FRWA 2002 BIODIVERSITY PROJECT
RARE PLANT AND NATURAL COMMUNITY INVENTORY
SUMMARY REPORT

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INTRODUCTION

This survey/inventory was commissioned by the Farmington River Watershed Association (FRWA), and coordinated by Hank Gruner, with the Science Museum of Connecticut. The inventory study area was comprised of the towns of Avon, Canton, East Granby, Granby, Farmington, Simsbury, and Suffield, Connecticut. The period of field investigation consisted of essentially the entire growing season of 2002.

Objectives of the inventory:

- Resurvey and update status of recently observed (since 1980) State-listed plant occurrences
- Relocation of historic (pre-1980) State-listed plant occurrences
- Identification of new State-listed plant occurrences
- Identify and document current status of significant natural, or ecological, communities that are a priority for biodiversity conservation, i.e., rare and uncommon natural communities, more common natural communities that are in rare or uncommon condition (e.g., old-growth forest)

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MATERIALS AND METHODS

The rare plants that were the object of the botanical survey were, more specifically, plants that are currently "State-listed"; i.e., plant species listed in the Regulations of the State of Connecticut (R.C.S.A. Sec. 22a-306-4 through 22a-306-6), pursuant to the Connecticut Endangered Species Act (Public Act 89-224), as "Endangered Species", "Threatened Species", or "Species of Special Concern". This State list also includes Federally Endangered and Threatened species and all other species considered to be globally rare. The survey was guided primarily by data on 41 recently observed and 64 historic (13 mapped to at least minutes-precision, 51 unmapped town records) rare species occurrences in the study area compiled over ca. 25 years and provided by the Connecticut Geological and Natural History Survey/Natural Diversity Data Base (CT-DEP-NDDB), a division of the Connecticut Department of Environmental Protection (CT-DEP). The CT-DEP-NDDB's historic occurrence data was based in largest part on herbarium research and in smaller part on reports in the botany literature, both published and unpublished. Additional data on historic occurrences was extracted from published reports of field trips (1928-present) in the study area by the Connecticut Botanical Society (CBS). In addition, non-duplicative data in historic occurrences was provided by the New England Wild Flower Society (NEWFS), Framingham, MA; this data was based on herbarium research.

Existing data on priority natural communities was provided in the form of landscape-level GIS map units developed by the CT-DEP-NDDB in cooperation with FRWA. The identification and naming of ecological/natural communities for this inventory follows as much as possible the draft Natural Communities of Connecticut (Metzler, 1990), which is the system currently used by the CT-DEP-NDDB. This classification has simultaneously the sharpest resolution and most complete coverage for Connecticut (there are several published and unpublished classifications of vegetation and ecological/natural communities covering this geographical area, but none are yet universally accepted and used by all partners involved in biodiversity conservation). Natural community entities discovered during this survey that are not represented in Metzler's Natural Communities of Connecticut were assigned "provisional" names, after consultation with Metzler.

There is a group of plants that have been identified as "*Flora conservanda*: New England", i.e., species in need of conservation because they are considered rare or uncommon in a New England regional context (Brumback et al. 1996). This list includes many of the plants State-listed in Connecticut, but it also includes many Connecticut species that are not State-listed. Some of these latter species are demonstrably not rare or uncommon in Connecticut ("Division 3" species that are rare farther north), while others ("Division 2" and "Indeterminate") are either believed to have fewer than 20 occurrences in all of New England ("Division 2" species) or their status in New England is unknown ("Indeterminate"). Documentation and mapping of these species was not within the scope of this project, but they were specially noted and highlighted in the Site Survey Summary for the sites at which they were encountered, because they are mostly at least uncommon and in some cases potential future State-listed plants, and they often have strong ecological indicator value.

Because of the strong correlation between the occurrence of rare plants and rare/uncommon natural communities, survey for and documentation of natural communities was done simultaneously with survey for rare plant species. The majority of survey work was performed within the above-mentioned priority landscape units developed by the CT-DEP-NDDB with FRWA.

All State-listed plant occurrences were documented using standard CT-DEP-NDDB reporting forms, and were mapped on CT-DEP leaf-off 1:12000 black-and-white stereo aerial photographs (flight years 2000, 2001, and 1995), using stereo-photo pairs with a stereoscope, with plotting uncertainties mostly between ± 6 m and about ± 15 m, rarely higher. Additionally, at many of the State-listed plant occurrences, GPS point readings (uncorrected) were taken using a Magellan GPS 2000 XL unit; at a few of the State-listed plant occurrences occurrence corrected GPS readings were taken around occurrence perimeters, by FRWA staff using FRWA GPS equipment. Occurrences of priority natural communities were documented using CT-DEP-NDDB-approved community reconnaissance forms adapted from those used by the Virginia Natural Heritage Program. Most occurrences of priority natural communities were mapped in a similar fashion to State-listed plant occurrences, on 1:12000 aerial photographs. However, for most communities I relied more heavily on aerial photo interpretation to determine extent and boundaries than I did for State-listed plants (because of the often large scale of the communities), so mapping precision of communities is often somewhat lower than for State-listed plants.

Documentation of State-listed plant occurrences, per the standard form, included: a basic description of the occurrence, including population size and area, phenologic state of population, health/vigor of plants; a description of the habitat, including landscape position and landform, slope, aspect, moisture/hydrologic regime, light levels, elevation, disturbance regime, the host natural community[ies], a list of associate plant species (non-comprehensive), soil type[s], bedrock geology (when relevant), and surficial geology (when relevant); collection and pressing of a specimen, when the population could support collection and landowner permission allowed it; slide or print voucher photographs of the plant, when a collection was not made. Documentation of priority natural community occurrences, per the standard form, consisted of: the same habitat description parameters as for State-listed plants; a listing of associated State-listed plants, *Flora Conservanda* Division 2 and Division Indeterminate plants, and other plants that in my Connecticut experience are uncommon or very restricted; animals I observed, including State-listed; and recommendations for further inventory, e.g., for invertebrates or other State-listed plants.

For each State-listed plant and priority community occurrence, subjective evaluations were made of current and future management issues and threats to the occurrence. In particular, this included a subjective evaluation of the importance of invasive species at the occurrence, the level of threat posed by them, and urgency of need for control at the site. The same evaluation of invasive plant status was made for all sites visited, whether or not State-listed plants and priority communities were found at the sites. Sites were assigned priority ranks indicating relative urgency of need for invasive species management actions, using a provisional ranking system devised by the author, and finalized after receiving comment and critique by NEWFS staff members Elizabeth Farnsworth, Chris Mattrick, and Bryan Connolly. NEWFS is probably the single institution in New England that has the most depth and breadth of hands-on experience controlling invasives on sites with rare plants and conservation-priority natural communities.

In addition to forms and maps documenting individual State-listed species and significant community occurrences, a "Site Survey Summary" digital EXCEL spreadsheet was prepared, in which all individual site surveys are listed. For each individual site survey, a summary of the site survey results is broken down into 17 parameters. These cover different classes of significant species and natural communities looked for and not found as well as those found at the site, an invasive species control urgency rank subjectively assigned to the site, together with explanatory comments, and comments on other site management concerns and issues (see previous paragraph). An explanation of the invasive control urgency ranks is appended to the Site Survey Summary EXCEL spreadsheet.

Routes of survey and/or areas surveyed at all survey sites were plotted, either (for the majority of site surveys) on CT-DEP leaf-off 1:12000 black-and-white stereo aerial photographs (flight years 2000, 2001, and 1995), or on 7.5-minute 1:24000 USGS topographic maps. Copies of these maps are included with the above-mentioned forms and maps documenting rare plants and communities.

As of May 2003, most (~170 specimens) of the voucher specimens from this survey have been deposited at the George Safford Torrey Herbarium (CONN), at the University of Connecticut at Storrs. Several of the specimens that may be interpreted as duplicates have been and may be deposited at other official repositories in/near New England (e.g., NCBS/YU, NEBC, or NYBG). Several specimens that have been

sent to authorities for determination may be deposited at more distant herbaria (e.g., MICH), at each authority's discretion. All voucher specimens will have been deposited to herbaria before the end of 2003.

RESULTS

Over the period 26 April – 9 November 2002, I conducted 221 surveys of ~120 locations. The number of individual extant State-listed plant occurrences known in the 7-town study area was increased by about 270%, from 41 to ~112. Approximately 159 significant natural community occurrences were documented and mapped. The results of the two components of the survey, botanical and natural community, are addressed in detail in separate sections below.

Rare plant survey.

In the course of this survey, between 111 and 141 occurrences of 41 State listed plant species were documented in the study area. Between 69 and ~100 of these occurrences represent either "new" discoveries (i.e., occurrences not previously known to and mapped by the CT-DEP-NDDB), or rediscovered historic occurrences (3-5 occurrences). The remainder of occurrences represent up-dates of previously documented occurrences (the numbers of occurrences are given as ranges because different criteria may be used for "lumping" separate populations into occurrences, depending on the use to which the data is being put). Roughly 79 previously undocumented sites supporting rare plants were discovered by this survey in the 7-town study area (see Table 1 for explanation). The complete numeric statistic breakdown of the survey of State-listed plants is presented in Table 1. The list of State-listed species documented extant in the study area is presented in Table 2.

Table 1. Botanical Survey - Summary Statistics.

Parameter	Before 2002 Survey	By end of 2002 Survey
Total number of State-listed species ever recorded from the study area (current + historic)[3]	64	76
Number of State-listed species documented in the study area since 1980	26	45 (41 by this survey)
Number of State-listed species only known historically (pre-1980) from study area	38	33-34
Number of recently documented (since 1980) occurrences of State-listed species in study area	41	~112[1, 4]
Number of new occurrences documented by this survey		~66[1]/~100[2] occurrences of 35 species
Number of new rare plant sites added to CT-DEP-NDDB coverage of Connecticut		~79[5]
Number of historic occurrences rediscovered (i.e., cases where historic data is specific enough to reasonably conclude rediscovery of a specific site)		3
Number of State-listed species only known historically from study area that were rediscovered		7
Number of State-listed species documented for the first time from the study area		11

Number of Connecticut state-historic species discovered/rediscovered in the study area		1 for sure, possibly 2 (the 2nd cannot be confirmed without revisit)
Number of New England-historic species discovered/rediscovered in the study area		1
Number of occurrences of State-listed species observed since 1980 that have evidently been lost via extirpation		2-3 occurrences of 2-3 species
Number of *Flora Conservanda* (Brumback et al. 1996) Division 2 and IND. species occurrences documented in the study area		19
Number of first Hartford County records of State-listed species		3[6]
Number of first Connecticut records of possibly native species		1 (2?)
Number of species documented in the study area that were not previously known to be established in Connecticut outside of cultivation (species presumed non-native in Connecticut		2 (3?)

[1]using CT-DEP convention for combining separate populations into an occurrence, i.e., ≤ 1 km of separation between populations = same occurrence, with some exceptions made for individual spp. based on species-specific bio-ecological factors. Note: 7 of these occurrences are of species proposed for delisting.

[2]number of new occurrences using simple distance threshold of ≥ ¼ mile (0.4 km) of separation (i.e., the radius of a "blob" on the CT-DEP-NDDB Rare Plant and Significant Community maps) between new discovery and other occurrence of same taxon. This number essentially represents the number of new occurrence "blobs" that would added to CT-DEP-NDDB maps by this survey (though since multiple rare species were found together at some sites, this is not the same as the number of apparent new "blobs" added to the CT-DEP-NDDB maps). Note: seven of these occurrences are of species proposed for delisting.

[3]based on CT-DEP-NDDB data, supplemented by Connecticut Botanical Society field trip reports (1928 to present), and New England Wild Flower Society data.

[4]this total does not equal the sum of new occurrences plus pre-survey, recently observed occurrences, because 5 of the latter occurrences were not revisited (and there is good reason to believe them still extant), and 3 of those that were could not be rediscovered, and there is reason to believe they are not extant.

[5]this is roughly the total number of apparent new ¼-mile-radius rare plant "blobs" added to CT-DEP-NDDB maps by this survey. This calculation considers any site ≥ ¼ mile from another rare plant occurrence to be one site, regardless of how many rare plants co-occur there.

[6] based on checks against CT-DEP-NDDB data performed and communicated to me by Zyko (pers. comm.)

Table 2. State-listed plant species documented by this survey.

Scientific Name[6]	Common Name[7]	# New Occur-rences[3] found by this survey	CT State-Status[4]	Proposed New CT State-Status in 2003/2004 List Revision[5]	Comments[8]
Acalypha virginica	Virginia copperleaf	2	SC*	SC	Last collected in Hartford County in 1892
Agastache scrophulariifolia	Purple giant hyssop	1	E	E	Could be interpreted as rediscovery of historic station (1902); seed collection and banking initiated, because population is dangerously small
Agrimonia parviflora[1]	Small-flowered agrimony	1	SC	delist	First record for study area
Andromeda glaucophylla	Bog rosemary	0	T	T	
Carex bushii	Sedge	2	SC	SC	
Carex davisii	Sedge	1	E	E[2]	Farmington River meta-occurrence largest known in New England
Carex hirsutella[1]	Sedge	5	SC	delist	
Carex limosa	Sedge	0	E	E	
Carex lupuliformis	False hop sedge	3(4?)	E	SC	First records for study area
Carex oligocarpa	Sedge	1	E	SC	First record for study area
Carex pseudo-cyperus	Cyperus-like sedge	1	E	E	First Hartford County record
Carex squarrosa	Sedge	2	SC	SC	Rediscovered historic (last collected/reported 1905) in study area
Desmodium glabellum	Dillen's tck-trefoil	2	SC*	SC	First records for study area
Elymus trachycaulus ssp. *subsecundus*	Slender wheatgrass	5	SC	SC	
Elymus wiegandii	Wiegand's wildrice	2	SC	SC	First records for study area
Eriophorum vaginatum var. *spissum*	Hare's tail	0	E	T	
Hemicarpha micrantha	Dwarf bulrush	1	E	E	Farmington River site is only known extant Connecticut site for this pond/lake shore species in lotic setting
Houstonia longifolia	Long-leaved bluets	4	E	E[2]	Survey study area holds only Connecticut occurrences of this species
Helianthemum propinquum	Low frostweed	3	E	T	
Hydrophyllum virginianum	Virginia waterleaf	2	SC	SC	
Mimulus alatus	Winged monkey-flower	4	SC	SC	Unexpectedly ubiquitous, though never in abundance, along meandering drawdown streams in the Hitchcock Lake-bottom and deltaic deposits landscape of Suffield
Najas guadalupensis[1]	Naiad	1	SC	delist	First record for study area

Oryzopsis pungens	Slender mountain-ricegrass	1	SC*	SC	First Connecticut record for this sand plain species on a rocky summit (an ecological bimodality shared by a number of other species); tiny size of population (1 plant) suggests decline due to fire-suppression in 20th century; focused resurvey/survey of similar habitats in area, earlier in growing season, may reveal more
Oxalis violacea	Violet wood-sorrel	1	SC	SC	First record for study area
Panax quinquefolius	American ginseng	0	SC	SC	
Podostemum ceratophyllum	Threadfoot	3	SC	SC	
Potentilla arguta	Tall cinquefoil	4	SC	SC	
Pycnanthemum clinopodioides	Basil mountain-mint	1	E	E	A globally rare species
Rhynchospora scirpoides	Long-leaved bald-rush	0	E	E	Only known site in state
Ribes glandulosum	Skunk currant	1	E	T	First record for this species in Hartford County; a northern species, previous to this survey only known from coldest parts of CT – found by this survey at low elevation at base of cold-air-exhaling (i.e., algific) talus
Salix exigua	Sandbar willow	1	T	T	First record for study area
Salix petiolaris	Slender willow	1	SC*	?	First Hartford County record; would've been first recent record in Connecticut of a State-historic, if a population in Salisbury had not been discovered 2 days earlier!
Scheuchzeria palustris	Pod grass	0	E	E	Only known extant site in state
Scirpus torreyi	Torrey bulrush	0	T	T	
Senecio pauperculus	Ragwort	2	E	E	
Silene stellata	Starry campion	4	SC	SC	A rediscovered historic in 7-town study area; Farmington River meta-occurrence is stronghold of this species in New England, based on current knowledge
Stellaria borealis	Northern stitchwort	1	SC	SC	Largest known CT occurrence; first record for study area
Streptopus amplexifolius	White mandarin	1	T	T	Rediscovered historic station (last reported 1934); on verge of extirpation at site, with one individual remaining; seed collection and banking initiated
Triosteum angustifolium	Narrow-leaved horse-gentian	1	SC*	SC*[2]	Rediscovered station where reported historically (1947) but never documented by specimen, hence veracity of original report was always in doubt; now only known extant site for species in New England; there are only a few individuals at this site, but there are potentially more subpopulations in a large nearby area with potentially similar habitat that could not be accessed for this survey

Trisetum spicatum var. *molle*	spiked false-oats	1	SC*	SC	Rediscovered historic station (last collected/reported 1909); on verge of extirpation at site; seed collection and banking initiated
Vitis novae-angliae	New England grape	6	SC	SC	Data from this survey support the view of this species as a F1 hybrid of 2 common species, and suggest that it is more common than previously thought
Xyris montana	Northern yellow-eyed grass	0	E	T	

[1]species proposed for delisting in 2003 or 2004

[2]proposed status may be revised based on this survey's data

[3]using CT-DEP convention for combining separate populations into an occurrence, i.e., ≤ 1 km of separation between populations = same occurrence, with some exceptions made for individual spp. based on species-specific bio-ecological factors

[4] State-listing status codes: E = Endangered, T = Threatened, SC = Special Concern, SC* = Special Concern (Historic)

[5]Metzler and Murray (CT-DEP-NDDB), personal communications, early 2003

[6]Per 1996 CT State list of Endangered, Threatened, and Special Concern species. Though there is standardization of scientific naming, scientific name changes result over time as taxonomic and systematic research changes species concepts and relationships. As a result, these listed species may found with different scientific names in certain reference manuals and at www.natureserve.org. In most references and at www.natureserve.org, one will be able to locate the species using these names, even when they have been superceded by a different name. An exception to this rule may be older manuals (i.e., mid-20th century publication or older).

[7] Per 1996 CT State list of Endangered, Threatened, and Special Concern species. Common names of plants are not standardized! Many species will be found with many different common names in different manuals and other references, many species have no meaningful common name (e.g., most sedges), and the same common name has been applied to different species (e.g., "Indian Paintbrush" is applied in different guides to both a State-Endangered plant and a ubiquitous exotic lawn weed). It is always best to use the species' scientific name to find it in any reference.

[8]statements regarding first county records based on checks against CT-DEP-NDDB data performed and communicated to me by Zyko (pers. comm.)

Species possibly lost/extirpated in study area. In addition to the 30-31 species known historically from the study area that were not rediscovered by this survey, three species that had been observed since 1980 could not be relocated, and may no longer be extant, at least at the sites from which they were known. These are *Smilacina trifolia*, *Lygodium palmatum*, and *Rotala ramosior*. This appears in all cases to be the result of habitat destruction or alteration: in the first case, by the State Dept. of Transportation at a State-owned facility; in the second case, by residential development; and apparently by beaver activity in the last case.

Historic species rediscovered on the brink of extirpation. Four species known historically from the study area were rediscovered by this survey, each with one occurrence, with populations so small as to put them in danger of disappearing from the sites. These are *Streptopus amplexifolius*, *Trisetum spicatum* var. *molle*, and *Agastache scrophulariifolia*, and *Oryzopsis pungens*. In each case, their discovery before their disappearance is fortuitous, as it has allowed volunteers to begin collection of seeds for banking (by the New England Wild Flower Society), just in the apparent nick of time. This seed bank of native genotypic material can be used in the event that reintroduction or population augmentation is required to preserve the occurrences. Also, at one occurrence that is town-owned, town staff have initiated management of the site, to prevent the accidental destruction of the plants by vehicle traffic, and to control/eradicate invasive plants. All four species are extremely rare in Connecticut, with 2, 2, 3, and 2 extant occurrences, respectively, statewide (including those discovered by this survey).

Survey study area as a stronghold in the state and/or New England for certain State-listed species. This survey revealed that several State-listed plants occur in the 7-town study area in an abundance that compels recognition of the study area as a critical stronghold for these species in Connecticut, in one case, and for New England as well in two other cases. These species are, respectively, *Houstonia longifolia*, *Silene stellata*, and *Carex davisii*. No extant occurrences of *Houstonia longifolia* are known in Connecticut outside of the study area; four occurrences were known in the study area prior to this survey. This survey discovered 4-12 more occurrences (depending on how one distinguishes between suboccurrences and occurrences), which together with the known occurrences comprise at least several hundred plants. *Silene stellata* was known from the study area, prior to this survey, from two herbarium specimens collected in Simsbury in 1862 and 1901. Currently, outside of the 7-town study area, one extant site in all of New England is known for the species, in a Connecticut coastal forest, where the population is about 10 plants. During this survey multiple occurrences were discovered in Simsbury and Avon, together comprised of several hundred plants. *Carex davisii* is also a New England rarity, with a handful of extant occurrences known, the largest of which, outside of the 7-town study area, being comprised of a few hundred plants. This survey discovered several dozen populations in Avon and Simsbury which have been grouped into three occurrences, and are together comprised of at least 1000 plants; extrapolating into potential habitat in the study area not covered in this survey, the true size of the Avon/Simsbury metapopulation is probably several thousand, making it the largest known in New England by an order of magnitude, and perhaps larger than all other known occurrences combined.

Rediscovery of a New England historic. Among the most exciting discoveries of the survey was a small population of *Triosteum angustifolium* in Granby. This species was a Connecticut and New England historic. The most recently collected herbarium specimen is dated 1905. However, there exists a report (Smith 1948) of the species, evidently unsubstantiated by a specimen, having been observed in 1947 on a traprock ridge in the study area. This report had apparently been considered dubious (i.e., a likely misidentification) because it was the only report ever of the species occurring on traprock in New England (all specimen-documented occurrences are from sand plains or an acid bedrock outcrop near the coast), and there is a more common congener species, *T. aurantiacum*, with which *T. angustifolium* is easily confused. The discovery of this species by this survey at the site where it was reported in 1947 substantiates the historic report, sharpening our understanding of its ecological behavior, and it is the first solid evidence in nearly 100 years that it is still extant in New England (this is now the only known New England occurrence of the species). This population is very small, but it is hoped that more subpopulations may occur nearby on a large section of the same trap ridge that could not be accessed for this survey. This discovery/confirmation also suggests that this species should be looked for on other traprock ridges.

Two possible additional State-listed species occurrences pending identification. Two occurrences of two species that at present cannot be identified with certainty were discovered in the study area. One of these is a potential occurrence of the State-historic ladies' tresses orchid *Goodyera repens* var. *ophioglossoides* (found in a pine forest), that could not be confirmed in 2002 because no fertile plants could be located in the population, and it cannot be determined with certainty in vegetative state (though leaf dimensions point to this taxon). It can only be confirmed by visiting the site again in a year when the population produces flowering plants. If confirmed, this would be the first documentation of this species in Connecticut since 1938. Identification is also uncertain for the sedge *Carex lupuliformis*, at only one of the four sites discovered for it in the study area during the survey. A specimen has been sent to an authority for determination, and the result will be communicated as a report addendum.

A taxonomic and phytogeographic mystery. I found a wormwood, *Artemisia* cf. *campestris* ssp. *caudata*, growing on a few open traprock ledges in the study area. The typical form of this species is the only wormwood native to Connecticut; it is a biennial, and grows on sand flats and dunes along the coast (as elsewhere in New England). The form found in the study area is in several characteristics distinctly unlike the typical coastal plants, principal among them being that it is a perennial. These characteristics make it appear intermediate between *A. campestris* ssp. *caudata* and *A. campestris* ssp. *borealis*, a rare perennial in New England that has never been documented in Connecticut. It also bears resemblance to the European *Artemisia campestris* ssp. *campestris*, which is not known to-date from New England. It appears to be the same taxon that has been collected from one other location in New England, a mountain in

Massachusetts. Specimens of the *Artemisia* have been sent to one authority, and the determination for now is that it is the native *A. campestris* ssp. *caudata* (Haines pers. comm.).

New species to the state. The survey documented three species established in the study that have not been previously recognized as established outside of cultivation in Connecticut: *Malus sieboldii* Toringo crab, *Aristida basiramea* forked three-awned grass, and *Juncus diffusissimus* a rush. These species are not included as part of the Connecticut flora by Dowhan (1979) or Mehrhoff (1995). *Malus sieboldii* and *Juncus diffusissimus* are well-established at many sites in the study area. *Aristida basiramea* was found at one disturbed sand barren site.

Malus sieboldii Toringo crab is shrub native to Japan and planted in North America as an ornamental. I found it frequently in the study area in open and semi-open traprock ridge communities, and less often in sand barrens and high flood plain forests and meadows. It has probably been spread to these communities via birds eating the fruit. I seldom saw a mature plant, but given the fairly high frequency that it occurs in conservation-priority communities, its invasive potential deserves evaluation, and it is probably a good idea to target it along with the more proven invasives in monitoring and control projects.

Juncus diffusissimus is native to the southern half of the coterminous US, and according to latest sources on its distribution (Natureserve 2002), it does not occur northeast of Delaware. I am aware of one previous Connecticut collection of this species, in 1996, from a sandy powerline right-of-way where it grew along the service road. To my knowledge it has not been collected again from that site, and it was suspected to be a non-persistent "waif" there, perhaps brought in on the treads of ATVs or power company vehicles that had been used in another part of the country where the *Juncus* was native. During this survey, I found it well-established and often abundant in riverbank and sand bar drawdown communities along the Farmington River, in Farmington, Avon, and Simsbury. It is not possible to say with any certainty whether *Juncus diffusissimus* is a previously overlooked part of the native flora of Connecticut or a recent introduction. As *Junci* go, *J. diffusissimus* is not a cryptic species. It seems unlikely that it, if native, would have been overlooked for the 200± years that the flora of Connecticut has had the attention of modern botanists, especially given its present abundance along the Farmington River (though there has probably never been, at any one time in Connecticut, more than a few botanizers conversant in the *Junci*). *Juncus diffusissimus* is not thought of as a species of special habitats in the main part of its range: in Virginia, for example, it is considered a common species of roadside ditches and otherwise undistinguished wetland habitats (Belden pers. comm.). Given this ecological behavior, the unusually large disjunction of 200-275 miles between the Connecticut sites and the nearest other known North American populations is easier to rationalize as more likely result of a anthropogenic introduction than a "natural" gap in its range. However, natural range gaps on this scale are observed in several other species. They include one species, *Echinodorus tenellus*, that is also of sandy drawdown habitats, and was not discovered in Connecticut until 1989. It is believed to be native here, ca. 450 miles northeast of the nearest other population known to be extant, in Virginia (though it was also known historically from disjunct sites in MA and NJ). *Juncus diffusissimus* in the 7-town study area appears to behave in one way like a native species: unlike many invasives, it appears to be faithful to a rather narrow ecological niche, in these drawdown communities. If it is an exotic addition to the Connecticut flora, it is abundant enough in the Farmington River drawdown communities to raise some concern over its potential invasiveness. The question of its nativity and its invasive potential should be studied.

Aristida basiramea forked three-awned grass is listed in *Flora Conservanda* (Brumback et al. 1996) as native in the three northern New England states and of indeterminate status. As of 1999, it was known from one Massachusetts county and considered an exotic (Sorrie and Somers 1999). It is considered a rare species in New York state, where it is known from a few northern counties, but its native vs. non-native status is debated (New York Flora Association 1990; Weldy pers. comm.). It is not listed as occurring in Connecticut in Dowhan (1979), Mehrhoff (1995), or Natureserve (2002). During this survey, I found and collected a voucher specimen of this species in a xeric sand barren grassland at Simsbury Airport, in an area that is clearly managed to some degree (periodic mowing), and where there is a mixture of native and introduced species. This is apparently the first documentation of this plant in Connecticut. Given the evident differences of interpretation regarding its native vs. non-native status in adjacent and nearby states,

it is hard to interpret its status in Connecticut. Whether it is a heretofore overlooked and possibly rare native, or a new introduction, or a heretofore overlooked introduced species, its documentation by this survey adds to our understanding of the Connecticut and New England flora, and provides a new data point that is potentially useful in the interpreting of this species' past and future behavior.

Potential additions to Conneciticut's invasive species list. Three non-native species, *Catalpa speciosa* western catalpa, *Verbascum* cf. *phlomoides* clasping-leaved mullein, and *Malus sieboldii* Toringo crab, were encountered frequently in the 7-town study area in conservation-priority natural communities, in most if not all cases clearly adventive. I recommend that land managers take measures to eradicate them in natural areas, and that the State Geological and Natural History Survey and the Connecticut Invasive Plant Working Group give serious consideration to their inclusion to the "Non-native Invasive and Potentially Invasive Vascular Plants of Connecticut" (Mehrhoff et al. 2003), upon its next revision. All age classes of *Catalpa speciosa* were encountered on the flood plain of the Farmington River, in younger successional flood plain forests and more mature flood plain forests of narrower breadth on riverbanks and levees, and, less frequently, in open sand barren habitats. The species identification is uncertain for *Verbascum* cf. *phlomoides*, because most individuals have characters more or less intermediate between *V. phlomoides* and another exotic mullein, *V. densiflorum*, which has not yet been confirmed to exist in Connecticut – while the species identification is uncertain, it is certain that the plants are exotic. This species is frequent and often extremely abundant in disturbed open habitats throughout the 7-town study area. It also occurs in some significant sand barren habitats and flood plain meadows in sufficient abundance to raise concerns about its competing with the rare and uncommon native plant species in those communities. *Malus sieboldii* is discussed in some detail in the earlier section on species new to Connecticut. While I did not find it growing anywhere in great abundance, I did repeatedly find it established in small numbers in open and semi-open communities of high biodiversity significance.

A fourth species encountered during this survey, *Juncus diffusissimus*, and discussed in the previous section, should also be evaluated as a potential new invasive species. However, in its case this evaluation is complicated by the question of its nativity, as discussed above.

Survey for significant natural communities.

The survey documented approx. 159 significant natural community occurrences representing approx. 34 natural community types. Because the CT-DEP-NDDB does not track natural communities in the same way that it does as rare species, it is not possible to say what proportion of these documented community occurrences represent new discoveries. Not surprisingly, there was a strong correlation between rare plant occurrences and occurrences of rare and uncommon natural communities. The most abundant types of significant communities in the 7-town study area fall into the following categories:

- **Open and semi-open upland communities on traprock ridges***
- **Open and semi-open sand plain communities***
- **"High" flood plain forest** and meadow communities**
- **Open wetland communities associated with glaciofluvial sand and gravel deposits** (i.e., poor fens [colloquially, "kettle bogs"], medium fens)*
- **Open and forested communities on Hitchcock Lake-bottom (clay) and deltaic (sand over clay) deposits** (e.g., seasonally inundated marshes, harsh low seasonally saturated wet meadows, and seasonally inundated "drawdown" pin oak-swamp white oak forests)
- **Sand and gravel pond shore and river shore "drawdown" communities**
- **Semi-open acid summit communities***

*these communities should be priority sites for inventories of State-listed invertebrates (Wagner, Thomas, pers. comms.; see also section below on invertebrate inventory)
**where *Silene stellata* occurs in these communities, especially where it occurs in some abundance, the rare moth *Hadena ectypa*, for whom the *Silene* is a host plant, might be looked for; it is not yet known from Connecticut, but it was recently discovered in Massachusetts (Schweitzer pers. comm.)

"Also-rans". For the purposes of this survey, a natural community or community complex was designated as "significant" only if: (1) there was reason to believe that it, as a community entity, was rare, uncommon, or restricted, either by virtue of its type or its condition, in a state, regional, or global context; and/or (2) it provided critical habitat, actual or potential, for rare and uncommon plants, especially in aggregations, or concentrations, of multiple rare and uncommon species. If a community/community complex did not meet the second criterium, which is relatively straightforward and objective, deciding if it meets the first criterium could involve a substantial element of subjectivity and uncertainty. This is because there does not yet exist a universally accepted classification of natural/plant communities in Connecticut that is well tailored to biodiversity conservation. Several published and unpublished classifications cover this geographical area (Metzler 1990; Metzler and Barrett 2001; Lundgren et al. 2000), and to some extent the gaps in one are filled by another, but there are still many discrete ecological community entities on the Connecticut landscape that are not addressed, or not adequately addressed, in any existing classification. It naturally follows that there is not yet a good understanding of the distribution and abundance/rarity of many natural communities.

In several cases, I did not designate and map as "significant" certain communities and, especially, community complexes that occur on a larger scale in the 7-town study area. Without question, all have some ecological and biological significance, perhaps high significance, but they did not meet the above-stated criteria, as far as I was able to determine with confidence. Those that I have judged the more significant of these are listed in Table 3, together with some indication of their distinguishing features and why they were not designated and mapped as "significant" in the context of this inventory.

Table 3. Natural communities/community complexes in the FRWA 2002 Biodiversity Project 7-town study area that are arguably ecologically/biologically significant by criteria other than rarity/uncommonness of their plants or plant communities.

Community or Community Complex	Comments
"Low" flood plain forest (*Acer saccharinum*-dominated) and slough complexes	More abundant/less restricted type than other communities designated as significant; less demonstrable potential as rare plant habitat; I did not explore a large enough portion of the extensive area occupied by this type to confidently distinguish a particular subset as significant. Sloughs in many cases impressive by absence of invasive/exotic species.
Complex of open and semi-open alluvial wetlands at Terry's Plain	Very large complex of multiple types, prevailingly native-species-dominated, except in some more recently farmed areas. Considerable (but not exhaustive) survey effort revealed no rare plants or rare/uncommon communities, and beaver activity will likely keep much of the area in constant transition. Area likely a very significant wildlife resource.
Complex of open and forested wetlands and upland forest along Rawlins Brook east of Rte. 75 in Suffield	Only a small portion designated as significant community because rare of uncommon type with multiple rare and uncommon plants. However larger matrix of wet meadow/marsh/scrubland, very large forested area dotted with vernal pools and occasional stands of mature swamp and upland forests is very impressive, and much of area with very

	low invasive component.
Large open fen at Ethel Walker School in Simsbury	Large wetland apparently stable in open condition, but with conspicuous invasive component; no rare plants discovered (but entire area not explored)
Large tract of near-old-growth forest in McClean Refuge on West Mountain	Very low invasives component; management/interpretation quandary: succession/forest development is likely to change species composition in absence of management (cutting or fire) or catastrophic disturbance, but management may diminish old-growth functions and values
Shade Swamp	Relatively small portion explored during this survey

DISCUSSION

Relative completeness of inventory. To oversimplify only a little, the strategy, or priority sequence, of this survey was essentially to:

- first, resurvey already-known "hotspots" rare plant and community to determine their current status
- second, to do "*de novo*" survey of areas judged to be potential "hotspots" because of their similarity to the already known "hotspots" in terms of certain salient habitat features (e.g., geology, soils, topography, etc.), with emphasis on potential sites for the unmapped historics
- third, to do "*de novo*" survey the large undeveloped areas with no mapped rare plant or community occurrences, focusing on areas that might have potential habitat for the many unmapped historic rare plants

The rate at which land areas could be surveyed was in largest part determined by the rate at which rare plants and communities were discovered and documented (see details of documentation protocol in introduction). Thus, with the unexpectedly high number of new rare plant occurrences and accompanying time requirements of documentation, it may be fairly concluded that the survey essentially completed the first task, accomplished perhaps ½ to □ of the second task, and accomplished perhaps $^{1}/_{10}$ of the third.

The results of this survey suggest to me that the poor fens (i.e., "bogs" sensu lato) in the 7-town study area are the only class of natural communities that had been fairly thoroughly inventoried for rare plants in recent years (this based on the dearth of new discoveries in these communities). The great majority of this survey's new discoveries of rare plant occurrences were on traprock (basalt and dolerite/diabase) ridge summits and upper slopes, and the Farmington River and its floodplain (especially the flood plain levee forests). These geomorphologic subsets of the study area were also among those favored during the first and second above-listed tasks, in terms of survey time and effort, because of the inferences of CT-DEP-NDDB data that these were rich sites. Significant sections of the traprock ridge lines and the Farmington River were not visited even once during this survey. Thus it can be fairly said that this survey never finished with the sites with the highest known potential for rare plants (except possibly the poor fens/bogs).

It is very difficult to estimate what proportion of the real total of rare plant occurrences in the 7-town study area is now known. This survey increased the number of extant occurrences known to the CT-DEP-NDDB by at least 270% (230% subtracting new occurrences of 3 species that are proposed for delisting and 2 species that this survey's results suggest should also be proposed for delisting). The rate of discovery of new State-listed plant occurrences remained essentially constant throughout the period of the survey, at about one new occurrence per day of field work. One would reasonably expect this rate to drop off as we approach the point where our inventory includes virtually all rare species occurrences in the study area.

Since we ended the survey still very much on a steep part of the cumulative-new-occurrence-per-unit-of-survey-time curve, it is reasonable to conclude that we are not yet in the high percentiles of knowledge of the rare plant occurrences in the 7-town study area. My admittedly subjective, or perhaps more accurately, "informed-intuitive", estimate is that 1-2 more field seasons of similar intensity of survey effort would be required before the cumulative-new-occurrence-per-unit-of-survey-time curve would definitely begin to approach level (i.e., the rate of new occurrence discovery drops off significantly because the number of known occurrences is a high percentage of the real number of occurrences). This point will likely not be reached before the entirety of several geomorphologic systems have been covered early, in the middle of, and late in the growing season. These include the traprock ridge systems (probably foremost), the Hitchcock Lake-bottom (clay) and deltaic (sand over clay) deposits areas of Suffield and East Granby (especially open and semi-open minimally managed habitats), and the flatwater/north-flowing section of the Farmington River and its adjacent floodplain. This will still leave very large unsurveyed areas, over which there is no known reason to suspect that rare plant occurrences are more than very thinly scattered. These include predominantly upland areas such as Ratlum Mountain and the western highlands of Granby, and large wetland areas such as Shade Swamp in Farmington, and Great Marsh in East Granby. Though current knowledge suggests there will be few rare plant occurrences in these areas, the occurrences that are there may be may well be of important species, such as the Federally Endangered orchid *Isotria medeoloides* small whorled pogonia, or State-historic *Triphora trianthophora* three-birds orchid. Thus it is highly recommended that at least some level of continuing rare plant and natural community inventory continue in the 7-town study area, the priority of which is the high-potential geomorphologic systems, but which includes at least some reconnaissance and/or survey of the large areas of putatively low rare species potential.

The following is a list of specific kinds of sites that I would prioritize in a continuing rare plant/community inventory effort in the 7-town-study area:

- **Traprock ridge summits and upper slopes not given full-growing season coverage during the 2002 survey**. Within this category, I would assign priority to those sections that were not visited at all in 2002.

- **Mesic low slopes and bases of traprock ridges.** These kinds of sites received relatively little attention in 2002, at least in proportion their extensive occurrence in the study area. There were three reasons for this. The foremost was that the patterns of landownership made gaining access a very time-consuming task: the lower slopes and bases of the ridges tended to be divided into many small parcels, while the upper slopes and summits were typically larger parcels and a higher proportion was already conservation land. Secondly, there were relatively few records in the 7-town study area for the nutrient-demanding, mesophytic rarities that occur, or potentially occur, in these kinds of sites. Finally, what survey that I did conduct in these kinds of sites in the study area suggested that the subset with rare plants and significant natural community occurrences might be rare enough in the study area (as suggested also by the dearth of records of the right kind of species), that the time invested in seeking tens to hundreds of landowner permissions would likely produce low return, compared with actual field survey time spent in other more accessible systems. This was probably true, but it leaves a site type that has large representation in the study area still largely unexplored.

- **Traprock talus slopes (especially low slopes and bases of slopes).** This is an often but not always a subset of the preceding type. Many open-canopy occurrences of this type were designated and mapped as significant communities, even without having been well-explored for rare plants, because: this community is of relative restricted occurrence; it frequently hosts (in many cases documented by this survey) the declining tree *Juglans cinerea* butternut, a *Flora Conservanda* (Bumback et al. 1996) Division Indeterminate species; the communitiy has high potential importance for amphibians and/or reptiles; and the community was very easy to identify and map using stereo-aerial photographs. However, many of the mapped occurrences of open talus and many other unmapped occurrences forested traprock talus habitat remain to be fully inventoried for rare plants and significant community occurrences.

Of particular interest and biodiversity importance are possible occurrences of "ice talus" (also known as "ice cave talus") communities. These occur occasionally low on, and at the base of, talus slopes at sites where a cold microclimate is maintained year-round because of the discharge through the talus of cold air that has drained through the intersticial spaces of upslope talus, far below the slope surface. In at least some cases, the air is cooled by contact with ice that has formed deep beneath the talus in winter and is very slow to melt in the summer because of its depth below the insolated talus slope surface. These are places where some of Connecticut's rarest plants occur. Strangely enough, this assemblage includes both northern boreal forest species, disjunct in Connecticut south of their main range, and southern and middle Appalachian Mountain species, in Connecticut disjunct well north of the main part of their range. Two poorly developed examples of this community type were discovered during the 2002 survey, in one case hosting a northern species, *Ribes glandulosum* skunk currant (CT State-Endangered). This was the first known record of *R. glandulosum* from Hartford County, and the lowest elevation at which this species has ever been recorded in Connecticut (all previous records are from higher elevations in the coldest part of the state, in northern Litchfield County). This discovery suggests that there are more such "ice talus" sites in the 7-town study area, since it was not the result of an extensive survey of potential habitat, but rather of a more or less random stop along an easily accessible roadside section of talus.

- **High flood plain forests (especially levee forests) along the flatwater section of the Farmington River.** These communities were among the most highly productive of important new rare plant records of any class of communities. Counting each side of the river as a separate section to survey, this survey covered only about 40% of the total length of riverside along which these communities may occur (i.e. about 15 miles out of ~36 miles total).

- **Open flood plain meadow communities and edge habitat along the Farmington River.** Though not quite as productive of new rare species records as the previous class of communities, several important meadow communities and a significant number of rare plant occurrences were discovered in these habitats (one very important plant occurrence was found at the edge between a managed field and a flood plain levee forest). Open flood plain habitat and field/forest edge habitat occupies a very large area in the study area, and only a small portion of the total was covered by this survey. Several of the unmapped historic records for the 7-town study area most likely occur somewhere in these communities. This recommendation applies mainly to minimally managed open habitats. With the exception of some very sandy places, intensively managed open habitat such as actively farmed and grazed fields, playing fields, and golf courses have little or no potential, but borders of such places with flood plain forest can host important rare plants.

- **Minimally managed open, semi-open, and forested habitats of the Hitchcock Lake-bottom and deltaic deposits landscape.** This geomorphologic system occupies a large portion of Suffield and some of East Granby. It is botanically a relatively little known area whose distinctive features include a vast number of seasonally flooded "drawdown" wetlands, including vernal pools, meandering seasonally flowing watercourses, and oak-dominated swamp forests. Soils over most of this area are formed from clay or shallow sand deposits over clay. Of the towns in the study area, Suffield has by far the highest number of historic rare plant records, and only one of the pre-2002 mapped recent records was from the Hitchcock Lake-bottom and deltaic deposits landscape portion of town. The relatively small portion of this landscape that was covered by this survey produced 13-14 new rare plant occurrences, representing two of the historic species, three species not previously known from Suffield, and one species previously documented in the area that turned out to be unexpectedly ubiquitous along the many seasonal and perennial streams that meander across this landscape. In addition, I encountered several wet meadow communities unlike any assemblages that I had encountered before in Connecticut, and that were not represented in existing geographically relevant natural community and vegetation classifications. These "new" finds strongly suggest that this landscape has been little explored botanically, or at least not in many decades (apologies to Jesse Smith!), and that the extensive remaining open

and semi-open habitats, especially, may support considerable numbers of rare plant and significant community occurrences. Most, if not all, of these open and semi-open habitats are likely post-agricultural land, and are on a developmental trajectory toward forest. Any light-demanding rare plants will not likely persist in these places without management, so there is some urgency to finding occurrences of these species before their habitat disappears, while there is still opportunity to preserve it through appropriate management.

- **Low flood plain forest and slough complexes along the Farmington River.** This habitat occupies extensive areas along the flatwater section of the Farmington River, and only a relatively small portion was explored during this survey. Though significant in many respects and having higher than average potential for rare plants, this class of habitat was effectively neglected in order to devote more survey time and effort to the high flood plain forests and other relatively rarer communities that were more productive of rare plant occurrences. However, the low flood plain forests and slough complexes undoubtedly host as-yet-undiscovered rare plat occurrences and should be considered among the next-in-priority sites for future botanical survey. In particular, the large complex west of the Farmington River, southwest of Pickerel Cove and north of Route 315, should be explored.

Rare Invertebrates and communities with high potential for rare invertebrates. A State-Threatened tiger beetle, *Cicindela formosa generosa*, along with a number of other insects thought to be rare or uncommon, were documented at two sand barrens in the study area, with the generous help of entomologist Michael Thomas. There is reason to believe that many of the significant community occurrences documented by this survey potentially host other as-yet-undiscovered State-listed invertebrates (Thomas pers. comm.; Wagner pers. comm.; Wagner et al. 2003). In many cases, the rare invertebrate component of the communities will likely overshadow the biodiversity significance of the community occurrence as rare plant habitat (Wagner, 2003). With the advances made by this survey in the understanding of the vascular plants, birds, amphibians, and reptiles, inventory of rare invertebrates is now arguably the highest priority next task to accomplish in the charting of the significant biodiversity hot-spots of the 7-town study area.

Preeminent Protection Issues

- **Sand Barren communities** – threatened by lack of recognition of the biodiversity significance of sites which are mostly "disturbed" and/or man-made, e.g., old sand/gravel excavations, road and powerline right-of-ways, graded lots, etc. Many people, including many conservationists, see these sites as waste places without ecological value, and therefore appropriate sites to develop, convert to playing fields, or "restore" via soil amendment and planting to some kind of more densely vegetated habitat. These sites are the last stronghold for many rare and uncommon plant and invertebrate species (Wagner et al. 2003) that once occupied more natural open and semi-open sand plain communities, which have now virtually disappeared from Connecticut, having been either developed, excavated, converted to forest, agriculture, and golf courses, or taken over by invasives such as *Eleagnus* autumn olive. It is unknown what portion of the original sand plain flora and fauna still hangs on in the sand barren communities of right-of-ways, roadsides, gravel pits, and airport grasslands, but indications are that the number is considerable.

Preeminent Management Issues. As explained in the introduction, subjective evaluations of threats and management issues were made for all rare plant and significant natural community occurrences. While at several sites the foremost threat is lack of protection (i.e., the site is not under conservation easement or ownership), by far the most ubiquitous threats and issues were management-related. Several specific threats/issues are preeminent because they recur at site after site, and are listed below.

- **Invasive species.** Among the welcome surprises of this survey was the finding of so many rare plant and priority community sites that were not already rife with invasives. However, the bad news is that the majority of rare species occurrences and significant natural community occurrences documented by this survey are threatened, sooner or later, by the invasion of the site and/or on-site increase of invasive plant species. Invasive plant species occur in at least small numbers at most sites, and at the more imminently threatened sites are more abundant. If no management of invasive species occurs at these sites, there is no evident reason to believe that invasive species will not increase and cause the decline of native species, especially the rare species, and habitat values. For the more imminently threatened sites, this will likely occur within 10 to 20 years, while for the less infested sites, it may take several more decades. I have assigned to all sites invasives control urgency ranks that reflect my subjective evaluation for each site (site ranks are found in the Site Survey Summary EXCEL spreadsheet).

- **Potential harmful effects on Farmington River flood plain communities of changes in flooding regimes caused by upstream ACoE flood control dams.** There occurs, along much of the north-flowing ,flatwater section of the Farmington River, a type of so-called "high" flood plain forest community that was already recognized by the CT-DEP-NDDB as a rarity in Connecticut. It is a "high" flood plain forest because it is at elevations that flood at between 10- and 50-year intervals, based on a preliminary comparision of town 2-foot contour topographic maps and a 1966 Army Corps of Engineers flood report (ACoE 1966). These sites are ecologically distinct from the more common "low" flood plain forests dominated by *Acer saccharinum* silver maple, which are at lower elevations that flood more frequently, and for longer durations (ACoE 1966; Metzler and Damman 1985). This particular type of high flood plain forest, which is unusually rich in species relatively intolerant of flooding, appears also to be rare in the context of New England, based on a review of the community literature ecological and consultation with plant ecologists in other states. Further analysis may reveal it to in fact support a globally rare plant assemblage. The flatwater section of the Farmington River is a stronghold for this community, which occurs at interval extensively along most of the flatwater section. It in turn supports New England strongholds of several rare plants. The unusual juxtaposition of flood-intolerant species, such as oaks and hickories, and flooding frequencies as high as 1-year-in-10, may be reasonably hypothesized to be the result of a relatively rare combination river size, the "flashiness" of its floods, and the predominance of sand in the alluvial sediments (due the geomorphologic "accident" of a large, high gradient New England river becoming "trapped" on a large glacio-fluvial sand plain by a long ridge line). These high flood plain forests are arguably the single most unique ecological feature of the 7-town study area.

  The entire meta-occurrence of this rare community along the flatwater section of the Farmington River may be threatened by the operation of upstream flood control structures constructed after the August 1955 floods, and operated by the Army Corps of Engineers (ACoE) since the 1960s. Counter-intuitively, the threat most likely comes not from too little flooding of these high flood plain forest sites, but rather from too much. More specifically, the potential threat is of longer duration floods that result from the way in which the flood control dams work: the peak flood elevations are lowered by spreading out the discharge, so that floods are not as high, but the duration of the flooding is longer at lower elevations, at least under certain conditions (Hanlon pers. comm.). The most likely explanation for the presence of old-age individuals of long-lived flood-intolerant species, such as oaks and hickories, on an active flood plain is that the flooding of the sites was of short duration historically (i.e., floods were "flashy"), and sandy soils are fast draining. It is theoretically possible that a precipitation event that would have produced a 100-year flood of short duration without ACoE flood control, may result in, say, a flood that peaks at a 30-year elevation, but remains at that elevation for longer than sites at that elevation have ever experienced. There is good reason to expect that this would result in profound changes in the vegetation at most of the sites occupied by high flood plain forest, in particular the decimation of the less flood-tolerant species. These include the New England rarity *Silene stellata* starry

campion: 99% of all the plants still known in New England are in this community.

A more rigorous assessment this threat is urgently recommended. The more easily accessible existing data is suggestive but not conclusive, and it may require substantial effort and time to effectively address the threat. For example, the ACoE flood control structures are constructed such that a range of flood manipulations is possible, but an Act of Congress would be required to modify the purpose for which, and way in which, the controls are operated (Hanlon pers. comm.). And the flood event that proves or disproves the hypothesis may occur at any time.

- **Changes in open and semi-open communities due to absence of periodic fire (especially, canopy closure and changes in competitive balance in herb layer)**. This survey uncovered strong indications that light-demanding rare and uncommon plant species of open and semi-open communities (i.e., meadows, glades, savannah-like shrublands and woodlands) are generally declining because of the "growing up" of these communities over the 20th century into forested habitat. This phenomenon is widespread in the 7-town study area, as it is throughout Connecticut, New England, and eastern North American. This is regarded by some as "natural succession". However, it has in large part resulted from widespread suppression of fire on the landscape, which began in earnest in the early 20th century. Fire is a periodic disturbance that creates openings in forest canopy and alters the competitive dynamics in the herb layer, and a large number of rare and uncommon species that were once evidently more common are adapted to take advantage of such disturbances. It is widely but not yet universally accepted that human-set fire was an important and widespread ecological force on the pre-European-colonization southern New England landscape (Cronon 1983). Less well understood and accepted is its importance/prevalence relative to logging and agriculture on the post-settlement landscape, but there is abundant anecdotal evidence to suggest that it was much used until recently to keep agricultural land open or return grown up land to open conditions. Also, it is reasonable to suspect that on the post-settlement landscape, on sites prone to drought, such as (then as now) ridge summits and upper slopes, wildfires occurred more frequently and over larger areas before the development of the organized and technologically advanced fire suppression of the 20th century. It is also clear that many of today's rare and uncommon plant species (as well as many today's rare and uncommon invertebrate and vertebrate fauna) that are associated with open and semi-open habitats were more common at the beginning of the 20th century.

  During this survey, populations of light-demanding rare and uncommon species were repeatedly found associated with openings that were clearly subsets of formerly much more extensive occurrences of open habitat that has mostly closed in over the last several decades. Often the populations of these rare and uncommon species were very small and/or the individuals relatively unthrifty, suggesting strongly a declining population. A parallel situation was also encountered, where the habitat was still open, due sometimes but not always to human manipulation such as right-of-way maintenance, but the rare /uncommon species population was restricted to the few microsites with relatively open soil and lower competition. In these situations, absence of periodic fire may be allowing more competitive native herbs and sub-shrubs to increasingly dominate most or all suitable soil sites, and squeeze out the rare/uncommon species, lowering the diversity of the community in spite of the maintenance of open-canopy conditions. Both kinds of sites appear clearly to be on a trajectory toward loss of rare and uncommon species and decreasing diversity, but it is not clear if prescribed fire is the only solution, or if other kinds of habitat manipulations, such as clearing, selective cutting, mechanical disturbance of the herb layer, etc., would suffice to reverse the trend. This is a very important question to answer since the use of prescribed fire in a largely developed landscape is likely always to be controversial and problematic.

  Toward the end of evaluating the effects of fire on certain significant communities, I recommend monitoring and study of one site in particular in the study area, where there was a recent wildfire on a traprock ridge summit where a priority community occurs.

Finally, in most discussions of reversing/preventing "natural succession", it is hard to avoid getting into philosophical disagreements centering around "natural" versus "un-natural" ecological processes. Fire, it may be argued, may have been an important and widespread ecological force on the southern New England ecosystem, but was "un-natural" because it is generally conceded that it could not have been so without having been human-induced (Cronon 1983). Thus it is "un-natural", and it is not necessarily ecologically "right" to reintroduce it. However, it may be also be argued that the widespread use of fire by native Americans was part of the "natural" disturbance regime in places like Connecticut because native Americans using fire to clear land, hunt, and manage habitat, have been here longer than the current climate and species assemblage (i.e., native Americans having arrived while Connecticut was still tundra-like), and the regime of widespread human-enhanced fire has thus probably been the rule for at least several thousand years, until the 20th century.

- **Conversion of open and semi-open communities to forest, due to the farm field and pasture abandonment.** This issue is similar to the preceding in terms of the loss of light-demanding rare and uncommon species, but these are sites where it is unlikely, or less likely, that fire was the agent that created/maintained the open conditions historcially, and there is no evident compelling ecological reason to believe that fire would be preferred over mowing, "bush-hogging", etc., as a means of maintaining open conditions (though further study of these situations may reveal that fire would be the best tool). Many of these sites have seasonally saturated/seasonally mesic to dry, sand or clay soils, and remarkably diverse native-species-rich herbaceous assemblages that include multiple rare and uncommon native species. Suffield appears to presently be a stronghold of these kinds of sites (I visited only a relatively small subset of those that appear to exist, based on aerial photograph interpretation), and indications are that those that are not threatened by development and intensive agriculture, are threatened by succession over the next several decades, if not managed to maintain their openness and their native diversity (i.e., they should not be converted to warm-season grasslands or other type of open community that would involve the destruction of the existing plant assemblages).

- **Overbrowse by deer.** Like invasive species, this is a "if not now, then sooner or later" threat to native plant diversity and the integrity of natural communities in the 7-town study area. There is strong evidence from various studies that deer overpopulation/-browse is causes loss of native plant species (especially native orchids), attenuation of forest regeneration, decline of breeding success of low-nesting forest birds (due to removal of low cover), and decline of butterflies due to loss of herbaceous forest species (Schweitzer pers. comm.). My subjective observations of the level of deer browse impact indicate that it is much heavier in some parts of the study area (e.g., the traprock ridge sections of McClean Game Refuge, the high flood plain forests at Fisher Meadows Recreation Area) than others. Deer over-browse is possibly the reason for the relative dearth of native orchids observed by this survey in the 7-town study area, as compared with other similar-sized areas in the state. However, my survey cannot be said to have covered sufficient area to be more than tentative and hypothesis-generating regarding either the observation or the correlation (also to consider, the number of rare native orchid historic records was relatively low). Considering the concentrations of rare and uncommon plants that still exist in even the above-noted more heavily browsed areas, it is imperative that deer overpopulation be addressed in managed areas before more species are lost.

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