A Characterization of Hine's Emerald Dragonfly (*Somatochlora hineana* Williamson) Habitat in Michigan

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Cover Photo: Acklund Road northern fen, Mackinac County, Michigan, August 2004. Photo by David L. Cuthrell, MNFI.

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ABSTRACT

Hine's emerald dragonfly (*Somatochlora hineana* Williamson) is a federally-listed endangered species that occurs in northern fens of Michigan. In an effort to characterize the habitat of northern fens which support known populations of Hine's emerald dragonflies, four sites in the Upper Peninsula and two sites in the northern Lower Peninsula of Michigan were sampled August 24 to 27, 2004. All species in 10 m x 10 m releves were assigned coverage classes in five vegetation strata. An additional six, 1 m x 1 m plots were sampled where oviposition was evident. Physical site factors incorporating various edaphic, hydrologic, and physiographic variables were also noted. A Floristic Quality Index (FQI) was generated for each releve and plot based on species composition. Additionally, several measures of species occurrence were calculated including site frequency, releve frequency, relative releve frequency, mean releve coverage, relative mean releve coverage, and importance value. The same calculations were applied to data in oviposition plots. Sorensen Coefficients and Detrended Correspondence Analysis (DCA) were used to compare overall similarity among sites and releves.

Among all sites, saturated, heavy-textured soil (both organic and mineral) was typical. Also, pH values were generally above 7.0, except where microtopographic variation caused acidic hummocks to be formed. Sites with the greatest abundance of Hine's emerald dragonfly adults during a 2004 survey correspond to areas where rivulets or sheetflow were observed. Vegetation was mostly concentrated in the ground layer, low shrub, and tall shrub strata, and species with the greatest importance values were *Carex lasiocarpa*, non-*Sphagnum* clump-forming mosses, *Thuja occidentalis, Potentilla fruticosa*, *Carex sterilis*, and *Chamaedaphne calyculata*. The average FQI among all releves was 37.2, which suggests high habitat quality for most of the observed sites. Sorensen Coefficients showed that average similarity between releves from within the same sites is significantly greater than the average similarity between releves from different sites. Detrended Correspondence Analysis showed that releves with high abundance of northern fen species clustered together, while sites that exhibited combined characteristics of northern fen, northern wet meadow, and northern shrub thicket occurred in separate clusters.

From the current study, general habitat characteristics have been established, and it appears that the presence of rivulets or sheetflow, multi-structured vegetation strata (i.e. ground layer, low shrub, and tall shrub), and the juxtaposition of areas with standing water and drier mounds caused by microtopographic variation are most important for Hine's emerald dragonflies. It is imperative to maintain a high degree of habitat quality through conservation of connected landscape ecosystems that incorporate the entire wetland and upland matrix.

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INTRODUCTION

Hine's emerald dragonfly (*Somatochlora hineana* Williamson) is a federally-listed endangered species. Records indicate that it historically occurred in Illinois, Wisconsin, Michigan, Missouri, Ohio, Indiana, and Alabama (U.S. Fish and Wildlife Service 2001). Currently, the known distribution in Michigan spans Mackinac, Presque Isle, and Alpena counties. Its life cycle typifies that of other dragonflies with an aquatic egg, aquatic larva, and a terrestrial/aerial adult stage, and it is an opportunistic predator with high feeding activity at night (Cuthrell 1999). Several surveys have been conducted with the aim to estimate abundance and extent of occurrence in Michigan (Steffens 1997, 1998, 1999; Cuthrell and Kost 2005).

Its habitat has been stated to be graminoid-dominated wetlands that contain seeps, or slow moving rivulets; cool, shallow water slowly flowing through vegetation; and open areas in close proximity to forest edge (Cuthrell 1999). Prior to the current study, most habitat descriptions have been primarily casual observations made during insect surveys. Therefore, a detailed characterization of sites known to support Hine's emerald dragonfly populations was needed. In Michigan, Hine's emerald dragonflies are known to occupy northern fens (Steffens 1997, 1998, 1999; Cuthrell and Kost 2005), which are considered a rare community type in this state (Michigan Natural Features Inventory 2003). Northern fens are most commonly found in flat areas or mild depressions of glacial outwash and glacial lake plains, often in close proximity to the Great Lakes shoreline. Currently, peat mining, logging, quarrying, agricultural runoff, draining, flooding, off-road vehicle (ORV) disturbance, and development pose the greatest threat to future persistence of northern fens and, therefore, Hine's emerald dragonflies.

A thorough understanding of the habitat factors that influence the presence or absence of Hine's emerald dragonflies can help elucidate management concerns and procedures for species recovery. The overall objective of the current study is to characterize several northern fen communities in Michigan where there are known populations of Hine's emerald dragonflies. The specific objectives are to:

1) Describe larval and adult Hine's emerald dragonfly habitat with respect to vegetation structure, composition, and coverage; soil substrate; and hydrology.

2) Compare and contrast community similarity based on plant species presence and abundance.

3) Assess habitat quality and threats in order to identify potential management and protection actions required for the long-term viability of Hine's emerald dragonfly.

METHODS

Field Procedures

Habitat characterization of six sites with known occurrences of Hine's emerald dragonfly was conducted August 24 to 27, 2004 (Figure 1). Four sites occurred in Mackinac County in the Upper Peninsula of Michigan: Acklund Road, Brevort Lake Road, Foley Creek Wetland, and Summerby Swamp. Two remaining sites occurred in the northern Lower Peninsula of Michigan: North Point Road Fen (Alpena County) and Thompson's Harbor State Park (THSP) Loop 2 Fen (Presque Isle County). A minimum of two 10 m x 10 m releves were sampled at each site, totaling 15 releves among all 6 sites. Placement of releves centered on areas where adult Hine's emerald dragonflies were observed flying earlier in the year, and the locations were considered to best represent habitats in which the range of searching, guarding, and ovipositing behaviors occurred within each site. In addition to releves, six 1 m x

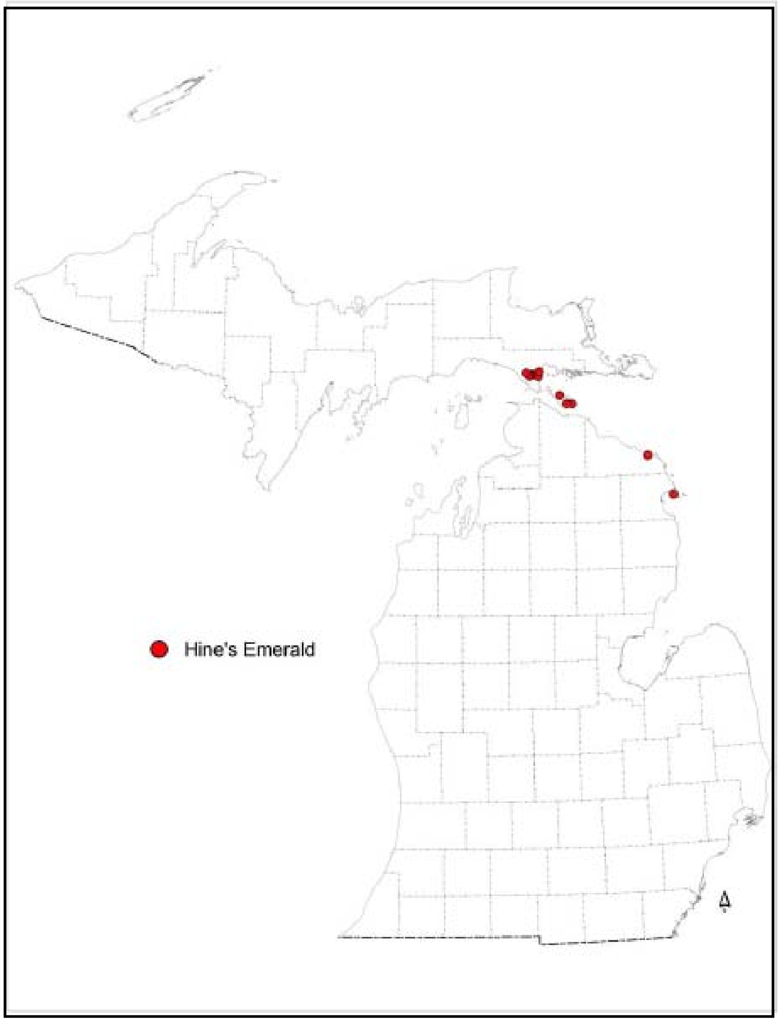

Figure 1. Michigan distribution of Hine's emerald dragonfly, 2004.

1 m plots were sampled where female Hine's emerald dragonflies were observed ovipositing earlier in the year or during the August sampling period. The vegetation in releves was sampled according to five strata based on physiognomy and height (Table 1). All vascular plant species were identified to genus and species when possible, and nomenclature followed that of Gleason and Cronquist (1991). Most unknown species were collected and later identified in the lab using dichotomous keys. Mosses were grouped as *Sphagnum* sp. or non-*Sphagnum* mosses. The latter includes mat-forming pleurocarps and tuft-forming acrocarpous mosses (Crum 1983). Each species was assigned a cover class corresponding to its percentage of areal coverage within a given strata for the 100 m^2 releve area (or the 1 m^2 plot area for oviposition plots). Additionally, an estimate of the total coverage of each vegetation stratum was recorded as well. Cover classes are defined as follows: 1 = 0.01%-<1%; 2 = 1%-5%; 3 = 6%-25%; 4 = 26%-50%; 5 = 51%-75%; and 6 = 76%-100% (Peet et al. 1998).

Physical site properties were evaluated with respect to the edaphic environment and local hydrology. Soil characterization of the upper 1.5 m layer was accomplished using a Dutch auger. Soil type, texture, pH, depth of organic matter,

Table 1. Woody strata and ground cover characteristics. Percent cover was estimated by cover class for each attribute below.

Strata	Description
Ground Cover	All graminoid, forb, woody, and non-vascular plant species <0.5 m in height
Low Shrub	All woody species ≥0.5 m and <1 m in height
Tall Shrub	All woody species ≥1 m and <3 m in height
Understory	All woody species ≥3 m and <10 m in height
Overstory	All woody species ≥10 m in height

and a profile of distinct soil layers were noted. Water depth was measured either as depth below ground surface or, in the presence of inundation, depth above ground surface. Evidence of water rivulets or sheetflow was also noted. Additional coverage classes were assigned to open water, litter, open ground, and overall vegetation. Because Hine's emerald dragonfly larvae may utilize crayfish burrows during drought (U.S. Fish and Wildlife Service 2001), a count of burrow density may be indicative of potential dragonfly presence (Plate 1). Therefore, the number of crayfish burrows found in a 1 m^2 plot placed inside each releve was recorded. Random burrows, not necessarily within plots, were also pumped for *Somatochlora* sp. larvae.

Plate 1. Crayfish burrow. Photo by M. Kost.

Data Analyses

Compilation of species lists for releves and plots was aided by the Floristic Quality Assessment Program (Herman et al. 2001). The program automatically generates a Floristic Quality Index (FQI) and a Mean Coefficient of Wetness (*W*) for each releve or plot based on species composition. Several measures of species occurrence were calculated including site frequency, releve frequency, relative releve frequency, mean releve coverage, relative mean releve coverage, and importance value. The same calculations were applied to data in oviposition plots. Site, releve, and plot frequency are simply the frequencies of occurrence of each species in each site (n = 6 for releves; n = 4 for oviposition plots), releve (n = 15), or plot (n = 6). Relative releve and plot frequency is the relative contribution of each species to the collective sum of releve or plot frequencies among all species. The sum of all species' relative releve or plot frequencies always equal 100%. Mean plot coverage for each species was calculated by averaging the percent coverage mid-point values for each corresponding cover class among all plots (n = 6). Mean releve coverage for each species was similarly calculated, but, due to the assignment of coverage values for each stratum, a single value representing the most likely overall coverage of each species needed to be estimated. The method used to assign an overall coverage was as follows: 1) For a given species, the mean coverage within each stratum was calculated (n = 15); 2) The stratum with the highest mean coverage value was assumed to be the dominant stratum for that species, and all other strata occupied by that species were arbitrarily assumed to overlap it by 75%. This assumption is reasonable, since the dominant stratum is usually one of the higher vegetation layers (i.e. tall shrub, understory, or overstory), and seedlings, sprouts, and clones of subordinate layers tend to occur directly beneath; 3) The coverage value of the dominant stratum was augmented by the addition of downweighted coverage values of each subordinate stratum. In this case, coverage values of each subordinate stratum were multiplied by 0.25, indicating a 25% non-overlap with the dominant stratum; 4) This augmented value served as the estimate of mean releve coverage for a given species. Relative mean releve and plot coverage is the relative contribution of each species to the collective sum of mean releve or plot coverage values among all species. The sum of all species' relative mean releve or plot coverage is always equal to 100%. An importance value for each species was calculated by summing the relative releve/plot frequency and relative mean releve/plot coverage. The sum of all species' importance value is always equal to 200%.

Two matrices of community coefficients (a measure of beta-diversity; Magurran 1998) based on species presence within sites and releves were constructed using the Sorensen Coefficient (Barbour et al. 1998). The Sorensen Coefficient is a measure of similarity between two sites or releves and is calculated as follows: $[2C / (A + B)] \times 100$, where C is the number species in common between two sites or releves, and A and B represent the total number of species that occur within those sites or releves. To test whether the average Sorensen Coefficient between releves from within the same sites were significantly different from those of different sites, a two-sample independent t-test with equal variances was performed with $\alpha = 0.05$.

A Detrended Correspondence Analysis (DCA) was performed using PC-ORD (McCune and Mefford 1999). Data input for the analysis consisted of a species by releve matrix using the percent coverage mid-point values for each corresponding cover class for all species occurring in a minimum of two releves. The final matrix size was 84 species by 15 releves. All default settings were maintained during analysis. Pearson product-moment correlations between species scores and the ordination axes and between ordination distances and distances in the original *n*-dimensional space were also generated. Distance measure for the original *n*-dimensional space was set as "relative Euclidean" as recommended by McCune and Mefford (1999) when performing DCA.

RESULTS

Site Descriptions

All sites, in which habitat characterization was conducted, can be classified as supporting northern fen natural communities (Cohen 2005). However, the northern fen was a small component of the total area at Foley Creek Wetland. Broad ecological zones were mostly occupied by emergent marsh and northern wet meadow natural communities. Study sites occurred in Sub-Subsection VII.6.3 Cheboygan and Sub-Subsection VIII.1.1 St. Ignace under the Regional Landscape Ecosystem Classification of Michigan by Albert (1995). The dominant landform in which these sites were located is sand lake plain with shallow dolomitic bedrock. These northern fens were commonly situated within large wetland complexes and nearby permanent water bodies, such as ponds, lakes, and streams. Calcareous groundwater seepage and precipitated calcium carbonate (marl) typifies poorly drained northern fens (Cohen 2005).

Three distinct soil types characterized the 15 releves at 6 sites (Appendices 1 and 2): 1) calcium carbonate precipitate in the form of marl or tufa; 2) heavy-textured mineral soil; and 3) organic soil. Marl and tufa were the most prevalent soil components at Acklund Road, Brevort Lake Road, and THSP Loop 2 Fen. Gleyed clay and sandy clay loam were common at Foley Creek Wetland. Sapric, hemic, and fibric peat were readily found at North Point Road Fen and Summerby Swamp. Organic matter depth was shallowest at Foley Creek Wetland and North Point Road Fen, averaging 19 cm and 47 cm, respectively. The low accumulation of organic matter could be attributed to shallow bedrock near the ground surface. In contrast, other sites regularly accumulated organic matter to depths exceeding 150 cm, where bedrock occurred much deeper underground. Soil pH of all sites were found to be calcareous (i.e. >7.0), with the exception of localized *Sphagnum* hummocks and peat ridges that were raised above the direct influence of groundwater seepage. Precipitation and cation exchange in the cell walls of *Sphagnum* (Clymo 1964) determine acidity levels of hummocks, with pH values of 4.0-4.5 found at releves B1, S1, and S3 (Appendix 1).

Concerning hydrology, all sites were at least water saturated. Acklund Road, Brevort Lake Road, Foley Creek Wetland, Summerby Swamp, and THSP Loop 2 Fen were shallowly inundated up to 10 cm. Furthermore, three sites were observed to exhibit sheetflow and/or contain rivulets: Acklund Road, Brevort Lake Road, and Summerby Swamp (Appendix 1). Consequently, these sites correspond to areas of highest *Somatochlora* sp. dragonfly larvae occurrence in pumped crayfish burrows from August 24, 2004 to September 10, 2004 (Cuthrell and Kost 2005).

Appreciable differences among sites in terms of open water, open ground, litter, and total vegetation coverage were not apparent (Appendices 1 and 2). The majority of 100 m^2 releves were vegetated, with an average cover class of 5 (63%) and a range from 4 (38%) to 6 (88%) (Appendix 1). Crayfish burrow density among sites was also consistent, ranging from 0 to 3 burrows per 1 m^2 plot.

Floristic Assessment

Vegetation Structure, Composition, and Coverage

Northern fens are distinguished by rich ground flora, low ericaceous evergreen shrubs, and scattered conifer trees (Cohen 2005). Furthermore, strong vegetative zonation can occur in northern fens in response to small-scale habitat heterogeneity affecting available nutrients, hydrology, and microtopography (Amon et al. 2002). Distinguishable zones include sedge lawns, sparsely vegetated marl flats, shrub thickets, and multi-structured tree margins (Plate 2) (Cohen 2005). Vegetation in all 15 releves was concentrated in the ground


a)


b)


c)


d)

Plate 2. The Hine's emerald dragonfly uses a wide range of habitats within northern fens that range from open sedge-dominated marl flats (photos a and b) to multi-layered tree- and shrub-dominated vegetative zones (photos c and d). Photos a-c by M. Kost. Photo d by D. Cuthrell.

cover, and coverage averaged 66.3% and ranged from 38% to 88% (Appendix 3). *Carex lasiocarpa*, non-*Sphagnum* clump-forming mosses, and *Chamaedaphne calyculata* were the most extensive ground cover species with respect to mean releve coverage (19.7%, 14.9%, and 7.3%, respectively). In the low shrub stratum, coverage averaged 15.0% and ranged from 0.5% to 38%. *Myrica gale* (4.5%), *Thuja occidentalis* (4.0%), and *Potentilla fruticosa* (3.5%) were most extensive. In the tall shrub stratum, coverage averaged 10.9% and ranged from 0% to 38%. *Thuja occidentalis* (4.3%) and *Larix laricina* (1.7%) were most extensive. In the understory, coverage averaged 4.5% and ranged from 0% to 15.5%. *Thuja occidentalis* (4.5%) was most extensive. In the overstory, coverage averaged 1.0% and ranged from 0% to 15.5%. Only one overstory-size tree was found: *Pinus strobus* (1.0%).

In total, 134 species occurred in 15 releves (Appendix 4), and 42 species occurred in 6 oviposition plots (Appendix 5). Richness in releves averaged 31 species and ranged from 8 at F3 to 51 at A1 (Appendix 4). Richness in sites averaged 49 species and ranged from 42 at North Point Road Fen to 59 at Acklund Road. The FQI is a measure of average fidelity of an assemblage of plants to unaltered areas in the condition of pre-European settlement (Herman et al. 2001). This singular index allows useful comparisons among releves and can serve as a metric for site quality. Values greater than 35 indicate areas that possess sufficient conservatism and richness to be considered floristically important from a statewide perspective. Values greater than 50 indicate extremely rare areas that demonstrate the highest of native biodiversity in the natural landscapes of Michigan (Herman et al. 2001). Average FQI among releves was 37.2 and ranged from 13.8 at F3 to 49.8 at A2 (Appendix 4). Foley Creek exhibited the poorest landscape context of the six sites and bordered a very disturbed *Typha angustifolia*-dominated wetland. By excluding the outlier releves of F1 and F3, which only harbored 14 and 8 species, respectively, average FQI among releves increases to 40.5. Similar to the FQI, the Mean Coefficient of Wetness (*W*) gauges the average fidelity of plant communities to moisture regimes (Herman et al. 2001). The coefficient ranges from -5 to 5, with smaller values indicating greater affinity for wetlands. Average *W* among releves was -3.7 (Facultative Wetland) and ranged from -2.3 (Facultative Wetland) at A1 and B1 to -4.8 (Obligate Wetland) at N3. The Facultative Wetland category denotes species with a 67%-99% probability of occurring in wetlands under natural conditions. The Obligate Wetland category denotes species with greater than 99% probability of occurring in wetlands under natural conditions (Herman et al. 2001).

Four species occurred at all sites: *Potentilla fruticosa*, *Lobelia kalmii*, *Thuja occidentalis*, and *Muhlenbergia glomerata* (Appendix 6). However, no species occurred in all releves. The most frequently occurring species was *Potentilla fruticosa*, which was found in 13 of 15 releves. Other species typical of northern fens and with greater than 50% releve frequency were *Sarracenia purpurea*, *Solidago uliginosa*, *Parnassia glauca*, *Picea mariana*, *Cladium mariscoides*, *Larix laricina*, *Rhynchospora capillacea*, *Andromeda glaucophylla*, *Tofieldia glutinosa*, and *Ledum groenlandicum*. Five state-listed species were found during sampling: *Juncus militaris*, *Muhlenbergia richardsonis*, and *Solidago houghtonii* are state threatened and *Pinguicula vulgaris* and *Trichophorum clintonii* are state special concern. Of these, only *Juncus militaris* was found commonly, occurring in 53% of the releves (Appendix 4). The most abundant bryophytes that occurred were non-*Sphagnum* clump-forming mosses, most likely in the family *Amblystegiaceae* (Cohen 2005). Frequency of occurrence was greater than 80% in both sites and releves. Similar species composition and frequency was found in areas where active oviposition was observed (Appendix 7).

The species with greatest coverage as reported in northern fens (Cohen 2005) and confirmed by the current study was *Carex lasiocarpa* (Appendix 6). Mean releve coverage for this species was 19.7%, which rivaled that of non-*Sphagnum* clump-forming mosses (14.9%) (Appendix 6). Although *Carex lasiocarpa* only occurred in six releves at two sites (Appendix 4), the habit of this particular sedge tends toward the formation of extensive lawns (NatureServe 2005) aided by well-developed rhizomes (Voss 1972). Other species with greater than 5% mean releve coverage were *Thuja occidentalis* (7.6%), *Chamaedaphne calyculata* (7.3%), *Carex sterilis* (7.1%), *Trichophorum alpinum* (6.1%), *Potentilla fruticosa* (5.7%), and *Eleocharis rostellata* (5.2%). Of these species, only *Potentilla fruticosa*, *Thuja occidentalis*, and non-*Sphagnum* clump-forming mosses occurred with greater than 70% site and releve frequencies. Similar species composition and coverage were found in areas where active oviposition was observed (Appendix 7).

The importance value, which incorporates species frequency of occurrence and extent of coverage, provides an overall measure of dominance (Appendix 6). Species with the greatest releve importance values were *Carex lasiocarpa* (13.4), non-*Sphagnum* clump-forming mosses (11.7), *Thuja occidentalis* (7.0), *Potentilla fruticosa* (6.3), *Carex sterilis* (5.9), and *Chamaedaphne calyculata* (5.4). Other tree species with significant importance values were *Picea mariana* (4.7) and *Larix laricina* (3.4). Fortunately, only two weedy species were found, *Cirsium palustre* and *Typha angustifolia*, and their importance values were low, both at 0.2. Similar species importance values were found in areas where active oviposition was observed (Appendix 7). However, values tended to be greater than those in releves because of greater single-species dominance (i.e. greater coverage) at the 1 m^2 scale than at the 100 m^2 scale. This is especially prominent when certain plants regenerate clonally to become mat or tuft formers.

Community Coefficients

Two tables of Sorensen Coefficients are given to demonstrate that although there may be significant habitat heterogeneity within sites and releves, a great deal of floristic similarity can exist (Tables 2 and 3). Community coefficients of 50% or greater are generally considered to signify two sites or releves that belong to the same association (i.e. putative community types) (Barbour et al. 1998). Comparisons show that 33% of the sites (Table 2) and 25% of the releves (Table 3) belonged to the same association. Acklund Road, Brevort Lake Road, and Summerby Swamp were all about 70% similar (Table 2). THSP Loop 2 Fen was about 50% similar to both Acklund Road and Brevort Lake Road (Table 2). An examination of Sorensen Coefficients reveals that greatest similarity among releves, in general, exists within sites (Table 3). Average similarity among releves from within the same sites (55.2%) is significantly greater than the average similarity among releves from different sites (30.8%) (Figure 2). Nevertheless, exceptions were found for comparisons of releves among Acklund Road, Brevort Lake Road, and Summerby Swamp, where average similarity was 62.1%.

Table 2. Sorensen coefficients comparing site percent similarity based on species presence (Barbour et al. 1998). Bolded values are comparisons greater than 50%.

	Acklund Road	Brevort Lake Road	Foley Creek Wetland	North Point Road Fen	Summerby Swamp	THSP Loop 2 Fen
Acklund Road		**70**	19	36	**69**	**54**
Brevort Lake Road			16	31	**78**	**51**
Foley Creek Wetland				31	25	21
North Point Road Fen					31	48
Summerby Swamp						48
THSP Loop 2 Fen						

Table 3. Sorensen coefficients comparing releve percent similarity based on species presence (Barbour et al. 1998). Bolded values are comparisons greater than 50%.

	Acklund Road		**Brevort Lake Road**		**Foley Creek Wetland**			**North Point Road Fen**			**Summerby Swamp**			**THSP Loop 2 Fen**	
	A1	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
A1		**80**	**67**	49	0	15	3	20	29	27	**64**	**59**	**58**	46	49
A2			**70**	**58**	3	22	4	28	41	41	**70**	**64**	**70**	**51**	**56**
B1				**52**	0	18	0	12	23	22	**72**	**74**	**65**	40	46
B2					0	20	0	22	40	40	44	**54**	**56**	**55**	**56**
F1						29	36	19	9	13	4	4	0	10	9
F2							24	10	33	17	21	23	21	20	16
F3								15	5	8	9	9	4	11	5
N1									41	**53**	19	18	20	35	37
N2										**55**	30	29	33	44	48
N3											19	19	28	45	47
S1												**79**	**69**	44	45
S2													**73**	46	47
S3														46	49
T1															**71**
T2															

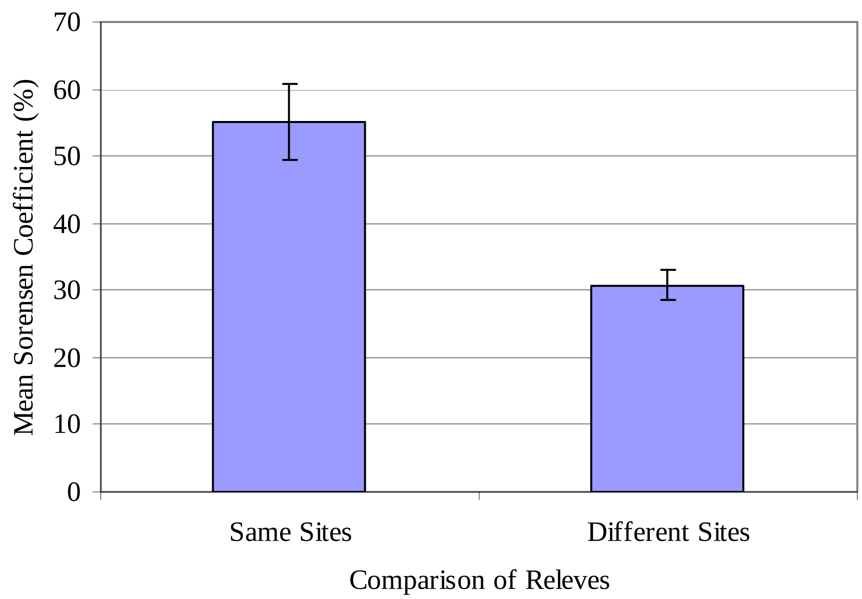

Figure 2. Average Sorensen Coefficient between releves from within the same sites (n = 12) and from different sites (n =93). Error bar shows one standard error. The difference is significant at $\alpha = 0.05$. $p = 0.0001$.

Detrended Correspondence Analysis

The DCA of species cover within releves shows distinct clustering of releves (Figure 3). In general, releves within the same sites are found clustered together. This indicates that releve species composition is more similar within sites than among sites, as confirmed by the Sorensen Coefficients above. While this suggests a degree of habitat homogeneity within sites, these northern fens demonstrated high microtopographic variation as evident by the occurrence of hummocks and hollows that support acidophiles and calciphiles, respectively, in close proximity (Plate 3). The percent of total variance explained in the ordination is a relatively low 57.2% for the first two axes (Appendix 8). Correlations between species coverage and ordination axes are moderate, with values mostly not exceeding 0.5 (Appendix 9). Greatest correlations are along the first ordination axis; the second ordination axis is weakly correlated to species coverage. Still, the distinct clustering of releves around species groups does lend some interpretive power (Figure 3).

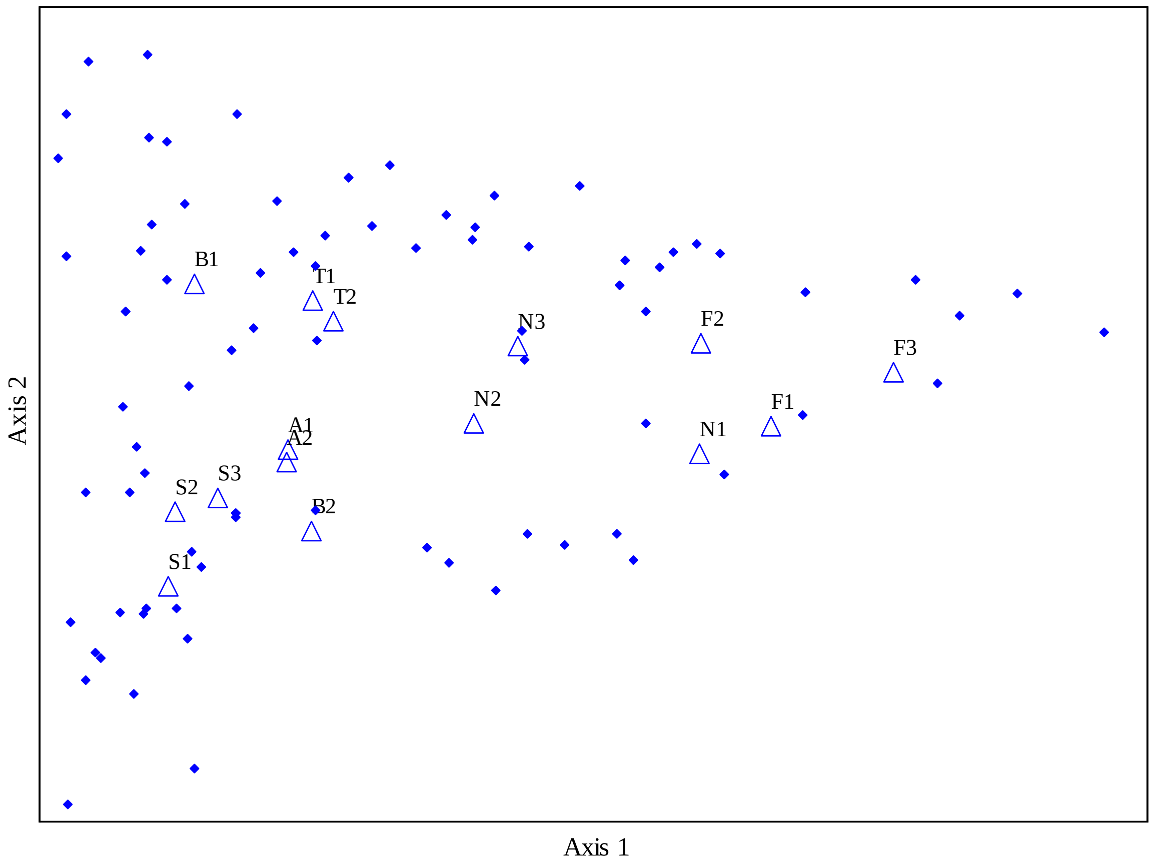

Figure 3. DCA of species cover within releves (n = 15). Ordination was performed using PC-ORD, version 4 (McCune and Mefford 1999). Species are represented by diamonds and releves by triangles. Releve abbreviations are as follows: A1 and A2, Acklund Road releves 1 and 2, respectively; B1 and B2, Brevort Lake Road releves 1 and 2, respectively; F1, F2, and F3, Foley Creek Wetland releves 1, 2, and 3, respectively; N1, N2, and N3, North Point Road Fen releves 1, 2, and 3, respectively; S1, S2, and S3, Summerby Swamp releves 1, 2, and 3, respectively; T1 and T2, THSP Loop 2 Fen releves 1 and 2, respectively.

a)


b)


c)


Plate 3. Examples of high microtopographic variation in northern fens: a) vegetative zonation resulting from a diversity of fine-scale microecosystems, Summerby Swamp; b) marl flat with peat hummocks, THSP Loop 2 Fen; c) structural and habitat heterogeneity, Acklund Road. All photos by M. Kost.

Along the first axis, there is prominent separation of releves into three clusters (Figure 3). All releves from Acklund Road, Brevort Lake Road, Summerby Swamp, and THSP Loop 2 Fen are grouped in the far left. These sites were quintessential northern fens with corresponding vegetation and physical site factors that are distinctive to these ecosystems. Species most correlated with this cluster are *Senecio pauperculus* (R^2 = 0.584), *Drosera rotundifolia* (R^2 = 0.565), *Equisetum* sp. (R^2 = 0.508), and *Trientalis borealis* (R^2 = 0.508) (Appendix 9). Characteristic northern fen species, both acidophilic and calciphilic, were common: *Chamaedaphne calyculata*, *Parnassia glauca*, *Gentianopsis procera*, *Tofieldia glutinosa*, *Carex sterilis*, *Ledum groenlandicum*, and *Eleocharis rostellata*. These sites were all very basic (pH 8.0), and marl formed the dominant soil substrate (Appendix 1). Furthermore, greatest observance of Hine's emerald dragonfly adults and *Somatochlora* sp. larvae were at Acklund Road, Brevort Lake Road, Summerby Swamp, and THSP Loop 2 Fen during the 2004 survey effort (Cuthrell and Kost 2005).

Two releves, N2 and N3 from North Point Road Fen, are clustered in the middle along the first ordination axis (Figure 3). This site had traits intermediate of a northern fen, northern wet meadow, and northern shrub thicket. Soil at N2 and N3 was fibric and hemic peat, respectively, over shallow limestone bedrock (Appendix 1). An observation rate for Hine's emerald dragonflies was 0.75 adults per hour during the 2004 survey effort (Cuthrell and Kost 2005). However, no *Somatochlora* sp. larvae were detected from crayfish burrows.

On the far right, along the first ordination axis, is a cluster of releves from Foley Creek Wetland (Figure 3). While a small portion of this wetland contained a northern fen community, the releves were centered on areas best described as northern wet meadows. Two species, *Carex lasiocarpa* (R^2 = 0.879) and *Salix petiolaris* (R^2 = 0.646), are strongly correlated to the axis (Appendix 9). Other species typical of northern wet meadows included *Cicuta bulbifera*, *Polygonum amphibium*, *Lysimachia thyrsiflora*, *Carex aquatilis*, *Schoenoplectus acutus*, and *Cornus stolonifera*. Soil at Foley Creek Wetland was mainly fibric peat mixed with heavy-textured mineral soil (Appendix 1). Observation rates for Hine's emerald dragonflies were 1.14 adults per hour and 0.10 *Somatochlora* sp. larvae per burrow during the 2004 survey effort (Cuthrell and Kost 2005).

DISCUSSION

Community types that have been cited to serve as Hine's emerald dragonfly habitat are marsh, sedge meadow, dolomite prairie, spring, seep, pond, ridge-swale, river estuary, cedar swamp, low-gradient stream, and various fen types (U.S. Fish and Wildlife Service 2001). In the current study, populations of Hine's emerald dragonfly were found in northern fens of the northern Lower Peninsula and eastern Upper Peninsula, Michigan. These minerotrophic wetlands receive considerable groundwater input, and the resulting soil substrate is saturated, calcareous, and rich in base cations (Heinselman 1970). A crucial physical process within northern fens is the flow of subsurface and surface water. Groundwater discharge, in the form of sheetflow and rivulets, maintains oxygenated water as turbulence causes water to be constantly exposed to the atmosphere. Additionally, seepages are shallow and cool due to their groundwater origin, which is a property facilitating the dissolution of atmospheric oxygen (Horne and Goldman 1994). This hydrologic property of northern fens is likely critical for egg and larvae survival of aquatic insects. Although the required dissolved oxygen concentration to maintain viability is not known, values up to 20.42 mg O_2/L were reported for sites in Illinois that supported Hine's emerald dragonflies (U.S. Fish and Wildlife Service 2001). Since the aquatic egg and larval stage can span two to four years (Soluk et al. 1998), adequate oxygen concentration is necessary to ensure proper respiratory and metabolic activity.

Water chemistry and quality has often been inferred by the use of biotic indices (Hilsenhoff 1987), which rely on the presence of certain invertebrate taxa: Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). These orders, if present in high abundance, signify lotic systems with a low degree of organic pollution and hydrologic alteration. Not coincidentally, mayflies, stoneflies, and caddisflies are important prey items for Hine's emerald dragonflies (U.S. Fish and Wildlife Service 2001). Maintaining the natural hydrology and overall habitat quality of northern fens is imperative, not only because it directly influences water chemistry, but also because it imparts an indirect effect on trophic relationships.

As newly emerging adults, Hine's emerald dragonflies require vertical structures, in the form of emergent vegetation, upon which they climb to shed their exoskeletons (Cuthrell 1999). It has been suggested by Nuzzo (1995) and Mierzwa et al. (1998), that the specific type of emergent vegetation is less important than the structural form afforded by such vegetation. Cattails, rushes, and sedges all exhibit vertical growth habits that allow a place for Hine's emerald dragonflies to transform from aquatic larvae to terrestrial adults. The vegetation of the northern fens surveyed in the current study was stratified in the lower strata. Understory and overstory vegetation were sparse, but there were ample ground cover, low shrubs, and tall shrubs. The mosaic of the lower vegetation strata may be important for the concealment of Hine's emerald dragonflies from predators, since most flying heights are less than 3 m (i.e. the maximum height of our tall shrub designation). Aerial feeding paths are usually irregular and occur over shrub clusters and near forest edges (Nuzzo 1995). In contrast, male territorial patrols occur above streamlets and inundated forest edges (Soluk et al. 1998). Individuals have previously been reported to perch on top of cattail floral spikes (Vogt and Cashatt 1994), but in the current study, cattails did not make up a large component of the vegetation. There is no reason to believe, however, that *Carex lasiocarpa*, *Potentilla fruticosa*, *Myrica gale*, and *Chamaedaphne calyculata* cannot serve as equally suitable perch sites. These plants were found in abundance in the surveyed sites, and they were interspersed between areas of open water. Oftentimes, acidic peat hummocks supported the acidophilic shrub species, further emphasizing the importance of microtopographic variation in northern fens. The juxtaposition of areas conducive for perching and ovipositing is crucial for female Hine's emerald dragonflies (U.S. Fish and Wildlife Service 2001).

Most of the northern fens sampled during this study were intact communities with high floristic richness, low occurrence of non-native species, and good landscape context. Acklund Road, Brevort Lake Road, and Summerby Swamp are managed by U.S. Forest Service in the Hiawatha National Forest and were in fairly pristine condition relative to sites in other states (U.S. Fish and Wildlife Service 2001). Similarly, North Point Road Fen and THSP Loop 2 Fen were mostly undisturbed by anthropogenic pressure. Observable damage by off-road vehicle (ORV) use was noticed at Brevort Lake Road, however, and wetlands surrounding Foley Creek Wetland were heavily dominated by *Typha angustifolia*. Vegetation richness within sites averaged 49 species and was comparable to the mean of 48 species for northern fens within the Michigan Natural Features Inventory's database (Cohen 2005). Although Hine's emerald dragonflies have been undetected in habitats seemingly suitable for their use (Cuthrell and Kost 2005; U.S. Fish and Wildlife Service 2001), the current study suggests the need to maintain high quality natural areas. This entails the need to conserve native vegetation structure and composition, exclude non-native invasive species, prohibit ORV use, maintain natural hydrology, maintain soil substrate and microtopography, maintain landscape context between graminoid-dominated northern fens and adjacent forest edges, and limit the encroachment of trees and tall shrubs through cutting, herbicidal application, or prescribed fire. In addition, the ability of Hine's emerald dragonflies to disperse up to 5.4 km (U.S. Fish and Wildlife Service 2001) may indicate genetic exchange between subpopulations within a metapopulation matrix.

Consequently, wetland complexes with intact corridors are likely required for the flight paths of Hine's emerald dragonflies.

The greatest threat to the viability of Hine's emerald dragonflies is habitat destruction, degradation, or manipulation. Because this species is dependent on both the aquatic and terrestrial component of northern fens in Michigan, additional studies should be conducted to identify the most critical ecosystem processes that influence feeding, mating, flying, territorial, and ovipositing behaviors for larval and adult life stages. From the current study, general habitat characteristics have been established, and it appears that the presence of rivulets or sheetflow, multi-structured vegetation strata (i.e. ground layer, low shrub, and tall shrub), and the juxtaposition of areas with standing water and drier mounds caused by microtopographic variation are most important. Efforts to preserve these ecosystem properties should be paramount, but it is equally essential to recognize that much is still unknown regarding this species' tolerances to various anthropogenic pressures and natural stochasticity associated with changes in prey abundance, competition, and reproduction. Therefore it is more prudent to conserve connected landscape ecosystems, which include the entire wetland and upland matrix, rather than piecemeal parcels in isolation.

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APPENDICES

Appendix 1. Habitat description for 15 releves at 6 sites.

	Acklund Road		**Brevort Lake Road**	
RELEVE CODE	**A1**	**A2**	**B1**	**B2**
TRS	T41N R3W Sec. 5-6 T42N R3W Sec. 31-32		T41N R4W Sec. 6	
Soil Type	Marl w/ Tufa	Marl	Marl	Marl
OM Depth (cm)	>150	100	45	>150
pH	8.0	8.0	8.0 (marl) 4.0-4.5 (on scattered *Sphagnum* hummocks)	8.0
Soil Description	0-20 cm: marl mixed with OM. 20-150+ cm: marl mixed with tufa.	0-10 cm: marl mixed with OM. 10-20 cm: hemic peat. 20-100 cm: marl mixed with tufa. >100 cm: gleyed sand.	0-20 cm: marl mixed with OM. 20-45 cm: marl mixed with tufa. >45 cm: bedrock	0-15 cm: marl mixed with OM and tufa. 15-150+ cm: marl mixed with tufa.
Water Depth Below Surface (cm)	-	-	-	-
Standing Water Depth (cm)	4	3	4	2
Evidence of Sheetflow / Rivulets?	Yes	No	Yes	Yes
Cover Class Open Water	4	4	4	4
Cover Class Open Ground	3	3	3	2
Cover Class Litter	4	3	3	4
Cover Class All Vegetation	5	5	5	4
# Crayfish Burrows per 1 m^2 plot	2	0	1	1
Additional Info	Four crayfish burrows were pumped and one larva collected.			Female HED collected and seen ovipositing around crayfish burrows and in small flowing rivulet.

Appendix 1. (cont.).

	Foley Creek Wetland			North Point Road Fen		
	F1	**F2**	**F3**	**N1**	**N2**	**N3**
TRS	T41N R4W Sec. 13 and 24			T31N R9E Sec. 9 and 16		
Soil Type	Clay-gleyed	Sandy Clay Loam	Fibric Peat	Muck	Fibric Peat	Hemic Peat
OM Depth (cm)	10	20	28	30	50	60
pH	>7.0	>7.0	>7.0	>7.0	>7.0	>7.0
Soil Description	0-4 cm: fibric peat and roots. 4-10 cm: marl mixed with OM, sand, pebbles, and tiny rock fragments. 10-30 cm: gleyed clay, marl, and cobbles. >30 cm: bedrock.	0-10 cm: OM with muck and roots. 10-20 cm: OM with gleyed clay and pebbles. >20 cm: bedrock.	0-26 cm: Fibric peat and roots. 26-28 cm: marl mixed with pebbles and rock fragments. >28 cm: bedrock.	Unspecified depth: muck with a coarse sand and fine gravel lens < 2.5 cm thick over bedrock.	0-50 cm: fibric peat with a coarse sand and fine gravel lens < 2.5 cm thick. >50 cm: bedrock.	0-60 cm: hemic peat. 60-63 cm: marl mixed with gravel and limestone cobble. >63 cm: bedrock.
Water Depth Below Surface (cm)	-	-	-	13	1	1
Standing Water Depth (cm)	10	4	4	-	-	-
Evidence of Sheetflow / Rivulets?	No	No	No	No	No	No
Cover Class Open Water	3	2	2	0	0	0
Cover Class Open Ground	0	2	3	n/a	3	4
Cover Class Litter	3	3	3	5	3	3
Cover Class All Vegetation	6	6	6	6	6	4
# Crayfish Burrows per 1 m^2 plot	0	0	0	2	0	0
Additional Info	Approximately 25-50% of the surrounding wetland is dominated by *Typha angustifolia* making site look disturbed. Two crayfish burrows were pumped. Thatch layer impeded sighting of burrows.	One crayfish burrow was pumped. Thatch layer impeded sighting of burrows.	Thatch layer impeded sighting of burrows.	With increasing distance from the forested edge, depth of OM increases: 15 cm of OM at the edge compared to 35 cm of OM in the wetland interior.		Crayfish burrows were detected outside 1 m^2 plot yet within releve.

Appendix 1. (cont.).

	Summerby Swamp			THSP Loop 2 Fen	
	S1	**S2**	**S3**	**T1**	**T2**
TRS	T41N R4W Sec. 3			T34N R7E Sec. 16	
Soil Type	Fibric Peat over Marl	Fibric Peat	Marl	Marl	Marl
OM Depth (cm)	>150	>150	>150	>150	140
pH	8.0 (on *Carex sterilis-Scirpus* flat) 4.0-4.5 (on scattered *Sphagnum* hummock)	8.0	8.0 (marl) 4.0-4.5 (on scattered *Sphagnum* hummocks)	7.0-8.0	>7.0
Soil Description	0-30 cm: fibric *Sphagnum* peat. 30-70 cm: fibric peat with woody debris. 70-90 cm: fibric peat with marl and tufa. 90-110 cm: fibric peat with muck and woody debris. 110-145 cm: muck. 145-150+ cm: marl mixed with muck and woody debris.	0-30 cm: Fibric peat with woody debris. 30-90 cm: hemic peat mixed with woody debris. 90-110 cm: marl. 110-unspecified: hemic peat mixed with woody debris. Unspecified-150+ cm: marl mixed with woody debris and muck.	0-150+ cm: marl mixed with tufa. Increasing tufa concentration with depth, especially after 30 cm.	0-150 cm: marl	0-140 cm: marl. >140 cm: bedrock
Water Depth Below Surface (cm)	-	-	-	7	-
Standing Water Depth (cm)	2	5	6	-	2
Evidence of Sheetflow / Rivulets?	No	Yes	Yes	No	No
Cover Class Open Water	3	3	4	0	3
Cover Class Open Ground	1	2	2	4	5
Cover Class Litter	3	4	3	3	3
Cover Class All Vegetation	6	6	5	4	4
# Crayfish Burrows per 1 m^2 plot	0	2	3	1	2
Additional Info	This habitat type occurred also at Acklund Road but was not sampled there.	*Phragmites australis* occurred outside of releve.	Height of a *Sphagnum* hummock was 52 cm.	Five crayfish burrows were pumped.	Depth of OM increases from forest edge: 140 cm at the edge compared to 150+ cm in the wetland interior.

Appendix 2. Habitat description for six oviposition plots at four sites.

	Acklund Road	Brevort Lake Road	Summerby Swamp		THSP Loop 2 Fen	
PLOT CODE	**OA1**	**OB1**	**OS1**	**OS2**	**OT1**	**OT2**
TRS	T41N R3W Sec. 5-6 T42N R3W Sec. 31-32	T41N R4W Sec. 6	T41N R4W Sec. 3		T34N R7E Sec. 16	
Water Depth Below Surface (cm)	0	0	0	0	0	0
Standing Water Depth (cm)	3	2	10	4	0	0
Evidence of Sheetflow / Rivulets?	No	Yes	No	No	No	No
Cover Class Open Water	6	n/a	4	5	n/a	n/a
Cover Class Open Ground	2	2	1	2	5	3
Cover Class Litter	2	3	4	3	3	3
Cover Class All Vegetation	3	3	5	5	4	5
# Crayfish Burrows per 1 m^2 plot	0	0	0	2	1	0
Additional Info	Open marl flat with pH 8.0 and organic matter exceeding 150 cm. 0-20 cm: marl. 20-100 cm: marl mixed with tufa. >100 cm: gleyed sand.	A female HED was observed and caught ovipositing in the 1 m^2 plot at noon.				

Appendix 3. Strata percent cover by releve. Values represent cover class mid-points (see text for cover classes). Strata categories: ground cover (<0.5 m in height); low shrub (0.5-<1 m in height); tall shrub (1-<3 m in height); understory (3-<10 m in height); overstory (≥10 m in height). Overall cover is an estimation of total vegetative cover in the field and is not a summation of cover values for the five strata.

	Acklund Road		**Brevort Lake Road**		**Foley Creek Wetland**			**North Point Road Fen**			**Summerby Swamp**			**THSP Loop 2 Fen**	
	A1	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Ground Cover	38	63	63	38	88	88	88	88	88	38	88	88	63	38	38
Low Shrub	38	38	15.5	0.5	15.5	15.5	3	15.5	15.5	3	15.5	15.5	15.5	15.5	3
Tall Shrub	38	3	15.5	0	0	38	3	0	38	0	15.5	3	3	3	3
Understory	15.5	3	15.5	0	0	0	0	0	15.5	0	15.5	0	3	0	0
Overstory	0	0	15.5	0	0	0	0	0	0	0	0	0	0	0	0
Overall Cover	63	63	63	38	88	88	88	88	88	38	88	88	63	38	38

Appendix 4. Species list for 15 releves at 6 sites organized by strata. Numbers represent cover class values: 1 = 0.01-<1% cover; 2 = 1-5% cover; 3 = 6-25% cover; 4 = 26-50% cover; 5 = 51-75% cover; 6 = 76-100% cover. Strata code: GC = ground cover (<0.5 m in height); LS = low shrub (0.5-<1 m in height); TS = tall shrub (1-<3 m in height); US = understory (3-<10 m in height); OS = overstory (≥10 m in height). Scientific names in all capital letters indicate non-native and adventive species. Species list were derived using the Floristic Quality Assessment program, and releve FQI values are give at the bottom of the appendix (Herman et al. 2001).

		Acklund Road		**Brevort Lake Road**		**Foley Creek Wetland**			**North Point Road Fen**			**Summerby Swamp**			**THSP Loop 2 Fen**	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Abies balsamea	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
balsam fir	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agropyron	GC	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
trachycaulum	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
slender wheat grass	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agrostis hyemalis	GC	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
ticklegrass	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Andromeda	GC	1	3	-	-	-	-	-	2	-	-	2	-	2	1	1
glaucophylla	LS	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-
bog rosemary	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Andropogon scoparius	GC	1	1	1	1	-	-	-	-	-	-	-	-	2	-	-
little bluestem grass	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aronia prunifolia	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
black chokeberry	LS	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Aronia prunifolia	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aster borealis	GC	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-
northern bog-aster	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aster firmus	GC	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
smooth swamp aster	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aster lateriflorus	GC	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-
side-flowering aster	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aster longifolius	GC	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
long-leaved aster	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aster nemoralis	GC	1	1	1	1	-	-	-	-	-	-	-	1	2	-	-
bog aster	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aster umbellatus	GC	-	-	-	-	-	2	-	-	-	-	-	-	1	-	-
tall flat-top white aster	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula papyrifera	GC	-	1	1	-	-	1	-	-	-	-	-	-	1	-	-
paper birch	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.)

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Betula papyrifera	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula pumila bog birch	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calamagrostis canadensis blue-joint grass	GC	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calopogon tuberosus grass-pink	GC	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Campanula aparinoides marsh bellflower	GC	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex alopecoidea sedge	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex aquatilis sedge	GC	-	-	-	-	2	2	4	-	-	-	-	-	-	2	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Carex buxbaumii sedge	GC	-	1	-	-	-	-	-	2	1	1	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex eburnea sedge	GC	3	1	1	-	-	-	-	-	-	-	2	-	2	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex flava sedge	GC	2	1	-	-	-	4	1	-	-	-	2	2	1	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex interior sedge	GC	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex lasiocarpa sedge	GC	-	-	-	-	5	5	6	5	3	2	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex leptalea sedge	GC	-	-	-	-	-	-	-	-	2	-	-	-	-	-	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex limosa bog sedge	GC	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Carex limosa	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex scoparia sedge	GC	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex sterilis sedge	GC	3	3	3	-	-	-	-	-	-	-	3	4	2	-	2
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex tetanica sedge	GC	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chamaedaphne calyculata leatherleaf	GC	-	-	3	-	-	-	-	-	-	-	5	3	3	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chara vulgaris common stonewort	GC	-	-	2	-	-	-	-	-	-	-	1	1	1	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cicuta bulbifera water hemlock	GC	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
CIRSIUM PALUSTRE	GC	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
marsh-thistle	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cladium mariscoides	GC	3	3	-	3	-	-	-	3	1	1	-	-	2	2	2
twig-rush	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Comandra umbellata	GC	1	1	1	-	-	-	-	-	-	-	1	-	-	1	-
bastard-toadflax	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cornus stolonifera	GC	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
red-osier dogwood	LS	-	-	-	-	-	3	-	-	1	-	-	-	-	-	-
	TS	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cypripedium acaule	GC	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pink lady's-slipper	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cypripedium calceolus	GC	-	1	-	-	-	-	-	-	-	-	1	-	1	-	-
var. parviflorum	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
small yellow lady's	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
slipper	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Danthonia spicata	GC	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
poverty grass	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Danthonia spicata	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deschampsia cespitosa hair grass	GC	1	1	1	-	-	1	-	-	-	-	1	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Drosera linearis linear-leaved sundew	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Drosera rotundifolia round-leaved sundew	GC	1	1	1	-	-	-	-	-	-	-	1	1	1	-	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eleocharis elliptica golden-seeded spike rush	GC	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eleocharis quinqueflora spike-rush	GC	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eleocharis rostellata spike-rush	GC	-	3	-	2	-	-	-	-	2	1	-	-	4	3	2
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.)

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Epigaea repens trailing arbutus	GC	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum sp. horsetail	GC	1	1	1	-	-	-	-	-	-	-	1	1	1	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eriophorum gracile slender cotton-grass	GC	-	-	-	-	-	-	-	-	1	-	-	-	-	2	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eriophorum sp. cotton-grass	GC	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eriophorum viridi-carinatum green-keeled cotton-grass	GC	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eupatorium maculatum joe-pye weed	GC	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eupatorium perfoliatum common boneset	GC	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Eupatorium perfoliatum	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Euthamia graminifolia grass-leaved goldenrod	GC	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fragaria virginiana wild strawberry	GC	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fraxinus nigra black ash	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gaultheria procumbens wintergreen	GC	-	-	1	-	-	-	-	-	-	-	1	1	2	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gaylussacia baccata huckleberry	GC	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
	LS	2	-	3	-	-	-	-	-	-	-	-	-	-	-	2
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gentianopsis procera small fringed gentian	GC	1	1	-	-	-	-	-	-	-	-	-	1	1	1	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Glyceria striata	GC	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-
fowl manna grass	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Halenia deflexa	GC	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-
spurred gentian	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iris virginica	GC	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
southern blue flag	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus alpinus	GC	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
rush	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus balticus	GC	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
rush	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus brachycephalus	GC	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
rush	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Juncus militaris soldier rush (STATE THREATENED)	GC	1	1	1	3	-	-	-	-	-	-	3	3	-	3	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juncus sp. rush	GC	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juniperus communis ground juniper	GC	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Juniperus horizontalis creeping juniper	GC	2	2	1	3	-	-	-	-	-	-	2	2	2	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalmia polifolia swamp-laurel	GC	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Larix laricina tamarack	GC	2	2	2	1	-	-	-	-	-	-	2	2	2	-	-
	LS	-	2	-	-	-	-	-	-	-	-	2	3	-	-	-
	TS	-	-	2	-	-	1	-	-	2	-	3	-	2	-	-
	US	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ledum groenlandicum labrador-tea	GC	2	2	2	-	-	-	-	-	-	-	3	3	2	1	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Ledum groenlandicum	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lichen	GC	3	3	2	-	-	-	-	-	-	-	3	3	2	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Linnaea borealis twinflower	GC	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lobelia kalmii bog lobelia	GC	1	1	1	1	-	1	-	-	1	-	1	1	1	1	2
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lonicera canadensis American fly honeysuckle	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lycopus americanus common water horehound	GC	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lycopus uniflorus northern bugle weed	GC	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Lysimachia thyrsiflora tufted loosestrife	GC	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mentha arvensis wild mint	GC	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Muhlenbergia glomerata marsh wild-timothy	GC	-	1	1	1	-	1	-	-	1	1	-	1	1	1	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Muhlenbergia mexicana leafy satin grass	GC	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Muhlenbergia richardsonis mat muhly (STATE THREATENED)	GC	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myrica gale sweet gale	GC	-	2	-	-	-	1	-	-	-	-	-	-	-	-	1
	LS	-	2	-	-	3	3	-	3	3	2	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NS (non-*Sphagnum*) clump-forming mosses	GC	3	4	3	3	-	-	-	1	4	2	3	4	4	2	2
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
NS (non-*Sphagnum*)	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
clump-forming mosses	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Osmunda regalis	GC	-	-	-	-	-	2	-	-	2	-	-	-	-	-	-
royal fern	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panicum implicatum	GC	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-
panic grass	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panicum sp.	GC	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
panic grass	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parnassia glauca	GC	2	2	1	1	-	-	-	-	1	-	2	1	2	1	1
grass-of-parnassus	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phragmites australis	GC	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
reed	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Picea mariana	GC	1	2	2	1	-	-	-	-	-	-	3	3	3	1	-
black spruce	LS	2	2	2	-	-	-	-	-	-	-	2	2	2	1	1
	TS	2	2	-	-	-	1	-	-	-	-	-	1	2	-	-
	US	-	-	2	-	-	-	-	-	-	-	2	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

Species		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
		A1	A2	B1	B2	F1	F2	F3	N1	N2	N3	S1	S2	S3	T1	T2
Pinguicula vulgaris butterwort (STATE SPECIAL CONCERN)	GC	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinus strobus white pine	GC	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
Pogonia ophioglossoides rose pogonia	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygonum amphibium water smartweed	GC	-	-	-	-	-	2	3	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Populus balsamifera balsam popular	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potentilla fruticosa shrubby cinquefoil	GC	3	3	2	3	-	-	-	-	-	-	2	2	3	1	1
	LS	3	2	2	-	-	2	-	2	3	2	2	-	2	1	1
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potentilla palustris marsh cinquefoil	GC	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Potentilla palustris	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proserpinaca palustris mermaid-weed	GC	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhamnus alnifolia alder-leaved buckthorn	GC	-	1	1	-	-	-	-	-	-	-	2	1	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhynchospora alba beak-rush	GC	1	1	-	-	-	-	-	1	2	3	-	-	-	2	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhynchospora capillacea beak-rush	GC	3	2	2	3	-	-	-	1	-	-	-	1	2	3	3
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rosa palustris swamp rose	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix candida hoary willow	GC	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
	LS	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-
	TS	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.)

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Salix discolor pussy willow	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix lucida shining willow	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salix petiolaris slender willow	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	2	2	2	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sarracenia purpurea pitcher-plant	GC	2	3	1	-	-	-	-	1	2	1	2	2	1	3	2
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Schoenoplectus acutus hardstem bulrush	GC	-	-	-	-	4	-	1	2	-	-	2	1	-	1	2
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Senecio pauperculus balsam ragwort	GC	1	1	1	1	-	-	-	-	-	-	1	1	1	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solidago hispida white goldenrod	GC	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.)

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Solidago hispida	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solidago houghtonii Houghton's goldenrod (STATE THREATENED)	GC	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solidago ptarmicoides upland white goldenrod	GC	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solidago rugosa rough goldenrod	GC	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solidago uliginosa bog goldenrod	GC	2	1	1	1	-	-	-	-	1	1	1	1	1	1	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphagnum sp. Sphagnum moss	GC	-	-	3	-	-	-	-	-	-	-	-	4	3	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spiranthes cernua nodding ladies'-tresses	GC	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Thuja occidentalis arbor vitae	GC	3	2	3	1	-	2	-	-	-	-	2	3	-	2	-
	LS	2	2	3	1	-	-	-	-	2	-	-	3	1	3	2
	TS	2	2	3	-	-	3	-	-	3	-	2	2	-	2	2
	US	3	2	3	-	-	-	-	-	3	-	3	-	2	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tofieldia glutinosa false asphodel	GC	2	1	1	1	-	-	-	-	-	-	1	1	1	1	2
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Triadenum fraseri marsh St. John's wort	GC	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichophorum alpinum bulrush	GC	-	-	-	-	-	-	-	-	-	-	4	4	3	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichophorum cespitosum bulrush	GC	-	-	4	-	-	-	-	-	-	1	-	-	-	3	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichophorum clintonii Clinton's bulrush (STATE SPECIAL CONCERN)	GC	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trientalis borealis starflower	GC	1	1	1	-	-	-	-	-	-	-	1	1	1	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		Brevort Lake Road		Foley Creek Wetland			North Point Road Fen			Summerby Swamp			THSP Loop 2 Fen	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Trientalis borealis	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Triglochin maritimum common bog arrow-grass	GC	1	1	1	1	-	-	-	-	-	1	-	-	-	-	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Triglochin palustre slender bog arrow-grass	GC	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TYPHA ANGUSTIFOLIA narrow-leaved cat-tail	GC	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utricularia cornuta horned bladderwort	GC	1	1	-	-	-	-	-	-	2	2	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utricularia sp. bladderwort	GC	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium angustifolium blueberry	GC	2	-	1	-	-	-	-	-	-	-	2	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. (cont.).

		Acklund Road		**Brevort Lake Road**		**Foley Creek Wetland**			**North Point Road Fen**			**Summerby Swamp**			**THSP Loop 2 Fen**	
Species		**A1**	**A2**	**B1**	**B2**	**F1**	**F2**	**F3**	**N1**	**N2**	**N3**	**S1**	**S2**	**S3**	**T1**	**T2**
Vaccinium macrocarpon large cranberry	GC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vaccinium oxycoccos small cranberry	GC	1	1	1	-	-	-	-	-	-	-	2	1	1	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Valeriana ciliata common valerian	GC	1	1	1	-	-	-	-	-	-	-	1	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Viola sp. violet	GC	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zigadenus glaucus white camas	GC	1	1	1	-	-	-	-	-	-	-	1	1	-	-	-
	LS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	US	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Species # per Releve		**51**	**47**	**47**	**19**	**14**	**42**	**8**	**18**	**31**	**16**	**36**	**37**	**42**	**28**	**31**
Total Species # per Site		**59**		**49**		**49**			**42**			**54**			**38**	
Floristic Quality Index (FQI)		**48.5**	**49.8**	**46.4**	**33.7**	**17.9**	**33.8**	**13.8**	**30.8**	**37.4**	**32**	**42.1**	**43.0**	**44.4**	**40.2**	**44.2**
Mean Coefficient of Wetness (*W*)		**-2.3**	**-3.1**	**-2.3**	**-3.5**	**-4.1**	**-3.8**	**-4.7**	**-4.6**	**-4.1**	**-4.8**	**-3.1**	**-3.6**	**-2.9**	**-4.1**	**-4.5**

Appendix 5. Species list for six oviposition plots at four sites. Numbers represent cover class values: 1 = 0.01-<1% cover; 2 = 1-5% cover; 3 = 6-25% cover; 4 = 26-50% cover; 5 = 51-75% cover; 6 = 76-100% cover. Species list were derived using the Floristic Quality Assessment program, and plot FQI values are give at the bottom of the appendix (Herman et al. 2001).

		Acklund Road	**Brevort Lake Road**	**Summerby Swamp**		**THSP Loop 2 Fen**	
Scientific Name	**Common Name**	**OA1**	**OB1**	**OS1**	**OS2**	**OT1**	**OT2**
Andromeda glaucophylla	bog rosemary	-	-	1	-	-	-
Aster borealis	northern bog-aster	-	-	-	1	-	-
Aster nemoralis	bog aster	-	-	-	1	-	-
Carex sterilis	sedge	-	-	3	3	-	-
Chamaedaphne calyculata	leatherleaf	-	-	2	-	-	-
Chara vulgaris	common stonewort	-	-	1	1	-	-
Cladium mariscoides	twig-rush	-	-	-	-	2	2
Comandra umbellata	bastard-toadflax	-	-	1	1	1	-
Deschampsia flexuosa	hair grass	-	-	1	-	-	-
Drosera rotundifolia	round-leaved sundew	-	-	1	1	-	-
Eleocharis rostellata	spike-rush	-	3	-	-	2	2
Eleocharis sp.	spike-rush	3	-	-	-	-	-
Equisetum sp.	horsetail	-	-	1	2	-	-
Eriophorum gracile	slender cotton-grass	-	-	-	-	1	1
Halenia deflexa	spurred gentian	-	-	-	1	-	-
Juncus militaris (STATE THREATENED)	soldier rush	-	3	1	3	-	-
Juniperus horizontalis	creeping juniper	-	-	-	3	-	-
Larix laricina	tamarack	-	-	2	1	-	-
Ledum groenlandicum	labrador-tea	-	-	2	-	-	-
Lichen	lichen	-	-	-	1	-	-
Lobelia kalmii	bog lobelia	1	1	1	1	1	1
Nostoc algae	Nostoc algae	3	-	-	-	-	-
NS clump-forming mosses	NS clump-forming mosses	1	3	3	4	2	3
Parnassia glauca	grass-of-parnassus	-	1	1	1	1	-
Pinguicula vulgaris (STATE SPECIAL CONCERN)	butterwort	1	-	-	-	-	-
Potentilla fruticosa	shrubby cinquefoil	1	-	2	2	1	1
Rhynchospora alba	beak-rush	-	-	-	-	1	-
Rhynchospora capillacea	beak-rush	2	2	-	2	2	1
Salix candida	hoary willow	-	-	1	-	-	-

Appendix 5. (cont.).

		Acklund Road	Brevort Lake Road	Summerby Swamp		THSP Loop 2 Fen	
Scientific Name	**Common Name**	**OA1**	**OB1**	**OS1**	**OS2**	**OT1**	**OT2**
Sarracenia purpurea	pitcher-plant	1	-	1	2	2	3
Senecio pauperculus	balsam ragwort	-	1	1	1	-	-
Solidago uliginosa	bog goldenrod	-	-	1	-	1	1
Sphagnum sp.	Sphagnum moss	-	-	3	-	-	-
Thuja occidentalis	arbor vitae	1	-	-	-	1	1
Tofieldia glutinosa	false asphodel	1	1	-	1	1	1
Trichophorum alpinum	bulrush	-	-	3	3	-	-
Trientalis borealis	starflower	-	-	1	-	-	-
Triglochin maritimum	common bog arrow-grass	1	1	-	-	-	-
Triglochin palustre	slender bog arrow-grass	-	-	-	-	-	1
Utricularia sp.	bladderwort	-	-	-	-	-	1
Vaccinium oxycoccos	small cranberry	-	-	1	1	-	-
Valeriana uliginosa	bog valerian	-	-	-	1	-	-
Total Species # per Plot		**11**	**9**	**23**	**23**	**14**	**13**
Floristic Quality Index (FQI)		**25.5**	**24.4**	**33.3**	**36.9**	**29.7**	**28.9**
Mean Coefficient of Wetness (*W*)		**-4.5**	**-4.5**	**-3.4**	**-3.5**	**-4.1**	**-4.6**

Appendix 6. Species list sorted by site (n = 6) and releve (n = 15) percent frequencies. Importance values were derived by summing the relative releve frequency and relative mean releve coverage for each species. For common names of species, see Appendix 4.

Scientific Name	Site Frequency (%)	Releve Frequency (%)	Relative Releve Frequency (%)	Mean Releve Coverage (%)	Relative Mean Releve Coverage (%)	Importance Value
Potentilla fruticosa	100.00	86.67	2.78	5.68	3.50	6.28
Lobelia kalmii	100.00	73.33	2.36	0.54	0.33	2.69
Thuja occidentalis	100.00	73.33	2.36	7.58	4.67	7.02
Muhlenbergia glomerata	100.00	66.67	2.14	0.34	0.21	2.35
NS clump-forming mosses	83.33	80.00	2.57	14.90	9.17	11.74
Sarracenia purpurea	83.33	73.33	2.36	3.20	1.97	4.33
Solidago uliginosa	83.33	73.33	2.36	0.54	0.33	2.69
Parnassia glauca	83.33	66.67	2.14	1.00	0.62	2.76
Picea mariana	83.33	66.67	2.14	4.18	2.57	4.72
Cladium mariscoides	83.33	60.00	1.93	4.80	2.95	4.88
Larix laricina	83.33	60.00	1.93	2.38	1.47	3.39
Rhynchospora capillacea	83.33	60.00	1.93	4.80	2.95	4.88
Eleocharis rostellata	83.33	46.67	1.50	5.23	3.22	4.72
Andromeda glaucophylla	66.67	60.00	1.93	1.79	1.10	3.03
Tofieldia glutinosa	66.67	60.00	1.93	0.64	0.39	2.32
Juncus militaris	66.67	53.33	1.71	4.27	2.63	4.34
Ledum groenlandicum	66.67	53.33	1.71	2.94	1.81	3.52
Carex sterilis	66.67	46.67	1.50	7.07	4.35	5.85
Drosera rotundifolia	66.67	46.67	1.50	0.24	0.15	1.64
Myrica gale	66.67	46.67	1.50	4.86	2.99	4.49
Schoenoplectus acutus	66.67	46.67	1.50	3.23	1.99	3.49
Triglochin maritimum	66.67	40.00	1.28	0.20	0.12	1.41
Comandra umbellata	66.67	33.33	1.07	0.17	0.10	1.17
Deschampsia cespitosa	66.67	33.33	1.07	0.17	0.10	1.17
Betula papyrifera	66.67	26.67	0.86	0.13	0.08	0.94
Carex flava	50.00	46.67	1.50	3.23	1.99	3.49
Juniperus horizontalis	50.00	46.67	1.50	2.07	1.27	2.77
Rhynchospora alba	50.00	46.67	1.50	1.57	0.96	2.46
Senecio pauperculus	50.00	46.67	1.50	0.24	0.15	1.64
Aster nemoralis	50.00	40.00	1.28	0.37	0.23	1.51
Equisetum sp.	50.00	40.00	1.28	0.20	0.12	1.41
Lichen	50.00	40.00	1.28	4.53	2.79	4.07
Trientalis borealis	50.00	40.00	1.28	0.20	0.12	1.41

Appendix 6. (cont.).

Scientific Name	Site Frequency (%)	Releve Frequency (%)	Relative Releve Frequency (%)	Mean Releve Coverage (%)	Relative Mean Releve Coverage (%)	Importance Value
Vaccinium oxycoccos	50.00	40.00	1.28	0.37	0.23	1.51
Andropogon scoparius	50.00	33.33	1.07	0.33	0.21	1.28
Carex eburnea	50.00	33.33	1.07	1.50	0.92	1.99
Gentianopsis procera	50.00	33.33	1.07	0.17	0.10	1.17
Zigadenus glaucus	50.00	33.33	1.07	0.17	0.10	1.17
Gaylussacia baccata	50.00	26.67	0.86	2.43	1.49	2.35
Rhamnus alnifolia	50.00	26.67	0.86	0.30	0.19	1.04
Salix candida	50.00	26.67	0.86	0.23	0.14	1.00
Valeriana ciliata	50.00	26.67	0.86	0.13	0.08	0.94
Pinus strobus	50.00	20.00	0.64	1.10	0.68	1.32
Trichophorum cespitosum	50.00	20.00	0.64	3.60	2.22	2.86
Vaccinium angustifolium	50.00	20.00	0.64	0.43	0.27	0.91
Carex lasiocarpa	33.33	40.00	1.28	19.70	12.12	13.41
Chamaedaphne calyculata	33.33	26.67	0.86	7.30	4.49	5.35
Chara vulgaris	33.33	26.67	0.86	0.30	0.19	1.04
Carex aquatilis	33.33	26.67	0.86	3.13	1.93	2.78
Carex buxbaumii	33.33	26.67	0.86	0.30	0.19	1.04
Gaultheria procumbens	33.33	26.67	0.86	0.30	0.19	1.04
Utricularia cornuta	33.33	26.67	0.86	0.47	0.29	1.14
Cypripedium calceolus var. parviflorum	33.33	20.00	0.64	0.10	0.06	0.70
Eriophorum gracile	33.33	20.00	0.64	0.27	0.16	0.81
Sphagnum sp.	33.33	20.00	0.64	4.60	2.83	3.47
Aster borealis	33.33	13.33	0.43	0.07	0.04	0.47
Aster lateriflorus	33.33	13.33	0.43	0.07	0.04	0.47
Aster umbellatus	33.33	13.33	0.43	0.23	0.14	0.57
Calopogon tuberosus	33.33	13.33	0.43	0.07	0.04	0.47
Cornus stolonifera	33.33	13.33	0.43	1.38	0.85	1.27
Carex leptalea	33.33	13.33	0.43	0.23	0.14	0.57
Carex scoparia	33.33	13.33	0.43	0.07	0.04	0.47
Fragaria virginiana	33.33	13.33	0.43	0.23	0.14	0.57
Glyceria striata	33.33	13.33	0.43	0.07	0.04	0.47
Halenia deflexa	33.33	13.33	0.43	0.07	0.04	0.47
Lycopus uniflorus	33.33	13.33	0.43	0.07	0.04	0.47

Appendix 6. (cont.).

Scientific Name	Site Frequency (%)	Releve Frequency (%)	Relative Releve Frequency (%)	Mean Releve Coverage (%)	Relative Mean Releve Coverage (%)	Importance Value
Osmunda regalis	33.33	13.33	0.43	0.40	0.25	0.67
Panicum implicatum	33.33	13.33	0.43	0.07	0.04	0.47
Triglochin palustre	33.33	13.33	0.43	0.07	0.04	0.47
Utricularia sp.	33.33	13.33	0.43	0.07	0.04	0.47
Salix petiolaris	16.67	20.00	0.64	0.65	0.40	1.04
Trichophorum alpinum	16.67	20.00	0.64	6.10	3.75	4.40
Campanula aparinoides	16.67	13.33	0.43	0.07	0.04	0.47
Cicuta bulbifera	16.67	13.33	0.43	0.07	0.04	0.47
Drosera linearis	16.67	13.33	0.43	0.07	0.04	0.47
Eriophorum sp.	16.67	13.33	0.43	0.07	0.04	0.47
Eriophorum viridi-carinatum	16.67	13.33	0.43	0.07	0.04	0.47
Lysimachia thyrsiflora	16.67	13.33	0.43	0.23	0.14	0.57
Mentha arvensis	16.67	13.33	0.43	0.07	0.04	0.47
Pogonia ophioglossoides	16.67	13.33	0.43	0.07	0.04	0.47
Polygonum amphibium	16.67	13.33	0.43	1.23	0.76	1.19
Trichophorum clintonii	16.67	13.33	0.43	3.57	2.19	2.62
Triadenum fraseri	16.67	13.33	0.43	0.23	0.14	0.57
Viola sp.	16.67	13.33	0.43	0.07	0.04	0.47
Abies balsamea	16.67	6.67	0.21	0.20	0.12	0.34
Agrostis hyemalis	16.67	6.67	0.21	0.03	0.02	0.23
Agropyron trachycaulum	16.67	6.67	0.21	0.03	0.02	0.23
Aronia prunifolia	16.67	6.67	0.21	0.03	0.02	0.23
Aster firmus	16.67	6.67	0.21	0.03	0.02	0.23
Aster longifolius	16.67	6.67	0.21	0.03	0.02	0.23
Betula pumila	16.67	6.67	0.21	1.08	0.67	0.88
Calamagrostis canadensis	16.67	6.67	0.21	1.03	0.64	0.85
CIRSIUM PALUSTRE	16.67	6.67	0.21	0.03	0.02	0.23
Carex alopecoidea	16.67	6.67	0.21	0.03	0.02	0.23
Carex interior	16.67	6.67	0.21	0.20	0.12	0.34
Carex limosa	16.67	6.67	0.21	0.03	0.02	0.23
Carex tetanica	16.67	6.67	0.21	0.03	0.02	0.23
Cypripedium acaule	16.67	6.67	0.21	0.03	0.02	0.23
Danthonia spicata	16.67	6.67	0.21	0.03	0.02	0.23
Eleocharis elliptica	16.67	6.67	0.21	1.03	0.64	0.85

Appendix 6. (cont.).

Scientific Name	Site Frequency (%)	Releve Frequency (%)	Relative Releve Frequency (%)	Mean Releve Coverage (%)	Relative Mean Releve Coverage (%)	Importance Value
Eleocharis quinqueflora	16.67	6.67	0.21	0.03	0.02	0.23
Epigaea repens	16.67	6.67	0.21	0.03	0.02	0.23
Eupatorium maculatum	16.67	6.67	0.21	0.20	0.12	0.34
Eupatorium perfoliatum	16.67	6.67	0.21	0.03	0.02	0.23
Euthamia graminifolia	16.67	6.67	0.21	0.03	0.02	0.23
Fraxinus nigra	16.67	6.67	0.21	0.03	0.02	0.23
Iris virginica	16.67	6.67	0.21	0.03	0.02	0.23
Juncus alpinus	16.67	6.67	0.21	0.03	0.02	0.23
Juncus balticus	16.67	6.67	0.21	0.20	0.12	0.34
Juncus brachycephalus	16.67	6.67	0.21	0.03	0.02	0.23
Juniperus communis	16.67	6.67	0.21	0.03	0.02	0.23
Juncus sp.	16.67	6.67	0.21	0.03	0.02	0.23
Kalmia polifolia	16.67	6.67	0.21	0.03	0.02	0.23
Linnaea borealis	16.67	6.67	0.21	0.03	0.02	0.23
Lonicera canadensis	16.67	6.67	0.21	0.03	0.02	0.23
Lycopus americanus	16.67	6.67	0.21	0.03	0.02	0.23
Muhlenbergia mexicana	16.67	6.67	0.21	0.03	0.02	0.23
Muhlenbergia richardsonis	16.67	6.67	0.21	0.03	0.02	0.23
Panicum sp.	16.67	6.67	0.21	0.03	0.02	0.23
Phragmites australis	16.67	6.67	0.21	0.20	0.12	0.34
Pinguicula vulgaris	16.67	6.67	0.21	0.03	0.02	0.23
Populus balsamifera	16.67	6.67	0.21	0.03	0.02	0.23
Potentilla palustris	16.67	6.67	0.21	0.03	0.02	0.23
Proserpinaca palustris	16.67	6.67	0.21	0.03	0.02	0.23
Rosa palustris	16.67	6.67	0.21	0.20	0.12	0.34
Salix discolor	16.67	6.67	0.21	0.03	0.02	0.23
Salix lucida	16.67	6.67	0.21	0.25	0.15	0.37
Solidago hispida	16.67	6.67	0.21	0.03	0.02	0.23
Solidago houghtonii	16.67	6.67	0.21	0.20	0.12	0.34
Solidago ptarmicoides	16.67	6.67	0.21	0.03	0.02	0.23
Solidago rugosa	16.67	6.67	0.21	0.20	0.12	0.34
Spiranthes cernua	16.67	6.67	0.21	0.03	0.02	0.23
TYPHA ANGUSTIFOLIA	16.67	6.67	0.21	0.03	0.02	0.23
Vaccinium macrocarpon	16.67	6.67	0.21	0.03	0.02	0.23
Totals	**4850.00**	**3113.33**	**100.00**	**162.52**	**100.00**	**200.00**

Appendix 7. Species list sorted by site (n = 4) and oviposition plot (n = 6) percent frequencies. Importance values were derived by summing the relative plot frequency with relative mean plot coverage for each species. For common names of species, see Appendix 5.

Scientific Name	Site Frequency (%)	Plot Frequency (%)	Relative Plot Frequency (%)	Mean Plot Coverage (%)	Relative Mean Plot Coverage (%)	Importance Value
Lobelia kalmii	100.00	100.00	6.45	0.51	0.86	7.31
NS clump-forming mosses	100.00	100.00	6.45	14.67	25.02	31.47
Rhynchospora capillacea	100.00	83.33	5.38	2.08	3.55	8.93
Tofieldia glutinosa	100.00	83.33	5.38	0.42	0.72	6.09
Potentilla fruticosa	75.00	83.33	5.38	1.25	2.14	7.51
Sarracenia purpurea	75.00	83.33	5.38	3.75	6.40	11.77
Parnassia glauca	75.00	66.67	4.30	0.34	0.57	4.88
Comandra umbellata	50.00	50.00	3.23	0.25	0.43	3.66
Eleocharis rostellata	50.00	50.00	3.23	3.58	6.11	9.34
Juncus militaris	50.00	50.00	3.23	5.25	8.96	12.18
Senecio pauperculus	50.00	50.00	3.23	0.25	0.43	3.66
Solidago uliginosa	50.00	50.00	3.23	0.25	0.43	3.66
Thuja occidentalis	50.00	50.00	3.23	0.25	0.43	3.66
Triglochin maritimum	50.00	33.33	2.15	0.17	0.29	2.44
Carex sterilis	25.00	33.33	2.15	5.17	8.81	10.96
Chara vulgaris	25.00	33.33	2.15	0.17	0.29	2.44
Cladium mariscoides	25.00	33.33	2.15	1.00	1.71	3.86
Drosera rotundifolia	25.00	33.33	2.15	0.17	0.29	2.44
Equisetum sp.	25.00	33.33	2.15	0.58	1.00	3.15
Eriophorum gracile	25.00	33.33	2.15	0.17	0.29	2.44
Larix laricina	25.00	33.33	2.15	0.58	1.00	3.15
Trichophorum alpinum	25.00	33.33	2.15	5.17	8.81	10.96
Vaccinium oxycoccos	25.00	33.33	2.15	0.17	0.29	2.44
Andromeda glaucophylla	25.00	16.67	1.08	0.08	0.14	1.22
Aster borealis	25.00	16.67	1.08	0.08	0.14	1.22
Aster nemoralis	25.00	16.67	1.08	0.08	0.14	1.22
Chamaedaphne calyculata	25.00	16.67	1.08	0.50	0.85	1.93
Deschampsia flexuosa	25.00	16.67	1.08	0.08	0.14	1.22
Eleocharis sp.	25.00	16.67	1.08	2.58	4.41	5.48
Halenia deflexa	25.00	16.67	1.08	0.08	0.14	1.22
Juniperus horizontalis	25.00	16.67	1.08	2.58	4.41	5.48
Ledum groenlandicum	25.00	16.67	1.08	0.50	0.85	1.93

Appendix 7. (cont.).

Scientific Name	Site Frequency (%)	Plot Frequency (%)	Relative Plot Frequency (%)	Mean Plot Coverage (%)	Relative Mean Plot Coverage (%)	Importance Value
Lichen	25.00	16.67	1.08	0.08	0.14	1.22
Nostoc algae	25.00	16.67	1.08	2.58	4.41	5.48
Pinguicula vulgaris	25.00	16.67	1.08	0.08	0.14	1.22
Rhynchospora alba	25.00	16.67	1.08	0.08	0.14	1.22
Salix candida	25.00	16.67	1.08	0.08	0.14	1.22
Sphagnum sp.	25.00	16.67	1.08	2.58	4.41	5.48
Trientalis borealis	25.00	16.67	1.08	0.08	0.14	1.22
Triglochin palustre	25.00	16.67	1.08	0.08	0.14	1.22
Utricularia sp.	25.00	16.67	1.08	0.08	0.14	1.22
Valeriana uliginosa	25.00	16.67	1.08	0.08	0.14	1.22
Totals	**1675.00**	**1550.00**	**100.00**	**58.63**	**100.00**	**200.00**

Appendix 8. DCA output from PC-ORD. Percent of variance explained in the distance matrix.

```
************************* Output from Graph *************************
PC-ORD Version 4.01
01/16/2006, 3:33 PM

Species and Releve Ordination

Coefficients of determination for the correlations between ordination
distances and distances in the original n-dimensional space:

            R Squared
Axis   Increment   Cumulative
 1       .529        .529
 2       .043        .572
 3      -.027        .545

Number of entities = 15
Number of entity pairs used in correlation = 105
Distance measure for ORIGINAL distance: Relative Euclidean
```

Appendix 9. DCA output from PC-ORD. Correlations of species coverage with the ordination axes.

```
************************* Output from Graph *************************
PC-ORD Version 4.01
01/16/2006, 3:30 PM

Species and Releve Ordination

Pearson and Kendall Correlations with Ordination Axes   N= 15
```

Axis:	1			2			3		
	r	r-sq	tau	r	r-sq	tau	r	r-sq	tau
ANDGLA	-.198	.039	-.199	-.269	.073	-.243	.019	.000	.110
ANDSCO	-.358	.129	-.425	-.259	.067	-.212	-.148	.022	-.159
ASTBOR	.025	.001	-.038	-.031	.001	-.038	-.526	.277	-.498
ASTLAT	.142	.020	.191	.442	.196	.383	-.224	.050	-.191
ASTNEM	-.409	.168	-.546	-.308	.095	-.318	-.203	.041	-.292
ASTUMB	.281	.079	.056	.198	.039	.019	-.408	.166	-.357
BETPAP	-.191	.036	-.206	.166	.027	.118	-.414	.172	-.353
CALTUB	-.251	.063	-.115	.052	.003	.038	.038	.001	.038
CAMAPR	.532	.283	.421	.161	.026	.153	-.084	.007	-.077
CHACAL	-.478	.228	-.669	-.517	.268	-.299	-.414	.171	-.441
CHAVUL	-.403	.162	-.612	.247	.061	-.214	-.354	.125	-.413
CICBUL	.636	.404	.459	.283	.080	.230	-.262	.069	-.230
CLAMAR	-.123	.015	-.109	-.334	.111	-.153	.237	.056	.306
COMUMB	-.530	.281	-.469	.032	.001	.055	-.377	.142	-.276
CORSTO	.324	.105	.282	.238	.057	.207	-.397	.158	-.319
CXAQUA	.597	.357	.555	.197	.039	.327	.037	.001	.014
CXBUXB	.323	.104	.214	-.085	.007	-.043	.580	.337	.384
CXEBUR	-.273	.075	-.513	-.223	.050	-.231	-.353	.124	-.436
CXFLAV	.268	.072	-.243	.168	.028	-.313	-.470	.221	-.706
CXLASI	.937	.879	.769	.172	.030	.168	.238	.057	.240
CXLEPA	.042	.002	.131	.045	.002	.207	-.027	.001	.056
CXSCOP	-.310	.096	-.268	.242	.059	.230	-.381	.145	-.306
CXSTER	-.602	.362	-.700	-.358	.128	-.233	-.579	.335	-.537
CYCAPA	-.431	.185	-.455	-.542	.294	-.455	-.227	.051	-.195
DESCES	-.292	.085	-.331	-.036	.001	.000	-.634	.402	-.524
DROLIN	-.170	.029	.038	.492	.242	.413	.163	.027	.188
DROROT	-.751	.565	-.678	-.257	.066	-.209	-.536	.288	-.443
ELEROS	-.343	.118	-.217	-.129	.017	.011	-.025	.001	.126
EQUSPP	-.713	.508	-.717	-.417	.174	-.345	-.614	.376	-.531
ERIGRA	-.135	.018	.063	.415	.172	.412	.104	.011	.127
ERISPP	-.231	.053	-.191	-.160	.026	-.153	-.217	.047	-.191
ERIVID	.279	.078	.230	-.079	.006	-.038	.342	.117	.230
FRAVIR	.331	.109	.282	.236	.056	.207	-.403	.162	-.319
GAUPRO	-.381	.145	-.584	-.296	.088	-.242	-.220	.048	-.384
GAYBAC	-.353	.125	-.321	.287	.082	.237	-.228	.052	-.153
GENPRO	-.512	.262	-.414	-.194	.038	-.193	-.322	.103	-.304
GLYSTR	.279	.078	.268	.169	.029	.191	-.326	.106	-.306
HALDEF	-.405	.164	-.421	.102	.010	.077	-.413	.171	-.345
JUNHOR	-.359	.129	-.584	-.568	.323	-.560	-.055	.003	-.322
JUNMIL	-.492	.242	-.575	-.424	.180	-.207	-.212	.045	-.207
LARLAR	-.569	.324	-.718	-.614	.378	-.418	-.563	.317	-.546
LEDGRO	-.570	.325	-.812	-.584	.341	-.211	-.532	.283	-.545

Appendix 9. (cont.).

Axis:	1			2			3		
	r	r-sq	tau	r	r-sq	tau	r	r-sq	tau
LICHEN	-.575	.330	-.669	-.560	.314	-.372	-.547	.299	-.545
LOBKAL	-.343	.118	-.452	.227	.052	.000	-.115	.013	-.398
LYCUNI	.316	.100	.306	.340	.116	.268	.042	.002	-.038
LYSTHY	.457	.209	.432	.022	.000	.131	.214	.046	-.056
MENARV	.532	.283	.421	.161	.026	.153	-.084	.007	-.077
MUHGLO	-.433	.187	-.221	.299	.090	.221	-.154	.024	-.110
MYRGAL	.597	.356	.470	.073	.005	.157	.229	.053	.224
NSCFMO	-.610	.372	-.680	-.495	.245	-.282	-.421	.177	-.282
OSMREG	.279	.078	.268	.169	.029	.191	-.326	.106	-.306
PANIMP	-.209	.044	-.077	.202	.041	.191	-.138	.019	-.115
PARGLA	-.606	.367	-.703	-.539	.290	-.295	-.418	.175	-.386
PICMAR	-.634	.402	-.802	-.618	.381	-.226	-.521	.272	-.494
PINSTR	-.304	.092	-.391	.392	.154	.078	-.304	.093	-.391
POGOPH	-.170	.029	.038	.492	.242	.413	.163	.027	.188
POLAMP	.604	.365	.470	.194	.038	.207	-.038	.001	-.207
POTFRU	-.407	.165	-.421	-.451	.203	-.280	-.235	.055	-.220
RHAALN	-.414	.172	-.641	-.505	.255	-.270	-.363	.132	-.384
RHYALB	.093	.009	.187	.296	.088	.303	.474	.225	.303
RHYCAL	-.380	.145	-.218	.143	.020	.000	.015	.000	.065
SALCAN	.015	.000	-.157	-.099	.010	-.185	-.215	.046	-.470
SALPET	.804	.646	.602	.232	.054	.190	-.038	.001	-.032
SARPUP	-.341	.116	-.453	.105	.011	-.022	-.045	.002	-.129
SCHACU	.404	.163	.151	-.039	.002	-.058	.312	.097	.290
SENPAU	-.764	.584	-.730	-.579	.335	-.496	-.533	.284	-.417
SOLULI	-.429	.184	-.584	-.129	.017	-.106	-.329	.108	-.266
SPHSPP	-.451	.203	-.507	-.187	.035	-.095	-.415	.172	-.380
THUOCC	-.501	.251	-.466	.124	.015	.089	-.762	.581	-.585
TOFGLU	-.401	.161	-.521	.077	.006	-.118	-.206	.042	-.260
TRIALP	-.492	.242	-.570	-.639	.408	-.538	-.449	.202	-.412
TRIBOR	-.713	.508	-.717	-.417	.174	-.345	-.614	.376	-.531
TRICES	-.300	.090	-.109	.543	.295	.547	-.189	.036	.109
TRICLI	-.210	.044	-.207	-.157	.025	-.169	-.124	.015	-.169
TRIFRA	.389	.151	.394	.234	.055	.169	-.347	.121	-.094
TRIMAR	-.357	.128	-.186	.201	.040	.133	.096	.009	.133
TRIPAL	-.191	.037	-.038	.159	.025	.153	-.107	.011	-.077
UTRCOR	.086	.007	.056	.136	.018	.056	.263	.069	.028
UTRSPP	-.270	.073	-.153	.532	.283	.459	-.080	.006	.000
VACANG	-.366	.134	-.443	-.388	.150	-.063	-.431	.186	-.412
VACOXY	-.486	.236	-.750	-.565	.319	-.394	-.428	.183	-.521
VALCIL	-.493	.243	-.500	-.172	.030	-.118	-.453	.205	-.353
VIOSPP	-.231	.053	-.191	-.160	.026	-.153	-.217	.047	-.191
ZIGGLA	-.588	.346	-.580	-.286	.082	-.221	-.467	.218	-.386