# Red Maple, *Acer rubrum,* Wetland Composition and Structure in Nova Scotia

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Red Maple (*Acer rubrum*) wetlands occur when Red Maple dominated forest occupies imperfectly drained to saturated soils. Plots were established in 28 Red Maple wetlands in Nova Scotia to document structure and plant composition. Non-metric multidimensional scaling (NMDS) was used to assess vegetation differences by wetland type (floodplain, depression, slope) and geographic region (inland vs. coastal and western vs. eastern shore). Seventy-eight species of vascular plants and 35 species of non-vascular plants were found in plots. Two species of rare vascular plants and four rare *Sphagnum* species were found in plots or within the wetlands. *Sphagnum* species richness was very high. Red Maple wetlands are structurally complex, often having five distinct vertical layers. NMDS species composition analyses suggest little difference between wetland types and geographic regions. Given the diversity of vascular and non-vascular plants and the structural complexity of Red Maple wetlands in Nova Scotia, these wetlands make a significant contribution to the biodiversity and heterogeneity of the landscape.

Key Words: Red Maple, *Acer rubrum*, *Sphagnum*, wetland, composition, structure, Nova Scotia.

Red Maple (*Acer rubrum*) is a common forest species of Nova Scotia occurring in a variety of ecological conditions (Saunders 1995). In imperfectly drained to saturated soils, Red Maple dominated forest forms Red Maple swamps or wetlands. These wetlands can occur as depressions, side slope seeps, or seasonally flooded areas such as river floodplains. Soils can be mineral or organic with seasonal, intermittent, or continuous flooding (Rheinhardt 2007).

Red Maple wetlands are often a unique community of flora not found elsewhere in the landscape and they contribute to the diversity of the surrounding landscape. Red Maple wetlands also provide the benefits associated with other wetlands, such as flood control, water storage, water quality protection, and habitat for wildlife (Golet et al. 1993).

Rare species have also been associated with Red Maple wetlands in Nova Scotia. Southern Twayblade (*Listera australis*), a rare species in Nova Scotia, is associated with these types of wetlands (Zinck 1998). Maass (1986), Cameron and Neily (2008), and Cameron and Richardson (2006) have reported a community of rare lichens in Red Maple and other forested wetlands in Nova Scotia. The lichen community includes the globally endangered Boreal Felt Lichen (*Erioderma pedicellatum*).

There have been several published works on Red Maple wetlands in the northeastern United States (Ehrenfeld and Gulick 1981; Golet et al. 1993; Rheinhardt 2007). However, there are no published detailed studies of Red Maple wetlands in Nova Scotia. Plots were established in 28 Red Maple wetlands in Nova Scotia to document the structure and plant composition.

## Methods

Plots were established in Red Maple wetlands as part of a larger project to assess the biodiversity of protected wilderness areas and candidate protected areas (Figure 1) (Table 1). Provincial wilderness areas make an ideal network for study because they were designed to represent the variety of ecosystems present in the province and they are relatively undisturbed by human impacts. Wilderness areas are legally protected from development, including forestry, mining, and road building.

Transects were established in 10 protected wilderness areas and 5 candidate wilderness areas. Transects were designed to traverse the variety of topographical features of each landscape. Whenever a Red Maple wetland was encountered, a plot was established. An area was considered a Red Maple wetland if it met the following criteria: (1) there were Red Maples in the canopy layer; (2) the area had imperfectly drained soil, poorly drained soil, or saturated soil; and (3) it had facultative or obligate wetland plant species. Twenty-four Red Maple wetland plots were established from the transects and an additional four plots were established because they were habitat of known rare species. Once encountered, each Red Maple wetland was traversed to determine the extent and variation of plants occurring there. A representative area was subjectively selected for a 20 m × 20 m plot. Presence and abundance of plant species and environmental site factors were collected at each plot, following standards set out by the Ecological Society of America (Jennings et al. 2002).

TABLE 1. North longitude and west latitude, wetland type, geographic position, and region of study plots.

| Plot Number | Latitude | Longitude | Wetland type | Position | Region |
|---|---|---|---|---|---|
| 1 | 44.070918 | −65.549466 | Floodplain | Inland | West |
| 2 | 44.275538 | −65.050733 | Floodplain | Inland | West |
| 3 | 44.276337 | −65.298548 | Floodplain | Inland | West |
| 4 | 44.074093 | −65.563302 | Floodplain | Inland | West |
| 5 | 44.072277 | −65.563149 | Depression | Inland | West |
| 6 | 44.069989 | −65.562813 | Depression | Inland | West |
| 7 | 44.074083 | −65.560130 | Depression | Inland | West |
| 8 | 44.077982 | −65.575297 | Depression | Inland | West |
| 9 | 44.073346 | −65.561659 | Depression | Inland | West |
| 10 | 44.279205 | −65.072039 | Depression | Inland | West |
| 11 | 44.446621 | −64.820082 | Depression | Inland | West |
| 12 | 44.439111 | −64.821268 | Depression | Inland | West |
| 13 | 44.437143 | −64.823896 | Depression | Inland | West |
| 14 | 44.074083 | −65.560130 | Depression | Inland | West |
| 15 | 44.914877 | −63.059061 | Depression | Coast | East |
| 16 | 43.839248 | −65.193824 | Depression | Coast | West |
| 17 | 43.836494 | −65.198001 | Depression | Coast | West |
| 18 | 44.449973 | −64.817044 | Depression | Inland | West |
| 19 | 44.448001 | −64.818755 | Depression | Inland | West |
| 20 | 44.911978 | −63.073881 | Depression | Coast | East |
| 21 | 44.863145 | −63.023263 | Depression | Coast | East |
| 22 | 44.863271 | −63.024149 | Depression | Coast | East |
| 23 | 44.870089 | −63.090449 | Depression | Coast | East |
| 24 | 44.836204 | −63.064700 | Side-slope | Coast | East |
| 25 | 44.840165 | −63.064540 | Side-slope | Coast | East |
| 26 | 44.932328 | −63.047116 | Side-slope | Coast | East |
| 27 | 43.855017 | −65.021355 | Side-slope | Coast | West |
| 28 | 43.849514 | −65.190480 | Side-slope | Coast | West |

Cover abundance classes for each plant species by layer was recorded within each plot. Seven cover classes were used based on the percentage of ground covered by each species within the 20 m × 20 m plot: 1 = trace, 2 = 0–1%, 3 = 2–5%, 4 = 6–25%, 5 = 26–50%, 6 = 51–75%, 7 = 76–100%. The five layers in which plant cover classes were estimated were (1) canopy, (2) subcanopy, (3) shrub, (4) herb, and (5) moss/lichen. Vascular plants were identified using Zinck (1998), mosses were identified using Ireland (1982), and lichens were identified using Brodo et al. (2001). Voucher specimens are held by Nova Scotia Environment.

Aspect was recorded at each plot as the direction in degrees from North that the ground was facing. Slope of the ground on which the plot occurred was estimated in percent. Universal Transverse Mercator coordinates and elevation were recorded using a handheld global positioning system (GPS). Elevation was later compared to 1:50 000 scale topographic maps to ensure accuracy. Soil drainage for each plot was recorded as one of three classes:

(1) *Imperfectly drained* – Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic plants.

(2) *Poorly drained* – Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic plants cannot grow.

(3) *Saturated* – Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season.

Each plot was described as occurring in a depression, slope, or floodplain. In order to get an understanding of geographic differences that might occur in Red Maple wetlands, plots were classified as coastal (within 20 km of the coast) or inland (greater than 20 km from the coast) and by geographic region. All plots within Kings, Annapolis, Digby, Yarmouth, Shelburne, Queens or Lunenburg counties were classified as western. Eastern shore was assigned to plots in Halifax or Guysborough counties, and plots in all other counties were considered northern.

## Analysis

Non-metric multidimensional scaling (NMDS) was used to assess differences between Red Maple wetland plots by type of wetland (depression, slope, floodplain) and geographic distribution (coastal vs. inland and western vs. eastern shore). NMDS plots were done separately for each layer. Shrub and subcanopy were

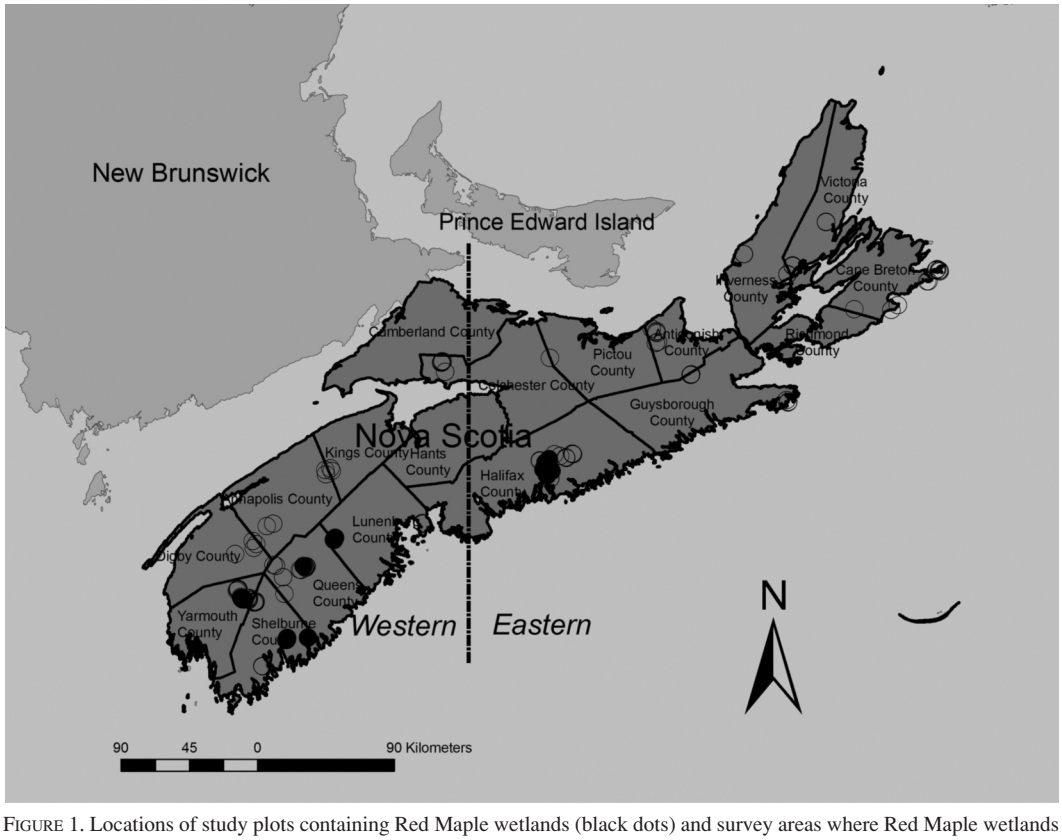


FIGURE 1. Locations of study plots containing Red Maple wetlands (black dots) and survey areas where Red Maple wetlands were not found (circles).

not assessed because of the low abundance of species in these layers. NMDS is part of a family of multivariate ordination methods used to arrange communities along environmental gradients based on community composition (ter Braak 1987). Differences (or similarities) between communities are calculated and then plotted in such a way that the distances between sites are maximally correlated with ecological distances. NMDS is one of the most robust methods of multivariate analysis (McCune et al. 1997; McCune et al. 1998; Neitlich et al. 2003). Barbour et al. (1999) compared four ordination techniques using tree species composition with *a priori* known differences. They found NMDS and canonical correspondence analysis the most useful methods in discerning differences in community type. To determine number of dimensions for NMDS analyses, five runs were done for each layer using 1 to 5 dimensions. Scree plots were created by plotting dimensions against stress. The number of dimensions was determined at the point where stress levelled off. Shepard diagrams where also created for each run by plotting reduced distances against the observations input data.

## Results

No Red Maple wetlands were encountered in transects in the eight protected areas and three candidate protected areas in northern Nova Scotia. Transects in the four protected areas and one candidate protected area in western Nova Scotia resulted in 20 Red Maple wetland plots. Transects in the two protected areas and two candidate protected areas in the eastern shore resulted in 8 Red Maple wetland plots.

Four plots occurred in floodplains, 19 in depressions, and 5 on slopes. Sixteen plots were classified as inland and 12 were classified as coastal. Soil drainage ranged from saturated to imperfect, with most sites being poorly drained.

Seventy-eight species of vascular plants and 35 species of non-vascular plants were found in plots (Table 2). Two rare species of vascular plants were found within the wetlands but outside plots. Southern Twayblade is considered S1 (Extremely rare—may be especially vulnerable to extirpation, typically 5 or fewer occurrences or very few remaining individuals) by the Atlantic Canada Conservation Data Centre (ACCDC) and yellow (sensitive) by the Province of Nova Scotia.

TABLE 2. Mean cover class of plants in 28 plots in Red Maple wetlands in Nova Scotia by layer, wetland type, and geographic distribution and for all plots and total number of plots of the 28 each species occurred in. Cover classes: 1= Trace, 2 = 0–1%, 3 = 1–5%, 4 = 6–25%, 5 = 26–50%, 6 = 51–75%, 7 = 76–100%.

| | Wetland type | | | Position | | Region | | Mean | |
|---|---|---|---|---|---|---|---|---|---|
| Species | Floodplain $n = 4$ | Depression $n = 19$ | Slope $n = 5$ | Inland $n = 16$ | Coast $n = 12$ | Western $n = 20$ | Eastern $n = 8$ | cover $n = 28$ | Occurrence $n = 28$ |
| **Canopy** | | | | | | | | | |
| *Abies balsamea* | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 10 |
| *Acer rubrum* | 6 | 4 | 3 | 5 | 3 | 4 | 3 | 4 | 28 |
| *Betula papyrifera* | 0 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 5 |
| *Fraxinus americana* | 0 | 4 | 2 | 4 | 2 | 4 | 2 | 3 | 2 |
| *Larix laricina* | 0 | 2 | 0 | 2 | 3 | 3 | 2 | 2 | 8 |
| *Picea mariana* | 2 | 3 | 4 | 3 | 4 | 3 | 4 | 3 | 16 |
| *Picea rubens* | 3 | 5 | 2 | 3 | 4 | 4 | 3 | 4 | 6 |
| *Pinus strobus* | 0 | 2 | 0 | 4 | 0 | 4 | 0 | 2 | 2 |
| *Populus tremuloides* | 0 | 5 | 0 | 0 | 5 | 5 | 0 | 5 | 1 |
| *Quercus rubra* | 0 | 5 | 2 | 0 | 4 | 4 | 0 | 4 | 2 |
| *Tsuga canadensis* | 4 | 0 | 0 | 4 | 0 | 4 | 0 | 4 | 1 |
| **Subcanopy** | | | | | | | | | |
| *Abies balsamea* | 3 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 8 |
| *Acer rubrum* | 0 | 2 | 0 | 0 | 2 | 1 | 3 | 2 | 4 |
| *Alnus incana* | 0 | 3 | 0 | 0 | 3 | 0 | 3 | 3 | 1 |
| *Betula papyrifera* | 0 | 2 | 0 | 0 | 2 | 1 | 2 | 2 | 2 |
| *Betula populifolia* | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| *Larix laricina* | 0 | 2 | 0 | 0 | 2 | 0 | 2 | 2 | 1 |
| *Nemopanthus mucronata* | 0 | 4 | 0 | 0 | 4 | 0 | 4 | 4 | 1 |
| *Picea mariana* | 0 | 4 | 4 | 2 | 4 | 2 | 4 | 4 | 6 |
| *Picea rubens* | 4 | 0 | 0 | 4 | 0 | 4 | 0 | 4 | 1 |
| *Pinus strobus* | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| *Quercus rubra* | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| *Sorbus americana* | 0 | 3 | 0 | 2 | 3 | 2 | 3 | 3 | 2 |
| *Tsuga canadensis* | 4 | 0 | 0 | 4 | 0 | 4 | 0 | 4 | 1 |
| **Shrub Layer** | | | | | | | | | |
| *Abies balsamea* | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 9 |
| *Acer rubrum* | 0 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 8 |
| *Alnus incana* | 0 | 4 | 0 | 4 | 4 | 4 | 3 | 4 | 5 |
| *Amelanchier* spp. | 0 | 1 | 0 | 1 | 2 | 1 | 2 | 1 | 3 |
| *Aronia melanocarpa* | 1 | 3 | 0 | 1 | 3 | 3 | 1 | 2 | 3 |
| *Chamaedaphne calyculata* | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| *Fraxinus americana* | 0 | 3 | 0 | 0 | 3 | 3 | 0 | 3 | 1 |
| *Gaylussacia baccata* | 2 | 3 | 5 | 3 | 4 | 3 | 4 | 4 | 7 |
| *Ilex glabra* | 3 | 3 | 0 | 3 | 0 | 3 | 0 | 3 | 2 |
| *Ilex verticillata* | 1 | 3 | 0 | 2 | 3 | 2 | 3 | 2 | 5 |
| *Kalmia angustifolia* | 3 | 3 | 4 | 3 | 3 | 3 | 3 | 3 | 10 |
| *Kalmia polifolia* | 0 | 3 | 0 | 0 | 3 | 3 | 0 | 3 | 1 |
| *Larix laricina* | 0 | 3 | 0 | 0 | 3 | 0 | 3 | 3 | 1 |
| *Ledum groenlandicum* | 1 | 3 | 4 | 1 | 3 | 2 | 3 | 3 | 10 |
| *Myrica gale* | 0 | 4 | 0 | 4 | 0 | 4 | 0 | 4 | 1 |
| *Myrica pensylvanica* | 0 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 |
| *Nemopanthus mucronata* | 2 | 3 | 3 | 2 | 3 | 2 | 4 | 3 | 12 |
| *Picea rubens* | 2 | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 1 |
| *Picea mariana* | 0 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 12 |
| *Rhododendron canadense* | 0 | 3 | 0 | 3 | 3 | 3 | 0 | 3 | 2 |
| *Rubus hispidus* | 2 | 3 | 0 | 3 | 0 | 3 | 0 | 3 | 4 |
| *Vaccinium angustifolium* | 2 | 2 | 0 | 2 | 3 | 2 | 0 | 2 | 5 |
| *Viburnum nudum* | 1 | 3 | 0 | 2 | 3 | 2 | 3 | 2 | 13 |

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| | Wetland type | | | Position | | Region | | Mean | |
|---|---|---|---|---|---|---|---|---|---|
| Species | Floodplain $n = 4$ | Depression $n = 19$ | Slope $n = 5$ | Inland $n = 16$ | Coast $n = 12$ | Western $n = 20$ | Eastern $n = 8$ | cover $n = 28$ | Occurrence $n = 28$ |
| **Herb Layer** | | | | | | | | | |
| *Abies balsamea* | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 4 |
| *Acer pensylvanicum* | 2 | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 1 |
| *Acer rubrum* | 0 | 2 | 2 | 4 | 2 | 2 | 2 | 2 | 11 |
| *Amelanchier* spp. | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| *Aralia nudicaulis* | 4 | 3 | 2 | 4 | 2 | 3 | 3 | 3 | 9 |
| *Aster acuminatus* | 3 | 3 | 0 | 3 | 3 | 3 | 2 | 3 | 9 |
| *Aster* spp. | 0 | 2 | 1 | 0 | 2 | 2 | 1 | 2 | 2 |
| *Betula papyrifera* | 1 | 2 | 0 | 1 | 2 | 2 | 0 | 2 | 2 |
| *Carex intumescens* | 0 | 4 | 0 | 4 | 0 | 4 | 0 | 4 | 1 |
| *Carex* spp. | 3 | 5 | 2 | 4 | 4 | 4 | 0 | 4 | 9 |
| *Clintonia borealis* | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| *Coptis trifolia* | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 14 |
| *Cornus canadensis* | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 21 |
| *Cypripedium acaule* | 0 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 |
| *Dennstaedtia punctilobula* | 0 | 2 | 4 | 0 | 3 | 4 | 3 | 3 | 3 |
| *Diervilla lonicera* | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| *Dryopteris cristata* | 0 | 1 | 0 | 1 | 2 | 1 | 0 | 1 | 3 |
| *Epigaea repens* | 2 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 |
| *Fagus grandifolia* | 2 | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 1 |
| *Gaultheria hispidula* | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 10 |
| *Gaultheria procumbens* | 0 | 3 | 0 | 3 | 2 | 3 | 2 | 3 | 3 |
| *Gymnocarpium dryopteris* | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| *Hamamelis virginiana* | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| *Impatiens capensis* | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| *Iris versicolor* | 1 | 2 | 0 | 1 | 2 | 2 | 0 | 2 | 6 |
| *Kalmia angustifolia* | 0 | 3 | 2 | 0 | 3 | 3 | 3 | 3 | 7 |
| *Ledum groenlandicum* | 0 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 3 |
| *Linnaea borealis* | 0 | 3 | 3 | 2 | 4 | 2 | 4 | 3 | 5 |
| *Lonicera canadensis* | 0 | 2 | 0 | 0 | 2 | 0 | 2 | 2 | 1 |
| *Lycopodium obscurum* | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 2 | 1 |
| *Lycopus americanus* | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 2 | 1 |
| *Maianthemum canadense* | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 10 |
| *Medeola virginiana* | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| *Mitchella repens* | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 5 |
| *Monotropa hypopithys* | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| *Myrica gale* | 0 | 2 | 0 | 0 | 2 | 2 | 0 | 2 | 1 |
| *Nemopanthus mucronata* | 0 | 2 | 0 | 0 | 2 | 2 | 0 | 2 | 1 |
| *Onoclea sensibilis* | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 2 | 1 |
| *Osmunda cinnamomea* | 2 | 5 | 4 | 4 | 4 | 4 | 5 | 4 | 22 |
| *Osmunda regalis* | 0 | 3 | 5 | 3 | 4 | 3 | 5 | 4 | 3 |
| *Oxalis acetosella* | 0 | 2 | 2 | 0 | 2 | 0 | 2 | 2 | 3 |
| *Phegopteris connectilis* | 0 | 4 | 0 | 4 | 0 | 4 | 0 | 4 | 2 |
| *Picea mariana* | 0 | 3 | 0 | 0 | 3 | 3 | 3 | 3 | 3 |
| *Picea rubens* | 3 | 0 | 0 | 3 | 0 | 3 | 0 | 3 | 1 |
| *Pinus strobus* | 2 | 2 | 0 | 2 | 2 | 2 | 0 | 2 | 2 |
| *Pteridium aquilinum* | 4 | 2 | 4 | 4 | 2 | 3 | 2 | 3 | 5 |
| *Pyrola* spp. | 1 | 0 | 2 | 1 | 2 | 1 | 2 | 2 | 2 |
| *Pyrola secunda* | 0 | 3 | 0 | 0 | 3 | 0 | 3 | 3 | 1 |
| *Quercus rubra* | 2 | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 1 |
| *Rhododendron canadense* | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| *Rosa nitida* | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 2 |
| *Rosa* spp. | 0 | 2 | 0 | 2 | 1 | 2 | 0 | 2 | 4 |
| *Rubus pubescens* | 0 | 3 | 3 | 4 | 2 | 3 | 2 | 3 | 10 |

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| | Wetland type | | | Position | | Region | | Mean | |
|---|---|---|---|---|---|---|---|---|---|
| Species | Floodplain $n = 4$ | Depression $n = 19$ | Slope $n = 5$ | Inland $n = 16$ | Coast $n = 12$ | Western $n = 20$ | Eastern $n = 8$ | cover $n = 28$ | Occurrence $n = 28$ |
| *Sarracenia purpurea* | 0 | 3 | 1 | 3 | 1 | 3 | 1 | 2 | 2 |
| *Scutellaria lateriflora* | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 1 |
| *Smilacina trifolia* | 0 | 5 | 4 | 5 | 4 | 5 | 4 | 5 | 2 |
| *Spiraea alba* | 0 | 1 | 3 | 2 | 2 | 1 | 3 | 2 | 4 |
| *Taxus canadensis* | 0 | 2 | 2 | 0 | 2 | 0 | 2 | 2 | 3 |
| *Thalictrum pubescens* | 0 | 3 | 0 | 0 | 3 | 3 | 0 | 3 | 1 |
| *Thelypteris palustris* | 0 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 5 |
| *Thelypteris simulata* | 1 | 4 | 0 | 3 | 0 | 3 | 0 | 3 | 2 |
| *Toxicodendron rydbergii* | 1 | 2 | 3 | 2 | 2 | 2 | 0 | 2 | 6 |
| *Trientalis borealis* | 4 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 13 |
| *Vaccinium angustifolium* | 0 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 6 |
| *Vaccinium myrtilloides* | 0 | 2 | 0 | 0 | 2 | 0 | 2 | 2 | 1 |
| *Vaccinium vitis-idaea* | 0 | 2 | 0 | 0 | 2 | 0 | 2 | 2 | 1 |
| *Viburnum nudum* | 0 | 2 | 1 | 1 | 2 | 2 | 0 | 2 | 4 |
| *Viola* spp. | 0 | 3 | 1 | 3 | 1 | 3 | 1 | 2 | 3 |
| **Moss/Lichen Layer** | | | | | | | | | |
| *Atricum* spp. | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| *Aulacomnium palustre* | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| *Bazzania trilobata* | 4 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 12 |
| *Cladonia maxima* | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 2 | 1 |
| *Cladonia mitis* | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 1 | 3 |
| *Cladonia rangiferina* | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 2 | 4 |
| *Cladonia terrae-novae* | 0 | 2 | 0 | 2 | 1 | 2 | 1 | 1 | 2 |
| *Dicranum majus* | 0 | 2 | 1 | 2 | 1 | 2 | 0 | 2 | 2 |
| *Dicranum polysetum* | 3 | 0 | 0 | 3 | 0 | 3 | 0 | 3 | 1 |
| *Dicranum scoparium* | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 5 |
| *Dicranum undulatum* | 0 | 2 | 0 | 0 | 2 | 0 | 2 | 2 | 1 |
| *Dicranum* spp. | 2 | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 2 |
| *Hylocomium splendens* | 0 | 3 | 2 | 0 | 3 | 2 | 3 | 3 | 10 |
| *Hypnum* sp. | 2 | 0 | 2 | 2 | 2 | 2 | 0 | 2 | 3 |
| *Leucobryum glaucum* | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| *Pleurozium shreberi* | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 14 |
| *Polytrichum commune* | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| *Polytrichum juniperinum* | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| *Polytricum strictum* | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 1 |
| *Polytrichum* spp. | 3 | 1 | 0 | 3 | 1 | 2 | 0 | 2 | 2 |
| *Ptilium crista-castrensis* | 0 | 2 | 0 | 0 | 2 | 0 | 2 | 2 | 1 |
| *Rhizomnium punctatum* | 6 | 0 | 0 | 6 | 0 | 6 | 0 | 6 | 1 |
| *Rhytidiadelphus triquetrus* | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 2 | 1 |
| *Sphagnum austinii* | 0 | 4 | 0 | 4 | 0 | 4 | 0 | 4 | 1 |
| *Sphagnum capillifolium* | 0 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 10 |
| *Sphagnum centrale* | 0 | 4 | 4 | 0 | 4 | 0 | 4 | 4 | 2 |
| *Sphagnum cuspidatum* | 0 | 3 | 0 | 0 | 3 | 3 | 0 | 3 | 1 |
| *Sphagnum flavicomens* | 0 | 5 | 0 | 5 | 0 | 5 | 0 | 5 | 1 |
| *Sphagnum fuscum* | 0 | 0 | 3 | 0 | 3 | 0 | 3 | 3 | 1 |
| *Sphagnum girgensohnii* | 3 | 5 | 5 | 4 | 5 | 4 | 4 | 4 | 14 |
| *Sphagnum magellanicum* | 5 | 3 | 5 | 3 | 4 | 3 | 4 | 4 | 8 |
| *Sphagnum papillosum* | 0 | 0 | 3 | 0 | 3 | 3 | 0 | 3 | 1 |
| *Sphagnum russowii* | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 1 |
| *Sphagnum squarrosum* | 4 | 5 | 0 | 5 | 1 | 5 | 0 | 5 | 8 |
| *Sphagnum wulfianum* | 3 | 2 | 0 | 3 | 1 | 3 | 1 | 2 | 4 |
| *Sphagnum* spp. | 0 | 6 | 0 | 6 | 0 | 6 | 0 | 6 | 3 |

Dwarf Chain Fern is ranked S2 (Rare—may be vulnerable to extirpation due to rarity or other factors, 6 to 20 occurrences or few remaining individuals) by the ACCDC and yellow by the Province of Nova Scotia.

*Sphagnum* species richness was high, with 12 species found, including 3 rare species. *Sphagnum centrale* was found in two plots and *S. flavicomens* was found in one plot. Both species are ranked S2 (Rare) in Nova Scotia by the ACCDC and G3 (Uncommon—found only in a restricted range, even if abundant at some locations, 21 to 100 occurrences) globally by Nature Serve. *Sphagnum wulfianum* was found in four plots and is considered S1 (Extremely rare) by ACCDC. *Sphagnum torreyanum* was found outside the plot in the river adjacent to the Red Maple floodplain wetland on the Shelburne River. *Sphagnum torreyanum* is ranked S2 (Rare) in Nova Scotia by the ACCDC. *Sphagnum* species have not yet been ranked by the Province of Nova Scotia.

Eleven tree species were found in the canopy. Red Maple was found in all plots in varying amounts. Black Spruce (*Picea mariana*) was the next most common species, found in 16 of 28 plots, followed by Balsam Fir (*Abies balsamea*) in 10 of 28 plots. Ten plots had a subcanopy present, most often with Balsam Fir (8 of 28 plots) or Black Spruce (6 of 28 plots). Red Maple occurred in the subcanopy in 4 of 28plots.

Mountain Holly (*Nemopanthus mucronata*) was the most commonly occurring shrub (12 of 28 plots) in the shrub layer. Labrador Tea (*Ledum groenlandicum*) and Lambkill (*Kalmia angustifolia*) were the next most common, occurring in 10 of 28 plots. Red Maple, Balsam Fir, and Black Spruce were common occurrences in the shrub layer, found in 8, 9, and 12 of 28 plots, respectively.

Cinnamon Fern (*Osmunda cinnamomea*) and Bunchberry (*Cornus canadensis*) were the most commonly occurring herbs, with 22 and 21 occurrences in 28 plots, respectively. Other common herbs include Gold Thread (*Coptis trifolia*), Starflower (*Trientalis borealis*), Dewberry (*Rubus pubescens*), and False Lily of the Valley (*Maianthemum canadense*). The most common tree species found in the herb layer include Red Maple, Balsam Fir, and Black Spruce.

*Sphagnum* species dominated the moss/lichen layer and occurred in every plot. The most commonly found species were *S. girgensohnii,* found in 14 plots, and *S. capillifolium,* found in 10 plots. *Bazzania trilobata* was a common liverwort (found in 12 plots) and Shrebers' Moss (*Pleurozium shreberi*) was the most common moss (found in 14 plots).

NMDS suggested little differences between wetland types or region. Scree plots for the herb and bryophyte layers show no levelling off at five dimensions for NMDS, indicating more variables are needed to explain differences between plots. Scree plot for canopy species, however, indicates stress is minimized with two dimensions. There is little clustering in the NMDS plot for canopy species, indicating small differences between wetland type and region. There were, however, some observable differences between wetland type and region in the canopy layer. There were more plots with Balsam Fir in western Nova Scotia and more Eastern Larch (*Larix laricina*) in plots in the eastern shore. Coastal plots had greater occurrences of Balsam Fir than inland plots. Floodplains tended to have a higher canopy cover of Red Maple than depressions or slopes, while depressions had a greater frequency of Black Spruce. Slope wetlands had only one plot with Black Spruce.

There are some observable differences between wetland types and regions in the herb and moss/lichen layer. Lambkill was found only in plots in the eastern shore, while Creeping Snowberry (*Gaultheria hispidula*) and Iris (*Iris versicolor*) occurred more frequently there than in western Nova Scotia. Cinnamon Fern occurred more often in plots in western Nova Scotia. The eastern shore tended to have greater richness and abundance of bryophytes. Coastal plots had more occurrences of Eastern Teaberry (*Gaultheria procumbens*) and Lambkill in the herb layer and *Bazzania trilobata* and *Sphagnum capillifolium* in the moss/lichen layer. Step Moss (*Hylocomium splendens*) was found only in coastal plots, and *Sphagnum squarrosum* was found only in inland plots. Floodplains had no occurrences of Lambkill, Dewberry (*Rubus pubescens*) or White Meadowsweet (*Spiraea alba*), and depressions were the only wetland type with Labrador Tea in the herb layer. Floodplains were the only wetland type without *Sphagnum capillifolium* and had the lowest *Sphagnum* species richness.

## Discussion

Regional distribution of plots may reflect the geographic distribution of Red Maple wetlands within the province. The transects were not designed to measure the distribution of Red Maple wetlands in the province and likely do not provide a representative sample. However, no Red Maple wetlands were encountered in transects in northern Nova Scotia. The low density in northern Nova Scotia (compared to western Nova Scotia and the eastern shore) may be a reflection of topography. Northern Nova Scotia has more highland terrain, with many more steep slopes and valleys (Davis and Browne 1996) that provide fewer topographic opportunities for wetlands to be established. It is unlikely that Red Maple wetlands do not occur in northern Nova Scotia, but density may be much lower than elsewhere in the province.

There were fewer differences in plant species composition by wetland type than expected. The availability of water is a significant determining factor in the occurrence of plant species and in the composition of plant communities (Barbour et al. 1999). Hydrological setting, e.g., depression, explains timing, duration, and frequency of soil saturation and thus would be expected

to influence the composition of plant species. Rheinhardt (2007) found differences in plant species composition between Red Maple wetland types in his study sites in Massachusetts. Plots in this study were assigned a wetland type based on field observations. It is possible that different hydrological dynamics were occurring than were observed in the field. Further, differences in plant species composition in wetlands in Massachusetts and Nova Scotia may help explain response. For example, Eastern White Cedar (*Thuja occidentalis*), a species strongly influenced by soil moisture (Farrar 1995), was not found in Nova Scotia study sites.

Greater regional differences in Red Maple wetlands might be expected given differences in geology, soils, and climate between plots. For example, Dzikowski (1985) identified the Atlantic coast of Nova Scotia as a distinct climate region separate from the interior of the province. Ecological land classification systems, which incorporate topography, soils, and geology, also identify distinct regions between areas of study plots (Lynds and LeDuc 1995; Davis and Browne 1996). However, the Red Maple community may be responding more to microclimate and microtopography than large-scale landscape features. There may also be some other attribute that Red Maple wetland communities are responding to. More research is needed to determine what factors affect the composition of Red Maple wetland communities.

Homogeneity of the Red Maple community in Nova Scotia suggests a repeating discrete assemblage of species with only small changes between wetland type and region of the province. This supports the concept of plant associations and confirms that they can be recognized and defined in the field.

Red Maple wetlands in Nova Scotia are structurally complex. Thirty-six percent of plots had a subcanopy and 93% had a shrub layer. Tree species were frequently found in the herb, shrub, and subcanopy layers, suggesting Red Maple wetlands will regenerate themselves if left undisturbed.

The relative dominance of Red Maple in these wetlands varies and may change over time. The cover of Red Maple in the canopy varied greatly between plots, with Balsam Fir and Black Spruce often within higher cover classes. This variation was also reflected in the other layers. Some plots have high cover of Red Maple in the canopy but little in other layers, suggesting other species may later become dominant if no major disturbance occurs.

Red Maple wetlands can provide habitat for some rare vascular plants. Southern Twayblade and Dwarf Chain Fern, Extremely rare and Rare, respectively, in Nova Scotia, were each found in a single wetland in western Nova Scotia. In a summary of research on Red Maple wetlands in the northeastern U.S., Golet et al. (1993) found that 33% of plant species known to occur in Red Maple swamps are considered rare, threatened, or endangered in one or more states. There may be other rare or uncommon plants in Red Maple wetlands in Nova Scotia.

The diversity and rarity of lichens in Red Maple wetlands is notable. These species include some of the rarest lichens in the world, including globally endangered Boreal Felt Lichen. At least 15 other species of epiphytic cyanolichens have been found in association with Red Maple wetlands (Maass 1986; Cameron and Richardson 2006; Cameron and Neily 2008). Seven of these species are considered rare in North America (Brodo et al. 2001) or Canada (Goward et al. 1998), and three species may be extirpated or extremely rare in Maine (Hinds and Hinds 2007). Five species have recently been designated as "red" status and eight species designated as "yellow" status in Nova Scotia by the Nova Scotia Department of Natural Resources (Anderson 2007). Some of the other most notable species are *Erioderma mollissimum, Pannaria lurida, Degelia plumbea,* and *Sticta limbata*.

The diversity and rarity of *Sphagnum* species found in study plots are also remarkable. Twelve species of *Sphagnum,* including four Rare or Extremely rare species, were found in these wetlands. Most other studies of Red Maple wetlands have tended to ignore the *Sphagnum* community, lumping them together as "*Sphagnum* species". In a summary of research on Red Maple wetlands in the northeastern United States, Golet et al. (1993) list six species of *Sphagnum* in Red Maple swamps. Clearly, the *Sphagnum* community of Red Maple wetlands in eastern North America is unexplored, rich, and significant.

Indeed, the bryophyte and lichen communities in general may be little investigated but worth studying in Red Maple wetlands. Thirty-five species of bryophytes and lichens were found in this study. Golet et al. (1993) list only 36 species in total in their summary for the northeastern United States.

Given the diversity of vascular and non-vascular plant richness and structural complexity of Red Maple wetlands in Nova Scotia, these wetlands make a significant contribution to the biodiversity and heterogeneity of the landscape. Landscape managers and planners should ensure these unique and valuable wetlands are conserved.

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