

A SURVEY FOR RARE PLANTS AT ATON FOREST

RESULTS OF MOORHEAD FIELD SURVEYS 2005 - 2010



Prepared for
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COVER PHOTO: Four of the five State-listed plants documented at Aton Forest, 2005-2010. Clockwise from upper left: *Mitella nuda*, *Corallorhiza trifida*, *Ribes glandulosum*, *Carex novae-angliae* (close-up of inflorescence), and *Carex novae-angliae* (habit).

INTRODUCTION

In 2005, I was commissioned by Aton Forest, Inc., to conduct a botanical survey of Aton Forest, a research forest occupying (during most of this survey), 1162± acres (470 ha) in Colebrook and Norfolk, Litchfield County, Connecticut. The object of the botanical survey was to discover any populations of rare vascular plants that that were detectable in the spring and early summer, and to assess the potential for rare plants detectable later in the season. For the purposes of this survey, “rare plants” include primarily any plant taxa that are currently “State-listed” pursuant to Connecticut's Endangered Species Act (State of CT 2009) as Endangered, Threatened, or Special Concern (State of CT 2010). However, also of conservation interest are plants whose native occurrence in Connecticut has not yet been documented, especially if they are tracked as rare plants in adjacent states. Also of interest was a set of species known to be native to Connecticut but whose status (i.e., how abundant or rare they are) is poorly understood. I prepared a report of the findings of the Apr-Jun 2005 survey, which I submitted in early 2006.

I was then commissioned to conduct additional rare plant survey of Aton Forest in 2006, the emphasis of which was on potential rare species with later phenologies (*i.e.*, that were best detected/identified in mid- to late summer and fall), and exploration of little-known areas and features whose potential for rare plants was as yet unknown. The bulk of this field survey was conducted in 2006, but some additional survey was conducted while this report was in preparation, in 2009 and 2010. In this report, I have combined the findings of the 2005 survey and the 2006-2101 survey, so that results of all my rare plant survey work at Aton Forest to-date may be found in this one document.

It should be noted that a 10± acre parcel was added to Aton Forest, Inc., since 2006. This parcel was not included in my surveys, though I traversed a portion of it on 17 May 2010.

METHODOLOGY

I prepared for field survey at Aton forest as follows. I reviewed existing aerial photographs, soils (USDA-NRCS & CT-DEP 1995), bedrock (Rodgers 1985), and surficial geology (Stone et al. 1992) maps, and a recent forest cover type map produced by EECOS. I queried Aton Forest's Executive Director John Anderson about certain natural communities that occurred at, or might occur at, Aton Forest. With this information, before starting field survey, I developed a list of “survey target taxa”, *i.e.*, State-listed plant taxa that might be expected to occur at Aton. This first list was developed based on a combination of my field experience and research, consultation of the botanical literature of Connecticut and adjacent states, and consultation with the Connecticut Department of Environmental Protection's Natural Diversity Data Base (CT-DEP-NDDDB). John Anderson compared this first survey target taxa list to the late Frank Egler's draft “Flora of Aton Forest” (Egler 1990) and other Egler notes (Egler ca. 1940-1996) on the plants at Aton. John extracted from these sources location information for

the several survey target taxa that evidently occurred naturally at Aton (as opposed to having been introduced – Egler’s “Flora” mentions several of these). I also screened Egler’s “Flora” for 1) survey target taxa that Egler may have noted using names other than current names, and notes on the occurrences of “indicator species”, i.e., species that indicate the presence of certain habitats/plant communities which have potential as habitat for certain State-listed species. John interpreted the Egler’s location information for these additional species.

Based primarily on 1) John Anderson’s knowledge of habitats and plant communities at Aton, and 2) location information for State-listed and indicator species extracted from Egler’s “Observed Flora of Aton Forest” (Egler 1990), and 3) the phenology of the subset of survey target taxa I considered most likely to occur at Aton, I stratified Aton Forest into priority survey areas. In 2005, the focus was on potential areas for rare species most, or only, detectable and/or identifiable in April, May, and June. In 2006, the foci of survey effort was on 1) potential areas for species most (or only) detectable and/or identifiable in the July-October period, and 2) exploration of areas and features at Aton about which not enough was known to judge their potential as rare plant habitat.

In 2005, I conducted a total of 26.5 hours of field survey at Aton on the following dates:

28 April 2005
11 May 2005
9 June 2005
24 June 2005
21 November 2005

From 2006 through 2010, I conducted 36.75 hours of field survey at Aton, on the following dates:

17 May 2006
11 June 2006
5 August 2006
8 August 2006
10 October 2006
23 October 2006
26 May 2009
17 May 2010

The cumulative area covered by field survey in 2005 within Aton Forest’s boundaries was roughly 120 ac (59 ha). Subsequent survey in 2006, 2009, and 2010 covered an additional 104 ac (42 ha), roughly. Thus, the cumulative area of Aton that I have inspected at least once closely enough to have detected rare plant occurrences in the range of 130-230 acres (52-94 ha), or 11-20% of Aton; perhaps 1/4 this area I have surveyed twice or more times during the growing season. These figures were calculated by applying a minimum 25-ft radius and a maximum 50-ft radius to my routes of survey.

If one assumes that a larger radius of, say, 100 ft can be used for the distance at which I could visually detect natural communities of high potential as rare plant habitat, then the area that I inspected for natural communities is ~390 ac (157 ha), or 33% of Aton. My total time conducting field survey 2005-2010 is about 65.5 hours.

Based on field reconnaissance and survey at Aton Forest, I revised the list of survey target taxa to include the 88 taxa presented in Table 2, page 12. This list is based upon my current understanding of habitat affinities and distribution of certain State-listed plants in Connecticut, in combination with my current understanding of habitats and plant communities that are present at Aton Forest. Having now seen much of Aton Forest, I believe that there is little chance that several species, especially certain calciphiles, on my first target taxa list occur at Aton. However, since there is a substantial portion of Aton that I have seen, I have not deleted these species from the target list, but rather noted my assessment of their potential in the "Comments" field.

Principal taxonomic references consulted during this survey are listed in the first subsection of the References section. In this report, taxonomy of State-listed plant taxa follows Regulations of Connecticut State Agencies Sections 26-306-4 to 26-306-6, inclusive (State of CT 2010). Taxonomy for legally banned plants invasive and potentially invasive plants follows Connecticut Public Acts 03-136 and 04-203, and follows Mehrhoff et al. (2003) for invasive and potentially invasive plants that are not yet legally banned. For all other plants, taxonomy either follows the published volumes of Flora of North America (FNA) series (Flora of North America Editorial Committee 1997; 2000; 2002a; 2002b; 2003a; 2003b), for all those plant groups that have been treated in a published FNA volume, or Haines' *Flora Novae-Angliae* 23 Feb 2010 Draft (Haines 2010) for groups whose treatment has not yet been published in FNA, and when Haines' taxonomy differs from FNA.

Plant communities were interpreted and classified using The Vegetation of Connecticut: A Preliminary Classification (Metzler & Barrett 2006) as a guide.

Locations of State-listed plants were documented using a Garmin GPSMAP 76 hand-held GPS receiver. These data were downloaded to a computer and mapped using ARCVIEW 3.2a GIS software. The accuracy and precision of these location data was supervised by comparison to 2004 digital B&W aerial ortho-photography and 2004 B&W stereo-pair 1:12,000 aerial photograph prints.

Each State-listed plant occurrence was documented with photographs and/or collection of a voucher specimen, and a CT-DEP-NDDDB Special Plant Survey Form was completed for each occurrence. The Special Plant Survey Form includes a basic description of the rare plant occurrence and its ecological setting, together with assessments of management issues, threats, and comparisons to other known occurrences. Copies of which were transmitted to the CT-DEP-NDDDB as well as to Aton Forest. State-listed plant voucher specimens from the 2005 survey were deposited at the George Safford Torrey Herbarium (CONN) at University of Connecticut - Storrs. Voucher specimens from the late survey work will soon be deposited at the same herbarium.

RESULTS

Development of natural community/vegetation type and potential rare plant survey target lists.

Prior to the commencement of field survey in 2005, I had some idea of what natural communities and vegetation types occurred, and might occur, at Aton Forest, based on my previous field survey experience at nearby sites such as the Phelps Tract, Great Mountain Forest, Kitchel Natural Area Preserve, Canaan Mountain Natural Area Preserve, the site of the proposed Yale Farm Golf Club, and even a bit of Aton Forest itself (a brief unintentional trespass onto Knapp Hill several years ago). My sense of what to expect was further refined by conversations with John Anderson, a review of Egler's writings, and a forest type map created by EECOS. Based on this, I developed "first approximation" lists of target natural communities/vegetation types that existed or might exist at Aton and target rare plants that potentially occurred in them. These target lists were refined by actual field reconnaissance and survey in 2005, and the revised lists were presented in my report of the 2005 survey. These revised lists provided the priority targets for my 2006 field reconnaissance and survey.

The objectives of my field survey in 2006 were 1) survey for rare plants that would have been difficult to detect and/or identify before mid-summer, and 2) "*de novo*" survey for additional natural communities/vegetation types that had potential as rare plant habitat and/or had biodiversity conservation significance independent of their rare plant habitat potential (e.g., communities that are rare or uncommon, exemplary, little-known communities, etc.). Based on the findings of this 2006 field work, together with the small amount of field work in 2009 and 2010, I have revised and annotated the above-described lists to reflect my current understanding of Aton's natural communities/vegetation types and its actual and potential rare plants. They are presented in this report as Tables 1 and 2, respectively, below.

Table 1. Natural communities/vegetation types identified to-date at Aton Forest that have been focus areas for 2005-2010 rare plant survey and/or should be focus of future rare plant survey¹.

Natural Community (<i>sensu</i> Metzler and Barrett 2006) ²	Metzler and Barrett Vegetation Classification Unit[s] (Metzler and Barrett 2006)	Comments
Dry Subacidic Forests	Pignut hickory – White ash (<i>Carya glabra</i> - <i>Fraxinus americana</i>) forests association	Occurring on summits, this natural community/vegetation type has been identified as a “Critical Habitat”, i.e., a habitat identified in Connecticut's Comprehensive Wildlife Strategy as important to “Greatest Conservation Need” (GCN) wildlife species (CT-DEP 2005). Both Aton occurrences are mapped and included in CT-DEP's statewide “Critical Habitat” GIS layer (CT-DEP 2009). To-date, this is the only “Critical Habitat” recognized by CT-DEP at Aton. Also relatively high potential as rare plant habitat, and a focus of my 2005-2006 survey work (no rare plants yet found). Merits additional inventory, especially for more cryptic species.
Mesic Acidic Forests on Glacial Till	Sugar maple – American beech – Yellow birch (<i>Acer saccharum</i> - <i>Fagus grandifolia</i> - <i>Betula alleghaniensis</i>) forests association	“Northern Hardwoods”, in the strictest sense (i.e., excluding Maple-Ash-Basswood forests), but including both deciduous and mixed Hemlock-Northern Hardwoods. Actual rare plant habitat.
Mesic Acidic Forests on Glacial Till	Sugar maple – White ash – American basswood (<i>Acer saccharum</i> – <i>Fraxinus americana</i> - <i>Tilia americana</i>) forests association	Some or all of these have been mapped as Northern Hardwoods by EECOS. Others may be mapped as Mixed Deciduous. Actual rare plant habitat.
Acidic Seepage Forests	Sugar maple – White ash – American basswood (<i>Acer saccharum</i> – <i>Fraxinus americana</i> - <i>Tilia americana</i>) forests association	Some or all of these have been mapped as Northern Hardwoods by EECOS. Others may be mapped as Mixed Deciduous. Actual rare plant habitat.
Acidic Seepage Swamps	Red maple / Skunk cabbage (<i>Acer rubrum</i> / <i>Symplocarpus foetidus</i>) seasonally flooded forests association (in part)	These include mixed Hemlock-deciduous seepage swamps. A number of these appear to be more or less “sweet”, though not to the point of being classifiable as “Circumneutral”. Actual rare plant habitat.
Acidic Basin Swamp	Red maple / Skunk cabbage (<i>Acer rubrum</i> / <i>Symplocarpus foetidus</i>) seasonally flooded forests association	The one known occurrence of this resembles a “bog forest”. Actual rare plant habitat.

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Natural Community (<i>sensu</i> Metzler and Barrett 2006) ²	Metzler and Barrett Vegetation Classification Unit[s] (Metzler and Barrett 2006)	Comments
Talus Forest/Woodlands	Northern red oak / Rock polypody (<i>Quercus rubra</i> / <i>Polypodium virginiana</i>) woodlands association (in part)	Actual rare plant habitat.
Medium Fen? ³	<i>Chamaedaphne calyculata</i> saturated dwarf shrublands ³	A small enclave of fen species (incl. <i>Chamaedaphne</i> , <i>Carex lasiocarpa</i>) in shrubby unforested wetland complex flanking a brook. Transitional between fen and shrub swamp, suspect formerly with stronger fen character. Seen only late in growing season. Merits more study/inventory.
Acidic Spring Fen? ³ (= spring seeps in various forest types ²)	<i>Chrysosplenium americanum</i> saturated forb vegetation ³	Of interest especially, series of seeps low on slopes above a brook. Merits more study/inventory.
Acidic Seepage Swamps	<i>Tsuga canadensis</i> seasonally flooded forests ³ ; <i>Acer rubrum</i> / <i>Symplocarpus foetidus</i> seasonally flooded forests	Varying from <i>Tsuga</i> -dominated to mixed to deciduous. Metzler & Barrett Vegetation Units may be legitimately applied even when one of the nominal taxa does not occur in the occurrence (RE absence of <i>Symplocarpus foetidus</i> from Aton occurrences). Merit further study and inventory, especially for more cryptic species (e.g., <i>Corallorhiza trifida</i>).
floating <i>Sphagnum</i> mats ²	no equivalent	Floating/quaking <i>Sphagnum</i> -sedge-forb mats in a swamp. Early stages of bog/fen development? No bog/fen specialist spp. noted, but seen to-date only late in season. Merits more study/inventory.
Acidic Pond and Lake Shore (= fen-like pond shoreline vegetation)	no equivalent, or equivalent unclear	Open mossy wetlands on eastern and southern margins of a pond. Seen only late in growing season. Merits more study/inventory.

TABLE NOTES:

¹this is not a comprehensive list of natural communities/vegetation types I have identified at Aton forest to-date, but rather that subset that 1) host actual rare plant occurrences, 2) potentially host rare plant occurrences that have not yet been found, and 3) types that in my experience are unusual or little known whose potential for rare plants is indeterminate

² not a recognized entity in Metzler & Barrett (2006) natural community classification, or natural community equivalent[s] unclear

³resembling but not exact match with Metzler & Barrett (2006) unit

Table 2. Survey target taxa: State-listed plants that potentially occur at Aton Forest (including rare plants documented at Aton by this survey) ¹ .		
Plant taxon ^{2,4}	State Listing status ⁵	Comments
<i>Abies balsamea</i>	Threatened	Searched for by Moorhead 2005-2006, though not all potential habitat (i.e., most of Aton) covered. In 2010, relocated population found by John Anderson some years ago on adjacent property, now part of Aton, but failed to relocate nearby population observed by John several years ago on Aton property. More research & field work needed to determine if this occurrence is native.
<i>Agastache nepetoides</i>	Endangered	If present, most likely associated with open upland habitat or edges. Not searched for in 2005 due to phenology, not searched for by Moorhead in 2006 due to presumed low probability (based on historic records) and limited time budget.
<i>Alopecurus aequalis</i>	Threatened	Searched for by Moorhead in 2005 and 2006, but not all potential habitat covered.
<i>Anemone canadensis</i>	Endangered	Searched for by Moorhead during 2005 and 2006. Not all potential habitat covered.
<i>Antennaria neglecta</i> ssp. <i>petaloidea</i>	Special Concern (historic) ³	Potential habitat exists at Aton, but this species not searched for by Moorhead in 2005 and 2006, due to low priority of this species as a conservation concern, in Moorhead's opinion, and limited time budget.
<i>Arethusa bulbosa</i>	Special Concern (historic)	Arguable potential habitats for this species searched in 2006 by Moorhead, though only a relatively small portion covered during the flowering period, when this species is most detectable. There are historic records for this species from Norfolk
<i>Asclepias purpurascens</i>	Special Concern	Not covered by Moorhead in 2005 due to phenology or in 2006 due to presumed low probability (based on historic records) and limited time budget.
<i>Asplenium montanum</i>	Special Concern	Not covered by Moorhead Apr-Jun 2005 survey or in 2006 due to presumed low probability (based on historic records) and limited time budget. Relatively low likelihood based on cold local climate, but documented recently by author on Canaan Mt, thus not impossible at Aton. Need to determine if appropriate acid cliff habitat exists at Aton.
<i>Asplenium ruta-mararia</i>	Threatened	Not covered by Moorhead in 2005 or 2006. Unlikely but not impossible at Aton, depending on whether high-pH exposed cliff-like habitat exists, which appears not to occur at Aton, but this needs to be confirmed.
<i>Blephilia ciliata</i>	Special Concern (historic)	Surveyed for in 2006 in Dry Subacidic Forest communities.
<i>Blephilia hirsuta</i>	Special Concern (historic)	Not covered by Moorhead Apr-Jun 2005 survey due to phenology; searched for in 2006, but not all potential habitat covered.
<i>Botrychium simplex</i>	Special Concern (historic)	Searched for by Moorhead in 2005 and 2006, but not all potential habitat covered.

Table 2. Survey target taxa: State-listed plants that potentially occur at Aton Forest (including rare plants documented at Aton by this survey)¹.		
Plant taxon^{2,4}	State Listing status⁵	Comments
<i>Calamagrostis stricta</i> ssp. <i>inexpansa</i>	Special Concern	Not covered by Moorhead Apr-Jun 2005 survey due to phenology, searched for in 2006 in most likely habitat, except one site where additional potential habitat may exist.
<i>Cardamine douglassii</i>	Special Concern	Searched for by Moorhead during Apr-Jun 2005 survey and in 2006; unlikely but not impossible at Aton.
<i>Carex aestivalis</i>	Special Concern	Searched for by Moorhead 2005 and 2006, but not all potential habitat (i.e., most of Aton Forest upland) covered. It is among the most likely State-listed species to occur at Aton.
<i>Carex bushii</i>	Special Concern	Not covered by Moorhead Apr-Jun 2005 survey due to phenology.
<i>Carex castanea</i>	Endangered	Potential habitat searched for by Moorhead 2005-2010, and none found to-date.
<i>Carex crawfordii</i>	Special Concern (historic)	Not covered by Moorhead 2005-2010. Appears to be a calciphile, so probably unlikely at Aton.
<i>Carex cumulata</i>	Threatened	Not covered by Moorhead Apr-Jun 2005 survey due to phenology, nor in 2006 due to limited time budget.
<i>Carex foenea</i>	Special Concern (historic) ³	Not covered by Moorhead Apr-Jun 2005 survey due to phenology, searched for in 2006, but not all potential habitat covered. There is a historic unmapped record of this species from Norfolk.
<i>Carex formosa</i>	Special Concern	Not covered by Moorhead Apr-Jun 2005 survey due to phenology. No potential habitat discovered at Aton 2005-2010.
<i>Carex novae-angliae</i>	Special Concern	Large meta-occurrence discovered at Aton Forest in 2005, additional new sub-populations discovered 2006-2010.
<i>Carex oligocarpa</i>	Special Concern	Not covered by Moorhead Apr-Jun 2005 survey due to phenology. Dry Subacidic Forest, only potential habitat discovered at Aton to-date, covered in 2006. There is a historic record (1928) from Colebrook. A relatively cryptic species worth resurveying for.
<i>Carex magellanica</i>	Endangered	Searched for by Moorhead in 2006, as part of a suite of bog specialists that might occur in fen/bog-like habitats discovered late in 2006 growing season at Aton, based on their occurrence in poor fens/bogs elsewhere in the vicinity.
<i>Carex prairea</i>	Special Concern	Potential habitat searched for by Moorhead 2005-2010, and none yet found.
<i>Carex pseudo-cyperus</i>	Endangered	Not covered by Moorhead Apr-Jun 2005 survey due to phenology. Searched for in 2006, and all or most potential habitat covered at least once.

Table 2. Survey target taxa: State-listed plants that potentially occur at Aton Forest (including rare plants documented at Aton by this survey)¹.		
Plant taxon^{2,4}	State Listing status⁵	Comments
<i>Castilleja coccinea</i>	Threatened	Potential habitat searched for by Moorhead 2005-2010, and none found. Unlikely but not impossible at Aton
<i>Chamaelirium luteum</i>	Endangered	Not covered by Moorhead 2005 survey, no habitat with high potential found 2005-2010.
<i>Coeloglossum viride</i>	Endangered	Searched for by Moorhead in 2005 and Moorhead & Anderson in 2006, but not all potential habitat covered; among the most likely State-listed species to occur at Aton. Egler reported, albeit with uncertainty about identification, a population of 25 plants in the late 1960s.
<i>Corallorhiza trifida</i>	Special Concern	Two suboccurrences discovered at Aton in 2005; one large by Connecticut standards, and possibly also by larger context standards. No additional suboccurrences found 2006-2010.
<i>Cynoglossum virginianum</i> var. <i>boreale</i>	Special Concern (historic)	Not specifically searched for by Moorhead in 2005 and 2006, but effectively surveyed for along survey routes because it is a distinctive plant. There is a historic record for Norfolk, but habitat specifics unknown.
<i>Cypripedium parviflorum</i>	Special Concern	Searched for by Moorhead during in 2005 in area where Egler reported a one-plant population last seen in the 1940s, and elsewhere in 2006. Most, but likely not all, the potential habitat that exists at Aton has been covered by Moorhead at least once.
<i>Cypripedium reginae</i>	Endangered	Searched for by Moorhead in 2005 and 2006. Most, maybe all, of the potential habitat at Aton was covered. This species is cryptic, and repeated searches of the same area are usually required to detect it.
<i>Dalibarda repens</i>	Endangered	Searched for by Moorhead in 2005 and 2006, uncertain if all likely potential habitat at Aton covered. Attributed by Nichols to adjacent Phelps property in early 1900s, but not recently documented on that property.
<i>Dicentra canadensis</i>	Threatened	Searched for by Moorhead during Apr-Jun 2005 survey, most or all potential habitat at Aton was likely covered. Additional, less likely habitat covered in 2006.
<i>Diplazium pycnocarpon</i>	Endangered	Searched for by Moorhead during Apr-Jun 2005 survey, all most likely potential habitat at Aton covered. Additional, less likely habitat covered in 2006.
<i>Dryopteris campyloptera</i>	Endangered	Searched for by Moorhead in 2005 and 2006; uncertain if all potential habitat covered.
<i>Dryopteris goldiana</i>	Special Concern	Searched for by Moorhead during Apr-Jun 2005 survey, all most likely potential habitat at Aton covered. Additional, less likely habitat covered in 2006.

Table 2. Survey target taxa: State-listed plants that potentially occur at Aton Forest (including rare plants documented at Aton by this survey)¹.		
Plant taxon^{2,4}	State Listing status⁵	Comments
<i>Elymus trachycaulus</i> ssp. <i>subsecundus</i>	Special Concern	Not covered by Moorhead Apr-Jun 2005 survey due to phenology. Searched for in 2006; all likely habitat covered at least once.
<i>Equisetum scirpoides</i>	Endangered	Searched for by Moorhead in 2005 and 2006. Most potential habitat has probably been covered at least once.
<i>Galium labradoricum</i>	Endangered	Searched for by Moorhead in 2005 and 2006. Most potential habitat (no high-potential habitat has been found) has probably been covered at least once.
<i>Gaultheria hispidula</i>	Threatened	Searched for by Moorhead in 2005 and 2006; all most likely potential habitat at Aton was covered, but small populations of this tiny plant can be easily overlooked.
<i>Gentiana quinquefolia</i> (= <i>Gentianella quinquefolia</i>)	Endangered	Not covered by Moorhead Apr-Jun 2005 survey due to phenology. Searched for in 2006 and no potential habitat discovered.
<i>Goodyera repens</i> var. <i>ophioides</i>	Special Concern (historic)	Not covered by Moorhead Apr-Jun 2005 survey due to phenology. Searched for passively ⁶ in 2006; uncertain whether all potential habitat was covered.
<i>Hepatica acutiloba</i>	Special Concern	Searched for by Moorhead in 2005 and 2006, all or most potential habitat at Aton covered.
<i>Isotria medeoloides</i>	Endangered	Searched for by Moorhead in 2005 and 2006, all or most potential habitat at Aton covered.
<i>Linnaea borealis</i> var. <i>americana</i>	Endangered	Searched for by Moorhead in 2005 and 2006, all likely potential habitat at Aton covered.
<i>Liparis liliifolia</i>	Endangered	Searched for by Moorhead in 2005 and 2006, but not all potential habitat covered.
<i>Lycopodium selago</i> (= <i>Huperzia selago</i>)	Special Concern (historic)	Searched for by Moorhead in 2005 and 2006, but not all potential habitat covered.
<i>Malaxis monophyllos</i>	Endangered	Egler reported one population at Aton, but with uncertainty about identification; not covered by Moorhead Apr-Jun 2005 survey due to phenology. Searched for in 2006.
<i>Malaxis unifolia</i>	Endangered	Searched for by Moorhead in 2005 and 2006, but not all potential habitat covered. Uncertain if all potential habitat at Aton covered.
<i>Milium effusum</i>	Endangered	Not covered by Moorhead Apr-Jun 2005 survey due to phenology. Searched for by Moorhead in 2006, all most likely potential habitat covered.
<i>Mitella nuda</i>	Special Concern	One small occurrence discovered at Aton.

Table 2. Survey target taxa: State-listed plants that potentially occur at Aton Forest (including rare plants documented at Aton by this survey)¹.		
Plant taxon^{2,4}	State Listing status⁵	Comments
<i>Moneses uniflora</i>	Endangered	Searched for by Moorhead during Apr-Jun 2005 survey; not all potential habitat covered.
<i>Ophioglossum pusillum</i>	Threatened	Searched for by Moorhead in 2005, 2006, and 2009, not all potential habitat covered.
<i>Panax quinquefolius</i>	Special Concern	Searched for by Moorhead 2005 and 2006. Most but probably not all, potential habitat at Aton covered.
<i>Pinus resinosa</i>	Endangered	Searched for passively ⁶ by Moorhead in 2005 and 2006, though not all potential habitat covered. Seems unlikely that a native occurrence would have been overlooked by Egler, Anderson, and EECOS.
<i>Platanthera blephariglottis</i>	Endangered	Searched for by Moorhead in 2006, as part of a suite of bog specialists that might occur in fen/bog-like habitats discovered late in 2006 growing season at Aton, based on their occurrence in poor fens/bogs elsewhere in the vicinity.
<i>Platanthera dilatata</i>	Special Concern (historic)	Not covered by Moorhead Apr-Jun 2005 survey due to phenology Searched for in 2006, all most likely habitat covered (probably no high potential habitat exists at Aton).
<i>Platanthera flava</i>	Special Concern	Searched for by Moorhead in 2005 and 2006 survey, but not all potential habitat (open meadow) at Aton covered.
<i>Platanthera hookeri</i>	Special Concern (historic)	Searched for by Moorhead in 2005 and 2006, but not all potential habitat covered.
<i>Platanthera orbiculata</i>	Special Concern (historic)	Searched for by Moorhead during Apr-Jun 2005 survey, but not all potential habitat covered. Reported by Nichols on adjacent Phelps property ca. early 1900s, and recent sighting (i.e., last 20 years) reported but unconfirmed on that property.
<i>Sibbaldiopsis tridentata</i>	Endangered	Searched for by Moorhead in 2005 and 2006, but not all potential habitat covered.
<i>Pycnanthemum clinopodioides</i>	Endangered	Not covered by Moorhead Apr-Jun 2005 survey due to phenology. Searched for in 2006, all likely habitat covered, at least once.
<i>Ranunculus pensylvanicus</i>	Special Concern (historic)	Searched for by Moorhead during Apr-Jun 2005 survey. Searched for passively ⁶ in 2006; unclear if any potential habitat exists at Aton.
<i>Rhynchospora capillacea</i>	Endangered	Not covered by Moorhead Apr-Jun 2005 survey due to phenology. Searched for passively ⁶ in 2006; unclear if any potential habitat exists at Aton.
<i>Ribes glandulosum</i>	Special Concern	One occurrence, with two sub-occurrences, discovered at Aton Forest in 2005. No additional suboccurrences discovered 2006-2010.

Table 2. Survey target taxa: State-listed plants that potentially occur at Aton Forest (including rare plants documented at Aton by this survey)¹.		
Plant taxon^{2,4}	State Listing status⁵	Comments
<i>Ribes lacustre</i>	Special Concern (historic)	Searched for by Moorhead in 2005 and 2006; uncertain if all potential habitat at Aton covered.
<i>Ribes rotundifolium</i>	Special Concern (historic) ³	Searched for by Moorhead in 2005 and 2006, but not all potential habitat covered.
<i>Ribes triste</i>	Endangered	Searched for by Moorhead in 2005 and 2006, uncertain if all potential habitat covered at least once.
<i>Salix pedicellaris</i>	Endangered	Not covered by Moorhead Apr-Jun 2005 survey due to phenology. Searched for passively ⁶ in 2006; unclear if any potential habitat exists at Aton.
<i>Salix petiolaris</i>	Special Concern	Not covered by Moorhead Apr-Jun 2005 survey due to phenology. Searched for in 2006, but not all potential habitat covered.
<i>Salix serissima</i>	Special Concern	Potential habitat searched for by Moorhead in 2005 and 2006; potential habitat probably does not exist at Aton.
<i>Schizachne purpurascens</i>	Special Concern	Searched for by Moorhead in 2005 and 2006, all or most potential habitat at Aton covered.
<i>Schoenoplectus acutus</i>	Threatened	Not covered by Moorhead Apr-Jun 2005 survey due to phenology. Searched for in 2006; unclear if any potential habitat exists at Aton.
<i>Senna hebecarpa</i>	Special Concern	Not covered by Moorhead Apr-Jun 2005 survey due to phenology. Searched for passively ⁶ in 2006; unclear if any potential habitat exists at Aton.
<i>Maianthemum trifolium</i>	Threatened	Searched for by Moorhead 2005 and 2006, all likely potential habitat at Aton covered at least once.
<i>Sparganium fluctuans</i>	Endangered	Not covered by Moorhead Apr-Jun 2005 survey due to phenology, searched for passively ⁶ in 2006. Not sure that appropriate habitat exists at Aton (because unclear on species' habitat affinities).
<i>Stellaria borealis</i>	Special Concern	Searched for in 2005 and 2006, most, possibly all, potential habitat covered.
<i>Triphora trianthophora</i>	Endangered	Not covered by Moorhead Apr-Jun 2005 survey due to phenology. Searched for passively ⁶ in 2006, but not all potential habitat covered. Reportedly rediscovered in 2005 in Connecticut, which if true raises the likelihood that it might exist at Aton.
<i>Trichomanes intricatum</i>	Special Concern	Not covered by Moorhead 2005-2010 survey. Appears unlikely that potential habitat exists at Aton, based on known CT and MA occurrences.
<i>Vaccinium myrtilloides</i>	Velvetleaf Blueberry	Searched for passively ⁶ by Moorhead in 2005 and 2006; not all potential habitat at Aton covered.

Table 2. Survey target taxa: State-listed plants that potentially occur at Aton Forest (including rare plants documented at Aton by this survey)¹.		
Plant taxon^{2,4}	State Listing status⁵	Comments
<i>Viola canadensis</i>	Special Concern	Searched for by Moorhead in 2005 and 2006, all or most potential habitat at Aton covered.
<i>Viola nephrophylla</i>	Special Concern	Potential habitat searched for by Moorhead in 2005 and 2006, none found at Aton to-date.
<i>Viola renifolia</i> var. <i>brainerdii</i>	Special Concern	Searched for by Moorhead in 2005 and 2006; all or most arguable potential habitat covered (at least all those habitats that are similar to the one known extant CT site). There is an unmapped historic record for this species from Norfolk, habitat unknown.
<i>Viola selkirkii</i>	Special Concern	Searched for by Moorhead in 2005 and 2006, all or most potential habitat at Aton covered.
<i>Waldsteinia fragarioides</i>	Special Concern	Searched for by Moorhead in 2005 and 2006, uncertain if all potential habitat at Aton covered at least once (because full range of habitat affinities unknown).
<i>Xyris montana</i>	Threatened	Searched for by Moorhead in 2006, as part of a suite of bog specialists that might occur in fen/bog-like habitats discovered late in 2006 growing season at Aton, based on their occurrence in poor fens/bogs elsewhere in the vicinity.

TABLE NOTES:

¹The first taxon name given above is the name as found in current Regulations of Connecticut State Agencies Sections 26-306-4 to 26-306-6 (revised 2010); synonyms in parentheses are given for those taxa that have a different accepted name according to either published volumes of Flora of North America (FNA), or Haines' *Flora Novae-Angliae* (23 Feb 2010 Draft) for groups not yet treated in FNA, and when Haines taxonomy differs from FNA.

²includes taxa that I have judged to be reasonable possibilities within the study area, based on the geographic position of the site, habitats known to be present and those that may be present, my experience, and the known historic and/or present distribution of these species in Connecticut. This list still includes a number of rare taxa whose potential occurrence I now judge to be unlikely, based on my current knowledge of Aton – I have not deleted these because there is still a substantial portion of Aton that I have not explored.

³this taxon is known to me and/or reliably reported to me to be extant in Connecticut; “Special Concern (historic)” listing status is either an artifact of the 5- to 7-year interval between updates of the State’s Endangered Species regulations, or represents an error on the State’s (or my) part.

⁴Taxa in bold font are potential taxa that were documented at Aton Forest 2005-2010

⁵State-listing status given here up-to-date with 2010 revision of CT Endangered Species regulations

⁶“searched for passively” means that plant was not focus of survey but is conspicuous and distinctive enough that I would likely have detected it during survey focused on other species and community reconnaissance

State-listed rare plants documented at Aton Forest 2005-2010.

In 2005, I documented “new” occurrences of four State-listed plant species at Aton Forest. These were new occurrences in the sense that they were unknown to CT-DEP-NDDB and these species are not mentioned in Egler's “Flora of Aton Forest” (Egler 1990) or other notes. During my field surveys in 2006, 2009, and 2010 I found no additional State-listed plant species (but documented 4 new suboccurrences for one of the species first documented in 2005). However, ca. 2007, executive director John Anderson discovered two small populations of *Abies balsamea* (Balsam Fir) that were apparently naturally occurring at Aton (as opposed to known to be, or likely to have been, planted). John and I attempted to relocate and document these populations in spring 2010. We were successful at relocating one of the two populations.

Thus, the total of State-listed plants documented to be extant at Aton since field survey began in 2005 is five species, as follows:

***Abies balsamea* Balsam Fir (State-Endangered)**
***Carex novae-angliae* New England Sedge (State-Special Concern)**
***Corallorhiza trifida* Early Coral Root (State-Special Concern)**
***Mitella nuda* Naked Miterwort (State-Special Concern)**
***Ribes glandulosum* Skunk Currant (State-Special Concern)**

It should be noted that the State legal status of one of these species, *Ribes glandulosum*, has been legally changed from “Threatened” to “Special Concern” since I first reported its discovery at Aton in 2005, due to discoveries of several other new populations in the state. Thus, of the State-listed rare plants currently known extant at Aton, only *Abies balsamea* is afforded the protections from “taking” afforded by Connecticut's Endangered Species Act (i.e., the Act affords no protection for “Special Concern” species). “Special Concern” species usually have more than 10 recently observed occurrences in the state. State-Endangered *Abies balsamea*, for which only 2-3 other native populations known in Connecticut (Karen Zyko, CT-DEP-NDDB, pers. comm.), is thus the rarest of the five State-listed plants currently known to be extant at Aton, if the Aton population can be interpreted as native (see discussion below).

As noted in my report of the spring 2005 survey, the Aton Forest occurrences of *Ribes glandulosum*, *Corallorhiza trifida*, and *Carex novae-angliae* are robust meta-occurrences (i.e., having multiple individual populations, or suboccurrences), that compare with or exceed in size and vigor the most robust occurrences of these species previously known in Connecticut. The occurrence of *Mitella nuda* is very small compared with the largest other known occurrences of this species in the state.

In a global context, all five State-listed species identified at Aton Forest are considered “Secure” (i.e., they have Natureserve global conservation ranks of “G5”). All five species are northern-affinity species which in Connecticut are in the geographically marginal portions of their range. As you go northward from Connecticut, all five species soon become common or at least not uncommon, e.g., none are tracked as rare or even Watch List species in Massachusetts. All five species except *Carex novae-angliae*

extend northward into the northern Canada provinces; three of these (*Corallorhiza trifida*, *Mitella nuda*, and *Ribes glandulosum*) are transcontinental, while *Abies balsamea* extends westward only to the Rockies.

Carex novae-angliae is exceptional in having a much more restricted geographic range than the other State-listed plants at Aton, and it has an unusually narrow zone of common (or at least not rare) occurrence. It extends northward only to Ontario, Quebec, and Newfoundland, westward only to Minnesota, and south only to into West Virginia. North of Connecticut, it is not tracked as rare plant north only as far as northern New England and Nova Scotia – in Quebec and Newfoundland it is tracked as a Vulnerable and Imperiled species, respectively. Moreover, it has a smaller geographic range than nearly every native vascular plant known to be native to Aton (the one species of which I am aware that has a smaller range is *Amelanchier nantucketensis*, whose native occurrence at Aton is not yet widely accepted – see discussion below).

The population of *Abies balsamea* is tiny in number and size: 8 stems under 50 cm, representing ~ 2 genets, occupying ~ 3 m², and presents some problems of interpretation, regarding especially whether it can be interpreted to be a native population. The population of several low, immature plants could be interpreted to recently established from seeds dispersed from an unknown source. There are no known mature/seed-producing *Abies balsamea* trees in close proximity to the population, but there are both introduced and presumed native populations within a few miles. Alternatively, it could represent a remnant of a long-established population that has declined, e.g., due to deer browse. This seems unlikely, in part because it seems unlikely that a larger population would have gone un-noticed and un-noted by Egler. It appears unlikely to have been a planting, because of the location in the middle of the forest (as opposed to at/near a current or former house yard or in a field). But beyond these inferences, the likelihood that it is native stock cannot be assessed without additional investigation. The closest known adult/seed-producing *Abies balsamea* are several trees planted as seedlings by Frank Egler in 1950, ca. 1.4 miles southwest of the population. Egler records indicate that these seedlings came from a “fir plantation northwest of Benedict Pond” (Egler 1983). There was no indication if this plantation was in Connecticut, but if one assumes so, then it might have been anywhere from 0.4 to 1.2 miles west of the new population. It is unknown if *Abies* plants of this plantation still exist, but if so, this is the closest potential source of seed dispersal. On the other hand, I personally know of a Massachusetts site within 2.5 miles of the new Aton population where *Abies balsamea* is common and by all appearances native in mesic forest habitat similar to that at the new Aton population (the 2-3 Connecticut *A. balsamea* occurrences that the CT-DEP-NDDDB recognizes as native are all in wetlands [Karen Zyko, CT-DEP-NDDDB pers. comm.]). In my opinion, the facts at hand at present do not strongly favor one origin over the other for this population. This question can best (and probably only) be addressed by an exploration of the surrounding area, including adjacent MA, to locate the closest potential parent plants and assess whether they are naturally occurring or planted.

In his “Flora of Aton Forest”, Frank Egler recorded a total of three State-listed species, all orchids, naturally occurring at Aton, and a portion of my survey effort was devoted to attempts, all unsuccessful, to relocate these occurrences. The names by which they are currently State-listed are *Coeloglossum viride* Long-bracted Green Orchid (State-

Endangered), *Cypripedium parviflorum* Yellow Lady's-slipper (State-Special Concern), and *Malaxis monophyllos* White Adder's-mouth (State-Endangered). Egler recorded uncertainty about the identification for the *Coeloglossum* and the *Malaxis*. Assuming that Egler's "Flora" was up-to-date in terms of his latest observations of these species, he had last observed *Coeloglossum* in the late 1960s, *Cypripedium parviflorum* in the late 1940s, and no date is given for the *Malaxis*, but he said that it was "found once", which implies that he had returned to the site one or more times without finding it again.

In my report on the 2005 survey, I noted finding potential populations of 2 additional State-listed species, *Dryopteris campyloptera* Mountain Wood-Fern (State-Endangered) and *Blephilia hirsuta* Hairy Woodmint (State-Special Concern [Historic]), which I could not identify early in the growing season. During the 2006 field season, I revisited these sites and determined that neither of these species was in fact present.

Other notable native plants documented at Aton Forest 2005-2010.

***Amelanchier nantucketensis* Bickn.** According to Frank Egler's written account and John Anderson's recollections, a small colony of this rhizomatous shrub species, possibly a single clone, was discovered by Egler (i.e., it was not planted at Aton by Egler) growing in the managed meadow/shrubland near the office, and was determined by him to be *Amelanchier obovalis*, using older manuals. I did not include the managed areas around the office in my survey, and thus was unaware of this population until John Anderson, who had recently done some thinning of competing *Ilex verticillata*, called it to my attention in 2009. Using up-to-date taxonomic guidance, I determined the plants to be *Amelanchier nantucketensis* (*Amelanchier obovalis* is not currently known to occur north of New Jersey). In early 2010, Arthur Haines, Research Botanist with the New England Wildflower Society and author of the forthcoming *Flora Novae-Angliae*, reviewed of photographs taken by John Anderson, agreed with the determination of these plants as *A. nantucketensis*. He went on to recommended that the occurrence be protected and the species be added to Connecticut's rare species list, this being the first known confirmed Connecticut record for species and the only known extant occurrence of it in the state (the latter distinction was short-lived: later in 2010, Massachusetts State Botanist Bryan Connolly reported finding at least one extant occurrence of *A. nantucketensis* in Groton, CT; and regarding the first distinction, a thorough screening of Connecticut *Amelanchier* herbarium specimens for this taxon has almost certainly not yet been done). *Amelanchier nantucketensis* currently has a Natureserve global conservation rank of "G3Q": the "G3" means globally "Vulnerable", i.e., "At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors"; the "Q" indicates that there is some question about the taxonomic distinctness of the species, i.e., it is not universally accepted as a distinct species. It is listed by Natureserve as occurring in only 5 states and 1 province, and state/province-ranked as either "Critically Imperiled" or "Imperiled" in all except Massachusetts, where it is state-ranked as "Vulnerable" (Natureserve 2010).

Thus, ironically, *Amelanchier nantucketensis*, with its G3 rank, is the only plant species at Aton that is currently considered rare in a global context, though it is not [yet] among the State-listed plants (the five State-listed species are all ranked as "G5", i.e., globally

“secure”). However, the biodiversity significance of this occurrence depends upon its being a natural element of the Aton flora, as opposed to having been introduced, and at least one authority on rare plants in Connecticut has cautioned against outright acceptance of this occurrence as natural, citing most prominently, among other reasons, 1) Egler's well-documented proclivity for experimental introductions of plants, including species native to other parts of Connecticut, New England, etc., but not native to Aton (Leslie Mehrhoff pers. comm.). An assembling and review of the evidence for and against accepting *Amelanchier nantucketensis* as a native part of the Aton flora was beyond the scope of my investigation, but it should be considered a priority for Aton stewards, given its global conservation rank.

Notable non-native plant species documented at Aton Forest 2005-2010.

One non-native species, *Geum urbanum* Herb-bennet (ROSACEAE), also known as Wood Avens, Town Avens, and Clove-root, had not been documented growing outside of cultivation in Connecticut before we found it growing in a seepage swamp at Aton Forest, during the 2005 survey. The discovery of *Geum urbanum* is perhaps the most significant discovery of the survey besides the rare plant occurrences. *Geum urbanum* is a yellow-flowered member of the genus *Geum*, in the Rose family. The genus *Geum*, is comprised worldwide of 50 species of perennial herbs with bur-like fruit, mostly of the northern hemisphere. The common name “avens” (in English at least) is applied to the entire genus. *Geum urbanum* is native to Eurasia (Gleason and Cronquist 1991), and was not listed as part of the Connecticut flora in any of the standard references as of 2006 (Dowhan 1979, Mehrhoff 1995, Natureserve 2006). It is not listed in Egler's writings as either a species he observed at Aton or among the species he recorded having been introduced at Aton (Egler 1983; 1990). In New England, it has previously been documented as adventive only in the two northeastern-most counties of Massachusetts (Sorrie & Somers 1999) and one county in northwestern Vermont (Natureserve 2006, USDA 2006). It is now also listed in one RI county (USDA 2010). There is a long history of human use of *Geum urbanum* in Europe, as a medicinal and culinary herb; today it is no longer used in conventional medicine, but is still used in herbalism and homeopathy (Bunney 1984). Based on a recent informal poll by me of local herb/nursery dealers and gardeners, it appears that *Geum urbanum* is today little known or cultivated by herb growers, in this area at least. Thus, it is reasonable to hypothesize that its introduction to the vicinity of Aton may have occurred as long ago as the 18th or 17th century, at a time when the plant was better known (i.e., especially among Europeans) as an herb with medicinal and other uses. In fact, the population that I documented at Aton forest is scattered along a linear headwater seepage swamp that originates just below the foundation of an ancient house or barn; the *Geum* may have escaped from an ancient garden in this area and dispersed along the drainage-way.

The larger significance of finding *Geum urbanum* growing in natural habitats at Aton is that it may represent an early detection of an invasive species that has not yet been widely recognized as an invasive in North America. *Geum urbanum* does not appear to be listed on any official state, provincial, or federal invasive species lists (USDA 2010), nor on the IPANE “Early Detection list” for New England (Mehrhoff et al. 2003b), but there are reports from around North America suggesting or stating outright that it is invasive

(Blaney 2001; Walters 2004; Czarapata 2005; NPSO 2008). *Geum urbanum* is a look-alike of the yellow-flowered native *Geum alepiccum*, and thus it is possible that it is being overlooked because of mis-identification. Also, when not in flower, *Geum urbanum* could easily be mistaken, in Connecticut, for the for the three white-flowered *Geum* species (*canadense*, *virginianum*, and *laciniatum*) that are common to ubiquitous in Connecticut.

The occurrence of *Geum urbanum* at Aton Forest merits further study, especially to determine its local distribution and, if possible, the original point[s] and time[s] of introduction. This information will help answer the question of whether this plant should be considered an invasive species, before it has become as abundant as most of today's recognized invasives.

Preliminary vascular plant taxa list.

During my rare plant survey and community reconnaissance 2005-2010, I identified approx. 335 vascular plant taxa growing at Aton outside of cultivation (i.e., not obviously planted, though in some cases, likely having spread from plantings). Also, I reviewed collections by interns working at Aton in 2006 and identified an additional 59 vascular plant taxa that may be reasonably interpreted as growing outside cultivation at Aton. This combined taxa list of 394 taxa (including one named hybrid) is presented in Appendix C. The list should not be misconstrued as a flora of Aton Forest, the production of which was beyond the scope of my investigations. However, I believe it is a tally of the largest part of the existing naturally occurring vascular plants of Aton, both native and clearly naturalized non-native. As such, it is useful as an approximation of the existing *naturally-occurring* native vascular plant diversity at Aton, a largely complete tally of naturalized non-natives, and a substantial contribution to a modern comprehensive flora of Aton. Because they have no relevance to the natural diversity values of Aton, I have attempted to exclude from this list any taxa (native or non-native to this part of CT) that are known to have been introduced by Frank Egler to Aton and have not spread, or have spread only a short distance, from point[s] of introduction. Egler's writings (Egler 1983; Egler 1990) and/or John Anderson's recollections provided the basis for deciding which species to exclude. Also, I have excluded obviously introduced ornamental species whose introduction may predate Egler's stewardship. I've excluded the introduced but not definitely naturalized species because 1) they belong in a separate ecological category from the native and naturalized species, and 2) I largely ignored them during my investigations, and identified only a handful of the many introduced, but not definitely naturalized, plants at Aton.

Of the 395 taxa on my preliminary taxa list, 324 taxa (82%) are native, 65 taxa (16%) are non-native, and 5 taxa (1%) native vs. non-native status is uncertain. Of the 2 latter groups, 20 taxa (5%) have been recognized as invasive or potentially invasive in Connecticut by the Connecticut Invasive Plants Council (Mehrhoff et al. 2003a); of these, all except three taxa (*Rhamnus frangula*, *Berberis thunbergii*, and *Ornithogalum* cf. *umbellatum*) have been recently banned from sale, transport, cultivation, etc., by Connecticut legislation on invasive plants (Public Acts 03-136 and 04-203).

CONCLUSIONS

Summary of survey effort and results.

From April 2005 through May 2010, I conducted a survey for rare plants (i.e., plants listed under state law as Endangered, Threatened, or Special Concern) at Aton Forest. The bulk of the ~65.5 hours of field survey occurred during the periods April-June 2005 and May-Oct, 2006, with small amounts of survey time spent in May 2009 and May 2010. Prior to the survey, I researched Aton Forest, principal sources consulted being the writings of the late Frank Egler, Executive Director John P. Anderson, bedrock and surficial geology maps, soils maps, topographic maps and aerial photographs, the Connecticut Natural Diversity Data Base, Massachusetts Natural Heritage & Endangered Species Program publications, and the botanical literature relevant to the vicinity of Aton Forest. Combining the findings of this research with my 15 years (as of 2005) botanical experience in southwestern New England, I synthesized a target list of highest potential rare plants that might occur at Aton and list of natural communities/vegetation types that likely occurred at Aton in which I would seek rare plants. Both target lists were modified as field survey progressed and I gained more first-hand knowledge of Aton Forest in the field. The cumulative area within Aton Forest's boundaries inspected me by closely enough to detect rare plant occurrences was between 130-230 acres (52-94 ha), or 11-20% of Aton forest. The cumulative area that I inspected closely enough to detect natural communities/vegetation types of special significance and/or with potential as rare species habitat was ~390 ac (157 ha), or 33% of Aton.

Three State-listed plant species, all orchids, had been previously reported by Frank Egler to have been observed at Aton Forest, some decades ago. I attempted to relocate these populations, without success.

I documented populations of the following four State-listed plant species not previously reported from Aton:

Carex novae-angliae New England Sedge (State-Special Concern)

Corallorhiza trifida Early Coral Root (State-Special Concern)

Mitella nuda Naked Miterwort (State-Special Concern)

Ribes glandulosum Skunk Currant (State-Special Concern)

Two populations of a fifth State-listed species *Abies balsamea* Balsam Fir (State-Endangered) was discovered ca. 2007 by Executive Director John P. Anderson, and in 2010 John and I were able to relocate and document one of these populations. While the population appears most likely to be naturally occurring, the plants could be either native or non-native stock, and without conducting more survey and research there is no good rationale to favor native or non-native origin. If both naturally occurring and of native stock, it is the highest ranking (i.e., the rarest and only legally protected species) of the State-listed species currently known at Aton. All five of the State-listed plant species at Aton are currently considered to be globally "Secure" (i.e., they have global conservation ranks of "G5"). *Carex novae-angliae* is notable among these species in having an unusually small geographic range and relatively narrow geographic zone in which it is not tracked as a rare species.

Ironically, the rarest putatively naturally occurring plant species at Aton is not State-listed at all. *Amelanchier nantucketensis* is currently ranked as a globally “Vulnerable” species (“G3”). A colony was pointed out to me in 2009 by John Anderson growing in the long-managed area near the office. Frank Egler reported this and a second colony in an unmanaged part of Aton, both of which predate his coming to Aton, and identified it as *Amelanchier obovalis*, using an older taxonomic manual. Using modern taxonomic guidance, I determined it to be *A. nantucketensis*, and this was an apparent first record for it in Connecticut and, for a few months, the only known extant occurrence in the state. The determination was seconded by Arthur Haines, Research Botanist with the New England Wildflower Society, based on a review of photographs. However, an authority on rare plants in Connecticut has questioned whether this occurrence should be accepted as native to Aton, as opposed to introduced. An assembling and review of evidence for and against its natural occurrence, which likely would include additional study of the Aton plants' morphology and perhaps more field survey (for additional occurrences), are needed before this taxon is to be generally accepted as native at Aton Forest.

State of knowledge of Aton Forest's complement of rare plant occurrences.

Obvious and important questions that stewards of Aton Forest should be asking at this point are: how close are we to knowing the full complement of plants of conservation concern for which Aton Forest has stewardship responsibility, and how is each species doing?

Regarding the first question, this survey had a limited time budget compared with the size and diversity of Aton Forest: I have to-date inspected at least once $\leq 20\%$ of Aton Forest closely enough to detect rare plants, and at most $\sim 33\%$ closely enough to detect natural communities/vegetation types of special significance. Thus, most of Aton Forest is still unsurveyed, at close range, for rare plants, though I believe that I have covered all of the natural communities/vegetation types that are known to have higher probability of rare plants, and especially concentrations of rare plants, with adequate intensity to have discovered all but the most cryptic species. There are undoubtedly more rare plant populations to be found at Aton, the most likely being additional suboccurrences of *Carex novae-angliae*, for which potential habitat occurs on a large scale at Aton. However, I would not say that comprehensive mapping of *Carex novae-angliae* is a priority with respect to finding out as soon as possible the full complement of extant rare plants at Aton.

The following are what I would consider the next logical steps of an attempt to approach complete knowledge of Aton Forest's rare plants, listed roughly in order of descending priority:

- survey for second *Amelanchier nantucketensis* occurrence reported by Egler
- survey to discover the nearest likely parents of the *Abies balsamea* occurrence
- survey of the set of natural communities/vegetation types whose potential for rare plants is indeterminate (see Table 1 entities with “Merits more study/inventory” in

“comments” field), which have been visited only once in the growing season and/or have not been thoroughly explored.

- survey of portions of the richer mesic *Acer-Fraxinus* forests, *Acer-Fraxinus* seepage forests, Northern Hardwoods (including *Tsuga*-mixed versions of all of these), Seepage Swamps, and spring seeps that were not covered by my 2005-2010 survey, especially for northern-affinity species (e.g., *Cynoglossum*, *Dalibarda*, etc.)
- survey of habitat types largely ignored by this survey, i.e., the relatively intensively managed portions of Aton. Among these areas, those which I suspect have the greatest potential are unforested habitats at Woodchuck Hill, “Far North Field”, and near the Aton office
- survey for target potential species not surveyed for, or incompletely surveyed for due to budget/time restrictions
- survey for “cryptic” species – this includes species that could have easily been overlooked by this survey, for one or more of the following reasons:
 - the plants themselves are tiny (e.g., *Botrychium simplex*)
 - populations are tiny
 - plants may not come up every year (e.g., several of the orchids, including *Isotria medeoloides*)
 - potential habitat for certain rare species (e.g. *Isotria medeoloides*, *Triphora trianthophora*) is a relatively common community/vegetation type that occurs on large scale, which is labor-intensive to survey with adequate intensity to detect species with one or more of the above characteristics

Most of these tasks are labor intensive, and the number of rare species occurrences discovered per unit of survey time would likely be low, so it probably makes sense to design studies that combine these investigations with other investigations which collect valuable data regardless of whether additional rare plant occurrences are found. The most productive of these other types of investigations would be a baseline characterization of all existing natural communities and vegetation types at Aton, using total-floristic-composition plots (also called “relevés”). Another worthwhile investigation would be the development of a modern baseline flora of Aton Forest.

Monitoring and management of rare plant occurrences

Regarding the second question Aton stewards should be asking (“how are the rare plant occurrences doing?”), this can only be answered with any precision by monitoring of rare plant occurrences over time. The basic objectives of monitoring should be to determine whether the rare plant occurrences are declining, stable, or increasing in numbers and vigor, and if the occurrence is declining, to identify the reason[s]. It has been my

impression that there is generally a lack of appreciation of the level of monitoring effort and rigor is required to answer these two questions with a reasonable degree of confidence. If a decline is detected and reasons identified, a decision should be made as to whether to try to intervene, and how. Monitoring of rare plant occurrences is worthwhile not only for the sake of preserving the rare plant occurrences, but also for early detection of phenomena and processes that have larger implications for the larger natural communities and ecosystems.

Regarding monitoring priorities, *Mitella nuda* is clearly the highest priority of the rare species whose nativity at Aton is incontrovertible, as it is evidently at the most risk of extirpation, due to the very small population size and area.

The same could obviously be said of the *Abies balsamea* occurrence, though with that occurrence the ancillary priority is additional research and field survey to determine if the occurrence is native and if it is part of a larger meta-occurrence. In at least the short term, until these questions are answered, I recommend installing protection against vole and deer predation.

REFERENCES

1. Taxonomic References

Clemants, S.E. 1990. Juncaceae (Rush Family) of New York State. Contributions to a Flora of New York State VII. N.Y. State Museum Bull. No. 475. State Education Dept., Albany, New York. 67 pp.

Clemants, S.E. 1992. Chenopodiaceae and Amaranthaceae of New York State. Contributions to a Flora of New York State X. N.Y. State Museum Bull. No. 475. State Education Dept., Albany, New York. 100 pp.

Crum, H. and L.E. Anderson. 1981. Mosses of eastern North America. Columbia Univ. Press, New York. 1328 pp.

Dowhan, J.J. 1979. A preliminary checklist of the vascular flora of Connecticut (growing without cultivation). State Geological & Natural History Survey of Connecticut. Report of Investigations No. 8. 176 pp.

Fernald, M.L. 1950. Gray's manual of botany, 8th ed. Dioscorides Press, Portland, Oregon. 1980 reprint. lxiv + 1632 pp.

Flora of North America Editorial Committee. 1993b. Flora of North America north of Mexico. Volume 2. Pteridophytes and gymnosperms. Oxford Univ. Press, New York and Oxford. 475 pp.

Flora of North America Editorial Committee. 1997. Flora of North America north of Mexico. Volume 3. Magnoliophyta: Magnoliidae and Hamamelidae. Oxford Univ. Press, New York and Oxford. 590 pp.

Flora of North America Editorial Committee. 2000. Flora of North America north of Mexico. Volume 22. Magnoliophyta: Alismatidae, Arecidae, Commelinidae (in part), and Zingiberidae. Oxford Univ. Press, New York and Oxford. 352 pp.

Flora of North America Editorial Committee. 2002a. Flora of North America north of Mexico. Volume 26. Magnoliophyta: Liliidae: Liliales and Orchidales. Oxford Univ. Press, New York and Oxford. 723 pp.

Flora of North America Editorial Committee. 2002b. Flora of North America north of Mexico. Volume 23. Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford Univ. Press, New York and Oxford. 608 pp.

Flora of North America Editorial Committee. 2003a. Flora of North America north of Mexico. Volume 4. Magnoliophyta: Caryophyllidae, part 1. Oxford Univ. Press, New York and Oxford. 559 pp.

Flora of North America Editorial Committee. 2003b. Flora of North America north of Mexico. Volume 25. Magnoliophyta: Commelinidae (in part): Poaceae (in part). Oxford Univ. Press, New York and Oxford. 783 pp.

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of the northeastern United States and adjacent Canada, 2nd ed. New York Botanical Garden, New York. lxxv + 910 pp.

Hicks, M.L. 1992. Guide to the liverworts of North Carolina. Duke Univ. Press, Durham, NC. 239 pp.

Greene, C.W. 1980. The systematics of *Calamagrostis* (Gramineae) in eastern North America. Ph.D. thesis. Harvard University, Cambridge, Mass.

Greene, C.W. 1984. Sexual and apomictic reproduction in *Calamagrostis* (Gramineae) from eastern North America. Amer. J. Bot. 71(3): 285-293.

Rothrock, P.E. and A.A. Reznicek. 1996. Draft key to *Carex* section *Ovales* in eastern North America (*i.e.*, east of the Rocky Mountains). Summer Systematics Workshop focusing on *Carex* Section *Ovales*, July 27-30, 1996. Geo. Safford Torrey Herbarium, Univ. of Connecticut, Storrs. 5 pp.

Seymour, F.C. 1982. The flora of New England. A manual for the identification of all vascular plants including ferns and fern allies growing without cultivation in New England. 2nd ed. 1989 reprint with supplement. Privately published. 611 pp. with 32-p. supplement.

2. Other References

Blaney, S. 2001. Exotic and invasive plants in Maritime Canada. 2004 Reprint on "Elements" website of article originally published in Blomidon Field-Naturalist newsletter. URL: http://www.elements.nb.ca/theme/invasive_species/sean/blaney.htm. (Accessed: 26 Mar 2006)

Brumback W. E., L. J. Mehrhoff, R. W. Enser, S. C. Gawler, R. G. Popp, P. Somers, D. D. Sperduto, W. D. Countryman, and C. B. Hellquist. 1996. *Flora Conservanda*: New England. The New England Plant Conservation Program (NEPCoP) list of plants in need of conservation. *Rhodora* 98: 233-361.

Bunney, S., ed. 1985. The illustrated book of herbs: their medicinal and culinary uses. Form a text by J. Stodola and J. Volák, translated by I. Kuthan and Olga Kuthanová. W. H. Smith Publishers, Inc, New York. 320 pp.

Connecticut, State of. 2009. Chapter 495. Endangered species. Connecticut General Statutes Sec . 22-306 thru 22-316, inclusive.

Connecticut, State of. 2010. Regulations of Connecticut state agencies. Sec. 26-306-1 through 6. Connecticut Law Journal, Aug 24, 2010 edition.

Connecticut, State of. 2003. An act concerning invasive plants. Public Act No. 03-136.

Connecticut, State of. 2004b. An act concerning fines for banned invasive plants. Public Act No. 04-203.

Connecticut Department of Environmental Protection. 2005. Connecticut's Comprehensive Wildlife Conservation Strategy. On-line technical report. Connecticut Department of Environmental Protection, Hartford, CT. URL: <ftp://ftp.state.ct.us/pub/dep/wildlife/cwcs/CWCSIntro.pdf> (last accessed 8 Oct 2010)

Connecticut Dept. of Environmental Protection. 2009. Connecticut Critical Habitats. CT ECO: Connecticut Environmental Conditions Online. URL: <http://ctecoapp1.uconn.edu/advancedviewer/> (last accessed 8 Oct 2010)

Czarapata, E. J. 2005. Invasive plants of the upper Midwest: an illustrated guide to their identification and control. Univ. of Wisconsin Press, Madison, WI. 216 pp.

Egler, F. E. ca. 1940-1996. Uncatalogued notes in Frank Egler Archive at Aton Forest.

Egler, F. E. 1983. The nature of naturalization II. Studies in naturalization: 1925-1980. The introduced flora of Aton Forest, Connecticut. Claude E. Phillips Herbarium, Dept. of Agriculture and Natural Resources, Delaware State College, Dover, DE. 145 pp.

Egler, F. E. 1990. The observed flora of Aton Forest, native and naturalized. With life-history annotations, 1925-1990. Unfinished manuscript. ca. 250 pp.

Mehrhoff, L. J. 1995. Additions to the preliminary checklist of vascular flora of Connecticut. *Rhodora* 97: 9-38.

Mehrhoff, L. J., K. J. Metzler, and E. E. Corrigan. 2003a. Non-native invasive and potentially invasive vascular plants in Connecticut. Center for Conservation and Biodiversity, University of Connecticut, Storrs. 4-page pamphlet.

Mehrhoff, L. J., J. A. Silander, Jr., S. A. Leicht, E. S. Mosher and N. M. Tabak. 2003b. IPANE: Invasive Plant Atlas of New England. Department of Ecology & Evolutionary Biology, University of Connecticut, Storrs, CT, USA. URL: http://nbii-nin.ciesin.columbia.edu/ipane/earlydetection/species_scientific.htm (accessed 11 Oct 2010)

Metzler, K.J. and J.P. Barrett. 2006. Vegetation classification for Connecticut: a preliminary classification. Connecticut Dept. of Environmental Protection. State Geological and Natural History Survey. Dept. of Environmental Protection. Hartford, CT. 109 pp.

Native Plant Society of Oregon, Emerald Chapter. 2008. Exotic gardening and landscaping plants invasive in native habitats of the southern Willamette Valley. Society publication available on-line as PDF. 18 pp. URL: <http://emerald.npsoregon.org/> (accessed 11 Oct 2010)

NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.7. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>. (Accessed: 27 Mar 2006).

NatureServe. 2010. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.7. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>. (Last accessed: 11 Oct 2010).

Rodgers, J. 1985. Bedrock geological map of Connecticut. State Geological and Natural History Survey and U.S. Geological Survey, Hartford. 2 sheets.

Sorrie, B. A., and P. Somers. 1999. The vascular plants of Massachusetts: a county checklist. Massachusetts Div. of Fisheries and Wildlife, Natural Heritage & Endangered Species Program, Westborough, MA. 186 pp.

Stone, J.R., Schafer, J.P., London, E.H. and Thompson, W.B., 1992. U.S. Geological Survey special map, 2 sheets, scale 1:125,000. U.S. Geological Survey and Connecticut Geological and Natural History Survey, 1995. Connecticut Dept. of Environmental Protection, Environmental and Geographic Information Center, 2001. Digitized version of map on CD-ROM.

U. S. Dept. of Agriculture, Natural Resources Conservation Service. 2006. The PLANTS Database, 6 March 2006 (<http://plants.usda.gov>). Data compiled from various sources by Mark W. Skinner. [National Plant Data Center](http://plants.usda.gov), Baton Rouge, LA 70874-4490 USA. (Accessed: 25 Mar 2006)

U. S. Dept. of Agriculture, Natural Resources Conservation Service. 2010. The PLANTS Database, 6 March 2006 (<http://plants.usda.gov>). Data compiled from various sources by Mark W. Skinner. [National Plant Data Center](http://plants.usda.gov), Baton Rouge, LA 70874-4490 USA. (Accessed: 11 Oct 2010).

U. S. Dept. of Agriculture, Natural Resources Conservation Service and Connecticut Dept. of Environmental Protection. 1995. Soils. Digital ARCVIEW shape files and supporting data files. Published on CD-ROM in 2001.

Walters, B. 2004. "Has *Geum urbanum* been a problem for anyone?....". Archived email. The Information Management Group, IUCN, Gland, Switzerland. URL: <http://indaba.iucn.org/archives/aliens-l/2004-06/00005966.htm>. (Accessed: 26 Mar 2006).