetland mitigation permits were issued in 2013 for the Tamarack Bog in the Bath Nature Preserve, Bath, Ohio, as compensation for proposed construction by CROWLAND LTD.

Study of the site began in 2013, to describe baseline conditions and set restoration goals.

This document focuses on:

1) Meeting goals established in permits.
2) Documentation of initial (2013) conditions.
3) Monitoring of vegetation cover and diversity in permanent plots from 2013 to 2023.
4) Studies in hydrology and water chemistry to understand physical elements that would influence vegetation characteristics and change.
5) Increasing seasonal water level by establishing an AGRI Drain at the outward drainage point of the site and conducting two increases of water level.
6) Mapping of wetland boundaries in 2023.
7) Documentation of biota change within the wetland.

These efforts were managed by Prof. Randall Mitchell at University of Akron, Biology Department. The Bath Park Commission, Davey Tree, Co., Prof. JeanMarie Hartman, and numerous students carried out the work.

The full document outlines the permit goals and then provides sections that discuss goals, data, and accomplishments.

The majority of goals have been met without any alterations. Two important factors developed through the studies:

1) Although the site is called "Tamarack Bog" the plant community is better described as a **Poor Fen** because of hydrology, soil chemistry, and water chemistry.
2) Correlated with the Poor Fen status, sphagnum expansion and increase of tamarack cover were minimal.

Both of these issues have been reported and discussed over the term of the project. The increase of wetland quality of the vegetation, in terms of species cover and wetland status, and the expansion of the wetland are both important successes of this project.

According to the original covenant, Bath Township (property owner) will maintain the physical improvements (AGRI Drain, boardwalk and signage) through regular observations and repairs by the Park Staff or appropriate contractors. In addition, vegetation wetland characteristics will be maintained through as needed removal of invasive and undesirable upland species.

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I. Introduction

The goals of the mitigation agreement for this project are: the preservation and enhancement of the Tamarack Bog at the Bath Nature Preserve. The project began in 2013 and continued through 2023. This is the final report for the project, as required by ACOE and Ohio EPA (see APPENDIX A and B for permit language).

Important supporting information is in the five prior reports (2013, 2014, 2016, 2018, 2020). A prior study of the area (Miletti et al. 2005) evaluated past changes and existing threats to this site. Drainage ditches placed in the 1960s and consequent reduction of habitat (from 13.8 to 4.36 acres) were the primary problems for this area. In addition, invasion by Red Maples (*Acer rubrum*) and Glossy Buckthorn (*Rhamnus frangula*) changed the characteristics of the vegetation.

Restoration of the plant community was addressed by

(1) placement of a drainage control structure (AGRI Drain) to increase water depth through the spring, as well as

(2) removal and control of invasive species.

The wetland contains several state listed species (e.g., *Carex atlantica* var. *capillacea*, *Larix laricina*) and their presence was documented throughout the study. Repeated vegetation sampling of 11 permanent plots provided data to document change in vegetation over time. The results of our investigations, summarized below, indicate that the restoration is successful, expanding the wetland area and improving or maintaining important habitat elements.

To organize the broad range of data, we have generated the following tables of performance criteria set forth in the mitigation documents, with notes on whether the criteria are met, and where the supporting information on each criterion can be found in the report (Table 1, Table 2).
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Table 1. Evaluation of Relevant USACOE Performance Criteria (see APPENDIX A):

Item from the mitigation documents	Status	Evidence
Item 6- Compensatory mitigation through rehabilitation of the Tamarack Wetland at the Bath Nature	Achieved	Project
Item 7. Establish a Conservation Easement on the Tamarack Wetland at Bath Nature Preserve.	Achieved	See attached Environmental Covenant.
Item 8. Ensure no mining and similar activities occur in the Tamarack wetland.	Achieved	Site is in a protected nature preserve.
Item 11. Baseline mitigation report.	Achieved	See Report #1, 2013
Item 12. Monitoring reports in years 1, 3, 5, 7 and 10.	Achieved	See all Prior Reports
Item 13 -Area meets the three wetland parameters.	Achieved	See Section II, and delineation report (APPENDIX D)
Item 14 - Re-established wetlands identified as bog habitat (as defined in the ORAM Manual) shall meet a Vegetation Index of Biotic Integrity (VIBI) score of at least 66.	Achieved	See Section III
Item 15 - Re-established wetlands identified as forested wetland habitat shall meet a Vegetation Index of Biotic Integrity (VIBI) score of at least 61.	Achieved	See Section III
Item 16 - Rehabilitated wetlands identified as bog habitat shall meet a VIBI score of at least 66 or show a 10 point increase from the baseline score, whichever is higher.	Acceptable (Mean VIBI 70.7)	See Section III
Item 17 - Rehabilitated wetlands identified as forested wetland habitat shall meet a VIBI score of at least 61 or show a 10-point increase from the baseline score, whichever is higher	Acceptable (Mean VIBI 70.7)	See Section III
Item 18 - Minimum of 75% relative cover native perennial hydrophytic vegetation.	Achieved	See Section III
Item 19 - Less than 5% relative cover of non-typha invasive species.	Achieved	See Section III
Item 20 - Minimum of 400 native live and healthy woody plants/acre in forested areas.	Achieved	See Section III
Item 21 - Minimum of 40 live and healthy Tamarack trees/acre.	Target was adjusted	See Section IV
Item 22 - If natural recruitment of tamaracks does not occur, supplemental planting required.	Achieved	See Section IV
Item 23 - A minimum of two times the baseline sphagnum cover shall be achieved.	Target was adjusted	See Section IV
Item 24 - At end, at least as many acres of bog habitat present as identified in the baseline report.	Achieved	
Item 25 - Mitigation should follow plan and permit conditions.	Achieved	

Table 2. Evaluation of Relevant OEPA Performance Goals (see APPENDIX B):

Item from the mitigation documents	Status	Evidence
Item H.1: Improvement in Bog VIBI score by 10 points above the baseline VIBI by the end of the 10 year monitoring period	Acceptable (Increase by 6.3 points)	See section III
Item H.2: At least 8.9 acres of wetland at the end of the monitoring period"	Increase to 8.79 Acres	See section II, and 2023 Delineation report.
Item H.3. Trajectory of increased area of permanently inundated wetland perimeter	Achieved	See Figure 1, Section VI
Item H4. Trajectory of successful growth and reproduction of Tamarack trees	Target was adjusted	Section IV
Item H5. Trajectory of success growth (aerial cover) and reproduction of Sphagnum moss	Target was adjusted	Section IV
Item H7. Less than 5% relative cover of all non-typha invasive plant species.	Achieved	Section I, Section III

II. Delineation and Wetland Area

Background: In 2013 we designated three zones of wetland vegetation for consideration.

> CORE: The area of the core bog community with high quality peatland plants (e.g., Speckled Alder, Blueberry, Tamarack, Cinnamon Fern, and Poison Sumac)
>
> EDGE: The area surrounding the core and well within the delineated wetland boundary, with distinctly different vegetation and an abundance of unwanted species (e.g., Red Maple and Crabapple).
>
> ENHANCEMENT: The area along the edge of the delineated wetland, with some potential for improvement based on topography and spread of wetland species.

We expected to maintain conditions in the CORE, and to improve conditions for wetland species dominance in the EDGE. Furthermore, we expected to create the possibility for more wetland species to spread into the ENHANCEMENT zone. We anticipated limited expansion of wetland conditions through increased seasonal water coverage and expansion of wetland species where appropriate topography exists. Figure 1 is an aerial photo that shows the site in 2015.

RESULTS

Item13, Item H2: In April 2023, professionals at Oxbow and River Restoration delineated the Tamarack Bog Wetland (see attached report (APPENDIX D). The delineation indicates that the wetland area has increased to 8.79 acres from the initial 4.36 acres, exceeding the USACE target of 8.6 acres, and nearly matching the EPA target of 8.9 acres.

Item 24, Item H5: In addition to that increase in wetland area, our extensive exploration of the area confirms that the bog habitat (represented by the 'Core' shown in the map below) has not decreased and may have slightly increased. For example, we now find that Sphagnum moss has established new clumps in some of the Edge habitat, and woody vegetation and Cinnamon Fern are increasing in the Edge habitat. Thus, there are at least as many acres of bog habitat as identified in the baseline report.

Figure1: Site Boundaries and Monitoring Sites.
The irregular white line shows the 2013 wetland boundary.
The irregular blue line shows the 2023 wetland boundary.
The irregular orange line, towards the center shows the Core wetland.
Elongated rectangles identify annual sampling plots, color coded to indicate their wetland zone.

III. VIBI scores, Vegetation Cover Scores, and Woody Stems

Item 14, 15, 16, 17, H1: From 2013 to 2023 we evaluated vegetation in 11 permanent 100M^2 VIBI plots (see specifics in prior reports). These plots are meant to reflect three main habitat zones. Each year since 2013 we have evaluated vegetation cover by species, as well as woody stem counts in these plots, as recorded in APPENDIX F. Over this time, we have cataloged 219 plant taxa in these plots (and another 69 species from the area that are not in the plots), including many peatland specialists (Table 3, APPENDIX E).

The USACE and EPA permit documents specified targets involving increasing VIBI scores by 10 points from the baseline (or minimum scores over 66 for item 16, or 61 for item 61). Across all 11 VIBI plots the initial mean VIBI score in 2013 was 64.4, which increased to 70.7 by 2023, a gain of 6.3 points. Thus, the VIBI scores were well above 66, but did not increase by 10 points. However, the restoration area started off with such high VIBI scores that an increase of 10 points were not feasible. We feel that the outcome meets the spirit of this requirement.

Broken down by the different zones, overall VIBI scores indicate that the plant community in the Tamarack Bog is holding steady in the Core and Edge zones and is improving mildly in the Enhancement zone (Figure 2). Statistical analysis shows no trends over time (P>0.7), and no interaction (P>0.7), but strong differences among zones (P<0.0001). We interpret these results to say that the overall quality of the wetland is not declining in response to the restoration activities, and shows some indication of mild improvement in the Enhancement zone.

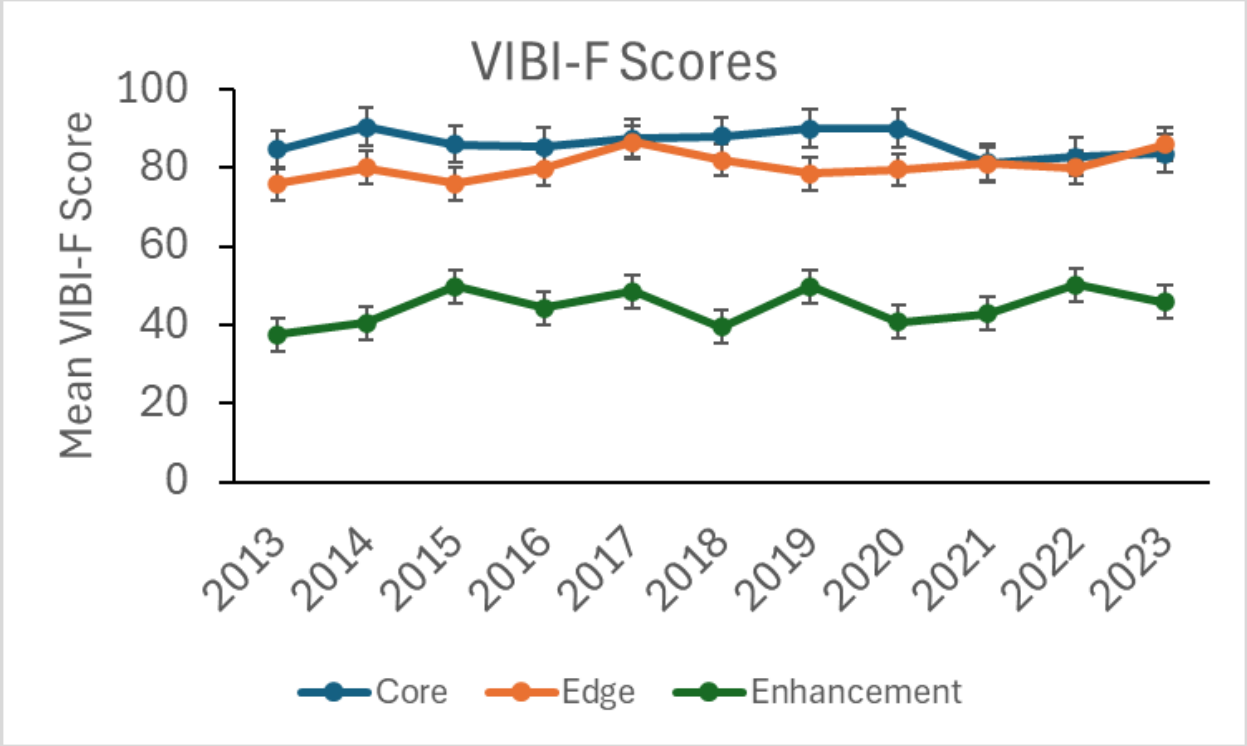

Figure 2. LSMean and SE for VIBI-F Scores across zones in the wetland. N=4 for Edge and Enhancement, N=3 for Core.

We also evaluated Mean FQAI scores (Floristic Quality Assessment Index) each year (Figure 3). The trajectory of the restoration is strong. FQAI scores for the Core zone stayed at 10 (the maximum) throughout the 11 years of monitoring. The other two zones improved strongly, with the Edge areas reaching 10, and the Enhancement zone improving strongly after the first few years. Statistical analysis indicates $P<0.02$ for Year, Zone, and Interaction effects. We interpret these results to say that the Core areas are retaining their original high quality, and the Edge and Enhancement zones are improving strongly, supporting the conclusion that the restoration has a strong positive trajectory over 10 years.

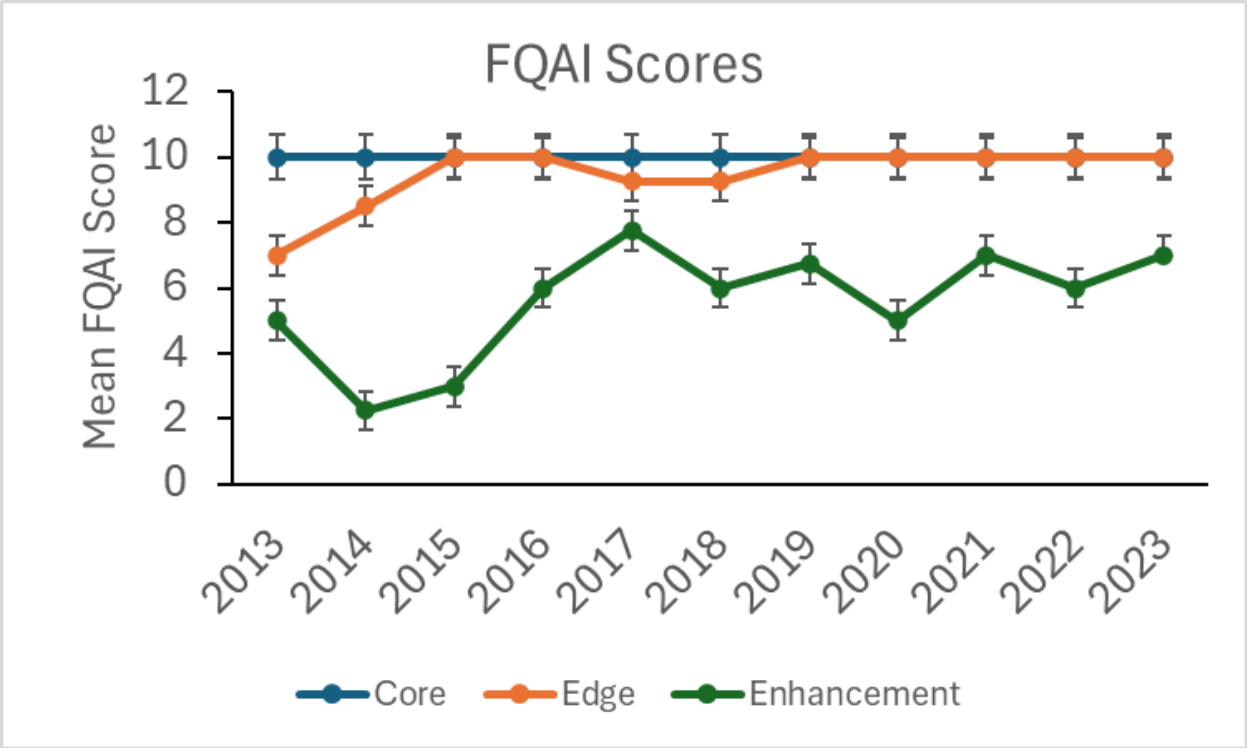

Figure 3. LSMean and SE for FQAI Scores across zones in the wetland.
N=4 for Edge and Enhancement, N=3 for Core.

To look at the vegetation patterns in more detail, we focused first on the dominant species. For this purpose, we present information on the ten species with highest absolute cover in each of the three habitat zones, and we compare the first year to the last year (Table 3). The three habitat zones of the wetland exhibit strong differences in the dominant species, and the species composition in each zone has changed for the better over the 10 years of monitoring (Table 3). In the Core, Speckled Alder (*Alnus incana*) increased while Buckthorn (*Rhamnus frangula*) decreased. In Edge and Enhancement plots *Carex lacustris* was initially not among the 10 most abundant species but was the most dominant plant in 2023. Likewise, in both those zones, the unwanted Crabapples (*Pyrus* sp.) were initially the most dominant plant but decreased to have less than half as much cover in 2023 through a combination of water level increase and physical removal efforts such as trunk girdling.

Coefficient of Conservatism is a helpful indicator of habitat quality, so we evaluated this for the dominant species. In the Core and Edge zones the mean C values for the 10 most abundant plant species increased (Table 3). In the Enhancement zones, mean C values slightly declined, largely because of the loss of high quality but dry-adapted species like *Carya ovata*, and addition of OBL species like *Leersia oryzoides* that have a lower C value.

Wetland indicator status for the dominant species is also informative regarding the wetland's trajectory. In 2013 FACW species dominated the Core and Edge zones, with a dryer flora in the Enhancement zone. By 2023 all zones have wetter-adapted vegetation: the number of OBL species among the dominant species increased substantially in all zones (Edge: 1 in 2013, 3 in 2023; Edge1➔4; Enhancement 0➔4).

It is worth noting that Skunk Cabbage cover increased strongly in the Edge habitat, a testament to the much wetter environment provided by the restoration's higher water levels.

Item 18, 19, Item H7: Percent cover of native perennial hydrophytic vegetation across the sample plots started off at 60% in 2013, and by 2023 had increased to 80.4%, well above the target of 75%. Overall cover of the wetland by invasive non-native species is below the target of 5%, decreasing from 6.8% in 2013 to 4.5% in 2023 (Figure 4). Both of these targets have been achieved.

NEXT PAGE:

Table 3. 10-year comparison of dominant species in each of the three wetland zones. Values are mean absolute cover from VIBI plots for each of the 10 most abundant species in that year. ***Boldface*** *indicates species present in both years. Red text indicates unwanted species. Also shown are Coefficient of Conservatism Values ("C"), and Wetland Indicator Status values ("Ind.") for each species. Mean C values are shown under each group.*

TABLE 3.

CORE: **2013**

Species	C	Ind.	Mean
Moss sp.	*	ND	39.2
Thuidium delicatulum	*	ND	39.2
Rhamnus frangula	0	FAC	32.5
Osmunda cinnamomea	6	FACW	25.8
Impatiens capensis	2	FACW	24.2
Alnus incana	6	FACW+	20.8
Vaccinium corymbosum	6	FACW-	15.5
Ilex verticillata	6	FACW+	15.0
Toxicodendron vernix	7	OBL	14.2
Rubus hispidus	5	FACW	11.8

4.8

EDGE **2013**

Species	C	Ind.	Mean
Pyrus coronaria	3	UPL	51.7
Acer rubrum	2	FAC	35.8
Impatiens capensis	2	FACW	33.3
Rubus hispidus	5	FACW	22.5
Fraxinus pennsylvanica	3	FACW	19.7
Pilea pumila	2	FACW	12.7
Polygonum sagittatum	2	OBL	11.8
Prunus serotina	3	FACU	11.7
Moss sp.	*	ND	10.0
Osmunda cinnamomea	6	FACW	8.7

3.1

ENHANCEMENT **2013**

Species	C	Ind.	Mean
Pyrus coronaria	3	UPL	48.7
Impatiens capensis	2	FACW	33.5
Acer rubrum	2	FAC	26.7
Rubus hispidus	5	FACW	26.7
Carya ovata	6	FACU-	20.8
Prunus serotina	3	FACU	13.2
Cornus amomum	2	FACW	12.7
Acer saccharum	5	FACU-	12.5
Juglans nigra	5	FACU	12.5
Fraxinus pennsylvanica	3	FACW	11.7

3.6

CORE: **2023**

Species	C	Ind.	Mean
Alnus incana	6	FACW+	45.8
Moss sp.	*	ND	45.8
Osmunda cinnamomea	6	FACW	29.2
Thuidium delicatulum	*	ND	24.2
Rhamnus frangula	0	FAC	24.2
Rosa palustris	5	OBL	14.2
Symplocarpus foetidus	7	OBL	14.2
Decodon verticillatus	6	OBL	11.8
Carex seorsa	7	FACW	9.5
Vaccinium corymbosum	6	FACW-	9.5

5.4

EDGE **2023**

Species	C	Ind.	Mean
Carex lacustris	5	OBL	26.3
Symplocarpus foetidus	7	OBL	22.5
Pilea pumila	2	FACW	21.5
Fraxinus pennsylvanica	3	FACW	17.5
Osmunda cinnamomea	6	FACW	11.5
Glyceria striata	2	OBL	11.5
Acer rubrum	2	FAC	10.4
Ilex verticillate	6	FACW+	10.0
Pyrus coronaria	3	UPL	8.0
Impatiens capensis	2	FACW	7.5

3.8

ENHANCEMENT **2023**

Species	C	Ind.	Mean
Carex lacustris	5	OBL	36.9
Fraxinus pennsylvanica	3	FACW	23.1
Pilea pumila	2	FACW	20.4
Acer rubrum	2	FAC	20.4
Pyrus coronaria	3	UPL	10.0
Acer saccharum	5	FACU-	9.4
Glyceria striata	2	OBL	7.3
Polygonum arifolium	4	OBL	6.3
Leersia oryzoides	1	OBL	5.6
Carex bromoides	7	FACW	5.3

3.4

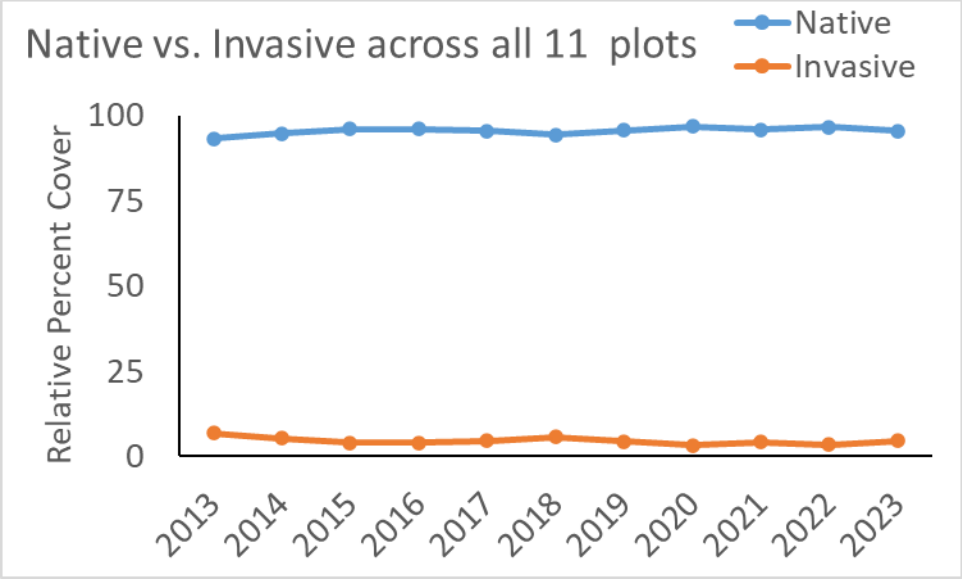

Figure 4. Mean relative percent cover of Native vs. Invasive species across all 11 plots.

For this project there were important concerns about not just non-native invasives, but problematic native species, especially Crabapple and Red Maple. Cover for these "Unwanted Species" has strongly decreased over the 10 years of monitoring, from 28% relative cover to 12% relative cover. (Figure 5). Most of this decline is in Crabapples (*Pyrus* spp.) and Red Maple (*Acer rubrum*), which have dropped from 25-30% absolute cover to about 10-15% absolute cover. This reflects vigorous and focused control efforts (mostly girdling) by Davey Tree, and an improved method of girdling since 2016.

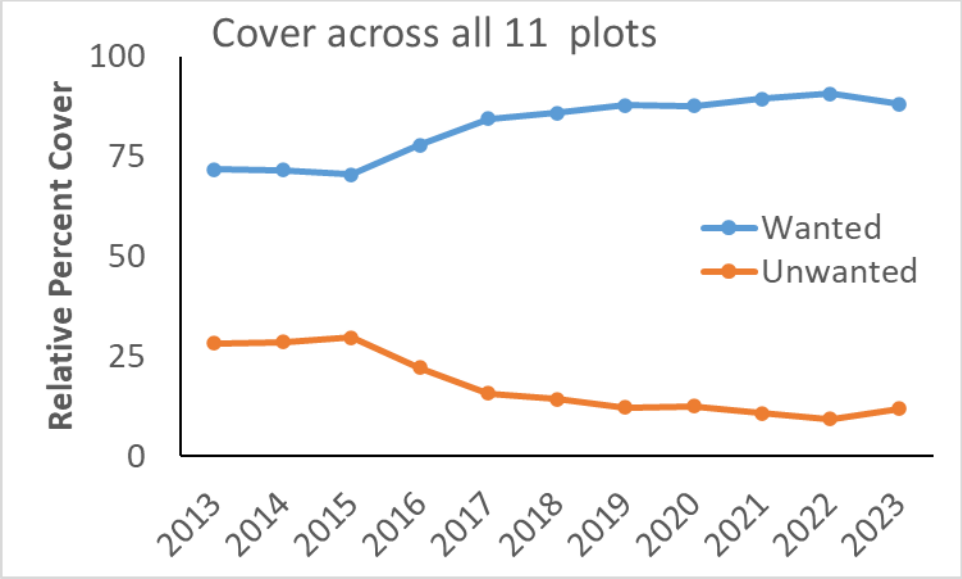

Figure 5. Mean relative percent cover of wanted vs. unwanted species. Unwanted species include invasive non-native species and several native species that are not contributing to habitat quality (Red Maple, Crabapple, and Black Cherry).

Other invasives (e.g., *Phragmites australis,* and *Phalaris arundinacea*) are not common in the project area and are not increasing. The only *Phragmites* currently in the area is in the gas line, where it has been aggressively sprayed by Davey Tree. Reed Canary is uncommon in most of the restoration area (currently <1% cover total and present in only two VIBI plots).

Our results and experience indicate that the invasive control efforts now in place (along with the change in hydrology) are having strong positive effects. We also conclude that continued aggressive control of invasive species will be necessary to maintain the currently high-quality project area. Based on the Bath Township covenant (APPENDIX C), continued invasive species control efforts are required to continue under the direction of Bath Township.

Two native species that have responded strongly to the restoration activities are Green Ash and Lake Sedge (*Fraxinus pennsylvanicus* and *Carex lacustris*; Figure 6). Green Ash in the Edge and Enhancement zones is strongly increasing. Most of these are saplings under 1-2" DBH and are therefore at this point too small to be colonized by Emerald Ash Borer. But soon they will grow enough to invite that invader and will probably die in consequence. It is not clear how the vegetation will respond to that strong change. This deserves continued attention.

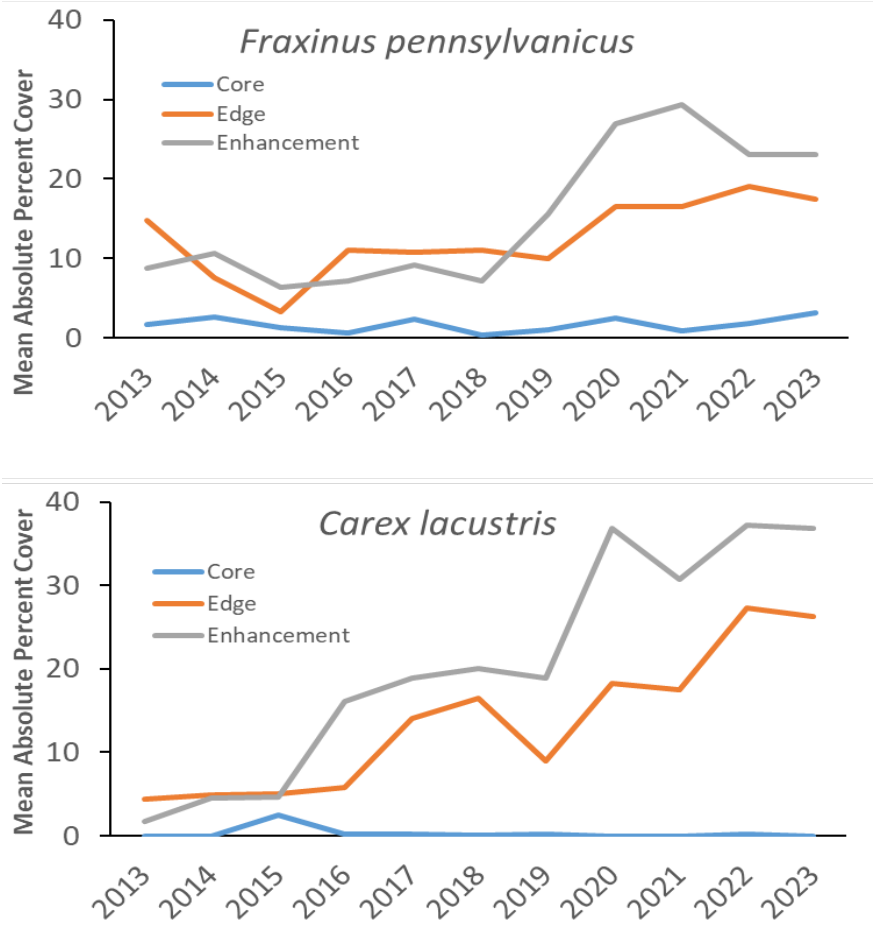

Figure 6. Mean absolute percent cover of two increasing native species.

The expansion of *Carex lacustris* (Lake Sedge) in the Edge and Enhancement zones (but not in the Core Bog) is a clear sign that those zones are transitioning to improved and wetter conditions. This high-quality wetland sedge (Coefficient of Conservatism = 5, OBL) thrives in slightly flooded sites (Yetka and Galatowitsch 1999), which are now provided by the elevated stoplog at the outlet.

Item 20: Woody stems increased over the restoration (from 16,018 /acre in 2013 to 20,155 in 2023; Figure 7). This improvement was almost entirely from gains in native species. Indeed, unwanted woody stems declined (from 5,091 stems/acre to 4,027). This surpasses the restoration criterion for woody stems (of 400 native live and healthy woody plants/acre in forested areas).

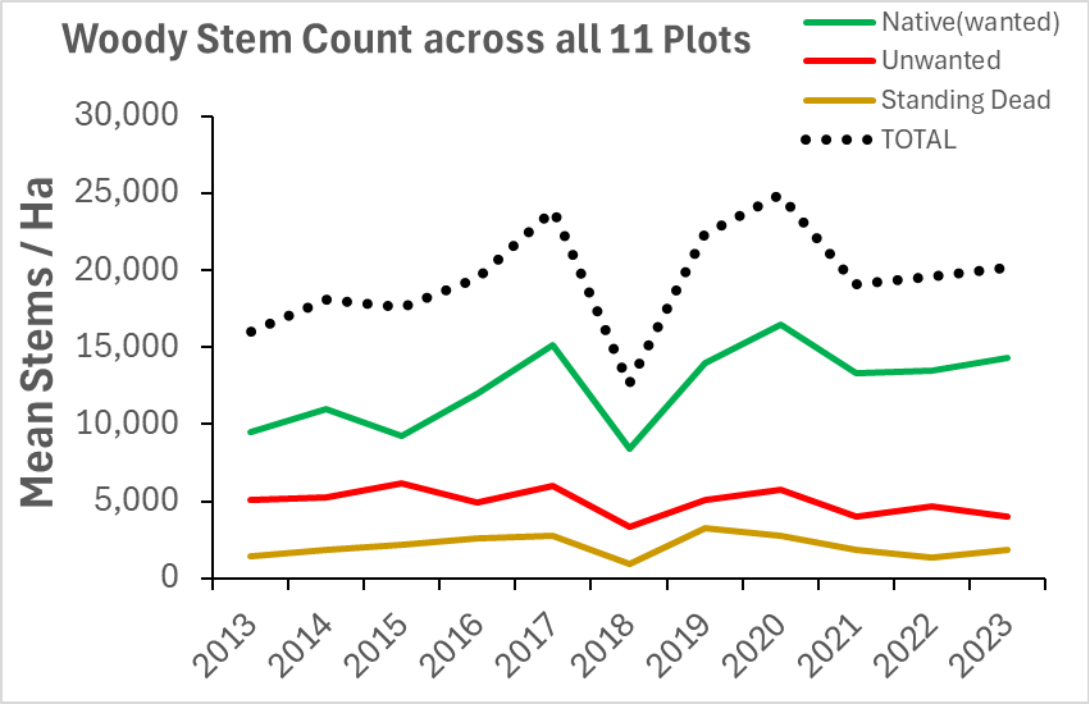

Figure 7. Mean stems/ha over 10 years of restoration for all 11 plots.
Note that in 2018 we used an incorrect counting method for clumps, generating an artificial dip in abundance.

IV. Tamarack Trees and Other Transplants

Items 21, 22, Item H4: Seven of the eight Tamarack trees that were present at the start of the project are still alive in 2023. The remaining trees have grown on average by 0.92cm in DBH since the first measurements (2016). Woodpeckers have made extensive excavations in one tree and this is probably going to shorten its life. Other than that, the remaining trees are healthy and produce seeds every year. Nonetheless, we have noted only one spontaneous seedling over 10 years of intense hands-and-knees exploration of the area. We suspect that herbivory by rodents is preventing establishment from seeds.

An initial criterion for this restoration, based on it being a "Tamarack Bog," was to establish a minimum of 40 live and healthy Tamarack trees/acre (8.9 acres*40 trees/acre = 356 trees total). However, that goal is not appropriate, since we determined in the first four years of this project that the wetland is not a Tamarack Bog, but, is instead a Poor Fen. Nonetheless, we conducted several Tamarack transplant trials – small and tentative at first, and more aggressively as we learned more. We summarize those efforts in the table below (Table 4), evaluated as of August 2023

Table 4. Overall Tamarack transplant survival as of August 2023
(note: seedlings for 2022 were 25cm tall at planting – all others were 50cm tall at planting)

Year planted	N Planted	N Alive 2023	% Survival to 2023	Mean Height (cm)	Height Range (cm)	N >1m tall
2016	48	5	10.4%	210	144 - 300	5
2017	128	38	29.9%	230	75 – 550	35
2020	124	0	0.0%	-	-	
2021	200	24	12.0%	98	23 - 176	1
2022	200	45	22.5%	43	11 - 152	11
2023	400	328	82.0%	50	10 - 79	0
Total	**1100**	**439**	**40.0%**	**-**	**10-550**	**52**

Survival of Tamarack seedlings was generally low in this study, and our efforts to improve this (preventing herbivory, site choice, planting methods) were not successful. Annual survival (from year to year) is typically near 50%. Despite problems with herbivory in the first year, we detected no strong herbivory after that, thus making comparisons of different herbivore deterrent methods moot. Those tamaracks that survived did quite well, with some exceeding 5m in height by 2023. Although most of the 439 planted trees now alive in the wetland are under 1m tall, 52 of them are over 1m, and some over 5m.

Item 23, Item H5: An initial criterion for this restoration, based on it being a "Tamarack Bog," was to double Sphagnum moss cover. However, as a Poor Fen/Alder Swamp, that criterion is no longer appropriate. Such communities do contain Sphagnum but not as a dominant species. Furthermore, attempts to establish Sphagnum through plug and other transplants were

unsuccessful, in part because of strong water currents in the fen environment during spring floods. However, moss in general (including all moss species; there are at least 28 species in this project; APPENDIX E) is nonetheless an important element of this and other wetland communities.

We present two pieces of information regarding this item:

First: Sphagnum coverage held fairly steady over the 10 years of the restoration (1.2% absolute cover in 2013 in Core plots, 0.8% in 2023), and Sphagnum actually expanded into one Edge plot (Plot S10) in the last 4 years.

Second: Many other moss species are important components of the Core zone. In particular, *Thuidium delicatulum* (Delicate Fern-Moss) is a very abundant moss in the area (and in fact, it may have been confused with Sphagnum in the initial evaluations that generated the restoration targets). Our results suggest no strong pattern of change in moss cover (Figure 8).

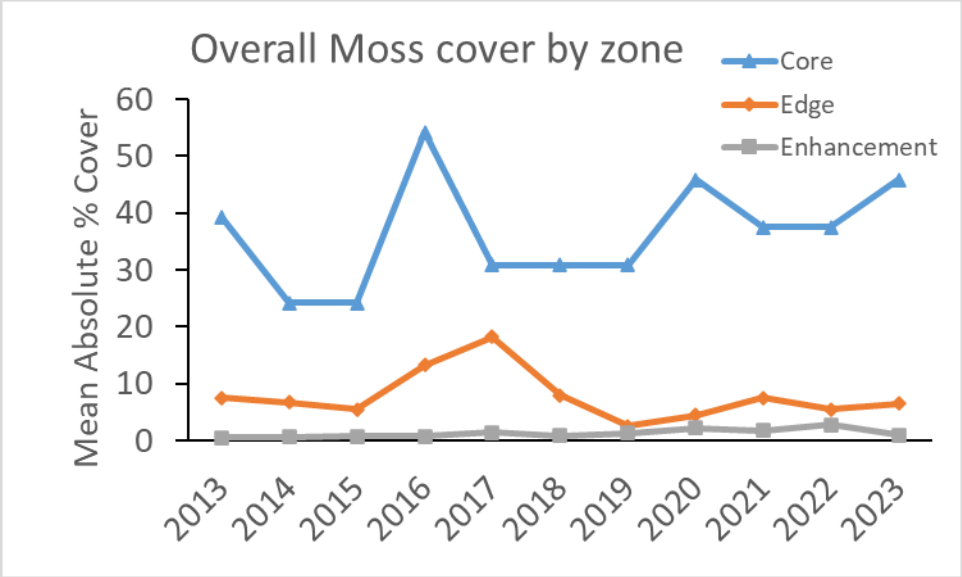

Figure 8. Mean absolute percentage cover by Moss (all species) in the three habitat zones.

Regarding transplantations, in addition to the Tamarack seedlings and Sphagnum plugs mentioned above, we attempted to establish live stake transplants of Speckled Alder (*Alnus incana*), but none survived.

V. Repeat Photo Summary

In 2014 we began to photograph from each corner in each of the 11 VIBI plots. We have also established photo sites at the transect endpoints. Additional representative photos are included in APPENDIX G. Those photos document a stable community in the Core bog (Plots S3, S5, S8), general improvements in the Edge zone (Plots S2, S6, S9, S10), and increased herbaceous cover in Enhancement plots (especially plots S1, S4, S7, S11).

Here are some examples of the changes seen, taken from APPENDIX G.

Figure 9. Example Plot Photos.

ENHANCEMENT PLOT PHOTOS:

Plot S7 August 2014 (Enhancement). From SE.

July 2023 Plot S7 SE. Lake Sedge expands. Silky dogwood in upper right is steady

Plot S1 May 2015 (Enhancement): From north.

May 2023 Plot S1 NE.
The large central tree has fallen, as has the sapling to its left. Enormous increase in Lake Sedge, and reduction in crabapple

EDGE PLOT Photos

Plot S2 July 2014 (Edge) Plot S2 from NE

July 2023 Plot S2 from NE corner (note Meter tape in center left). Strong increase in herbaceous and woody cover.

Plot S9 May 2015 (Edge). Plot S9 from NW

May 2023 Plot S9 NW corner.
Skunk cabbage perseveres, Lake Sedge and Quaking Aspen arrive, woody vegetation matured.

CORE PLOT PHOTOS

Plot S8 August 2014 (Core): S8 NE Corner to SW

July 2023. Plot S8 NE, view to SW. The thick woody veg. remains in place.

Plot S5 May 2015 (Core): Plot S5

May 2023 Plot S5 NE. A large shrub has fallen into the plot, but veg structure is consistent over time, skunk cabbage remains abundant.

In April 2017 we installed six citizen science repeat photo stations along the boardwalk and have received dozens of photos from the public. We also use those stations for our own photos and have recorded several hundred images of those same sites ourselves. Examples are presented in APPENDIX E. These and the other photos support the conclusions reported above about the VIBI plots.

VI. Water Depth and Chemistry

As required by the mitigation agreement, we monitored the groundwater wells established in 2013 each year through 2019. Details of our findings are in previous reports. In brief, these results indicate stable chemistry and normal yearly fluctuations that confirmed the categorization of the wetland as a Poor Fen rather than a Bog (Mezentseva,2015). In June 2020 we requested and received agency permission to be released from continued ground water monitoring.

We have continued two other types of water monitoring.

First, we evaluated water depth at the AGRI Drain outlet (Figure 10). These data confirm that the two stoplogs added to the AGRI Drain have continued to elevate water levels to an appropriate height, and that there is substantial yearly variation in water levels.

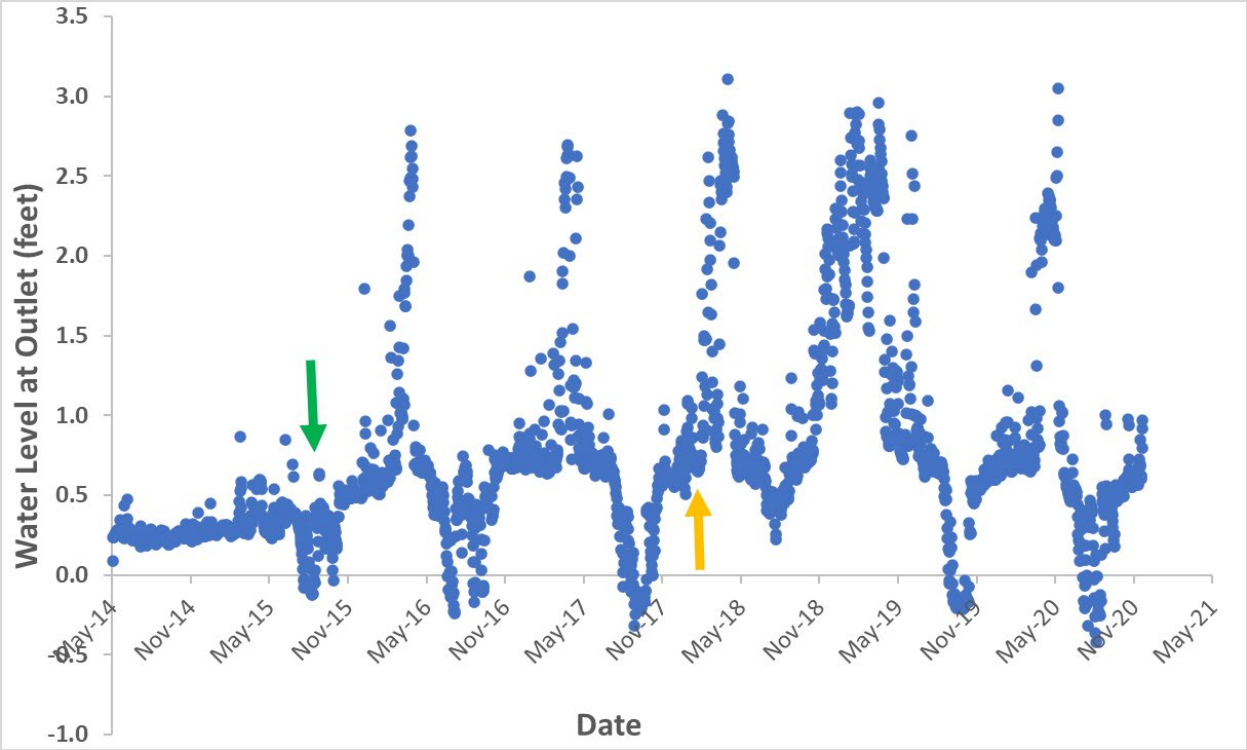

Figure 10. Water level at the AGRI drain (outlet) of the wetland, from Hobo Pressure transducer.
Green arrow indicates Sept 12, 2015, when the water outlet level was first raised. The orange arrow indicates the second time the water outlet was raised, Feb 12, 2018. The logger began malfunctioning in late 2020, so measurements were not continued.

Second, we have continued monitoring the absolute elevation of the peat/muck mat of the wetland using a fixed pole at two points in the wetland (Figure 11; see previous reports for methodological details). These data confirm that the bog mat floats on an underground pond.

Since the pond varies its elevation with the seasonal variation in water availability, the mat also rises and drops, with an amplitude of ~6". These fluctuations match those of the outlet level but with reduced amplitude. This elasticity has insulated the vegetation of the Core bog from the raised water level, preventing extreme flooding and potential drowning risk.

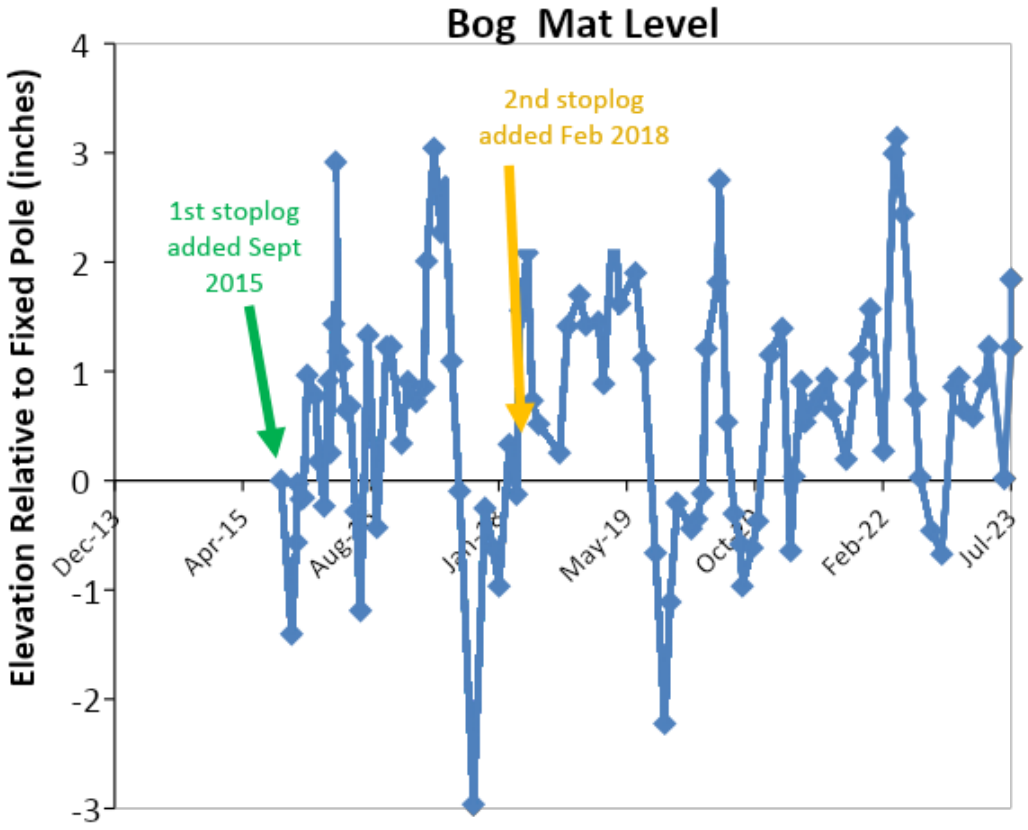

Figure 11. Absolute elevation of the bog mat.
Note that y axis in this graph is in inches, while that for the previous figure is in feet. The mat fluctuates in height by about 6" over the yearly cycle.

VII. Target Goal Adjustment

In Spring 2018 we began discussions about changing the target criteria for this restoration among all interested parties (EPA, ACOE, Bath Township, Balog, Mitchell, Hartman). A general agreement was reached that

1) The wetland is not a bog, but the criteria for a successful restoration largely assume that bog-like conditions should be established
2) The wetland is best described as a Poor Fen and may have been originally an 'Alder Shrub Swamp' (Anderson 1982).

Mitchell and Hartman shared a specific proposal for these changes in February 2020. The major features of this request are:

a) Change in target vegetation to "Mixed Shrub-Swamp community" (circumneutral - a "Poor Fen") with a small area of Tamarack Fen.
b) Eliminating the requirement to double Sphagnum coverage.
c) Request clarification of tamarack planting requirements, and an adjustment to the number of tamaracks required, to account for this being a Poor Fen.
d) Clarification on terminology regarding bog vs other wetland types.
e) Clarification that baseline year was 2013, and 2014 was year 1.

VIII List of Appendices

APPENDIX A: USACOE Permit
– see attachment

APPENDIX B: EPA Permit
– see attachment

APPENDIX C: Environmental Covenant
– see attachment

APPENDIX D: Delineation Report, April 2023.
– see attachment

APPENDIX E: Plant and Animal Species List for the Tamarack Bog.
- See attachment. Includes 288 identified plant species and 98 animal species.

APPENDIX F: Copies of all data sheets
– see attachment

APPENDIX G: Repeat photos of plots
– see attachments (one file for each plot)

APPENDIX E: Repeat photos from Boardwalk
– see attachment

Appendices and digital copies of this and prior reports are available online at
https://fieldstation.uakron.edu/permits-and-reports/bath-tamarack-bog-restoration/

IX. Publications and Presentations To Date Resulting From This Project

Publications *(PDFs available online, or hardcopies available on request)*

- Florent, M. 2024. Restoration for The Small and Slimy: How Pond-breeding Amphibians Utilize Natural, Restored, and Created Wetlands. Honors thesis, University of Akron. https://ideaexchange.uakron.edu/honors_research_projects/1859/
- Gunn, C. 2021. An assessment of the pH of the soil in the Tamarack Bog. Honors thesis, University of Akron. https://ideaexchange.uakron.edu/honors_research_projects/1285/
- Lanz, N. 2020. Effect of sunlight exposure and herbivory prevention on growth of *Larix laricina* in Bath Nature Preserve, Ohio. Honors thesis, University of Akron.
- Mezentseva, K. (2015). Hydrology of the Tamarack Bog, Bath Nature Preserve, Bath Township, Ohio, The University of Akron. (http://gradworks.umi.com/16/01/1601098.html)
- Mezentseva, K, I Sasowsky, RJ Mitchell, J Senko, T Quick, J Rizzo, & Loucek J. (2015). Disturbed tamarack "bog" in Northern Ohio revealed as a fen. Poster, Geological Society of America meeting, Baltimore, MD. Abstract with Programs V 47, No. 7, p. 749.
- Miller, J. A. (2016). Monitoring of *Sphagnum* at a Restoration Site and Possibilities for Restorative Activities. The University of Akron. (https://etd.ohiolink.edu/pg_10?0::NO:10:P10_ETD_SUBID:115968)
- Miller, J.A. and R. J. Mitchell (2018). Source Locality Effects on Restoration Potential in *Sphagnum palustre* L. from 3 Ohio Sites. The Ohio Journal of Science 118(2): 34-42. DOI: http://dx.doi.org/10.18061/ojs.v118i2.6354
- Shwaiki, Z. 2015. Micro-topographic and pH effects on *Sphagnum* growth. Honors thesis, University of Akron. https://ideaexchange.uakron.edu/honors_research_projects/58/

Presentations

- 2018. Akron Garden Club. Restoring the Bath Tamarack Bog
- 2017. Bath Township Parks Board. Restoring the Bath Tamarack Bog
- 2016. Summit County Master Gardeners. Restoring the Bath Tamarack Bog
- 2021. Mitchell, RJ, JM Hartman. Restoration of a remnant peatland in northeastern Ohio - the Bath Tamarack Bog. Midwest/Great Lakes Meeting of the Society for Ecological Restoration. Online and in Cleveland.
- 2023. Mitchell, RJ, JM Hartman. Restoration of a remnant peatland in northeastern Ohio - the Bath Tamarack Bog. National meeting of the Society for Wetland Scientists. Spokane WA, 2023..
- 2024. Restoring the Bath Tamarack Bog. Merriman Hills Garden Club.

X. References

Anderson, DM. 1982. Plant communities of Ohio: a preliminary classification and description. ODNR, 184 pp

Mezentseva, K. (2015). Hydrology of The Tamarack Bog. Bath Nature Preserve, Bath Township, Ohio. MS Thesis, Geology, The University of Akron.

Miletti, T. E., C. N. Carlyle, C. R. Picard, K. M. Mulac, A. Landaw, and L. H. Fraser. 2005. Hydrology, Water Chemistry, and Vegetation Characteristics of a Tamarack Bog in Bath Township, Ohio: Towards Restoration and Enhancement. Ohio Journal of Science 105:21-30.

Yetka, L. A., and S. M. Galatowitsch. 1999. Factors Affecting Revegetation of Carex *lacustris* and *Carex stricta* from Rhizomes. Restoration Ecology 7:162-171.

Appendices and digital copies of this and prior reports are available online at https://fieldstation.uakron.edu/permits-and-reports/bath-tamarack-bog-restoration/