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Annual Report #2 (2014)

Crowland Mitigation through Restoration

of the Tamarack Bog, Bath Nature Preserve. Summit County Ohio.

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Appendices

Appendix A: Copies of all Field data sheets

Appendix B: List of Vouchers and Voucher numbers collected

Appendix C: List of Taxa

Monitoring Methods and Results

VIBI Modules- Methods. As in 2013 we used a modified VIBI methodology (Mack 2007) to evaluate wetland quality. Methods follow those in the 2013 report – we repeat those here for convenience. Our modifications largely involve the shape of individual modules to accommodate the challenging terrain, thick shrub vegetation, and sensitive habitat (especially in the core bog area). We modified the standard 10x10m VIBI module layout as shown in Figure 1. In this modified design we first established a central 25x1m access lane, then sampled 2m on either side of this lane. This design minimized trampling while allowing good access to the 4x25m sampling area.

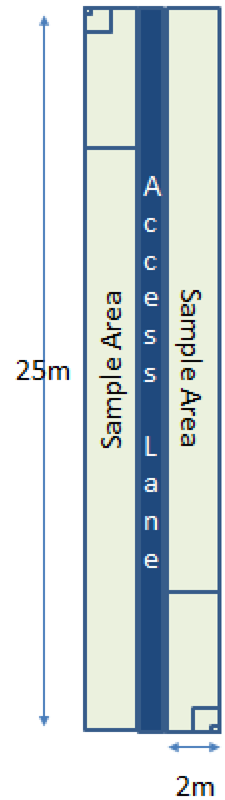


Figure 1. Modified VIBI intensive module design used in the tamarack bog project. Two sample areas of 2x25m are on either side of a central 1x25m access lane. In two of the outside corners we established nested quadrats of 10m², 1 m², and 0.1m².

We established 11 such modules (Figure 2): 3 in the core bog area, 4 adjacent to the wetland edge (near the delineated boundary of the wetland), and 4 that are potential areas of wetland expansion. Our intent was to: 1) use the core modules to evaluate whether the existing bog maintains its status during the restoration. 2) use the wetland Edge modules to evaluate whether conditions at the edge improve (e.g., become more boglike, and experience spread of sphagnum or other bog specialists). 3) use the Expansion modules (which generally had a noticeably peaty soil with a 'bounce', and seemed likely to improve if hydrology was restored) to evaluate wetland quality and the extent of responses to the restoration. We denoted each module in the field with permanent markers, and recorded gps coordinates. We sited modules to include representative habitat of each of the areas listed above.

In each module we used standard VIBI methods to assess presence and percent cover of herbaceous vegetation, along with both percent cover and stem abundance of different size classes of woody plants. We summarized these data using the OEPA's VIBI spreadsheet calculator available online.

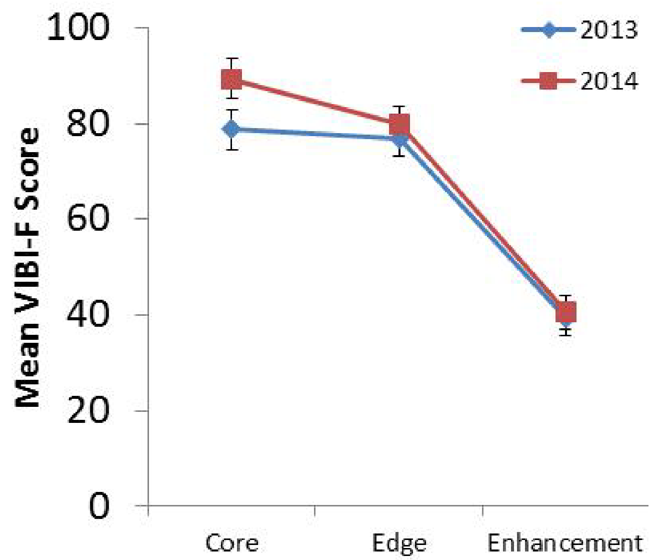
VIBI Modules- Results 2014**.** In August 2014 we repeated the 2013 sampling of all 11 100M^2 plots. We identified 140 plant species and another 62 (mostly rare) taxa during our survey, including many peatland specialists (Table 1, Appendix A). We also documented substantial cover by undesirable (e.g., Red Maple, Crabapple), and invasive species (e.g., Buckthorn).

***Figure** 2 – Approximate locations of major landscape elements of the tamarack bog restoration. Yellow and orange dashed lines indicate approximate boundaries of major plant communities. Boxes indicate the 11 VIBI modules. The orange boxes are 'core' modules, the yellow boxes are 'edge' modules, and the green boxes are 'enhancement' modules. The 8 green lines indicate vegetation transects. The red T's indicate locations of the 8 tamarack trees.*

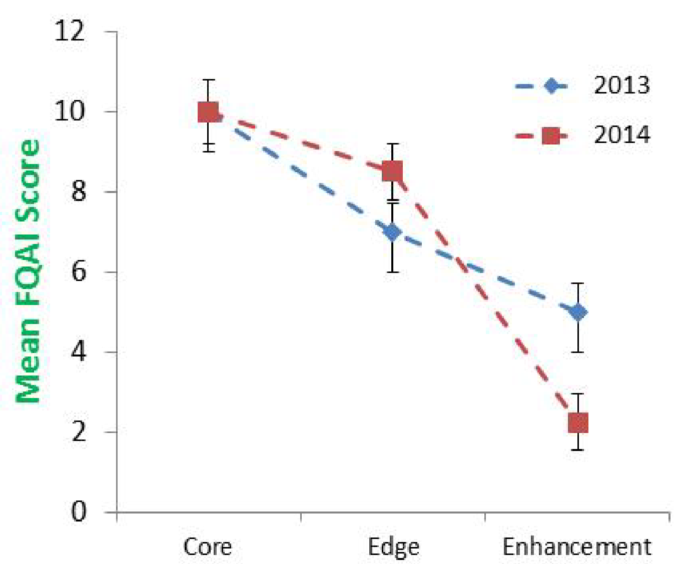
***Table 1.** Dominant plants (mean relative cover over 5%) from VIBI plots in each wetland area (mean relative cover for each species in parentheses) during 2014.*

Enhancement (92 taxa in 4 plots)	**Wetland Edge (99 taxa in 4 plots)**	**Core (85 taxa in 3 plots)**
Pyrus coronaria (0.39)	*Acer rubrum (0.26)*	*Alnus serrulata (0.23)*
Acer rubrum (0.32)	*Pyrus coronaria (0.20)*	*Moss sp. (0.18)*
Pyrus sp. (0.21)	*Rubus hispidus (0.10)*	*Vaccinium corymbosum (0.16)*
Pilea pumila (0.20)	*Pyrus sieboldii (0.10)*	*Decodon verticillatus (0.16)*
Impatiens capensis (0.16)	*Fraxinus pennsylvanica (0.08)*	*Osmunda cinnamomea (0.14)*
Prunus serotina (0.10)	*Osmunda cinnamomea (0.08)*	*Rhamnus frangula (0.14)*
Juglans nigra (0.10)	*Ilex verticillata (0.07)*	*Toxicodendron vernix (0.14)*
Fraxinus pennsylvanica (0.06)	*Symplocarpus foetidus (0.06)*	*Larix laricina (0.11)*
Rubus hispidus (0.06)	*Vaccinium corymbosum (0.06)*	*Impatiens capensis (0.10)*
	Rhamnus frangula (0.05)	*Carex seorsa (0.10)*
		Alnus incana (0.10)
		Ilex verticillata 0.07)
		Pyrus coronaria (0.06)
		Rosa palustris 0.06)
		Salix sp. (0.06)
		Sphagnum sp. (0.06)

In 2014 we did not detect strong changes in the plant community or in of the metrics from the 2013 (year 0) survey. Below are some summaries of our findings for these two initial years of study.



VIBI scores for Core and Edge VIBI areas were high in both years, while the Enhancement areas scored much lower. ANOVA indicates that only the effect of habitat area (core/edge/enhancement) is significant ($F_{2, 16}$= 84, P<0.001), with no significant differences among years ($F_{1, 16}$= 2.7, P>0.1), and no interaction ($F_{2, 16}$= 0.8, P>0.4).



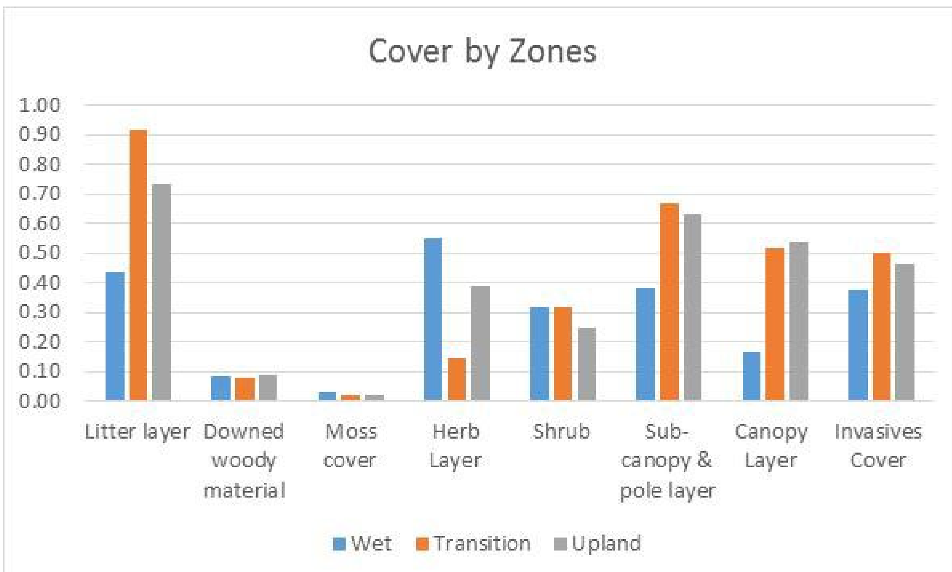
FQAI scores were high and showed strong differences among areas that were generally consistent across years, despite a significant interaction of year and area ($F_{2, 16}$= 18, P<0.03) that reflects minor improvements in edge plots and declines in enhancement plots. Areas differed significantly ($F_{2, 16}$= 37 P<0.001), although years did not ($F_{1, 16}$= 0.4, P>0.5).

Rare species of concern are maintaining themselves, but there is no noticeable numerical growth or spatial spread in 2014 compared to 2013. For example, although the tamarack trees continue to survive and produce cones, we saw no seedling tamarack trees.

The Sphagnum Reach monitoring plots were established in early 2014. Because those results were included in the 2013 report, we do not repeat that information here.

Repeat Photography. In 2014 we established repeat photography stations at each of the 11 VIBI plots. Those photos are included at the end of each of the individual transect sheets (attached). We have also established photo sites at the transect endpoints.

Transects. To evaluate habitat status and future expansion outside of the core bog we resampled 8 transects radiating out from the bog (see Figure 1, green lines). Each transect extended from ~10m inside the delineated wetland boundary to upland habitat (determined by elevation and vegetation). Transects ranged from 40 to 100m in length. NOTE - for this second year of sampling we extended several transects further upland and into the wetland, to better capture potential changes. Every 10m along each transect we scored canopy coverage, hydrology, and soils. We considered each 10m portion of a transect as a 'segment'. We grouped the data across transects using soil description into wetland (25 segments), transition (13 segments), and upland (14 segments). In most cases the transect results match expectations, with clear gradients along the transition from wetland to upland habitat: litter generally increased, mosses decreased, and canopy increased. We noted minor changes between 2013 and 2014, but because of the expanded coverage of the transects these are not interpretable.



Hydrological chemistry

Two rounds of water chemistry evaluation have been completed in the tamarack bog, and those data are now being evaluated by UA geologists (Ira Sasowsky and Karyna Mezentseva), and Ohio EPA scientists (Jeff Rizzo and Joe Loucek). They are working to resolve the causes and meaning of an imbalance of cations and anion. That evaluation should be completed by mid to late 2015, when Mezentseva completes her Master's thesis on the hydrology of the bog.

Hydrological monitoring – Methods (From Dr. Ira Sasowsky and Karyna Mezentseva, UA Geology).

Dates: 12/03/13 and 12/05/13. A total of 11 borings were made using Geoprobe direct push method. Initial probing was done using a 2.25" diameter probe that collects a 1.25" diameter sample. Samples were collected from all borings using clear acrylic liners, 48 inches in length. The boring numbers and status are given in the summary table. The liners were cut open in the field for examination. All samples were photographed. The samples were later closed up, and wrapped in Saran wrap for preservation and later testing. It was typical that the first 4' push returned <4' of sample (compression). It was also typical that deeper samples would fill a 4' core with only 3' of push (expansion). The typical sampling core-column was organic matter on top, followed by brown clay, and then gray clay. The gray clay had occasional pebbles in it. A few holes had sand or gravel layers. Many holes were dry. Wells that were completed (i.e. screen and pipe installed) are 1.5" inner diameter white PVC, with pre-packed screens of 5' length. They are installed in a 3.25" diameter pushed hole. Riser pipe is screwed together. Sand was poured in to the annulus after screens were placed, and a weighted line was used to try and allow 2' of sand above top of screen. Annulus was then backfilled to surface with granular bentonite.

Date: 03-15-2014. The purpose of field work was to install several hand-drilled wells within the bog boundaries for water level and chemical monitoring. Possible auger well locations were previously selected. Map with wells positions was created in a GIS program Global Mapper. Disto laser distance meter and tape measure along with Brunton bearing (corrected for 8 degree declination) were used to get the approximate position for the new borings. A 4.2 feet long and 0.3 foot width bucket auger, with 3 feet extensions, was used for creating the borings.

Total number of installed augured was wells 5. Two wells at different depth (long and shorter) were installed at the spot # 7 and 8 in order to calculate hydraulic gradient at those places. Boreholes were made by twisting an auger directly into the peat with subsequent placing of PVC 1” x1’SDR-21 PR 200 PSI pipes (outer and inner diameter s are1.25 and 1.125 inches, respectively). Filters made of dense cotton thread were designed by Tom Quick (Research Associate at the Department of Geosciences, the University of Akron) and attached to the bottoms of the PVC pipes in order to prevent pipes from clogging by sediment. Total length of filter was 13.5”. Mud and peat samples were laid out on the yellow cloth, described, collected in Ziploc bags, appropriately labeled. All samples were photographed. Generally, samples made of somewhat muddy layer on the top that gradually changes into wet partially decomposed organic layer sometimes abundant with woody fragments. Consistently graded medium grit sand Arena Mediana and granular bentonite were poured into the annulus to isolate the sampling interval in the wells. Due to the unstable nature of the borehole walls, and the small annular space, it was not possible to quantify the height of sand placed in the screened intervals.

Auger wells characteristics

Well #	Total depth of probing, (ft)	Length of the tube, (ft)	Stick-up, (ft)	Notes
7	23 ft	21 ft 1.5 in	1 ft 10 in	Whole profile made of some mud and peat on the top up to 8-10 feet, other part of borehole just a body of water without any sediment recovery below13 feet depth.
7A	7 ft 3 in	11 ft 1 in	3 ft 10 in	Bad sample recovery due to the abundance of roots along the whole profile.
8	16 ft	15 ft 8.5 in	1 ft 9.25 in	Good recovery for each sample.
8A	7 f 2.5 in	11 ft 1.5 in	3 ft 11 in	Pretty dry well, no standing water was found up to the depth 5 feet,
9	7 ft 11.5 in	11 ft 1.5 in	3 f 1 in	All sample are very resistant and dense

Well #	# of interval	Depth interval, ft	Total depth of section (segment), ft	Sediment description
7A	1	0-2 ft 5 in	2 ft 5 in	Very wet mud with roots
	2	2 ft 5 in-3 ft 2 in	9 in	Very wet mud with roots
	3	3 ft 2 in- 5 ft 9 in	2 ft 7 in	Very moist undecomposed peat with a lot of roots
	4	5 ft 9 in – 7 f 3 in	1 ft 6 in	Very moist undecomposed peat with a lot of roots
8	1	0-11 in	11 in	Dark wet saturated mud with organic material
	2	11 in-3 ft 9 in	2 ft 10 in	Dark moist mud with organics
	3	3 ft 9 in-4 ft 1 in	4 in	Dark moist mud with organics
	4	4 ft 1 in-6 ft 2 in	2 ft 1 in	Dark undecomposed peat
	5	6 ft 2 in-7 ft 2 in	1 ft	Dark undecomposed peat
	6	7 ft 2 in- 8 ft 4 in	1 ft 2 in	Dark undecomposed peat
	7	8 ft 4 in – 8 ft 8 in	4 in	Peat with a lot of woody fragments
	8	8 ft 8 in-9 ft 10 in	1 ft 2 in	Resistant peat full of woody fragments
	9	9 ft 10 in-13 ft 4 in	3 ft 6 in	Organic dark peat
	10	13 ft 4 in-16 ft 4 in	3 ft	Organic dark peat
9	1	0-10 in	10 in	Dump granular mud
	2	10 in -1ft 10 in	1 ft	Moist mud, dense
	3	1 ft 10 in-2 ft 11 in	1 ft 1 in	Wet mud, very resistant
	4	2 ft 11 in-3 ft 11 in	1 ft	Moist ark organic peat
	5	3 ft 11 in - 4 ft 3 in	4 in	Dense black peat with a lot of woody fragments
	6	4 ft 3 in – 5 ft 2 in	11 in	Moist peat with some woody fragments
	7	5 ft 2 in -5 ft 9 in	7 in	Moist peat
	8	5 ft 9 in -6 ft 5 in	8 in	Moist dense peat, very resistant
	9	6 ft 5 in -7 ft 11 in	1 ft 6 in	Dark dense moist peat

Hydrological monitoring – Results to date.

Summary table for all wells/borings at the Tamarack Bog, Bath Nature Preserve

ID	Date	*a)* Comp-letion type	Install-ation method	*b)* Position	*c)* Land Elev-ation, ft	*d)* Depth of boring below ground surface, ft	Screen depth below ground surface, ft	*e)* Stick up, ft	*f)* Land elev-ation, ft	*b)* Top of casi ng, ft
1	12/3/13	Boring	Geoprobe	N41 10.706 W81 38.662	1012	17'11"	-*	-	-	1048
1A	12/3/13	Well	Geoprobe	N41 10.695 W81 38.662	1000	27'	7'-12'	2'9"	1039'3"	1042
2	12/3/13	Boring	Geoprobe	N41 10.616 W81 38.692	1011	22'	-	-	-	1055
2A	12/3/13	Well	Geoprobe	N41 10.624 W81 38.678	998	14'	9'-14'	2'5"	992'7"	995
3	12/3/13	Boring	Geoprobe	N41 10.692 W81 38.741	1012	26'	-	-	-	1053
4	12/5/13	Boring	Geoprobe	N41 10.573 W81 38.524	997	21'	-	-	-	984
5	12/5/13	Boring	Geoprobe	N41 10.667 W81 38.524	1024	30'	-	-	-	1036
5A	12/5/13	Boring	Geoprobe	N41 10.652 W81 38.535	1005	24'	-	-	-	1055
5B	12/5/13	Well	Geoprobe	N41 10.646 W81 38.561	995	28'	21' -26'	3'2"	1006'10"	1010
5C	12/5/13	Well	Geoprobe	N41 10.648 W81 38.560	995	16'	10'-15'	2'6"	1000'6"	1003
6	12/5/13	Well	Geoprobe	N41 10.568 W81 38.656	1002	16'	8'-13'	2'01"	993'	995
7	3/15/14	Well	Auger	N41.17723 W 81.64360	995	23'	19'3"- 18'1.5"	1'10"	968'11"	970
7A	3/15/14	Well	Auger	N41.17725 W81.64362	995	7'3''	7'3''- 6'1.5"	3'10.5"	980'1.5"	984
8	3/15/14	Well	Auger	N41.17766 W81.64432	995	16'	13'11.25"- 12'9.75"	1'9.25"	1014'2.5"	1016
8A	3/15/14	Well	Auger	N41.17768 W81.64432	995	7'25"	7'2.5"- 6'1"	3'11"	1034'1"	1038
9	3/15/14	Well	Auger	N41.17681 W 81.64310	995	7'11"	7'11.5"- 6'10"	3' 1"	997'1"	1001

"-" -not applicable,
a – Only select borings were completed as wells,
b – Measured by GPS placed on the top of casing or stake, 100 point average, do not trust,
c – Elevations derived from Lidar data using Global Mapper,
d – Reported by driller,
e – Measured by tape,
f –Determined by subtracting stick up values from top of the casing wells.

Appendix A: Copies of all Field data sheets – see attachment

Appendix B: List of Vouchers and plant specimens collected in 2014
(68 specimens total in 2014, 292 specimens total since 2013)

NUMBER	TAXON	Family	Voucher #
2014-072	Carex sp "wooly sedge"	Cyperaceae	S11.01.14
2014-092	Scutellaria lateriflorus	Lamiaceae	S3.02.14
2014-099	Epilobium ciliatum	Onagraceae	S3.03.14
2014-029	Carex bromoides	Cyperaceae	S4.01.14
2014-035	Carex cristatella	Cyperaceae	S4.02.14
2014-034	Carex seorsa?	Cyperaceae	S4.05.14
2014-031	Geum laciniatum	Rosaceae	S4.06.14
2014-030	Pilea pumila	Urticaceae	S4.07.14
2014-075	Carex atlantica capillacea	Cyperaceae	S5.01.14
2014-033	Cuscuta goronovii	Convolvulaceae	S7.01.14
2014-046	carex sect. ovales?	Cyperaceae	S7.03.14.1
2014-047	Juncus sp - effusus?	Juncaceae	S7.04.14
2014-032	Carex cristatella	Cyperaceae	S7.05.14
2014-045	Galium sp.	Rubiaceae	S7.07.14
2014-044	Alnus incana	Betulaceae	
2014-095	Alnus viridis	Betulaceae	
2014-096	Alnus viridis	Betulaceae	
2014-065	Amelancier arboreus (?)	Rosaceae	
2014-011	Arisaema triphyllum	Araceae	
2014-094	Arisaema triphyllum	Araceae	
2014-081	Aronia melanocarpa	Rosaceae	
2014-038	Bidens cernua	Asteraceae	
2014-058	Bidens connata	Asteraceae	
2014-042	Boehmeria cylindracea	Urticaceae	
2014-079	Cardamine bulbosa	Brassicaceae	
2014-006	Carex atlantica capillacea	Cyperaceae	
2014-005	Carex bromoides	Cyperaceae	
2014-023	Carex bromoides	Cyperaceae	
2014-028	Carex bromoides	Cyperaceae	
2014-016	Carex cristatella	Cyperaceae	
2014-027	Carex cristatella	Cyperaceae	
2014-056	Carex cristatella	Cyperaceae	
2014-022	Carex gracillima	Cyperaceae	
2014-026	Carex leptalea	Cyperaceae	
2014-020	Carex seorsa	Cyperaceae	
2014-025	Carex seorsa	Cyperaceae	
2014-007	Carex seorsa?	Cyperaceae	
2014-008	Carex seorsa?	Cyperaceae	
2014-024	Carex seorsa?	Cyperaceae	

2014-021	Carex stipata	Cyperaceae	
2014-076	Carex trisperma	Cyperaceae	
2014-077	Carex trisperma	Cyperaceae	
2014-010	Cornus ammomum	Cornaceae	
2014-074	Cuscuta goronovii	Convolvulaceae	
2014-059	Fraxinus nigra	Oleaceae	
2014-057	Fraxinus pennsylvanica	Oleaceae	
2014-036	Galium sp.	Rubiaceae	
2014-018	Galium tinctorium	Rubiaceae	
2014-012	Glyceria canadensis	Poaceae	
2014-003	Glyceria striata	Poaceae	
2014-093	Lapsana communis	Asteraceae	
2014-087	Lemna minor	Lemnaceae	
2014-009	Lonicera maackii??	Caprifoliaceae	
2014-097	Lycopus americanus	Lamiaceae	
2014-043	Lycopus virginiana?	Lamiaceae	
2014-013	Lysimachia ciliata	Myrsinaceae	
2014-014	Lysimachia ciliata	Myrsinaceae	
2014-080	Lysimachia thyrsiflora	Myrsinaceae	
2014-039	Pilea pumila	Urticaceae	
2014-098	Pilea pumila	Urticaceae	
2014-083	Prunus serotina	Rosaceae	
2014-073	Rhamnus alnifolia	Rhamnaceae	
2014-086	Rhamnus frangula	Rhamnaceae	
2014-015	Salix… humilis? Bebbiana?	Salicaceae	
2014-041	Verbesina alternifolia	Asteraceae	
2014-085	Viburnum cassinoides	Adoxaceae	
2014-078	Viburnum cassinoides	Adoxaceae	

Appendix C. Taxon List for Tamarack Bog as of 2014. Includes 140 identified species, and 62 taxa not yet confirmed to species. Does not distinguish mosses (approximately 20 species identified in the bog so far).

Acer rubrum
Acer saccharum
Agrimonia pubescens
Agrimonia striata
Alliaria petiolata
Alnus incana
Alnus serrulata
Alnus sp.
Amelanchier laevis
Amelanchier sp.
Amphicarpaea bracteata
Arctium sp.
Arisaema triphyllum subsp. Triphyllum
Aronia melanocarpa
Aster lateriflorus
Aster puniceus
Aster sp.
Berberis thunbergii
Bidens cernua
Bidens sp.
Boehmeria cylindrica
Botrychium sp.
Calamagrostis sp.
Caltha palustris
Cardamine sp.
Carex atlantica subsp. Capillacea
Carex bromoides
Carex comosa
Carex crinita var. crinita
Carex cristatella
Carex gracillima
Carex lacustris
Carex leptalea
Carex seorsa
Carex sp.
Carex trisperma
Carpinus caroliniana
Carya glabra
Carya ovata
Carya sp.
Cephalanthus occidentalis
Chelone glabra
Cinna arundinacea
Circaea lutetiana
Clematis virginiana
Cornus amomum
Cornus florida
Cornus racemosa
Crataegus alnifolia
Crataegus sp
Crataegus sp.
Cuscuta gronovii
Decodon verticillatus
Desmodium sp.
Dryopteris carthusiana
Dryopteris cristata
Dryopteris marginalis
Epilobium ciliatum
Epilobium coloratum
Epilobium sp.
Erechtites hieracifolia
Erigeron annuus
Euonymus alatus
eupatorium perfoliatum
Fern 2
Fern sp.
Fraxinus pennsylvanica
Fraxinus sp.
Fungus sp.
Galium aparine
Galium asprellum
Galium labradoricum
Galium sp.
Galium triflorum
Gaylussacia baccata
Geranium maculatum
Geum canadense
Geum laciniatum
Geum sp.
Glechoma hederacea
Glyceria canadensis
Glyceria striata
grass sp
Grass sp.
Hackelia virginiana
Herb sp.
Holcos lanatus
Hydrophyllum virginianum
Ilex verticillata
Impatiens capensis
Impatiens pallida
Juglans nigra
Juncus effusus
Lactuca biennis
Larix laricina
Leersia oryzoides
Leersia virginica
Lemna minor
Lichen sp.
Ligustrum sp.
Ligustrum vulgare
Lindera benzoin
Liverwort sp.
Lonicera morrowii
Lonicera sp.
Loniciera maackii
Lycopus sp.
Marchantiophyta sp.
Mentha arvensis
Mimulus ringens
Mitchella repens
Moss sp.
Nyssa sylvatica
Onoclea sensibilis
Osmunda cinnamomea
Osmunda regalis
Ostrya virginiana
Oxalis sp.
Oxalis stricta
Parthenocissus quinquefolia
Penthorum sedoides
persicaria virginiana
Phalaris arundinacea
Physocarpus opulifolius
Pilea pumila
Poa pratensis
Poa sp.
Poaceae sp.
Polygonum arifolium
Polygonum sagittatum
Polygonum virginianum
Polystichum braunii
Polytrichum
Populus deltoides
Prunus serotina
Prunus sp.
Prunus virginiana
Pyrus coronaria
Pyrus sieboldii
Pyrus sp.
Quercus alba
Quercus rubra
quercus sp.
Ranunculus sp.
Rhamnus alnifolia
Rhamnus frangula
Ribes americanum
Ribes palustre
Ribes sp.
Rosa multiflora
Rosa palustris

Rubus allegheniensis
Rubus flagelarris
Rubus flagellaris
Rubus hispidus
Rubus occidentalis
Rubus setosus
Rubus sp.
Rumex orbicularis
Salix sp.
Sambucus canadensis
Scutellaria lateriflora
Sium suave
Solanum dulcamara
Solidago canadensis
Solidago patula
Solidago rugosa
Solidago sp.
Solidago uliginosa
Solidago UNK narrow leaved
Sphagnum sp.
Spiraea alba
Stellaria longifolia
Symphyotrichum sp.
Symphyotruchum novae-angliae
Symplocarpus foetidus
Symplyotirchum sp.
Taraxacum sp.
Thelypteris palustris
Tiarella cordifolia
Toxicodendron radicans
Toxicodendron vernix
Triadenum fraseri
Typha latifolia
Typha sp.
Ulmus americana
Ulmus rubra
Ulmus sp.
UNK tree seedling 1
Urtica dioica var dioica
Urtica dioica var. procera
Vaccinium corymbosum
Verbena urticifolia
Verbesina alternifolia
Viburnum cassinoides
Viburnum dentatum
Viburnum nudum
Viola canadensis
Viola sp.
Vitis sp.
Zelkova serrata