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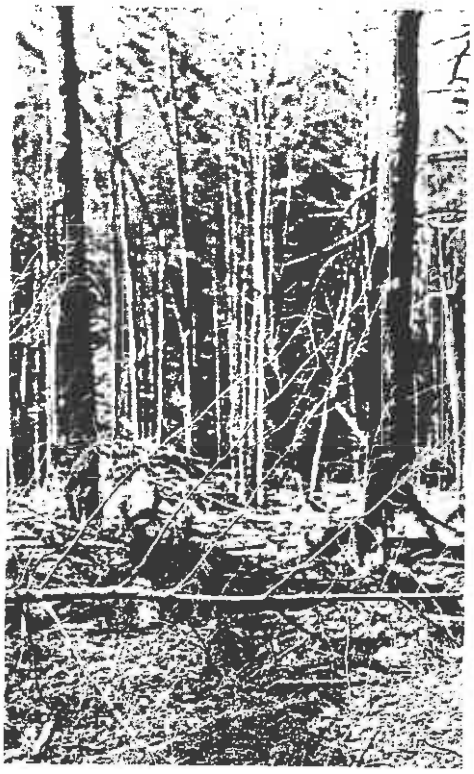
# Vegetation Analysis of Four "Biologically Significant Interest Areas" of the Greater Goose Pond Forest, Keene, NH



A report submitted to the City of Keene, Department of Parks and Recreation
and
The Keene Conservation Commission

Submitted by:

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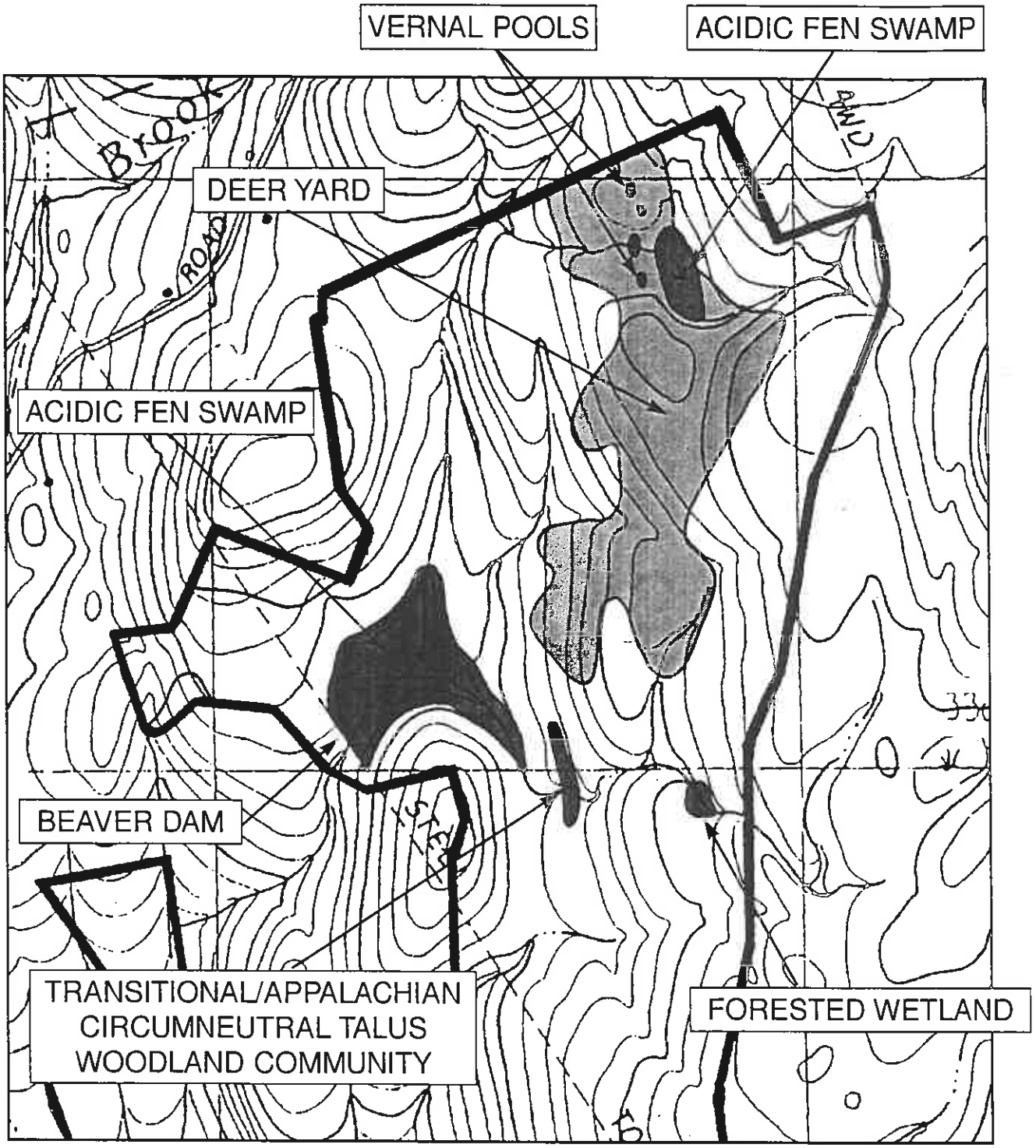



MAP 3. BIOLOGICALLY SIGNIFICANT INTEREST AREAS WITHIN THE NORTHERN SECTION OF THE GREATER GOOSE POND FOREST

## ABSTRACT

Between April and September of 1995 a vegetation analysis was completed on four "Biologically Significant Interest Areas" (BSIA's) in the 1046 acre Greater Goose Pond Forest (GGPF) in Keene, NH. These four areas were previously identified by a study conducted by the principal author and three Antioch graduate students in the fall of 1994. The four sites included an acidic talus slope community, a forested wetland, and two acidic fen swamps. The latter two areas received more intensive sampling efforts because of their complexity and diversity. Thirty plots in each fen-swamp were established; sizes of 32 $m^2$ and 40 $m^2$ were configured through species area curve data in the 'Beaver Impounded' fen swamp and the 'Northeastern Fen' respectively. A stratified random sampling approach was used for each area, wherein relative frequency, relative density, and/or relative coverage was calculated for the tree, sapling, shrub and groundcover layers. Importance values for each area indicated that red maple (*Acer rubrum*) was clearly the dominant species in the tree stratum; eastern hemlock (*Tsuga canadensis*), red maple and yellow birch (*Betula allegheniensis*) were the dominant saplings; winterberry holly (*Ilex verticillata*), meadowsweet (*Spirea latifolia*), witch-hazel (*Hamamelis virginiana*), and highbush blueberry (*Vaccinium corymbosum*) were the dominants shrubs; and cinnamon fern (*Osmunda cinnamomea*) was the most abundant groundcover species. Greater hydrologic and substrate diversity in the beaver impounded fen-swamp was reflected by greater plant diversity, although state-listed rare plants were found in both areas. The other two BSIA's were cursorily studied after it was determined that their uniqueness and sensitivity was low relative to similar areas in the surrounding region.


## LIST OF FIGURES and ILLUSTRATIONS

## Introduction

In 1986 a city appointed committee drafted a land management plan entitled, "Plan for the Greater Goose Pond Forest (GGPF)". It was later revised in 1992. This latter version contained several short term goals including the identification of "Biologically Significant Interest Areas (BSIAs)" within the forest as a component for its implementation strategy. A preliminary investigation of potential BSIAs was conducted in the fall of 1994 by three Antioch graduate students under the supervision of core faculty member Rick Van de Poll. The criteria established in identifying potential BSIAs for the study were developed under the Committee's suggestion that "nature study and the protection of natural areas" were an appropriate use of the town forest. The criteria developed for the preliminary assessment included the following:

1) any unusual or rare natural community whose basic nature could be dramatically and or permanently altered by direct human activity.

2) any natural community that is exemplary relative to the surrounding Monadnock region and whose basic nature could be dramatically and or permanently altered by direct human activity.

3) any habitat that supports or has the documented potential to support state or federally listed rare and endangered species.

4) any area of exceptionally high species richness relative to the surrounding area (such as an existing wetland); and

5) any area by virtue of its uniqueness would provide valuable scientific and or educational benefits.

The preliminary work conducted in the fall of 1994 identified six potential BSIAs. It was recommended that these sites be further characterized by more intensive ecological studies during the appropriate seasons. This recommendation was strengthened by the GGPF Management Review Committee in their November 1994 report to the Keene Conservation Committee and City Council. Recognizing the efforts of Antioch's work, recommendation #2 suggested that, "given the growing awareness of threatened species and habitats, we believe an in-depth assessment should follow this preliminary study."

A proposal to conduct this work was submitted on April 27, 1995 and officially approved by signed contract on June 10, 1995. The following report summarizes the first part of this three-tiered assessment project. It was conducted by Antioch faculty member Rick Van de Poll and

graduate intern, Charlie Donahue, and focused on the growing season vegetation analysis of four of the six BSIA's. The four areas included the "Transitional/Appalachian Circumneutral Talus Woodland Community," the "Forested Wetland," and the two "Acidic Fen Swamps," as identified in the preliminary study. Field work took place between June 1st and September 18th, 1995, and primarily involved plot research on the beaver-impounded fen swamp just north of the power lines and the acidic fen swamp in the northeastern corner of the Paquette lot.

This report includes a general description of the GGPF, the methods used in the assessment of these four areas, and a discussion of the study results for each site. Conclusive remarks discuss some of the salient attributes of these four areas, and defines recommendations for management and use. An appendix contains a sample data sheet, the species lists for each acidic fen swamp (with scientific names for all common names used in the text), and a list of wildlife species observed during the course of this study.

## Area Description

The Greater Goose Pond Forest encompasses 1,046 acres within the Keene city limits and is composed of 16 individual parcels. Most of the parcels abut each other, although a couple of tracts such as the Drummer Hill section are relatively isolated. As described in the project proposal dated April 27, 1995, the six BSIA's that were preliminarily identified in the fall of 1994 are all contained in the Paquette lot in the northern portion of the GGPF.

All BSIA's are within the upper watershed of Goose Pond, which includes @1660 acres of second and third growth forest. The Paquette lot contains both mixed softwoods and hardwood and is completely forested, with the exception of the ponded water behind the beaver dams and the right of way beneath the transmission lines. Several perennial streams drain the upper part of the watershed, and descend from elevations of about 1100 ft. above sea level to about 630 ft. above sea level at Goose Pond.

Soils in this part of the GGPF are generally fine sandy loams that formed in glacial till. Most soil series are acidic, have moderate to rapid permeability in the substratum, and are moderately deep. Occasional soil areas are shallow to bedrock, particularly on the steep slopes and ridgetops. One significant outcropping occurs in the talus woodland community as identified above. The remainder of the BSIA's in the Paquette lot occur in depressional areas that have water at or near the surface for most of the year. The two fen swamps that received the most intensive work are permanently to periodically inundated or saturated, and have deep accumulations of muck and peat in all or most of their areas.

Access to this area of the GGPF is easiest by either walking in a southeasterly direction along the power line right of way adjacent to Gunn Road, or along the former county road which runs from Belvedere Road in Gilsum to the Drummer Hill section of Keene. Additional access is afforded by hiking uphill from the northern edge of Goose Pond along an old logging road and then traversing northwesterly from the height of land where it crosses easterly over a low ridge.

## Methods

The first part of the assessment involved a field reconnaissance of the Transitional/ Appalachian Circumneutral Talus slope community and the Forested Wetland. Two site visits were conducted at a time when vegetation indicative of these community types would be present. The first was in mid June and involved a careful floristic, geologic and soils review of the talus woodland community. The second took place in late August and focused on the forested wetland. Both site reviews were qualitative and cursory on account of the lack of significant indicators of uniqueness or sensitivity as described under the BSIA criteria above. A more complete discussion of the findings is included below.

The second part of the BSIA assessment involved a six week vegetational analysis of the two acidic fens located in the northern portion of the Greater Goose Pond Forest. This study was conducted after a preliminary review indicated a significant diversity and complexity of plant community types at each site. It focused on the physiognomic characteristics of the plant communities by surveying the vegetational dominance within each stratum. A modified relevé approach was selected to obtain a statistical sample of species dominance within the four strata. The approach was based on an inventory of 30 plots within each fen.

To determine the minimal plot size, a series of four species area curves was conducted within the different cover types. These test plots followed the nested plot sequence of Cain & Castro (1959) as summarized in Brower, Zar, and von Ende (1989).[1] One was performed in the so-called "Northeast Fen" (in the northeastern portion of the Paquette lot), while three were conducted in the "Beaver Impoundment," the lower fen swamp adjacent to the power lines. Three species area curves were performed in this latter location due to the distinct difference in cover types associated with the fluctuating water levels above the beaver dams. These assessments determined that the minimum plot size in the Beaver Impoundment should be 32 square meters, while in the Northeast Fen the plot size should be at least 40 square meters. Because of the variable terrain at each site, the configuration of the plots were rectangular, and had a size of 4m x 8m and 4m x 10m, respectively.[2]

The map position of each plot was determined through the use of a random grid generator. The field location of the plot was determined by using a site map and grid overlay, a Silva Ranger Type 15 compass and measured paces. Once the centrum point was located and temporarily marked, the plots were laid out with a 50 m fiberglass measuring tape, a compass and 4 flagged

stakes. Statistical measurements within each plot included a count and dbh estimation of all trees, a count of all saplings, and a visual estimation of areal cover of all shrubs and ground cover species. Strata were defined according to the following standards:

| | |
|---|---|
| Trees | DBH ≥ 5"; height ≥ 20' |
| Saplings | DBH ≥ .4" and < 5"; height ≥ 20' |
| Shrubs | height ≥ 3' and < 20' |
| Ground cover | < 3' (including all woody species) |

DBH was defined as the diameter of the tree trunk 4.5 ft above the forest floor on its uphill side. Measurements of the circumference of each tree were taken with a 20 ft metal tape and converted to dbh and basal area (cross-sectional area of the tree at breast height) after entry onto a computer spreadsheet. Height was estimated with a Suunto 360 PC-5 clinometer. Notes for each plot regarding soil types, surrounding area, canopy closure, slope, aspect as well as water level and inundation were made during the plot work. Special attention was also paid to any mammal sign encountered in or adjacent to the plot. An example of a completed data sheet is included in Appendix A.

Dominance within each stratum was determined on the basis of the statistical measurements taken. Trees were analyzed for frequency, density and basal area; these measures were combined for all species in order to determine relative and importance values. The latter was based upon a total of 300 points, or the sum of relative frequency, relative density and relative coverage (as measured by the cumulative basal area per species). Importance values for saplings were based upon their relative frequency and relative density; both shrub and ground cover importance values were also based upon 200 points, but included relative coverage instead of relative density values.

An assumption was made that the 30 individual plots in each location would be sufficient to obtain a representative statistical sample of the two locations and satisfy the project objectives as outlined above. It was also assumed that the data from these plots would provide a sufficiently comprehensive view of the two plant communities for BSIA assessment purposes.

## Results and Discussion

### Transitional/Appalachian Circumneutral Talus Woodland Community

Preliminary indications of a talus woodland community were observed in the fall of 1994. Large diameter hardwood trees, a 25-30 ft high ledge, and a significant collection of boulders and talus stones were recorded for a @ 150 yd stretch above and to the east of the inlet to the Beaver Impoundment area. Appearances of the humus-rich soil pockets showed promise of high nutrient levels in the soils. However, site inspection in the early summer showed that the floristic composition of the talus area was more acid-loving and very similar to the surrounding forest community. A prevalence of silicaceous bedrock (Oliverian granite-gneiss), scattered conifers (pines and hemlocks) immediately above the ledge, and prior disturbance from clearing and pasturing contributed to the acidic rather than circumneutral nature of the plant community at the site. Soils tested at two representative locations of both the A and B layers indicated a pH of 5.2 - 5.4. Dominant species included red oak, white pine, white ash and yellow birch in the canopy, and eastern hemlock, yellow birch, striped maple and fringed bindweed in the understory.

Some development of a talus woodland community was present however, and given sufficient time, this area will likely become a significant, albeit small example of this natural community type in southern New Hampshire. The presence of white ash and some sugar maple in the canopy; red-berried elder, hop-hornbeam, and poison ivy in the shrub layer; and herb-robert, marginal wood fern, and rock polypody in the herbaceous layer indicated a certain proportion of species typical to the classic talus woodland community as identified by Sperduto (1994).[3] Since both the acidic and circumneutral talus woodland communities are listed as "S3's" (state threatened = 20 or less occurrences in the state), this site should still receive special consideration for the potential it holds to add to this natural resource type over time.

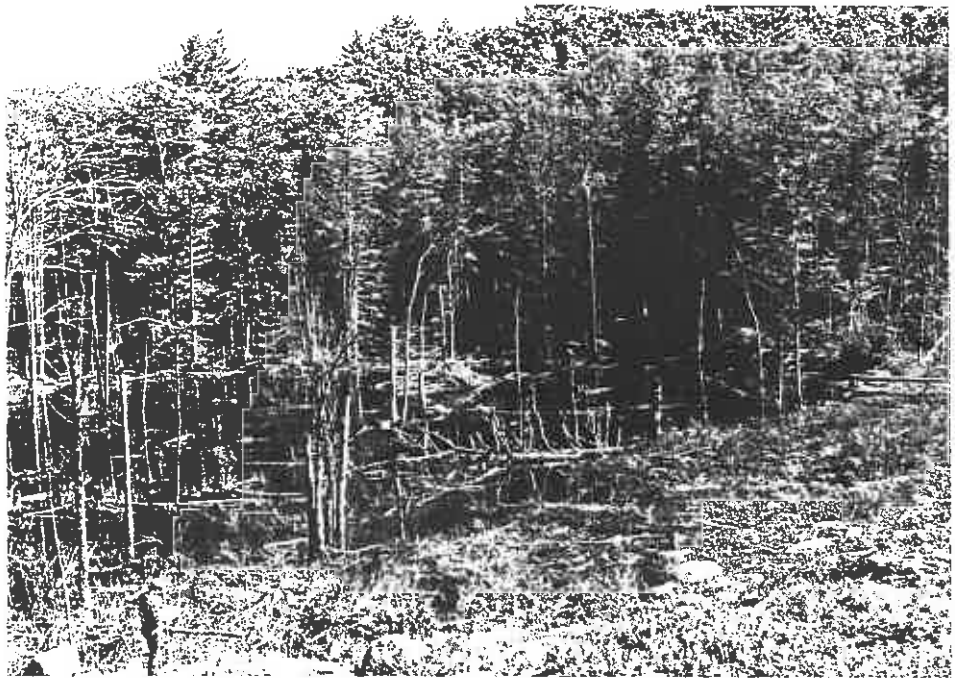
### Forested Wetland

This site was also reviewed in the fall of 1994 and determined to hold potential for special consideration by the GGPF Management Committee. It comprised a ± 1 acre tract of red maple-dominated forest over periodically inundated/saturated hardpan soils. The hummocky terrain indicated frequent windthrows in the past, some of which appeared to have dated back to the 1938 hurricane. A perennial stream with a braided channel and several isolated pockets crossed the wetland from SE to NW. This stream dissipated both westerly and northwesterly prior to reaching

the bench above the aforementioned talus woodland community. Because of the shallow slope and the stony, compact soil, a lush understory of ferns were prevalent on the site.

Preliminary concerns arose over the potential presence of small vernal pools, muck and peat-based seepage herbs, and an unstable substrate over which logging equipment, trail-riders and/or pedestrian traffic may impede natural community development. Additional assumptions were made about the likelihood of rare and endangered species in the area owing to the physical characteristics of the seepage area.

Two site evaluations were made, one in the early part of the summer and one in early fall. Both field visits did not turn up any vernal pools or rare species, and a closer look at the overstory and understory indicated that the site itself was marginally wet during the growing season. Red maple was intermixed with red oak, white birch, and yellow birch in the canopy, and numerous non-hydrophytes such as hay-scented fern, canada mayflower, and wild sarsaparilla were intermixed with the more hydrophytic cinnamon and interrupted ferns. A quick assessment of basal area per acre indicated an volume of timber similar to the surrounding uplands (@ 180 - 190 sq.ft. per acre), and a mixture of species that reflected positive growing conditions for upland species. In addition, the second site visit showed a water table well below the surface, even in the deepest portion of the channellized stream. While this year perhaps represented the driest year in 20, it did appear that logging activities, should there ever be any in the area, would not be prevented by the presence of soft or wet soils in the late summer.



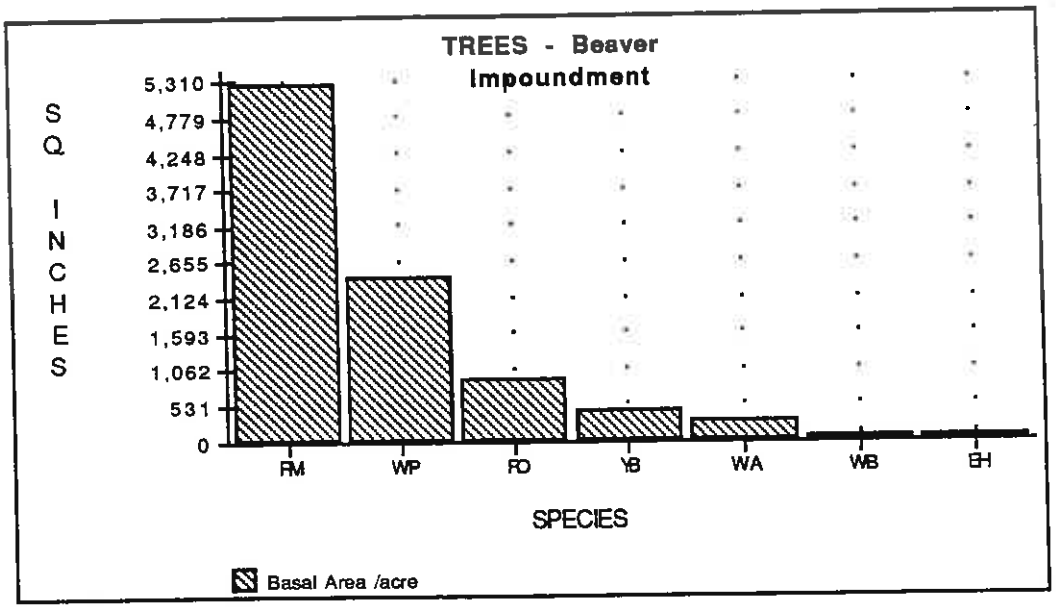
## Acidic Fen Swamp #1: The Beaver Impoundment

The Beaver Impoundment was located in the Paquette lot of the Greater Goose Pond Forest (GGPF) and covered 6.85 acres in area. Overall, the slope of the acidic fen swamp was rather gentle and ranged from 0-5%; however, it was steeper in the riverine section below the beaver dams. The fluctuating water level mentioned previously contributed to the development of the hummocky terrain. It was located at an elevation of @ 850 ft and was situated between two steep hills to the north and south along the most significant perennial stream flowing into Goose Pond. The canopy closure during 'leaf out' was observed to be 40.66 % in the plots that were sampled. This was consistent with the percentage of the area that appeared open due to the flooded conditions behind the beaver dams. As a result, wide ranging temperature fluctuations were observed between the open and closed canopy areas.

This wetland could be divided into three distinct segments along a hydrologic continuum. Starting at the extreme western portion below the power lines it could be characterized as riverine. The flow of the stream was retarded in this section by three actively maintained (yet small) beaver dams. As a result, a series of small open water bodies have developed along this segment. Above this, the uppermost dam in this area has created a rather extensive (@2.5 acre) area of open water, within which two beaver lodges were located. The variability of the water level in this area was evident by visible water marks on most of the tree trunks. The water level dropped @ 24-32 inches over the course of the summer, as is evident in the picture below.

The easternmost portion of the Beaver Impoundment contained two perennial streams and had the most fen and swamp like characteristics of the wetland complex. In this area the presence of sphagnum moss and organically rich soil material combined with stream flow and groundwater seepage to create a unique vegetative community. An overstory of red maple and a lush ground cover layer appeared park-like amidst small stream channels and hollows created by windthrown trees. Plant diversity reached its highest expression here, partly a result of the continual, periodic disturbance of floodwater and beaver inundation, and partly a result of the continuous enrichment of the soils by organic material.

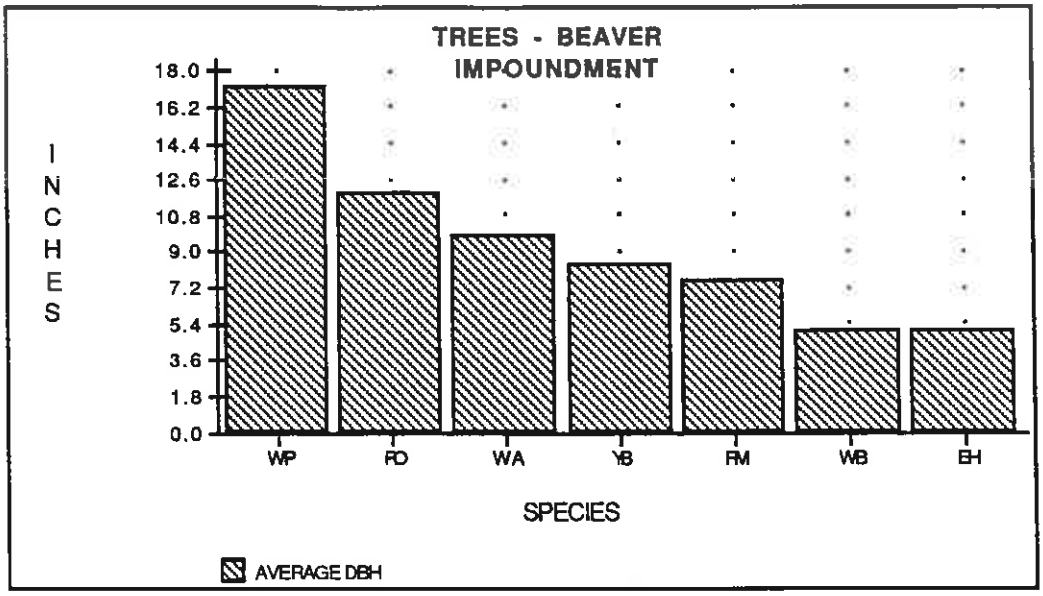
## Tree Stratum



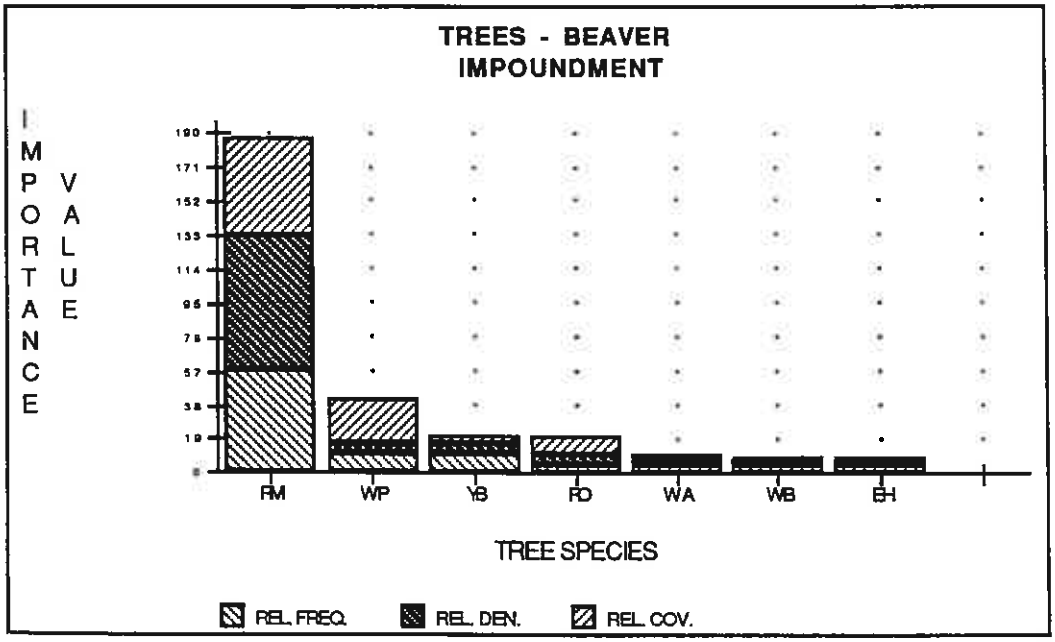

The results of the beaver wetland assessment included seven different species within the tree stratum. This layer was dominated by red maple (RM) with an average basal area of 5,307 square inches per acre. White pine (WP) had the second highest average of 2449 square inches, yet had less than one-half the total of red maple. Red oak (RO) and white birch (WB) were identified in only one plot during the assessment. The location of this plot was on the extreme northern edge of the area in a moderately well-drained drainage way and would only be considered part of the defined wetland boundary under the 1989 Federal Wetland Delineation Manual.[4]

Canopy closure approximated 90-95% in the fen swamp area of the Beaver Impoundment, and averaged less than 10% in the other two areas. Overall, the average height of the canopy was 43.5 feet. The red maples were predominantly small and multiple stemmed, as indicated by the

following chart which summarizes average dbh for all canopy species.



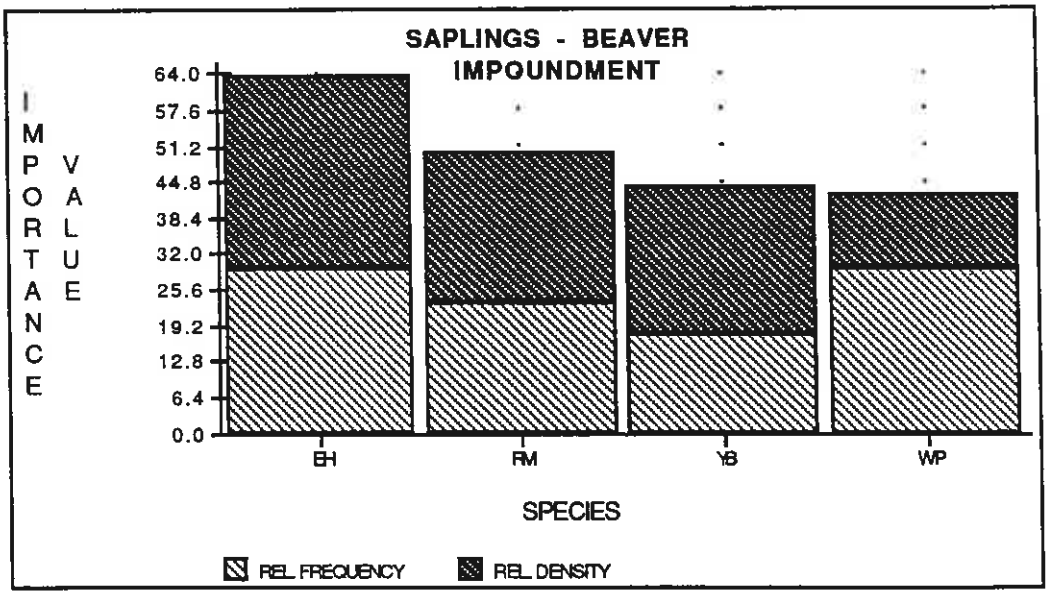

White pines, although scattered, had the highest average dbh of 17.20 inches. This was more than double that of red maple which had an average dbh of 7.67 inches. Three other species had a higher DBH than red maple. The average for red oaks was 11.94 inches, for white ash 9.87 inches, and for yellow birch 8.44 inches. It should be noted, however, that the sample size for all species except red maple was very low. While the above data appeared representative for this site, the results should not be applied to a general assessment of the forest type in the area.



The importance values as exemplified above can assist in characterizing the wetland and its different layers by looking at the relative values of each species. The summation of the importance values for the tree layer included relative frequency, density and dominance. As indicated on the above chart, the most significant species in the tree layer of the beaver wetland was red maple with a total value of 187.06. Its importance value was greater than two times the combined total of the next three species which included white pine, yellow birch and red oak.

Red maple is a species that is typically found in swampy areas with acidic soils (Jorgensen 1978). It has the ability to tolerate saturated conditions but thrives best in a wet environment where a fluctuating water level exposes the roots in summer. Long periods of deep inundation that submerge its roots continuously will eventually cause it to die as a result of oxygen depletion. This scenario has been created and recreated by beaver dams in the ponded portion of the wetland probably for centuries. As a result, the trees that have survived this fluctuating water regime are scattered, small in diameter, and clustered on hummocks throughout the swamp. This slight elevation in relief has enabled them to aerate their roots and survive sustained periods of flooding.

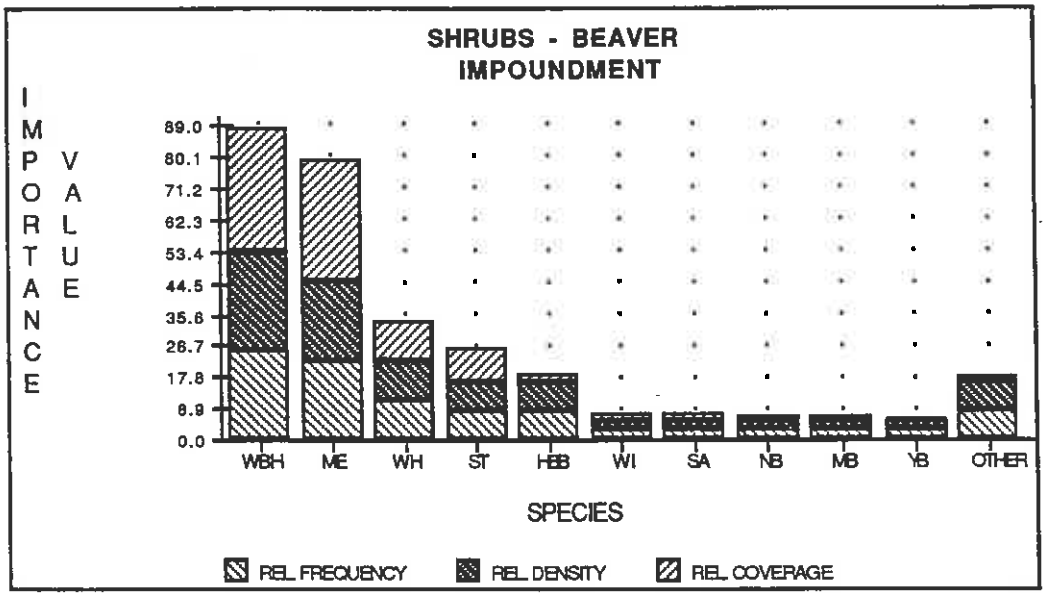
## Sapling Stratum




The number of different species in the sapling layer was limited to four. Given the nature of the hydrologic regime in the area, this was not surprising. Each species must have a high tolerance for flooding or be able to survive by regenerating on hummocks. The results indicated an even

mixture of both hardwoods and softwoods. Importance values showed a fairly equal distribution, although eastern hemlock (EH) was clearly more dense than white pine. The latter species had an equivalent frequency to eastern hemlock, however, largely on account of its more randomized pattern of growth. It was interesting to note how well all four species were represented in this layer under a predominantly red maple canopy.

### Shrub Stratum




A total of thirteen different species were identified within the shrub layer of the beaver wetland. The importance values for this layer indicated that winterberry holly (WBH) was the dominant species with an importance value of 86.99. Meadowsweet (ME) had the second highest importance value with a combined figure of 72.51. Three other species, witch-hazel (WH), steeplebush (ST), and highbush blueberry (HBB), had importance values over 18 points. These top five species represented @ 82% of the total point values for all thirteen shrub species.

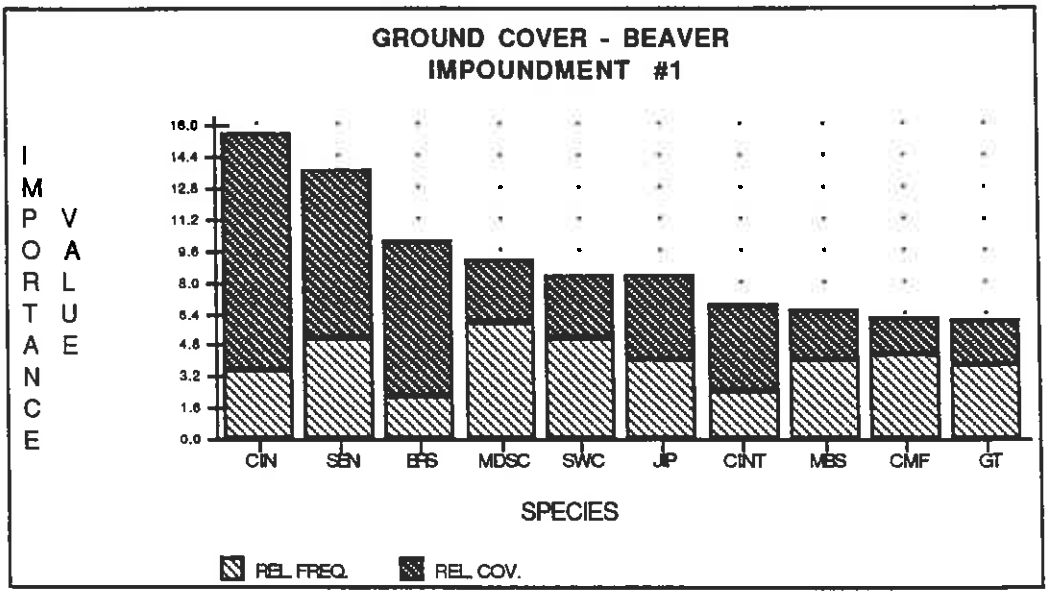
Winterberry holly occurred more frequently than any other species and was typically taller and denser in habit than the others. These latter two characteristics contributed to its higher percent of areal coverage and dominance in the surveyed plots. Although meadowsweet was located throughout the wetland, it and steeplebush tended to be located most heavily along the ponded margins of the wetland and along the banks of the beaver dams. The shrub with the third highest value was witch-hazel. It was located most heavily along the wooded margins of the eastern

portion of the fen near the two inlet channels. Highbush blueberry, with the fifth highest importance value, was as dense and frequent as witch-hazel and steeplebush, although its percent areal coverage was lower due to a smaller spread and fewer stems per plant.

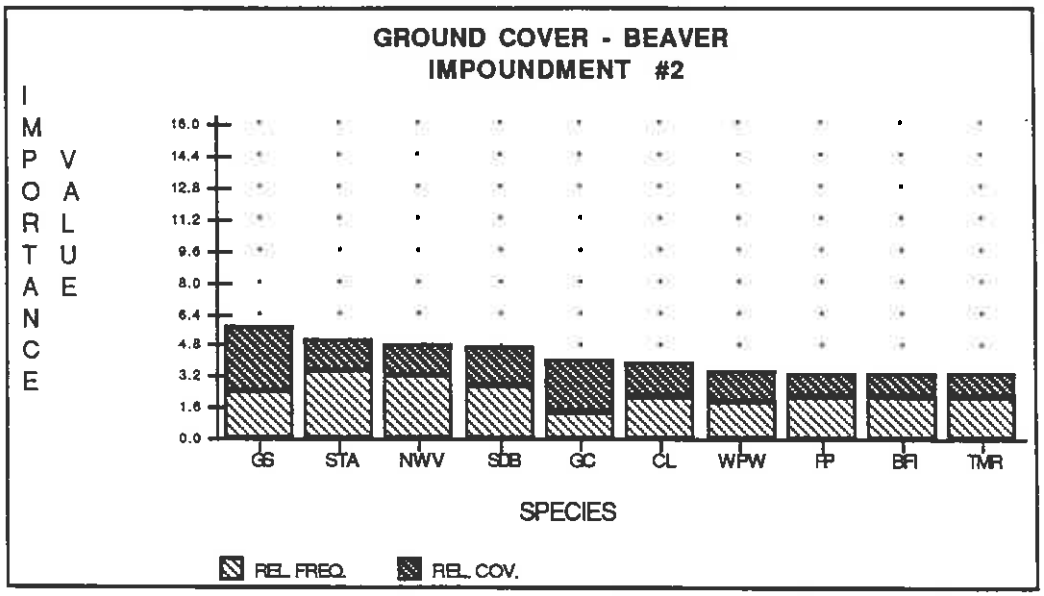
The combination of the shade from the canopy and the periodic inundation in this area probably contributed to the limited development of this layer. In areas around the beaver pond where there was ample sun, however, a dense thicket of bordering shrubs was well developed. These provided ample cover for birds and amphibians, as well as an abundant berry and seed supply for these and other species of wildlife.

## Ground Cover

The fluctuating water level has created areas of vegetated, hummocky terrain and exposed organic-rich soils throughout the wetland. This was particularly true in the forested portion to the east of the open water. In the flats where acidic, organic debris have built up, significant amounts of sphagnum moss have developed. These mats could also be seen on the lower hummocks and at the base of fallen trees. The presence of several species of sphagnum contributed to the persistently damp condition by retaining moisture throughout this dry summer. The following five importance value charts for the ground cover layer testifies to the diversity that these moist, nutrient-rich conditions provided the flowering plants in the Beaver Impounded wetland.



A total of 78 ground cover species were identified in the Beaver Impoundment plots during the survey. The two most dominant species in the ground cover layer were cinnamon (CIN) and sensitive fern (SEN) with importance values of 15.61 and 13.69 respectively. Both species seemed to thrive in shady and muddy areas where there was a constant supply of moisture. The dense growth and clustered effect of cinnamon fern contributed to its dominance within this stratum. These two ferns were followed in importance by a species of bur-reed that grew extensively in the plots along the flatter portion of the stream channels and in exposed mud areas near the beaver dams. Of the remaining seven species from the above chart, all but bladder sedge (CINT) were wildflowers commonly associated with cool moist areas and wooded swamps.

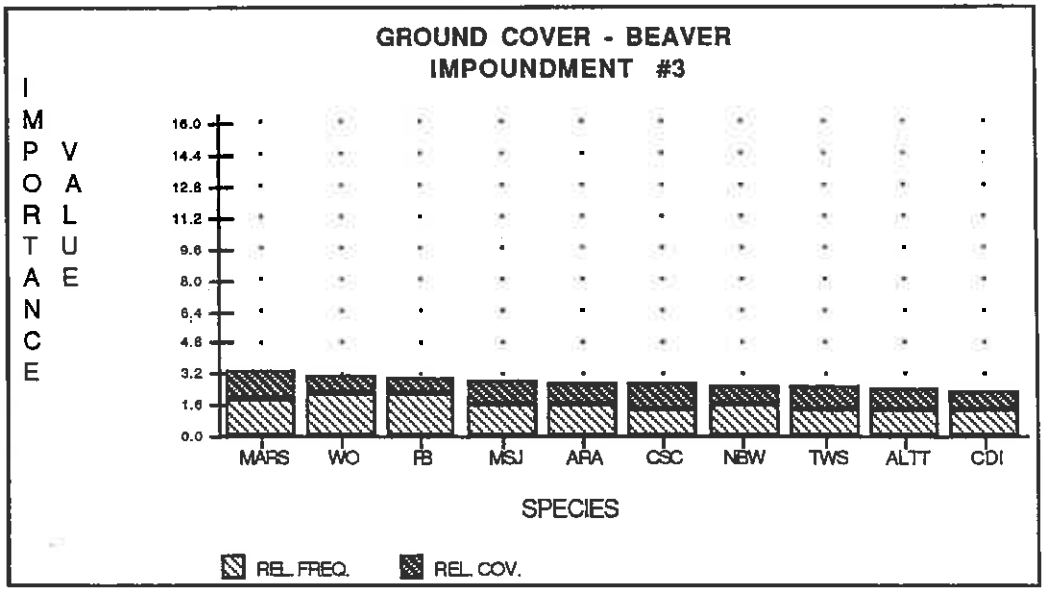



In addition to bladder sedge there were 14 species of *Carex* identified in the survey as well as 6 species of grasses. Lurid sedge (CL) in the above chart was another sedge commonly found throughout the plot work. Fowl manna grass (GS) and Canada manna grass (GC) were the two most common grasses and had importance values of 5.79 and 4.03, respectively. It was interesting to note that while these two grasses were less frequent than other herbs of comparable abundance, they had higher relative areal coverages on account of their colonial growth habit.

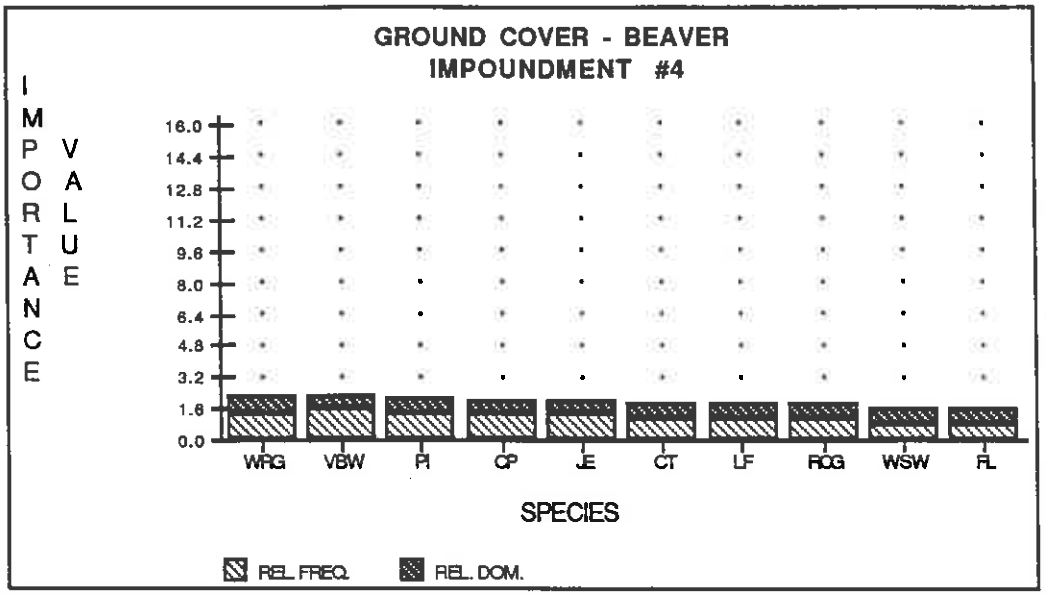
Blue flag iris (BFI) had an importance value of 3.38 and is pictured below with swamp candles (SWC) from the preceding chart. They are both wild flowers that were in bloom during the initial portion of the study period. This picture was taken below the beaver dams in the riverine section of the wetland. The two flowers were found throughout the sphagnum dominated areas

both in muddy areas along the streams and in sunnier locations in the flats. Both are associated with soils that have prolonged periods of saturation (Magee 1981).

In this next set of importance values for ground cover in the Beaver Impoundment, marsh fern (MARS) had the highest overall value of 3.32. Both woodland grass (WO) and partridgeberry (PB) had higher relative frequencies (2.14 each), but do not have very broad areal coverages in their growth form. They are also more patchy in their distribution and may have been less adequately represented in the plot data.

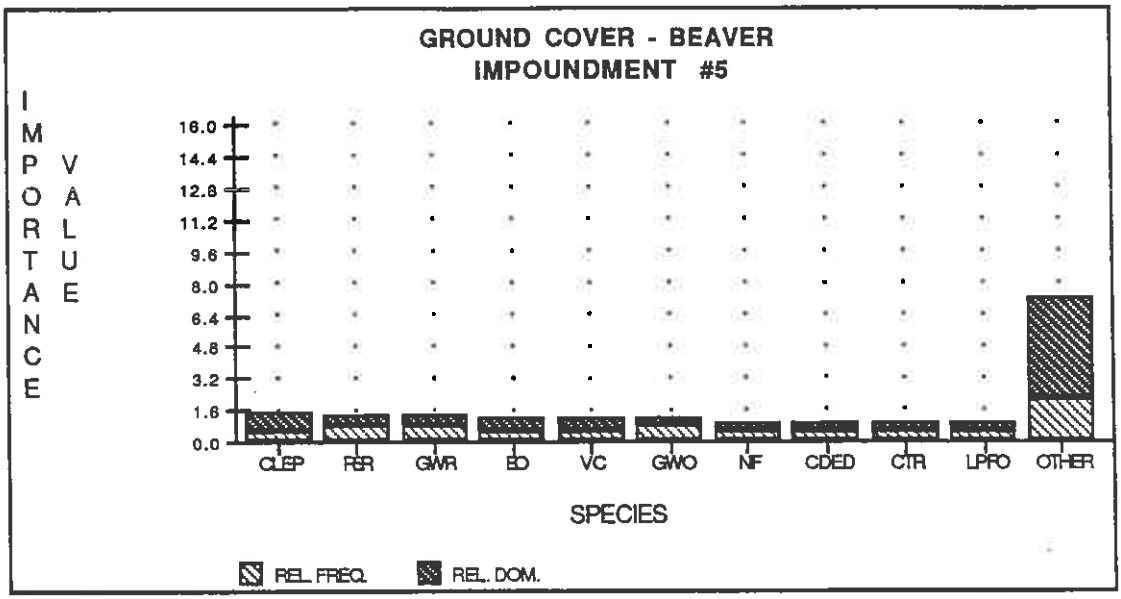


Both wood reed grass (WRG) and Virginia bugleweed (VBW) were relatively common in their occurrence in the Beaver Impoundment fen swamp. However, both species tended to reflect low areal coverage values and preferred distinctly unique microhabitat sites. The wood reed grass was found in the wetter hollows between the hummocks and the Virginia bugleweed was located mostly on the sides of sphagnum-dominated mounds above water.




Although the importance value for the species in the last ground cover chart below are rather small, there were two species of interest which were associated with saturated conditions created by the inflowing streams. These were the large flowered purple orchid (LPFO) and the green wood orchid (GWO). Both species were indicators of relatively nutrient rich conditions associated with groundwater seepage and flowing water. Their presence in conjunction with the abundance of cinnamon fern was an indication of an acidic fen and seepage swamp (Sperduto 1994). It should be noted that both species of orchids are on the state "special concern" list owing to their uncommon, yet widespread distribution and potential for over-collecting by orchid hunters.

The "other" category in this last chart includes species whose total percent areal coverage was less than 5% of the stratum's total.




The composition of the vegetative community in the Beaver Impoundment area was indicative of a mosaic of wetland community types. According to the Cowardin classification system of wetlands, the lowest area could have been considered a PSS1H, or a palustrine scrub-shrub swamp of deciduous leaved plants that was permanently flooded; the larger impoundment area could have been classified as a PFO5/PUBFb, or a palustrine forested dead / open water wetland that was semi-permanently flooded or temporarily exposed with a beaver-controlled outflow; and the uppermost portion could have been called a PFO4E, a palustrine forested swamp of broad-leaved deciduous-leaved trees that was seasonally flooded or saturated.

The primary physical characteristic that was responsible for this mosaic was the fluctuating water level. The variable hydrology associated with the periodic beaver impoundment, in-flowing streams and groundwater discharge at the edge of the basin contributed to the subtle changes along the ecotones or boundaries within the impoundment. The fluctuating water level dictated which vegetative species could survive or even thrive in each location, and contributed to an interspersion of species along the ecotonal boundaries. Several species identified in this area as well as their growth habits provided clues as to the extent of inundation of the soils and the acidity of the water.

At the deepest water sites, no rooting vegetation was observed. Only floating-leaved and submergent plants were recorded. In shallower water, common burreed formed extensive patches of bright yellowish-green growth. Vascular plant cover was sparse on the exposed banks,

especially in the shaded areas under the red maples, although scattered hummocks were well vegetated with both trees and herbaceous perennials. Red maple, yellow birch, white pine and eastern hemlock seedlings were infrequent relative to the other ground cover species, although they appeared to be the only tree seedlings that could potentially regenerate the canopy.

Where the upper water line was exceeded a greater variety of woody vegetation was evident, along with a consequently greater canopy closure. Winterberry holly was the dominant understory species in this area, since it could tolerate periodic inundation and shadier conditions (Thunhorst 1993). Meadowsweet formed a dense bordering thicket along the open beaver pond, whereas witch-hazel was scattered in clumps along the upper edge, particularly on hummocks. Highbush blueberry, the only other shrub dominant, was quite frequent in the fen swamp portion of the Beaver Impoundment, due to its tolerance for higher acidity and greater dryness in the root zone.

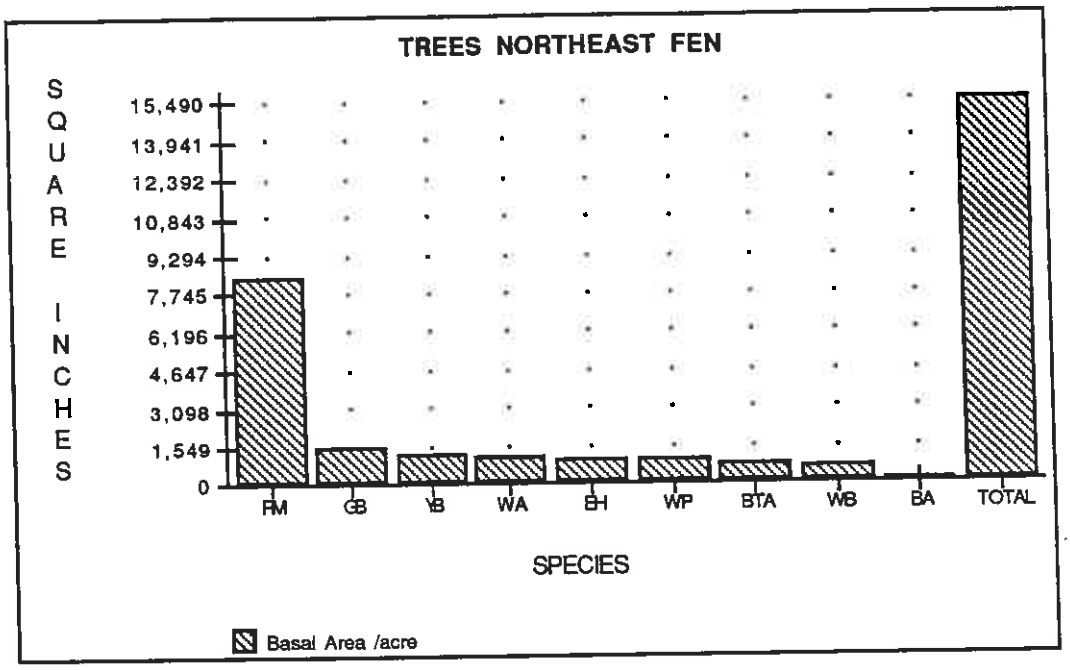
Most of the herbaceous plants were obligate or facultative wetland species. Some, however, also indicated specific types of saturation as well as certain soil conditions. The presence of the green wood and large fringed purple orchid along the stream channels were indicators of fairly continual moisture from flowing water. Their association with certain species of sphagnum moss near or along the inflow stream channel suggested strict hydrochemical requirements. Jack-in-the-pulpit reflected this condition as well, although its organic mat requirements were apparently more stringent. As could be expected, most of the common species showed a much wider tolerance for site conditions; cinnamon and sensitive fern, swamp candles, and skull cap were found throughout the area from inundated to saturated and organic to mineral soil sites.

Finally, it appeared that the relative stability from major human disturbance has allowed the vegetational seedbank to develop to a significant degree. Both the exposed organic mats and the upturned roots from recent windthrows showed immediate colonization by seedling herbs that were present on the site. The wind-dispersed graminoids were very well developed, wherein 34% of the dominant herbs were represented by the grass, sedge and rush families. Fern gametophytes were quickly colonizing newly exposed mineral soils, and stability-sensitive club-mosses lined the upper edges of the entire area. As a further testament to this relative stability, none of dominant herbaceous forbs or graminoids were non-native species, in spite of an actively maintained power line adjacent to the site.

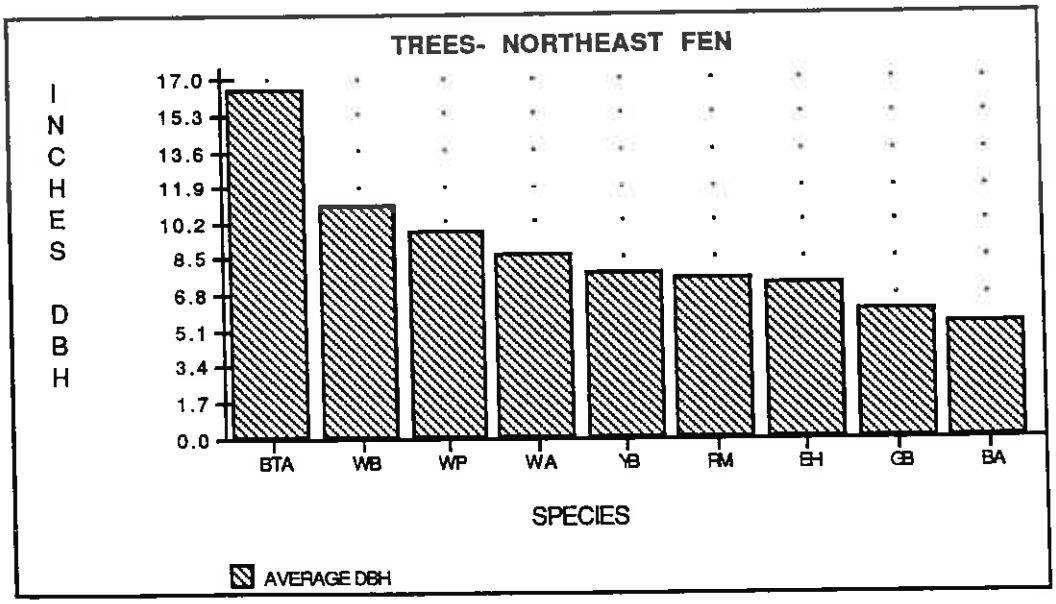
## Northeastern Fen Swamp

This second fen swamp was also located in the Paquette lot of the Greater Goose Pond Forest. It was in the northeast corner of the property and covered 2.3 acres. Observations made during the growing season indicated a canopy closure of @ 46%. The slope of the fen swamp was rather gentle ( 0-3%) and it had a westerly aspect. The surrounding topography rose abruptly to the north, south and east, and created a small basin-like depression at an elevation of 1045 ft. The surrounding uplands contributed both ground water seepage and surface run-off, as represented by two intermittent stream inlets. One stream was located at the northern extreme of the area while the other was located to the southeast. Periodic surface inflows and steady groundwater seepage helped diversify the plant communities by maintaining a high level of saturation throughout the year. The development of an extensive sphagnum mat throughout the fen attested to this saturation. The ± 6 species of sphagnum concealed much of the hummocky terrain and micro relief in the fen. The coverage of this mat was higher than 85% in the plots surveyed.

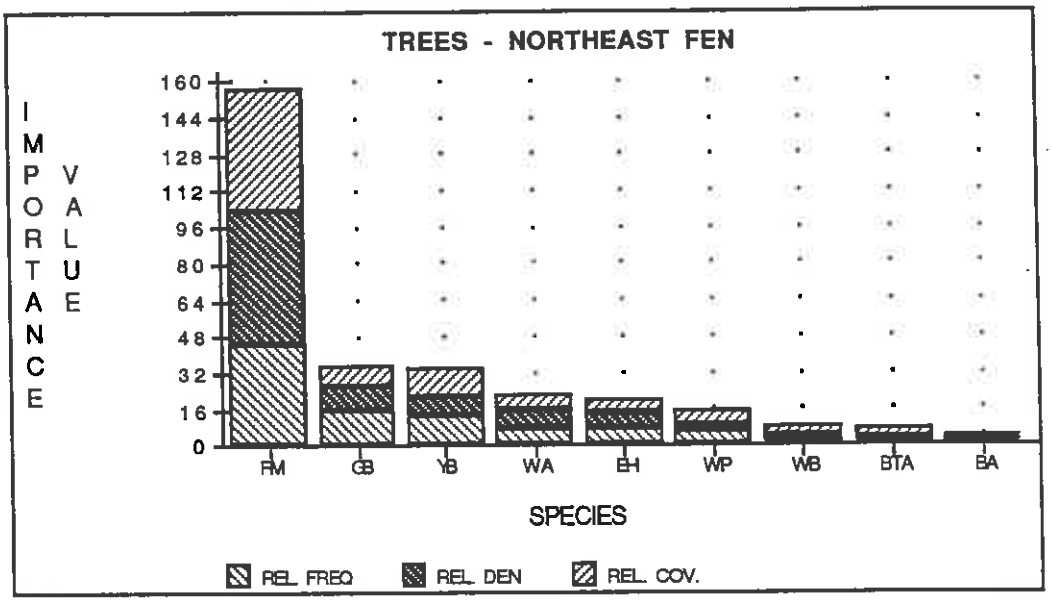
## Tree Stratum




The results of the northeast fen swamp field work revealed that 9 different species of trees occupied the survey area. The tree stratum was clearly dominated by red maple (RM) with an average basal area per acre of 8373 square inches, followed by two members of the Betulaceae, gray birch (GB, 1458 sq.in. per acre) and yellow birch (YB, 1085 sq.in. per acre). The species with the least amount of basal area in the plots surveyed was black ash (BA), with an average of 78 square inches per acre.



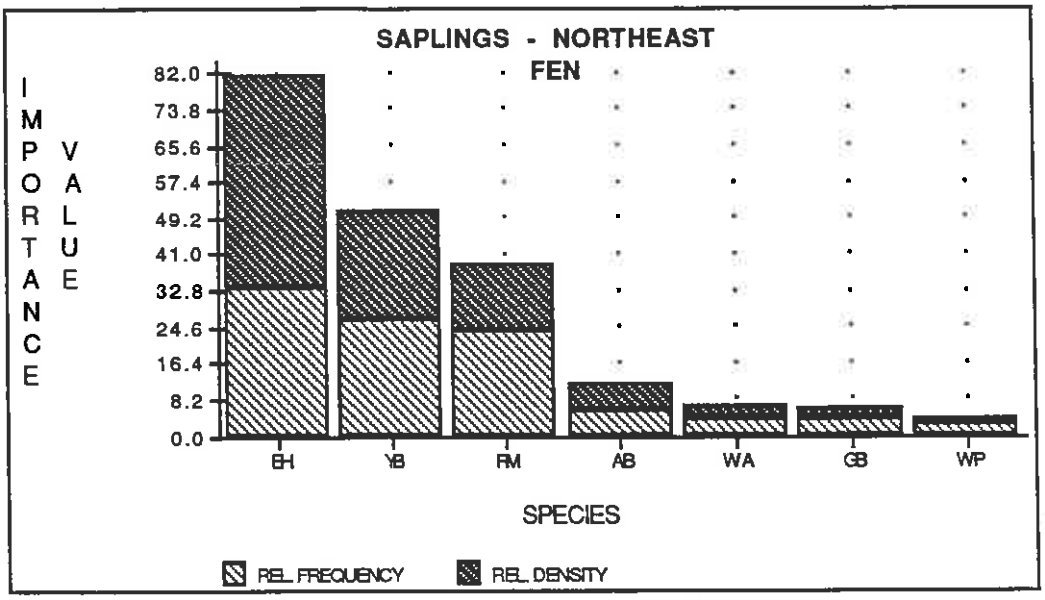
The average DBH for the trees in this fen swamp showed that the majority of the species were below 8 inches in diameter. The trees with the largest average diameters were the big-toothed aspen (BTA), the white birches (WB) and the white pines (WP). All three of these species were located either along the inlets or close to the edge of the wetland boundary where the level of saturation and development of the sphagnum moss was not as high. It should be noted that there were ≤ 3 individuals for each of these species in the plots.




The importance values confirm that red maple was the most significant species in the Northeastern Fen. As seen in the above chart, it had the highest values within each relative category and a total point value of 152.66. Gray and yellow birch were the second and third most significant species with values of 34.72 and 34.36, respectively. The presence of black ash was noted in only one of the plots surveyed; it had an importance value of 14.98.

The hummocky terrain appeared to be a result of former windthrows in the fen swamp. Shallow-rooted trees are quite common in areas of regular inundation or saturation, wherein their root mounds contribute to the diversity of plant species that can occur (Thunhorst 1993). With the exception of black ash, virtually all of the trees that occurred in the plots were elevated on small mounds.

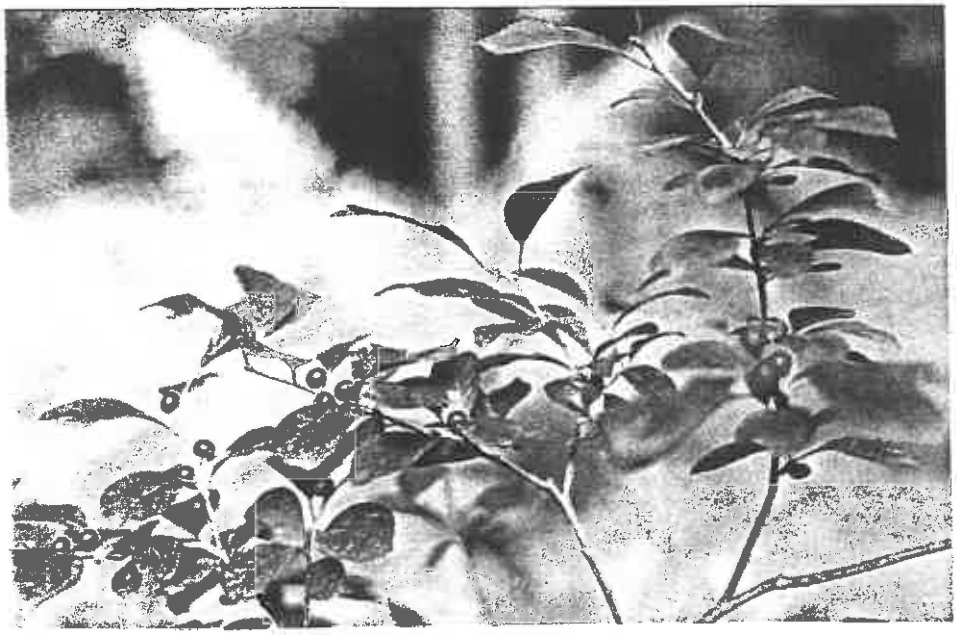
## Sapling Layer

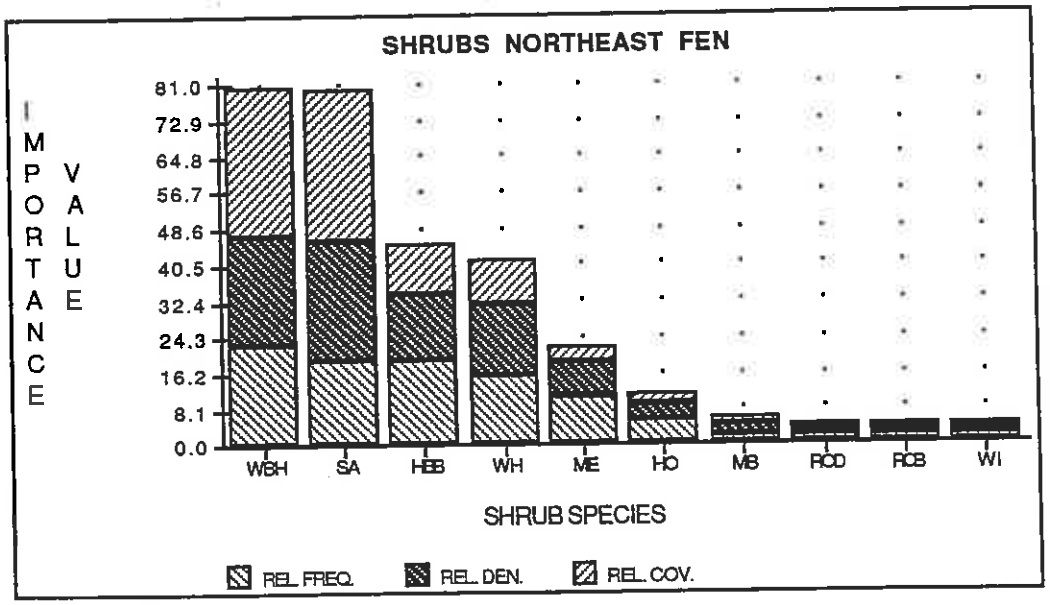



A total of 7 different species were identified in the sapling layer. Importance values indicated that eastern hemlock (EH) was the dominant species in this layer with a point value of 91.76. Yellow birch had the second highest value of 51.37, while red maple was third with a value of 30.64. All four of the remaining saplings had importance values of ≤ 12, and were scattered throughout the fen swamp on high ground. The most restricted of these was American beech (AB), which was primarily found in the plots that bordered the northeastern portion of the study area.

The high percentage of hemlocks in this stratum was an indication of the cool, moist condition of the site as well as the acidic nature of the water flowing through the fen. This species was found throughout the site, but was especially abundant along the western margin of the fen. The likelihood that hemlock will replace red maple as a dominant in the canopy is not great, however, since a considerable amount of water still flows into and out of the site.

## Shrub layer

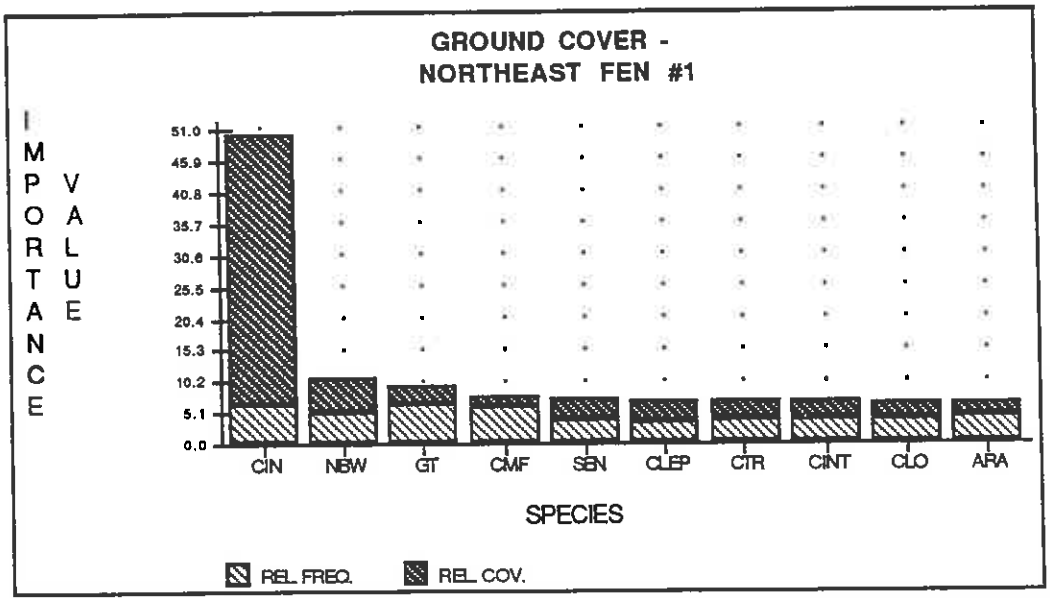





When the relative frequency and coverage figures were combined to develop importance values, two species of shrubs scored significantly higher than the rest. Winterberry holly (WBH) and speckled alder (SA) were the most significant shrub species with point values of 80.34 and 79.94, respectively. They both had similar habits and grew in dense thickets throughout the fen. The third and fourth species were much less significant, but also had close values as well. Highbush blueberry (HBB) had a value of 44.9 and witch-hazel had an unexpectedly high value of

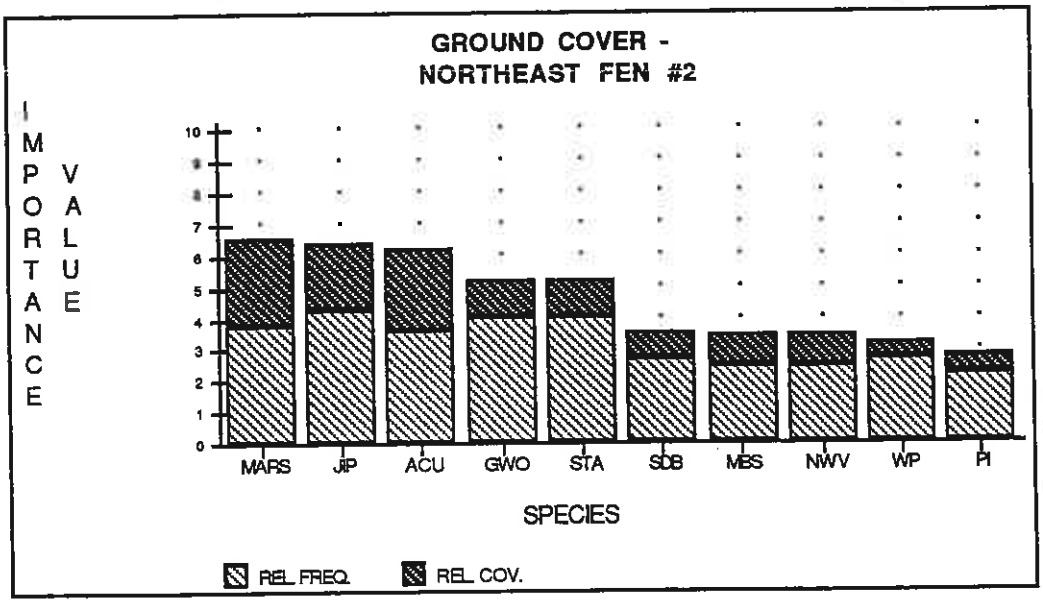
41.39. Most of the latter species were observed along the slightly higher western edge where there was less saturation and the sphagnum mat was less extensive. The remaining species had a combined point value of 52.52, and included meadowsweet (ME), hobblebush (HO), maleberry (MB), red-osier dogwood (ROD), red chokeberry (RCB) and witherod (WI). All of these species are fairly common in central New England in forested or scrub-shrub wetlands (Tiner 1989).

## Ground Cover Layer

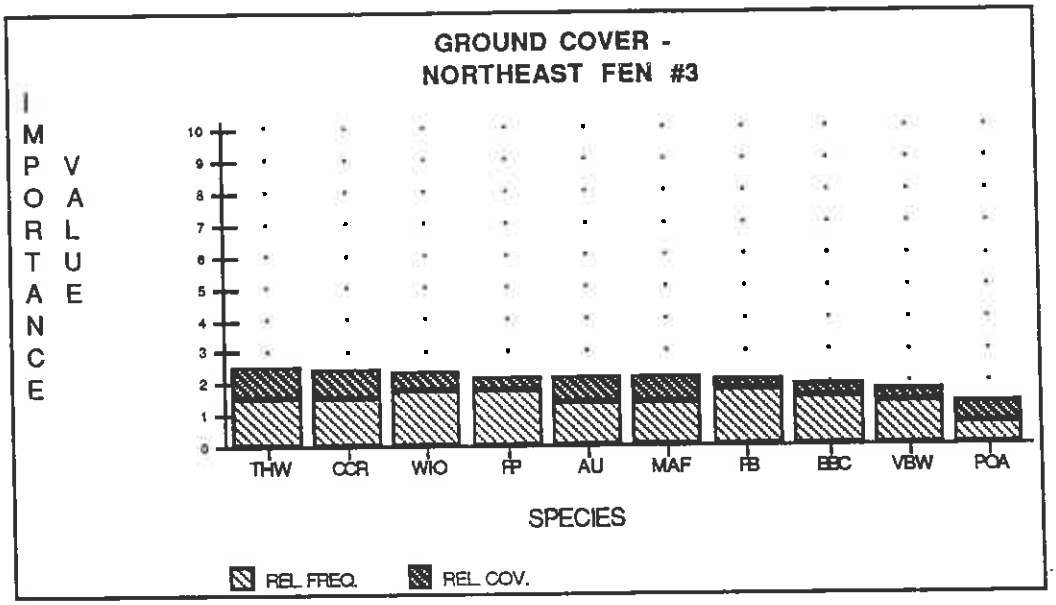



There was a total of 79 species identified in the ground cover layer of the Northeastern Fen. The above chart clearly shows the predominance of cinnamon fern (CIN) in this stratum with an importance value of 50.12. The second most significant species was northern bugleweed (NBW), a common wildflower of organic-rich depressions in wooded swamps. Its point value of 10.84 was followed by two additional wildflowers that were common throughout the area, goldthread (GT) (9.31) and canada mayflower (CMF) (7.9). The fifth most significant species was another fern, the sensitive fern, with an importance value of 7.5. The next four were sedge species, bristle-stalk sedge (CLEP)(7.1), three-seeded sedge (CTR) (7.09), bladder sedge (CINT) (6.88) and long sedge (CLO) (6.72). Wild sarsaparilla completed the top ten list with an importance value of 6.7. It is a common perennial found in woods throughout the northeast, and was not uncommon on the higher mounds in the study area.

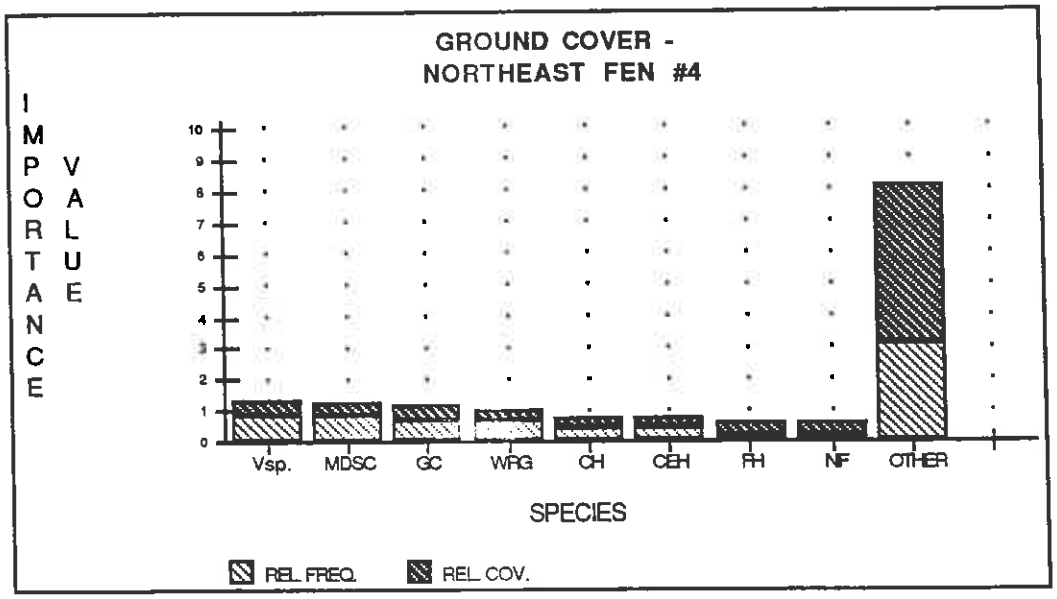
Combined with the high importance value of cinnamon fern, the abundance of sedges in the first ten positions were indicators of an acidic fen (Sperduto 1994). Goldthread and Canada mayflower are typical associates of wooded swamps (Tiner 1988), and were primarily located within or above the sphagnum moss at the base of trees and on hummocks.




The second group of ten species included the green wood orchid and the starflower. Both had an importance value of 5.24 and are indicators of seepage and acidic soil conditions (Tiner 1988; Sperduto 1994). Several of the species in this second group were encountered frequently during the assessment, but the size of the individuals as well as their growth habit restricted their dominance based on areal percent coverage. Swamp dewberry (SDB) spread laterally via runners and stayed close to the sphagnum moss, while the weak structure of marsh bedstraw (MBS) caused it to recline on other species or lie directly on top of the sphagnum. Both of these species were well below an importance value of 5.0.




The third group of ten species included white turtlehead (THW) with a point value of 2.52. Turtlehead is commonly associated with watercourses and wetlands with flowing water (Magee 1981). It was found scattered along the inflowing water course and near the western outlet in saturated muck. This group also included Massachusetts fern (MAF), a good indicator of acidic, often mixed or coniferous swamps in southern New Hampshire. At the northern limit of its range, this species becomes quite uncommon north of Keene.



The final ten species in this stratum were all below 1.5 in point value. They included several sedge species, all of which were widely scattered and had low coverages owing to their hair-thin foliage. One of the latter, Howe's sedge, is fairly uncommon in New Hampshire, and tends to indicate deep peat mats. It presence here likely dated from the time when the fen swamp was more fen-like and had less tree cover.

Species which were below 5% of the total were rolled into the "other" category in the above chart. Each of these species had importance values below 0.58. Most of these 39 remaining species in the Northeastern Fen were relatively insignificant in importance, although a few provided strong indicators of specific environmental conditions. One of the species which was included in this latter group was *Malaxis unifolia*, the green adder's mouth. It's stringent site requirements for acidic, mossy, open woods has caused it to be listed on the State's threatened plant list. Its presence on the site was rather unusual for southern New Hampshire.

The vegetative community in the Northeastern Fen was dominated by red maple in the tree layer, eastern hemlock in the sapling layer, winterberry holly and speckled alder in the shrub layer, and cinnamon fern in the herbaceous layer. The physical characteristics of the surrounding topography and the extensive development of the sphagnum moss blanket depicted a long history of organic accumulation in a saturated basin that has received surface water flows and groundwater seepage since the time of glacial scouring. Formerly a shrub fen as indicated by the presence of certain plants, it has since developed swamp characteristics as a result of the gradual in-filling of sedimentary and vegetative debris. Slightly drier conditions likely prevailed during the "hypsothermal period" of warmer climes several thousand years ago (Johnson 1985); large tree root mounds since that time has created a microrelief diversity that has spawned a rich array of plant species relative to the surrounding terrain.

The variable soil acidity has likely contributed to the transition between deciduous and coniferous areas within the fen. The abundance of eastern hemlocks on the western and southwestern slope as well as at the outlet of the fen were an indication of a subtle change in that condition. The shading provided by the canopy, in conjunction with the moisture that the sphagnum moss retained, has created a cool environment that has contributed to the extensive development of cinnamon fern and thickets of winterberry holly and speckled alder. The moss has also provided an excellent medium for the different species of sedges and orchids to thrive in this location. As mentioned previously, the combination of an abundance of sedges, cinnamon ferns and orchids in the sphagnum moss bed can all be used as good indicators of an acidic fen.

## Summary

The field work revealed that there were strong similarities between the two communities as well as some distinct differences. The similarities were evidenced by a dominance of red maple in the tree stratum, eastern hemlock in the sapling stratum, winterberry holly in the shrub layer and cinnamon fern in the ground cover layer. All of these species indicated cool, moist, acidic conditions throughout most of the growing season. The presence of a thick sphagnum mat over most of both areas testified to this site condition as well.

Total areal coverage was quite similar between the two sites (41% vs 46%), as was the average dbh for the dominant species in the canopy, red maple (7.67 in. vs 7.54 in.). In the ground cover layer, where site conditions tended to be more exacting, five of the ten most common species in the Beaver Impoundment were in the top ten list for the Northeastern Fen. High levels of soil saturation accounted for this similarity, as nine out of ten of the top ten herbaceous species for both areas were facultative wetland (FACW) or obligate (OBL) wetland species.[5]

Looking more closely at the statistical data, however, distinct differences between the two fen swamps begin to appear. Whereas the average basal area per acre for all trees in the beaver wetland was 9670 square inches (67 sq.ft.), it was 15485 square inches (108 sq.ft.) in the northeast fen. This corresponded with a higher density of trees in the Northeastern Fen as well as a higher frequency in the plots.

The sapling layer also reflected a slight, but significant difference. While both areas were dominated by eastern hemlock, the Northeastern Fen had a higher importance value for yellow birch (26.39 vs 17.65), and contained four additional species which indicated slightly drier conditions: American beech, white ash, gray birch and white pine.

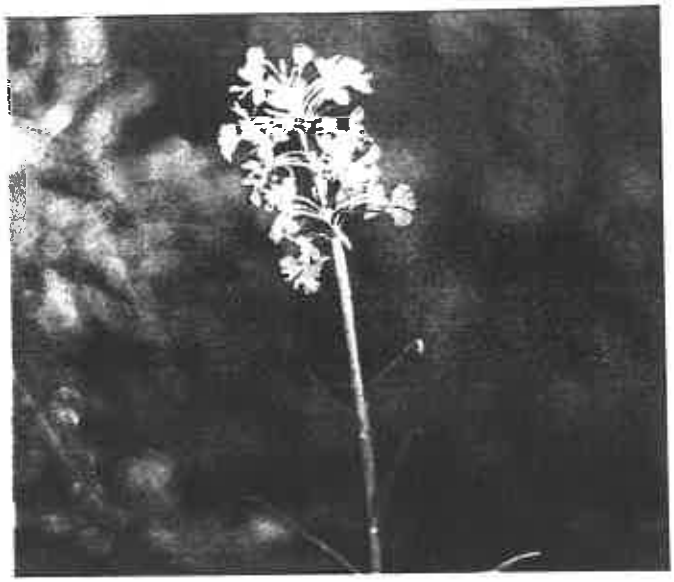
The shrub stratum in the two locations were similar in that they were dominated by winterberry holly; however, the co-dominant species in the northeast fen was speckled alder instead of meadowsweet. Speckled alder is indicative of relatively stable water table conditions, whereas meadowsweet can tolerate a significant amount of dryness in the summer months (Redington 1994).

Importance values for cinnamon fern in the ground cover layer of the Northeastern Fen was far greater than in the Beaver Impoundment area ( 50.12 vs 15.61). Again, the more stable amount

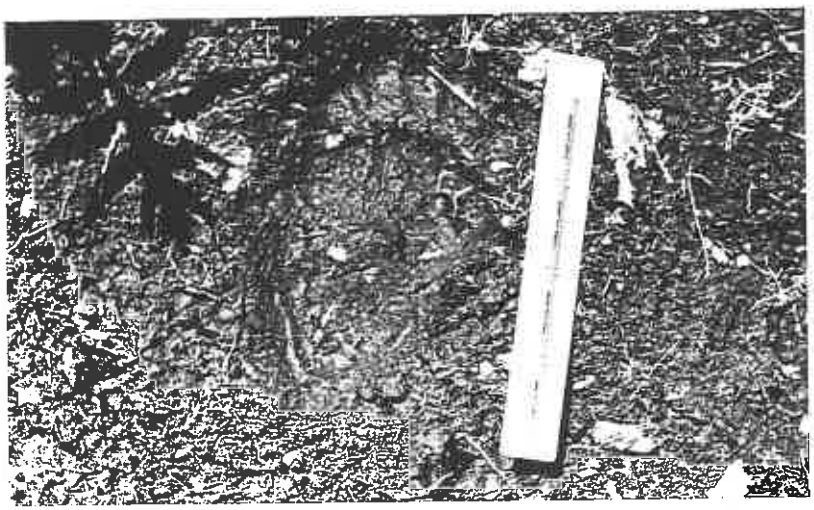
of saturation was likely responsible for this. The higher percentage of *Carex* species in the Northeastern Fen (four of the top ten), a denser cover of sphagnum (85% vs 45%), and the absence of deeper water species such as bur-reed and swamp candles indicated a more fen-like quality to this area (Sperduto 1994).

Overall, the lack of significant inflows to the upper fen was likely responsible for the significant differences between the two sites. Without sufficient water quantity, beavers have not been attracted to the Northeastern Fen for quite a long while. The gradual in-filling of sediment and organic matter has created an evenly saturated site that has acidified over time. In contrast, the Beaver Impoundment area still undergoes significant water table fluctuations, and continues to create dynamic alterations in the amount of exposed soil. While both areas contain good indicators of unique ecological conditions, the Beaver Impoundment area will likely continue to offer a higher overall diversity of micro-habitats for plant and animal species.

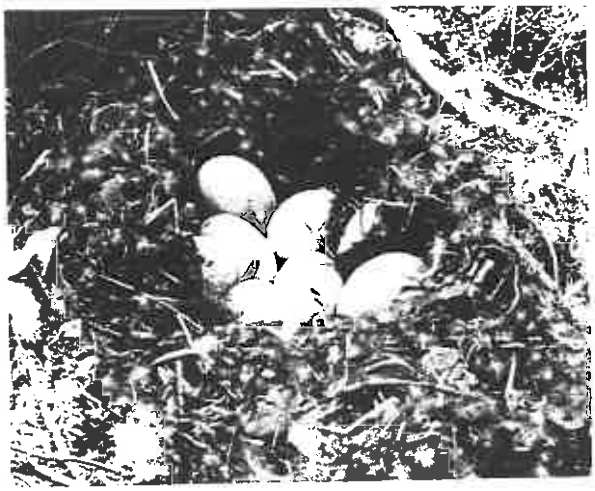
The forested wetland and the acidic talus slope communities contributed to the two fen swamps in their own way. The forested wetland, while not a significant area floristically, encompassed the first basin upstream of the Beaver Impoundment. Its hydrologic contribution across and through the talus slope community provided both water and nutrients to the fen portion of the beaver wetland. The talus slope, while not significantly high in pH, did filter percolating groundwater in the direction of the easterly inflow stream, and probably contributed some mineral leachate to this fen. While it may be impossible to determine how this mineral leachate contributes to the plant diversity downstream (particularly in regards to the occurrence of both orchids at the base of the inflow stream), the presence of exposed bedrock no doubt serves other valuable natural community functions, such as unique habitat for certain kinds of wildlife species.



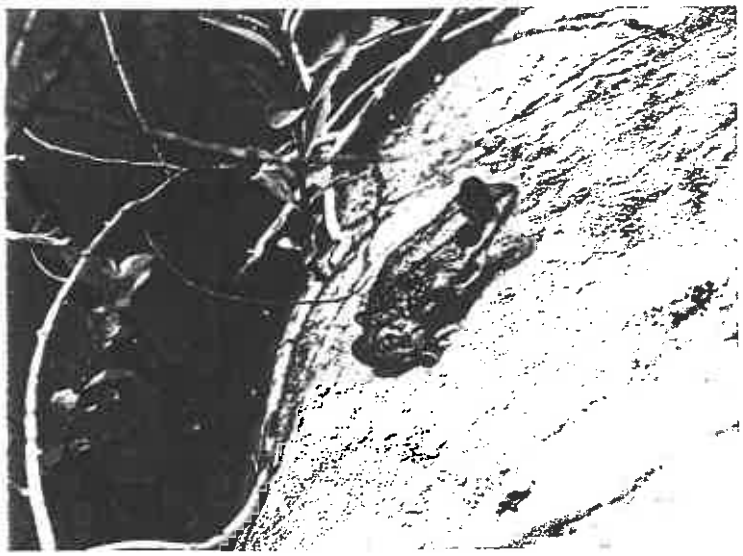
The presence of green wood and large purple fringed orchids in the Beaver Impoundment area, as well as the threatened green adder's mouth in the northeast fen, contributed to the especial quality of the two fen swamps. Rare species such as these reflected highly specific edaphic conditions that have been shaped by changing plant communities over time. The interplay of succession, natural and artificial disturbance has created a mosaic of wetland types that are unique to the GGPF as a whole.



The abundance and diversity of the mammal, bird, and other animal species that were observed during the vegetative assessment contributed to the unique quality of this portion of the GGPF. While the vernal pool assessment in the Paquette lot remains to be done, the diversity of natural communities present in this area appeared to have been more than sufficient to attract a large number of wildlife species. Evidence of bear tracks and scat in both locations were observed throughout the study period in addition to deer, beaver and muskrat sightings. An abundance of ground cover and berry-producing shrubs provided both food and cover for these species were quite prevalent within each of these communities.



The ponded water of the Beaver Impoundment also provided food, reproductive areas and cover for a variety of waterfowl and raptors, including wood ducks, mallards, broad-winged hawks and great horned owls. The presence of amphibian species, such as the green frog pictured below, also served as a food source for migrating herons and bitterns. Numerous other wildlife species contributed to the overall diversity and unique character of this natural community. Many of these have been compiled in a species list contained in Appendix C below.



## Conclusion

This study involved a review of only a portion of the Greater Goose Pond Forest. It focused on four natural communities that preliminarily met the BSIA criteria established in the fall of 1994. While a significant amount of data has been collected and reviewed, we realize that the other two components of this BSIA assessment project must be completed before conclusive recommendations can be made relative to the entire GGPF. Nonetheless, we have included below preliminary recommendations that address the four areas we studied.

As natural community ecologists, we feel that none of the natural areas of the GGPF would seem uninteresting. All portions of the GGPF contain some significance relative to the "study of nature" as outlined in the 1992 revised management plan. While we have focused on four ecological areas that appeared to have had greater *uniqueness* relative to the surrounding forest, we recognize that their respective ßeta or natural community diversities represent only one consideration for proper management.

In reviewing the BSIA criteria as listed in the introduction above, it appears that both fen swamps contain all or most of the characteristics of a BSIA. The presence of rare species, locally high diversity, and unique plant associations make them candidates for inclusion as "Biologically Significant Interest Areas." They also have scientific and educational value on account of their relative rarity in the GGPF, and could be dramatically altered or disturbed by logging or other activities. Regionally, there is some question about their significance, however: Sperduto (1994) lists both the Hardwood-Conifer Seepage Swamp and the Hardwood-Conifer Basin Swamp as "SU's," or status unknown. In a further clarification of this term, he offers the Natural Heritage Program definition: "possibly in peril in state but status uncertain; need more information."

The forested wetland and the talus slope sites do not appear to meet the BSIA criteria on account of the absence of characteristics described above. However, as discussed earlier, the talus slope community type is considered "rare in the state (on the order of 20+ occurrences)," (Sperduto 1994). Over time, this area may develop more of the floristic characteristics of a talus slope community, as it structurally contains a sufficient amount of ledge and talus to do so. It also stands as a unique geologic area in the GGPF and deserves merit for its potential scientific research value as well.

Van de Pol 1995

**Recommendations** - Vegetation Analysis - 4 Biologically Significant Interest Areas

Assessing biological significance is not a static process, nor is the compilation of recommendations that arise from an assessment. The following points should be considered as preliminary only, since all six of the potential BSIA's have not been thoroughly studied as of this date. For example, the determination of whether or not logging should be restricted from the area has not been adequately established; therefore, the recommendations only pertain to site specific BMP's should logging be allowed. Additionally, since the findings above only include a review of four of the six BSIA's, the recommendations below are restricted to a discussion of these four areas only.

1). **Do not conduct any logging activities within the boundaries of the two fen swamps as described above.** Both the Beaver Impoundment area and the Northeastern Fen contain deep, organic soils that do not likely freeze in their entirety during the winter, and would thus be subject to significant disturbance by heavy equipment.

2) **Maintain a minimum buffer of all land within the immediate watershed of any perennial stream entering both fen swamps.** Slopes are steep and certain sections appear unstable due to periodic high water tables in most areas that are immediately adjacent to these perennial streams. This latter area includes the ravines associated with the northern and eastern inflows to the Beaver Impoundment area as far up as the talus community, and the eastern inflow to the Northeastern Fen a distance of approximately 500 feet upstream of the fen swamp.

3) **Maintain a minimum logging buffer of two tree lengths from the boundary of each fen swamp.** Beaver activities in the lower area have indicated a natural successional sequence of periodic inundation and drawdown. This sequence would be dramatically altered by either removal of suitable browse material in the understory or the enhancement of the same through selective removal of the overstory.

4) **Consider that all access roads, skid trails and walking paths be <u>temporary</u> in the vicinity of these areas.** Given the present overland access via the power lines into the Beaver Impoundment, and via the 4WD Old County Rd into the northeastern fen swamp, sufficient access has already been established. Any new roads and trails would likely increase foot and motorized vehicle traffic into the swamp areas and disrupt the occurrence of sensitive species such as black bear, nesting wood ducks, feeding herons, as well as the very localized occurrence of the

attractive, potentially collectible orchids.

**5) Limit the amount and types of information that are published in regards to the locations of these areas.** For the same reasons mentioned above, these areas (particularly the fen swamps) deserve some discretion in the advertisement of the Paquette lot portion of the GGPF. If nature studies are to take place, far greater merit can be offered by a site that has not been periodically visited (and potentially vandalized) by human visitors. Sufficiently interesting and aesthetically pleasing areas have already been provided for the general public around and in the vicinity of Goose Pond itself.

**6) Consider the establishment of permanent plot studies in this portion of the GGPF.** Both the talus community and highly diverse fen swamp areas warrant ongoing research, especially considering the unknown status of the Hardwood-Conifer Seepage Swamps and Hardwood-Conifer Basin Swamps as described above. Moreover, the single, small population of the state-threatened green adder's mouth should be more clearly defined and carefully monitored for its response to changing conditions in the northeastern fen swamp.

## NOTES

1 For further information on this method, consult either Cain, S.A. 1938. The species area curve. *American Midland Naturalist* 19: 573-81; or Cain, S.A. and G.M. De O. Castro. 1959. *Manual of Vegetation Analysis.* Harper: New York; or Brower, J.E., J.H. Zar, and C.N. von Ende. 1989. *Field and Laboratory Methods for General Ecology.* Dubuque, IA: Wm. C. Brown.

2 Topographic and micro-relief variability has been shown to be better represented by rectangular, rather than square plots (cf. Curtis, J.T., and G. Cottam. 1962. *Plant Ecology Workbook.* Minneapolis: Burgess Publishing Company).

3 For a more full explanation of this community type, see Sperduto, Dan. 1994. A classification of the natural communities of New Hampshire. NH Natural Heritage Inventory, Concord, NH.

4 The 1989 *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* contains a more liberal set of criteria for delineating wetlands than the currently employed 1987 wetlands delineation manual published by the US Army Corps of Engineers. Primary among the differences is the mandatory requirement for evidence of hydrology, which, in this plot, was presumed to be marginally present during some, but not all years.

5 The code designations indicate a prevalence of occurrence in wetlands; FACW plant species supposedly occur in wetlands 67-99% of the time and OBL species occur in wetlands >99% of the time (Reed 1988).

## REFERENCES

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## Greater Goose Pond Forest Project - Plant Plot Data Sheet

Date: 7-24-95 Observers: Charlie Donohue Location: Northeastern Fen

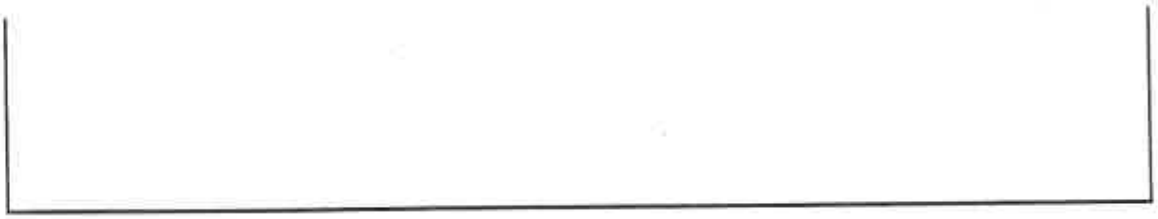
Plot Number: 12 Compass Direction: W 266° Canopy Closure: 60°

Soil Series: Chocorua Ground Cover: ~10% sphagnum moss leaf litter Slope: 0-3 %

Surrounding Area Description: ≈ 20 m. from edge Aspect: variable

Max. Inundation/Water Level: 55 %: 0

Plot Profile:



Plot Data:

**TREES**

| Species | Circum. | Height |
|---|---|---|
| red maple | 2' | 42' |
| red maple | 1.8' | 42' |
| red maple | 1.6' | 38' |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| Total Basal Area | 108.34 | sq. inches |

**SAPLINGS**

| Species | Circum. | Height |
|---|---|---|
| yellow birch | .6' | 20' |
| yellow birch | .8' | 24' |
| red maple | .9' | 24' |
| yellow birch | 1.2' | 26' |
| yellow birch | .7' | 18' |
| yellow birch | .6 | 18' |
| eastern hemlock | .4 | 14' |
| | | |
| | | |
| | | |
| | | |
| | | |
| Total Count | 6 | |

**DEAD TREES**

| Species | Circum. | Height |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| Total Basal Area | | |

**SHRUBS**

| Species | % Cover | Height |
|---|---|---|
| winter berry | | |
| holly | 4 | 6' |
| highbush blueberry | 2 | 5' |
| highbush blueberry | 4 | 7' |
| | | |
| | | |
| | | |
| | | |
| Total % Cover | 10 | |

Plot Data: **Herbaceous**

| Species | % Cover | | Species | % Cover |
|---|---|---|---|---|
| sensitive fern | 4 | | Bristly stalk | |
| cinnamon fern | 60 | | sedge | 15 |
| bladder sedge | 5 | | Flat topped | |
| green wood | | | aster | 4 |
| orchid | 2 | | whorled | |
| marsh bedstraw | 2 | | aster | 2 |
| N. bugleweed | 2 | | Canada Manna | |
| long sedge | 4 | | grass | 5 |
| gold thread | 2 | | N. white violet | 2 |
| eastern white | | | Marsh Fern | 4 |
| pine | 1 | | | |
| starflower | 1 | | | |
| Canada | | | | |
| mayflower | 1 | | | |
| bunchberry | 1 | | | |
| wild sasparilla | 2 | | | |
| | | | | |
| | | | | |
| | | | | |
| Total % Cover | 87 | | Total % Cover | 32 |

Comments:

* deer scat and tracks located within plot

| SCIENTIFIC NAME | COMMON NAME | FAMILY | R1IND |
|---|---|---|---|
| Acer pensylvanicum | Maple, Striped | Aceraceae | FACU |
| Acer rubrum | Maple, Red | Aceraceae | FAC |
| Acer saccharum | Maple, Sugar | Aceraceae | FACU |
| Acer spicatum | Maple, Mountain | Aceraceae | FACU- |
| Agrostis alba | Grass, Red Top | Poaceae | FACW |
| Agrostis perennans | Bentgrass, Perennial | Poaceae | FACU |
| Agrostis stolonifera | Bentgrass, Spreading | Poaceae | FACW |
| Agrostis tenuis | Bentgrass, Slender | Poaceae | UPL |
| Alnus rugosa | Alder, Speckled | Betulaceae | FACW+ |
| Amelanchier arborea | Serviceberry, Downy | Rosaceae | FAC- |
| Anemone quinquefolia | Thimble-weed, Woodland | Ranunculaceae | FACU |
| Anthoxanthum odoratum | Grass, Sweet Vernal | Poaceae | FACU |
| Aralia hispida | Sarsaparilla, Bristly | Araliaceae | UPL |
| Aralia nudicaulis | Sarsaparilla, Wild | Araliaceae | FACU |
| Arisaema triphyllum | Jack-in-the-Pulpit, Swamp | Araceae | FACW- |
| Aronia (Pyrus) arbutifolia | Chokeberry, Red | Rosaceae | FACW |
| Aster acuminatus | Aster, Whorled | Asteraceae | FAC-? |
| Aster cordifolius | Aster, Heart-leaved | Asteraceae | UPL |
| Aster divaricatus | Aster, White Wood | Asteraceae | UPL |
| Aster lateriflorus | Aster, Calico | Asteraceae | FACW- |
| Aster novae-angliae | Aster, New England | Asteraceae | FACW- |
| Aster puniceus | Aster, Swamp (Purple-stemmed) | Asteraceae | OBL |
| Aster simplex | Aster, Panicled | Asteraceae | FACW |
| Aster umbellatus | Aster, Flat-Topped | Asteraceae | FACW |
| Athyrium filix-femina | Lady Fern | Polypodiaceae | FAC |
| Athyrium thelypteroides | Fern, Silvery Lady | Polypodiaceae | FAC |
| Bartonia virginica | Screwstem, Yellow | Gentianaceae | FACW |
| Betula alleghaniensis | Birch, Yellow | Betulaceae | FAC |
| Betula lenta | Birch, Black | Betulaceae | FACU |
| Betula papyrifera | Birch, Paper or White | Betulaceae | FACU |
| Betula populifolia | Birch, Gray | Betulaceae | FAC |
| Bidens connata | Beggar-Ticks, Purple-stem (Swar | Asteraceae | FACW+ |
| Bidens frondosa | Beggar-ticks, Devil's | Asteraceae | FACW |
| Brachyelytrum erectum | Grass, Woodland | Poaceae | FAC+? |
| Carex angustior (=echinata) | Sedge, Little Prickly | Cyperaceae | OBL? |

| SCIENTIFIC NAME | COMMON NAME | FAMILY | R1IND |
|---|---|---|---|
| Carex arctata | Sedge, Drooping Wood | Cyperaceae | FAC? |
| Carex atlantica | Sedge, Prickly Bog | Cyperaceae | FACW+ |
| Carex brunnescens | Sedge, Brownish | Cyperaceae | FACW |
| Carex canescens | Sedge, Hoary | Cyperaceae | OBL |
| Carex cephalantha (=echinata) | Sedge, Little Prickly | Cyperaceae | OBL? |
| Carex crinita | Sedge, Fringed | Cyperaceae | OBL |
| Carex debilis | Sedge, White-edge | Cyperaceae | FAC |
| Carex deweyana | Sedge, Short-Scale | Cyperaceae | FACU |
| Carex disperma | Sedge, Soft-Leaf | Cyperaceae | FACW+ |
| Carex echinata | Sedge, Little Prickly | Cyperaceae | OBL? |
| Carex gracillima | Sedge, Graceful | Cyperaceae | FACU? |
| Carex intumescens | Sedge, Bladder | Cyperaceae | FACW+ |
| Carex leptalea | Sedge, Bristly-stalk | Cyperaceae | OBL |
| Carex lonchocarpa (=folliculata) | Sedge, Long | Cyperaceae | OBL |
| Carex nigromarginata | Sedge, black-margined | Cyperaceae | UPL |
| Carex pensylvanica | Sedge, Pennsylvania | Cyperaceae | UPL |
| Carex prasina | Sedge, Drooping | Cyperaceae | OBL |
| Carex projecta | Sedge, Necklace | | FACW |
| Carex rosea | Sedge, Rose-like | Cyperaceae | FACU? |
| Carex scoparia | Sedge, Pointed Broom | Cyperaceae | FACW |
| Carex stipata | Sedge, Stalk-grain | Cyperaceae | OBL? |
| Carex stricta | Sedge, Uptight or Tussock | Cyperaceae | OBL |
| Carex tenera | Sedge, Slender | Cyperaceae | FAC |
| Carex tribuloides | Sedge, Blunt Broom | Cyperaceae | FACW+ |
| Carex trisperma | Sedge, Three-Seed | Cyperaceae | OBL |
| Cephalanthus occidentalis | Buttonbush | Rubiaceae | OBL |
| Chelone glabra | Turtlehead, White | Scrophulariaceae | OBL |
| Circaea alpina | Nightshade, Small Enchanter's | Onagraceae | FACW |
| Clematis virginiana | Virgin's-Bower, Virginia | Ranunculaceae | FACU- |
| Clintonia borealis | Bead-Lily, Blue | Liliaceae | FAC |
| Coptis trifolia (=groenlandica) | Goldthread | Ranunculaceae | FACW |
| Cornus canadensis | Bunchberry, Canada | Cornaceae | FAC- |
| Cornus stolonifera | Dogwood, Red-osier | Cornaceae | FACW+ |
| Crataegus spp. | Hawthorne | Rosaceae | - |
| Cypripedium acaule | Lady's-Slipper, Pink | Orchidaceae | FACU |

| SCIENTIFIC NAME | COMMON NAME | FAMILY | R1IND |
|---|---|---|---|
| Danthonia spicata | Wild Oat or Poverty Grass | Poaceae | UPL |
| Dennstaedtia punctilobula | Hay-scented Fern | Polypodiaceae | UPL |
| Dichanthelium acuminatum | Grass, Panic | Poaceae | FAC |
| Diervilla lonicera | Honeysuckle, Bush- | Caprifoliaceae | UPL |
| Dryopteris clintoniana | Woodfern, Clinton's | Polypodiaceae | FACW |
| Dryopteris cristata | Shield-fern, Crested | Polypodiaceae | FACW+ |
| Dryopteris intermedia | Woodfern, Evergreen | Polypodiaceae | FACU |
| Dryopteris marginalis | Shield-fern, Marginal | Polypodiaceae | FACU- |
| Dryopteris spinulosa | Woodfern, Spinulose | Polypodiaceae | FAC+ |
| Eleocharis obtusa | Spikerush, Blunt | Cyperaceae | OBL |
| Epigaea repens | Arbutus, Trailing | Ericaceae | UPL |
| Epipactis helleborine | Helleborine | Orchidaceae | NL |
| Equisetum arvense | Horsetail, Field | Equisetaceae | FAC |
| Eupatoriadelphus maculatus | Joe-Pye-Weed, Spotted | Asteraceae | FACW |
| Eupatorium perfoliatum | Boneset, Common | Asteraceae | FACW+ |
| Euthamia graminifolia | Fragrant-Golden-Rod, Flat-Top | Asteraceae | FAC |
| Fagus grandifolia | Beech, American | Fagaceae | FACU |
| Fragaria virginiana | Strawberry, Virginia | Rosaceae | FACU |
| Fraxinus americana | Ash, White | Oleaceae | FACU |
| Fraxinus nigra | Ash, Black | Oleaceae | FACW |
| Galium palustre | Bedstraw, Marsh | Rubiaceae | OBL |
| Gaultheria procumbens | Wintergreen | Ericaceae | FACU |
| Glyceria canadensis | Grass, Canada Manna | Poaceae | OBL |
| Glyceria maxima (=grandis) | Grass, Reed Meadow | Poaceae | OBL |
| Glyceria striata | Grass, Fowl Manna | Poaceae | OBL |
| Hamamelis virginiana | Witch-hazel, American | Hamamelidaceae | FAC- |
| Hydrocotyle americana | Water Pennywort | Apiaceae | OBL |
| Hypericum canadense | St. Johnswort, Canada | Hypericaceae | FACW |
| Hypericum punctatum | St. Johnswort, Spotted | Hypericaceae | FAC- |
| Ilex verticillata | Winterberry, Common | Aquifoliaceae | FACW+ |
| Impatiens capensis | Touch-me-not, Spotted | Balsaminaceae | FACW |
| Iris versicolor | Blue flag | Iridaceae | OBL |
| Juncus effusus | Rush, Soft | Juncaceae | FACW+ |
| Leersia oryzoides | Cut-grass, Rice | Poaceae | OBL |
| Lemna minor | Duckweed, Lesser | Lemnaceae | OBL |

| SCIENTIFIC NAME | COMMON NAME | FAMILY | R1IND |
|---|---|---|---|
| Lilium philadephicum | Lily, Wood | Liliaceae | FACU+ |
| Lonicera canadensis | Honeysuckle, American Fly | Caprifoliaceae | FACU |
| Ludwigia palustris | Seedbox, Marsh | Onagraceae | OBL |
| Lycopodium annotinum | Clubmoss, Stiff | Lycopodiaceae | FAC |
| Lycopodium clavatum | Pine, Running | Lycopodiaceae | FAC |
| Lycopodium flabelliforme | Ground Cedar, Northern | Lycopodiaceae | FACU? |
| Lycopodium lucidulum | Clubmoss, Shining | Lycopodiaceae | FACW- |
| Lycopodium obscurum | Clubmoss, Tree | Lycopodiaceae | FACU |
| Lycopodium tristachyum | Ground Cedar | Lycopodiaceae | UPL |
| Lycopus uniforus | Bugleweed, Northern | Lamiaceae | OBL |
| Lycopus virginicus | Bugleweed, Virginia | Lamiaceae | OBL |
| Lyonia ligustrina | Maleberry | Ericaceae | FACW |
| Lysimachia ciliata | Loosestrife, Fringed | Primulaceae | FACW |
| Lysimachia terrestris | Loosestrife, Swamp (Candles) | Primulaceae | OBL |
| Maianthemum canadense | Lily-of-the-Valley, Wild | Liliaceae | FAC- |
| Malaxis unifolia | Adder's-mouth, Green | Orchidaceae | FAC |
| Medeola virginiana | Indian Cucumber Root | Liliaceae | UPL? |
| Mitchella repens | Partridgeberry | Rubiaceae | FACU |
| Onoclea sensibilis | Fern, Sensitive | Polypodiaceae | FACW |
| Oryzopsis racemosa | Mountain Rice, Black-fruited | Poaceae | UPL |
| Osmunda cinnamomea | Cinnamon Fern | Osmundaceae | FACW |
| Osmunda claytoniana | Interrupted Fern | Osmundaceae | FAC |
| Osmunda regalis | Royal Fern | Osmundaceae | OBL |
| Ostrya virginiana | Hop-Hornbeam | Betulaceae | FACU- |
| Oxalis montana | Woodsorrel, White | Oxalidaceae | FAC- |
| Panicum sp. | Grass, Panic | Poaceae | |
| Panicum xanthophysum | Grass, Yellow Bladder Panic | Poaceae | UPL |
| Parthenocissus quinquefolia | Virginia Creeper | Vitaceae | FACU |
| Pinus strobus | Pine, Eastern White | Pinaceae | FACU |
| Platanthera (Habenaria) clavellata | Orchis, Green Wood | Orchidaceae | FACW+ |
| Platanthera grandiflora | Orchid, Large Purple Fringed | Orchidaceae | FACW |
| Poa pratensis | Bluegrass, Kentucky | Poaceae | FACU |
| Polygonatum pubescens | Solomon's Seal, Hairy | Liliaceae | FACU? |
| Polygonum amphibium | Smartweed, Water | Polygonaceae | OBL |
| Polygonum cilinode | Bindweed, Fringed | Polygonaceae | UPL |

| SCIENTIFIC NAME | COMMON NAME | FAMILY | R1IND |
|---|---|---|---|
| Polygonum hydropiper | Smartweed, Marshpepper | Polygonaceae | OBL |
| Polygonum sagittatum | Tearthumb, Arrow-leaved | Polygonaceae | OBL |
| Polypodium virginianum | Polypody, Common | Polypodiaceae | UPL |
| Polystichum acrostichoides | Fern, Christmas | Polypodiaceae | FACU- |
| Populus grandidentata | Aspen, Bigtooth | Salicaceae | FACU- |
| Populus tremula | Aspen, Quaking | Salicaceae | FACU |
| Potamogeton epihydrus | Pondweed, Ribbonleaf | Zosteraceae | OBL |
| Potentilla canadensis | Cinquefoil, Dwarf | Rosaceae | FACU- |
| Prenanthes alba | Rattlesnake-root, White | Asteraceae | FACU |
| Prunus serotina | Cherry, Black | Rosaceae | FACU |
| Pteridium aquilinum | Fern, Bracken | Polypodiaceae | FACU |
| Pyrola elliptica | Pyrola, Shinleaf | Pyrolaceae | UPL? |
| Pyrus malus | Apple | Rosaceae | UPL |
| Quercus rubra | Oak, Red (incl.Northern) | Fagaceae | FACU- |
| Ranunculus acris | Buttercup, Tall | Ranunculaceae | FAC+ |
| Ribes glandulosm | Currant, Skunk | Saxifragaceae | FACW |
| Ribes lacustre | Currant, Prickly | Saxifragaceae | FACW |
| Rubus allegheniensis | Blackberry, Allegheny | Rosaceae | FAU- |
| Rubus flagellaris | Dewberry | Rosaceae | UPL |
| Rubus hispidus | Blackberry, Bristly (Dewberry) | Rosaceae | FACW |
| Rubus idaeus | Raspberry, Common Red | Rosaceae | FAC- |
| Rubus pubescens | Blackberry, Dwarf | Rosaceae | FACW |
| Rumex acetosella | Sorrel, Field or Sheep | Polygonaceae | UPL |
| Sambucus canadensis | Elder, American | Caprifoliaceae | FACW- |
| Sambucus racemosa | Elder, European Red | Caprifoliaceae | FACU |
| Scutellaria lateriflora | Skullcap, Blue | Lamiaceae | FACW+ |
| Sisyrinchium atlanticum | Blue-eyed Grass, Eastern | Iridaceae | FACW |
| Smilacina racemosa | False-Solomon's-Seal, Feather | Liliaceae | FACU- |
| Solidago arguta | Goldenrod, Sharp-leaved | Asteraceae | UPL |
| Solidago canadensis | Goldenrod, Canada | Asteraceae | FACU |
| Solidago rugosa | Goldenrod, Wrinkled | Asteraceae | FAC |
| Sparganium americanum | Bur-reed, American | Sparganiaceae | OBL |
| Sparganium sp. | Bur-reed | Sparganiaceae | OBL |
| Sphagnum spp | Sphagnum | Sphagnaceae | OBL |
| Spiraea latifolia | Meadowsweet, Broad-leaf | Rosaceae | FAC+ |

| SCIENTIFIC NAME | COMMON NAME | FAMILY | R1IND |
|---|---|---|---|
| Spiraea tomentosa | Steeplebush | Rosaceae | FACW |
| Spiranthes cernua | Ladies' Tresses, Nodding | Orchidaceae | FACW |
| Taxus canadensis | Yew, Canadian | Taxaceae | FAC |
| Thalictrum pubescens (=polygamum) | Meadow-rue, Tall | Ranunculaceae | FACW+ |
| Thelypteris noveboracensis | Fern, New York | Polypodiaceae | FAC |
| Thelypteris phegopteris | Fern, Long Beech | Polypodiaceae | FAC-? |
| Thelypteris simulata | Fern, Massachusetts | Polypodiaceae | FACW |
| Thelypteris thelypteroides (=palustris) | Fern, Marsh | Polypodiaceae | FACW+ |
| Tiarella cordifolia | Foamflower | Saxifragaceae | FAC- |
| Toxicodendron radicans | Ivy, Poison | Anacardiaceae | FAC |
| Triadenum (Hypericum) virginicum | St. Johnswort, Marsh | Hypericaceae | OBL |
| Trientalis borealis | Starflower | Primulaceae | FAC |
| Trifolium pratense | Clover, Red | Fabaceae | FACU- |
| Trillium erectum | Trillium, Purple | Liliaceae | FACU- |
| Tsuga canadensis | Hemlock, Eastern | Pinaceae | FACU |
| Uvularia sessilifolia | Bellwort, Sessile-leaf | Liliaceae | FACU- |
| Vaccinium angustifolium | Blueberry, Lowbush | Ericaceae | FACU- |
| Vaccinium corymbosum | Blueberry, Highbush | Ericaceae | FACW- |
| Veratrum viride | False-hellebore, American | Liliaceae | FACW+ |
| Veronica officinalis | Speedwell, Common | Scrophulariaceae | FACU- |
| Viburnum acerifolium | Viburnum, Maple-Leaved | Caprifoliaceae | UPL |
| Viburnum cassinoides | Witherod | Caprifoliaceae | FACW |
| Viburnum lantanoides (=alnifolium) | Hobblebush | Caprifoliaceae | FAC |
| Viburnum lentago | Nannyberry | Caprifoliaceae | FAC |
| Viburnum recognitum | Arrowwood, Northern | Caprifoliaceae | FACW- |
| Viola cucullata | Violet, Marsh Blue | Violaceae | FACW+ |
| Viola pallens | Violet, Northern White | Violaceae | OBL |

Wildlife Species List - Greater Goose Pond Forest
Summer 1995

## Mammals

| Scientific Name | Common Name |
|---|---|
| *Ursus americanus* | Black bear |
| *Procyon lotor* | Raccoon |
| *Mustela vison* | Mink |
| *Martes pennanti* | Fisher |
| *Lutra canadensis* | River otter |
| *Canis latrans sp.* | Eastern coyote |
| *Vulpes vulpes* | Red fox |
| *Castor canadensis* | Beaver |
| *Ondatra zibethicus* | Muskrat |
| *Erethizon dorsatum* | Porcupine |
| *Tamiasciurus hudsonicus* | Red squirrel |
| *Tamias striatus* | Eastern chipmunk |
| *Clethrionomys g. gapperi* | Red-backed vole |
| *Lepus americanus* | Snowshoe hare |
| *Odocoileus virginianus* | White-tailed deer |

## Birds

{All but the heron, turkey, woodcock, and kingfisher likely nest in the vicinity of the study area based upon repeated vocalizations by males heard during site visits. Those species that were confirmed nesters based upon observations of nest material, eggs, or fledglings are indicated with a '*'}

| Scientific Name | Common Name |
|---|---|
| *Ardea herodias* | Great blue heron |
| *Aix sponsa* | Wood duck* |
| *Anas platyrhynchos* | Mallard* |
| *Buteo platypterus* | Broad-winged hawk |
| *Meleagris gallopavo* | Wild turkey |
| *Bonasa umbellus* | Ruffed grouse |
| *Scolopax minor* | American woodcock |
| *Zenaida macroura* | Mourning dove |
| *Bubo virginianus* | Great horned owl |
| *Archilochis colubris* | Ruby-throated hummingbird |
| *Ceryle alcyon* | Belted kingfisher |
| *Colaptes auratus* | Common flicker |
| *Dryocopus pileatus* | Pileated woodpecker |
| *Sphyrapicus varius* | Yellow-bellied sapsucker |
| *Picoides villosus* | Hairy woodpecker |
| *Picoides pubescens* | Downy woodpecker |
| *Myiarchus crinitus* | Great-crested flycatcher |
| *Tyrannus tyrannus* | Eastern kingbird* |
| *Sayornis phoebe* | Eastern phoebe* |
| *Contopus virens* | Eastern wood pewee |

**Birds** (cont'd)

| | |
|---|---|
| *Tachycineta bicolor* | Tree swallow |
| *Cyanocitta cristata* | Blue jay |
| *Corvus brachyrhynchos* | American crow |
| *Parus atricapillus* | Black-capped chickadee |
| *Sitta carolinensis* | White-breasted nuthatch |
| *Sitta canadensis* | Red-breasted nuthatch |
| *Certhia familiaris* | Brown creeper |
| *Catharus guttatus* | Hermit thrush |
| *Catharus fuscescens* | Veery |
| *Bombycilla cedrorum* | Cedar waxwing |
| *Vireo olivaceus* | Red-eyed vireo |
| *Mniotilta varia* | Black-and-white warbler |
| *Dendroica caerulescens* | Black-throated blue warbler |
| *Dendroica virens* | Black-throated green wrabler |
| *Dendroica coronata* | Yellow-rumped warbler |
| *Seiurus motacilla* | Louisiana waterthrush |
| *Geothlypis trichas* | Common yellowthroat |
| *Piranga ludovicianus* | Scarlet tanager |
| *Quiscalus quiscalus* | Common grackle* |
| *Ageliaeus phoeniceus* | Red-winged blackbird* |
| *Icterus galbula* | Northern oriole |
| *Pipilo erythrophthalmus* | Rufous-sided towhee |
| *Carduelis tristes* | American goldfinch |

**Amphibians & reptiles**

| | |
|---|---|
| *Rana catesbeiana* | Bullfrog |
| *Rana palustris* | Pickerel frog |
| *Rana clamitans melanota* | Green frog |
| *Hyla versicolor* | Gray tree frog |
| *Bufo a. americanus* | Eastern american toad |
| *Notophthalmus v. viridescens* | Red spotted newt |

**Arthropods** (Primarily families)

| | |
|---|---|
| Simuliidae | black flies |
| Anopheles spp. | mosquitos |
| Collembola sp. | springtails |
| *Limnephilidae rhombicus* | caddisfly |
| Libellulidae | water skimmers |
| Gerridae | water striders |
| Lycaenidae, subfamily Plebeiinae | common blue butterfly |
| *Anisoptera* sp. | white-banded dragonfly |
| *Enallagma* sp. | bluet |
| Aestinidae | blue darner |
| Trichoceridae | zebra cranefly |