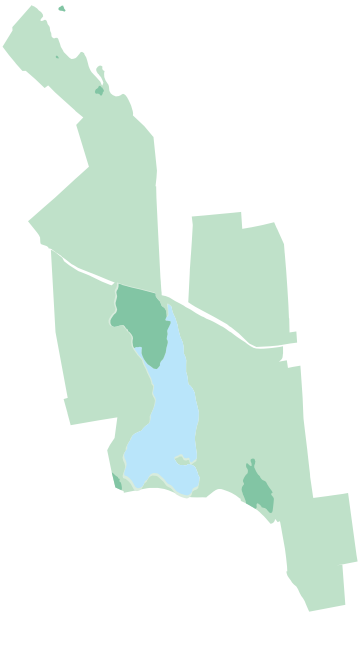
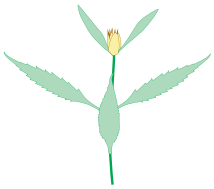
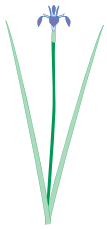
THE HARVARD FOREST FLORA

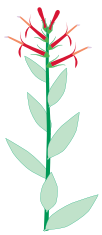


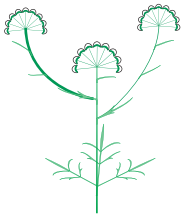


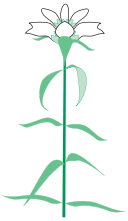
AN INVENTORY, ANALYSIS, & ECOLOGICAL HISTORY

JERRY JENKINS,
GLENN MOTZKIN,
KIRSTEN WARD









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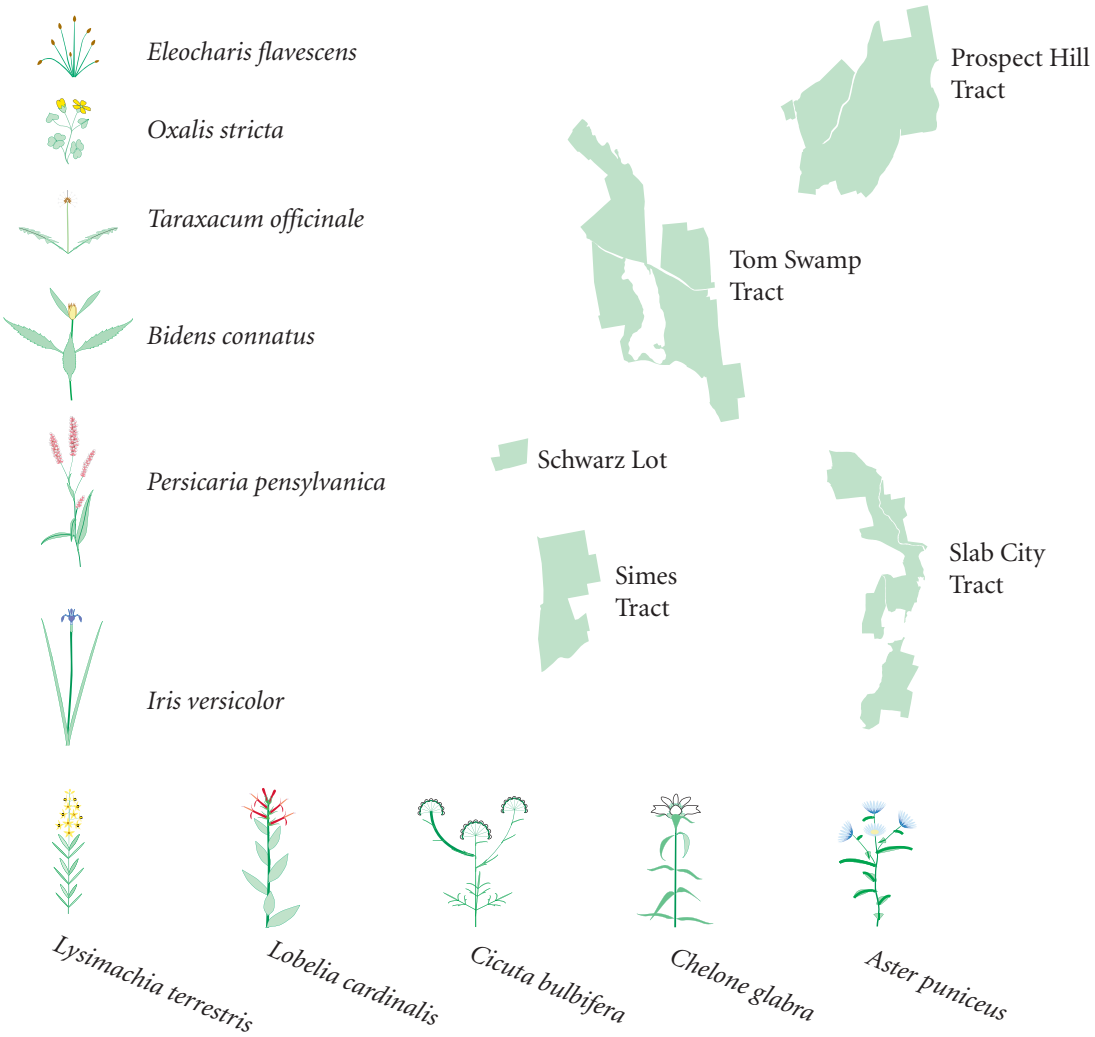

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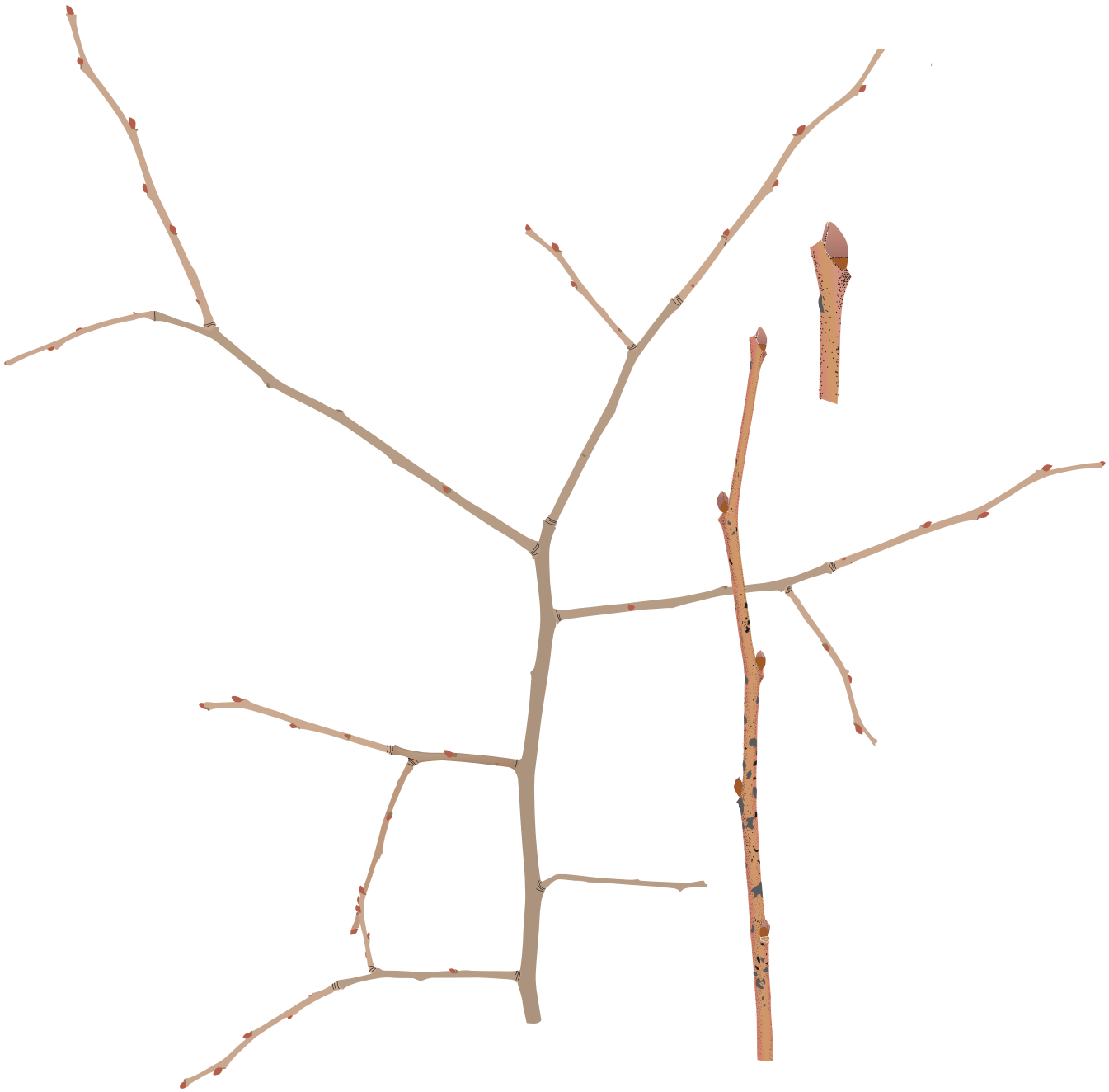


BLACK HUCKLEBERRY

1 INTRODUCTION

This book presents the results of a botanical survey of the Harvard Forest (HF), by Jerry Jenkins, Glenn Motzkin, and Kirsten Ward. The purpose of the survey was to determine and map the current flora of the forest, compare it to the flora recorded in previous surveys, and estimate the rate of floristic change. The survey began in the spring of 2004 and was completed in 2007, a hundred years after Harvard Forest was created. We call it the centennial survey.

Roles and Authorship

Kirsten Ward was the principal field surveyor, spending 20 weeks on the project in 2004 and 2005. Glenn Motzkin assembled the historical information, relocated historical specimens, worked with Kirsten in the field, managed the project databases, and relocated many missing species during the second half of the project. Jerry Jenkins trained Glenn and Kirsten in identification and assisted them in field work, reviewed the herbarium specimens and did the technical identification of field material, did the quantitative analysis of the flora and, in constant consultation with Glenn, wrote this document and prepared the illustrations for it.

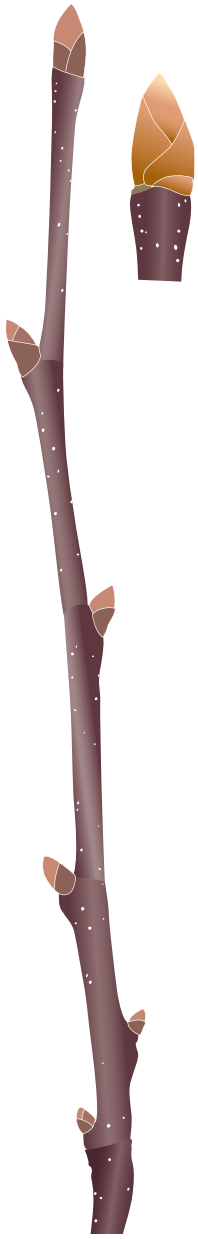
Other Products

The results of this survey are contained in this document and two master databases, available on the Harvard Forest website. HF.final.master (the most recent version is 8 January 08) contains the status and, where we have recent records, the field data for each species that we recognize. HF.Herbarium.Database (most recent version is 5 January 2008) is an index of all the specimens in the HF collection.

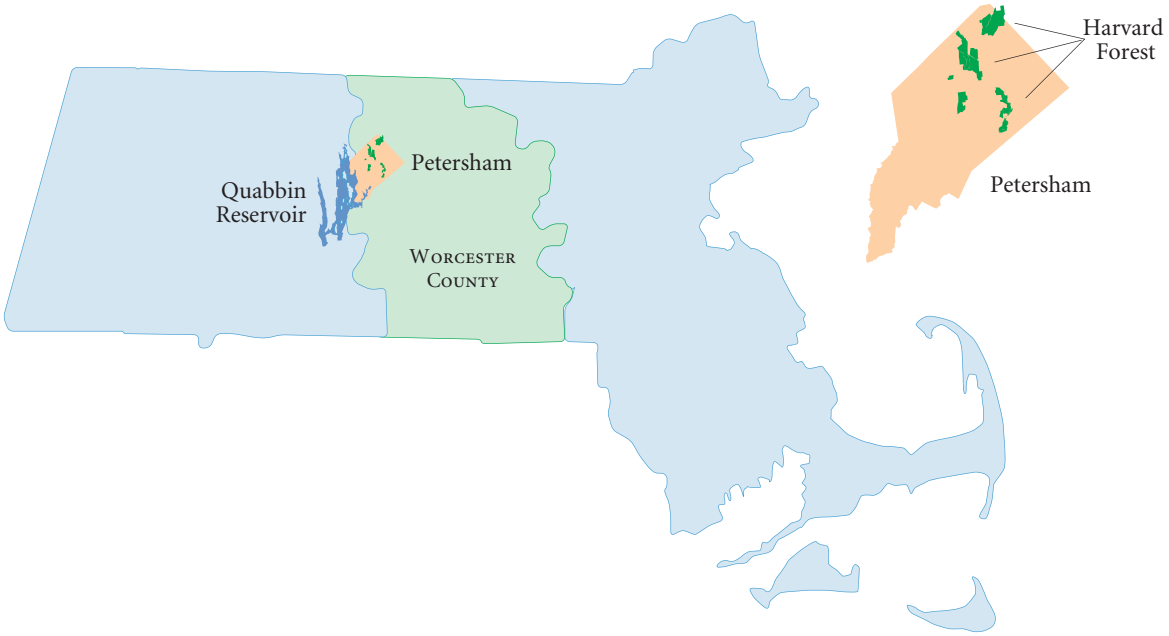
Acknowledgements & Thanks

This project is a contribution of the Harvard Forest Long Term Ecological Research program. Kirsten Ward was supported through the National Science Foundation Research Experience for Undergraduates program. Jerry Jenkins was supported in part by a Charles Bullard Fellowship from Harvard University.

This project required the assembly, verification, and analysis of a large amount of field and historical data, and would not have been possible without the help of many people. David Foster, Director of the Harvard Forest, provided interest and support throughout the project. Marshall Ward assisted with field work and data entry. Brian Hall of the HF staff provided GIS data and John Burk, Brian

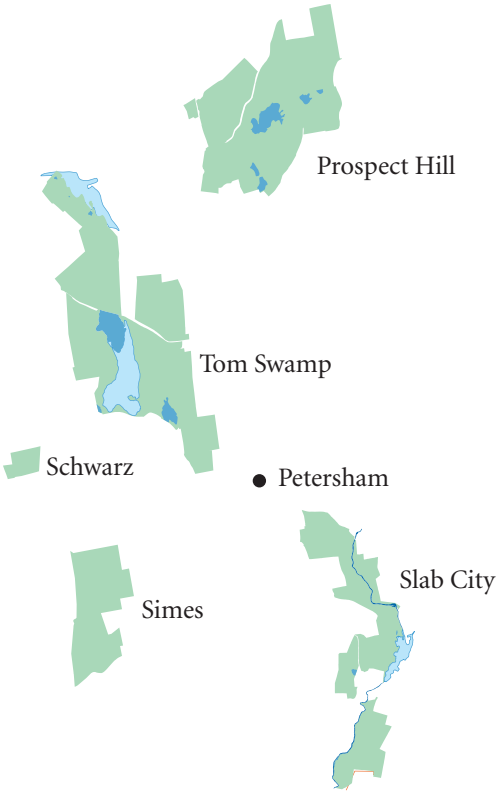


American chestnut, formerly one of the iconic trees of central New England forests, has been reduced to an understory tree by the chestnut blight, *Cryphonectria parasitica,* a fungus which kills the stems but not the roots. The blight was discovered in the United States in 1904 and at HF, where chestnut was an important canopy tree, in 1910. By 1950 canopy chestnuts were largely gone from the forest; none of the authors has ever seen a mature chestnut tree.



DeGasperis, Julie Hall, and Laurie Miskimins assisted with herbarium specimens, data entry, and error checking. John O'Keefe and John Wisnewski of the HF staff provided historical information and helped us identify old place names. Paul Somers and Henry Woolsey of the Massachusetts Natural Heritage and Endangered Species Program provided a database of county records of vascular plants that was invaluable for our analysis of floristic gradients. Henry Woolsey also provided information on locations of several species observed in Petersham in the late 1970s and early 1980s. Robert Bertin kindly shared records from his Worcester County Flora with us, verified specimens in the HF herbarium, and pointed out several mistakes that we would not otherwise have caught. Matt Hickler helped survey Harvard Pond for aquatics. Emily Wood and Melinda Peters at the Harvard University Herbaria and Roberta Lombardi and Karen Searcy at the UMASS Herbarium provided assistance searching for Harvard Forest specimens. Judy Warnement and Lisa DeCesare of the HU Botany Libraries and Sheila Connor at the Arnold Arboretum helped us track down photos of early botanists at the Harvard Forest. Karen Adler Abramson of the Farber Archives and Dan Perlman of the Biology Department at Brandeis University helped to locate our long-missing C. E. Smith specimens and arranged for the transfer of these specimens to Harvard Forest. To all of these people, without whom this project could never have been brought to its present form, we are deeply grateful, and offer our acknowledgement and thanks.

THE MAIN HARVARD FOREST TRACTS

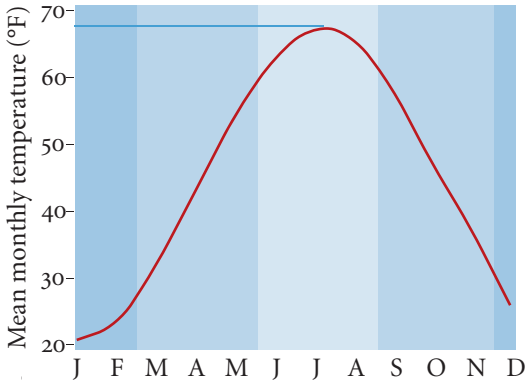


The Harvard Forest is a collection of five properties, totaling about 3,100 acres, in Petersham, Massachusetts. The three main properties, the Prospect Hill, Tom Swamp, and Slab City Tracts, were acquired in 1907 by Harvard University and used to train forestry students and to conduct experiments in silviculture. Professional forestry had only been introduced to the United States in the early 1900s—Yale had created the country's first forestry department in 1902 and Harvard followed in 1903—and was considered an important academic field. Harvard awarded its first masters degree in Forest Science in 1907 and continues to award them today, though it no longer has professorships of dendrology or forestry and it is no longer possible to be, as Dr. John Nelson Spaeth was in 1921, an Instructor in Lumbering in the Graduate School of Business Administration.

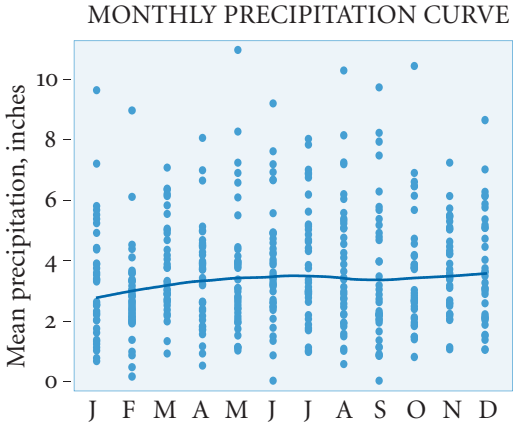
The teaching and silvicultural programs slowed in the late 1930s, and were largely discontinued after World War II. For the next forty years the facilities at Harvard Forest, which by then included a large laboratory and administrative complex, were used for research in plant biology. Much distinguished work was carried on here—Barry Tomlinson, John Torrey, and Martin Zimmermann are three famous botanists associated with the forest in this period—but the work was not particularly ecological and not strongly related to the Harvard Forest lands.

The use of the forest changed again in 1988, when it was designated a National Science Foundation Long-term Ecological Research site and began to attract students and researchers interested in forest ecology and global change. Over the last 20 years it has come to specialize in forest dynamics and forest biogeochemistry. Current research programs include long-term soil-warming, nitrogen-addition, and flux-tower experiments, studies of regional land-use and vegetation history, and studies of stream ecology and the hemlock woolly adelgid.

MONTHLY TEMPERATURE CURVE



MONTHLY PRECIPITATION CURVE



Mean monthly temperatures and precipitation for 1966-2002, from the weather station at Harvard Forest.

The Ecological Setting

Petersham is a rural town in Worcester County, Massachusetts, about 60 miles west of Boston and 10 miles south of New Hampshire. It is largely in the Swift River Watershed, one of the eastern watersheds of the Connecticut River, and lies near the center of a twenty-mile wide band of hilly uplands that form the eastern edge of the Connecticut Valley. The north part of the town is rolling and the south more distinctly hilly; the lowest basins are about 800 feet above sea level, the flats around 1100 feet, and the summits 1,200 feet to 1,400 feet.

The climate is cool temperate. The annual temperature and precipitation curves are shown on the previous page. The mean temperature is about 45°F, the coldest month about 21°F, and the warmest 68°F. Exceptional months have had means as low as 12°F and as warm as 72°F. Annual rainfall is about 43 inches, and equally distributed though the seasons.

As elsewhere in the east, winter temperatures have warmed over the last forty years. Mean winter temperatures are now about 5°F higher than in the 1960s (p. 35), and spring is coming, on average, about 12 days earlier. This is a remarkable rate of change in a short period of time.

Geologically Petersham lies on a mixture of metasediments and meta-igneous rocks, schists, gneisses, and tonalites of Ordovician and Devonian age. All are hard, low in calcium, and very similar to a nongeological eye. They were deposited or intruded in the basin created when the Iapetus Ocean opened in the early Paleozoic, and were driven eastwards, metamorphosed, further intruded, and finally added to the North American continent when North America collided with Baltica in the middle Devonian. They belong to a suite of rocks now generally called the Iapetus Terrane. Like the Avalonian rocks further to the east, the Iapetus is said to be an exotic terrane because it was not initially part of North America.

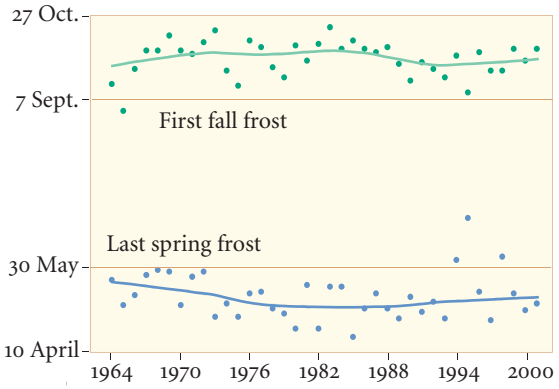
Most of Harvard Forest seems to be geologically uniform, and bedrock outcrops and bedrock differences seem to have little effect on the vegetation. The important exceptions are Camel's Hump, in the Simes Tract, and several smaller hills in the Slab City Tract. Camel's Hump appears to have bands of some sort of a soft rock that support a number of calciphilic plants that occur nowhere else on the forest. We have not found any description of the bedrock in published sources, and do not know its mineralogy.

The soils are much less uniform than the rocks. Regionally, the soils are mostly stony glacial tills and wetland peats. Glacial-fluvial gravels and outwash occur but are local at HF and supply microhabitats for some dry-soil species we don't otherwise see.

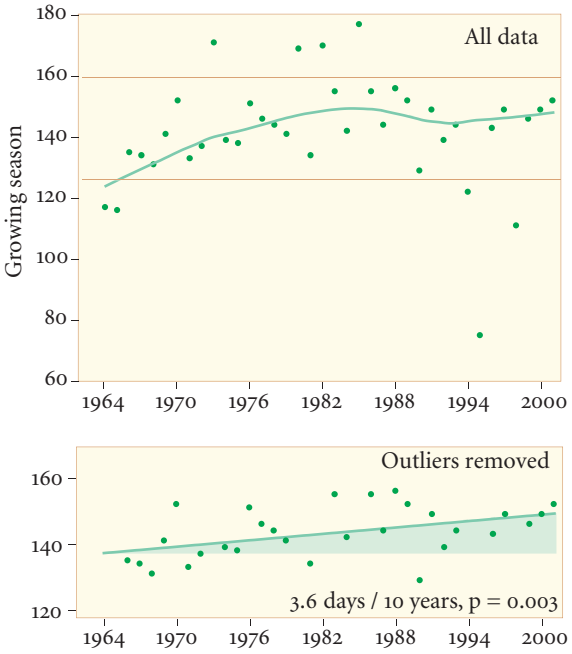
The tills at HF are shallow and sandy on the ridges. On convex terrain they are dry or very dry in the summer and fall, and support oak and pine forests. On the lower slopes they are deeper, wetter, and more fertile. In basins they are often wet and peaty, and support wooded swamps or open bogs. The transition from dry rocky hillslopes to peaty basins is often abrupt, and you can go from a dry oak forest to a wooded swamp in a few meters.

Because the rocks are hard and low in bases the soils are quite acid. The typical pHs on Prospect Hill are in the 4.0-4.4 range. Values of 4.8 and 5.2 occur on Camel's Hump in the Simes Tract, and are among the highest recorded at Harvard Forest. We consider this, by local standards, a calcareous site.

HARVARD FOREST FROST DATES,
1964-2002



HARVARD FOREST GROWING SEASON,
1964–2002



Trends in first and last frost dates, from the Harvard Forest weather station. The first fall frosts have not changed much, but the last spring frosts are coming nearly two weeks earlier and the growing season is about 12 days longer. For more information on temperature trends, see p. 35.

The uplands of central Massachusetts are not particularly wet—Harvard Forest contains about 4% wetlands and no natural ponds—but they do contain wetlands that are striking individual features and collectively of considerable ecological and floristic importance.

The two largest wetlands at Harvard Forest are Tom Swamp, a peat-filled valley about 2 kilometers long and 200 to 500 meters wide; and the black gum swamp in the Prospect Hill Tract, a peat-filled basin about 600 meters long by 200 meters wide. The black gum swamp has had extensive stratigraphic studies (Anderson et al., 2003); it is known to be about 6 meters thick and over 14,000 years old in the deepest part, to have begun as four separate bog lakes, and to have acquired its present size when the bog mats in these lakes expanded laterally and coalesced between 5,000 and 9,000 years ago.

Many smaller wetlands, most under an acre in size and many much smaller than that, are scattered through the woods and along the streams. These include vernal pools, small forested peatlands, seepage areas along streams, beaver ponds, and one open bog (Gould's Bog, in the Prospect Hill Tract). Most of these have never been mapped, and their size and distribution are poorly known.

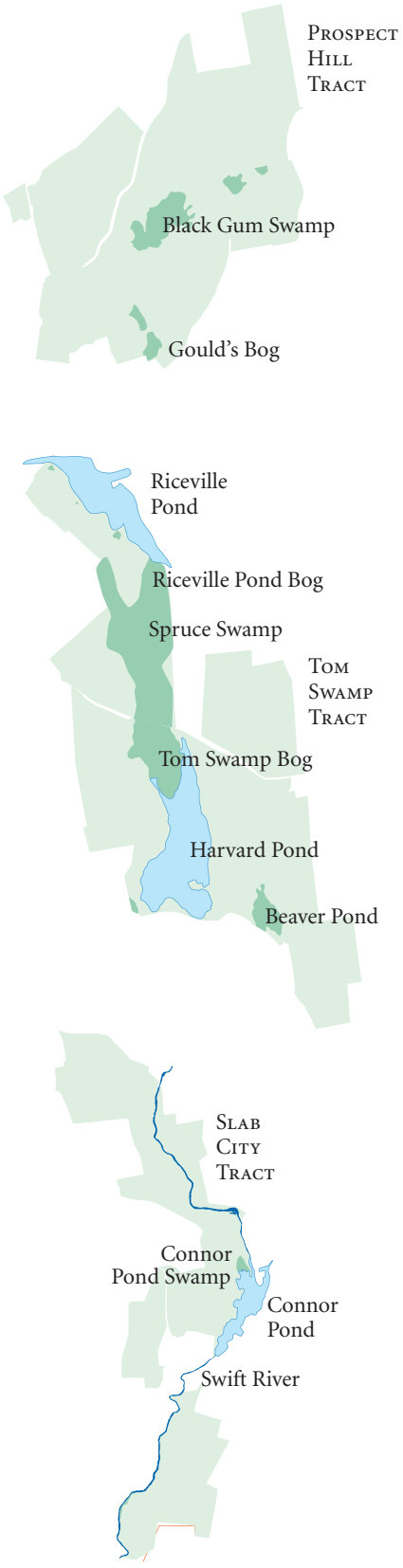
Ponds Harvard Forest contains one artificial pond and borders two others. Harvard Pond, at the south end of the Tom Swamp Tract, is completely in HF. It was created by flooding what an early map called a "meadow" and which may have been a fen or a bog, contains about 100 acres of open water, and was made in the 1880s. Riceville Pond, which forms the north border of the Tom Swamp Tract, is about 60 acres and was created after 1855. And Connor Pond, on the east edge of the Slab City Tract, is about 40 acres and was created before 1830.

All the ponds have associated wetlands: Riceville Pond and Harvard Pond have floating bog mats; Connor Pond has an inlet delta with a shrub swamp and open marshy shores. All the ponds likely flooded pre-existing wetlands, and the wetlands that remain have likely been altered by flooding.

Streams The major stream at Harvard Forest is the East Branch of the Swift River, which borders or runs through the Slab City Tract for about 3 kilometers. It is a medium-sized stream where it passes through the forest, 10-15 meters wide, rocky, partially shaded and partially open, with a watershed of around 70 square kilometers and a gradient of 15-20 feet per mile.

Beside the Swift River there are few streams. The uplands at Harvard Forest are mostly rounded or flat-topped and constitute

WATERBODIES AND WETLANDS



drainage divides. The water on them tends to accumulate in small wetlands with only small inlets or outlets. What streams there are have small watersheds and narrow channels, and are often intermittent.

Land-use History

Petersham, like many of the adjacent towns, was settled in the early 18th century, extensively cleared and farmed in the next hundred years, and then progressively abandoned after about 1830 as subsistence agriculture became unsustainable and the hill farmers failed to make the transition to the more intensive dairy-based agriculture of the later nineteenth century.

The earliest map of land cover in the town, prepared in 1830, shows about 7,300 acres out of 26,000 (28%) as forested. This probably was approaching the peak of land clearance. The decadal censuses for Massachusetts show 3,385 acres of woodlands in 1865, and increases in every subsequent census.*

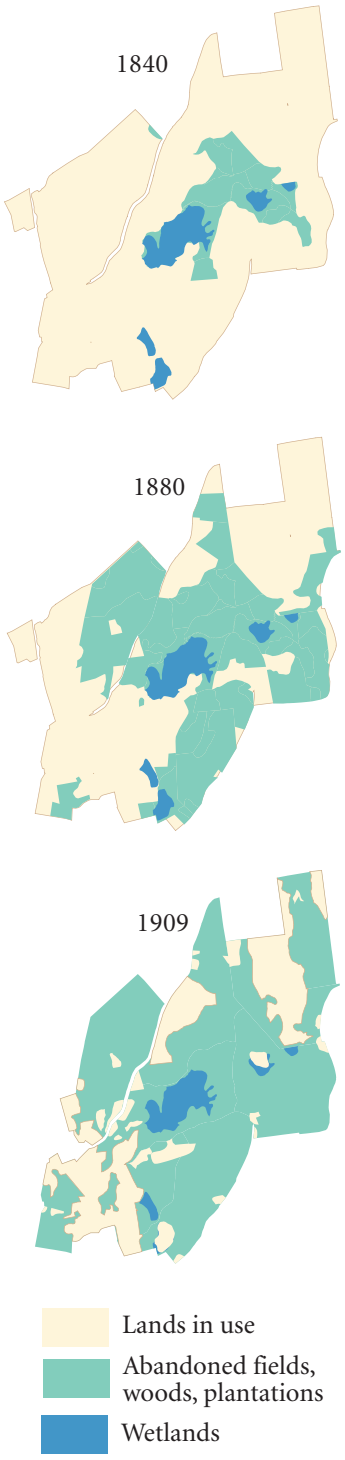
Abandonment seems to have begun somewhat earlier on the Harvard Forest tracts. On Prospect Hill, for which D.R. Foster (1992) has reconstructed the abandonment sequence, the maps show a small core of woodlots and wetlands in 1840. Abandonment proceeded rapidly for the remainder of the 19th century and then more slowly in the 20th century, till at present the tract is 99% wooded.

The abandonment sequences for the other tracts are presumed to be similar but are less well known. The 1830s map shows significant areas of woodland remaining in both the Tom Swamp and Slab City Tracts. These woods seem to cross some fence lines; it is possible that some clearing happened after 1830, and even more possible that there are inaccuracies in the original maps or in our interpretation of them.

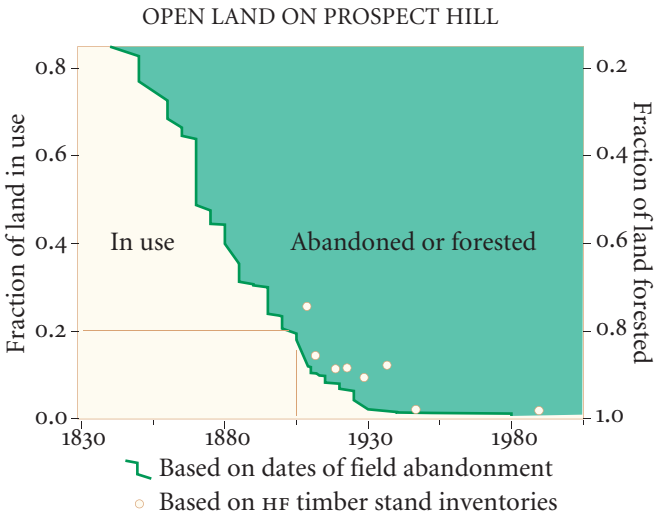
In any case, reforestation seems to have proceeded quickly, and by the time of the first Harvard Forest maps in 1909 both tracts were almost entirely wooded.

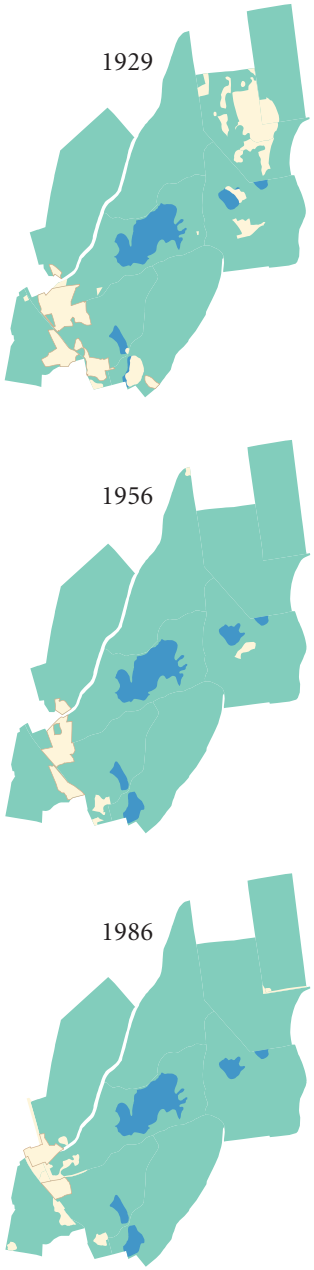
One consequence of the early abandonment was that many of the local place names appear to have been lost. By the time botanical work began at Harvard Forest the names of most of the homesteads and woods roads had been lost. The most conspicuous hills, streams, and swamps had names. The names for the others, if they ever existed, had been lost as well. As a result, the botanists of the early 20th century were often very vague about where they had seen plants or taken specimens, and our ability, fifty or a hundred years later, to interpret their records is vaguer still.

LAND ABANDONMENT ON PROSPECT HILL



*Census data from H.M. Raup and R.E. Carlson (1941).





Forestry

For the first thirty years of its existence, commercial forestry was a central concern at Harvard Forest. This was both a matter of pride and necessity for the staff. As professional foresters they wanted to demonstrate that forests could produce timber sustainably; as managers of a property which Harvard University had accepted under the condition that it support itself, they needed to cover their operating expenses.

The abandoned fields at HF, as elsewhere in eastern New England, grew much white pine and so had high commercial value. This led to intense harvests of pine in the late 19th century and to many acres of young, even-aged, successional woods in the forests of the early twentieth century. A commemorative history of the forest (J.S. Ames et al., 1935) says that in 1907 Harvard Forest was "90% even-aged and originated either on abandoned farms or on clear cuttings."

This is clearly shown by the first timber cruise of the Harvard Forest in 1909. The maps from this cruise show that the Prospect Hill Tract, which had been logged heavily for white pine in the 1890s, was almost uniformly young. The Tom Swamp and Slab City Tracts, which had been abandoned earlier and had kept more primary woodlands, are shown with a mosaic of younger and older trees.

The harvesting of white pine was necessarily limited by its inability to reproduce in its own shade: when the old-field pines were cut they were usually replaced by hemlocks and hardwoods that had been growing under them. This resulted in the gradual

Above and left-hand page, field abandonment on the Prospect Hill Tract, from GIS layers available from Harvard Forest. The 19th century maps, summarized by the line dividing the green and white portions of the graph at the top of the page, are based on Foster (1992). The 20th century maps are based on forest inventories conducted by Harvard Forest. The forest inventories show somewhat more open land than does the abandonment curve, perhaps because of the lag between abandonment and reforestation.

conversion of the successional lands on the forest from pine stands to the mixtures pine, oak, beech, and hemlock that are common today.

It also resulted in considerable efforts by the Harvard Forest silviculturists to harvest the pines while they could and to find ways of improving the hardwood stands when they couldn't. Their efforts took two forms. The first was to harvest the remaining old field pines and convert them, as well as the remaining old fields, to softwood plantations. The second, to which R.T. Fisher, the first director of the forest, devoted much thought and research, was to thin young stands of mixed hardwoods and softwoods and to try to grow commercial softwoods within a hardwood matrix.

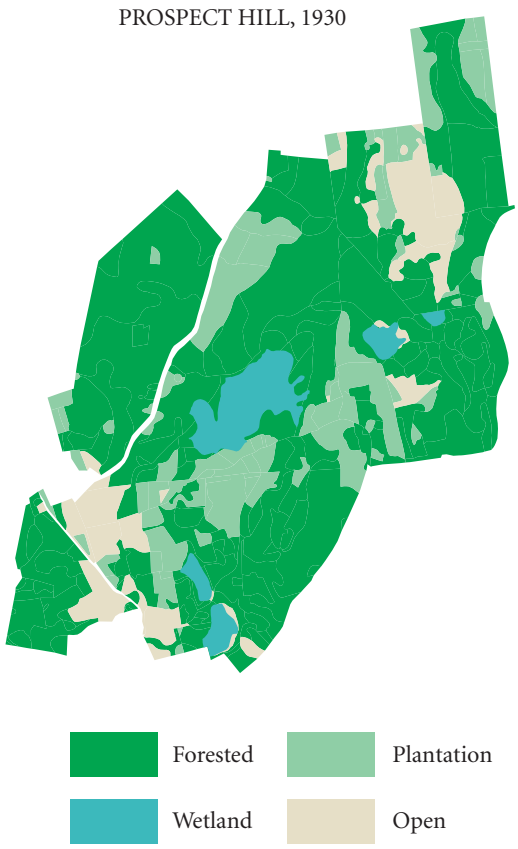
The 1935 history (J.S. Ames et al.) gives some statistics on early silviculture at the forest. In 1907 the estimated volume of the forest was 10.5 million board feet of merchantable timber, of which 95% was white pine. The forest was then about 2000 acres, giving an average stocking of 5,000 board feet per acre, a figure quite typical of post-agricultural New England.

In the next 27 years Harvard Forest harvested a total 7 million board feet of wood, most of it low-grade white pine for the box industry, on 960 acres, making an average cut of around 7,000 board feet per acre. The foresters mistrusted natural regeneration, probably justifiably, and instead planted softwoods in old fields and in any cut where they thought the soils were right.

One reason for the emphasis on plantations was that the alternative strategy of managing natural stands to grow mixtures of softwoods in the midst of hardwoods, was not working. The hardwoods at Harvard Forest are determined competitors. On all but the lightest soils they outgrew and suppressed the softwoods, no matter how the stand was treated or how much weeding it received.

The creation and tending of these plantations was a large-scale business. Between 1908 and 1935 the Harvard Forest nursery at Black Brook (Hamilton, Massachusetts) produced some 600,000 seedlings of red pine, white pine, Norway spruce, and European and Japanese larches. These were set out in 360 acres of plantations. Once the plantations were created they had to be thinned to keep the hardwoods at bay; the silvicultural records show over 1,000 acres of thinnings and weedings, mostly in plantations, in the same period.

Harvesting and Salvage The harvest rate in the first three decades of forest operations was, as the foresters had planned, less than the growth rate, and the total volume of merchantable timber in the forest rose slightly in the 20s and 30s. It then crashed abruptly with the 1938 hurricane and the salvage that followed it: the 1947 timber inventory shows a total timber volume of 1.2 million board feet, a

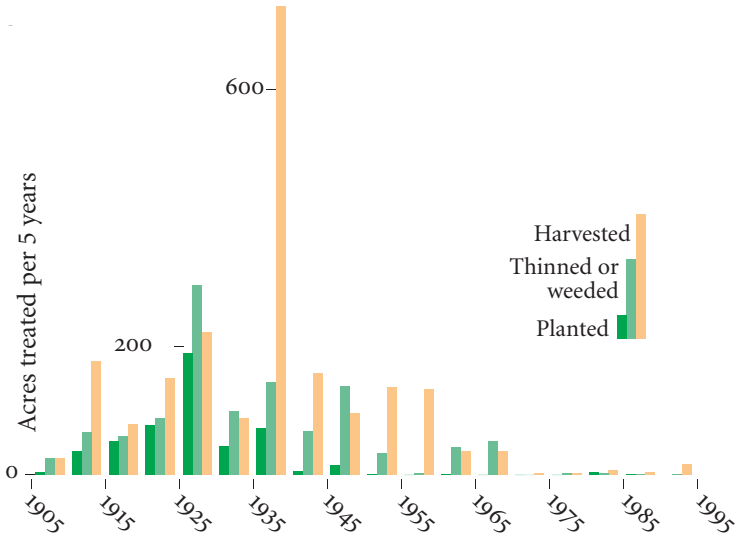


Land-use on Prospect Hill in 1930, from a forestry inventory conducted by Harvard Forest. The forest was relying on plantation silviculture to maintain its supply of softwoods, and was replanting most of the areas that it harvested.

tenth of that in 1938, and 600 stands with no merchantable timber at all.

The salvage that followed the 1938 hurricane lasted four years, treated about 450 acres, and marked the end of large scale silviculture and silvicultural research at Harvard Forest. After 1950, planting was largely discontinued, harvests were reduced, and the weeding and thinning of young stands were gradually discontinued. Cordwood and some timber have continued to be harvested, but the areas involved have only been a few tens of acres per year, and the volumes have only occasionally risen above a few tens of thousands board feet per year. When 77 of the remaining plantations are harvested in 2008-2009, the total cut of 1.4 million board feet will be the largest silvicultural operation at HF for almost 70 years.

FOREST OPERATIONS AT HARVARD FOREST, 1907-1995



Forest operations, from a GIS layer prepared from the original forest records. The period of active silvicultural management extended from 1907 through the salvage that followed the 1938 hurricane. After that planting and thinning operations largely stopped. Moderate levels of cutting continued until the 1950s; since then there has been only limited harvesting.

Other Changes in Land Use

In the seventy years since the 1938 hurricane there has been very little change in the land-use pattern at HF and very little expansion of the areas subject to active land use. A new laboratory was built behind Shaler Hall in 1972; three pastures that had been allowed to grow back to woods were recreated about 1992; and several experiments (soil warming, nitrogen addition, hemlock removal, a simulated blowdown) with footprints of an acre or more have been initiated in the 1990s and 2000s. Otherwise the landscape has been largely left alone; when we began our botanical survey in 2004 we were probably looking at a landscape that was as lightly used as any that could have been seen here in the last 200 years.

Human Impacts on Wetlands

The wetlands at HF have had much less human use than the forests, but have still had some impacts. All three of the major ponds at HF are artificial and likely resulted in some flooding of wetlands. The size of the previous waterbodies and the extent of the alterations are not known. The flooding at Connor Pond lowered the slope of the Swift River, which feeds the pond, and seems to have created some open shrubby wetlands and an inlet delta with several alternate channels. The flooding at Harvard Pond inundated parts of a large peatland, and created new channels and ponds within the peatland. It is possible that it converted forested swamps to open shrubby bog, but this has not been documented. The flooding at Riceville Pond seems to have had similar effects.

The levels of both Harvard and Riceville Ponds were raised for a year or more in the late 1930s to store the logs that were salvaged from the 1938 hurricane. A photo in the Harvard Forest archives shows Harvard Pond completely filled with sawlogs. This flooding may have generated the floating peaty islands that are now a conspicuous feature of the pond. It also may have killed shrubs and possibly trees. We consider it likely that the recent expansion of leatherleaf clones that Swan and Gill documented in 1970 represented the recolonization of the bog mat by leatherleaf after the flooding thirty years before.

Two artificial causeways cross HF wetlands, one on Tom Swamp Road and one on a woods road that crosses Gould's Bog in the Prospect Hill Tract. In both cases they divide a lower, more open section of a wetland from a more wooded upper one. This is a little odd: causeways typically behave as impoundments, flooding the portion of the wetland above them and leaving it less woody than the portion below. The reverse is true here. Our guess, and it is only that, is that these wetlands, because they are near drainage divides, have little flow. As a result the causeways, rather than impounding water from above, may actually serve to limit the flooding from the impoundments (artificial at Harvard Pond, beaver at Gould's Bog) below them.

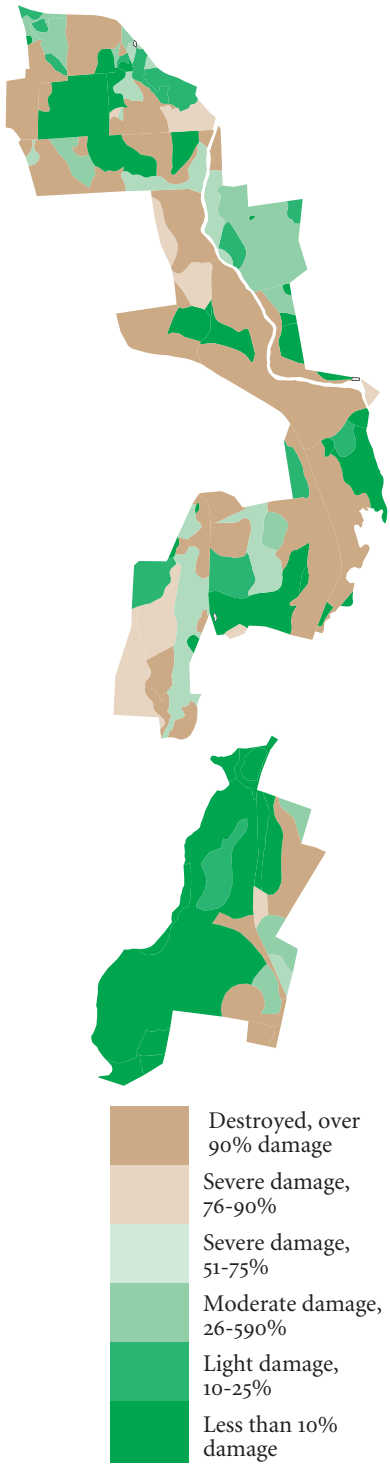
Natural Disturbances

With the striking exception of the hurricane of 1938, there have been no major fires or windstorms in the 20th century at HF. But there have been significant biological disturbances, which may have had a greater aggregate effect than either storms or fires, and whose effects continue at present. We consider them in chronological order.

Chestnut Blight Chestnut was a mid-successional tree that attained great size and seems to have been found mostly mixed with other species rather than in pure stands. J.G. Jack (1911) said it was "common and important." In 1910 he discovered the chestnut blight in Petersham, and by 1913 Harvard Forest was salvaging chestnut stands. By 1950 about 150 acres had been salvaged. Chestnuts remain common today—we saw them in 28 compartments—but only as small understory shrubs or trees that rarely are more than a few inches in diameter.

White Pine Blister Rust The white pine blister rust, a fungus disease that requires gooseberries or currants as alternate hosts, was introduced to the United States from Europe in 1900 and spread rapidly through the Northeast. Because pine was such an important timber tree, and because foresters believed that they could

HURRICANE DAMAGE IN THE SLAB CITY TRACT



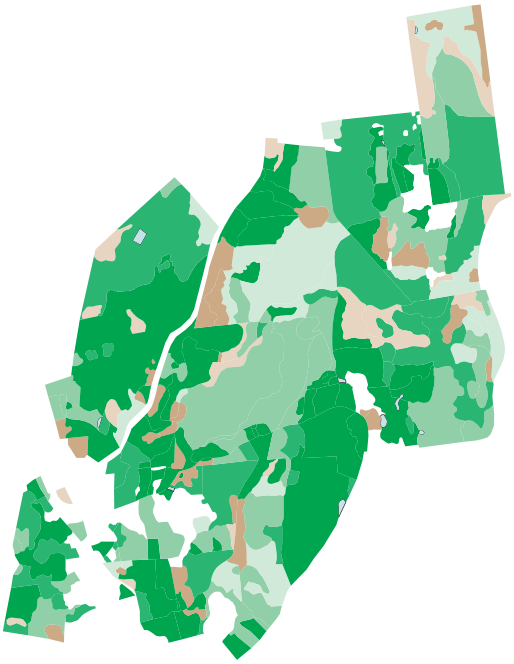
eradicate the disease by eradicating the alternate hosts, state and federal agencies embarked on extensive programs to eliminate currants and gooseberries. The programs were continued for many years, and are said to have become the largest plant disease control program in the United States. Whether they were successful is unclear. The disease eventually stopped being a problem. Whether this was because there were fewer gooseberries, or fewer white pine monocultures, or because the pines had become resistant is not known In any event, gooseberries are now common forest plants in the region and seem to be coexisting with white pine without causing major outbreaks of disease.

Blister rust seems never to have been a major problem at Harvard Forest, though it may, given the forest's economic dependence on pine, have been a major worry. Currants were present in the forest in 1911 and 1933 but do not seem to have been common. J.G. Jack (1911) said that the native *Ribes cynosbati* and the escaped *R. rubrum* were both occasional. H.M. Raup (1938) listed *R. cynosbati, rubrum, glandulosum, hirtellum,* and *rotundifolium* for Petersham; *R. rotundifolium* is barely found in Massachusetts and may have been a misidentification of *R. hirtellum*. The 1935 history (J.S. Ames et al.) says that the forest has been "thoroughly checked over for gooseberries and currants at two different times" and that thus far only scattered pine trees and a quarter of an acre of a pine plantation had been killed by the rust. We know that some of this checking occurred in the 1920s and produced detailed, hand-drawn maps of stone walls which are now in the archives. Likely the crews searched the walls—a favorite habitat for currants and gooseberries—and removed all the plants they found.

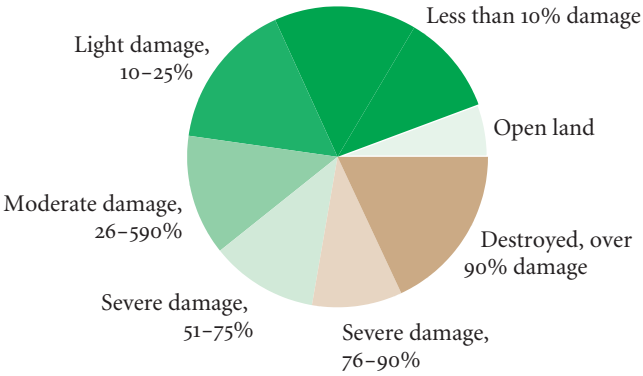
It is quite possible that the control programs have had lasting effects. Although H.M. Raup found at least four species of *Ribes* in the 1930s, the 1947 survey only found a single species, the introduced *R. rubrum*, and that only in a single place. Sixty years later our survey found *R. rubrum* in two places and the swamp currant *R. glandulosum* in three. But neither of us found *R. cynosbati*, which had been reported in the 1911 and 1938 surveys, and which in much of western New England is the commonest gooseberry of upland woods.

1938 Hurricane The Great New England Hurricane of 1938 originated near Africa, tracked west over the Atlantic, and then turned north heading up the Atlantic coast. At its peak intensity, in the vicinity of the Bahamas, it was a category 5 storm with sustained winds of 160 miles per hour. When it came ashore on Long Island, New York, on September 21 it

HURRICANE DAMAGE ON THE PROSPECT HILL TRACT



FOREST DAMAGE IN THE 1938 HURRICANE



Above and left, damage in the 1938 hurricane, from a GIS layer prepared from Harvard Forest records. The Slab City and Tom Swamp (not shown) Tracts were heavily damaged, with many stands suffering 50% damage or more. The Prospect Hill Tract was more lightly damaged and the damage more of a mosaic, but still there was moderate damage or more over half of the tract.

was a category 3 storm with winds of around 115 miles per hour. It then tracked up the Connecticut Valley. Its center passed somewhere near Rowe, Massachusetts; the eyewall would have been over the Connecticut Valley and its violent northeast quadrant, where the winds were the most intense, would have passed over Petersham.

The hurricane damage to the forest was extensive and intense. About a fifth of the forest was considered to be completely destroyed, and over half had 25% damage or more. The older and larger trees were considered most at risk; at least 70% of the merchantable volume of the forest was blown down, and stand type maps made in the forties and fifties show little mature timber at all.

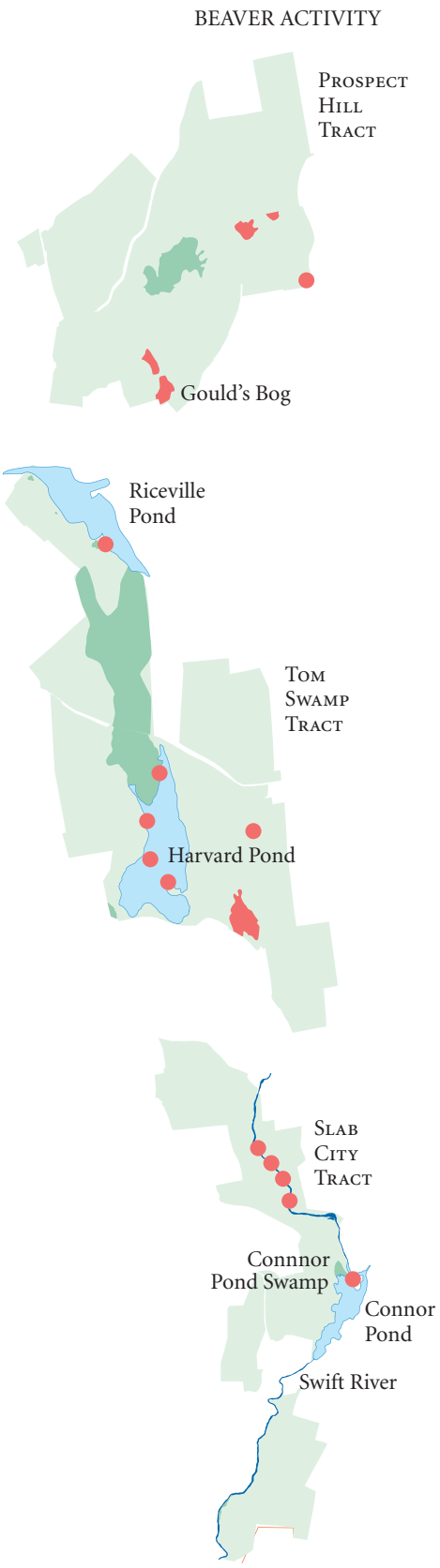
Beaver Return After an absence of 150 years or more, beaver were reintroduced in central New England in the twentieth century. We know they were introduced in western Massachusetts in the 1920s and had reached north-central Massachusetts by the 1940s. They probably were present in Petersham by the 1950s, but were slow to colonize upland parts of Harvard Forest, which lie at the headwaters of several watersheds and have only a few small streams. Swan and Gill (1970) noted them in Harvard Pond when they did their research on bog mat development in the 1960s.

Beavers seem to have become more numerous in the 1980s and 1990s. They are now found in all the large ponds and along some of the smaller forest streams. The large ponds probably support permanent colonies. Many of the small ponds on woodland streams have very little food, and the colonies there, like those in similar situations elsewhere, will probably move from pond to pond or abandon a pond and then return.

Beechbark Disease The beech disease is a complex of an alien scale insect and several alien fungi. The scale insects make tiny holes in the bark. The holes make the bark swell and cracks form. The fungi then enter through the cracks and kill the tree.

Beechbark disease was introduced into Nova Scotia in the nineteenth century and spread south and west, reaching our part of New England in the 1950s or 1960s. Beech is somewhat scattered and rarely forms pure stands here, and so the disease has spread slowly. Although we do not know when the disease first arrived at HF, we saw several stands where beech are now dying.

Woody Aliens Over the last fifty years four alien woody plants—Morrow's honeysuckle, European Buckthorn, Japanese barberry, and oriental bittersweet—have spread very widely and in some cases come to dominate second-growth woods in many parts of post-agricultural New England. All do best in areas that are limy



or nitrogen enriched and invade most effectively when there are openings for them to colonize. The poor acid soils and continuous woods here are not well suited to them, but none the less they are here and seemingly expanding, especially along woods roads and edges. None were seen in previous surveys. Currently Morrow's honeysuckle is in 15 compartments, Japanese barberry in 14, oriental bittersweet in 13, and glossy buckthorn in 6. We can no longer find the native bittersweet, which was reported from the first survey in 1911 and collected here as late as 1947; whether this is connected to the spread of the alien we do not know.

Hemlock Woolly Adelgid The hemlock adelgid is a small insect that feeds on hemlock. It was first found in the eastern United States in Virginia in the early 1950s and now has spread from Georgia to southern Maine. It reached Connecticut in 1985, central Massachusetts about 1995, and Harvard Forest in 2001. In Pennsylvania and Connecticut it was able to increase its populations rapidly and kill trees within a few years of first infecting them. At HF the winter temperatures have thus far prevented it from building up to the point where it can kill trees. After six years it is now found in most parts of the forest, but has not yet killed trees or caused much visible damage.

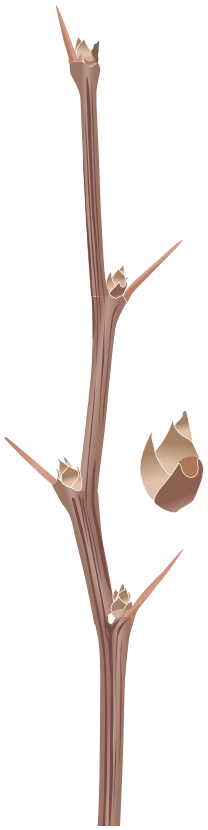
The Botanical Record

The botanical record of the Harvard Forest, prior to our survey, extends back to 1907 and consists of one published flora, two manuscript floras, and 2,700 herbarium specimens representing about 700 species. Most of these species were collected in three periods of concentrated study, separated by intervals in which very little botanical work occurred.

The first began in the fall of 1908 when John George Jack, then 46 and an assistant professor of dendrology at the Arnold Arboretum, brought his students to the forest to study the woody plants.* Over the next four years Jack and his students collected about 280 specimens and reported about 130 species of native woody plants from the forest. Besides the common species they recorded a number of rarities (smooth winterberry, leather wood, limber honeysuckle, snowberry) that still persist today and, of equal interest, about ten species that we have not been able to relocate (pp. 39-40).

In 1911 Jack published an annotated list of the woody plants of the Harvard Forest in the first issue of the *Bulletin of the Harvard Forestry Club*. The list is the first historical document to describe the flora of the forest and, because of the notes it includes, is extremely valuable as a record of the species that were present and as a picture of the landscape. It must, however, be used with caution. Although Jack called it the *Trees and Other Woody Plants*

Japanese Barberry



The Japanese barberry, a shade-tolerant invasive that can dominate the understories of successional woods, arrived at Harvard Forest some time after 1947, and is now found in about a third of the compartments in the forest. It is, as yet, mostly found as scattered plants, and has not become locally dominant here.

*Jack's students, whom we know mostly from their herbarium records, included J. S. Ames, R. R. Chaffee, W. W. Cole, A. B. Glidden, P. Haynes, H. J. Miles, K. Mills, W. A. Shepard, W. A. Stalker, and H. H. Tryon. Ames, Chaffee, Miles, Mills, and Shepard were master's students in forestry and received their degrees between 1910 and 1913. Shepard went on to succeed R.T. Fisher as the director of the Harvard Forest in 1934, and H.H. Tryon became the director of the Black Rock Forest in Cornwall, New York. S.M. Dohanian, who made about 50 collections in the fall of 1913, received his degree in 1915.

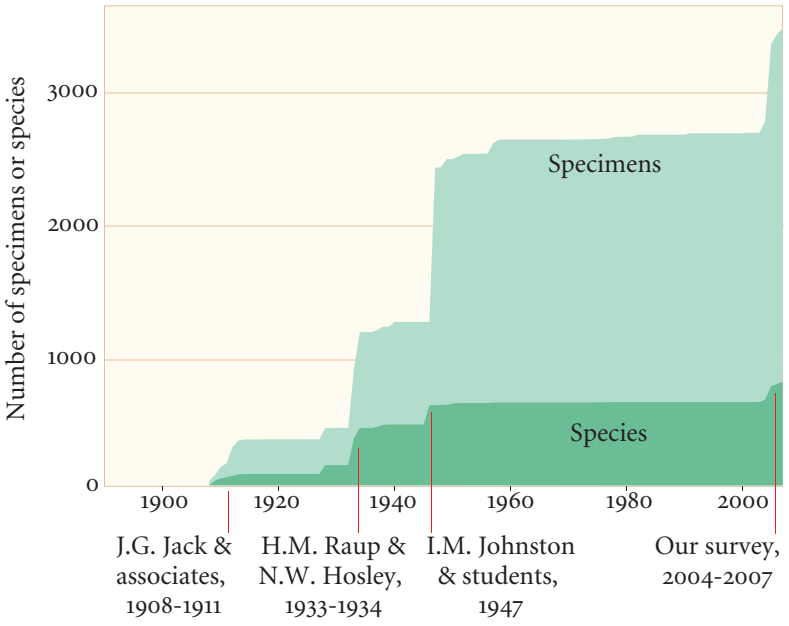
Found in the Harvard Forest he said in his introduction that it also included plants from the "proximity of Harvard Forest." In some cases he was very explicit about where plants were from: he notes that common barberry is "occasionally naturalized in Harvard Forest" and that bog rosemary is "not yet noticed in Harvard Forest." But sometimes he was not, and some of his most interesting records (bayberry, fetterbush, slippery elm) have no localities and may or may not have been from the forest.

The second period of intense study began in 1933 when Hugh M. Raup, then 32 years old and a botanist at the Arnold Arboretum, came to Harvard Forest to collect plants. In the next two seasons he and Neil Hosley, an instructor in forestry, collected about 700 specimens, mostly from HF but some from other parts of Petersham. Raup returned in 1937 and 1938, collected about 170 more specimens, and in 1938, after a search for other Petersham specimens in the herbarium of the New England Botanical Club, completed a typescript *Checklist of the Vascular Plants of Petersham.*

Raup was a fine botanist, who would later go on to do extensive field work in the arctic and then become director of the forest in 1946. His checklist lists about 575 species of plants for Petersham. We have, from a review of the herbarium record, been able to show that about 512 of them definitely occurred in Petersham. Six—a very small number, given the variability of plants and the uncertainties of botanical work, seem to us to have been misidentified. The remaining species, for which we have not been able to find herbarium specimens, can neither be accepted nor rejected. Some of them may have been misidentifications, some species that occurred elsewhere in Petersham, and some Harvard Forest species that have since vanished. Unfortunately, his checklist has no annotations, and without specimens we do not know what he saw at Harvard Forest and what elsewhere.

The third period of concentrated study began when Ivan Murray Johnston, an associate professor of botany at Harvard and a world-class taxonomist and widely-traveled plant collector, brought about 10 students to the forest to collect plants. The class was either inspired or diligent; in less than three months they had collected over 1100 specimens (with the formidable Dr. Johnston leading the way with 450) and added 84 species to the flora of the forest.

THE HERBARIUM RECORD OF THE HARVARD FOREST



The cumulative numbers of Harvard Forest species and all specimens (mostly Harvard Forest but some Petersham and some unlabeled) in the Harvard Forest Herbarium.

In 1948 Claude Earle Smith, one of the students from the class and a dedicated collector whose collection numbers were by then in the two thousands, took some or all of the class's collections to the Gray Herbarium, verified them by comparing them to specimens in the New England Botanical Club collection, and prepared a typescript *Survey of the Petersham Flora: Pteridophyta through Monocotoyledoneae.* The next year he returned to the forest with E.E. Smith* and collected about 50 more specimens, including about 17 from Camel's Hump, which they and H.M. Raup may have been the first botanists to visit. That summer or fall he prepared the second half of his *Survey of the Petersham Flora,* dealing with the dicots.

Smith's two checklists are impressive documents, especially considering that he was only 26 when he started them. They are carefully researched, carefully sourced, and supported by an impressive collection of specimens. But, like the other early checklists, they must be used with care and an awareness of their limitations. Smith was clearly a bright and energetic botanist, and working with an expert teacher and an enthusiastic class. But no one in the class really knew the eastern flora, and, although he says he verified specimens by comparing them to herbarium specimens in Cambridge, it does not appear that they ever consulted with anyone—like H.M. Raup who was then the director of the forest, or M.L. Fernald and A.S. Pease, who were in Cambridge in that period—who did. One consequence was that their technical identifications were haphazard; many were right, but many were wrong. Another is that C.E. Smith did not know the technical species in the field, and so his notes on abundance may not have been accurate. He lists as absent or occasional many graminoids—*Brachyelytrum septentrionale, Carex pensylvanica, Carex debilis, Danthonia compressa*—that are very common in our woods and which we suspect to have been common in his as well.

A vexing historical problem, that we have worked on but have been unable to solve, is what happened to C.E. Smith's missing specimens. His specimen numbers suggest that he may have collected 800 or more specimens at HF in the summer of 1947. We have about 300 of these—120 from the HF herbarium, and 180 donated to us by Brandeis University, to which they had been given by the Gray Herbarium in the 1950s. Our guess is that he took the whole collection to the Gray Herbarium, returned some to HF, left some at the Gray, and perhaps took the rest with him. But we have no idea where they went and what happened to them afterwards, despite much correspondence with people who knew him and institutions where he worked. The loss of these specimens is unfortunate because many are cited in his manuscripts, and at least 20, if they are correctly determined, are species that are not otherwise known from Harvard Forest.

Professor John George Jack. J.G. Jack was born in Chateaugay, Quebec in 1861 and was one of 12 children of a farm family with a bent for horticulture and nature. His father introduced and experimented with new varieties of fruit. His mother was a poet, author, and horticulturist. Jack, who had been a naturalist since boyhood, was largely self-educated: he corresponded with other naturalists, attended lectures on entomology and botany at Harvard in the 1880s, met Charles Sprague Sargent, director of the Arnold Arboretum, and did manual work for him (at $1 per day) in 1886, was appointed a lecturer in arboriculture at the arboretum in 1890, held lectureships in forestry at both Harvard University and the Massachusetts Institute of Technology in the early 1900s, and was made an assistant professor of dendrology at the arboretum in 1908.

Photo of J.G. Jack and biographical information from the archives of the Arnold Arboretum, © Harvard University, used with permission.

*E.E. Smith, whom we believe to have been a student, also prepared a checklist of the birds of the Harvard Forest.

Other Collectors

About 30 other collectors are represented in the HF herbarium, most of them by only a few specimens or a few tens of specimens each. Very few of these collectors contributed new species to the record. The most active of these collectors were Mrs. Gast, who collected in the late 1920s and early 1930s, and Professor Martin Zimmermann, later the fifth director of the forest, who collected in 1957 and 1958.

Mrs. Gast, whom we know by little more than her married name, was the wife of Paul Rupert Gast, a professor of forestry at the forest. She collected about 80 species, mostly common wildflowers and weeds and most, unfortunately, with neither a date nor a location. Several of her plants—*Helianthus divaricatus, Orobanche uniflora*—are uncommon in the area and we wish we knew when she found them and whether she was on the forest. But lacking this information, we mostly remember her for two things: for being one of only three women represented in the herbarium and for collecting, on the first of July of an unknown year, one of the only two specimens of twinflower ever found at HF.

Martin Zimmermann, in contrast, is extremely well known. He was a distinguished plant physiologist specializing in vascular anatomy and transport, and also a man with wide interests in general botany. He collected about 100 specimens at HF, for what purpose we do not know. Most are common herbs, and most had been long known from the forest.

Hugh Miller Raup. H.M. Raup was born in Springfield, Ohio, in 1901. He graduated from Wittenberg College, and remained there to teach for three years before going to the University of Pittsburgh in 1925. In 1926 he made his first field trip to northwestern Canada, kindling what was to be a life-long interest in the botany and geomorphology of the arctic. He received his Ph.D. from Pittsburgh at 28, and joined the Arnold Arboretum as a researcher in 1932. He was appointed an assistant professor of plant ecology at Harvard in 1938, the director of the Harvard Forest in 1946, and a full professor of botany at Harvard in 1949. He died in Sister Bay, Wisconsin on August 10, 1995, at the age of 94. Raup is the only one of the previous surveyors to have known all the others, and the only one to have met one of us: Jerry Jenkins met him at Harvard Forest in the early 1970s.

Photo of H.M. Raup from the archives of the Harvard Forest. Photo of C.E. Smith and biographical information from an obituary by Richard A. Krause (*American Antiquity,* 1989). Photo of I.M. Johnston from the archives of the Harvard University Botany Libraries, © Harvard University, used with permission. Biographical information on I.M. Johnston from an obituary by Donovan S. Correll (*Taxon*, 1961).

Claude Earle Smith Jr., called Smitty by friends and colleagues, was born in Boston in 1922 and grew up in Florida. In 1940 he enrolled in Harvard and in 1941 he made his first collecting trip to South America. He joined the navy after Pearl Harbor, then returned to Harvard in 1945 where he completed his undergraduate degree and worked as a botanist for the Arnold Arboretum. He continued to study tropical floras and received his Ph.D. in 1953 for a study of the new world species of *Sloanea*, a genus of tropical timber trees. He then became director of the Taylor Arboretum, went to the Field Museum in 1959, the United States Department of Agriculture in 1962, and the University of Alabama in 1970. Somewhere along the way he had specialized in the botany of archaeological sites; at Alabama he held a dual professorship in botany and anthropology and was recognized as the country's leading archaeoethnobotanist. He died in an automobile accident on his way to a seminar at the university on October 19, 1987.

I.M. Johnston, said in his obituary in *Taxon* to have been a "brilliant, complicated and, to some, controversial personality" and a man "replete with physical and mental energy," was born in California in 1898. He did his undergraduate and master's degree work at Berkeley, and his doctoral work at Harvard. He became an associate professor of botany at Harvard in 1938 and the associate director of the Arnold Arboretum in 1948. He was interested in western American floras in general and the Boraginaceae in particular, and traveled and collected widely in Central and South America and the western United States. His obituary states that some of his colleagues believed that at the time of his death he knew more about world floras than any other American botanist.

The students who worked with Johnston in 1947, whom we know mostly from the herbarium record, are W. D. Beal, J. Canright, R. J. Carini, W. H. Drury Jr., K. A. Raup, R. S. Sigafoos, C. E. Smith Jr., E. P. Stephens, W. Chi-Wu, and M. Ward.

1903 Harvard University creates a department of forestry and appoints Richard Thornton Fisher, then 27 years old and 1898 Harvard graduate, and John George Jack, then 42 years old and a botanist and teacher at the Arnold Arboretum, as instructors in forestry.

1907 A gift from John S. Ames allows Harvard to purchase about 1,800 acres of land in Petersham to be used for research, demonstration forestry, and teaching. Gifts of adjoining lands bring the property to about 2,100 acres. Harvard accepts the gift on the condition that the new forest support itself through timber sales.

1908 R.T. Fisher is appointed chairman of the Division of Forestry. The Community House, formerly the home of the Adonai Shomo Community, is remodeled, becomes the forest headquarters, and provides living and laboratory space for students. J.G. Jack, now an assistant professor of dendrology, brings his students to the forest in October, 1908, and they begin collecting specimens of woody plants.

1908-1913 In the next five years Jack and his students collect approximately 280 plant specimens, almost all of trees and shrubs. In 1911 he publishes an annotated list of the woody plants of the Harvard Forest in the first issue of the *Bulletin of the Harvard Forestry Club*.

1908-1935 A period of intense silviculture begins. A timber cruise in 1908 suggests that the forest has 10.5 million board feet of merchantable timber and an annual increment of at least 250,000 board feet (2.5% of the standing crop), almost all in pine. In the next 27 years the forest harvests 262 acres of white pine, 25 acres of mixed forest, and 3 acres of hardwoods; replants many of the harvested pine stands and creates 200 acres of new plantations in old fields; harvests 107 acres of "inferior hardwoods" and replaces them with planted conifers; weeds 300 acres of cut-over land and releases and improves 134 acres of sapling stands; and thins 92 acres of young white pine.

1910 J.G. Jack finds chestnut blight near HF in Petersham. The salvage of diseased chestnut stands starts in 1913. By 1950, 150 acres have been salvaged and chestnut is no longer listed in the stand maps, though it persists as a scattered understory tree.

1915 R.T. Fisher is officially appointed the first director of the Harvard Forest, a post which he has unofficially been filling for the previous eight years.

1921 The Management of the Harvard Forest, the first Harvard Forest Bulletin, by R.T. Fisher, explains that it is impossible to regenerate pure white pine stands when old-field pines are cut, and that it will be necessary to develop a mixed pine-hardwood silviculture if stocks of pine are to be preserved. Because this sage advice yields few useful results, the forest continues to rely on plantations to assure future softwood crops, and plants nearly 200 acres between 1925 and 1930.

1924 The first sawmill is built at the forest.

1926 A gift from Dr. John C. Phillips allows the forest to acquire 20 acres of old growth forest on Mt. Pisgah, in Winchester, New Hampshire.

1927 A timber cruise finds that the forest now has 12 million board feet of merchantable timber, showing that timber production since 1908 has been sustainable.

1928 G. Fredrick Schwarz donates 45 acres of forest on Bald Hill in the western part of Petersham to the Harvard Forest for the "development and demonstration of landscape forestry."

The State of Massachusetts builds a fire tower on top of Prospect Hill on land belonging to Harvard Forest. The tower blows down in the 1938 hurricane and is rebuilt in 1940. It currently functions as a regional emergency communications hub and continues to be used as an observation post when fire danger is high.

1928-34 A woman that we know only as Mrs. Gast, the wife of Paul Rupert Gast, a professor of forestry, collects about 100 specimens of plants from Petersham.

1933-34 Hugh M. Raup, then 32 years old and a botanist with the Arnold Arboretum, visits the forest, meets with R.T. Fisher and others and proposes a botanical survey of the forest. He begins the survey that summer; over the next two seasons he and Neil Hosley, an instructor at the forest, collect about 700 specimens, making the first collections of many of the herbs of the forest.

1934 R.T. Fisher dies. Ward A. Shepard, who had received his masters degree in forestry from Harvard in 1913 and gone on to work for the Bureau of Indian Affairs, becomes the second director of the forest.

1935 Over the last 27 years the forest has cut 7 million board feet of lumber, mostly box grade white pine, for a cutting rate of about 260,000 board feet per year. The harvests have, if we read the silvicultural summaries correctly, covered 960 acres, for an average harvest rate of 7,300 board feet per acre. Stumpage prices began at about $4 per thousand board feet in 1908, peaked at $10 to $15 per thousand in the 1920s, and fell back to $4 in the depression.

The revenues from these cuts have been very important to the operation of the forest, which in the early days supported itself nearly entirely from timber sales and in 1935 was generating about a third of its income from forest products and two-thirds from its endowment. Low timber prices and even lower returns on investment had reduced its income greatly. The 1935 history says that at present HF "cannot meet more than the most necessary expenses. It is not now possible to continue the high standards of research which have been adhered to until recently."

The first ten forest dioramas, designed by R.T. Fisher and A.C. Cline and constructed by the firm of Guernsey and Pitman, in Cambridge, Massachusetts, have been completed.

1937-38 H.M. Raup returns to the forest, collects about 170 more specimens, returns to the Arnold Arboretum and completes a *Check List of the Vascular Plants of Petersham.*

1937 to 1987 The forest receives major funding from the Cabot Foundation for botanical research.

1920s? The main state roads in Petersham are first paved. The paving of the smaller roads is probably done in the 1930s.

1938 On September 21 a category 3 hurricane sweeps up the Connecticut Valley, passing just west of Petersham. Over half of the forest sustains moderate to severe damage. Salvage operations are initiated in 1939; these will continue for the next four years. Eventually about 450 acres, representing roughly a quarter of the forest and the largest single silvicultural operation ever conducted here, will be salvaged.

1939 Albert Collins Cline, who had been R.T. Fisher's assistant, becomes the third director of the forest.

Using a gift from Ernest Stillman, the forest builds Shaler Hall and the Fisher Museum. Mr. Stillman does not believe in wasting money on architects, and so the building is identical, except for interior details, to a hospital he endowed in Cornwall, New York.

1940 In the summer of 1940 P. Smith and J. Wright, perhaps students but not otherwise known to us, collect about 50 specimens from the Tom Swamp and Prospect Hill Tracts.

1941 H.M. Raup and R.E. Carlson publish Harvard Forest Bulletin 20, *The History of Land Use in the Harvard Forest.*

1946 A.C. Cline is succeeded by H.M. Raup as the fourth director of the forest.

1947 Dr. Ivan M. Johnston of the Gray Herbarium and a group of about nine students who are taking a summer course at Harvard spend the summer collecting plants at the forest. In three months time they collect 1154 specimens and add 84 species to the flora of the forest.

A small fire in the northwest portion of the Prospect Hill Tract burns 7 acres.

1948 Claude Earle Smith Jr., the most dedicated collector in Johnston's 1947 class, takes some or all of the class's collections to the Gray Herbarium, verifies them by comparing them to specimens in the New England Botanical Club collection, and prepares a *Survey of the Petersham Flora: Pteridophyta through Monocotoyledoneae.*

1949 C.E. Smith and E.E. Smith return to the forest in May and collect about 50 more specimens, including about 17 from Camel's Hump, which they and H.M. Raup may have been the first botanists to visit. That year C.E. Smith prepares the second half of his *Survey of the Petersham Flora,* dealing with the dicots.

John George Jack, age 88, dies from injuries sustained while pruning the apple trees at his farm in East Walpole, Massachusetts.

1949-52 Massachusetts Route 32, the highway that runs along the Prospect Hill and Slab City Tracts, is relocated and rebuilt.

1951-52 T. Grisez, W.H. Hatheway and M. Hambleton, who may have been students at the forest, and W. Chi-wu, who definitely was, collect about 40 specimens from various sites around Petersham.

1953 A tornado starts in Petersham and then continues towards Worcester, where it does heavy damage. About 25 acres in the Slab City Tract are damaged and salvaged.

1957 A second fire burns about 75 acres in the northwest part of the Prospect Hill Tract.

1957-58 Professor Martin H. Zimmermann, a plant physiologist specializing in vascular anatomy and transport who has a laboratory at the forest, collects about a hundred plant specimens.

1958 By this time the period of silvicultural activity is nearly over. Almost no plantings has been done in the last decade. The forest is only thinning and harvesting a few acres every year, and will soon be harvesting none at all.

1960 Ivan Murray Johnston, a "real teacher and philosopher" and a botanist with a world-wide reputation, dies at his home in Jamaica Plain, Massachusetts, at age 62.

1969 M. H. Zimmermann becomes the fifth director of Harvard Forest.

1977 The Simes Tract, a 313-acre property in the western part of Petersham, is acquired. It contains Camel's Hump, a limy hill with many plants that occur nowhere else in the forest.

1970s? Beech-bark disease arrives at the forest but, probably because beech is a minor species here and doesn't form pure stands, spreads only slowly. At present several stands are completely infected, with many dying trees.

1984 Professor John Gordon Torrey, a distinguished plant physiologist who had researched root development and symbiotic nitrogen fixation, becomes the sixth director of Harvard Forest.

1987 C.E. Smith, who had become the leading American archaeoethnobotanist and held dual professorships in botany and anthropology at the University of Alabama, dies in an automobile accident at the age of 65.

1988 Under J.G. Torrey's leadership the forest is designated a long-term ecological research site by the National Science Foundation and begins to conduct ecological and ecophysiological experiments..

1990 David Foster, a forest ecologist with interests in landscape history and regional conservation, becomes the seventh director of the forest.

ca. 1990 Beaver, which returned to central Massachusetts in the 1940s and have been present in Petersham since at least the 1960s, begin to dam small streams on the forest.

1990s Forestry in this period is limited to cutting about 50 cords a year of cordwood for the boiler in Shaler Hall and making small harvests of a few tens of acres for sale or for forest projects. In 1999, a 700-foot boardwalk is constructed through the black gum swamp in the Prospect Hill Tract, using 14,000 board feet of larch harvested from old plantations.

1992 The young woods around Fisher, Raup, and Lyford houses are cleared to recreate several small pastures.

1995 H.M. Raup the fourth director of Harvard Forest, dies in Sister Bay Wisconsin, aged 94.

ca. 1995 Moose, which were established in the Monadnock region of New Hampshire in the late 1980s and appeared in central Massachusetts in the early 1990s, begin to be seen on the forest. By 2000 they seem to be permanent residents.

2001 The hemlock woolly adelgid, an alien insect that has caused much damage to hemlocks in southern New England, is first detected at the forest. Over the next seven years it spreads through much of the forest but has not thus far killed trees or caused visible damage.

2004 in June, the authors of this flora begin inventorying the flora of the forest.

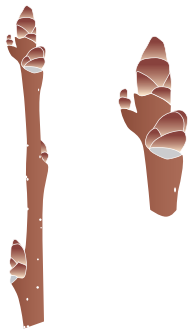
2005-6 A new shop is constructed east of Fisher House, using 16,000 board feet of lumber harvested from the forest.

2007 Glenn Motzkin, who has been searching for missing specimens cited in previous floras, discovers about 180 C.E. Smith specimens in the archives of Brandeis University, and 9 boxes containing 1400 Harvard Forest collections by Hugh and Karl Raup in a storeroom at the forest.

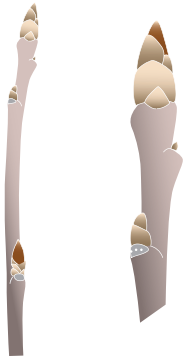
Ten kilowatts of photovoltaic panels are installed in a field next to the shop, marking the first significant generation of electricity from renewable resources at Harvard University.

The forest makes plans to harvest 77 out of the 130 acres of remaining plantations and allow them to regenerate naturally, officially ending the era of plantation forestry that began a hundred years before.

BLACK CHERRY



CHOKE CHERRY



III CONCEPTS, METHODS, TAXONOMIC APPROACH

Harvard Forest is an ecological research station, and our goal in the centennial flora project was to provide an ecological description of the flora. To us this meant that we had to both enumerate the species that were present and describe what they were doing. In particular, we wanted to know how abundant they were, how they were distributed, how they were organized into communities, and how they had changed over the last century.

In planning a study that would do this, our guiding principal was that plant populations are ecologically interesting entities in a way that individual plants are not. A few stems of a rare species, seen once in one place, are an interesting botanical detail but provide little ecological information. A group of occurrences of the same species starts to have an ecological shape; a group of occurrences with a habitat and a history have a story to tell.

A similar principal applies to taxonomy. A single variant individual may be taxonomically noteworthy, but may not mean much biologically. The uncommon dewberry *Rubus setosus*, which looks very much like a more erect and more bristly form of the common dewberry *R. hispidus*, tends to occur as individual plants within *R. hispidus* populations and does not seem to form pure populations. Individual *R. setosus* plants are usually distinctive and have a fairly clear taxonomic identity. But because they may be nothing more than rare variants of a common species, they may not be very important in an ecological survey.

Variant populations, on the other hand, and especially variant populations with their own habitats and distributions, are more important. The thornless blackberry *Rubus canadensis*, though similar and somewhat transitional to the common blackberry *R. alleghaniensis*, tends to occur in pure populations in moist woods at medium and high elevations. Though both *R. setosus* and *R. canadensis* have occurred at Harvard Forest and are listed in our catalog, in our view *R. canadensis* has an ecological identity and importance that *R. setosus* doesn't.

Our goal then, was to learn as much as we could about the ecology and taxonomy of the plant populations at Harvard Forest. The question was the best way to do this. A conventional botanical inventory—cover as much ground as you can and record as many species as you can— yields a long list and a good sense of what the commonest and rarest species are, but tells you little about the medium-frequency species that are of considerable ecological and historical interest. A more quantitative plot-based study would measure abundances and document communities, but plot-based studies inevitably miss many species and don't tell you much about overall distributions and frequencies.

ALLEGHENY BLACKBERRY

The common blackberry, *Rubus alleghaniensis*, has many minor variants. Some, like *R. canadensis*, seem to have both a taxonomic and an ecological identity. Some, like *R. penslyvanicus*, may have a taxonomic identity but not an ecological one. And some, including over a hundred named northeastern taxa we now treat as synonyms, may have no identity at all.

After some discussion we decided on a middle course. We would do a series of 33 inventories, one for each of the main compartments into which the forest is divided, and then supplement these with additional studies of habitats and species of interest. This would allow us to get a reasonably complete list of the current flora of the forest and so evaluate the historical changes in the flora, while at the same time providing enough distributional and frequency data to allow us to make a quantitative evaluation of the current structure of the flora.

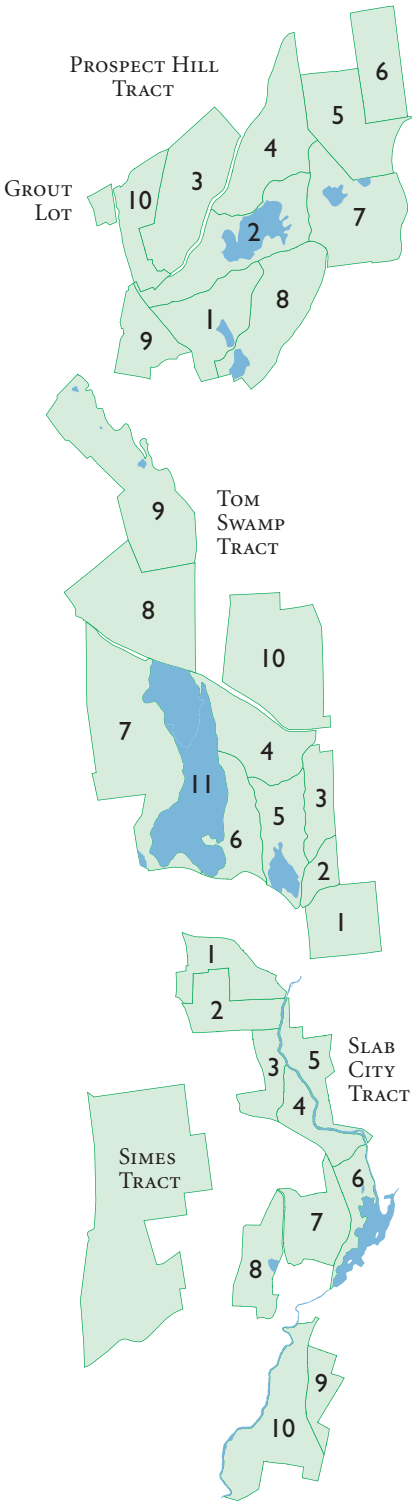
Field Methods

The 33 compartments we surveyed range from 9 to 313 acres in size, with most between 30 and 120 acres. During 2004, the first year of survey, we visited almost all the compartments, typically with a two-person crew, and typically spending between 3 hours and a full day in each compartment. We tried to make as full a list of the plants as we could, identifying the majority of species in the field, and collecting the others for herbarium study. The extent to which we could do this depended on who the surveyors were and how far along in the survey we were. At the start of the survey Jerry Jenkins, who had about 40 years of experience with the northeastern flora and is a specialist in vegetative identification of the technical groups, did most of the difficult identifications. Glenn Motzkin, with about 20 years of previous experience, and Kirsten Ward, with only a few, learned very quickly and by the second year knew all the widespread species and many of the rarities.

During the fall of 2004 and the winter of 2005 we began a historical review of the flora and summarized our 2004 data. We made lists of what we had found in each compartment in 2004, what other collectors had found previously, and what species we were apparently missing.

In the summer of 2005 we revisited most of the compartments and also concentrated on special habitats (rocky slopes, wetlands) which were rich in species. In 2006 and 2007 we began a bryophyte survey (not yet completed and not discussed here) and continued the vascular plant work with visits to places of special interest and collections of groups that we felt we needed more information about. Glenn Motzkin made a focused effort to relocate the missing species for which we had good historical records, and was surprisingly successful: in spite of locating additional historical records and thus increasing the pool of historical species by 10 species, he reduced the number of missing species by 23, from 102 to 79.

HARVARD FOREST COMPARTMENTS
SURVEYED 2004-2007



Our survey focused on the four large tracts that contain the bulk of the HF lands and for which the historical record is best. We did not search several small outlying tracts (Schwarz, Pisgah, Hamilton, Tall Timbers) and several recent additions (the Bryant, Wilson, Flint, and Gould lots).

Our primary historical knowledge of the flora comes from the herbarium record, two manuscript checklists (Raup, 1938; Smith, 1948-49), and one published checklist (Jack, 1911).* Our major historical task, and one that took several years to complete, was to cross correlate and verify these sources. We needed to account for every name that had been used for a Petersham record or specimen, determine which records were and were not supported by specimens, then verify the identities of these specimens, and finally determine which of the supporting specimens were actually from HF.

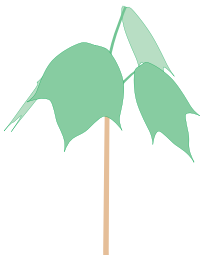
When this was done we had, for the first time, a verified checklist of Harvard Forest records. We knew who had seen what, and when it was first reported, and whether it was, in our judgement, what the seers and reporters thought it to be.

In examining the results, we became aware that there were significant gaps in the specimen record. The work of J.G. Jack and his students, the first collectors, was well represented in the HF herbarium. We had a large number of H.M. Raup collections from 1933 and 1934, and most of the 1947 collections by I.M. Johnston cited in C.E. Smith's checklists. But we seemed to be missing a significant number of later collections by H.M. Raup and many C.E. Smith collections from 1947.

We searched for the missing collections at the Gray Herbarium, since Smith and Johnston had worked there and Raup had deposited specimens there, but we found only a few Harvard Forest specimens. We did, however, learn that Harvard University had given some C.E. Smith specimens to Brandeis University in the 1950s to help them start a herbarium. The Brandeis herbarium no longer exists, but we were able to locate 180 of the missing specimens in the university archives, and arrange to have them returned to Harvard Forest. Glenn Motzkin continued to search for the remaining C.E. Smith specimens along a forty-year trail that lead from Gray Herbarium to the Taylor Arboretum, the Field Museum, the United States Department of Agriculture, and the University of Alabama, but to no avail.

The Raup specimens were closer than we thought. In August 2007, after we thought the historical phase of the project complete and were just starting the final data analysis, Glenn Motzkin and John Burk, then the HF archivist, discovered 9 boxes of plant specimens behind a pile of discarded furniture in a storeroom attached to the HF archives. The boxes, which had never been accessioned or cataloged, contained 1400 unmounted collections, and were most likely from the personal collection of H.M. Raup. They included 350 specimens from various collectors from 1934 or earlier, 170 of Raup's own collections from 1937-38, and 400 collections by K.A.

* There are also a few secondary sources, but they contain no additional information. In 1984, Tim Sipe revised Smith (1948, 1949) to update nomenclature. In 1993, Wenda Luff, an HF summer student, annotated the specimens in the HF herbarium to follow the nomenclature of Gleason and Cronquist (1991).



Striped Maple

Wood Anemone

The two oldest collections in the Harvard Forest herbarium are a specimen of striped maple collected by H.J. Miles on the 5th of May, 1908 from the Prospect Hill Tract and a specimen of wood anemone collected by W.A. Stalker from the Tom Swamp Tract twelve days later. Both plants are still widely distributed at the forest.

Raup from 1947. Apparently H.M. Raup had mounted very little material after 1934, and these collections had remained in boxes and never been placed in the herbarium. Many of the collections were of common species and 450 were duplicates of collections for which we had mounted specimens, but many others were new. Sorting, verifying, and mounting these specimens, and incorporating the results into our databases and analysis kept us busy for much of the fall of 2007.

Quantitative Analysis and Presentation

The analysis of the flora was done in Splus, using its native data manipulation functions and a small library of summarizing, mapping, and resampling functions written by Jerry Jenkins (HF database tools.ssc, HF mapping and resampling functions.ssc). The objective of the analysis was to divide the flora into ecological groups by habitat, life-form, provenance, and taxonomic affinities, and then compare the diversity, frequency distribution, species-area relations, and historical dynamics of the different groups.

The illustrations for this flora were prepared in Adobe Illustrator, often based on maps prepared in Arcview and graphs from Splus. The flora itself was composed in Adobe Indesign, and designed and typeset by Jerry Jenkins.

Documentation

Our primary records are our field notebooks, about 670 herbarium specimens that we collected during this project, and another 2,700 herbarium specimens that we verified or annotated. Our results are summarized in two digital databases, one of the species in the flora and one of the herbarium specimens in the HF herbarium; in this flora; in a poster showing the structure and dynamics of the HF flora; and a distribution atlas that contains the compartment maps from this volume.

In many projects of this kind the individual field records are first entered in a field database organized by place and date, and then summarized in a master species-by-site database. For efficiency, we decided to skip this and enter our field results directly in the species-by-site file. This turns out to have been a mistake: what we saved in time we more than lost in the increased difficulty of error-checking and tracing records, and in the loss of analytical power that came from not being able to examine our information chronologically and ecologically in electronic form. If we were repeating the survey, this is the only major feature of the design, other than forbidding Glenn to dabble around in storerooms and the backs of archives, that we would change.

```
# Routine to Generate a Random SA Curve

perm<-sample(1:33,33)
species.area.curve<-function(n,perm){
        sums<-colSums(compartments.trans
                        [perm[1:n],])
  area<-sums[729]
        div<-sum(sums>0)-1
        result<-c(area,div)
        result}
A<-lapply(1:33, species.area.curve,perm)
B<-t(array(unlist(A),c(2,33)))
B
A
```

Above, the Splus code for generating a species-area curve from a random sequence of 33 compartments. The species-area envelopes on p. 84 were generated by applying this routine to a species-by-compartment matrix 100 times.

Nomenclature

Taxonomy is the only scholarly field whose practitioners are free to choose between competing nomenclatures. The names of clouds, elements, genes, kings, minerals, mountains, stars, and even the zoo of elementary particles, are largely fixed. The fifty-plus New England ferns have had, in contrast, over 450 names in the last 200 years, an average of slightly under ten names per species, with no end in sight.

The multiplication of names is held, quaintly, by many taxonomists to be a scientific necessity. Name changes, the argument runs, are the way phylogeny is made manifest and scientific progress marked. We, like many biologists of our generation, have our doubts: we wonder if phylogeny, especially in the bioinformatic age, is not too complicated to be represented by binomial names. And we wonder if trying to use names to represent phylogeny—something that names do poorly—compromises their ability to designate individual plants, which in our opinion is their basic task and something they do quite well.

All these are arguments for another day. All that we can do here is pick names that are widely used, and supply the synonyms we think necessary for them to be understood by the people who don't use them.

Our first choice, based on the names that are in widest use and that agree with the largest part of the historical literature, would have been to follow Arthur Cronquist in the second edition of the *Manual of Vascular Plants of the Northeastern United States and Adjacent Canada* (H.A. Gleason and A. Cronquist, 1991). Unfortunately, this nomenclature has been to some extent been superseded. Though many botanists in our generation use Cronquist names, those in the future won't. Accordingly we decided to follow the nomenclature of the new *Flora of North America* (1992-2007, not complete) where it was available, and that of B.A. Sorrie and P. Somers *The Vascular Plants of Massachusetts* (1999) where it was not.

We did this reluctantly, knowing that well-bred readers will be saddened to see *Dichanthelium, Diphasiastrum, Elytrigia, Nuttallanthus*, *Schizachyrium*, and *Schoenoplectus* used as primary names and will ask if it is unreasonable to expect that familiar plants should have familiar names. All we can offer them for solace is to note that we done our best to be inconsistent and thus saved them from *Doellingeria, Eurybia, Ionactis, Piptatherum*, *Schedonorus,* and *Symphotrichum* as well.

THE NAMES OF OUR WOOD FERNS

Crested Wood Fern
Dryopteris cristata (Linnaeus) A. Gray, 1848
Polypodium cristatum Linnaeus, 1753
Aspidium cristatum Swartz
Thelypteris cristata (Linnaeus) Nieuwland

Evergreen Wood Fern
Dryopteris intermedia (Muhlenberg ex Wildenow) A. Gray, 1848
Aspidium intermedium Muhlenberg, 1810
Dryopteris austriaca (Jaquin) Woynar var. *intermedia* (Muhlenberg ex Wildenow) C.V. Morton
Dryopteris spinulosua (O.F. Mueller) Watt var. *intermedia* (Muhlenberg ex Wildenow) L. Underwood
Thelypteris spinulosa (Muhlenberg ex Wildenow) var. *intermedia* Weatherby
Thelypteris intermedia (Muhlenberg ex Wildenow) House

Marginal Wood Fern
Dryopteris marginalis (Linnaeus) A. Gray, 1848
Polypodium marginale Linnaeus, 1753
Aspidium marginale Swartz
Thelypteris marginalis (Linnaeus) Nieuwland

Spinulose Wood Fern
Dryopteris carthusiana (Villars) H.P. Fuchs, 1959
Polypodium carthusianum Villars, 1786
Aspidium spinulosa Swartz
Dryopteris austriaca (Jaquin) Schinz & Thellung var. *spinulosa* (O.F. Mueller) Fiori
Dryopteris spinulosa (O.F. Mueller) Watt
Polypodium spinulosum O.F. Mueller
Thelypteris spinulosa (O.F. Mueller) Nieuwland

Synonymies of the four wood ferns, from the *Flora of North America* and House (1924). Formal botanical nomenclature is a heraldic tradition, deeply and perhaps obsessively concerned with what plants have been called and who called them that. We have broken, deliberately, with this tradition and supply no authorities and only the most relevant synonyms here.

Our goal in this project was to say something about floral diversity and ecological change. To do this quantitatively the species that we used had to be somewhat comparable—ten species of violet have to be in some way equivalent to ten species of sedge or ten species of aster. This meant that we had to think carefully about the species concepts we were going to use and how we were going to use them. If, for example, we treated the rose family expansively and the composites conservatively, we would not only distort the relative importance of these families, but we might distort the ratios of native to alien species and wetland to upland species as well.

Some numbers may make this clear. In most northeastern floras something around 10% of the species come with identity problems. They may have vague boundaries, vary in a complex way, or contain subentities which may be species themselves. If, as in the relatively stable Harvard Forest flora, we are trying to detect historical gain and turnover rates of 10% or lower, we will need to reduce taxonomic uncertainties to a few percent or less.

To do this we need to be very careful about the operational definitions of species boundaries. In taxonomy, as in physics, the narrowness of a measurement and the certainty you have in it are often inverse. Narrowly defined species concepts are more precise but often less useful, because there will invariably be many specimens that they don't fit. This suggests that, in an ecological survey, we may want to widen our concepts of taxa, to be sure we can identify all our material consistently, and to be sure that our concepts agree with those used in previous surveys.

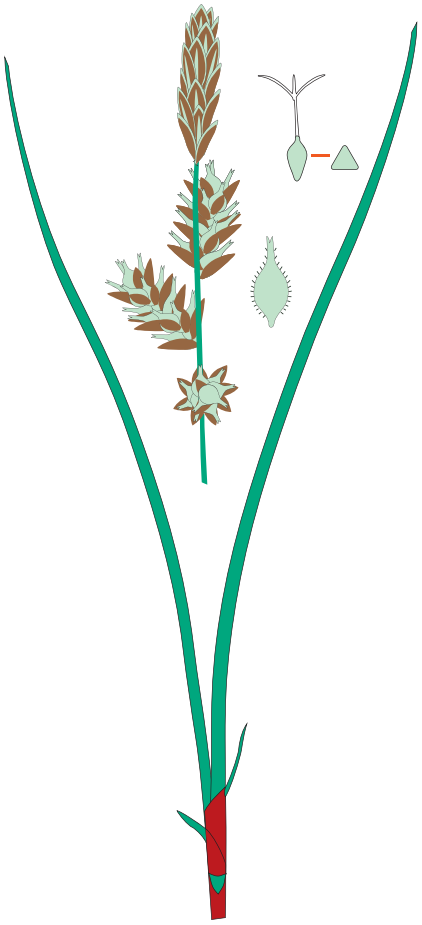
If we don't do this—if, for example, our species concepts in *Lycopodium* or *Rosa* don't fit 20% or 30% of our specimens, or if we fail to recognize that *Amelanchier canadensis* and *Carex festucacea* had different meanings in 1930 than they do today—we will never succeed in getting accurate measurements of floristic structure and change.

Considerations like these convinced us that we needed an ecologically useful taxonomy, and that the three main requirements of such a taxonomy would be comprehensiveness, accuracy, and significance.

By comprehensiveness we mean the ability to identify most of the plants that you encounter. A small distinction, like that between *Scirpus hattorianus* and *Scirpus georgianus* will not be ecologically useful if you can't apply it to young plants and if it simply results in a lot of records labeled *Scirpus sp.*

By accuracy we mean the ability to apply the distinction consistently throughout our survey. The distinction between the microspecies in the *Scirpus cyperinus* group would be useful if all our

CAREX PENSYLVANICA



Carex pensylvanica, a common sedge with several difficult relatives. One of these, *Carex albicans*, occurs at Harvard Forest and presents taxonomic problems that, owing to the limited amounts of material we have and the lack of a clear population to sample from, we have not resolved.

surveyors could be trusted to make it in the same way on all the material they encountered. But it would be a source of error if they can't, or if other botanists with whom we wished to compare our work used it in different ways, or if the older surveyors didn't use it at all.

By significance we meant that we wished to use taxonomic units that were to some extent ecological units as well. We wanted, as noted on p. 21, to count populations rather than variants within populations, and we preferred that these populations have a geographic or historical identity. *Scirpus atrocinctus* and *Scirpus cyperinus*, though close morphologically, seem to have such an identity. They have different growth habits and fruit at different times. *Scirpus pedicellatus*, which overlaps with both and seems to occur as scattered individuals among populations of the other species, may not (p. 54).

A way of summarizing this is to say we believe the number of species you recognize will depend on the kind of survey you are doing and how you are going to analyze the results. If you wish to maximize detail you will use narrow species; if you wish to measure diversity in some uniform way, you will use broader ones. Thus if a taxonomist and an ecologist inventory the same study, they will make different species lists, and the ecologist's species will likely be (and should be) broader and her list shorter. The taxonomist wants to inventory as much genetic diversity as possible; if he can see it, the chances are that he will list it. The ecologist wants to measure the biologically recurrent components of diversity: she will tend to neglect small variations that appear irregularly or lack ecological correlates. The taxonomist, who will be judged by the length of his list, is scared of leaving anything out. If one plant looks like a Hickey's clubmoss in a sea of clubmosses that don't, Hickey's will go on the list. The ecologist, who knows that random noise degrades signals, is scared of introducing spurious records: she will leave the variant clubmoss out until she has evidence that it represents a variant population.

How applicable are regional species concepts to local ecological studies?

They are valuable guides, but only that. Our experience suggests that the definitions of difficult species need to be tested against the local variation pattern. There are useful simplifications that work locally but not regionally, and local problems that are not recognized in regional treatments.

The basic difference between a regional and a local study is that the authors of a regional monograph or flora typically look at

specimens from a wide geographic area, but do not get to see the populations from which those specimens come. The authors of a local study can see the populations, but may not know how these populations relate to the rest of the species.

Because the regional and local authors have different points of view, they see different things. The two shadbushes *Amelanchier laevis* and *A. arborea* occasionally hybridize; the hybrids accumulate in museums, and many books treat them as varieties of a single species. In many parts of New England, however, the hybrids are rare. The two species bloom at different times, and seem quite separate. Here, the two species are easier to see locally than regionally.

In other cases, the opposite may be true. The stemless blue violets produce some very distinctive forms, at least in parts of their range. When you look at herbarium specimens in a regional collection, it is easy to convince yourself, say, that *Viola sororia* and *V. cucullata* are distinct, and indeed they are treated as distinct species in all recent manuals. But when you look at them locally and assess the local variation pattern (p. 64), the distinctness often vanishes. We have worked in many places, including Harvard Forest, where the consistent separation of *sororia* and *cucullata* was all but impossible.

Taxonomic Methods

We believe in evaluating difficult species locally by using population samples, usually analyzed graphically, to assess the local variation pattern of difficult species. Essentially, when we get to a disputed case, we put the manuals away and let the species speak for themselves. If they are distinguishable, in our study area and with our material, we assume that we will see it. If they are not distinguishable, we assume that we will see that too.

Our method has four steps.

– We know in advance, from experience and reading, what plants are likely to present taxonomic problems in a given area.

– We determine which of those plants have significant populations in our study area and collect population samples, ideally of several dozen specimens, from them.

– We first evaluate our specimens by using the manuals and comparing them to herbarium material and try to determine how many species we are seeing.

– When straightforward comparison doesn't yield a clear result, we measure and graph them, and examine the vegetation pattern quantitatively.

We believe this approach gives us a better sense of the ecologically significant species in a local study than simply comparing individual specimens to herbarium sheets and running them through the keys. In Chapter V we give some examples of this approach, and we show that, although quick and local, they can suggest some interesting things that the regional treatments may have overlooked.

Completeness

Taxonomic problems aside, just how complete is a survey like this? How many of the species that might be found have we already found, and how complete are the distribution maps that we have made for them?

We have no way, short of finding another team to survey the forest and comparing our results, to answer this. But our sense of how the survey has progressed and how frequently or infrequently we now see new species or rediscover missing ones, suggests an approximate answer. After four years of survey:

> –We are only rarely discovering new species or missing historical ones in undisturbed native habitats. Doubtless there are still some there to find, but we suspect that there are only a few left.
>
> –We are, however, continuing to find new species in open or disturbed habitats. Many of these are ruderal or opportunistic species that arrive in places quickly and leave equally quickly.
>
> –We are also continuing to find new compartment records for the general forest and wetland species, suggesting that, as would be expected, they are more generally distributed than our maps show.
>
> –But we are not, on the other hand, finding many more records for the species of special habitats. Which is to say that we have now been to all the bogs and ledges, and have seen most of the bog and ledge species.

Putting these observations in more general terms, we propose that species-abundance distribution consists of a core of species that are either common enough or specialized enough to persist for long periods, and a tail, of unknown length, of vagrant and usually rare species that come and go quickly. We think that both our survey and previous surveys did pretty well at assessing the persistent core but that we only have snapshots of the volatile tail. We certainly know the common vagrants of our period. But we think it quite likely that there have been a significant number (20? 50?) of transient species in the last 50 years that no survey has recorded, and that there will be a similar number, new or returned, in the next 50.

What are the major plant communities at Harvard Forest?

The large and widespread communities are successional forests, wooded and shrubby wetlands, and aquatic communities of shallow water ponds. Compared to these, everything else is smaller and more local.

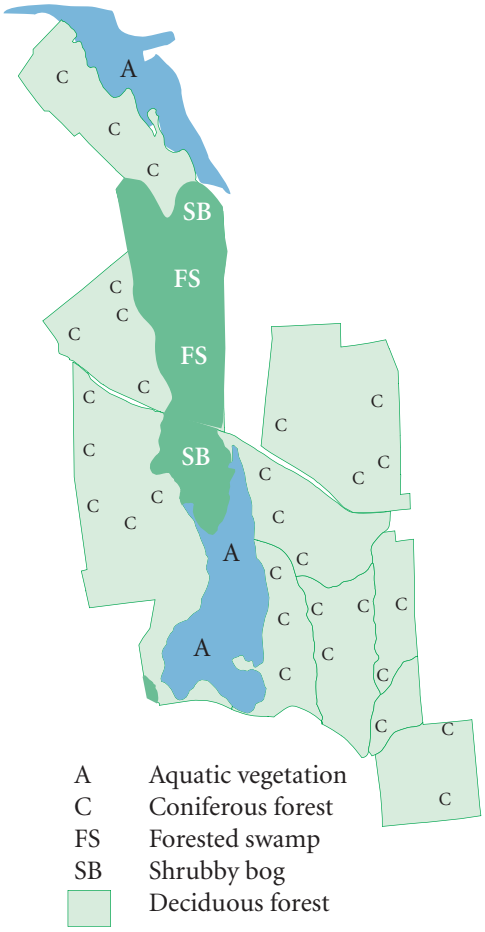
The common forest types are dominated, variously, by red oak, red maple, white pine, or hemlock. Most are of low or average fertility and under 100 years old. Hemlock is now locally dominant in many stands that have been continuously forested; oaks, red maples and pines are the common dominants in stands that developed in old fields. Red spruce, or something between red and black spruce, occurs in wetland forests in the Tom Swamp valley.

Forest understory communities are typically sparse on dry sites and better developed in the wet ones. Understory diversities range from near zero in some conifer stands to 40 to 50 species in moist, relatively fertile ones. Shrubs, small trees, ferns, and late-flowering herbs are common. Early-spring herbs are uncommon, and spring ephemerals are essentially absent. Fertility-indicating herbs and shrubs are mostly limited to rocky slopes in the Slab City and Simes Tracts. Elsewhere they occur occasionally but do not form anything that resembles a continuous rich-woods community.

Wooded and shrubby wetlands are common in peaty basins in the Prospect Hill and Tom Swamp Tracts. Typically they are in headwaters areas, at least somewhat isolated from groundwater, and do not flood in the spring. All are acid, and most are dominated by ombrotrophic or weakly minerotrophic species of sphagnum. In composition they range from dwarf-shrub bogs, through tall shrub thickets, to either hemlock-hardwoods swamps (on Prospect Hill) or spruce-tamarack swamps (in Tom Swamp). Their understories are commonly dominated by ferns and shrubs and have relatively few graminoids and very few herbs.

The aquatic communities are limited to shallow water in three medium-sized, peaty ponds, and consist of dense stands of floating and submerged aquatics, with bands of deepwater emergents along the shores. The ponds seem to be of low or medium fertility, and have acid water; their floras are moderately diverse, almost entirely native, and acid-tolerant. Pondweeds, water lilies, bladderworts, burreeds, pickerel weed and watershield are common. The bladderworts, in particular, are strikingly abundant and diverse. We have six species, of which five are common.

MAJOR COMMUNITIES ON THE TOM SWAMP TRACT



What are the most important minor communities and how important are they?

There are basically four types of minor community that are significant for plant diversity, and they are very important indeed.

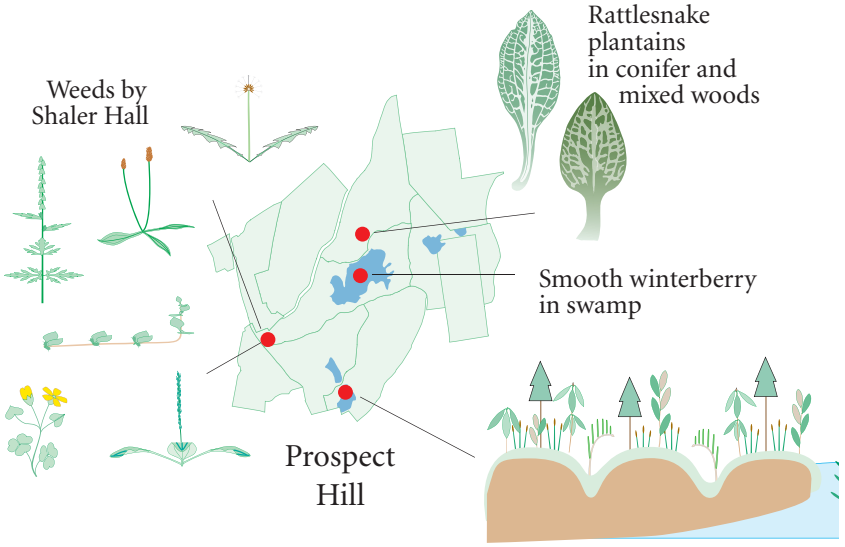
The first type is fertile rocky woods, usually southeast or east facing, which support a group of early-flowering herbs and graminoids that occur nowhere else. This community is rare. It is best developed on the east slope of Camel's Hump in the Simes Tract and also occurs, in a less rich but still attractive form, on three rocky slopes in the Slab City Tract.

The second and third types are pond shores and river shores, variously stony or peaty, and variously open or shaded. The shorelines are more minerotrophic than the large peatlands, and correspondingly more diverse. They tend to develop rich mid-summer and late summer herb communities and are the only communities at the forest to have a significant number of native annuals.

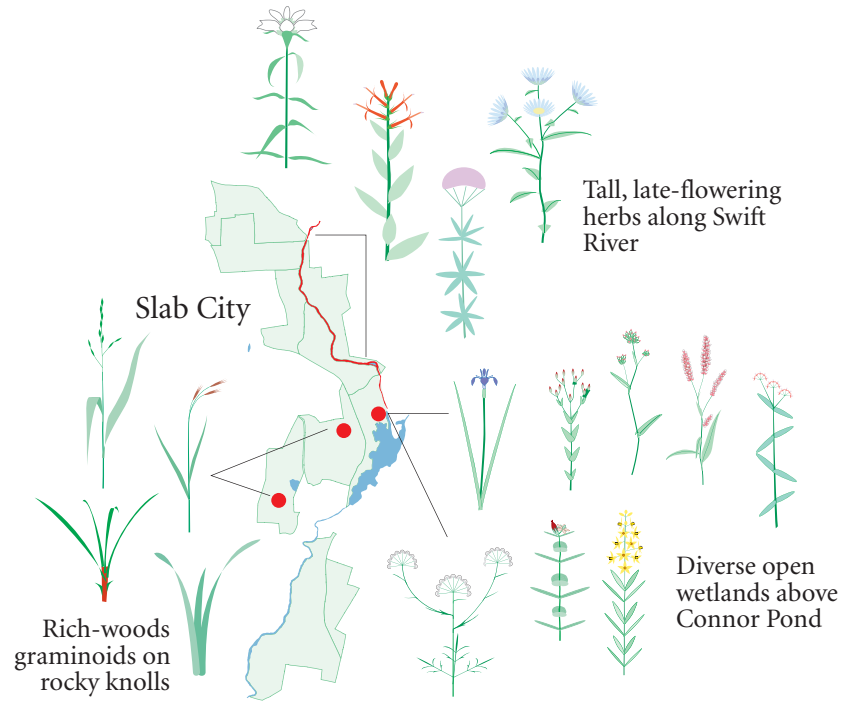
The fourth type includes the open, vegetated habitats: lawns, woods road edges, and three recreated pastures. These contain a mixture of native and alien species. The natives are an interesting group: mobile by necessity, rich in grasses and sedges, and surprisingly persistent despite large changes in the amount and kind of habitat available to them.

The open communities include several barren habitats with recent disturbance: the edges of the paved roads, and a few borrow pits and log landings. These habitats are of course rich in alien species but also have some natives of open sandy soils: our species of *Lechea*, *Helianthemum,* and *Bulbostylis* are restricted to recently disturbed habitats, and for many of our species of *Cyperus* and *Polygonum* (*Persicaria)* they are a preferred habitat.

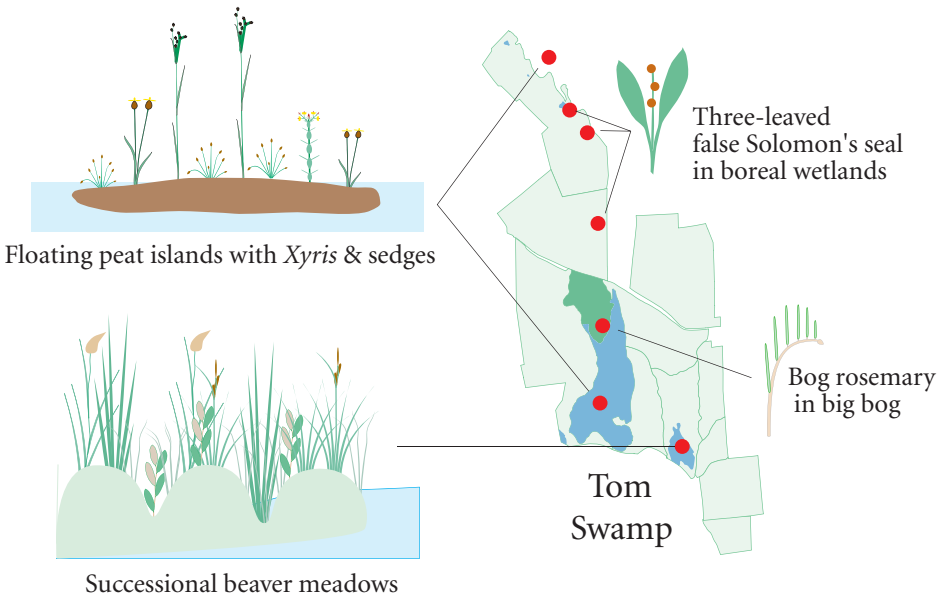
DISTINCTIVE SPECIES AND HABITATS ON PROSPECT HILL



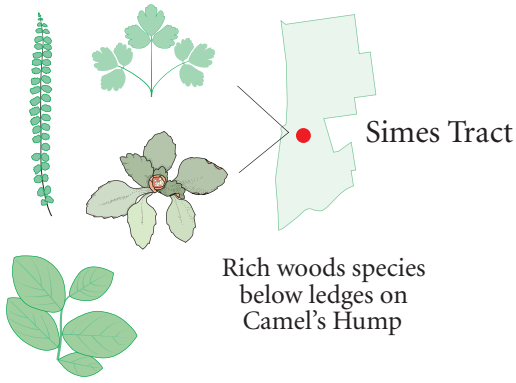
DISTINCTIVE SPECIES AND HABITATS IN THE SLAB CITY TRACT



DISTINCTIVE SPECIES AND HABITATS IN THE TOM SWAMP TRACT



RICH-WOODS SPECIES IN THE SIMES TRACT



The aggregate diversity of these minor communities is quite high. Because many plants occur in several habitats it is hard to come up with exact figures for the number of plants that are restricted to each habitat, but something like 60 native species are found all or mostly in the fertile woods, 120 native species in the various open and edge communities, and 150 species in the pond-shore and river-shore communities. This is a total of roughly 335 species, or 60% of our current native flora of 569 species. Considering that these habitats probably total less than 10% of the area of the forest, this indicates that a surprising percentage of the plants are packed into a small and ecologically unremarkable area.

What is the overall flora like?

In quick summary, the flora is large, rich in shrubs, graminoids, and evergreens, and relatively poorer in herbs. It has many acidiphilic species, many species of peaty wetlands, and many of the shallow-rooted, colony-forming species of shallow, podzolized soils. It has relatively few calciphiles, annuals, or species of minerotrophic wetlands, but it does have a substantial number of disturbance, edge, and gap species, especially along the edges of roads.

The total flora, historical and contemporary, is about 808 species, or somewhat over one-third of the flora of Massachusetts. This may seem large for an area only a thousandth the size of Massachusetts,

but it is consistent with the logarithmic species-area relations that seem to hold in our area (p. 89).

The dominant species in the forest are familiar, wide-ranging plants of the oak and northern hardwoods zones. Most are of cold-temperate affinities, and most are tolerant of acid soils. White pine, red maple, hemlock, red oak, and beech are the commonest trees, highbush blueberry, lowbush blueberry, maple-leaved viburnum and winterberry holly the commonest shrubs, and Canada mayflower, wild sarsaparilla, starflower, and white wood aster the commonest herbs. The species diversity is about equally divided between woodlands, wetlands and open habitats. Since the woodlands have over 5 times the area of all the other communities combined, this suggests that woodland floras are relatively uniform, and that many woodlands contribute little to the overall diversity.

What are some of the ecologically specialized species, and where are they found?

The figures on pp. 31-32 illustrate some of the more specialized species and their habitats and the map on this page shows the number of locally uncommon species per compartment. The Prospect Hill Tract has the fewest specialist species but still has smooth winterberry in the main swamp, rose pogonia and buckbean in Gould's Bog, and white-fringed orchid and the blue-eyed grass *Sisyrinchium atlanticum* in the main pasture. Interestingly, the last two were here in the 1930s, apparently persisted when the original pastures were abandoned, and have recolonized the new pastures that were created in 1992.

The Tom Swamp Tract has a large peaty pond, a large shrubby bog, and one of the largest spruce swamps in eastern Massachusetts. The yellow-eyed grass *Xyris montana* and the sedge *Eleocharis flavescens* grow on floating peaty islands; the bog aster *Aster nemoralis* grows on the edges of the bog mat, and the three-leaved Solomon's seal and dwarf mistletoe grow in openings in the spruce swamp.

The Slab City Tract has several miles of shaded river shores, a pond and wetland complex, and three rocky south- and east-facing hills. Cardinal flower and the marsh-bellwort grow along the river, the tiny bladderwort *Utricularia gibba* in the pond, and several rich woods graminoids (*Oryzopsis racemosa, Elymus hysterix, Sphenopholis obtusata*…) on the rocky slopes.

The Simes Tract has our largest area of fertile rocky woods, and several small wetlands that may be less acid than those in other compartments. It is our best site for species of fertile woods. Leatherwood, hepatica, several tick-trefoils, maidenhair spleenwort and twenty other fertility-dependent species grow there and nowhere else at HF.

The maps show the numbers of species in each compartment that were found in two or fewer compartments in our survey.

Are some Harvard Forest species rare in Massachusetts?

Very few. Most of the habitats are reasonably common in the state and so most of the species occur in many counties, though they may be scarce or local. *Carex tuckermannii*, known for 60 years from a small pond is the Simes Tract and only known in three other counties in Massachusetts, is probably our rarest species. *Carex abscondita*, collected here once and known from four other counties in Massachusetts, would be quite rare if we could relocate it. *Carex ormostachya* and *Xyris montana*, both known from five other counties, are also reasonably rare.

To what extent does the flora have range-limit or geographically specialized species?

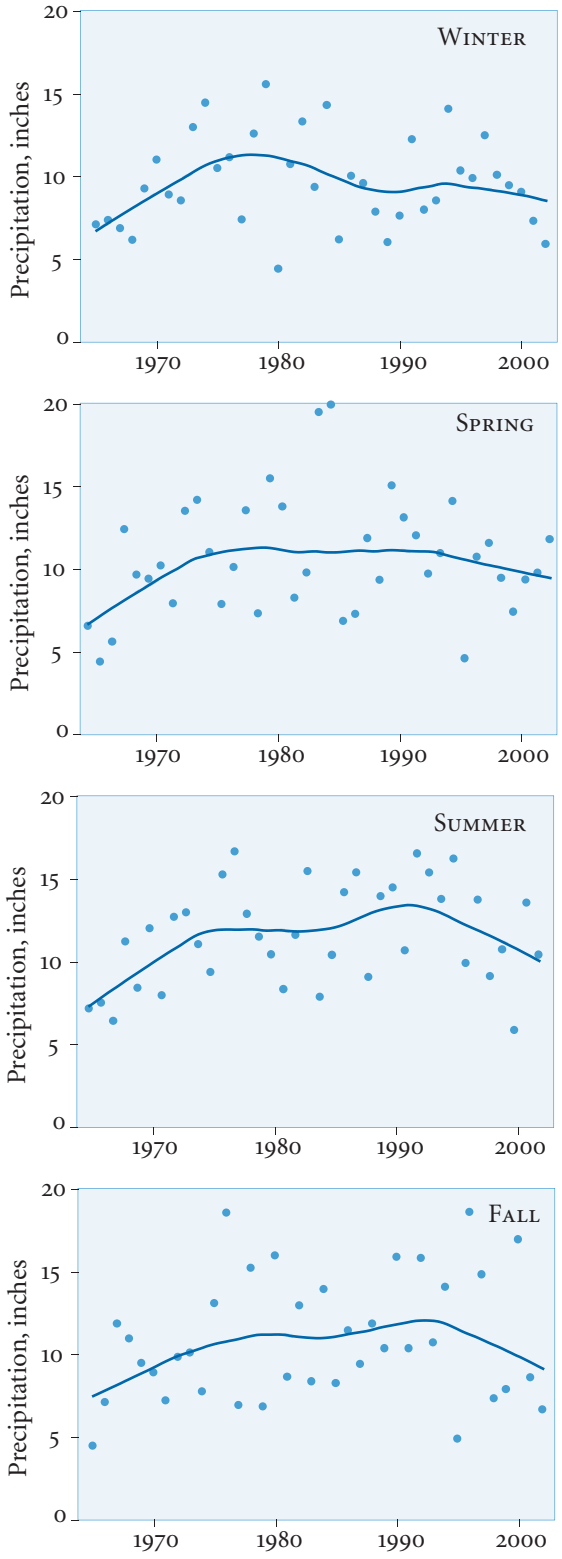
We discuss this in more detail in v VII. Range limits are broadly distributed and almost any area you study contains some range-limit or near range-limit species, though the smaller the area surveyed the fewer there will be.

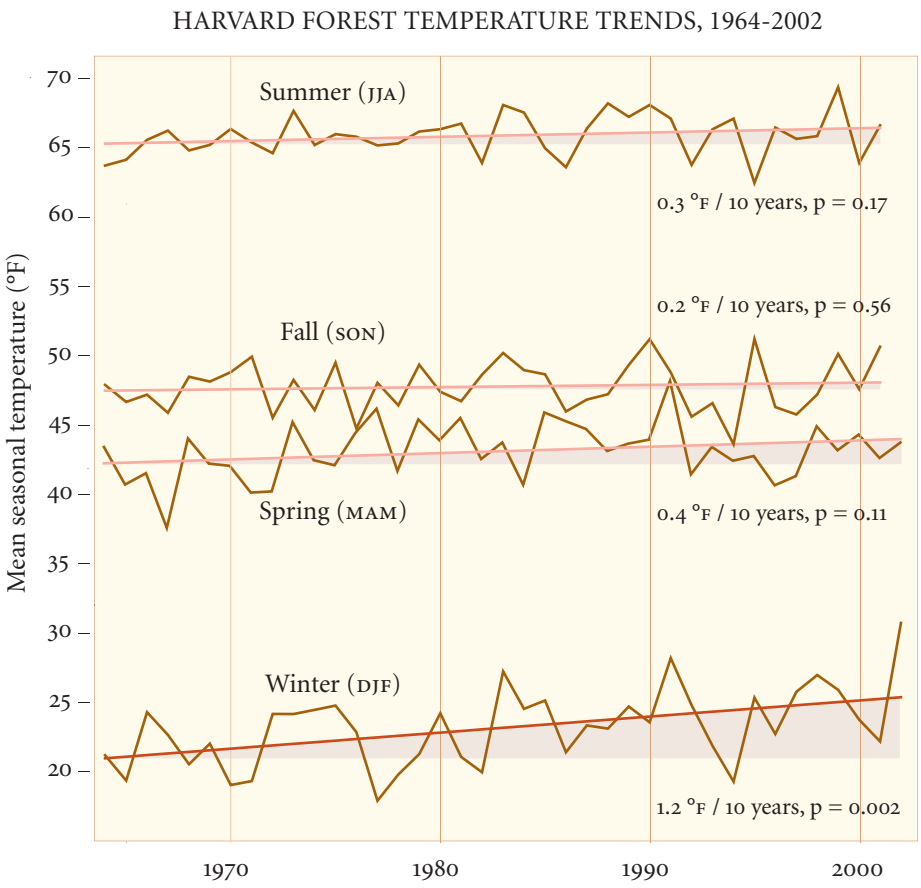
At Harvard Forest, the spruce swamp in the Tom Swamp Tract is one of our more unusual features, and many of its northern plants—black spruce, three-leaved false solomon's seal, dwarf mistletoe—are at or near their southern limits. Likewise, because of its elevation and pockets of fertile soils, HF has a number of montane and rich-woods species that are more common further west in the state. Ginseng, red spruce, narrow-leaved gentian, and rose twisted stalked are distinctive examples. And finally, though the forest does not have any true coastal-plain habitats, it is near enough to the coast to pick up a few coastal plain species. We have red chokeberry, sweet pepperbush, and the blue huckleberry (*Gaylussacia frondosa*), and formerly may have had fetterbush and bayberry.

Are there any old-growth woods?

We think not. There are a few old trees, but no truly old stands. Based on the forest outlines shown in the 1830 map of Petersham and the historical information assembled by H.M. Raup and R.E. Carlson (1941) there are primary woods—woods that have never been cleared for agriculture—in every tract. And according to the commemorative history of the forest (J.S. Ames et al., 1935) there were "culled old-growth" stands in the Tom Swamp and Slab City Tracts. But all of these were hit quite hard by the 1938 hurricane and, so far as we saw, do not contain old growth today.

SEASONAL PRECIPIATION TRENDS



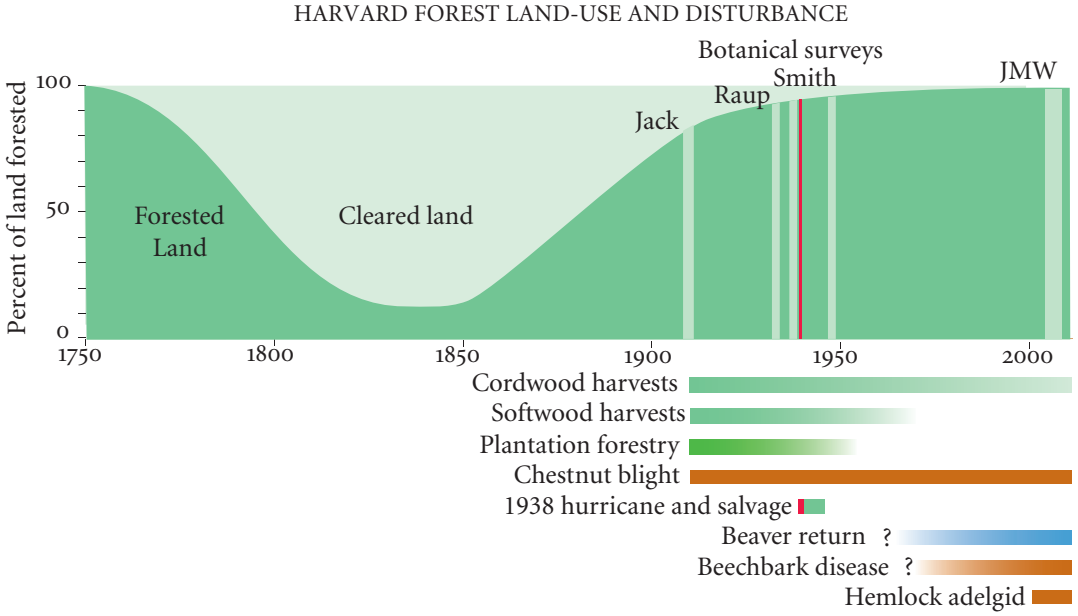


Trends in seasonal precipitation and mean temperatures, from the Harvard Forest weather station. Precipitation increased after the multi-year drought in the mid 1960s, and has held steady or decreased since then. Interdecadal fluctuations in historical records are common, and it is not clear that the recent decreases mean anything. Mean temperatures have risen in all seasons; the winter rise, which is equivalent to a startling 12 °F per century, is by far the largest and the only one that is statistically significant at the 0.05 level.

How much has Harvard Forest changed ecologically in the last 100 years?

It has changed considerably in the amounts of different habitats, but less in what these habitats contain or how they work. It has gone from about 20% open land in 1907 to less than 1% today. It has created and then liquidated plantations, lost old-growth to cutting and a major windstorm, and greatly increased the amount of middle-aged forest as cutting has decreased and the young pre-war forests have aged. It lost small amounts of forest and gained proportionately larger amounts of wetlands when the beaver returned. It has lost chestnut and beech to disease, and gooseberries to a forest sanitation program; it has gained hemlock from successional processes and hardwoods as the old-field pines were harvested. It has gained a significant number of new weeds, including five that are major invaders of native forests elsewhere. And it has experienced gradual increases in annual temperature and growing season, and the cumulative effects of acid deposition and increases in low-level ozone.

All these changes not withstanding, it is our sense that the basic ecological framework has changed relatively little. Neither the



Above, a graphical chronology of land use and major disurbances at Harvard Forest. The four periods of botanical survey are represented by light green vertical bars; JMW is this survey. The vertical red bar is the hurricane of 1938. The peak of agricultural seems to have been between 1830 and 1860; by the time the Harvard Forest was founded, much of the land that had originaly been cleared had already reverted to woods. None of the surveys saw the forest when half or more of the land was under active agricultural use, and none inventoried the plants of old-growth forests. Had they done this, the flora they reported might have been significantly different.

forests nor the wetlands seem to have eutrophied; no dominant species have vanished, and no new dominants, alien or native, have become established. We have seen, thus far, no obvious consequences of climate change or of acid and nitrogen deposition. We believe, as we will explain below, that some forest and wetland species have changed their abundance. But these changes, if they are real at all, are near the lower limit of what we can measure, and none of them represent major changes in forest or wetland composition.

In the next three sections, we summarize the floristic changes that have accompanied these ecological changes, starting first with the woody plants, for which the evidence is most complete.

How much have the woody plants of the Harvard Forest changed over the last hundred years?

Apparently the dominants have changed very little. The following table lists the commonest trees and shrubs of the forest as determined by our survey. The numbers are the number of compartments in which they occur today, and the phrases in quotes are J.G. Jack's descriptions of their distribution in 1911.

The Commonest Harvard Forest Trees

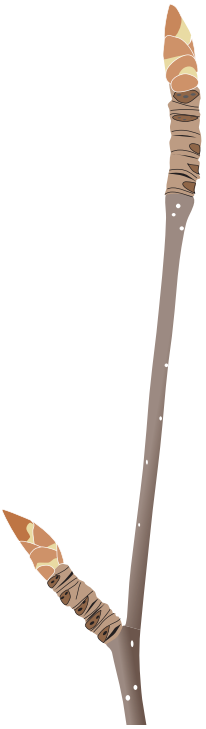
White Pine	33	"abundant in all situations except deep swamps"
Red Maple	33	"very common, especially in low ground"

Hemlock	32	"common on cool north situations and occasionally as an understory to white pine
Red Oak	32	"common, especially in rich soil and protected situations"
Beech	31	"occasional as individuals or groups in well-drained woods"
Black Cherry	30	"common, in woods, along roadsides, and in pastures"
Chestnut	28	"common and important tree"
White Oak	27	"common, in various soils and situations"
White Ash	27	"common, in rich soils"
White Birch	27	"frequent, most abundant in Meadow Water Tract"
Yellow Birch	27	"frequent on rich moist or wet situations"
Sugar Maple	27	"common, attaining good size"
Black Birch	26	"common on well-drained soils"
Striped Maple	26	"occurs scattered through woods, frequent"
Hawthorn	25	"frequent, neglected pastures, open woods"
Canada Shadbush	25	"common, usually in dry or well-drained woods"
American Mt. Ash	21	"rather rare, in woods and along roadsides"

The Commonest Harvard Forest Shrubs

Highbush Blueberry	33	"common, swamps or drier situations"
Early Lowbush Blueberry	32	"common, dry situations, fields and woods"
Maple-leaved Viburnum	29	"common, dry woods, opening, and roadsides
Late Lowbush Blueberry	27	"common, dry soil"

BLACK BIRCH



EARLY LOWBUSH BLUEBERRY

Two common woody species that are found throughout the forest and have been common for at least a hundred years. Black birch is a canopy tree of successional woods; it is an excellent gap species and often increases when other species are harvested. Early lowbush blueberry is a ubquitous understory plant.

Winterberry Holly	27	“very common, usually in moist or wet ground”
Witch Hazel	27	“a common shrub, found in both moist and relatively dry situations, chiefly in shady woods”
Withe-rod	26	“very common. Chiefly moist rich soils and swamps”
Hobblebush	26	“numerous colonies and individuals, chiefly in moist shady woods”
Northern Arrow-wood	26	“common, open woods, roadsides”
Meadowsweet Spiraea	26	“common, pastures, open woods, moist ground, roadsides”
Sheep Laurel	22	“old fields and wet ground, common”
Bush Honeysuckle	21	“common, dry woods, roadsides, and old fields”
Canada Honeysuckle	17	“in woods occasional”
Beaked Hazelnut	17	“common, roadsides, woods, and thickets”
Alternate dogwood	17	“common along roadsides and in open woods”
Maleberry	16	“common throughout the region, preferring moist or wet places”
Sweet Fern	16	“common, chiefly in pastures and abandoned fields, a weed”
Mountain Laurel	15	“plentiful in a few localities and frequent scattered individuals”
Common Blackberry	14	“common”
Red Raspberry	13	“common”
Mountain Holly	12	“common in swamps or wet ground in woods
Juniperus communis	12	“in abandoned pastures”
Black chokeberry	11	“very common”
Speckled alder	11	“common on wet ground, swamps, and borders of streams”

LEATHERWOOD

Leatherwood, a low understory shrub with untoothed leaves and rubbery branches, is very rare at the forest but has been present, though not necessarily in the same place, for a hundred years.

Looking at Jack's comments from 97 years away, what is striking is how similar the forests seem. We note some immediate changes: hemlock, beech, and red maple are more widespread and chestnut is now mostly an understory shrub. And we think we see some subtle changes as well: mountain ash (which is bird-dispersed and occurs mostly as seedlings) seems to have spread; sheep laurel and hazelnut have made the transition from openings to the understories of open woods. But what we take from these lists is a sense that if Jack could walk in our woods or we in his, neither the flora nor the abundances of the individual species would seem very different.

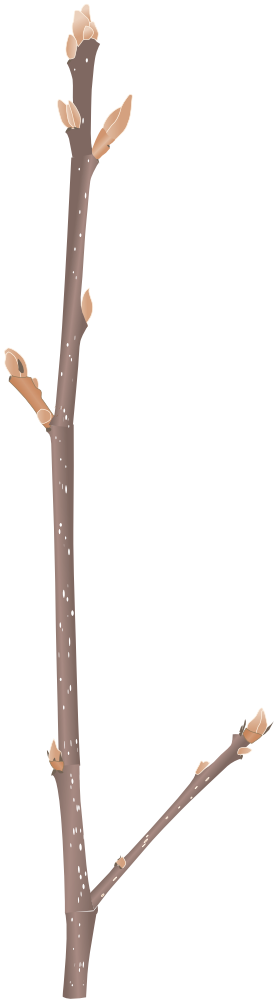
Jack also recorded many of same uncommon woodland and wetland species that we did. He knew sites for bog laurel, dwarf cranberry, leatherwood, limber honeysuckle and smooth winterberry. Many of them were in the same general areas where we find them today.

The biggest difference between Jack's landscape and ours is that he had several hundred acres of pastures and recently abandoned fields and we have less than 20.* Jack lists 16 species as occurring in pastures and fields in or near Harvard Forest: American elm, apple, bayberry, black huckleberry, bush honeysuckle, common juniper, dwarf sumac, early lowbush blueberry, gray birch, hawthorn, meadowsweet spiraea, pin cherry, red cedar, sheep laurel, staghorn sumac, and sweet fern. Doubtless others, including several dogwoods and willows for which he doesn't give a specific habitat, occurred in meadows and old fields as well.

Unlike the forest plants, the abundance of the pasture plants seems to have changed greatly. Bayberry and gray dogwood seem to be gone. Early lowbush blueberry, huckleberry, meadowsweet, and sheep laurel remain common but have left the pastures and are now plants of wetlands and open woods. Elm, common in Jack's time and now decreased by loss of habitat and the Dutch elm disease, is now an uncommon species of forest edges. Pin cherry and gray birch, formerly "very common," are now scattered or uncommon. The four willows *Salix bebbiana, discolor, eriocephala,* and *sericea,* which Jack said were common and which remain common in places with open land, are now rare: we have only eight records for the four of them.

A second noteworthy difference between our floras is that the only woody invasives that Jack mentioned were common buckthorn, which had "frequently become naturalized", and European barberry and a bush honeysuckle that he called *L. tatarica,* which he said were rare escapes. Our most serious woody weeds—Morrow's honeysuckle, Japanese barberry, oriental bittersweet, and glossy buckthorn—were unknown to him and do not seem to have arrived until 50 years after his time.

GLOSSY BUCKTHORN



Glossy buckthorn is a highly invasive species that now dominates the understories of sucessional woods elsewhere in the state. It arrived at Harvard Forest sometime in the past 60 years, and is still scattered and uncommon here.

*Additionally, our pastures are not historically continuous with his but were recreated from woodlands in 1992.

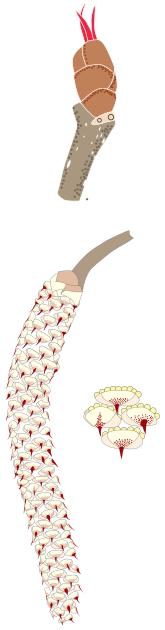
There are other differences between Jack's day and ours that, while not forming any simple ecological pattern, are individually interesting. Some of them may simply be species that he or we overlooked. Others may be examples of the kind of uncorrelated, single-species floristic change that we believe to be common in most floras. The most striking ones are that:

> Butternut, which Jack said was frequent in woods and on roadsides, has suffered much mortality from the butternut canker and is now known from only three compartments.
>
> The blue-fruited honeysuckle, *Lonicera villosa,* which Jack said was common in wet meadows and swamps, is now very rare at HF and, in our experience, in most other places in central New England. It is a high northern plant near its southern range limit with us, and we have to wonder if the warming of the last 100 years has made it less competitive.
>
> Jack found two species, sycamore and American hazelnut, which we have not found at HF. He also found another six—bayberry, fetterbush, prickly gooseberry, white azalea, and the two willows *Salix humilis* and *S. petiolaris*—which we also have not seen, at unspecified locations in or near the forest.
>
> We, in turn found a few woody plants—blue huckleberry, sweet pepper bush, dwarf mistletoe—that Jack does not mention. All are uncommon, and it is equally possible that he missed them or that they established themselves after his time.
>
> And finally, we now have three low woodland creepers—partridge berry, now present in 30 compartments, spotted wintergreen, present in at least 16, and pipsissewa, present in at least 10—that Jack doesn't mention. He was a careful worker and he mentions several other dwarf creepers, and so it is hard to believe that he overlooked them. Partridge-berry and pipsissewa were first collected here in the 1930s, and spotted wintergreen was not collected until our survey. The most likely interpretation seems to us that they were absent or uncommon in the young woods of the early 1900s, and have become more common as the woods matured.

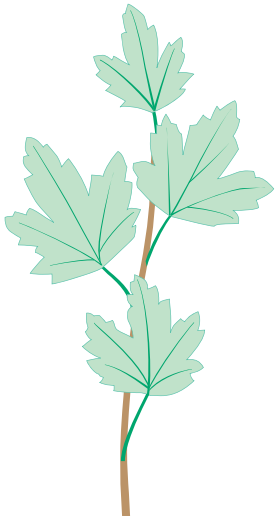
How much have the woodland understories of the Harvard Forest changed over the last fifty years?

Our best historical information on understories comes from the collections made in 1933-38 and 1947-49, and the annotations in C.E. Smith's Petersham checklists (1948-49). Smith was 25 years

AMERICAN HAZELNUT



PRICKLY GOOSEBERRY



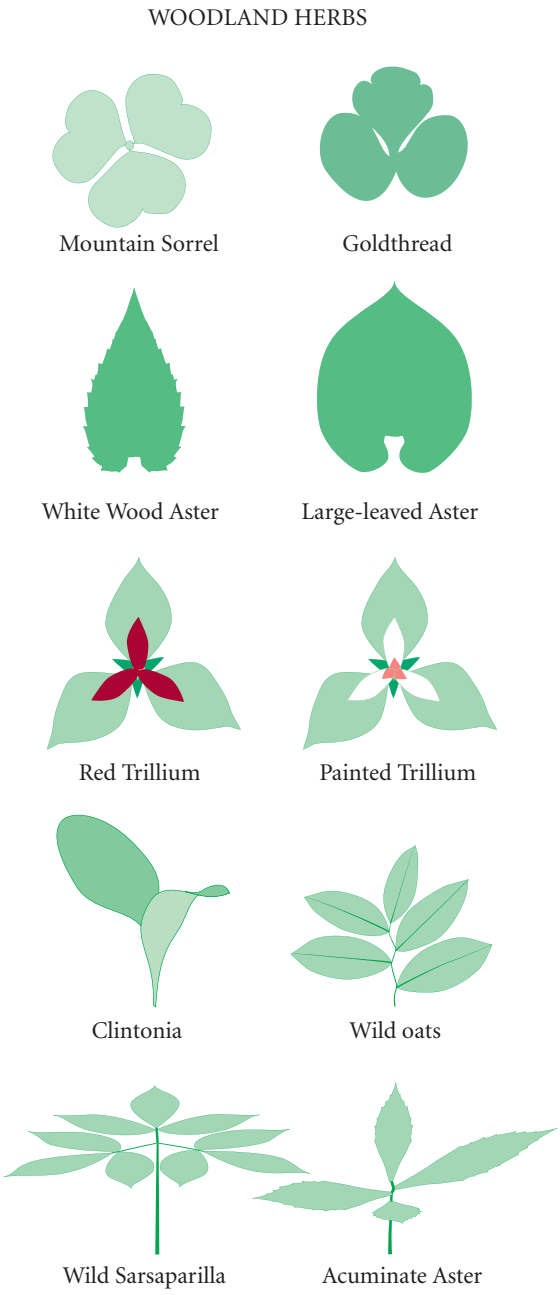
The American hazelnut and prickly gooseberry were found in or near Harvard Forest by J.G. Jack. We have not been able to relocate either. The hazelnut is usually found in openings or along forest edges, and it may be that suitable habitat no longer exists. The gooseberry is a forest interior plant, usually found in rocky fertile woods. We have looked for it in all the sites where its habitat occurs, but with no success.

younger when he wrote his checklist than Jack had been when he wrote his, and much less experienced in field identification. He also had only a single season of fieldwork, while Jack had three or four. We cannot, accordingly, give too much weight to what he didn't see but can still use his checklist and specimens as a valuable record of what he did.

We start with the forest herbs (here defined as herbaceous plants other than ferns and graminoids) and ferns. As in the previous section, the table lists the species we found to be most common, gives the number of compartments in which we saw them, and then, in quotes, what C.E. Smith said about them.

The Commonest Woodland Herbs

Canada Mayflower	32	"common in moist woods"
Wild Sarsaparilla	32	"common in moist woods throughout"
Starflower	31	"common in woods"
White Wood Aster	31	"common in moist woods"
Wild Cucumber-root	30	"occasionally found in moist woods"
Common Cinquefoil	29	"common in moist open fields"
Indian Pipes	29	"common in moist woods"
False Solomon's-seal	29	"common in moist situations"
Wild Oats	28	"occasionally in rich woods"
Acuminate Aster	28	"occasional in dry shaded areas"
Clintonia	27	"common in moist woods"
Pink Lady's-slipper	24	"occasionally in moist woods"
True Solomon's-seal	23	(omitted)
Cut-leaved Goldenrod	22	"in dry open woods"
Whorled Loosestrife	19	"common in moist open sites"
Painted Trillium	18	"few in shaded bogs"
Cow's-wheat	18	"occasional in dry woods"
Wild Bean	17	"occasional in moist shaded sites"



Some characteristic forest herbs of the Harvard Forest. The acuminate aster, wild sarsaparilla, wild oats, and painted trillium—all species that we think of as common in the proper habitats—were considered occasional by C.E. Smith.

The Commonest Woodland Ferns and Clubmosses

Hay-scented Fern	32	"common on dry sites"
Tree Clubmoss	31	"abundant in moist to well-drained woods"
Evergreen Woodfern	31	"occasionally in moist woods"
Cinnamon Fern	31	"moist woods throughout the township"
Bracken	31	"common on dry sites"
Sensitive Fern	29	"common on moist sites"
Interrupted Fern	28	"moist open woods throughout the township"
Ground Cedar	27	"throughout moist to well-drained woodland"
Lady Fern	24	"common in moist wet woods"
Christmas Fern	23	"occasional in moist woods"
Marginal Woodfern	21	"common on and around rock"
Common Polypody	18	"common on dry rocks"

As with the woody plants, what is impressive about this list is the agreement between 1947 and today. Twelve of our 18 commonest forest herbs and 10 of our 12 commonest ferns were listed as common then. Their woods were much younger than ours and recovering from a major windstorm ten years before but still had an herb flora very like ours with many of the same dominants.

According to Smith's annotations, they also had differences. He lists six of our most widespread plants—acuminate aster, Christmas fern, cucumber root, evergreen woodfern, painted trillium, pink lady's-slipper, and wild oats—as occasional rather than common. All of these except the lady's-slipper are characteristic forest-interior species that prefer moist, continuous-canopy woods.

If Smith is to be believed, and since these are common and distinctive plants we are inclined to believe him, the abundance of these species has changed since his time. The changes suggest, consistent with what the forest history tells us, that our woods may be deeper, moister, and perhaps more mature than his.

Can we determine whether the woodland graminoids have changed?

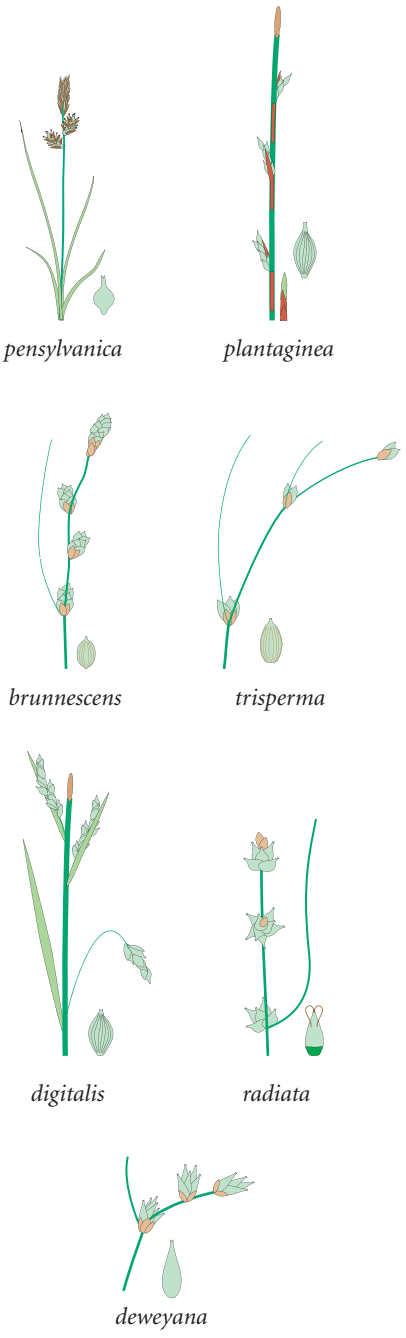
Probably not. When we make a similar tabulation of the grasses and sedges, again comparing the number of compartments in which we saw them to what C.E. Smith said about their abundance, his estimates and ours are very different. If Smith's annotations are taken at face value, 9 of our 13 commonest forest graminoids were uncommon in 1947, and another three were absent altogether..

The Commonest Woodland Grasses and Sedges

Brachyelytrum septent.	29	"reported on Dr. Raup's check list"
Carex pensylvanica	28	"occasionally in dry areas"
Carex debilis	27	"occasionally in woods and moist open sites"
Danthonia compressa	26	"occasionally found in dry woods"
Luzula multiflora	24	"common in woods"
Carex swanii	24	"occasionally in moist to dry sites"
Carex communis	20	not listed
Carex arctata	17	not listed
Carex digitalis	14	rare in dry woods
Carex radiata	13	"occasionally in woods"
Oryzopsis asperifolia	11	"occasionally in well-drained open places"
Carex leptonervia	11	not listed
Carex gracillima	11	"occasionally in moist meadows"

We think that it is unlikely that the abundances of all of these species have changed, and favor an alternative explanation—that C.E. Smith was just learning his grasses and sedges and unable to identify them or judge their abundance in the field. We know that the only sedges and grasses C.E. Smith included in the illustrative species lists in the introduction to his 1947 checklist were "*Panicum species*" and "*Carex species,*" and that the only sedges and grasses he listed as common in the checklist are the largest and most distinctive species of open meadows and wetlands. And so it seems likely that the woodland graminoids of 1947 were a mystery to him and, sadly, have to remain one to us as well.

WOODLAND CARICES



Seven sedges of woodlands and forested wetlands at Harvard Forest. C.E. Smith treated them all as uncommon or occasional. *Carex trisperma* and *C. pensylvanica* are dominants in wooded swamps and dry woods, and *C. radiata* and *C. digitalis* are widely distributed and frequent throughout.

Have any woodland herbs or graminoids appeared or disappeared?

Yes they have, though surprisingly few. All but one of the old species that are missing seem to have been uncommon, and none of the new species are common now.

Twelve species of native woodland herbs and graminoids that were seen in earlier surveys are currently missing: bastard toadflax*, flat-topped aster, Hooker's orchid, Maryland snakeroot, one-sided shinleaf, red baneberry, wild comfrey, wild ginger, wood betony, and the sedges *Carex lucorum* and *C. vestita.* The flat-topped aster (*Aster paternus*), a species of open, often sandy habitats, was listed as "common in dry woods." All the other species, as best we can tell, seem to have been uncommon or scattered.

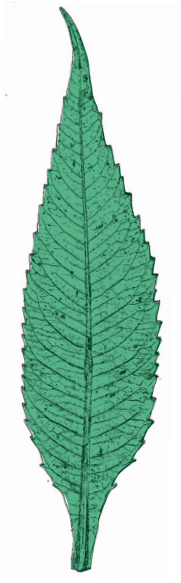
In compensation, we found 25 species of native woodland plants that had not been seen in previous surveys (Appendix II). All are scattered or uncommon, and half have only been found in a single location. Eleven were grasses and sedges, and 19 were fertility-demanding species associated with rich sites. Some, like *Carex novae-angliae* and *Sphenopholis obtusata* are technical species that could easily have been overlooked. Others, and indeed many others, are showy but rare species like the two false-foxgloves, the maidenhair spleenwort, and the grasses *Elymus hysterix* and *Dichanthelium latifolium.* It is possible that these are new species and that several of our fertile rocky woodlands have become richer in species as the forests have matured. But it is also possible that these species have always been here in small quantities and that previous botanists simply missed them. We know that several botanists collected in the areas where these species are found, but we also know that we visited these areas several times ourselves before we found them.

Have the woodlands gained or lost alien herbs or graminoids?

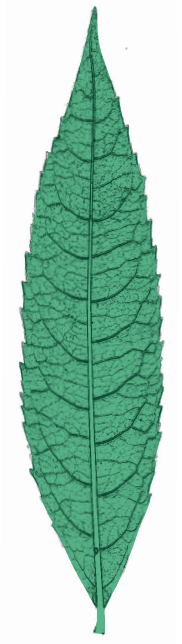
Almost not. The woods at HF were largely without alien herbs and graminoids in 1947, and remain so today. The helleborine, an alien orchid that is now widespread in northeastern forests, arrived sometime after 1950 and is now found in five compartments in small amounts. Garlic mustard, an aggressive woodland weed elsewhere, is now present at HF but largely found along woods roads and in open areas. A few plants of a cultivated columbine (*Aquilegia vulgaris*) and a European hawkweed (*Hieracium piloselloides*) were seen along woods roads in our survey. Otherwise, and in striking contrast to forests in lower and more fertile areas of the state, the forest interiors at HF still have almost entirely native species.

* The bastard toadflax was originally collected on Camel's Hump. We relocated it there but just outside the HF property line. It is possible that this is the only population and that it never occurred in HF at all.

BEGGARS TICKS



TURTLEHEAD



Two frequent wetland herbs. Turtlehead occurs on shaded stream banks; it is common along the Swift River in the Slab City Tract, and occasional along streams and at the edges of shaded wetlands elsewhere. The common beggar's ticks, *Bidens connatus* is frequent in open wetlands and pond shores. It was not found in previous surveys. It may have been mistaken for other species or may be a new arrival in the flora.

How much have the wetland floras changed?

We are not sure. We do not have good historical descriptions of the wetlands and so have no way of determining whether the abundance of the dominant species has changed. There has definitely been a turnover of wetland species but, as with the woodland species, it has been small and, with a few interesting exceptions, has mostly involved the loss of species that were uncommon historically and the gain of species that are uncommon now.

By our tally about 16 species have been lost from the wetlands. All are native, and all seem to have been local or uncommon. Some, like the bottle gentian, grass-pink orchid, and purple-fringed orchid are showy plants that should be easy to find if they are here. Others, like the small native milfoil *Myriophyllum humile* and the small bullrush *Schoenoplectus purshii* are inconspicuous plants that we might easily have overlooked.

Balancing these losses, we found 38 new wetland species. Five—creeping bentgrass, dame's rocket, purple loosestrife, spearmint, and yellow-flag iris—are aliens, and one, phragmites, is probably the alien race of a native species. All are currently scarce or rare here, but all except spearmint have a proven capacity as invasives and could easily become more common in the future.

The remaining 32 new wetland species are native and non-weedy. Thirteen are graminoids, 11 are terrestrial or emergent herbs, 5 are aquatic herbs, and 3 are woody plants.

Most, but not all of the new species are uncommon, and found in small amounts. One, the swamp beggar's-tick *Bidens connatus* was found in 8 compartments, and thus in many of the open wetlands we visited. It is a conspicuous and somewhat weedy annual; we assume that it is newly arrived, and has found conditions to its liking.

Another five species (*Cladium mariscoides, Cyperus erythrorhizos, Juncus pelocarpus, Rhynchospora fusca,* and *Utricularia cornuta*) are found in considerable abundance on the floating peat islands in Harvard Pond. All of these are technical species, but they are still distinctive plants, and would not be passed over by any botanist looking for interesting species. We suspect (p. 10) that some or all of the peaty islands may have been generated when the pond was flooded to store logs in the salvage that followed the 1938 hurricane. If so, this could be a newly created habitat that had not assembled its characteristic flora when the last survey was done in 1947.

Interestingly, two of the new aquatics, the bladderworts *Utricularia geminiscapa* and *U. radiata*, are now common in the water in between the peat islands in Harvard Pond. Previous surveys found three other bladderworts there, including the tiny *U. gibba*, but

SWEETGALE

Sweetgale is a characteristic shrub of wet peaty shores and floating mats that have been intermittently flooded. We found it to be common around Harvard Pond, which was flooded to hold salvaged logs in the late 1930s.

did not find these two. As with the plants of the peat islands, this suggests to us that some real changes in species composition have occurred.

How much have the floras of open areas changed?

Because the open areas are the most changed ecologically, their floras have changed more than those of any habitat. This change has had three components: a rearrangement of the flora as it moved from fields and pastures to roadsides and disturbed areas; a turnover of native and alien species associated with the move; and a gain in alien species that is part of a larger gain in alien species throughout the region.

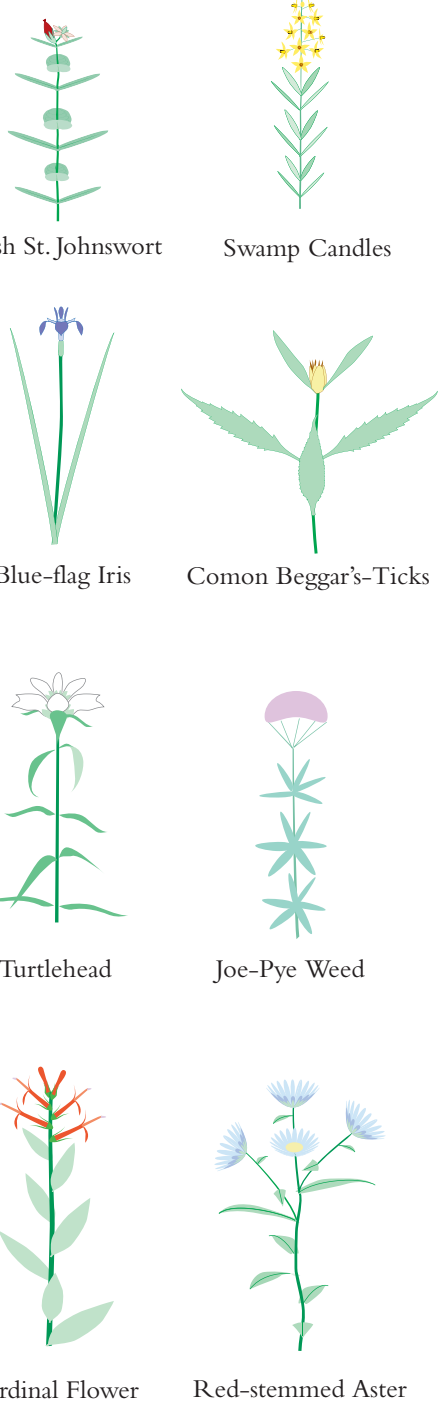
The net result of the changes has been different for the native and the alien species. The natives started with 136 species, added 25 and lost 24 and ended up about where they started. The aliens began with about 163 species, added 62 and lost 11, and ended up with 214, a third more than at the start.

It may seem surprising that there was no net loss of native species as the pastures were abandoned. Our explanation is that the native plants of pastures started off as plants of other habitats and migrated to pastures when they had the opportunity. To do this they had to be disturbance-tolerant species with good dispersal ability. Now that the pastures have gone, they have used these same abilities to move to other habitats—roadsides, gravel pits, beaver ponds, maintained grounds, and so on. Having, as it were, been preselected by their success in the first round of the habitat-change tournament, it is not surprising that they have done well in the second round as well.

The 35 missing open species are an ecologically scattered group that, saving growing in open habitats and tending to be uncommon, share few other characters. Nineteen are herbs, 8 graminoids, and 8 shrubs. Only a very few, like the slender lady's-tresses, are characteristic plants of active pastures. Several, like fireweed, gray dogwood, and the pilose and heath asters are characteristic old-field plants, suggesting that most of the fields that remained in the 1930s and 1940s were no longer used. Many of the rest, like caraway, hops, meadow fescue, and prickly ash, are opportunists and edge species. These can grow in many different habitats, and their disappearance probably has more to do with their small population sizes and sporadic appearance and disappearance than with changes in the quantity or type of habitat.

We currently list 87 new species of open ground, of which 25 are native and 62 alien. This includes about 11 alien species (red clover, English plantain, annual bluegrass, chicory …) that have been common in our region for a century or more, and were most likely

COMMON WETLAND HERBS



Some of the commonest wetland herbs at Harvard Forest. The first four are characteristic of open wetlands, though sterile plants can occur in the shade. The last four are found both in sun and in partial shade; at HF they are most common along the banks of the Swift River.

missed or overlooked by previous surveys. Removing them leaves 76 species, including 44 herbs, 22 graminoids, and 6 woody plants. They are, very uniformly, opportunistic species of disturbed and successional habitats. Some, like Morrow's honeysuckle, Japanese knotweed, and spotted knapweed, are highly invasive and have the capacity to dominate suitable habitats. Several others, like the crabgrasses and the sedges *Bulbostylis capillaris* and *Cyperus lupulinus*, are habitat specialists that can be very numerous, but only where conditions are right and competition is limited. Most of the rest, like *Oxalis dillenii, Commelina communis,* or *Rumex longifolius* are casual adventives that occur in small quantities and rarely persist for more than a few years. All are able to use relatively small patches of disturbed habitat, and all seem to be able to disperse effectively between such patches.

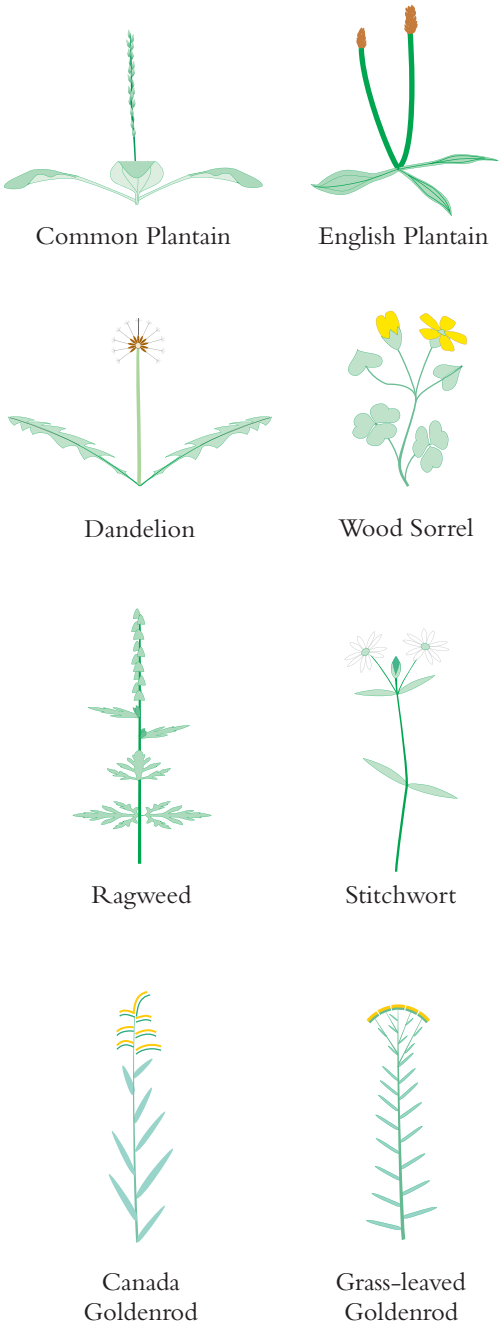
The increase in the number of alien species, even if not as great as the raw numbers suggest, is still a consequential floristic event. While we see about the same number of native open ground species as previous surveys, we see many more alien weeds. Cypress spurge, cat's ear, crabgrass, fall dandelion, Japanese knotweed, nodding foxtail, spotted knapweed, tower mustard, velvet mallow and many other familiar twentieth century weeds were not reported from HF prior to our survey.

The arrival of the new species and the redistribution of the older species from pastures to roadsides and disturbed ground has had two consequences, which can be illustrated by listing our commonest open-ground species with, as in previous tables, the number of compartments in which they are found and C.E. Smith's comments on them. An asterisk indicates an alien species.

The Commonest Plants of Open Ground

Juncus tenuis	21	"few in Slab City VIII"
Danthonia spicata	20	"common in dry areas"
Yellow Wood-sorrel	20	"occasional on roadsides and in fields"
Meadow Strawberry	19	"occasional woods"
Dandelion*	17	"common weed"
Sweetfern	16	"common in dry open ground"
Common Plantain*	16	"common in disturbed ground"
Morrow's Honeysuckle*	15	not listed
Carex normalis	15	"occasionally in moist to dry sites"
Calico aster	15	"occasional in dry open sites"

COMMON OPEN-GROUND PLANTS



Plants of disturbed open ground and successional meadows. All but the wood sorrel and the two goldenrods are aliens.

Common blackberry	14	"common in dry blow-down areas"
Self-heal	13	"common in moist open meadows, fields, and roads"
Red Raspberry	13	"common in partially shaded sites"
Arrow-leaved violet	12	"few near brook in Prospect Hill Tract" (*V. sagittata*); "occasional on dry sandy banks" (*V. fimbriatula*)
Indian tobacco	12	"common in moist woods and along roads"
Grass-leaved goldenrod	12	"occasional in moist open sites"
Spreading dogbane	12	"occasional in dry open sites"

The first consequence illustrated by this table is that our open-ground flora is no longer an alien-dominated flora of grasslands or a native tall-herb and shrub-dominated flora of rough fields and thickets. It is, instead a native low-herb and graminoid flora of woods edges and woods roads.

The second is that, despite all the new arrivals, our current open-ground flora is dominated by species that have been here for a long time. The new arrivals, though locally important in disturbed ground and along paved roads, are present in only a few compartments each and do not have much of a presence in the forest as a whole. The most common open ground species were all here by the 1930s. Some may have been uncommon then, but all had at least a beach-head from which they could expand. Apparently arriving is easier than prevailing. The newcomers, though numerous, are still mostly in the special habitats they favor, and thus far have not had much of an impact on the forest as a whole.

v CASE HISTORIES OF DIFFICULT SPECIES

What is a good species and how many of our species are good?

A good biological species, in the sense the evolutionary zoologists of the last century used the word, is unified by gene flow within the species and separated by isolating mechanisms and discontinuities in genotype and phenotype from related species. It is, in other words, continuous inside and discontinuous outside. If it is especially good it may be geographically or ecologically distinct as well, but we live in a complex world, and it is not uncommon to find closely related species whose ecologies and distributions overlap.

Depending on how hard you look at them and how widely you search for problems, at least 90 percent of our flora consists of species that are good almost everywhere. There is, for example, really no dispute about what we mean by a common horsetail, long-beaked sedge, wild geranium, wood lily, or white ash. And if we are doing a local flora and don't need to look at what the species do when they are out of our sight, 95 percent of our flora or more may be good. Many common plants like the Canada lily, sugar maple, and New York aster have taxonomic problems at the edges of their range but are well-behaved locally.

What is a difficult species?

A difficult species is either one in which there are no genetic or morphological discontinuities separating it from related species, or where the genetic discontinuities that exist are not marked by morphological discontinuities.

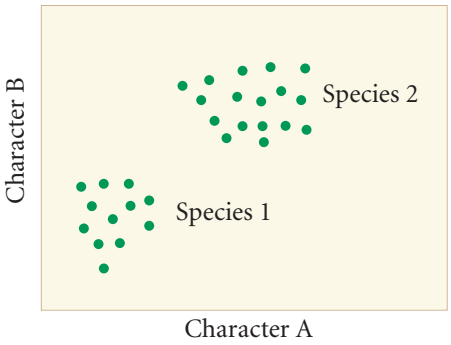
Either way, since working botanists evaluate species by morphology, for them a difficult species is one that does not have discontinuities in the variation pattern. This may arise because a the characters vary continuously, or because characters used to define the species are not stable, or because the characters mix randomly and do not form diagnostic combinations (diagrams on pp. 50-51).

What makes a species difficult?

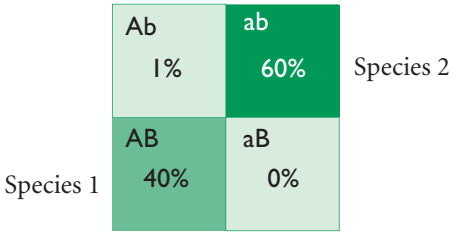
There seem to be three basic causes.

The first is that it is not really a useful species, but just a line that a taxonomist has tried to draw across a continuously varying population. The 39 species of white wood aster that E.S. Burgess described in 1906, and the hundreds of species of blackberry that W.H. Blanchard and L.H. Bailey were describing in the same period are extreme examples. But because many taxonomists like to cut their species very fine, they are far from the only examples.

TWO GOOD SPECIES SEPARATED BY CONTINUOUS CHARACTERS



TWO GOOD SPECIES SEPARATED BY DESCRETE CHARACTERS



Good species form discrete clusters in morphological space. Above, two species separated by two continuous characters; they separate clearly on Character B, more weakly on Character A. Below, the frequencies of the combinations of two discrete characters. Species 1 has the character combination **AB**, Species 2 has the combination **ab**. The intermediate combinations **Ab** and **aB**, are rare or absent, and the species are clearly separate.

The second reason a species can be difficult is that it is variable, and that its characters overlap those of other species. This is common in what we call metrical species—species distinguished from their close relatives by quantitative characters—but it occurs with discrete characters as well. It is particularly common for polyploids to overlap their diploid ancestors, and since polyploidy is common in our flora, we have many cases of this.

Variability is a tractable problem when species are distinguished by multiple characters. If, for example, you have a species pair like *Scirpus (Schoenoplectus) acutus* and *tabernaemontani* that are distinguished by five or six characters, you can treat the number of *acutus* characters as an index, and use it to name all but the most intermediate specimens. But if you have only a few characters or, worse, only one character, then any significant variability in *any* of the characters will produce intermediate states that you can't name.

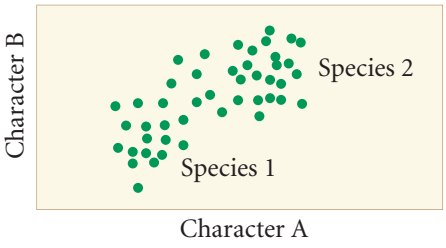
The third reason that species can be difficult is that they may not in fact be fully separate. Closely related plant species are commonly interfertile and form species complexes of hybridizing and overlapping species. When, as commonly happens, interfertility is combined with polyploidy and asexual reproduction, complexes may include both widespread sexual forms and local asexual forms, and be almost impossible to divide into species in a conventional way. Such complexes are common in the rose family—H.A. Gleason said that "species in the ordinary sense" scarcely existed among the blackberries—but occur in a number of other groups as well.

In addition to the intrinsically difficul species of the sort just discussed, there are others that are practically difficult, either because fruiting material is rarely collected, or because many individuals don't fruit at all. In this survey, for example, we found many hawthorns, shads, chokeberries, azaleas, and woodbines in forest understories that were not fertile and could not be determined with certainty. We determined fruiting plants when we saw them, but still have the ecologically unsatisfying situation that there were more individuals that we couldn't determine than that we could.

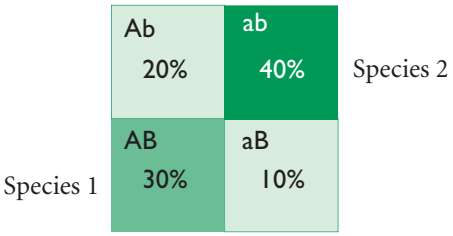
How did you evaluate difficult species?

When we had enough material, by the method described on p. 28. We gathered population samples, scored or measured them, graphed the results and looked for discontinuities in the variation pattern. When the characters varied continuously, we looked to see if the scatterplots of characters formed clusters. If they did, we assumed we had potentially useful species. When they were discrete we made a matrix of character states, and looked to see how many of the states were populated. If only separated states were

BAD SPECIES WITH OVERLAPPING VARIATION

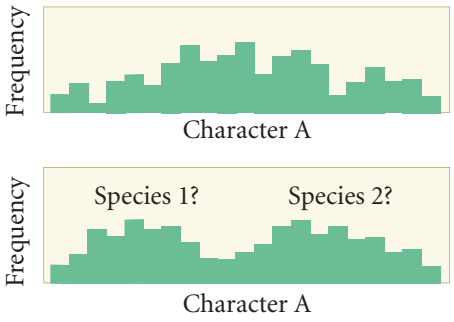


BAD SPECIES WITH POORLY CORRELATED CHARACTERS



The variation patterns of bad species. Above, two continuous characters, some values of which could belong to either species. Below, two species defined by discrete characters in which the characters aren't well correlated and intermediate character combinations are common.

ONE-CHARACTER SPECIES



One-character species are always suspect. The top histogram shows continuous variation in the character A; we could divide this variation into two groups but the groups would be meaningless. The lower histogram shows two peaks that might be species or just two states of a single gene; without other characters we have no way of telling.

populated then again we had potentially useful species. If many adjacent states were populated, we had some more complex variation pattern, which might or might not be resolvable into species.

Two things are worth noting about this method. The first is that it tells you nothing about the underlying genetics. Plants like the red oak and black oak, which are interfertile, may still have stable enough character combinations to be practically useful species. Species like the Appalachian and Virginian polypodies, which are genetically separate, may overlap too much to be useful species.

The second is that as noted above, when a species pair is separated by only two or three characters, it doesn't take much variability to blur the species lines badly. If, as in the example at right, two species are separated by two characters, and each character varies from the norm for its species about 10% of the time, a mixture of 50% of species A and 50% of species B will contain 41% plants that are clearly A, 41% that are clearly B, and 18% intermediates. Intermediates, in other words, will be about half as common as either of the parental species, and the species lines will likely be hopelessly blurred in the field. Because many plants vary, this suggests that it is true, at least as a first approximation, that many or most few-character species will be difficult.

The lesson to take from this discussion is that there are many reasons for a species to be difficult, and so in most floras there are many difficult species.

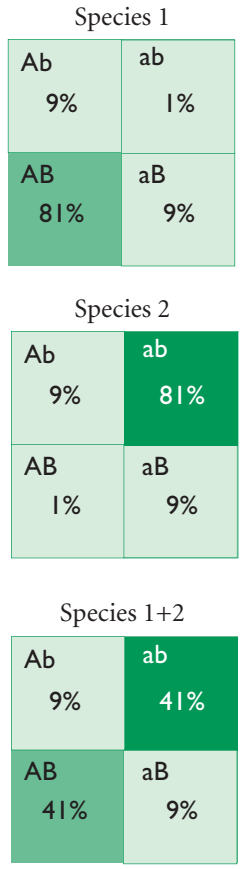
Is it possible to evaluate one-character species morphologically?

Not really, and this is why many taxonomists try to avoid recognizing them. All species have variable characters, and so there is really no way of telling whether such a character marks the genetic boundary between two species or is simply the consequence of one or two genes that vary within a species. If we have independent genetic evidence, as we do for *Dryopteris intermedia* and *D. carthusiana*, we may be able to show that the single character marks the species boundary. But if, as with the beak-length difference between *Carex pensylvanica* and *Carex lucorum* or the leaf shape difference between *Anemone (Hepatica) acutiloba* and *americana*, we know nothing of the genetics, we really have no way of telling what, if anything, the differences mean.

Are there fewer difficult species in local floras than in regional ones?

Probably there are, but it is hard to be sure because two competing processes are involved. A local flora can ignore the problems that occur at the range-limits of species. We don't have to worry, for example, about whether our northern wild-raisins are separate

HOW VARIATION OBSCURES SPECIES LINES



The boundaries of few-character species are easily obscured by small amounts of variation. In this example, Species 1 is defined by two characters (**AB**) that vary 10% of the time, producing combinations **Ab**, **aB** and rarely **ab**. The top figure gives the observed frequencies of the character combinations for a pure population of Species 1, and the middle figure the observed frequencies for a pure population of Species 2 (**ab**), also with 10% variation.

The lower figure shows the frequencies that would be found in a mixed population of 50% Species 1 and 50% Species 2. Now intermediates (**Ab**, **aB**) that could not be assigned to either species make up 18% of the population. This is an unacceptably high percentage of undeterminables for an ecological survey, and we would probably choose to lump the two species to reduce the error rate.

DIFFICULT SPECIES IN THE HARVARD FOREST FLORA

One-Character Species

Anemone americana, acutiloba
Carex lucorum, pensylvanica
Carex appalachica, radiata
Carex virescens, swanii
Dryopteris carthusiana, intermedia
Echinochloa crus-galli, muricata
Hieracium caespitosum, piloselloides
Prenanthes alba, trifoliolata
Triadenum fraseri, virginicum

Interbreeding Complexes

Amelanchier stolonifera, spicata, sanguinea, canadensis
Antennaria neglecta, plantaginifolia, others?
Apocynum androsaemifolium, cannabinum, sibiricum
Botrychium dissectum, oneidense, multifidum?
Crataegus spp.
Dichanthelium acuminatum, ssp. columbianum, fasciculatum, implicatum, spretum
Lycopodium dendroideum, hickeyi, obscurum?
Rosa blanda, carolina, nitida, palustris, virginiana
Rubus alleghaniensis, pensylvanicus, canadensis, etc.
Taraxacum officinale, etc.
Viola cucullata, palmata, sagittata, sororia, etc.
Viola blanda, incognita, macloskeyi, renifolia

Introgressive Hybridization

Acer rubrum, saccharinum
Alnus incana, serrulata
Amelanchier arborea, laevis
Aronia arbutifolia, melanocarpa
Dichanthelium depauperatum, linearifolium?
Picea mariana, rubens
Quercus coccinea, rubra, velutina
Rhus glabra, Rhus hirta
Scirpus atrocinctus, pedicellatus, cyperinus
Spiraea alba, latifolia
Sisyrinchium atlanticum, montanum?
Typha angustifolia, latifolia
Malva cf. moschata, alcea
Viburnum cassinoides, nudum
Viburnum dentatum, recognitum

Polyploid Complexes
Asplenium trichomanes
Cystopteris fragilis, tenuis
Polypodium appalachianum, virginianum
Vaccinium angustifolium, boreale, pallidum
Vaccinium corymbosum

Few-Character Species

Agrostis hyemalis, scabra
Aster lanceolatus, racemosus
Aster lateriflorus, ontariensis
Aster novi-belgii, varieties.
Carex albicans, varieties
Carex crinita, gynandra
Carex cryptolepis, flava
Carex normalis, projecta, tribuloides
Carex rosea, radiata
Carex rugosperma, tonsa
Caulophyllum giganteum, thalictroides
Eleocharis elliptica, tenuis
Eleocharis obtusa, ovata
Epilobium ciliatum, coloratum
Eragrostis pectinacea, pilosa
Festuca ovina, trachyphylla
Eupatorium dubium, maculatum
Lycopodium clavatum, lagopus
Mentha arvensis, canadensis
Oenothera biennis, parviflora
Potentilla canadensis, simplex
Schoenoplectus purshii, smithii
Scirpus atrovirens, georgianus, hattorianus
Solidago altissima, canadensis
Sphenopholis intermedia, obtusata
Torreyochloa fernaldii, pallida

Polymorphic Species

Arisaema triphyllum
Vitis aestivalis

Genera With Large Sterile Populations

Amelanchier
Aronia
Crataegus
Iris
Parthenocissus
Rhododendron

from the southern black-haw, or whether our goldthread is the same as or different from the goldthread of Europe. But, by the same token, a local flora may have to solve problems that can be ignored in a regional one. All our cattails, for example, may turn out to be hybrids. Our *Carex virescens,* in contrast, may be genetically pure but undersized and so overlap *Carex swanii.*

Approximately how many difficult species are there in the Harvard Forest flora?

We do not know exactly. The table on the preceding page contains an approximate tabulation. Over 100 taxa in the flora—12%— have close relatives in our immediate region from which they must either be distinguished, or with which it may be reasonable to combine them. Not all of these close relatives occur at Harvard Forest. But still over 70 taxa, or about 9% of the flora, have one or more close relatives here, and so belong to a difficult group.

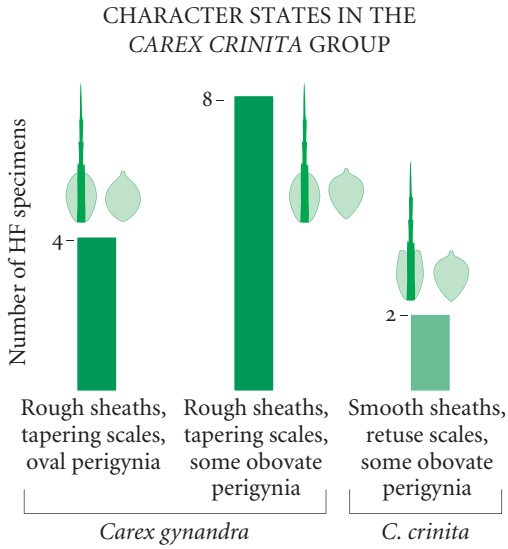
Both as a guide to some of the problems in our flora, and as an illustration of our taxonomic and graphical methods, we present several case-studies below. We caution that all of these studies are brief, that they were done incidentally to our main survey project, and that studies of more plants or different areas might yield different results.

1 Barely Separable Species in Sedges

Many of our sedge species are separated by very small differences, and so may be called microspecies. In many cases these have been found to be stabilized by small chromosomal differences that create sterility barriers. In *Carex*, for example, many species hybridize within their groups, but the hybrids are commonly sterile.

Carex crinita and *Carex gynandra* are closely related taxa, formerly treated as a single species and now, following the work of Lisa Standley (1983), generally treated as two species. They are said to be separated by three characters: the roughness of the lower sheaths, the shape of the body of the pistillate scales, and the shape of the perigynia. They tend to have different ecologies, with *gynandra* in peaty and upland situations and *crinita* in lower and more fertile ones. The characters seem to work consistently in the field, and most botanists seem comfortable with the separation.

Our comparison of a dozen HF specimens collected over a 70-year period suggests that the confidence is warranted but that the perigynia shape may not be a reliable distinction. Our common plants seem to be *gynandra*, as expected from the habitat here. Rough sheaths and tapering scales are well correlated, but more



of our *gynandra*-like plants have oboval perigynia, which they shouldn't, than oval ones, which they should.

Another closely related sedge group is the *Scirpus cyperinus* complex, usually treated, following Albert Schuyler (1967, 2002). Two species, *S. atrocinctus* and *S. cyperinus,* are common in our area. According to Schuyler they hybridize freely but the hybrids are sterile or have reduced fertility and may complicate identification but do not obscure the basic species lines.

Once again that seems to be the case at HF. Comparing 16 herbarium specimens, again from a seventy-year period, *Scirpus atrocinctus* had more consistently stalked spikelets, darker pistillate scales, and bloomed earlier and had dispersed nearly all of its seeds by August 1. *S. cyperinus* had mostly unstalked spikelets, often lighter or browner scales, and did not have mature achenes until about August 14. We found no intermediate specimens in our collection, and think that these two are both morphologically and ecologically distinct here.

The same can not be said, however, for the third member of the group, *S. pedicellatus*, said to be like *cyperinus* (and to hybridize with it). The *Flora of North America* attempts to distinguish them with what must be one of the most uninformative key couplets ever written:

> Spikelets in open cymes, central spikelet of each cyme sessile, others usually pedicellate; scales usually pale brown, black pigment absent (sometimes a little beside the distal midrib); achenes maturing July ..... 17. *Scirpus pedicellatus*
>
> Spikelets in cymes of 2–15, central spikelet of each cyme sessile, others sessile or pedicellate; scales reddish brown, brownish, or blackish; achenes maturing Aug–Sep ..... 18. *Scirpus cyperinus*

About all that it is possible to take from this is that *pedicellatus* always has some stalked spikelets, blooms earlier than *cyperinus*, and has paler scales. The first two are also true for *atrocinctus*, so all we end up with is that *pedicellatus* has paler scales than either of its relatives.

This of course is not much in a difficult group and Schuyler concedes in his *Flora of North America* account that it is "often difficult to identify isolated herbarium specimens with confidence." We concur. We have one or two herbarium collections from HF that might be *pedicellatus* but no populations to go with them. And since, for ecological work, we need to be able to identify our species with confidence and point to the population from which they came, we don't regard these as sufficient evidence that *Scirpus pedicellatus* exists here.

A number of other microspecies of sedges occur or have occurred at HF: *Carex albicans, appalachica, atlantica, cryptolepis, laxiflora, leptonervia, lucorum, radiata,* and *rugosperma* are familiar examples, as are *Schoenoplectus purshianus* and *Scirpus hattorianus.* In some cases (*Carex appalachica* and *laxiflora* groups, *Scirpus hattorianus*) where we have adequate material, our field work suggests that the species are fairly reliable. In others like *Carex albicans* they may not be, but we lack the material to investigate.

2 Elusive Polyploid Species in Ferns

Many plant groups have evolved by mixtures of hybridization and chromosome doubling (which is a way of escaping hybrid sterility), and so it is very common for there to be several chromosome numbers within a single species or a group of related species. Such polyploid complexes invariably present taxonomic problems because they don't divide well into biological species. Biological species are supposed to be interfertile, and to be interfertile plants must have the same chromosome number; by a strict application of this rule many common species like heart-leaved aster and highbush blueberry are not species. But species are also supposed to have diverged from their relatives, and by this rule two populations with different chromosome levels that are not otherwise different can't be different species.

Taxonomists in different groups have dealt with the problem differently. In the species-rich and highly polyploid aster and rose families, taxonomists routinely accept species with two or more chromosome levels. In the ferns, which are less species-rich and in which polyploidy is less pervasive, taxonomists have tended to take the discoveries of new polyploids as equivalent to the discovery of new species.

As a result, we now have a number of closely related diploid-polyploid species pairs in the northeastern fern flora: *Dryopteris intermedia* and *carthusiana, Polystichum acrostichoides* and *braunii,* and *Thelypteris noveboracensis* and *simulata* are familiar examples that have been around for a while. *Adiantum pedatum* and *viridimontanum, Cystopteris tenuis* and *fragilis,* and *Polystichum appalachianum* and *virginianum* are more recently described examples that are all treated as species in the *Flora of North America.*

The question about these pairs is not whether they are genetically isolated—that is given—but whether they have the morphological and ecological distinctness to make good species in the ecological sense. Some, like the two *Thelypteris* and the two *Polystichum* have clear morphological differences and separate habitats and ranges and clearly do. Others, like the two *Dryopteris*, which overlap in habitat and are separable from each other only by their glandularity, are at the low end of what we are willing to call eco-

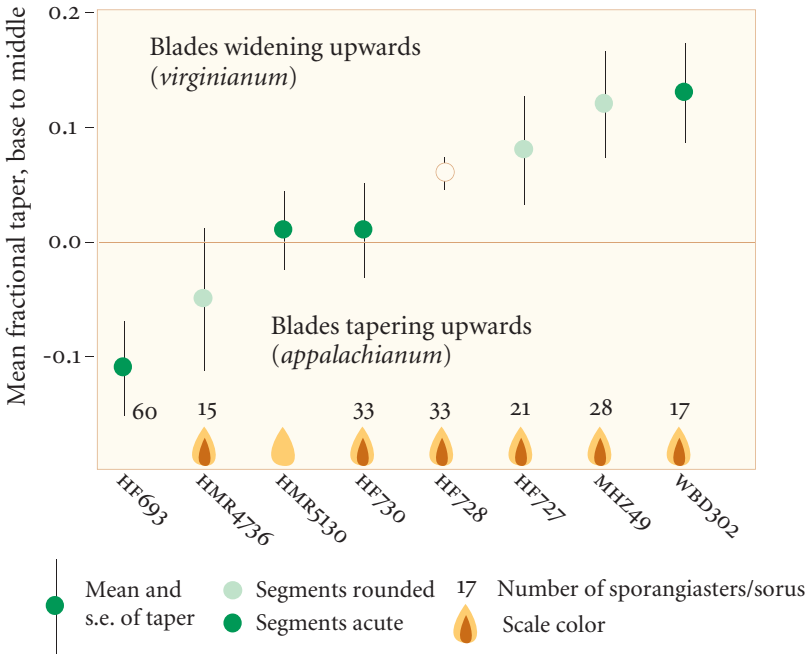
logically useful species. And some of the new ones, particularly the two fragile ferns and the two polypodies, may not be reliably distinguishable and so may not be useful species in our sense.

Fragile fern is rare at HF and we didn't have the material for a population analysis. Jerry Jenkins took a population sample a few years ago from Bartholomew's Cobble in southwestern Massachusetts and found that the population there was intermediate between the two alleged species. The characters supposed to separate *C. fragilis* and *C. tenuis* did not associate reliably, and when plants were scored on a morphological scale with 0 being *fragilis* and 1 being *tenuis*, most came out between 0.4 and 0.6.

The two polypodies are said to differ in four characters, as shown in the table on this page. If these characters associate the way they are supposed to, then plants that widen upward should be *P. virginianum* and have rounded segment tips, scales with dark centers, and fewer than 40 sporangiasters. The ones that taper upwards should be *P. appalachianum* and have uniform scales, sharp segments, and more than 40 sporangiasters.

Unfortunately, as the graph of eight HF samples shows, these characters aren't strongly associated. The taper varies more or less continuously, the scales don't vary much at all, and the leaf tips vary but are not correlated with the taper. We have two plants (HF727, MHZ49) whose characters fit *P. virginianum*, and one plant (HF693, far left) whose characters fit *P. appalachianum*. The other five mix the alleged characters of the two species in a disconcerting way.

TAPER AND SHARPNESS OF POLYPODY LEAVES



CHARACTERS IN POLYPODY

	appalachianum	*virginianum*
rhizome scales	uniform golden	dark center
leaves	tapering upwards	widest near middle
segment tips	narrow or sharp	rounded
sporangiasters	>40	<40

Character combinations in *Polypodium,* from eight specimens in the Harvard Forest herbarium. Tapers vary from positive (widening from base to middle) to slightly negative. The taper does not associate with the scale color, or the sharpness of the leaf tips. The number of sporangiasters (glandular hairs within the sori) is below 40 in all specimens but HF693, which also had the greatest upward taper.

Although these are small studies and larger samples might change the results, there still seems to be a lesson: polyploid species can be strong in genetics but weak in morphology and, whatever their merit as biological and evolutionary units, can vary in ways that make them unusable in ecological studies.

3 Metrical Species in Sedges and Grasses

In many of the technical groups much of the variation between species is in the size and number of plant parts. We call such species metrical species. *Aster lateriflorus*, distinguished from its relatives by the more deeply lobed disk corollas, is a metrical species; *Triadenum fraseri*, distinguished from the almost identical *Triadenum virginicum* by slightly smaller sepals, styles, and pods, is another one. Metrical species occur in all groups. They are partic-

ularly common in groups like the grasses, sedges, and composites where the flowers all have a common plan and are made from small repeating units.

In some metrical species the variation is discontinuous; the species are, in effect, islands in some space defined by the relevant measurements. All we have to do to identify them is to figure out which island we are on; the measurements are, in effect, simply coordinates that enable us to look up the name of the island.

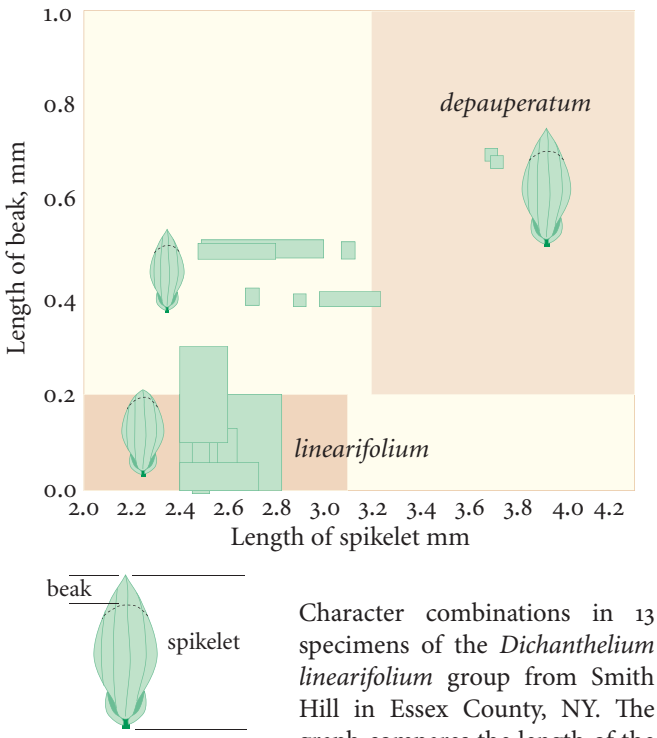
Most metrical species, however, vary continuously. In these cases the species do not have sharp boundaries; we have instead centers of variation, which we may visualize as densely populated regions of the measurement space, and overlap regions which may be occupied, we hope sparsely, by several species.

There is nothing conceptually difficult about metrical species, and in some ways they are rather attractive. It is, after all, comforting that you can pick out, say, *Aster racemosus* or *Carex baileyi* using nothing more than a ruler. But they do pose some practical problems, and these sometimes need careful study.

The commonest is that when you plot your measurements you may not hit an island—a named taxon—at all. You may instead land in between taxa, or someplace out at sea where no species are supposed to be.

This may happen for any of several reasons. Your plants may be hybrids, or odd variants. Or they may be a nonrepresentative population, whose measurements, under the influence of local ecological conditions, differ from the regional norm.

Such shifts, we have come to believe, are common. To a monographer they represent minor variants or outliers that add a percent or two to the standard deviation. To a botanist doing a local flora who sees nothing but unclassifiable variants, they can be a stubborn problem that refuses to be averaged away.



Character combinations in 13 specimens of the *Dichanthelium linearifolium* group from Smith Hill in Essex County, NY. The graph compares the length of the whole spikelet to the length of the beak. The shaded rectangles are the bounds for the two species given by the *Flora of North America,* and the green squares are the range of measurements obtained from individual plants.

We give two examples of local populations that refuse to conform to regional expectations. The first is from two common species of panic grass, *Dichanthelium linearifolium* and *D. depauperatum*, that occur in barren rocky or sandy places. They are supposed to be easy to distinguish, and in many places they are. One has big pointed spikelets with a long beak, and one has smaller rounded spikelets with a short one. But in many other places, including HF, they fit less well. The graph shows the distribution of one population from a rocky hillside in Essex County, New York. The shaded areas are where the measurements are supposed to fall. Two plants were clearly *D. depauperatum,* five were clearly *D. linearifolium,* and six were like *linearifolium* in size but had longer and sharper

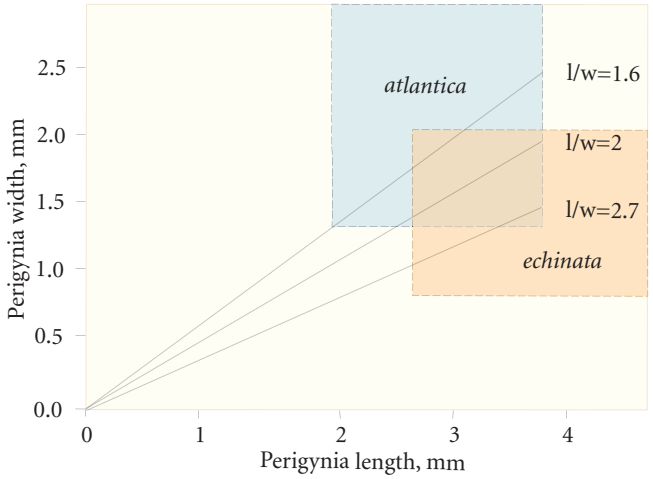
beaks than it was supposed to. They may have been hybrids or environmental variants; whatever they were, they made up about half of all the plants we measured, and effectively prevented us from distinguishing the two species reliably.

The second example is a sample of *Carex atlantica*, a species of the section Stellulatae. The species of the Stellulatae are superficially very similar; they were first really sorted out by A.A. Reznicek and P.W. Ball in a 1980 study that is still a model of how to deal with a continuously varying, metrical group. We have two species, *C. atlantica* and *C. echinata* at HF. Neither is common and neither seems to present great problems here. The graph at right shows the basic situation. The perigynia of *atlantica*, whose measures are supposed to fall in the blue square, tend to be shorter and wider than those of *echinata* and have a longer length-to-width ratio. Their beaks (not shown) are also shorter relative to their body length.

At several high-elevation, acid ponds in southern Vermont, the plants of this group have always been difficult to place. The scatterplot at the lower right, giving the measurements of 20 perigynia from each of three ponds, shows the reason. The measurements from the three ponds each form a cluster with a slightly different mean, suggesting that there is local variation in metrical properties from pond to pond. The measurements and their means are all within the overlap zone of length and width, and near to or within the lines l/w=1.7 and l/w 1.9 which, in theory, mark the lower boundary of *atlantica* and the upper boundary of *echinata*.

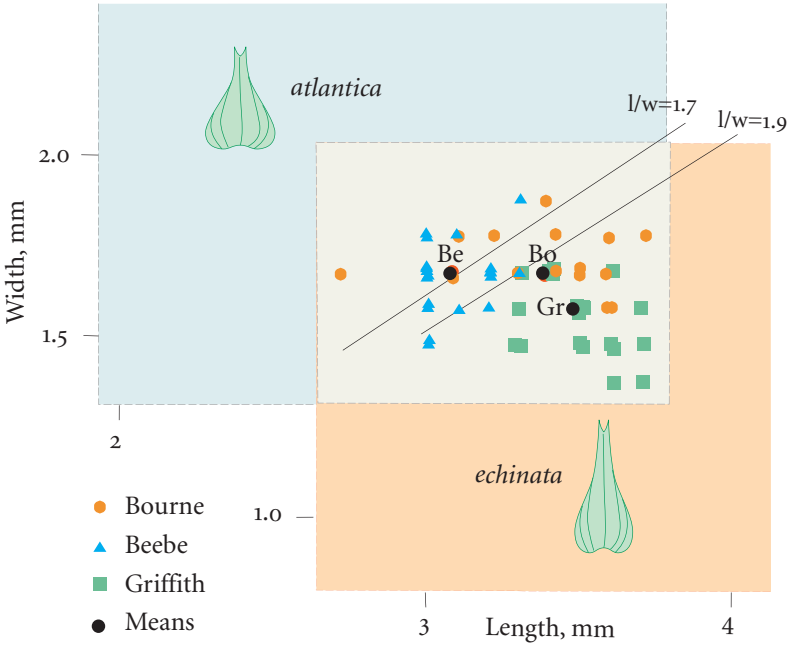
The lesson from these examples is simple. Species that are well understood regionally can have local metrical variants. When your local population is one of those variants, you may not be able to determine which species you have. And when this happens, it probably doesn't matter what species you call it, but it does matter that you recognize that the situation is atypical, and not try to describe more species than your population actually contains.

PERIGYNIA MEASUREMENTS IN *CAREX ATLANTICA* AND *ECHINATA*

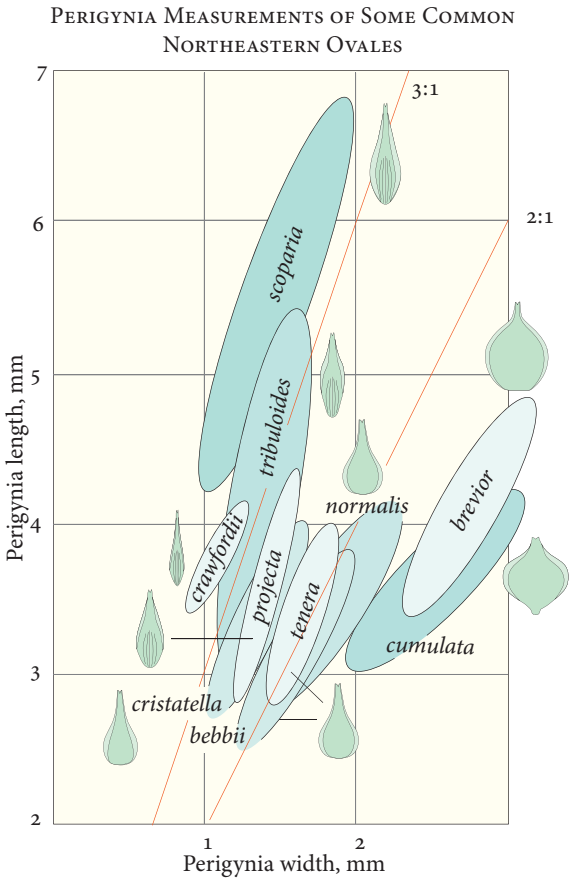


According to Reznicek & Ball (1980), the perigynia of *Carex atlantica* are, on average, slightly shorter and distinctly wider than those of *Carex echinata.* There is, however, a significant overlap in both length and width, shown as a gray area on the chart.

CAREX ECHINATA GROUP FROM 3 VERMONT PONDS



Measurements of individual plants and population means for three populations of plants in the *Carex echinata* group from southern Vermont. All fall in the overlap zone.



4 Metrical Complexes

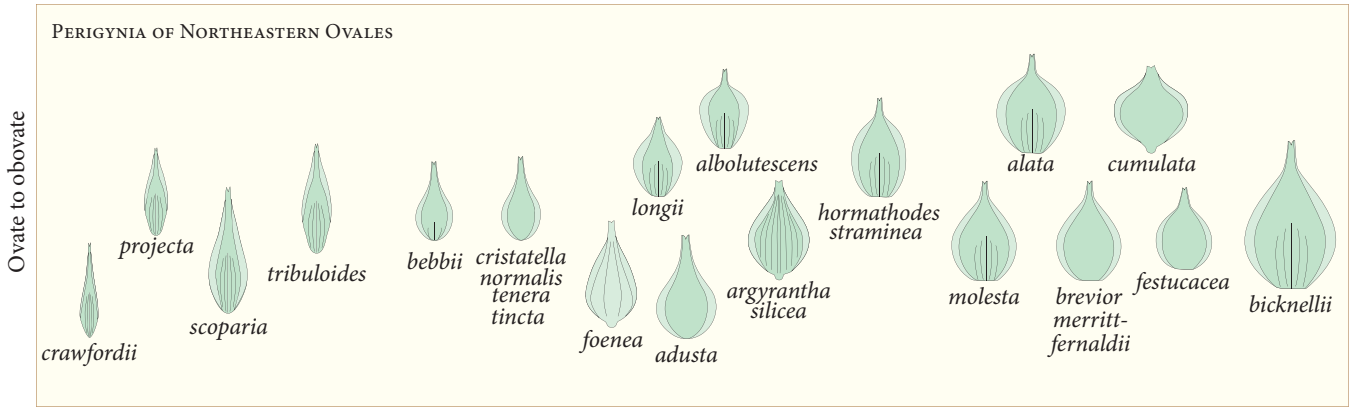
Thus far we have dealt with pairs of metrical species. But metrical species also come in larger groups, and these can present special problems. The most famous of these, and surely among the most difficult groups in our flora, are the panic grasses and the ovalean sedges. Both have been extensively studied, and in both the problems are now well understood. We illustrate the situation with the Ovales here.

The Ovales is a section of *Carex* with flattened, winged, perigynia and male flowers at the bottom of the pistillate spikes. There are over 20 species in our region and about 8 in our area, making it the largest section of the largest genus in our flora.

Ovales have traditionally been identified by quantitative binning; in theory, by measuring the sizes of the leaves, perigynia, and achenes, and noting the shape of the inflorescence you can come out with a name. In practice, this sometimes works quite poorly because, as the figures show, the measurements of many of the species overlap. Thus the *Flora of North America* distinguishes *C. tenera* and *C. normalis,* two of the common species at HF like this:

The perigynia shapes and overlap in perigynia and leaf measurements of some common species of the Ovales. The measurements are taken from the *Flora of North America*. The perigynia measurements are represented as lying in a Gaussian ellipse bounded by the typical range given in the *FNA*. This captures the central tendency of the distribution, but not the possible extremes.

The graphs illustrate the difficulty of identifying species in this group with metrical characters. Six out of the 10 species in the left diagram can have perigynia widths between 1 and 2 mm, perigynia widths between 3 and 4 mm, and length to width ratios between 2 and 3. Seventeen of the 22 species in the second diagram can have leaf widths between 3 and 4 mm.



Perigynia shapes of northeastern Ovales, showing the similarity in the forms of many species. Species with similar perigynia have to be identified by small differences in the nerves and wings of the perigynia, or by leaf and sheath characters. Sometimes these suffice, but all characters in this group are variable and sometimes they don't. In practice, the species, rather than being peaks in morphological space, are low hills. Specimens that fall on a hill can generally be identified. Those that fall between them can't be.

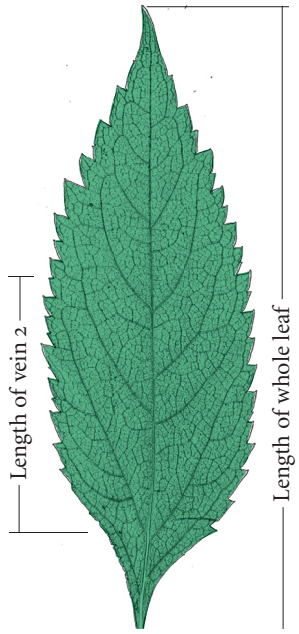
Inflorescence erect to somewhat bent; proximal internode mostly 6–10(–11.5) mm; rachis stiff; leaves 2.2–6.5 mm wide; larger perigynia mostly 2.7–4.1 mm and 1.8–2.2 times as long as wide; plants forming small, ± erect clumps of fewer than 40 culms ....153. *Carex normalis* (in part)

Inflorescence arching nodding; proximal internode mostly 6–(10–21.5) mm; rachis usually thin, wiry; leaves 1.5–3.5 (–3.7) mm wide; larger perigynia mostly (3.4–)3.6–4.6 mm, (1.9–)2.1–2.8(–3.2) times as long as wide; plants often forming large, spreading clumps of many culms.....152. *Carex tenera* (in part)

When you consider the overlaps in the characters, realize that these species not only have to be distinguished from one another but from other closely related species, and note that the somewhat difficult couplet just cited is only one of five in the *Flora of North America* key in which one or the other of these species are mentioned, it becomes clear that this is not an ordinary group and can not be dealt by the usual combination of keying and character recognition.

Just how you deal with them will depend on your goals and the resources you have available, and on how important it is to you to confront the problem. Since they were a consequential part of the HF vegetation (1% of our flora, and locally common on forest roads) we wanted to give as good an account of them as we could. We recognized that the species boundaries were uncertain, and that we would have to give them arbitrary limits if we were going to use them in survey work. We first collected as many specimens as possible, then measured them and grouped them according to the measurements in the *Flora of North America* treatment. We verified the identifications of each group by comparing them to specimens that had been determined by an authority on the section. We then set quantitative boundaries to each group based on the variation we saw in the collections, named as many specimens

JOE-PYE WEED



A leaf of joe-pye weed, *Eupatorium maculatum* sensu lato, showing the strong second veins found in the lower leaves of many plants. The ratio of the length of this vein to the length of the whole leaf is a gradational metric character; it varies both within individuals and between populations.

as we could using these boundaries, and left the ones that fell on or across the boundaries. Thus we decided, for example, that when other characters were ambiguous, plants whose perigynia were twice as long as wide would be called *normalis*, plants whose perigynia were three times as long as wide would be called *projecta*, and plants in between wouldn't be named.

5 Gradational Species

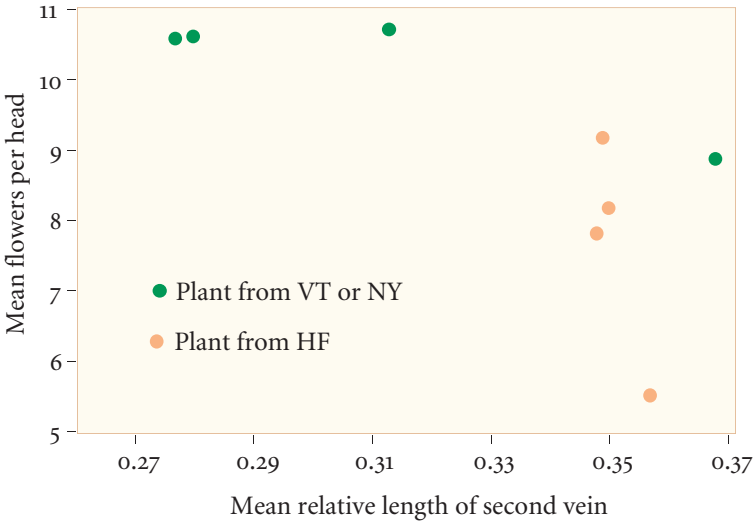
Many species of wide geographic range vary from one part of their range to another. The highbush blueberry is tetraploid and largely blue-fruited in the north, blacker and more commonly diploid in the south. The rough-stemmed goldenrod is long-leaved and long-haired in our range, short-leaved and with short rough hairs on the coast. The formation of gradients like these is thought to be a basic evolutionary process, leading to closely related species pairs like the red and black chokeberries, the beaked and American hazelnuts, the red and black spruces, the black and yellow birches, and so on.

The problem for field biologists is that species lines in plants are often weak, and that many of these pairs of species have overlap zones where intermediate populations occur. Thus intermediate spruces occur commonly around peatlands, and intermediate chokeberries are found over a large part of the Northeast.

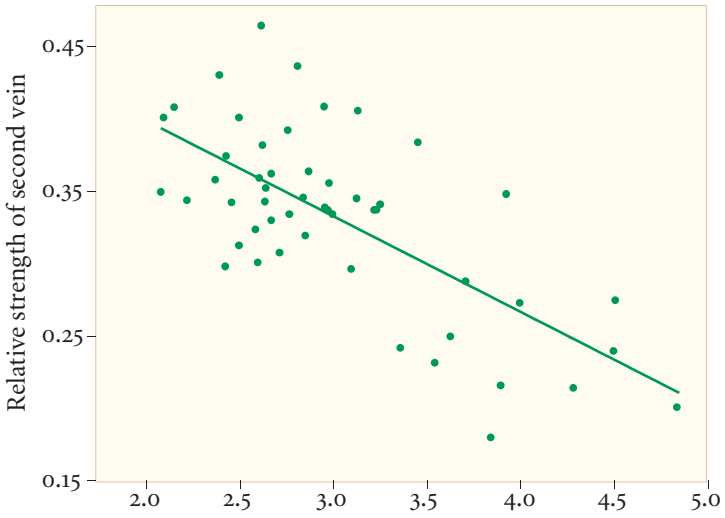
When these intermediates are common they present two taxonomic problems. The larger problem, which can't be solved in a local study, is whether the species involved are really separate or not. Are the red and black spruce, the smooth and speckled alders, and the smooth and downy arrowwoods each single species or species pairs? Currently most botanists say yes for the spruces, no for the arrowwoods, and maybe for the alders.

The smaller problem, which can be solved in local surveys, is how many separable populations occur in the survey area. We have decided, somewhat arbitrarily, that we have one alder, two spruces, and possibly two chokeberries, though until we see fruiting plants we can't tell for certain.

EUPATORIUM MACULATUM GROUP: RELATIVE LENGTH OF VEIN 2 VS. NUMBER OF FLOWERS



EUPATORIUM MACULATUM GROUP: STRENGTH OF SECOND VEIN VS. LENGTH-TO-WIDTH



Metrical gradients in the *Eupatorium maculatum* group. The average number of flowers per head and average strength of the second vein vary between inland and HF populations. The relative strength of the second vein is also anticorrelated with the leaf length-to-width ratio.

The same general methods that we have used for other groups can be used to investigate gradational species. Here is an example, inconclusive but interesting, for a gradational herb.

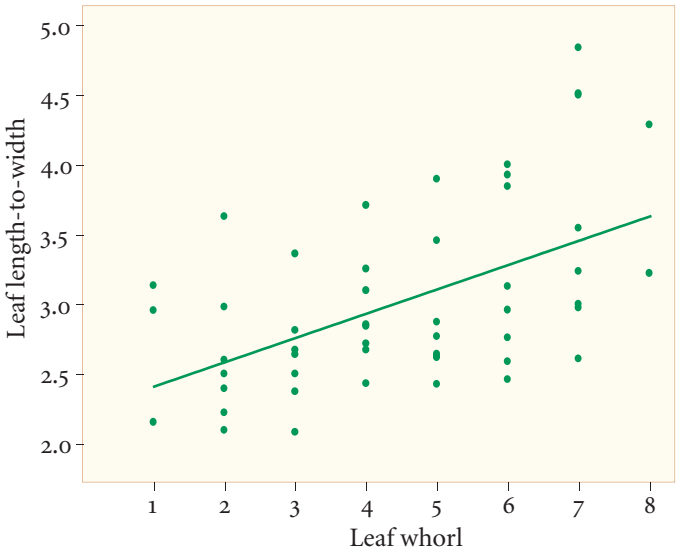
The joe-pye weeds, *Eupatorium maculatum* and *dubium*, may be two closely related species or a single gradational one. The inland *maculatum* is supposed to be distinguished from the coastal *dubium* by having more flowers per head and relatively weaker second veins in the leaves. We did a small study (four plants from Vermont and New York and four from HF), cut short by frost, and found that the means were different but that individual measurements overlapped greatly. We could in general tell the Vermont and New York plants from a HF one, but we could in no way tell a Vermont or New York leaf or a flower head from a HF one. The plants, it appeared, were different, but the simple statements in the keys that the eastern plants were triple-nerved and had more flowers than the western ones was clearly not true.

When we looked into how this worked, an interesting situation appeared. First, the relative strength of the leaf veins was, it turned out, correlated with leaf shape, measured as the ratio of length to width. Relatively short leaves had relatively strong veins. Second, the leaf shape varied systematically from the bottom to the top of the plants. All plants, HF and western, had short leaves with strong veins at the bottom of the plants.

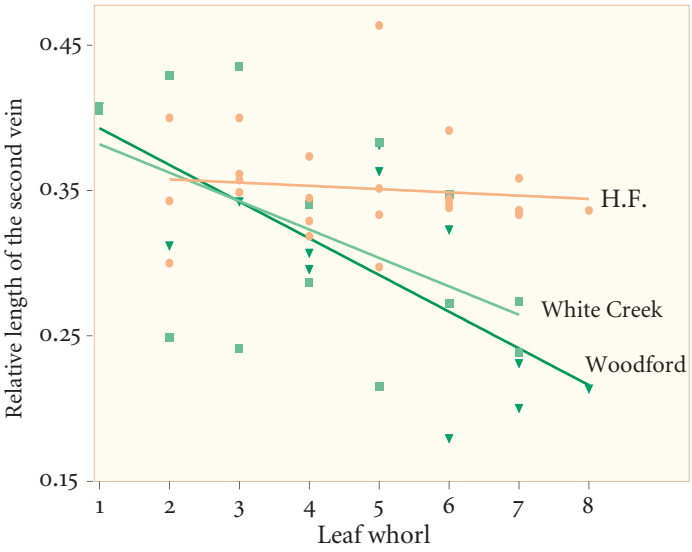
Third, and this was the key to the situation, the way that leaf shape and hence vein strength decreased as you went up the plant was different for the two groups of plants. In the western plants it decreased quickly, in the HF plants more slowly. Thus both HF and western plants had strong three-veined leaves at the bottom of the plants; where they differed was in how high you had to go before you stopped seeing them.

It will take more investigation to determine whether these differences hold true in other populations, and whether eastern and western plants blend in the middle or remain separate. But what our little study has showed is that the situation is more complicated, and perhaps less convincing, than the books make it. If we say to you that one plant has strong veins and another doesn't, that sounds very clear. But if we say to you that both have strong veins at the bottom of the plant and one becomes less strong less rapidly, that is much less clear, and possibly less significant as well.

EUPATORIUM MACULATUM GROUP: LEAF LENGTH-TO-WIDTH VS. HEIGHT ON PLANT



EUPATORIUM MACULATUM GROUP: RELATIVE LENGTH OF 2ND VEIN VS HEIGHT ON PLANT



Allometric relations in the *Eupatorium maculatum* group. The length-to-width increases from the bottom of the plant to the top. In consequence, the strength of the second vein decreases from the bottom to the top. Strong second veins were found at the bottoms of all the plants we sampled. In the HF plants they decreased slowly with height; in the inland plants they decreased more rapidly. The plants did not differ qualitatively but rather allometrically; they all possessed strong veins, but differed in the way these veins varied.

Interbreeding complexes are groups of interfertile species in which there are at most partial barriers to gene flow. In such groups hybrids are common. In some cases, they are partially sterile; in others they can reproduce apomictically, and in others they are fully fertile, and can cross with their parents and with each other.

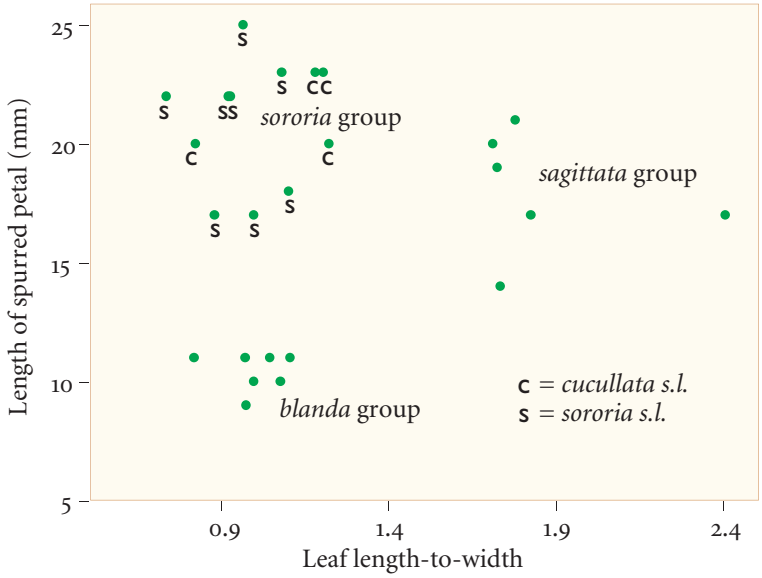
Hybrid complexes are relatively frequent. Wide hybridization, which frequently produces hybrid populations but doesn't really obscure the species lines occurs, among others, in willows, oaks, bush clovers, and asters. More general hybridization, which has so blurred species lines that it is difficult to tell what is a species and what is a hybrid, has occurred in panic grasses, roses, sunflowers, and violets. And a mixture of hybridization and microspeciation, involving polyploidy and the apomictic reproduction of sterile hybrids, occurs in blackberries, hawthorns, shadbushes, cinquefoils, pussytoes, dandelions and a number of other genera.

The occasionally-hybridizing groups present few basic problems, as long as you remember that there are going to be intermediate populations that will be difficult to name. Hybrids and hybrid populations are common, for example, in willows and asters, but the basic species lines still appear to be pretty much what the books say they are.

The situation is different in the more thoroughly hybridized groups like roses, shadbushes, and violets. In these groups the characters associate very freely. If you take, say, the four basic characters used to define rose species and look around long enough, sooner or later you will find a rose with every possible combination of these characters.

The problem in an ecological survey is to avoid doing this; what you need to know in an ecological survey is not how many different character combinations occur in your flora, but how many occur frequently enough that they represent important elements of the flora.

MEASUREMENTS OF STEMLESS VIOLETS



Characters in the stemless violets. In 2005 we collected and scored stemless violets from forest and woods roads at Harvard Forest. They divided into three clear groups by leaf shape and flower length. The *blanda* group had short leaves and short flowers, the *sororia* group short leaves and larger flowers, and the *sagittata* group elongate leaves and large flowers. When we then tried to use flower and pubescence characters (tables, this page and next) to resolve these groups we found that the *sagittata* group was homogenous and seemed to be a single species. The *blanda* and *sororia* groups were diverse, but didn't divide into conventional species.

CHARACTERS IN THE *VIOLA SAGITTATA* GROUP

Specimen	Color	Beard clubbed	Spurred petal bearded	Leaf hairy above	Leaf hairy below	Sepals ovate	Sepals ciliate	
1	D	-	+	++	++	-	+	*sagittata s.l.*
2	D	-	+	++	++	+	-	*sagittata s.l.*
3	M	-	+	++	++	-	+	*sagittata s.l.*
4	D	-	+	++	++	+	+	*sagittata s.l.*
5	M	-	+	++	++	+	+	*sagittata s.l.*
6	D	-	+	++	++	+	+	*sagittata s.l.*
7	D	-	+	++	++	+	-	*sagittata s.l.*
8	D	-	+	++	++	+	-	*sagittata s.l.*

Color: P = pale, M=medium, D=dark

We use the stemless blue and stemless white violets as an example. The violets are divided into groups that interbreed freely. All the stemless blues interbreed and all the stemless whites interbreed. Formerly over 20 species of stemless blues were recognized in the Northeast. Now there are less than 10, but even so there still may be more species in the books than in the field. The stemless whites are a smaller group. Formerly we had six widely recognized species; now we have five and, once again, one or two of these may be superfluous.

The stemless violets at HF fall into three groups, based on leaf shape and flower length. The long-leaved and densely furry *sagittata* group, shown in the chart and table on the preceding page is quite homogenous and presents no problems. Much of it corresponds to what previous botanists would have called *Viola fimbriatula.*

The white violets with short leaves, which we call the *blanda* group, are a bit more of a problem. Our plants are supposed to divide into two species: *V. macloskeyi,* with no hairs at all, and *V. blanda* which may or may not, depending on whom you read, have hairs and a beard on the lateral petals, and which is supposed to have red flower stalks and twisted petals. Our problem is that these characters don't group well. Only a few of our plants had red stalks or twisted petals and only one of them had hairy leaves, but many of them had a beard on the petals. We don't, as yet, know what to make of this. We certainly have variation but, as is the violet way, it doesn't organize well into species.

Much the same thing seems to be happening in the stemless blues. Our plants are fairly homogenous: most have some leaf hairs on the upper surfaces, a beard on the lateral petals, and ciliate sepals that tend to be ovate. All of this fits into a generalized concept of *V. sororia.* But a number of them have either clubbed beard hairs, or a bearded lower petal, neither of which are usually cited as *sororia* characters. The clubbed beard hairs and pale flowers suggest *V. cucullata,* but the beard hairs only rarely have the knobbed tips of the typical forms of that species,

CHARACTERS IN THE *VIOLA BLANDA* GROUP

Specimen	Beard	Leaf hairy above	Leaf hairy below	
1	+	+	-	*?*
2	+	-	-	*?*
3	+	-	-	*?*
4	+	-	-	*?*
5	+	-	-	*?*
6	-	+	-	*blanda*
7	-	-	-	*macloskeyi*

Above, character combinations in the stemless white violets. Only two plants, numbers 6 and 7, have character combinations according to currently recognized species. The rest have a distinct beard, while according to the books they should be "beardless or nearly so." Below, the character combinations for the stemless blue violets with short leaves. The character combinations, as explained in the text, correspond roughly but not exactly to the book descriptions of *V. sororia* and *V. cucullata.*

CHARACTERS IN THE *VIOLA SORORIA* GROUP

Specimen	Color	Beard clubbed	Spurred petal bearded	Leaf hairy above	Leaf hairy below	Sepals ovate	Sepals ciliate	
1	P	++	-	+	-	+	+	*cucullata s.l.*
2	P	+	-	+	-	+	-	*cucullata s.l.*
3	P	+	-	+	-	+	+	*cucullata s.l.*
4	P	+	-	+	-	-	+	*cucullata s.l.*
5	P	+	-	+	-	-	+	*cucullata s.l.*
6	P	+	+	+	+	+	+	*sororia s.l.*
7	D	-	+	+	+	+	+	*sororia s.l.*
8	M	-	+	+	+	+	+	*sororia s.l.*
9	M	-	+	+	-	++	+	*sororia s.l.*
10	M	-	+	+	-	++	+	*sororia s.l.*
11	M	-	+	+	-	++	+	*sororia s.l.*
12	M	-	+	+	-	++	+	*sororia s.l.*

Color: P = pale, M=medium, D=dark

and the hairy leaves and relatively broad sepals with short auricles fit poorly in that species.

Faced with these difficulties we decided to go with tradition and call the plants with clubbed beard hairs *cucullata* and the rest *sororia.* No one is going to fault us for this, but we acknowledge that we are using these names in a very generalized sense and that the character table could as easily support the idea that we have a single variable species in this group.

8 The Tree Clubmoss Complex

We conclude with a puzzling example of supposedly good species that seem to be behaving as a freely associating group. It is an example, at a minimum, of just how much the taxonomy of populations, viewed locally, can differ from the taxonomy of species, treated at a continental scale.

The common tree clubmosses of the *Lycopodium obscurum* group have been long known to vary in leaf arrangements. The shoots may be round or flattened, the ventral leaves strong or reduced, and the leaves may be arranged in an M1 pattern with one medial row of leaves, or an M2 pattern with two. Originally these were used to define varieties. More recently, following on two short papers that presented no quantitative evidence, they have been used to separate the group into three species.*

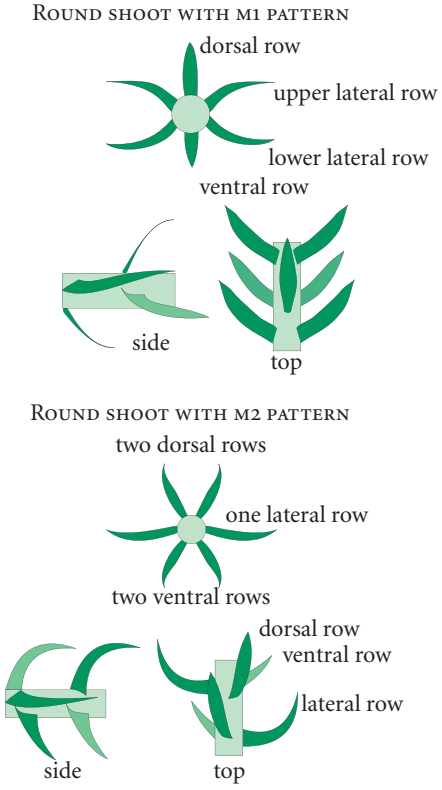
The papers, and the *Flora of North America* account by two of the same authors, use four characters to define three species. *Lycopodium obscurum,* for example, has appressed stem leaves and flattened shoots with reduced ventral leaves and M1 phyllotaxy. *L. dendroideum* reverses these characters, and *L. hickeyi*, with appressed stem leaves, round shoots, and M1 phyllotaxy, is in between.

Although these three species have been generally accepted, many botanists, including ourselves, have difficulty recognizing them in the field. It is not hard to recognize strongly rounded plants as *dendroideum* and strongly flattened ones as *obscurum* but many plants seem to fall in between.

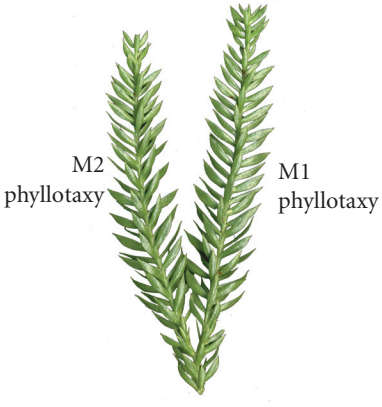
To try to sort things out we took a population sample, collecting 3 plants from each of 34 HF clones. The multiple collections from each clone allowed us to evaluate the stability of the individual characters, while the collections from different clones allowed us to measure the frequency of different character combinations

If the standard description fit our plants we should find that the characters were constant within each clone, and that three character combinations for the three standard species (three darkest squares in the graph) dominate the plot. Neither turned out to be true at HF. All the characters were to some extent unstable (p. 180), and the phyllotaxy, relied upon in the literature as a basic char-

SHOOT PATTERNS IN THE TREE CLUBMOSSES



TREE CLUBMOSS BRANCH WITH TWO LEAF ARRANGEMENTS

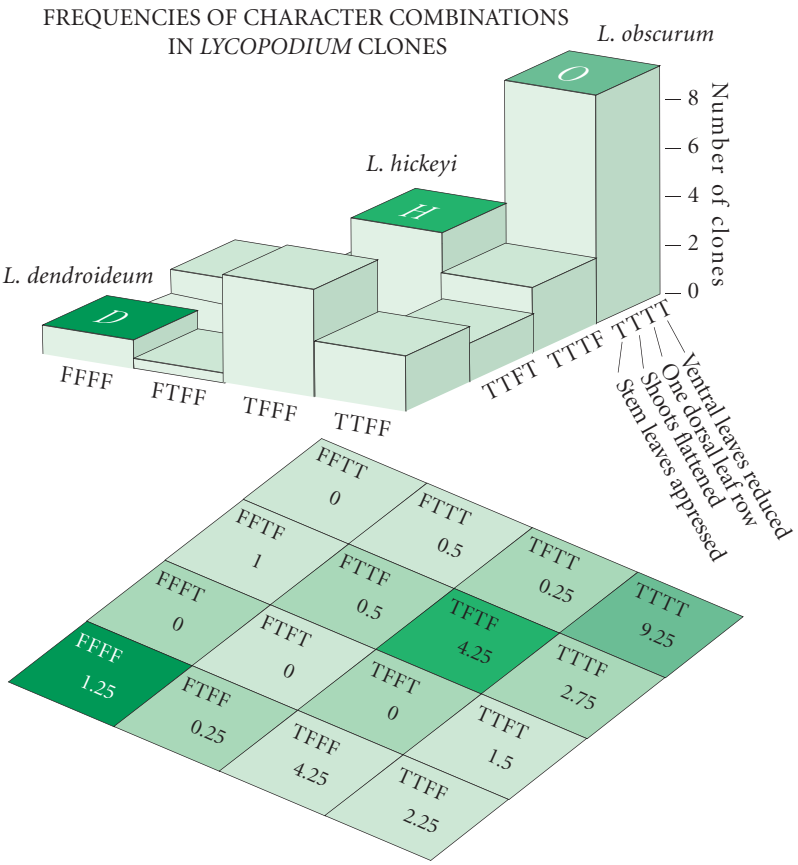


* The papers are Hickey (1977) and Wagner, Beitel, and Moran, (1989).

acter for separating the species, was the most variable of all. On the previous page we show a branch with two phyllotaxies; on p. 181 we show one where the phyllotaxy changes eight times.

The character frequency map to the right is similarly complex. The character combination for *L. obscurum* dominates the map, and the ones for *L. hickeyi* and *L. dendroideum* are present and visible, at least if you color their tops green. But 8 other character combinations also occur. Four of these are more frequent then *L. dendroideum*, and one as frequent as *L. hickeyi.*

This graph could be interpreted in several different ways. It could be saying that there are three species here whose outlines have been blurred by variability and hybridization. Or it could be saying that there is really one species here and all the rest is variation. Without more sampling it is impossible to tell. But one thing that is sure is that the simple picture of three distinct species does not correspond to what we have in the woods at HF and would badly misrepresent the complexity of the situation if we used it for ecological studies here.



Frequency of character combinations in a sample of 34 clones of tree clubmoss from Harvard Forest. The four characters are used to define a 4 × 4 matrix of character combinations. Because many of the characters vary within clones some clones couldn't be scored, and some had be spread over two squares (if they had one variable character), or four squares (if they had two). This is the reason for the fractional numbers of clones.

The three darkest squares in the lower figure correspond to the character combinations for the three conventional species. If these character combinations were discrete, most of the clones could be assigned to one of these squares. But in fact, only about 15 out of 34 clones fall on one of these squares. The remainder—over half the sample—fall on other squares or no squares at all.

Summary of Taxonomic Conclusions

Our review of some taxonomically difficult species has suggested three general principles that we think will apply to other surveys as well.

– *Don't believe taxonomists, and don't recognize more species than you really need to.* In an ecological survey you are interested in species that are present in populations and distinct from other populations. There will generally be fewer of these than the books and regional floras claim.

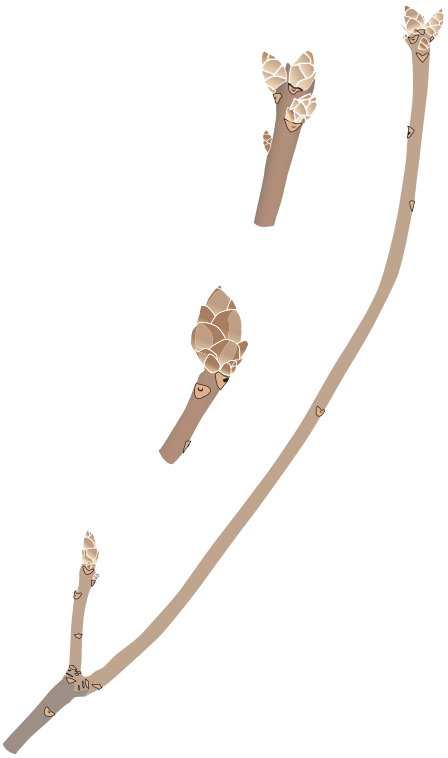
– *Most species, viewed locally, are well behaved.* In a local survey you see only a small portion of a species' range, and so only a small portion of its complexity. Since you do not need to solve problems you can't see, this is a great simplification.

– *When a species or species group presents local problems, these often have a local solution.* It is often reasonably easy, using population samples and simple statistical and graphical techniques, to determine the variation pattern in your

study area and to determine how many ecologically useful entities you have.

Summarizing, our experience has been that taxonomic problems are real, and can be numerous enough to affect our quantitative description of the flora. But, as with other measurement problems, they can be recognized and controlled for. The hard part, especially for uncommon species, is getting enough data. Once you have the data the analysis is usually straightforward, and often a simple analysis will suggest an equally simple solution.

AZALEA TWIGS



We have three wild azaleas in the region (*Rhododendron periclymenoides, prinophyllum,* and *viscosum*). The species are close together and can be difficult. *R. prinophyllum* and *R. periclymenoides* are a gradational species pair and hard to separate when they occur together. *R. prinophyllum* and *R. viscosum* seem to be good species, but their vegetative and fruit characters vary, and we had trouble separating nonflowering material.

VI THE QUANTITATIVE STRUCTURE OF THE FLORA

This section gives a quantitative picture of the Harvard Forest flora. Its purpose is to illustrate a number of ways that the flora can be characterized and to determine how the HF flora has changed since previous surveys. Our notion is that in the coming century we will want to measure the rate of floral change associated with climate change, and to do this we will need a measure of how the flora changed in a century when the climate was relatively constant.

How many species are there?

For the purposes of this analysis there are 808 accepted species that we believe are or have within the last century have been growing without cultivation at the Harvard Forest. This includes:

– Plants represented by specimens in the HF herbarium, which we believe to have been native or naturalized at HF.

– Plants reported by us for which we believe field identifications are adequate.

– Two species (*Berberis vulgaris*, *Platanus occidentalis*) that J.G. Jack (1911) said were in HF but for which there are no supporting specimens.

– And three species (*Sparganium angustifolium, Salix humilis,* and *Rhododendron viscosum*) for which the specimens are ambiguous but which we think, considering both specimens and documentary evidence, probably occurred here.

Our total does not include:

– Plants like *Pachysandra terminalis, Alnus hirsuta,* and *Juglans nigra* which were planted and may have persisted or spread locally but have not moved beyond the areas in which they were originally planted.

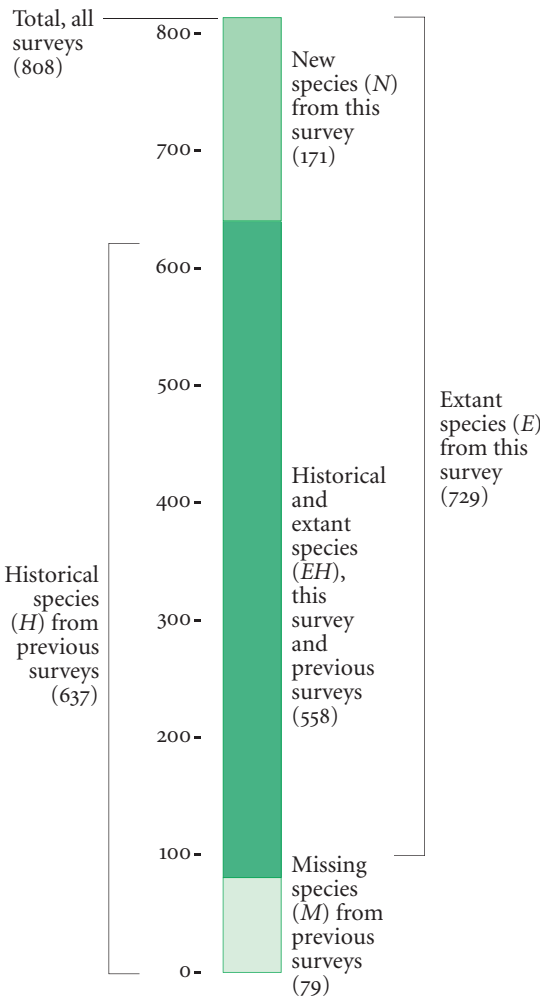
– Plants like *Alnus serrulata, Cystopteris tenuis, Eupatorium dubium,* and *Lycopodium hickeyi* for which the HF material seems to intergrade with other species we do recognize.

– Some species like *Prunus avium* which we believe we saw in the field but did not confirm.

– About 50 records, listed in Appendix I, which are based on herbarium specimens that we believe to have been misidentified.

– Another 48 species, listed in Appendix I, that were listed for Petersham by J.G. Jack (1911), H.M. Raup (1938), or C.E. Smith (1948-49), which may or may not have been seen in HF and for which we have found no supporting specimens.

ACCEPTED FLORA OF HARVARD FOREST



How does our estimate compare with previous ones?

It is about 171 species larger than our current estimate of "accepted" species from previous floras.

To compare it to previous floras we define the following historical categories, which describe the status of the flora:

extant species (*E*), seen in our survey or since 2000,

new species (*N*), not vouchered or plausibly reported prior to our survey,

historical species (*H*), vouchered or plausibly reported prior to 2000

E&H species (*EH*), both historical and extant,

missing species (*M*), historical but not seen in our survey and so not extant.

These five categories involve only three independent numbers. EH is by definition the intersection of *E* and *H* and so we have:

$$EH = H\text{-}M = E\text{-}N$$

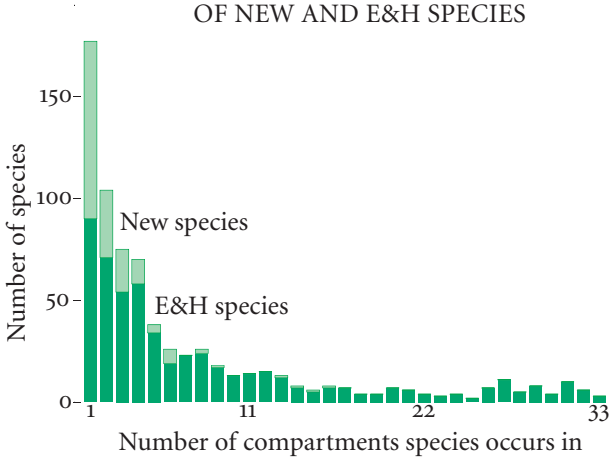
With these definitions our current estimate is that the flora contains:

729 extant species of which 171 are new,

637 historical species of which 79 are missing,

and thus 558 species that are both historical and extant.

CURRENT FREQUENCY DISTRIBUTION OF NEW AND E&H SPECIES



The frequency distributions of the new and the E&H (both extant and historical) species, with frequency measured as the number of compartments the species was seen in during our survey. The E&H species have a number of infrequent ones (bars to the left) but also a reasonable number of species that occur in 10 or more compartments. The new species have many infrequent species, and almost none in ten or more compartments.

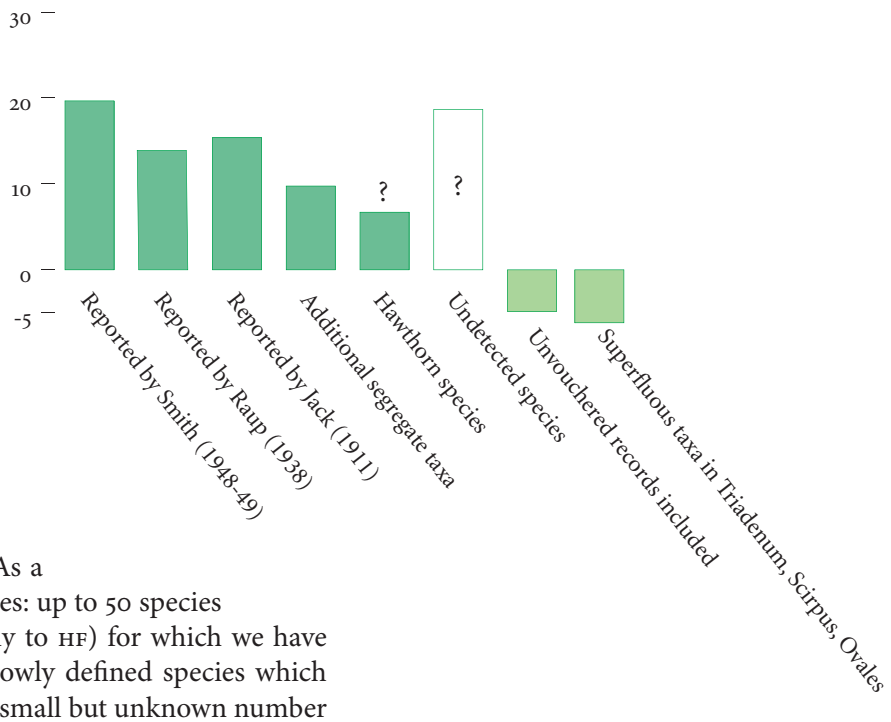
What are the possible errors and range of this estimate? Is there a confidence interval?

The number 808 sounds like a precise enumeration, as if the species had been laid out in front of us and all we had to do was count them. But it is not. It results from relatively crude measurements—of the reliability of historical sources, of the degrees of difference between specimens in front of us, of the degree of correspondence between these specimens and the taxa described in manuals, and of the relevance of different taxonomic treatments to the material we are dealing with. As a result there are significant uncertainties: up to 50 species credited to Petersham (not necessarily to HF) for which we have not found vouchers, perhaps 10 narrowly defined species which we have lumped with other species, a small but unknown number of unidentified hawthorns, three or four records that we accepted without full proof, and five or so narrowly defined species that we accepted but remain suspicious of.

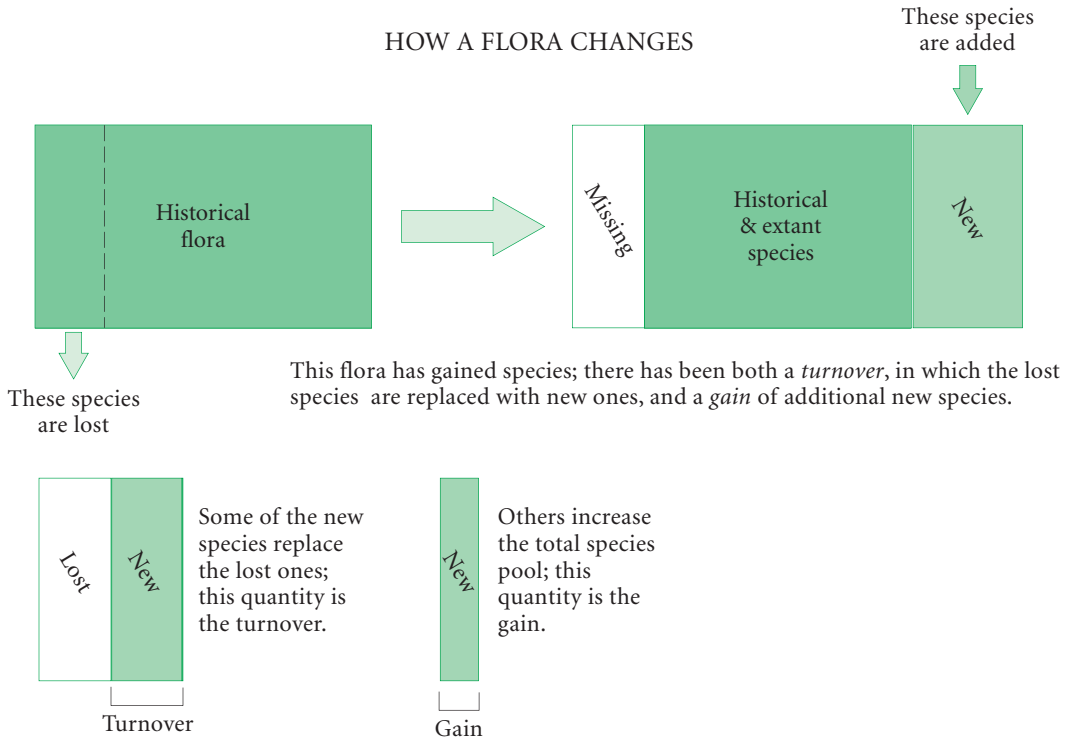
Thus, instead of an exact 808 species the total HF known flora, historical plus extant, might be as few as 800 species or as many as 875 species. This possible range is about 10% of our best value. We believe the likely range may be half of this or less, but we have no knowledge whatever of the statistics of the errors, and so can't give a true confidence interval.

Note that this is, by intent, only an estimate of the naturalized species growing out of doors for which we have records. There are, in addition, cultivars inside and out, unsurveyed weeds in greenhouses and flower boxes, and certainly a significant number of native and alien species that, either because they are rare and reclusive or because they were only here briefly, have escaped detection and never been recorded.

SOURCES OF ERROR IN THE TOTAL SPECIES COUNT



Numbers of species that might be added or removed from the total count of accepted species. Besides extant plants that might still be discovered ("Undetected species"), possible additions include unvouchered records from previous surveys, taxonomic segregates that we did not recognize, and an unknown number of hawthorns which we did not study. (We believe that many of the unvouchered records are incorrect, but some may be additions to the pool of historical species.) Possible deletions include a few unvouchered records that we treated as accepted species, and a few of the entities that we have recognized in difficult or introgressive groups.



What parameters describe floral dynamics?

The elementary floral processes are species loss and species gain. It is convenient to look at these as creating two types of change: the replacement of species by other species, which we call *turnover,* and the net gain or loss of species which we call *species gain.* Turnover, which is always positive, is the lesser of N and M; species gain, which may be positive or negative, is N-M. For comparing floras of different sizes we standardize N and M by dividing them by the historical flora H and express the rate of turnover and species loss or gain as a percentage of the historical flora. It is these percentage rates that we will use to describe the dynamics of the flora.

With these definitions, 79 species out of a historical flora of 637 have apparently been lost and replaced with others, for an apparent turnover of 12.4%. An additional 92 species have been added to the flora, for an apparent net gain of 14.4%. We call these *apparent* rates, because we do not know whether these are actual changes in the flora or apparent changes caused by our imperfect ability to survey. The species we call missing might, after all, still be here; the ones we are calling new might have been here all along.

BASIC HF STATISTICS

Total flora	808
Native	637
Alien	171
Historical flora	637
Native	547
Aliens	90
Missing natives	68
Missing aliens	11
All missing	79
Contemporary flora	729
New natives	90
New aliens	81
All new	171

The basic contemporary and historical statistics of the Harvard Forest flora. Sharp-eyed readers will note that the figure 637 occurs twice; this is an accident, but not a mistake.

How do the status and dynamics of the native and the alien floras compare?

We estimate that the 808 accepted HF species divide into 637 natives and 171 aliens. Like the estimate of the total species number, this involves approximations and uncertainties, especially in the case of species whose history is unclear, or which may contain both native and alien genotypes. We assume, conventionally but without proof, that we encounter at least some native genotypes in *Achillea* and *Prunella;* and, less conventionally, that *Sagina procumbens* and *Amaranthus retroflexus* are natives or have (like *Phragmites*) at least some native elements. And we have, arbitrarily, treated *Rhododendron maximum, Thuja occidentalis,* and *Liriodendron tulipifera* as natives, even though our plants may be escapes from cultivation.

The alien and native species have different histories and to some extent constitute two separate floras living in the same study area. Their historical structure and dynamics, shown at right, differ significantly. The native flora has changed only 4% in size (not meaningful given the errors) in the 60 years since the last survey, but has had about a 12% apparent turnover in composition. The alien flora has had the same apparent turnover as the native flora but has grown rapidly and has apparently increased 78% since previous surveys.

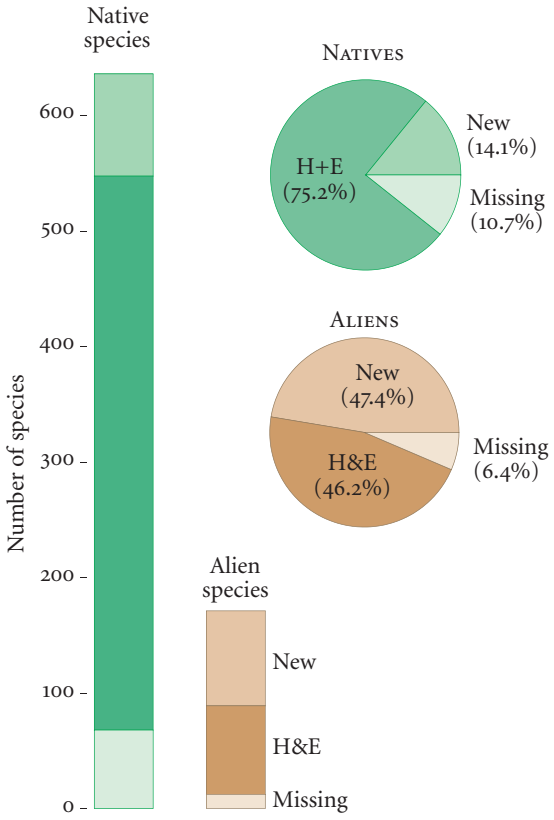
How accurate are these estimates of turnover and gain, and in what directions do they err?

We do not know. Our suspicion is that our turnover figures underestimate the true rate, essentially because species can come and without being noticed, and that our figures for gain overestimate the true rate, because our survey was more thorough than the previous ones. But compensating errors are involved, and it is difficult to be sure.

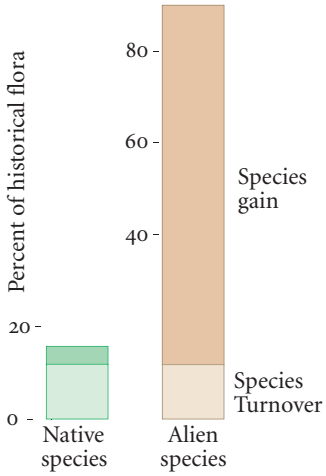
Gain is the simpler case, and we deal with it first. We spent more time than previous surveys, knew the regional flora better, spent more time in several species-rich habiats, and, perhaps most important of all, had the previous work to build on. We suspect that much or all of the apparent gain in native species is the result of these differences.

The gain in alien species is similar in absolute numbers to the gain in native species but much larger relative to the number of alien species found in previous floras. We think that, with the exception of perhaps 11 common aliens that were missed or omitted from previous surveys (p. 47), it is a real gain. We know from our own experience that many weeds have arrived or increased in abundance in the last 50 years, and we think it very unlikely that

STATUS OF NATIVE AND ALIEN FLORAS



DYNAMICS OF NATIVE AND ALIEN FLORAS



H.M. Raup, I.M. Johnston, or C.E. Smith would have overlooked or omitted half the weeds they saw.

The situation with turnover is more complicated. Any estimate of turnover is closely connected with how thorough the surveys have been. If each survey misses some plants that the other has found, it will appear as if some species have disappeared and others replaced them. There will, in other words, be a *simulated turnover.*

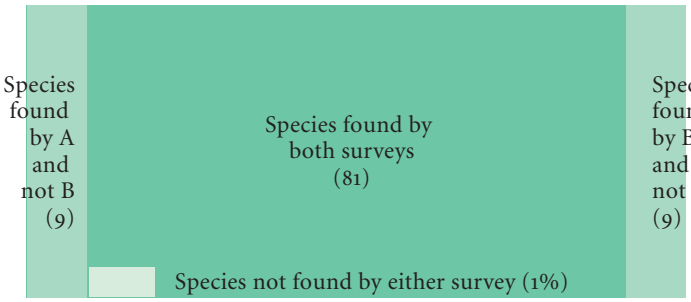
The top figure gives a simple example. It assumes that there flora doesn't change, and that each group has probability of 90% of detecting any species in the flora. The first group finds 90 species. The second group also finds 90 species, but it misses 9 the first group found and finds 9 they didn't find. The real turnover is zero, but there appears to have been a turnover of 9/90 = 10%.

This example seems to say that if a survey misses 10% of the plants in the woods—something most working botanists would think quite possible—than it will introduce a spurious 10% into its estimate of turnover. Since our estimates of turnover are not much larger than 10%, this suggests that there might be little real turnover at all.

This could be true, but doesn't have to be. The example assumes that there is no real turnover and that the detection probabilities are the same for all species. But we know that detection probabilities vary, and that they are effectively 100% for the common species and likely only a few percent for the rarest ones. And we also know that species have different probabilities of persisting over the interval between surveys, which in our case was 60 to 100 years. For a common species of a stable habitat, the probability of persisting is effectively 1. For the rare species in some special habitat like a bog mat it may also be high. But for a rare species in an unstable habitat, or one competing with the common dominants in a stable one, it may be very low.

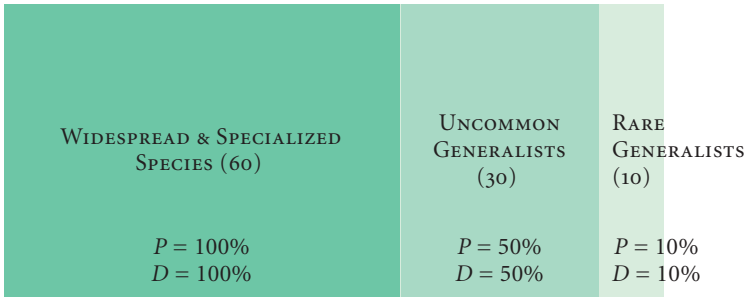
There is then, a correlation between rarity and persistence, and when we put this in a model it changes everything. The bottom figure shows a flora with three groups of plants, each of which have a different detectability and different persistence. The numbers are

DETECTION RATES < 100% CAN SIMULATE TURNOVER WHERE THERE IS NONE



Total flora = 100 species; persistence P = 100%
.Surveys A and B have a detection rate D = 90%.
They each detect 90 species, including 9 the other misses.
The apparent turnover = 9/90 = 10% = 1 - D.

NONUNIFORM RATES CAN MASK TURNOVER



Total flora = 100 species; persistence P and detection rate D vary.
The actual turnover of the widespread and specialized species = 0.
The actual turnover of the uncommon generalists = 15 species.
The actual turnover of the rare generalists = 9 species.
The actual turnover of the whole flora = 24 species = 24%.

Simple models to show the relation between detectability, persistence, and the real and estimated turnover rate. We a imagine flora of N species and two surveys, each with a detection rate D, which may apply to the whole flora (top diagram) or a group within it (lower diagram). Both report ND species, but not the same ND species. In particular the second team finds $(ND)D$ of the species the first team found, misses the remaining $ND(1-D)$ they found, and, by symmetry, finds an additional $ND(1-D)$ new species the first team didn't find. Dividing by the historical flora, in this case ND, everything simplifies and it appears that the fractions of the flora that are missing and new are both $1-D$, and so the turnover rate is $1-D$ too.

not assumed to be realistic, but are just chosen to illustrate what happens when detectability and persistence are correlated.

The first group contains common or ecologically specialized species that are easy to detect and long persistent.* Both groups get them all. There is no turnover and they estimate none.

The second group contains species that are harder to find but also less likely to persist. The ones that don't persist are by definition turnover and—here is the trick—so it doesn't matter whether they are hard to relocate or not because they are not there to relocate. The true turnover is 15 species; the surveyors miss some of this and estimate a turnover 11.75 species.

The third group is so rare that it is for all practical purposes invisible. Its real turnover is 9 species, and the surveyors see only one of these.

Adding the three groups, the real turnover is 24/100=24%, the estimated turnover 12.25/86=15%. Thus about half the turnover takes place out of the sight of the surveyors, among the species they don't detect at all.

We think that this model, which basically says that many of the species from previous surveys that we didn't detect weren't around for us to detect, is biologically reasonable. We guess, accordingly, that our estimates of turnover underestimate rather than overestimate the true rate.

How are the native and alien species distributed across the habitats at Harvard Forest?

This cannot be answered exactly because most species occur in a number of habitats, and most sites that you study are mosaics of habitats, and in fact fractal mosaics, meaning that habitats are interspersed on a number of different scales. We computed a rough distribution for the extant species at HF by classifying the habitats in a very general way, and then assigning each species to the habitat (or 2-3 habitats in the case of species of wide amplitude) where it occurred most often.

Some of the results are expected, some not. Observe in the graphs on the opposite page that:

–The alien species are largely found in open habitats.

– Roughly two-thirds of the native species are found in wetlands and open habitats, which together make up less than a tenth of the area of Harvard Forest.

– The total native + alien diversity of open habitats is actually a bit greater than either the woods or wetlands, even though the area of open habitats is very small.

– While rich woods are typically more diverse than non-rich woods, their diversity is a mixture of rich-woods specialists

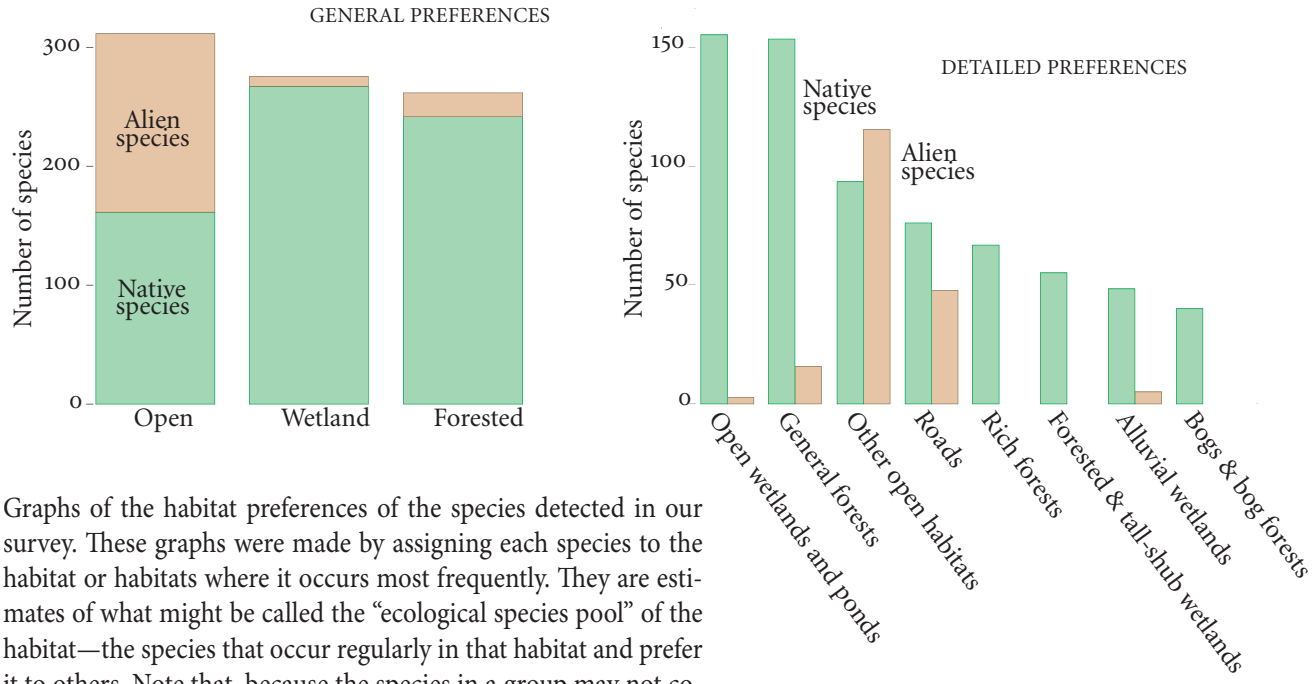
*There are two assumptions here: first that common species in stable habitats persist for long periods of time, and second that rare species in specialized stable habitats (like a bog mat or wet limy cliff) are both persistent and easy to locate. This is borne out by experience: we relocated every species that previous surveyors had listed as widespread or common in stable habitats, and almost all of the rarities which were associated with specialized habitats.

and ordinary forest plants, and the pool of rich woods specialists, by itself, is not particularly big.

– Looking at the detailed breakdown, roads and open habitats not only have high total diversities but are surprisingly rich in native species.

This last point is one that deserves more field investigation. A lot of what we call woods and meadow species are really road and edge species instead. Roads, both paved and woods, are ecologically special because they are dispersal corridors, because they are fine-scale mosaics of microhabitats, and maybe because as linear features they are good traps, like drift fences, that intercept propagules going other places.

HABITAT PREFERENCES OF EXTANT SPECIES



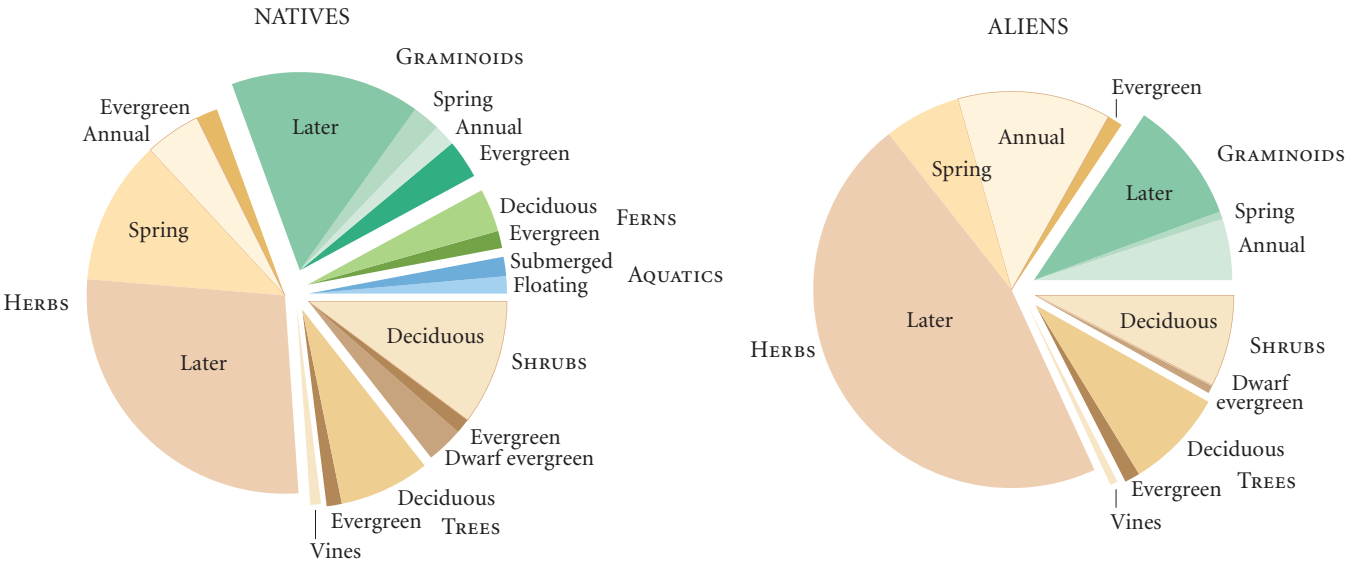
Graphs of the habitat preferences of the species detected in our survey. These graphs were made by assigning each species to the habitat or habitats where it occurs most frequently. They are estimates of what might be called the "ecological species pool" of the habitat—the species that occur regularly in that habitat and prefer it to others. Note that, because the species in a group may not co-occur, it is not an estimate of the average diversity of the habitat. Thus while the total species pool of general forests is high, the species are spread widely and the diversity of individual stands is often low. Conversely, while the total pool of rich-woods species is not particularly high, the species are often concentrated and the diversity of individual sites can be high.

What is the morphological structure of the flora?

The graphs below divide the alien and native floras by life form. Herbs and graminoids are further separated into early and later species; since early and late species often have different growth forms this is in fact a morphological difference. No ephemerals are included because, excepting a couple of plants of trout lily, there aren't any!

Herbs and woody plants make up two thirds to three quarters of the flora, and graminoids a fifth to a quarter. The aliens and natives are surprisingly similar in this respect. The big differences are that the aliens have more annual herbs and annual graminoids, fewer spring herbs, and no ferns or (at HF anyway) aquatics.

LIFE-FORM SPECTRA OF EXTANT NATIVES & ALIENS

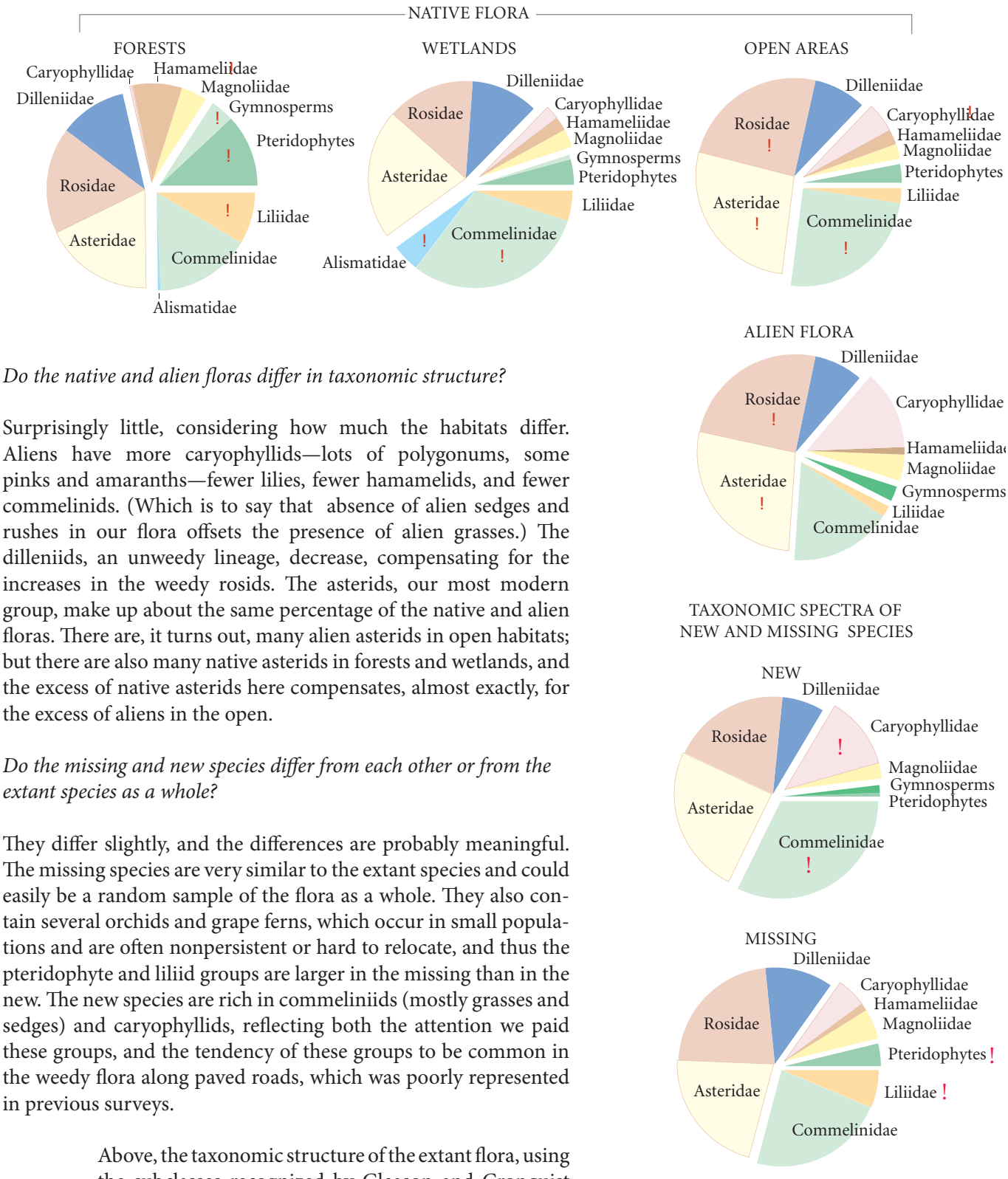


Life-form spectra of the extant flora. The graphs divide the flora by general form. Graminoids are grasses, sedges, and rushes; herbs are all non-woody plants except graminoids. Evergreen species are then separated in each group and, within the herbs and graminoids, annual, early-blooming, and late-blooming species.

What is the taxonomic structure of the flora?

The graphs divide the flora by subclasses, using Cronquist's system. The gaps in the pies separate gymnosperms and pteridophytes, basal dicots (Magnoliidae through Caryophyllidae), advanced dicots (Dillenidae through Asteridae), and monocots (Alismatidae, Commelinidae and Liliidae).

A number of patterns appear. The advanced dicots dominate in all habitats, but are most numerous in the open and less so in forests and wetlands. Ferns, gymnosperms, hamamelids, and liliids are important in forests; asterids rosids, and caryophyllids in the open, commelinids and, surprisingly, dilleniids in the open.



Do the native and alien floras differ in taxonomic structure?

Surprisingly little, considering how much the habitats differ. Aliens have more caryophyllids—lots of polygonums, some pinks and amaranths—fewer lilies, fewer hamamelids, and fewer commelinids. (Which is to say that absence of alien sedges and rushes in our flora offsets the presence of alien grasses.) The dilleniids, an unweedy lineage, decrease, compensating for the increases in the weedy rosids. The asterids, our most modern group, make up about the same percentage of the native and alien floras. There are, it turns out, many alien asterids in open habitats; but there are also many native asterids in forests and wetlands, and the excess of native asterids here compensates, almost exactly, for the excess of aliens in the open.

Do the missing and new species differ from each other or from the extant species as a whole?

They differ slightly, and the differences are probably meaningful. The missing species are very similar to the extant species and could easily be a random sample of the flora as a whole. They also contain several orchids and grape ferns, which occur in small populations and are often nonpersistent or hard to relocate, and thus the pteridophyte and liliid groups are larger in the missing than in the new. The new species are rich in commeliniids (mostly grasses and sedges) and caryophyllids, reflecting both the attention we paid these groups, and the tendency of these groups to be common in the weedy flora along paved roads, which was poorly represented in previous surveys.

Above, the taxonomic structure of the extant flora, using the subclasses recognized by Gleason and Cronquist (1991). The exclamation points indicate groups that are relatively large in that subflora. Right, the taxonomic structure of the missing species we could not relocate and the new species found in our survey.

Do the different life-forms differ in floral dynamics?

Yes they do, though the numbers aren't certain because many of the groups are small. But the differences form a reasonable pattern, and so may have some truth in them.

This analysis deals only with natives; the aliens are mostly herbs and graminoids, and so don't lend themselves to a comparative analysis.

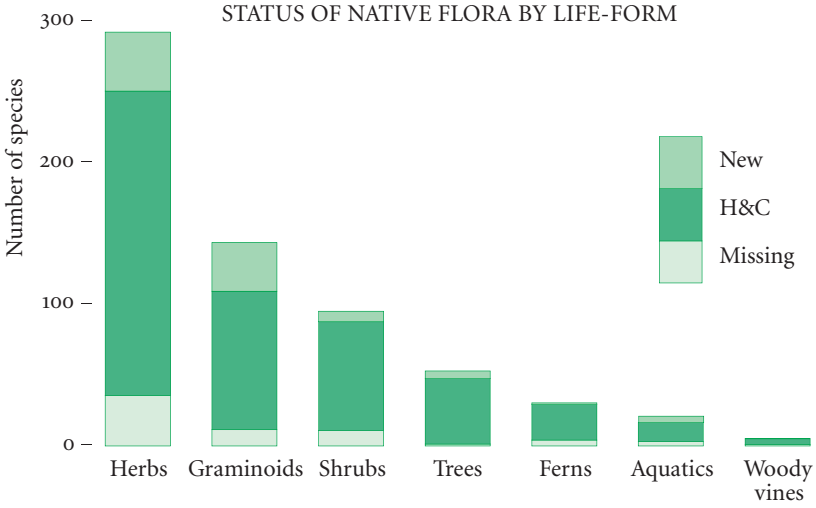
Taking the groups one by one: the herbs are the biggest group, and show a significant turnover of about 35 species or 14% and a small gain of 7 species or 3%.

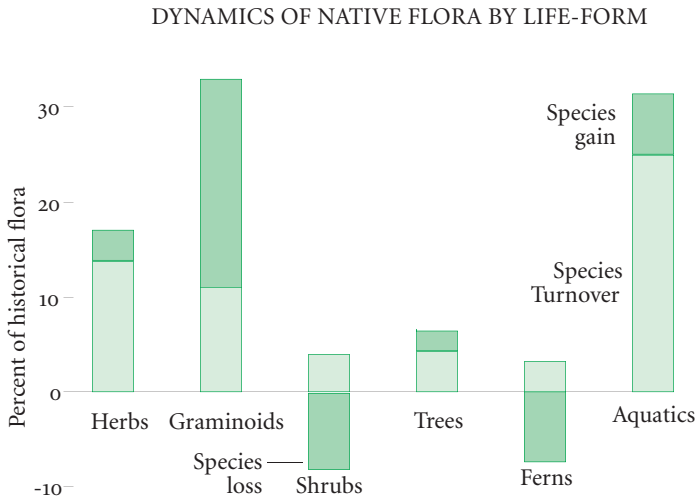
The shrubs, trees and ferns are relatively stable groups: the shrubs show 4% turnover, the trees 2% and the ferns 1%. These numbers are probably at or below the lower limit of what we can measure, given survey errors.

The shrubs and ferns also show net losses in species. The shrub losses, of about 7%, are ecologically meaningful: the missing species are early-successional species, particularly willows and dogwoods, that according to Jack were common plants in 1910. The lost ferns are all grape ferns. Except for rattlesnake fern they are all early successional, and were never common here.

The graminoids have a turnover of 11%, comparable to that of the herbs, and probably typical for plants of fairly short life cycles. Their gain of 21% is the highest of any group, and some of it is probably an artifact of different survey methods: we were more familiar with the regional flora than any of the previous surveyors, and more systematic about looking for them in the field. But some of it may be a real change, reflecting the floristic maturation of the woods; sedge and grass diversities are typically low in the early successional woods that previous surveys were examining.

The aquatics seem to show big changes (turnover 25%, gain of 6%), but this is mostly because there were only 16 historical species and so the coming and going of a few species looks like a large percentage change. There are definitely some real changes, involving the arrival of species such as *Utricularia radiata* and *U. geminiscapa* that are common in the ponds now, and unlikely to have been missed by earlier surveys. But the overall shifts in the aquatics are small and, like those in trees and ferns, at the lower limits of what we can measure accurately.





Status and dynamics of the native flora, by life-form. These graphs use the categories defined on pages 69 and 71.

Do the different communities differ in floral dynamics?

Apparently less than the different life-forms do.

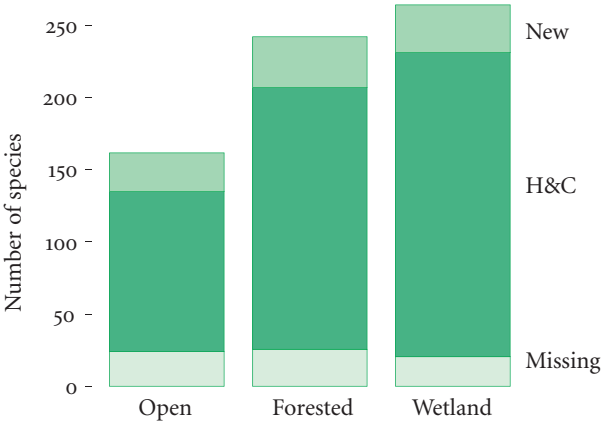
Here again, because the aliens are mostly in open habitats, there was not much point to analyzing them.

Forest and wetland communities were almost identical, showing about 10% turnover and 5% gain. Some of the gain may be real and some, again because we were very thorough about looking for native graminoids, may reflect the difference in the surveys

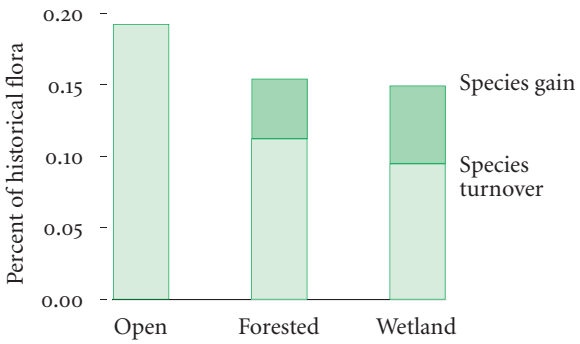
Open communities show a large amount (19%) of turnover but no net gain or loss. A number of pasture species were lost, but these were replaced by new species, found mostly along the edges of paved roads.

The striking fact that emerges in all these analyses is that for all components of the native flora except graminids, turnover is significantly larger than gain. When you think of the amount that the forest has changed in the period represented here – woods maturing, fields vanishing, climate changing, land uses changing— and when you think that in this period about 25% of the species are found in either our survey or the historical surveys but not both,* then a balance of gains and losses this exact seems very surprising. We have long felt that the cynical Dr. Gleason overstated the case for the unaffiliatedness of plant species. They may indeed arrive, chose habitats and depart independently, just as the sand grains in a dune do. But in between they form a complex ensemble, and we know now, and Gleason did not, that almost every complex ensemble, when studied carefully, is found to superimpose some organization and (this is the same thing) self-regulation on the independence of its components. Dunes do it, rivers do it, flocks and branches and schools do it. Our work suggests some surprising regularities in dynamics between communities, and life-form and taxonomic spectra between natives and aliens. (Apparently the visiting team has elected to play by some of the home team's rules.) We suggest that this may mean that our communities are also doing it.

STATUS OF NATIVE FLORA BY COMMUNITY



DYNAMICS OF NATIVE FLORA BY COMMUNITY



As with the habitat graphs on p. 75, some species are assigned to more than one habitat, and so the total number of species in the upper graph is greater than 637, the number of native species in the flora.

*Put another way, the contemporary and historical native floras have 479 of 637 species in common for a similarity of 75%.

How frequently are the new species encountered?

Mostly infrequently. Half of them only occur in one compartment, and 88% of them in less than 4 compartments, suggesting that they are either rare species that escaped detection in previous surveys, or recent arrivals that have not spread much. The only exceptions to this are two native species, the spotted wintergreen and common beggar's-ticks (*Bidens frondosus*), that seem to be new to HF and are now widespread; and several aliens—smooth crabgrass, red clover, oriental bittersweet, Japanese barberry, and Morrow's honeysuckle—which are recently arrived and have already spread widely.

Do the new and missing species tend to certain life forms?

Yes. The distribution of life forms for the missing natives (opposite page) is very like the distribution of extant natives on p. 76. The distribution of new natives is similar, but poor in woody shrubs and the evergreen herbs and grasses (previous surveys found them all) and enriched in graminoids (we worked hard on these) and annual herbs, many of them part of the new flora of paved road edges.

Because almost half of the aliens are new, the distribution of life forms for the new aliens looks much like that for the aliens as a whole—rich in grasses and herbs, especially annual species, and with a significant (and ecologically troubling) component of woody species. As with the aliens in general, late herbs are more numerous than spring herbs and annuals, and there are no strictly evergreen species, though there are several semi-evergreen or long-season species.

The missing aliens are a very small group—only 11 species—and so their life-form distribution is probably accidental.

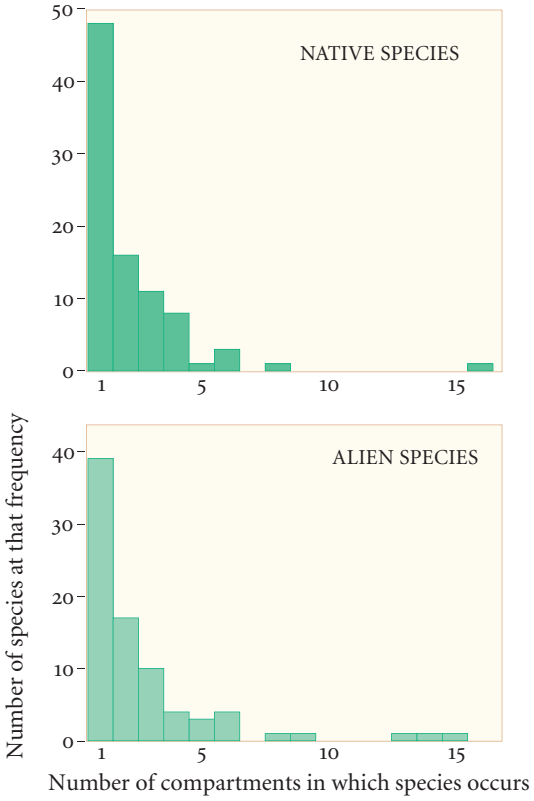
Do the new and missing species prefer certain habitats?

The aliens do, the natives do not.

The missing native species are almost equally distributed between forests, open habitats and wetlands; the new native species are slightly less common in open habitats than in forests and wetlands, perhaps because there are now fewer open habitats for them to occur in.

Both the missing and the new alien species are strongly concentrated in open habitats. Historically there were almost no aliens in either wetlands or forests, and so no species to go missing from these habitats.

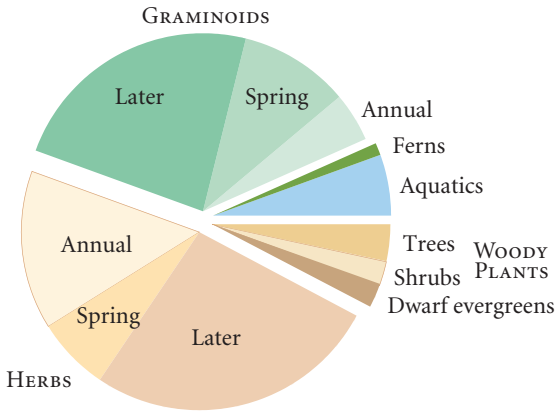
FREQUENCIES OF NEW SPECIES



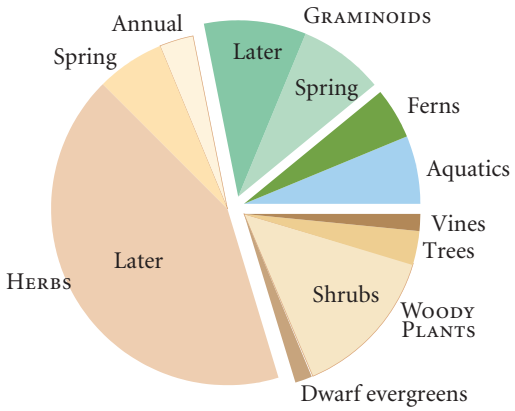
Species-frequency histograms for the species that were not encountered in previous surveys. The x-axis is a range of frequencies, measured as the number of compartments in which a species was seen. The y-axis is the number of species at that frequency.

LIFE-FORM SPECTRA OF NEW AND MISSING SPECIES

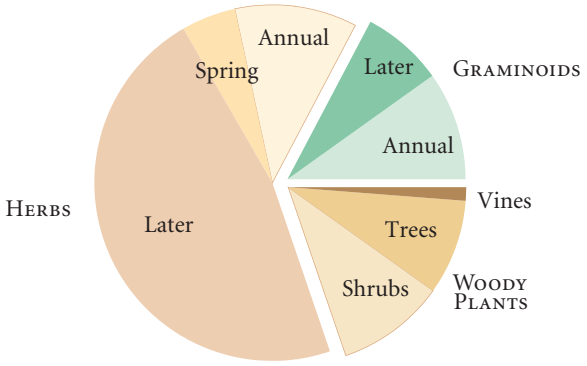
NEW NATIVES



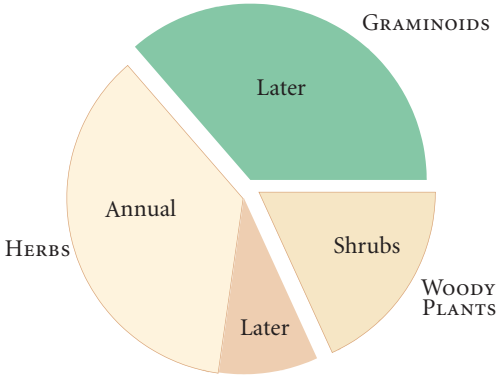
MISSING NATIVES



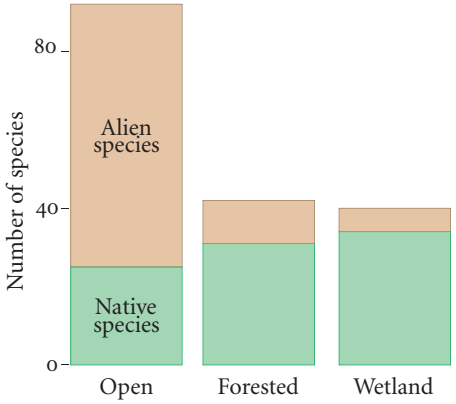
NEW ALIENS



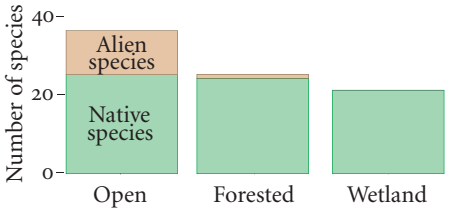
MISSING ALIENS

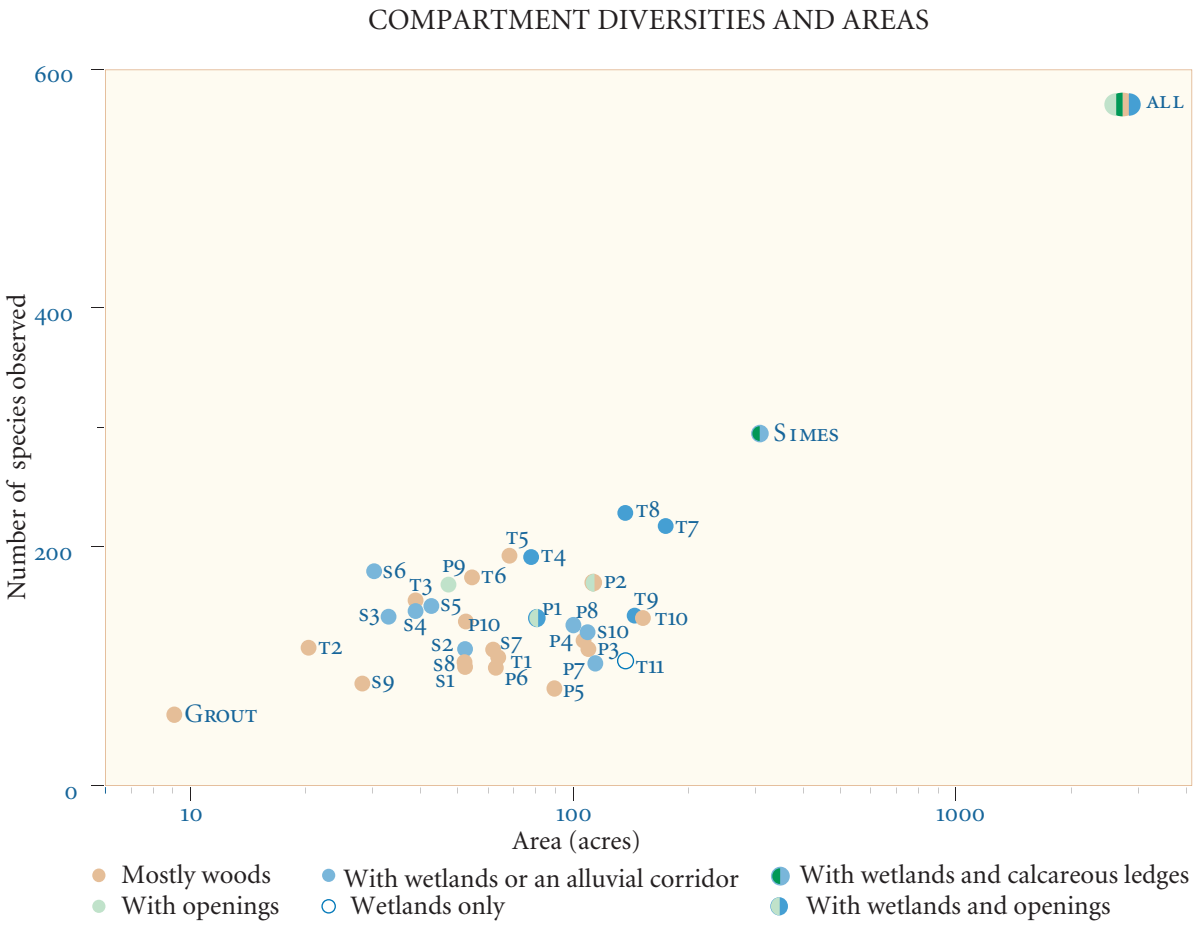


HABITAT PREFERENCES OF NEW SPECIES



HABITAT PREFERENCES OF MISSING SPECIES

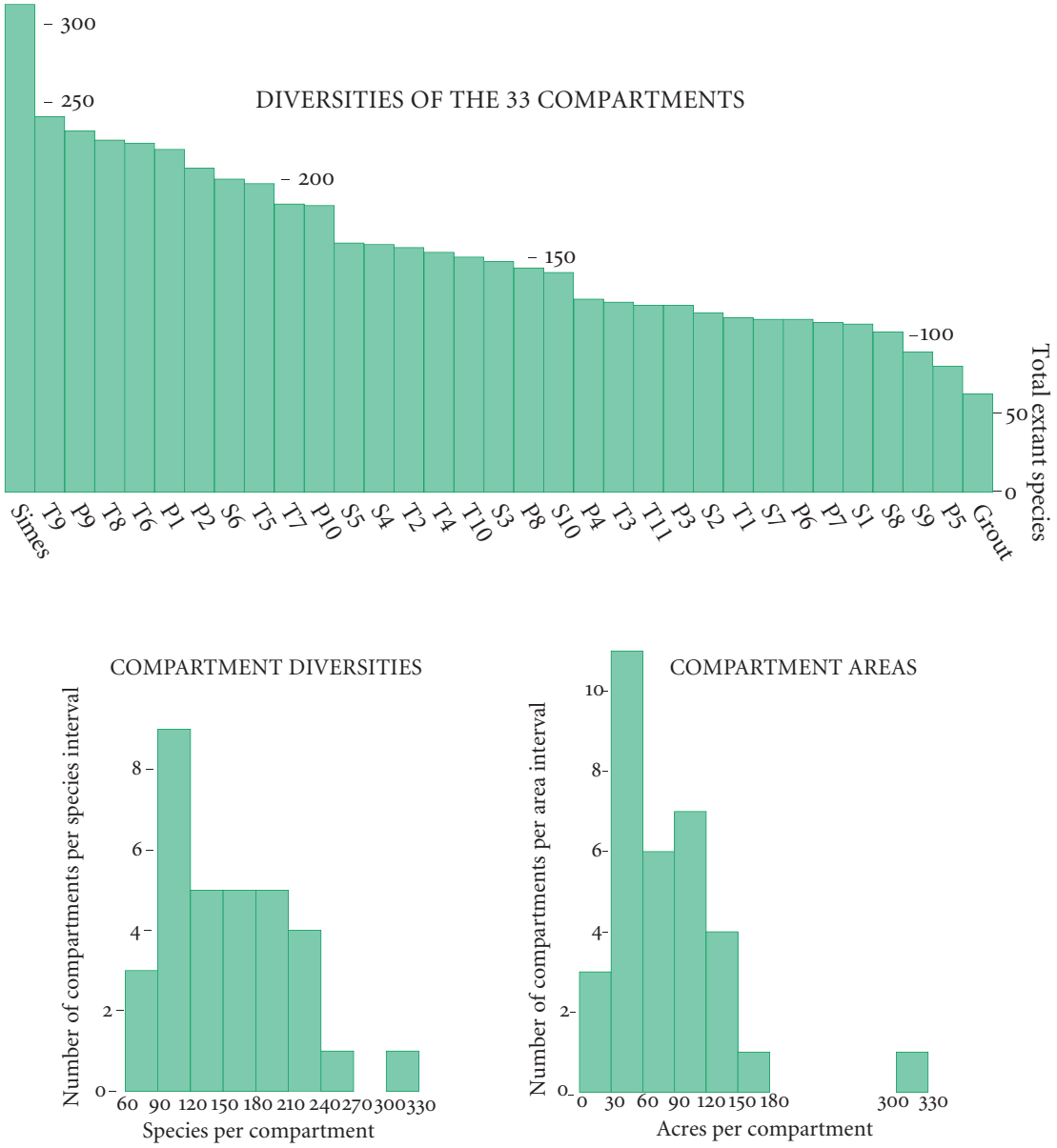




How much do the compartments differ in diversity?

Greatly. They range from 63 species in the Grout Lot to 313 in the Simes Tract; the mean is 156 and standard deviation 55, so Grout is two standard deviations out and Simes three. Much of this variation, as the graph above shows, is directly related to area: the Grout Lot, for example, is 9 acres and Simes is 318. But some of it is related to ecological diversity as well. Simes is not only the largest compartment, it is the only one with calcareous outcrops. And the tracts with large wetlands, and especially those like s6, t7, and t8 with a variety of types of wetlands, tend to be more diverse than those that are all woods or woods and one type of wetland.

The distribution of compartment diversities is asymmetrical, with a peak to the left of the mean. It seems closely related to the distribution of areas, and is probably controlled by the dependence of diversity on area.



Above, ranked compartment diversities and the distribution of compartment diversities and compartment areas. Simes, the largest compartment, is also the most diverse, but its diversity probably owes as much to its limy outcrops as to its total area.

What is the slope of the species area curve?

A species-area curve is a graph of the total number of species seen as increasingly large areas are searched. As such it is a measure of the way diversity changes as we move from single habitats to ensembles of habitats.

The increase of diversity with area—call it the *diversity-slope*—is generated by two different processes. The first is increase in the area of habitats you already have: with more forests to search you have a better chance of finding rare forest species. The second is the addition of new habitats: when you add your first pond you will get lots of new species from the ponds-species pool. Thus the diversity slope depends on both the rate at which your sampling of existing species pools improves, and the rate at which you encounter new pools to sample.

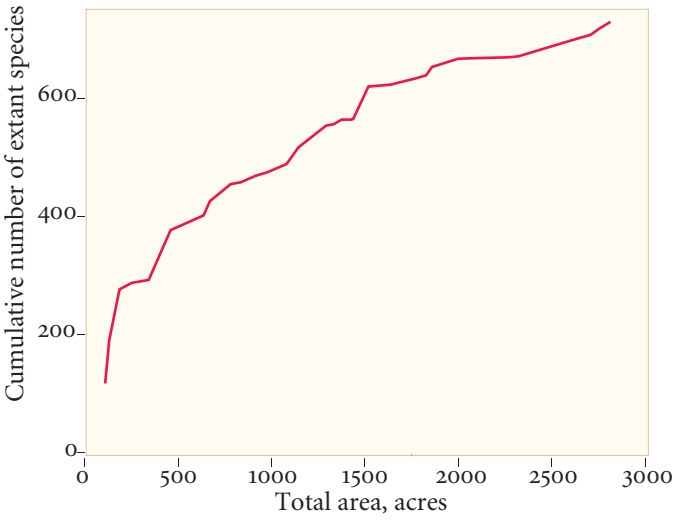
Both of these processes are biologically important, and one reason species-area curves have been much studied is that they seem to offer a simple way of quantifying them. But the simplicity is misleading: species-area curves tend to be uniformative, both because the confounds two different processes and because they have has less information than they seem to.

The upper graph is a single species-area curve made by taking the data from a randomly selected compartment, in this case P3, computing the number of species in it, and then adding one compartment at a time in random order and computing the total number of species at each step.

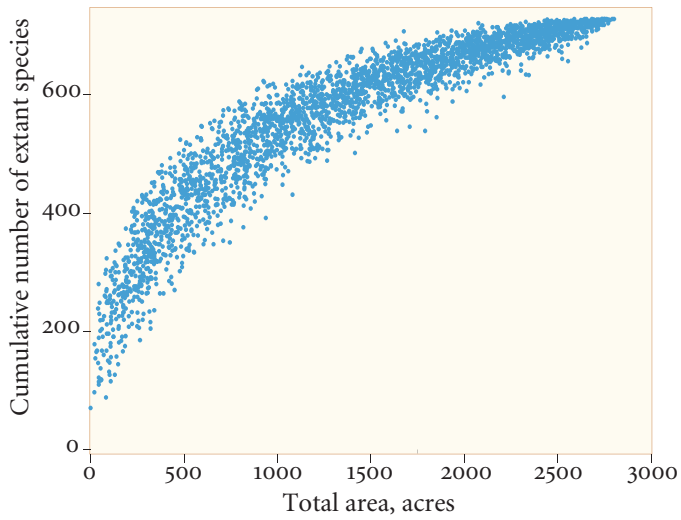
The curve appears to have a rather complex shape. But this shape is entirely the result of the order in which we added the compartments. If, as in the second graph, we repeat the computation a hundred times, the irregular curve becomes a regular envelope that can be fitted with a power law or, as in the third graph, transformed into a linear relation by scaling the area with an exponent of somewhere around 0.2.

Right, three graphs of the species-area relationship for the 33 compartments at HF. In the first, a single compartment (P3) was chosen randomly and then the remaining compartments added, one at a time, in random order. In the second, this process was repeated a hundred times, with the lines connecting the data points omitted for clarity. In the third, this data was plotted against the 0.2 power of area, showing that there is, roughly, a power-law relation between the number of species and the area.

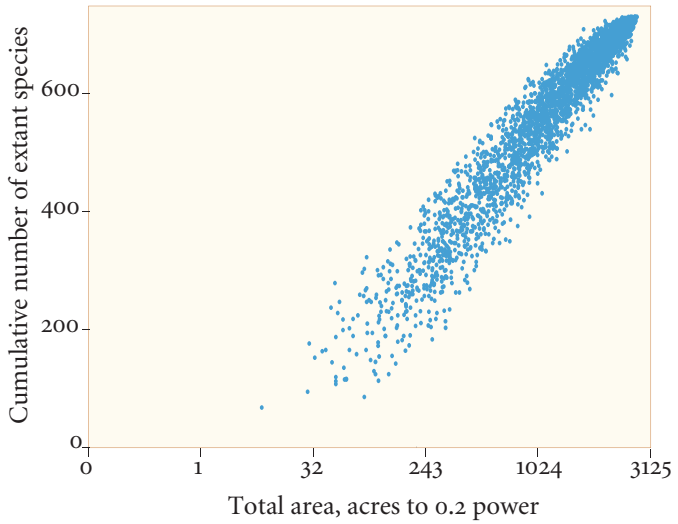
A CUMULATIVE SPECIES-AREA CURVE



THE CUMULATIVE SPECIES-AREA ENVELOPE



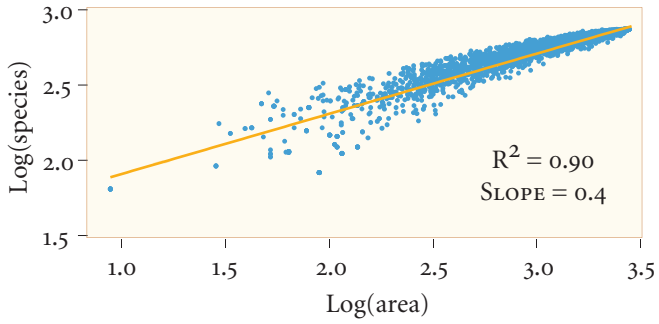
THE SAME WITH THE AREA SCALED



What this all means is that the species-area curve can be transformed into a linear relationship that only contains two numbers—one that tells where it starts and one that tells where it ends, or, alternately, how fast it rises. We can obtain these numbers for a power function fit by randomizing the compartment data and then regressing the log of the cumulative number of species against the log of the cumulative area. This is shown at right: the best fit has a slope of 0.4, corresponding to a power function exponent of 0.4.

Alternately, and with much less work, we can forget about randomizing the compartments altogether and approximate the diversity slope as the ratio of the total number of species in all compartments to the mean number of species per one compartment. Alternatively, if we want to estimate the exponent of a power law fit, we divide the log of this ratio by the log of the same ratio for areas. In our example, the species ratio is 729/155 = 4.7, meaning that the number of species increases 4.7 times in passing from one average compartment to the ensemble of 33 compartments. The area ratio is 2808/85=33. The logs of these ratios are 0.67 and 1.5, and 0.67/1.5=0.45 is a reasonable approximation to the power-law exponent (0.4) obtained through randomization.

SPECIES-AREA, DOUBLE LOG PLOT



Obtaining the power-law fit. The slope of a linear regression of log(species) against log(area) estimates the exponent of the power law.

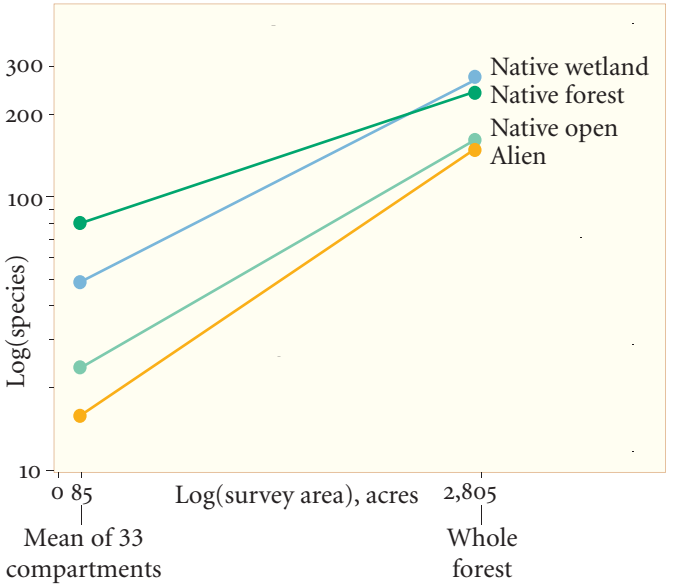
It would be nice to be able to compare the diversity slope at HF to that of other similar areas. Unfortunately, no similar data seem to exist. Lacking these data, we can still compare the slopes of different subgroups at HF.

Do the diversity slopes of the different subfloras differ?

Interestingly, they seem to. The woodland plants have the lowest slope and the highest starting point. An average compartment already has a third of the woodland plants, and adding more woods, especially woods that are similar to those you already have, doesn't add many species. The average compartment has fewer wetland species than woodland ones and fewer open habitat species than wetland ones, and adds these at about the same rate. It has even fewer aliens, and adds species with area at the fastest rate of all.

A possible interpretation of these results is that, at least in our landscape, it is easier to gain species by adding small patches of relatively distinct habitats (different types of openings and wetlands) than by adding large areas of a common habitat you already have. Finding new habitats to search, most botanists would probably agree, is more rewarding than looking for new species in habitats you have already searched.

DIVERSITY SLOPES OF DIFFERENT SUBFLORAS



The mean number of species per compartment and the total number of species for the 33 compartments for four subfloras at HF, shown on a log-log scale. The lines connecting the points are a rough estimate of the power-law fits.

20 *How do species frequencies vary?*

By the species frequency we mean the number of compartments that a species is found in. The species frequency is a measure of how well distributed the species are but not how abundant they are: a species that was locally abundant could have a low frequency, and one that was scarce but widely distributed could have a high one.

The graphs show the distributions of frequencies. The number of species at a particular frequency is plotted against the frequency. The bars at the left of the graph represent the low frequency species, the bars on the right the high frequency ones. As in most botanical surveys, there are far more low-frequency species than high frequency ones.

The extent to which this is true differs from group to group.

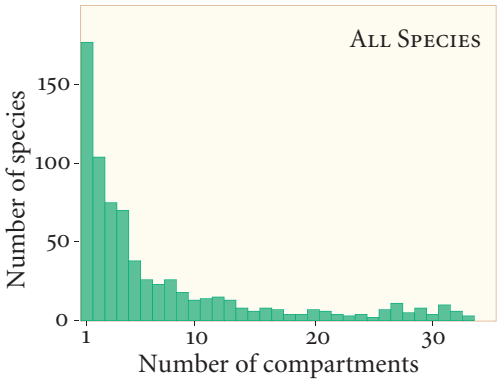
The aliens, which as we have seen are concentrated in the open habitats, tend to occur at low frequencies in small patches of uncommon habitats: 51% only occur in one or two compartments, and 87% in 8 compartments or less.

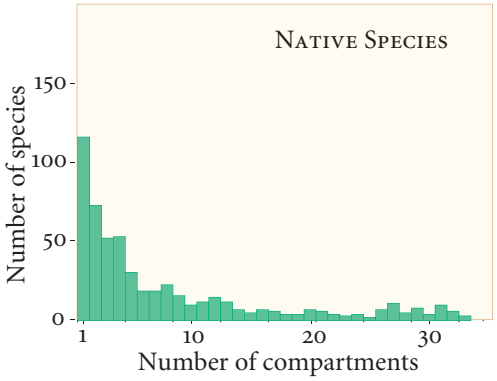
The native species of open habitats and wetlands have similar distributions but with more common species. About 80% of them were seen in 8 compartments or less, and few of them were seen in more than 20 compartments (we have a number of dry, continuously forested compartments.) But the native wetland plants have 12% of their species in the 11-20 compartment range, and the open habitat plants have 16%. The aliens, in contrast, have only 4% of their species in this range.

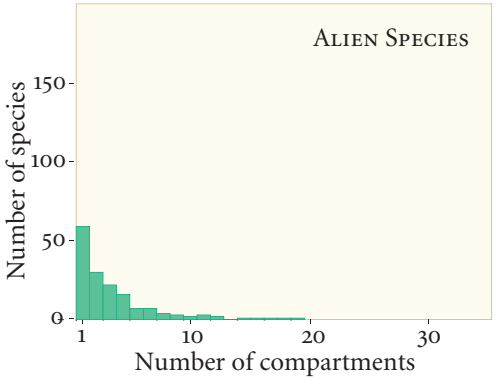
What this means, is that while a few aliens are common, most are not. Our open communities are about as well stocked with uncommon aliens as forests and woodlands are with uncommon natives.

The distribution of forest species is somewhat different. Forests occur in all compartments, and so, relative to the other groups there are fewer low-frequency species and more high frequency ones. The forests still have many local species: about 50% of the native forest species, say 125 species, are found in 8 compartments or less. But they also have many common ones: 58 native forest species, 26% of the total, are found in over 20 compartments each.

Frequency distributions like those for the wetland and open species are common: high peaks of rare species and skinny tails of common ones are biological universals, at least when you are sampling small areas that have big pools of potential species. The height of the peaks arise from the same two processes that govern the rise of the the species area curve: the rates at which, as your sampling procedes, you encounter special habitats on the one hand and rare generalists on the other. Interestingly, these distributions don't change much as you increase the sampling effort. As







Above, Species frequency histograms for the whole flora and native and alien subfloras. Right, the same for different ecological groups. Each graph shows the number of species at different frequencies. The upper graph, for examples, says that about 165 species are restricted to a single compartment each, that about 100 species occur in 2 compartments each, and so on.

you sample more some species become more common (you find more coral-roots), but in the process you also encounter new species that were even rarer than coral-root and the overall shape of the curve doesn't change much.

Distributions like that of the native forest species, with a broad right-hand tail or even the suggestion of a right-hand peak, are less well known, but may still be common if you look at uniform communities with limited species pools. In such communities, sampling over larger area increases the frequencies of the common species but does not introduce new rarities, because after a point there are no new rarities to be found.

Older floras often had a section in which the authors listed range-limit and geographically-specialized species—the northern and southern species that went no farther, the coastal species, the species confined to a particular valley or particular side of a mountain range. We could do the same, identifying *Vaccinium myrtilloides* and *Maianthemum trifolium* as northern species, *Aronia arbutifolia* and *Aster nemoralis* as coastal, *Xyris difformis* as southern, *Schizachne purpurascens* and *Carex plantaginea* as western and montane, and so on.

This sort of analysis is very botanical—it labels the species and puts them in boxes—but it doesn't tell you very much. Every flora will contain species of different geographical affinities and will likely contain range limit species as well. But a few geographic specialists don't make a specialized flora. The interesting questions are how many there are, what they say about the predominant character of the flora, and how they relate to the larger geographic patterns in which the flora is embedded.

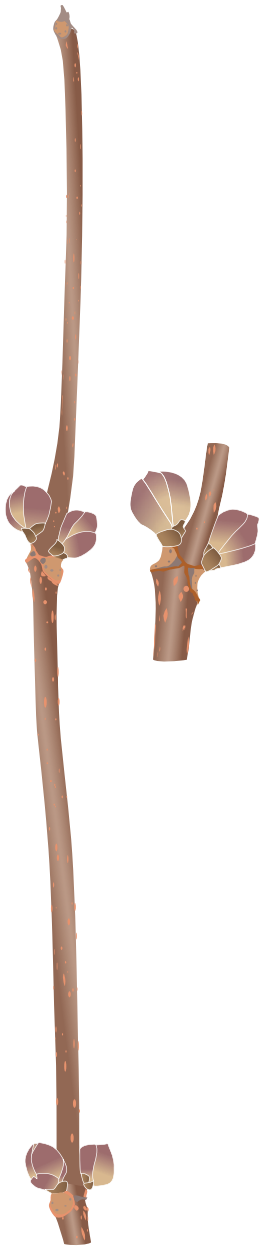
In this section we sketch out what a quantitative geographic analysis might look like for Massachusetts and Harvard Forest. We show a species-area diagram for the state flora; estimate the geographic gradient crudely with a range-limit analysis; then estimate it more accurately with a centroid analysis; and finally, note that the floras of relatively small areas, like HF, tend to lose their geographic character because of sampling effects and are hard to place accurately on these gradients.

Regional Species-Area Relations

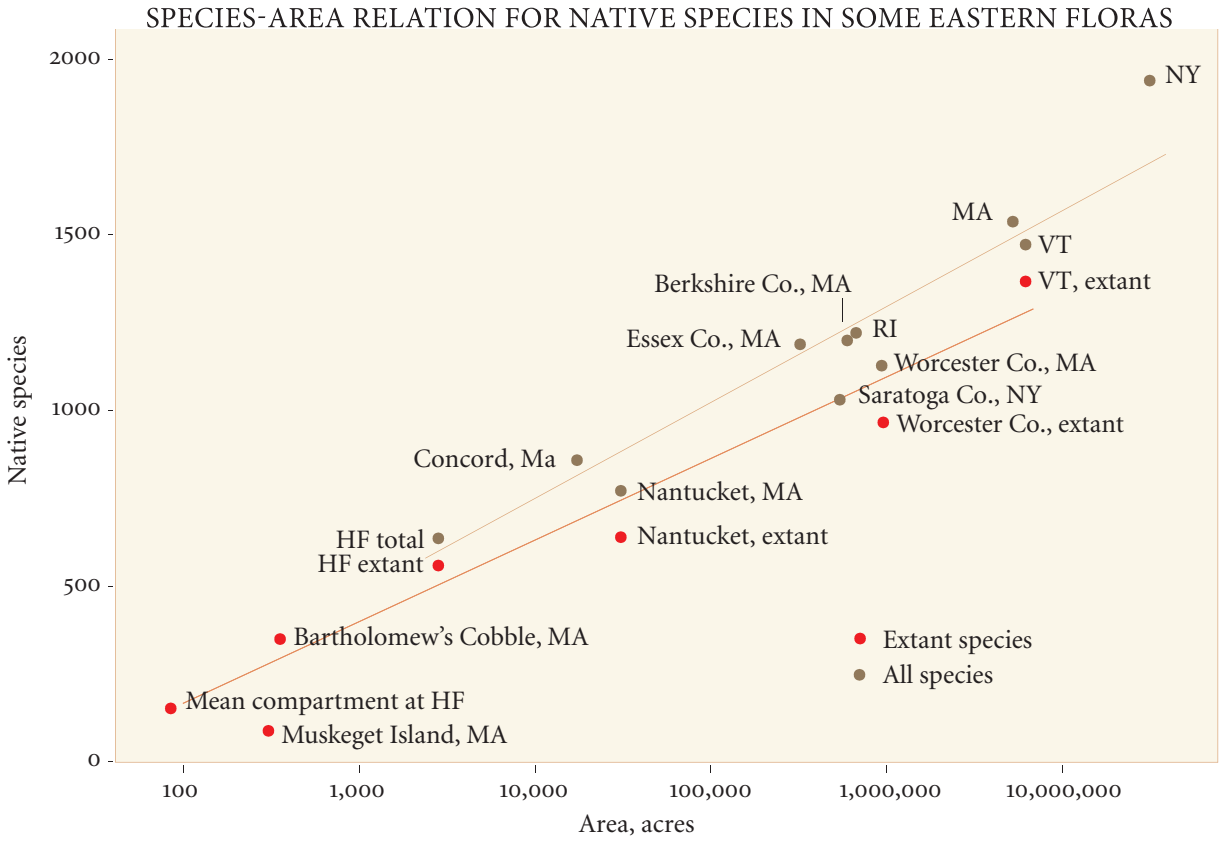
Relationships between the area of a flora and the number of species it contains are often impressively regular. The source of this regularity has been much speculated about by theorists and imitated by modelers but is still not understood. What is clear is that regular species-area relations often extend over many orders of magnitude and that, whether the causes be evolutionary, edaphic, or stochastic, they suggest that there are some important and unobvious large-scale forces organizing biological communities.

The graph on the right hand page shows the species-area relation for HF and several nearby areas for which we have recent data. The brown dots are total floras, the red ones extant floras. Both the total floras and the extant floras seem to scale as the log of area, which is to say more slowly than the power-law relationship we found in the randomized compartment data (p. 84) and which has been widely reported in other species-area studies. The relation-

RED ELDERBERRY



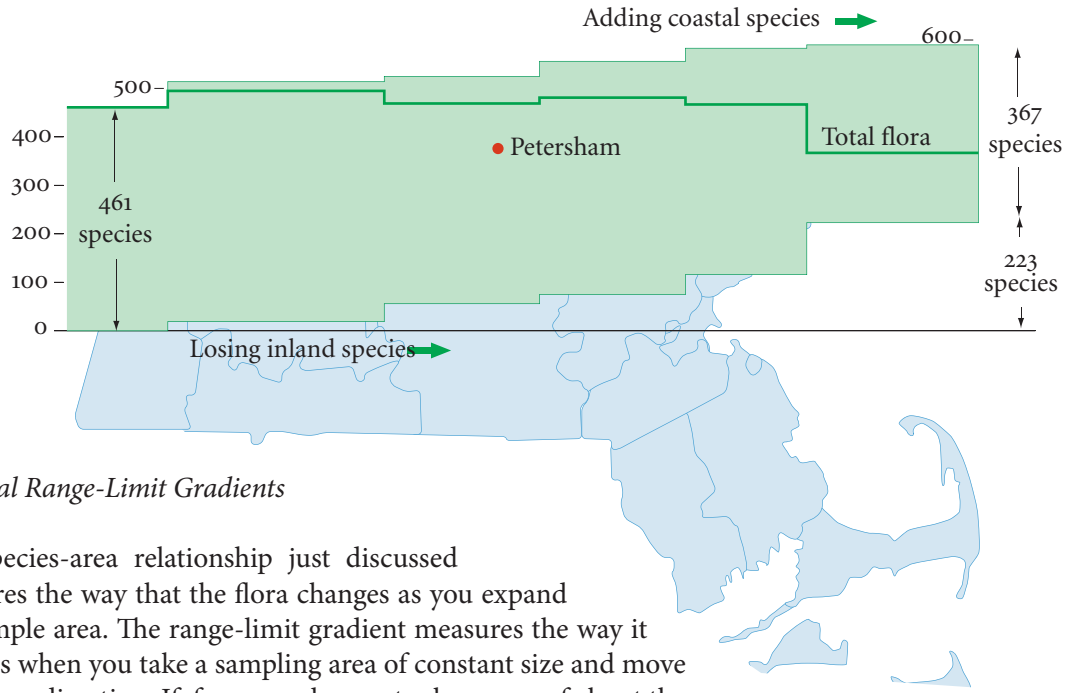
The red elderberry is a geographically specialized species in Massachusetts, common inland and in the mountains, rare on the coastal plain and absent from the outer coast. We assign it a geographic index of 4.0, on a scale that runs from 1 to 6 (p. 94).



ship extends over six orders of magnitude which, even granting that logarithmic fits are easier than linear ones, is pretty good for ecology.

Interestingly, the deviations from the lines are in many cases reasonable. Muskeget is a treeless sandbar island with little on it except dune grass and poison ivy. Nantucket, Saratoga, and Worcester Counties are all flat counties with somewhat limited ranges of communities. Vermont is slightly poorer than Massachusetts because what it gains from having mountains doesn't make up for what it loses by not having a coastal plain. And New York State may be rich relative to its area because it has a wide latitudinal range and picks up many southern species in Long Island and along its southern tier.

Sources: Bartholomew's Cobble, Jenkins and Williams, 2003; Berkshire County, Weatherbee, 1996; Concord, Eaton, 1974; Essex County, Harris, 1975; Muskeget Island, Wetherbee et al., 1972; Nantucket, Sorrie and Dunwiddie, 1996; New York, Mitchell and Tucker, 1997; Rhode Island, Gould et al., 1998; Saratoga, Howard, 1995; Vermont, Jenkins and Zika, 1995; Worcester County, R. Bertin, 2005 unpublished data. The floras differ in their taxonomies; were these corrected to the conservative taxonomy we have used in VT and HF, the medium sized floras might lose a few tens of species, and the large ones 50 or more. The lines are for reference only and have not been fitted to the data.



The east-west turnover of monocots in Massachusetts. Going from west to east you add 139 species in 160 miles, for a gradient of 80 species per 100 miles. Simultaneously you lose 223 species, for a gradient of 139 species per 100 miles. The net turnover is -59 species/100 miles.

Regional Range-Limit Gradients

The species-area relationship just discussed measures the way that the flora changes as you expand the sample area. The range-limit gradient measures the way it changes when you take a sampling area of constant size and move it in some direction. If, for example, you took an area of about the size of Berkshire County and moved it from west to east across Massachusetts, it would gradually lose western species acquire eastern species. There is thus a gradient in species composition that may be quantified as the number of ranges entered or exited per mile. If we can quantify this gradient, we will in effect have a coordinate system that will allow us to relate local floras to regional ones, and which may allow us to measure future rates of floral change.

Range limits are, however, quite difficult to measure, both because range limit populations are poorly known, and because species are discontinuous at their range limits and so it is hard to say just where the limits really are.

The diagrams on this and the next pages show approximate range-limit gradients determined from county-level data. The green shapes in the diagrams are turnover polygons. The width of the polygon at any point is the number of species in the county. The steps at the edges of counties represent gains or losses of species. If, in the diagram above, you imagine yourself going from west to east, the steps up in the top border represent eastern species gained, and the steps up in the lower border represent western species lost. The upward shift of the polygon shows the turnover (replacement) of western species with eastern ones. The taper of the polygon shows the net loss or gain of species.

As with the measurements of historical gain and turnover in the HF it is useful to relativize the gain and turnover and express them as percentages of the starting flora. In these terms as you travel from west to east across Massachusetts you lose 30% of the mono-

cot flora per 100 miles, gain 17% per 100 miles, and have a turnover of 17% and a net loss of -13%.

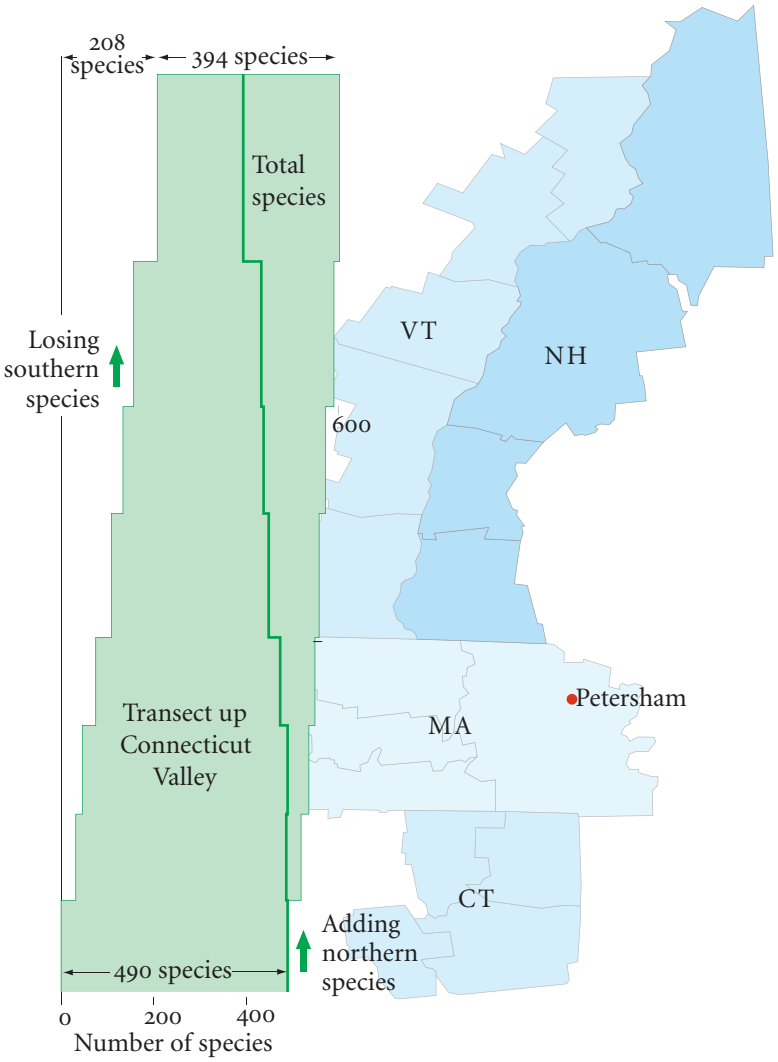
The diagram at the right shows a turnover polygon for the Connecticut River Valley. As you move north from Long Island Sound to the Canadian border you lose 15% of the monocot flora per 100 miles, gain 8%, and have a turnover of 8% and a net loss of -7%.

Note two things here. First, although we normally think of the northward loss of species as the strong geographical gradient in our flora, the west to east gradient is twice as strong as the south-north one. And second, the species loss is only half the story. In both directions the gradient consists of both turnover and loss, and the turnover rate is, as best we can measure it, a little higher than the loss rate.

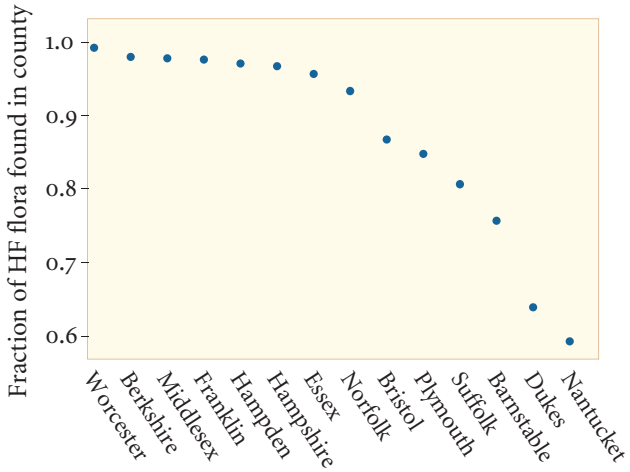
Can we locate the HF *flora along these gradients?*

Because the HF flora contains mostly wide-ranging species, we can only locate it in a very generalized way. The graph below shows the fraction of HF species that are found in other Massachusetts counties. Worcester County is the best fit, but almost any of the other five inland counties will do as well. In this case, the geographical gradient tells us that HF is unlikely to be in a coastal county but not much more than that.

TURNOVER OF NATIVE NEW ENGLAND MONOCOTS IN THE CONNECTICUT VALLEY

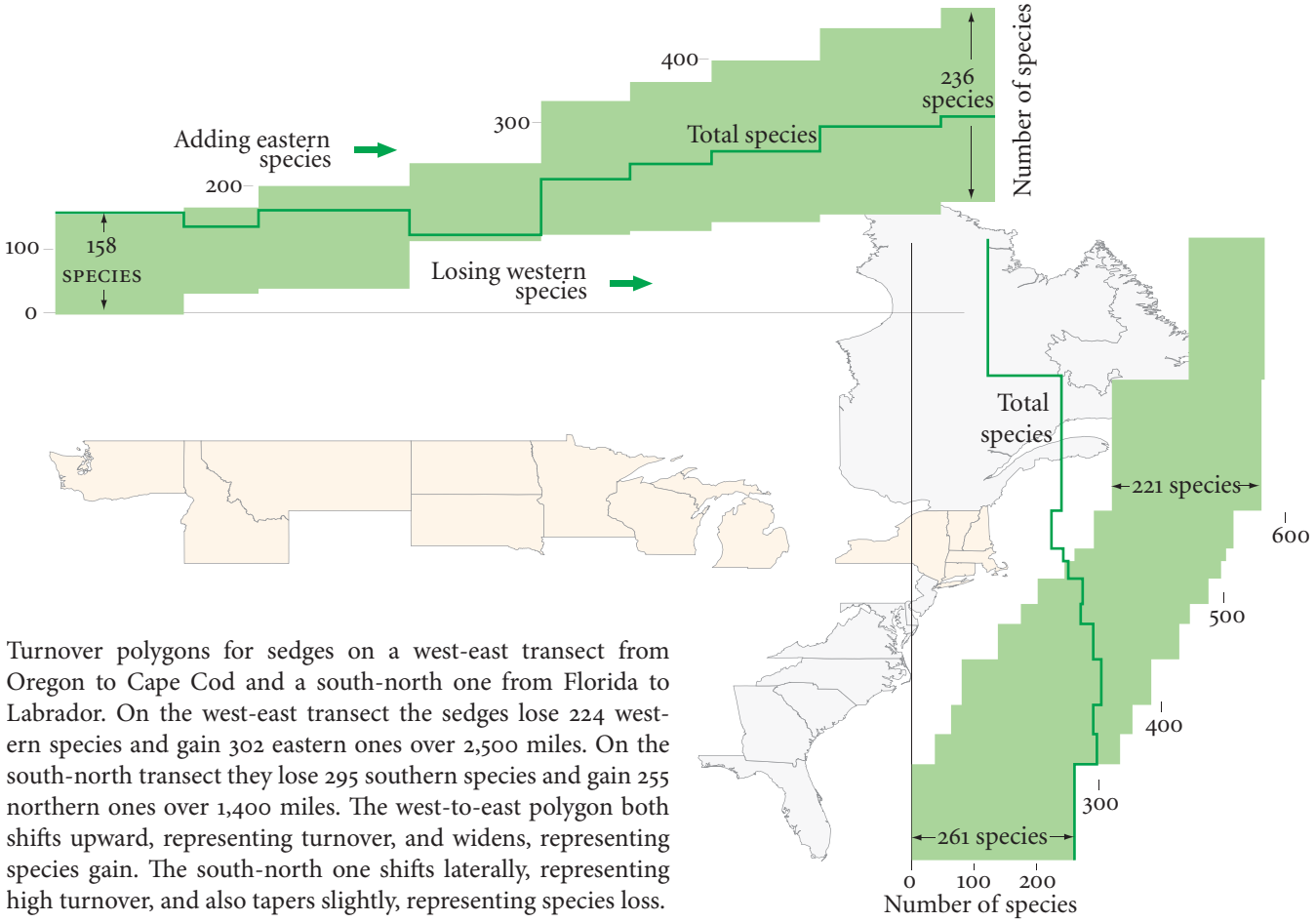


SIMILARITY OF HF NATIVE FLORA TO MASSACHUSETTS COUNTY FLORAS



The north-south turnover of monocots in the Connecticut River Valley. As you move north you gain 112 species in 280 miles for a gradient of 40 species per 100 miles. Simultaneously you lose 208 species, for a gradient of -74 species per 100 miles.

TURNOVER OF NORTH AMERICAN SEDGES ON TWO TRANSECTS



Turnover polygons for sedges on a west-east transect from Oregon to Cape Cod and a south-north one from Florida to Labrador. On the west-east transect the sedges lose 224 western species and gain 302 eastern ones over 2,500 miles. On the south-north transect they lose 295 southern species and gain 255 northern ones over 1,400 miles. The west-to-east polygon both shifts upward, representing turnover, and widens, representing species gain. The south-north one shifts laterally, representing high turnover, and also tapers slightly, representing species loss.

How do our regional gradients compare with continental ones?

We have calculated continental-scale species turnover rates for four groups, the trees, ferns and allies, sedges, and Liliid monocots (lilies, irises, orchids, etc.), using data from the *Flora of North America.* The turnover diagram for the sedges is shown above and the turnover rates, expressed as percentages of the flora at the starting point, are given in the table at right and shown in the graph on the top of the opposite page, which uses the same format as the historical turnover graphs on p. 72.

Two things stand out from these graphs. The first is that the south-to-north turnover and gain rates, calculated rather crudely at the state scale for the whole east coast, are comparable to the rates for the Connecticut Valley, calculated at the county scale. An estimate of 5% geographic turnover and 5% species loss per hundred miles from south to north would be roughly true for many groups.

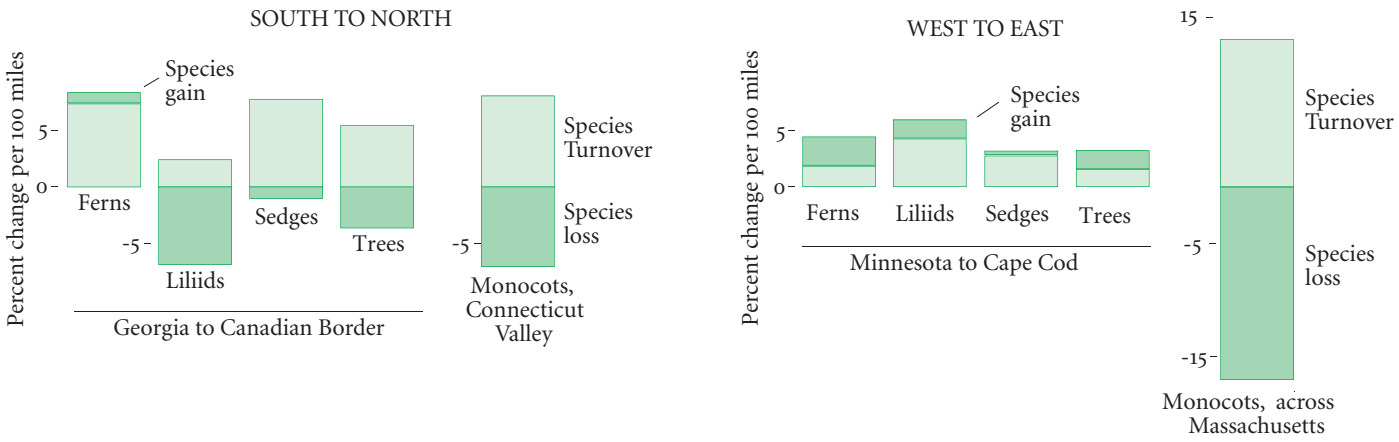
West to East Turnover Rates, Minnesota to Cape Cod

	Turnover	Net Change
Sedges	3.0%	0.3%
Liliids	4.2%	1.6%
Ferns	1.8%	2.5%
Trees	1.5%	2.2%

North to South Turnover Rates, Georgia to Canadian Border

Sedges	7.7%	-1.0%
Liliids	2.4%	-6.8%
Ferns	7.3%	0.9%
Trees	5.4%	-3.6%

GEOGRAPHIC TURNOVER AND GAIN, CONTINENTAL VS. NEW ENGLAND



Geographic turnover and gain at two scales. Geographic turnover is the percentage of the flora lost and replaced by new species per hundred miles. Species gains and losses are the percent changes in the flora that are not compensated for by turnover. Thus if a flora of 100 species loses 5 species in a hundred miles and gains 10, it will have a turnover of 5% and a net gain of 5%. The results for ferns, liliids, sedges, and trees are calculated from state-level data in the *Flora of North America.* The results for New England monocots are calculated from data in Magee and Ahles, 1999.

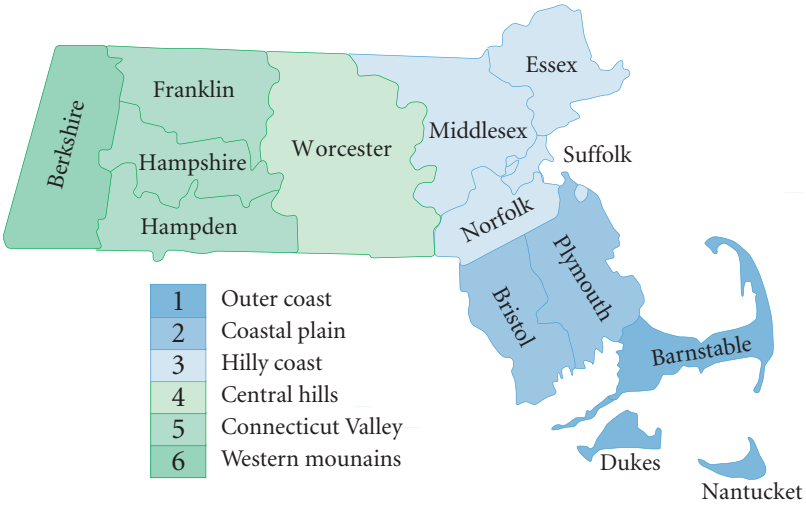
The second thing is that the local and continental west-to-east rates are not comparable. The continental-scale rates, calculated by states, are on the order of 2-3% turnover and 1-2% species gain per hundred miles. The regional rate, calculated from Massachusetts county data, is five to ten times higher, and shows a striking west-east loss of species not picked up in the state data.

Thus the latitudinal rates at the regional scale (260 miles) and the continental scale (1000 miles) are pretty well coupled. But the longitudinal rates are not. There is a sharp reverse gradient across Massachusetts at the regional scale (160 miles) that does not occur at the continental scale (1250 miles). This suggests that, when county data become available for larger areas, it would be interesting to reexamine the east-west gradient and see if other local anomalies occur.

This concludes the analysis of range-limits. As mentioned above (p. 90), range limits are an easy but imperfect way of looking at species distributions. Essentially they focus our attention on a species' edges, where it is uncommon and hard to map, and ignore the center of the distribution, which is biologically more important and much easier to map.

The analysis in the following sections attempts to get around these problems by looking at the centroids of species ranges instead of their edges. The procedure is, in concept, a direct ordination in two stages. First, each occurrence of a species is assigned a geographic weight depending on the county that it occurs in, and then the weights for each species are averaged to produce a geographic index for that species. Second, the geographic indices of all the species in a county are averaged to produce a geographic index for the county. In a formal ordination this would be continued iteratively: the geographic indices computed for the counties would become the weights for a new calculation of species indices and so

GEOGRAPHIC WEGHTINGS FOR MASSACHUSETTS COUNTIES



Geographic weights from 1 to six were assigned to the 14 Massachusetts counties, based on their distance from the outer coast. This created an ordination axis.

on. Here we are not looking for great precision, and one round of calculations suffices to get the information we need.

The Geographic Indices of Massachusetts Plants

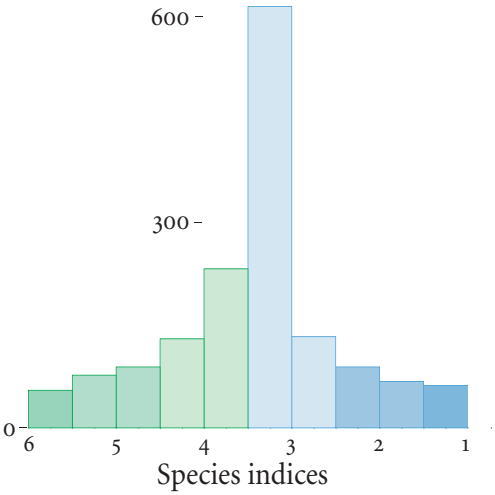
We did such an analysis for the native vascular plants of Massachusetts, using county-level data compiled by Bruce Sorrie and Paul Somers and supplied by the Massachusetts Natural Heritage and Endangered Species Program.

First we created an ordination axis. The 14 Massachusetts counties were divided into 6 groups based on ecological similarity to the outer coast, and each group assigned a weight. The weights are show on the map above. The weighting was a hypothesis, and could have been improved by iterating the procedure if the results were inconsistent. As it happened, the results were reasonably consistent and one pass seemed enough.

A geographic index is then computed for each species by taking the mean of the weights of the counties it occurs in. Thus *Linum intercursum,* a small coastal flax, occurs in Barnstable, Dukes, and Nantucket counties. Each county has a weight of 1 and so the geographic index of *Linum* is 1. Balsam fir, an inland and northern species occurs in Middlesex, Worcester, Hampshire, Franklin, and Berkshire counties. Its geographic index is (3+4+5+5+6)/5=4.6. And steeplebush spiraea, a wide-ranging species, occurs in all counties and has a geographic index of 3.14. (Not 3.5, because there are more coastal counties than inland ones.)

The distribution of the geographic indices of 1549 native Massachusetts species is shown on the at right. The right-hand tail,

GEOGRAPHIC INDICES OF MASSACHUSETTS NATIVE SPECIES



Species were then placed along this axis by computing the mean of the geographic weights of the counties they occurred in. Species in the tails of the distribution have low standard deviations and are geographic specialists, occurring in only one or two counties. Species in the central peak have high standard deviations and are mostly generalists, occurring across the state.

the species with an index less than 3, are mostly coastal species. Virginia chain fern, goat's rue, and birdsfoot violet, for example, all have coastal-centered (though not strictly coastal) distributions and have indices of 2.92. And likewise bloodroot, thimbleberry, and cut-leaved goldenrod, all plants with inland and upland distributions, have indices of 4.11.

The big bunch of plants with indices between 3 and 4—796 species, 51% of the flora— are mostly generalists found in many counties.

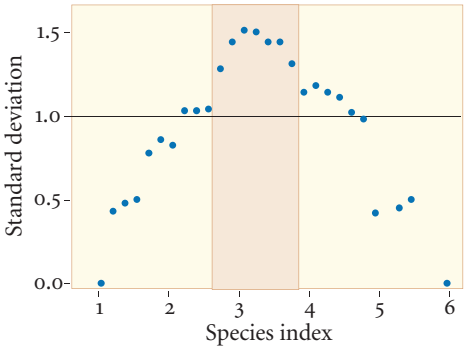
This can be seen by calculating the standard deviation of the geographic index for each species. The standard deviations range between 0 (for species found in one county, or several counties with the same weight) to 1.60 for species found in all counties. As shown in the graph, the curve of standard deviation against geographic index peaks sharply, showing that the wide-ranging species (with standard deviations around 1.3 or more) are confined to a narrow band of geographic indices centered on 3.1.

The abundance of generalists in our flora was a surprise. Distributions of species frequencies for small areas, like the distribution of compartment frequencies on p. 86, usually have a left-hand peak, meaning more species are rare than are common. In contrast, the distribution of county frequencies is reversed: more species tend to be found in a lot of counties than in a few counties, and 349 species, 22% of the flora, are actually found in all the counties.

The reversal of the frequency curve is a result of using sampling areas that are large relative to the species pool being sampled. When you sample small areas, the frequency approximates the abundance. High-frequency plants are found in a lot of places, and are usually reasonably abundant. But when you sample large areas like counties, the frequency no longer measures the abundance, but rather the uniformity of the geographic distribution. Thus both the abundant species red maple and the rare species arethusa are found in all 14 Massachusetts counties, and have county frequencies of 100%.

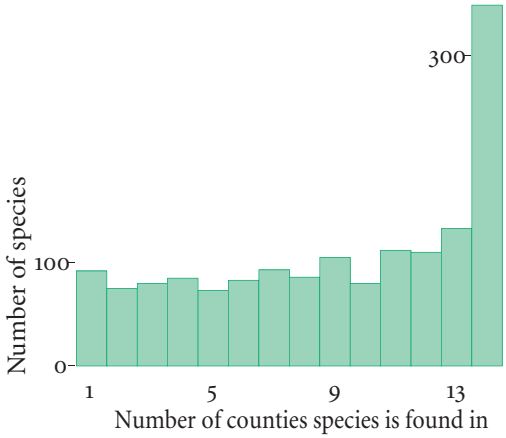
This result suggests an interesting way of looking at county-level frequency data. If you imagine starting with a fairly small sampling size, say 1000 acres, and gradually expand it to the size of a county, around 500,000 acres, what you are in effect doing is taking the uncommon but widely distributed species and pushing them to the right hand side of the frequency-distribution graph, where they pile up and form a right hand peak. In effect this expands the left hand side of the graph, reducing the peak but affording more detail. Whether this detail is useful depends, of course, on how you plan to use it.

STANDARD DEVIATION OF THE SPECIES INDEX



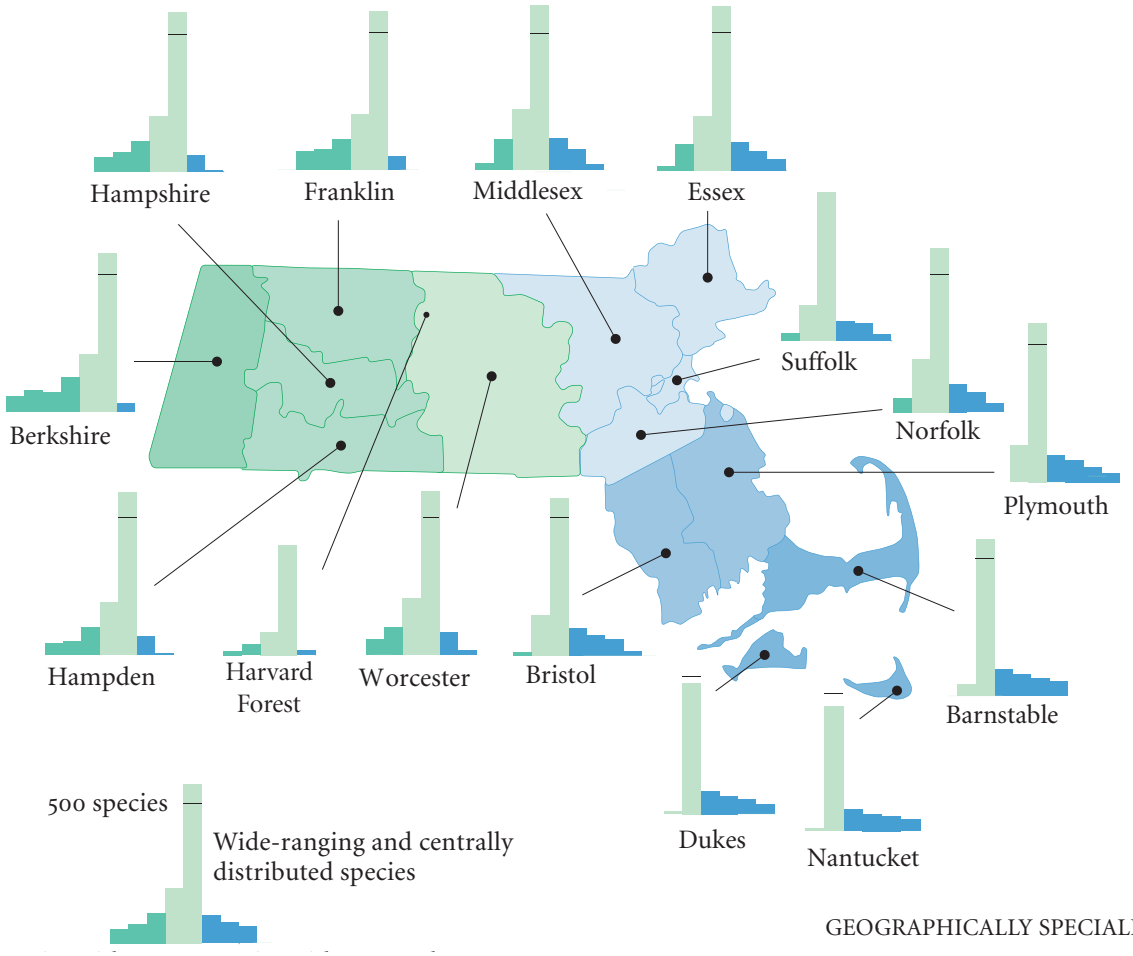
The mean standard deviation of the species indices for Massachusetts plants, averaged over intervals of 0.2. A low standard deviation means that the species is restricted to a few counties; a high one means it is spread across the state. The mean standard deviations of the species in the brown band are high, meaning that most species in the band are spread out across the state, rather than being concentrated in the center.

COUNTY FREQUENCY DISTRIBUTION OF MASSACHUSETTS NATIVE SPECIES



The distribution of county frequencies for native species in Massachusetts. The curve climbs to the right: more species are found in a lot of counties than in a few.

DISTRIBUTIONS OF GEOGRAPHIC INDICATORS FOR MASSACHUSETTS COUNTIES

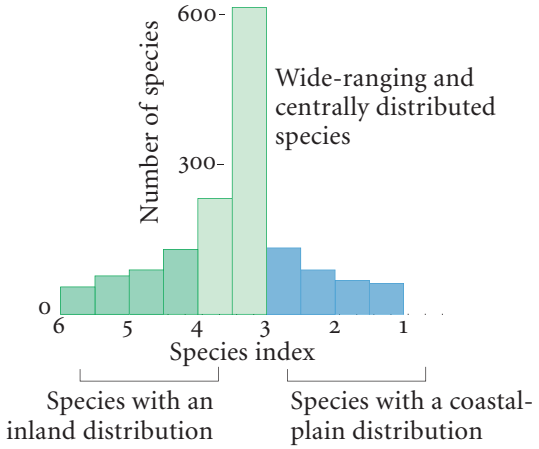


Geographically Specialized Species in the Massachusetts Flora

In our case, the county-level frequencies are very useful because they tell us that the central peak, between 3.0 and 4.0 on the histogram contains mostly wide-ranging species and the two tails, below 3 and above 4, contain mostly geographically specialized species.

Using this idea, we can get a picture of the geographical gradient across Massachusetts by plotting the histograms of species index for the species in each county and then coloring them to show the coastal and the inland species. The map above shows the results. As expected, the coastal species (right-hand tail, in blue) decrease and are replaced by inland species (left-hand tail, in green), as you move inland and westward.

GEOGRAPHICALLY SPECIALIZED SPECIES



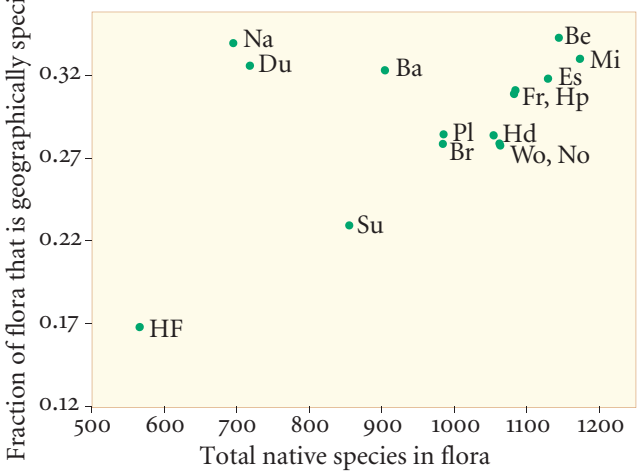
The distributions of the species index for the 14 Massachusetts counties. To a first approximation the species with an index of less than 3 may be regarded as coastal species and those with an index of greater than 4 as inland species.

Where does Harvard Forest fit on the coastal-inland gradient?

Looking at the map, the histogram for HF is generally similar to those for Worcester and Franklin Counties but has smaller tails. Harvard Forest thus has lots of wide-ranging species and, compared to the counties around it, few geographic specialists.

This turns out to be an example of a general sampling effect, shown in the graph at right, which plots the percent of the flora that is geographically specialized (in the tails of the species geographic index distribution) against the total size of the flora. HF and the mainland counties in Massachusetts fall on a line. This suggests that specialists tend to be rare, and so small areas have fewer of them than larger areas. The Cape and islands plot above the line: they are, in a sense, almost all sea coast, and have smaller floras with fewer wide-ranging species.

GEOGRAPHIC SPECIALISTS VS. TOTAL FLORA



The percent of geographically specialized species (coastal + inland) in a county generally scales with the size of the flora, except for the outer coast where there are fewer wide-ranging species. Harvard Forest, with a small area, has proportionally fewer specialists.

Computing the County Indices

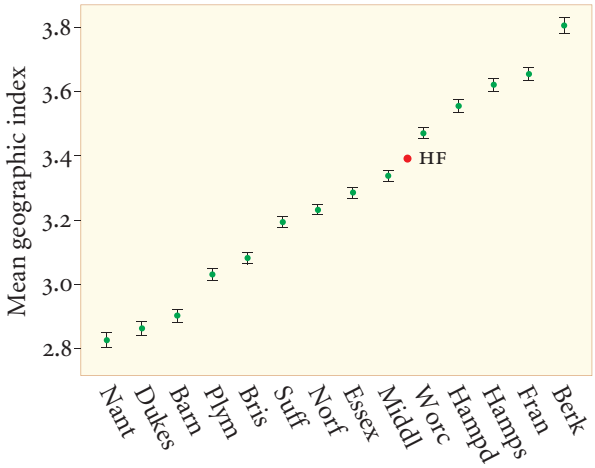
The histograms shown on the map give us a detailed picture of the distribution of geographically specialized species in Massachusetts. To simplify the picture, we continue the ordination by averaging the geographic indices for all the species in a county, giving a single geographic index for the county.

When we do this we get the plot at right. The order of the counties is reasonable, as are the groupings that occur. All this suggests that our original choices of geographic weights were plausible. There is, in other words, a geographic gradient across the whole state, and the farther northwards and inland a county extends the higher its index.

This has some biological significance: it says that the flora of the state is best described as lying on a gradient rather than separating into regional subfloras. Or put another way, there are enough species and their centroids are distributed evenly enough that they can be used to create a one-dimensional coordinate system extending across the state.

Measured by that coordinate system, the Harvard Forest has a geographic index of 3.4, midway between those of Middlesex County (3.3) and Worcester County (3.5). Thus, in this example at least, a local flora of sufficient size can be located fairly well in the state using its geographic index.

MEAN GEOGRAPHIC INDICES OF MASSACHUSETTS COUNTIES

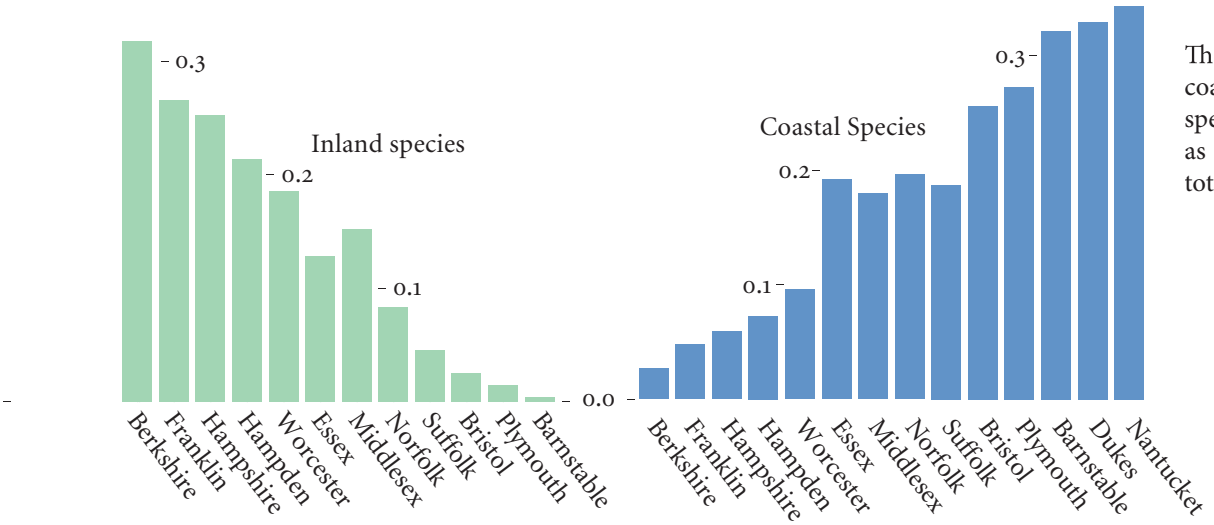


The geographic indices of the 14 counties, computed by averaging the species indices for all the species in the county.

The geographic indices of the counties cluster between 2.8 and 3.8, indicating that they are dominated by the wide-ranging species with index values near 3.1.

To look more specifically at the geographically specialized species, we assume, as an approximation, that all the species with geographic indices of 3 or less are coastal species, that all those with indices of 4 or more are inland species, and that everything in between 3 and 4 is wide-ranging. We then calculate the fractions of coastal and inland species in the flora of each county, shown in the bar graphs below.

FRACTION OF THE FLORA THAT IS GEOGRAPHICALLY SPECIALIZED



The number of coastal and inland species, computed as a fraction of the total flora.

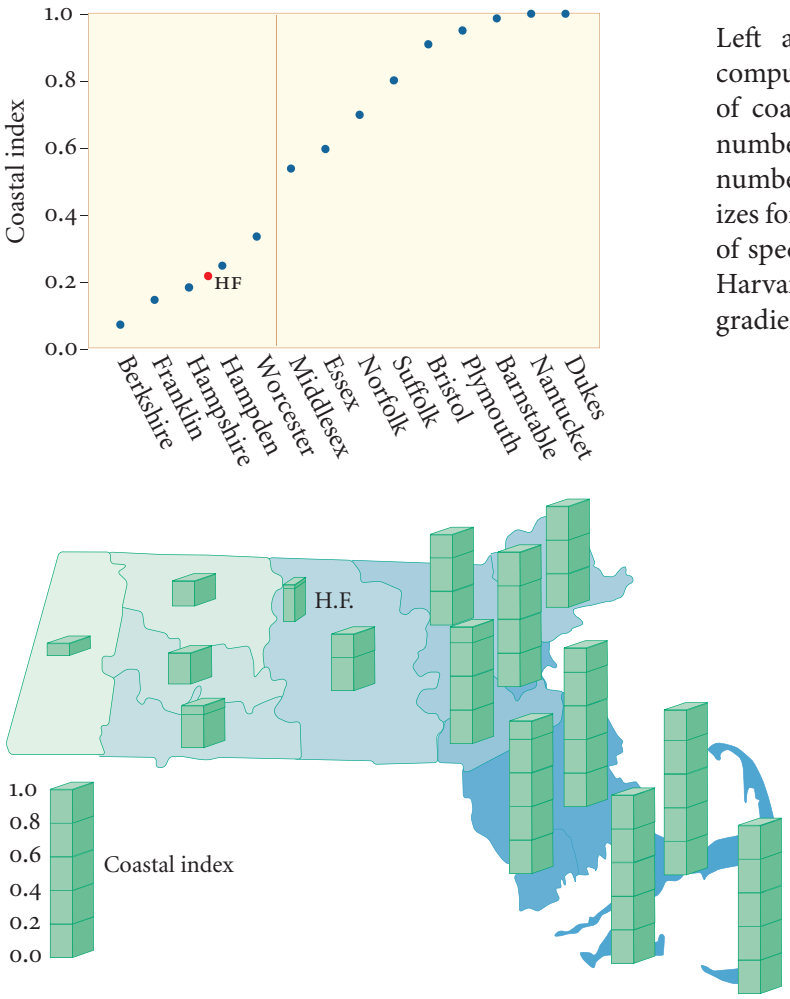
The result has a pleasing symmetry: as you move northwards and inland, the fraction of coastal species decreases from 33% to about 2%, and the fraction of inland species increases in almost the same order, from 0% to 32%. Thus the coastal-inland gradient isn't just the loss of one group of species but rather the replacement of this group with another—a turnover gradient rather than a diversity gradient.

This seems to confirm what the range-limit analysis on p. 90 suggested; that there is a steep west-east gradient in floristic composition across Massachusetts, on the order of 10-20% of the flora per 100 miles, that much exceeds the continental-scale gradient of a few percent per hundred miles.

Thus the coastal-inland gradient is the sum of two processes, the loss of coastal species and the addition of inland ones. We can combine these in a single index (and at the same time ignore the common species altogether) by calculating the ratio of the number of coastal species to the number of coastal species + inland species.

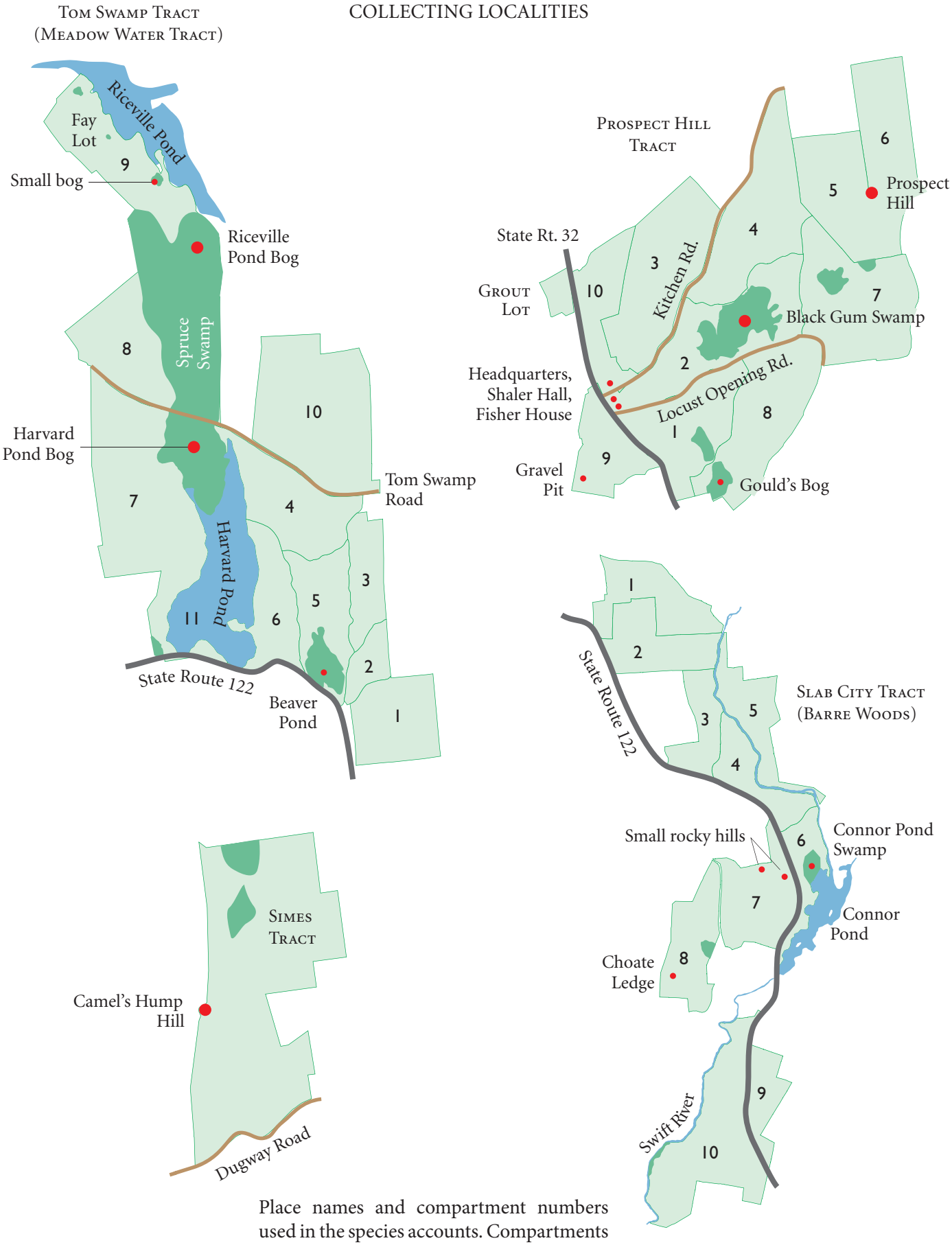
Put graphically, this is the number of species in the coastal tail of the distribution of the geographic index relative to the number of species in both tails. The result produces a "coastal index," a standardized measure of the importance of coastal species in the geographically specialized portion of the flora. It varies evenly across the state, only showing an abrupt change when we go from the counties (Worcester and west) that are more than 50 miles from the sea. The results are shown below. Harvard Forest has an index of 0.22, showing that even though it is poor in indicators, the indicators that it does have suffice to place it reasonably well on the coastal-inland gradient. Its calculated position, between Hampden and Hampshire Counties in the Connecticut Valley, lies to the west of its geographic position in western Worcester County. This is reasonable: the cliffs on Camel's Hump have a number of calcareous species that are common in western Massachusetts but otherwise rare in Worcester County.

COASTAL INDICES FOR MASSACHUSETTS COUNTIES



Left and below, a "coastal index," computed as the ratio of the number of coastal species to the sum of the number of coastal species plus the number of inland ones. This relativizes for differences in the total number of species, and allows small areas like Harvard Forest to be placed on the gradient more accurately.

COLLECTING LOCALITIES



Place names and compartment numbers used in the species accounts. Compartments are designated by a single-letter prefix; thus P10 is Prospect Hill Compartment 10.

PART II: SPECIES ACCOUNTS

The main entries in this section give the species for which we have good evidence—a specimen or a recent field record by a knowledgeable observer—that they occur or have occurred as native or naturalized plants at Harvard Forest. The bracketed entries are species that are interesting to us but whose presence at HF has not been established. Some are unvouchered historical records, some field observations whose identification is in doubt, some species that may have been present but not become naturalized, and some vouchered species that are from outside HF.

Full lists of unvouchered and misidentified species may be found in Appendix I, p. 246. An asterisk after a species name indicates that the species is introduced or adventive in eastern North America. The maps give the compartments in which we observed the species.

Abies balsamea

Abies balsamea, BALSAM FIR. (Pinaceae) A native conifer of cold woods, uncommon in central Massachusetts; occasionally planted at HF in the first half of the twentieth century. First seen wild at HF by J. McLachlan in T1 in the early 1990s. Currently known from the conifer swamp at the southern end of T9, where it is presumably native. A few small saplings, of unknown provenance, also occur along Tom Swamp Road in T4 and in the Flint Lot.

Abutilon theophrasti

Abutilon theophrasti,* VELVET-LEAF MALLOW. (Malvaceae) A tall alien weed with velvety heart-shaped leaves, long known in the Northeast but recently increased in abundance and now a common weed of cornfields and open fertile ground. Not previously reported from HF; we found it in the pasture in P2 and on the filled-in pool by the Fisher House in P10.

Acalypha rhomboidea

Acer pensylvanicum

Acalypha rhomboidea, COMMON THREE-SEEDED MERCURY. (Euphorbiaceae) A common, somewhat weedy native herb of open moist soil, recognized by the small flowers in palmately lobed axillary bracts. Not previously reported from HF and apparently uncommon here; we have records from the gravel pit in P9, and from the grounds of the Lyford House and by the Pole Barn in P1.

Acer pensylvanicum, STRIPED MAPLE. (Aceraceae) Common understory tree of mixed forests, with striped bark and large heart-shaped leaves. It is perhaps most typical of openings on moist but somewhat infertile soils, but has a wide ecological range and is found in a wide range of forest communities, with associates ranging from white oak to black spruce. J.G. Jack (1911) said that it was frequent and scattered through the woods at HF; we found it in 26 compartments, and would describe it in much the same way.

Acer rubrum

Acer saccharum

Acer rubrum, RED MAPLE. (Aceraceae) A common tree of mixed forests, shores, and open wetlands, often locally dominant in young successional forests. J.G. Jack (1911) said it was "very common, especially in low ground." We found it present in every compartment we examined and locally common in both wetlands and uplands.

Acer saccharum, SUGAR MAPLE. (Aceraceae) Common tree of mixed forests, preferring moist fertile sites. J.G. Jack (1911) said simply that it

was common and attained good size. We would call it locally common at present; it is found throughout HF but usually in small quantities and only dominant on moister or more fertile sites.

Acer spicatum, MOUNTAIN MAPLE. (Aceraceae) A characteristic shrub of openings in moist upland woods, generally similar to striped maple but with furry twigs and smaller and more coarsely-toothed leaves. It is uncommon in lowland New England, and mostly restricted to streambanks, wetland edges, and talus and boulder slopes. J.G. Jack (1911) noted that it was much less abundant than striped maple at HF. We found it very locally in the Prospect Hill and Tom Swamp Tracts and in the Simes Tract, and more frequently in the southern part of the Slab City Tract.*

Acer spicatum

Achillea millefolium,* YARROW. (Asteraceae) Weedy alien herb of dry open ground, frequent on roadsides and in open fields. First collected at HF by H.M. Raup from the Prospect Hill Tract in 1933. Found casually by us, mostly near roads, in 13 compartments.

Achillea millefolium

Actaea pachypoda, WHITE BANEBERRY. (Ranunculaceae) Native herb of moist fertile woods and wooded ledges with multiply compound leaves, white flowers, and white berries with a central spot. Occasional at HF: first collected by H.M. Raup from the east part of the Tom Swamp Tract in 1933; subsequently collected by W.D. Beal in 1947 in the same area and reported for Prospect Hill by C.E. Smith (1949), based on a collection that we did not see. Based mostly on records of sterile plants, which we determine by assuming that plants without hairs on the lower leaf surface are all *A. pachypoda,* it is now occasional in P9, S7, T9, and the Simes Tract, and rare in P1, P5, P6, P10, S1, S8, and in the Grout Lot, and likely elsewhere. Also called *A. alba,* an older name but one that, M.L. Fernald has argued, was apparently based on a published illustration of the European *A. spicata*.

Actaea pachypoda

Actaea rubra, RED BANEBERRY. (Ranunculaceae) Native herb of fertile woods, collected by W.D. Beal on a "road near an abandoned farm" in S8 in 1947 and reported by C.E. Smith (1949) from S7, based on a specimen that we did not see. Not definitely seen in our survey; we did see a red-berried *Actaea* in the backyard of Higginson House, but the plant was large and somewhat glaucous, and we think that it may have been a cultivar.

Adiantum pedatum, COMMON MAIDENHAIR. (Adiantaceae) Colony-forming fern of fertile moist woods and wooded ledges. Very local at HF: first collected by H.M. Raup from "woods east of the pond" in the Tom Swamp Tract; re-collected in T4, likely at the same site, by I.M. Johnston and W.D. Beal in 1947. We searched T4 several times. We found silvery spleenwort and *Carex pedunculata,* both calcium indicators, on hummocks in a seepage swamp there, but did not find either maidenhair nor any rich woods indicators on the slopes above.

Currently maidenhair is known from the east slopes of Camel's Hump in the Simes Tract and the rocky knoll in the southwest portion of S8; in both places it is associated with a number of rich-woods species. Maid-

Adiantum pedatum

*Other maples: J.G. Jack (1911) and H.M. Raup (1938) both listed *Acer negundo* (box elder) and *A. saccharinum* (silver maple) for Petersham. Jack noted that both were planted in town but neither are indigenous in the area. Neither occurs at HF.

enhair also occurs in the courtyard by the schoolhouse in P10, where it was presumably planted.

Aegopodium podagraria,* GOUTWEED. (Apiaceae) Introduced, colony-forming cultivar that has escaped or persisted locally in fields and along roads. Elsewhere it is considered an invasive species in lowland woods; at HF it is currently rare and local. Not reported in previous surveys; seen with other weedy species in P2 and P6, at the edge of a meadow in P9, and along the entrance road at the southeast corner of the Simes Tract.


Aegopodium podagraria

Agalinis paupercula, SMALL-FLOWERED GERARDIA. (Scrophulariaceae) Native annual herb of open, wet, sandy or peaty soil. Collected in 1937 by H.M. Raup at the north end of Tom Swamp and in 1947 by W.D. Beal from the shore of Riceville Pond; not seen in this study. This is the more widely distributed of the two *Agalinis* species reported from HF and the most common one inland; it may also be treated as a variety, *Agalinis purpurea* var. *parviflora,* of the next species.


Agalinis purpurea

Agalinis purpurea, PURPLE GERARDIA. (Scrophulariaceae) Native annual herb of open, wet, sandy or peaty soil. First collected at HF by H.M. Raup from the "margins of a bog" in the Fay Lot (T9) in 1933. Seen in two locations along the margins of Riceville Pond (T9) in this study. This and other *Agalinis* species were formerly placed in *Gerardia*, a name now used for a genus of the Acanthus family.

Agrimonia gryposepala, COMMON AGRIMONY. (Rosaceae) Tall native herb with animal-dispersed fruits, commonly growing in moist fertile ground in partial sun, and often found along trails. Uncommon and scattered at HF: first collected by H.M. Raup from the woods east of the pond in Tom Swamp in 1933, and subsequently by W.H. Drury from P6 in 1947. We have records from S1, T2, and Simes.


Agrimonia gryposepala

Agrostis canina,* VELVET BENT. (Poaceae) Awned alien rhizomatous grass, said to be used commonly in lawns and golf courses, but either overlooked or rare outside of cultivation. Known at HF from a single 1947 collection by W.D. Beal, near an abandoned farm site in S8.

Agrostis capillaris,* RHODE ISLAND BENT. (Poaceae) Alien rhizomatous grass, commonly sown in pastures and lawns and escaped casually to dry roadsides and open ground. At least occasional at HF: first collected in 1933 by H.M. Raup, from a woods road in the Prospect Hill Tract and a "gravel island in pond" in the Tom Swamp Tract. We recorded it at the edges of six compartments, and it is doubtless found in a number of others. Formerly called *A. tenuis.*


Agrostis capillaris


Agrostis gigantea

Agrostis gigantea,* REDTOP. (Poaceae) Alien rhizomatous grass, commonly sown in pastures and lawns and widely escaped in moist ground. Similar to Rhode Island bent but taller and redder, with longer ligules, wider leaves, and more basal spikelets on the panicle branches. Not well documented for HF. Not listed for Petersham by H.M. Raup (1938) but doubtless here in his time. First listed for HF by C.E. Smith (1948), but apparently not vouchered. Seen along roads and in open ground in six

compartments in this survey, and likely found in others. Formerly called *A. alba* and *A. stolonifera* var. *gigantea*; both the native and cultivated *Agrostis* are highly variable and correspondingly difficult to separate and name.

Agrostis hyemalis sensu lato, TICKLEGRASS. (Poaceae) Native perennial grass of open wet soils, found both on mineral soils and peats. Apparently uncommon at HF. First collected by H.M. Raup from the eastern part of the Tom Swamp Tract in 1933; re-collected along the eastern part of Tom Swamp Road in 1947. These records are notable because *A. hyemalis* is a grass of open habitats, and this portion of Tom Swamp is now densely wooded. We have records from a gravel pit in P9, wetlands in T5, S3, and the shores of Riceville Pond in T9. Here treated as including *A. scabra*, which is said to have longer spikelets on longer pedicels and the glumes slightly separated in fruit. The characters are not strong: specimens from HF tend to have long pedicels but are of intermediate size and have glumes that are separated when the spikelets are young and closer when they are mature. Given this variation, it seems more realistic to recognize a broadly defined *A. hyemalis* than to recognize *A. scabra* on pedicel length alone.


Agrostis
hyemalis s.l.

Agrostis perennans, BENTGRASS. (Poaceae) Native perennial grass of moist shaded soils, often on ledges and along trails in the woods. Not listed by H.M. Raup (1938), who did list *A. tenuis* (= *A. capillaris*) and *A. scabra*, and perhaps less common then than now. First collected in 1947 from Camel's Hump in the Simes Tract by I.M. Johnston, and reported from S9 by C.E. Smith (1948), who said there were a few plants in damp shady sites. Now occasional in forests and along woods roads in HF, mostly in compartments with moister or more fertile soils; we observed it in eight compartments and confirmed specimens from four of them.


Agrostis
perennans

Agrostis stolonifera,* CREEPING BENTGRASS. (Poaceae) Stoloniferous grass, alien at least in part, of shores and moist open ground. Similar to *A. gigantea* but lower, with creeping basal parts and much smaller panicles. Uncommon at HF and either not previously recorded here or not distinguished from *A. gigantea,* which was formerly called *A. stolonifera.* We have records from rivershores in S6, S10, and from the Grout Lot. Note that many older records of *stolonifera*, including the one from "fields and meadows" by C.E. Smith (1948), refer to *A. gigantea*.


Agrostis
stolonifera


Ajuga
reptans

Ajuga reptans,* CARPET BUGLEWEED. (Lamiaceae) Creeping, cultivated herb, with blue flowers, widely planted and locally naturalized in lawns and disturbed places. Not previously reported from HF; now found in the lawns around Shaler Hall (P1) and the schoolhouse (P10), and along the woods road and lower slopes in the Simes Tract.

Alisma plantago-aquatica, COMMON WATER-PLANTAIN. (Alismataceae) A common broad-leaved aquatic with plantain-like leaves, growing in shallow water and on shores. Rare and not previously reported at HF; found once, at the west end of the utility right-of-way in T8, in this survey.


Alisma
plantago-aquatica

Alliaria petiolata,* GARLIC MUSTARD. (Brassicaceae) Highly invasive alien herb. First collected at HF by K. Esseichick in 1979; now found in 7 compartments, mostly in cultivated areas and along woods roads. Formerly called *A. officinalis.*

Alliaria petiolata

[**Alnus hirsuta?,*** MANCHURIAN ALDER. (Betulaceae) Three species of exotic alders were planted in 1981 in low ground between Shaler Hall and the cemetery to the south, and some have persisted and grown to be small trees. The HF archives list plantings of *A. hirsuta*, an Asiatic species, and its variety *sibirica*, as well as *A. maximowiczii*, which apparently did not do well at this site. We have not verified the identification of these trees.]

Alnus incana, SPECKLED ALDER. (Betulaceae) Native colony-forming shrub, often a local dominant on pond and river shores, and common, usually in a stunted form, in open peatlands. Locally common in wetlands at HF; J.G. Jack (1911) said it was "common on wet ground, swamps and borders of streams;" we recorded it from 11 compartments. Formerly sometimes treated as the eastern North American species *A. rugosa;* now generally regarded as subspecies *rugosa* of the circumboreal *A. incana.*

Alnus incana

[**Alnus serrulata**, SMOOTH ALDER. (Betulaceae) A closely related species with a more southern and coastal distribution, often growing and hybridizing with *A. incana* and perhaps better considered a subspecies of it. Widely reported in eastern Massachusetts but not strongly marked and often transitional to *A. incana* here. J.G. Jack (1911) said that it was less common than *A. incana* and that "Plants with characters intermediate between these two alders are common in Petersham." We concur. Our alders vary more or less continuously in the shape of the leaf blade, the angle of the leaf base, and the waviness (double-toothing) of the leaf edge. The commonest forms have wavy edges and rounded bases (*A. incana* characters), but are often obovate (a *serrulata* character) or have wedge-shaped bases (another *serrulata* character.) A few collections (S.M. Dohanian 53, from the Barre Woods, W.D. Beal from a "moist swale" in the eastern part of T4) are largely single-toothed and look like southern *A. serrulata*. But if you look carefully at them you will see that they mix *serrulata* and *incana* characters: they are not consistently obovate, they have both rounded and wedge-shaped bases, and they have some double toothed leaves. They may well have *A. serrulata* genes, but it seems to us more likely that they represent *A. serrulata* genes cropping up within a population that is dominantly *A. incana* than that they show that we once had a population of pure *A. serrulata* here.

In summary, the alders at HF seem to be dominantly a variable population of *A. incana*, which often show some *A. serrulata* traits. These suggest genetic contact with *A. serrulata*, but we have no evidence, contemporary or historical, that pure forms of *A. serrulata* ever occurred here.

Early specimens of the smooth alder are often labeled *A. rugosa*; since 1950 this name has been applied to the speckled alder, first at the species level and then at the subspecies level.]

Alopecurus pratensis,* MEADOW FOXTAIL**.** (Poaceae) A European forage grass, formerly cultivated and sporadically escaped but never common in

the wild. Known at HF from two records, a 1914 collection by J. Murdoch (at HUH), labelled simply as from "Harvard Forest," and a specimen cited by C.E. Smith (1948) from near HF headquarters that we have been unable to locate.

Amaranthus retroflexus, PIGWEED. (Amaranthaceae) Probably our commonest amaranth, believed to be native in the eastern United States but thoroughly weedy in behavior and ecology; distinguished by its relatively long pistillate tepals which are rounded at their tips. Not previously reported from HF: seen twice in our survey, by the sawmill in P2 and on the filled-in pool by Fisher House in P10.


Amaranthus retroflexus

Ambrosia artemisiifolia, RAGWEED. (Asteraceae) A native weed of dry open soil, very common in waste and fallow ground but rarely invading native communities. Occasional and mostly found along roads at HF. Not reported by H.M. Raup (1938); first collected in 1947 by W.D. Beal from "behind the HF buildings." C.E. Smith (1949) said it was a common weed. We recorded it from five compartments but it is doubtless present along the edges of others.


Ambrosia artemisiifolia

[**Amelanchier arborea**, DOWNY SHADBUSH. (Rosaceae) A small tree of mixed forests and hedgerows, common in western Massachusetts and tending to be replaced by *A. canadensis* eastwards. The two species are similar; *arborea* has longer petals and leaves with longer, more acuminate tips. Likely present at HF but not confirmed. Two herbarium specimens from S8 collected by W.D. Beal in 1947 and originally determined as *A. canadensis* seem to have the leaf shape of *A. arborea* but lack flowers and could not be verified.]

Amelanchier canadensis, CANADA SHADBUSH. (Rosaceae) A small native tree of mixed forests, distinguished by its small flowers and oblong leaves which are very hairy in spring and often have some persistent hairs in summer. Based on vegetative determinations, this is a common species at HF and occurs in almost every compartment. Includes *A. oblongifolia.*


Amelanchier canadensis

Amelanchier laevis, SMOOTH SHADBUSH. (Rosaceae) A related species with larger flowers and somewhat shorter leaves that are smooth from the start and have more acuminate tips. It is sometimes treated as a variety of *A. arborea*, from which it differs in its smoother leaves, looser and more nodding flower clusters, and somewhat later blooming time. The two seem adequately separate to us, or at least as separate as any two shadbushes are likely to be.

Frequent at HF, and, based on observations of flowering plants, the most common shadbush in the Prospect Hill and Tom Swamp Tracts. Specimens from H.M. Raup (1934, no locality) and J.L. d'Este (no date or locality) are definitely this species; a 1947 specimen collected by W.D. Beal from west of the Tom Swamp bog probably is as well. We confirmed it in P2, T2, T5, T7, and T10; likely it occurs in other compartments as well.


Amelanchier laevis

Amelanchier stolonifera sensu lato, RUNNING SHADBUSH. (Rosaceae) A variable complex of small shadbushes with rounded leaves and wooly

ovaries that tend to spread at ground level and may flower when they are less than one meter high. Plants of this general description are frequent on open rocky ridges and also occur on sand plains. The complex is often further divided by the fineness of the leaf teeth and the presence or absence of stolons, but these characters are very unstable and hard to use in our area. In addition, our small shads seem to cross rather frequently with the tree species, making the recognition of segregates even harder.

In any event, we have very little HF material to worry about. J.G. Jack (1911) said that a small shadbush, which he called *A. spicata* and we would likely call *A. stolonifera*, was uncommon in the Prospect Hill Tract and other places. No specimens have been found. H.M. Raup collected a small *Amelanchier* from the Tom Swamp Tract in 1933 which he called *A. sanguinea*. The specimen has round leaves with rather coarse teeth; it is sterile and cannot be determined with certainty but is likely part of the *A. stolonifera* complex. We saw a fine-toothed plant that we would call *A. stolonifera* once in our survey, on the top of Camel's Hump, just west of the western boundary of the Simes Tract, and so in the Quabbin Reservation and not in HF.

[**Ampelopsis brevipedunculata**,* CHINABERRY. (Vitaceae) Cultivated vine with lobed leaves and blue-white berries. Recorded twice in this study, from a hedgerow at Higginson House, and by the schoolhouse in P10. Both collections are from cultivated grounds and though, like a beagle in a pen, the plants intend to naturalize themselves at the first opportunity, are probably not really members of the wild flora yet.]

Amphicarpaea bracteata

Amphicarpaea bracteata, HOG PEANUT. (Fabaceae) Delicate twining native herb of moist woods, shores and thickets; frequent at HF: first collected from the Slab City Tract by H.M. Raup in 1933; seen in 17 compartments in our survey. The generic name is spelled *Amphicarpa* in many books; the spelling used here has been conserved and is now considered correct. The species *A. bracteata* is now defined broadly and includes *A. monoica*, a name used in older books.

Anaphalis margaritacea

Anaphalis margaritacea, PEARLY EVERLASTING. (Asteraceae) Native, somewhat weedy herb of dry, often disturbed soil. Apparently uncommon at HF; first collected by H.M. Raup from the east part of the Tom Swamp Tract in 1933; subsequently collected near the buildings in P1 by W.D. Beal in 1947; and we recorded it from the gravel pit in P9 and along Route 122 in T7. *Gnaphalium obtusifolium*, which looks very similar and grows in similar places, seems somewhat more common. It may be distinguished by small rough or glandular hairs on the upper surface of its leaves and by browner phyllaries which lack any pleats.

Andromeda glaucophylla

Andromeda glaucophylla, BOG ROSEMARY, RABBIT-EARS. (Ericaceae) Low, blue-green, narrow-leaved evergreen shrub of wet peaty mats, and floating bogs. Not previously reported from HF though noted as "rare or local in cold wet bogs" outside of HF by J.G. Jack (1911). Now common in the Harvard Pond Bog (T11). Formerly treated as a form of the circumboreal *A. polifolia*; now generally considered a separate North American taxon, *A. glaucophylla.*

Andropogon gerardii, TURKEYFOOT, BIG BLUESTEM. (Poaceae) Tall native perennial grass of dry open soil. Uncommon at HF: collected in 1947 by I.M. Johnston from the meadow north of HF headquarters but now gone from there; recorded in this survey from roadsides in S2, S10 and T9. Formerly called *A. furcatus*, an impolite name.

Andropogon gerardii

Anemone americana, ROUND-LOBED HEPATICA. (Ranunculaceae) Native, partly evergreen herb of fertile dry forests. Rare at HF: collected by W.A. Stalker from the Slab City Tract in 1909 and on the cliffs of Camel's Hump in the Simes Tract by I.M. Johnston in 1947; relocated on Camel's Hump and found in S7 and S8 in our survey. Long called *Hepatica americana,* but treated in *Anemone* by the *Flora of North America*, which notes that it shares many morphological and molecular attributes with *Anemone.* Close to but generally distinguishable from *Anemone acutiloba,* a species of moister and often limier woods which is not known from HF.

Anemone americana

Anemone quinquefolia

Anemone quinquefolia, WOOD ANEMONE. (Ranunculaceae) Delicate native herb of moist woods, shaded stream banks, and wooded swamps, frequent in open woodlands and not seeming to have a strong soil preference. First collected at HF by W.A. Stalker in Tom Swamp in 1908, and by H.M. Raup in Slab City in 1934. Currently it is occasional at HF; we found it in ten compartments in the Simes, Slab City and Tom Swamp Tracts, but did not see it on Prospect Hill.

Anemone virginiana, THIMBLEWEED. (Ranunculaceae) Tall native herb of dry, often limy soil, found both in the open and in partial shade. Rare at HF; first collected in 1933 by H.M. Raup from the Tom Swamp Tract; also collected in 1947 by W.D. Beal from the "old pasture" at the top of Prospect Hill and by W.H. Drury on a roadside by an orchard on Prospect Hill, both in P6; seen once in our study, on the upper slopes of Camel's Hump in the Simes Tract.*

Anemone virginiana

Angelica atropurpurea

Angelica atropurpurea, ANGELICA. (Apiaceae) A tall, purple-stemmed umbellifer of riverbanks and open wetlands, with large, multiply compound leaves. First reported for HF in this study, along the banks of the Swift River in S6.

Antennaria neglecta, SMALL PUSSY-TOES. (Asteraceae) Small native herb of dry woods and shaded roadside banks. Widespread in our area and generally common in fertile rocky woods but apparently uncommon at HF. Collected by H.M. Raup in 1934 and listed in his Petersham checklist (1938); the specimen lacks a locality. Collected in 1947 by J. Canright from Phillipston Road in P4 and by W.H. Drury from Tom Swamp Road; seen once in our study by the Raup House. Listed by C.E. Smith (1949) as *A. neodioica* var. *attenuata*; the genus as a whole is genetically complex, and has an accordingly rich and confused synonymy. H.M. Raup (1938) listed both *A. neglecta* and *A. neodioica* for Petersham. No specimens exist and so the question of what he meant by this and whether his plants would stand as separate species today is moot.

Antennaria neglecta

Antennaria plantaginifolia, PLANTAIN-LEAVED PUSSY-TOES. (Asteraceae) Native herb of dry fertile woods and wooded banks by roads.

* The pasture on the top of Prospect Hill has now shrunk to a small area of mowed grass around the fire tower. We do not know where the orchard was.

Uncommon at HF; collected in 1937 by H.M. Raup from an unknown location and listed in his Petersham checklist (1938); collected in 1949 by H.M. Raup and both the Smiths on Camel's Hump in the Simes Tract, and by K.A. Raup in 1947 from Slab City; seen in S4, S6, S7, and the Simes Tract in this study.

Anthemis cotula,* STINKING CHAMOMILE. (Asteraceae) Weedy alien herb of roadsides and pastures, widely distributed in disturbed ground in our area. First collected in 1934 by H.M. Raup from the Prospect Hill Tract; currently found near the HF buildings.

Anthoxanthum odoratum,* SWEET VERNAL GRASS. (Poaceae) Alien grass, widely sown in hayfields and pastures and commonly adventive along roads and streambanks and in dry open ground. Occasional along roads at HF. First collected in 1934 by H.M. Raup from the Prospect Hill Tract; seen in eight compartments in this study.

Apios americana, GROUNDNUT. (Fabaceae) Climbing compound-leaved herb of river shores and moist thickets, common but somewhat local in our area. Occasional at HF; first collected in 1933 by H.M. Raup from the Prospect Hill Tract; recorded in five compartments in our study.

Apocynum androsaemifolium, SPREADING DOGBANE. (Apocynaceae) Somewhat weedy native herb of roadside thickets and open ground; frequent at HF, mostly along roads. First collected in 1913 by S.M. Dohanian on Prospect Hill; recorded in 12 compartments in our study.

Aquilegia canadensis, WILD COLUMBINE. (Ranunculaceae) Native herb of fertile woods and calcareous ledges, frequent in the right habitats but rare at HF because of the lack of fertile soils. First collected in 1933 by H.M. Raup from the Prospect Hill Tract, and then in 1947 by W.D. Beal in S8; seen in our survey on the ledges in S7, S8, and the Simes Tract.

Aquilegia vulgaris,* EUROPEAN COLUMBINE. (Ranunculaceae) A few plants of a cultivated columbine, likely this species, are naturalized along a trail in T7.

Arabis glabra, TOWER-MUSTARD. (Brassicaceae) A tall, weedy, short-lived mustard with clasping leaves and erect pods, frequent in disturbed soil throughout our area. Not previously reported from HF; seen once in our survey, in the pasture in P2.

Aralia hispida, BRISTLY SARSAPARILLA. (Araliaceae) A native herb of dry, open ground, usually preferring acid soil and often in disturbed areas. Occasional, especially near roads, at HF: first collected by H.M. Raup from the Fay Lot (T9) in 1933; we saw it along Locust Opening Road in P8, near the highway in S10, and along woods roads in T7, T8, and T9, where it was first reported in 1947. It was reported near the HF buildings in 1933, but does not seem to have persisted.

Aralia nudicaulis, WILD SARSAPARILLA. (Araliaceae) Very common native herb of woodlands with acid soils. First collected at HF in 1928 by


Antennaria plantaginifolia


Anthemis cotula


Anthoxanthum odoratum


Apios americana


Apocynum androsaemifolium


Aquilegia canadensis


Aquilegia vulgaris


Arabis glabra


Aralia hispida

Mrs. Gast from the Slab City Tract. Now found throughout HF, in both dry and wet soils, and both in deciduous and mixed woods.

Aralia racemosa, SPIKENARD. (Araliaceae) Tall herb of moist fertile woods, commonly with a scattered distribution and often found along trails. Rare at HF: collected in Slab City by J.G. Jack in 1907 and H.M. Raup in 1933; observed by us in S7 and on the fertile talus of Camel's Hump in the Simes Tract.

Aralia sp.,* ANGELICA-TREE (Araliaceae) One of several spiny aralias planted as ornamentals and occasionally persistent or escaped in our area. Several plants occur in a former conifer plantation in P1, where they were first noted by Barry Tomlinson in 1977, and along Route 32. They did not flower during our study and so have not been identified; the straight leaf veins suggest that they may be *A. chinense* or *A. elata*, both Asiatic species, rather than the American *A. spinosa.*

Arceuthobium pusillum, DWARF MISTLETOE. (Viscaceae) Tiny parasitic shrub, mostly found on black spruce trees in bogs. Known at HF only from a single site in a peatland in T8, where it was first found by Henry Woolsey and Robert Clark in 1982 and relocated by Henry Woolsey and Glenn Motzkin in 2004. Listed as a species of special concern by the Massachusetts Natural Heritage and Endangered Species Program.

Arctium minus,* COMMON BURDOCK. (Asteraceae) Weedy alien herb of open fertile ground, doubtless long present at HF but first documented (in the gravel pit in P9 and by the entrance to the Simes Tract) in this study.

Arisaema triphyllum, JACK-IN-THE-PULPIT. (Araceae) Native forest herb of moist soil, frequent throughout HF where it was first recorded by N.W. Hosley on Prospect Hill in 1933. Variable in size and the coloring of the spathe; as now conceived, it includes the plants formerly called *A. pusillum* and *A. atrorubens.*

Armoracia rusticana,* HORSERADISH. (Brassicaceae) Alien cultivar, frequently escaped or persisting; currently known at HF by a few plants by the pole barn behind Shaler Hall, where it was also collected by W.H. Hatheway in 1951.

Aronia arbutifolia-melanocarpa complex, RED AND BLACK CHOKEBERRIES. (Rosaceae) Native shrubs of fields, thickets, and wetlands, found throughout our range and forming a complex that includes *A. arbutifolia,* a southern species, *A. melanocarpa*, a northern species, and an apomictic hybrid complex (*A. x prunifolia*) that has spread widely and now occurs beyond the range where the parent species overlap. *A. arbutifolia*, the red chokeberry, has densely furry twigs and leaves, and red berries; *A. melanocarpa,* the black chokeberry, is almost smooth and has black berries. The hybrid complex, often called purple chokeberry and formerly treated as a distinct species (*A. atropurpurea*), likely backcrosses with both parents, and varies greatly in hairiness and fruit color.*


Aralia nudicaulis


Aralia racemosa


Aralia sp.


Arceuthobium pusillum


Arctium minus


Arisaema triphyllum


Armoracia rusticana


Aronia arbutifolia

Harvard Forest is in the overlap zone, and seems to have all three forms. Chokeberries are common here in wetlands and along woods roads, but are often found sterile and so can't be accurately identified. J.G. Jack (1911) said that black chokeberry was very common, the purple chokeberry frequent, and that "the chokeberries in this region show a great deal of variation." H.M. Raup (1938) and C.E. Smith (1949) followed J.G. Jack (1911) in recognizing two species, black and purple. Our review of the genus, hampered by a lack of fruiting material, raised more questions than it answered. The HF herbarium contains 15 specimens of chokeberry; none have notes on fruit color and so none can be definitely identified. Based on hairiness, 8 could be *A. arbutifolia,* 5 are *A. melanocarpa*, and 2 are intermediate. In our own field work we confirmed *A. melanocarpa* from several swamps and saw very furry (but fruitless) plants, which resemble *A. arbutifolia* as we know it from the Massachusetts coast, along woods roads. But we haven't as yet confirmed this by finding a distinctly red-fruited plant.

Hybrid complexes like this may be treated, as here, as two parental species and a series of hybrids, or as a single variable species. The difference seems mostly a matter of perspective. The picture of two parental species and their hybrids is historically informative and gives a useful evolutionary picture of what is going on. The broad treatment with a single variable species may be truer to what is observed today in the overlap zone, and certainly is comforting to the floristic botanist who has no practical way of determining where the parents stop and the hybrids begin.

* See J.W. Hardin, 1973, "The enigmatic chokeberries (*Aronia*, Rosaceae)." (*Bulletin of the Torrey Botanical Club,* 100(3): 178-184). If the complex is treated as a single variable species it probably should be called *A. prunifolia.* (Voss 1985)

Aronia melanocarpa

Arrhenatherum elatius,* TALL OATGRASS. (Poaceae) Tall weedy alien grass of open ground, with two flowered spikelets in which the lower flower bears a long bent awn with a twisted base. Uncommon at HF: first collected in 1934 by H.M. Raup from around the HF buildings; found there seventy years later in our survey, and also along roads in P9, P10, and T6.

Arrhenatherum elatius

Artemisia vulgaris,* MUGWORT. (Asteraceae) Tall alien herb of open ground, casual in waste ground and very common along roads. This species seems to have become much more common in the last thirty years. Not previously reported from HF; currently uncommon and found along paved roads in P1, P3, and S9 in our survey.

Asarum canadense, WILD GINGER. (Aristolochiaceae) Native forest herb of moist fertile soils, growing both in alluvium and on rocky slopes. Frequent and locally common in western Massachusetts but uncommon eastward and rare in Worcester County. Known at HF only from 1947 collections by I.M. Johnston, C.E. Smith, and E.E. Smith from near the buildings in P1; we do not know whether these plants were naturally occurring or were planted. Not relocated in our study.

Artemisia vulgaris

Asclepias exaltata

Asclepias exaltata, POKE MILKWEED. (Asclepiadaceae) Tall and somewhat uncommon or fugitive herb of fertile woods. Collected on Prospect Hill by H.M. Raup in 1933, and seen on woods roads near Lyford House (P1), Pierce Farm (P7), and Fisher House (P10), and in T4 and the Grout Lot in this study. Formerly called *A. phytolaccoides.*

Asclepias incarnata, SWAMP MILKWEED. (Asclepiadaceae) Native wetland herb, frequent or common on open river and pond shores. Rare at HF: collected in 1933 by H.M. Raup at Connor Pond and Riceville Pond, and relocated by us at Connor Pond and in the Simes Tract but not at Riceville Pond.

Asclepias syriaca, COMMON MILKWEED. (Asclepiadaceae) The common, broad-leaved milkweed of old fields and open ground. First collected in 1933 by H.M. Raup from the fields north of the HF buildings; currently known from roadsides and fields in seven compartments and likely present in others. Despite the name, the species is native.

Asclepias incarnata

Asclepias syriaca

Asplenium platyneuron, EBONY SPLEENWORT. (Aspleniaceae) A slender, black-stemmed fern of dry limy soil, often on or near boulders and outcrops. Separated from the maidenhair spleenwort, which is generally similar, by its more erect habit and more elongate leaflets that are arranged alternately on the leaf axis. Apparently rare at HF where it is known only from a 1937 collection by H.M. Raup from the Slab City Tract, and a single record (possibly in the same site) from hickory woods on a rocky slope in the west side of S7 in our survey.

Asplenium trichomanes, MAIDENHAIR SPLEENWORT. (Aspleniaceae) Delicate but partially evergreen fern of shaded calcareous ledges. Like the ebony spleenwort it has narrow once-cut leaves with black shiny stems and small leaflets. Unlike that species it forms distinct rosettes and has opposite lower leaflets. Known at HF only from a small colony on the eastern cliffs of Camel's Hump (Simes), from which they were first collected by I.M. Johnston in 1947.

Asplenium platyneuron

Asplenium trichomanes

Aster acuminatus

Aster spp., ASTERS. (Asteraceae) The genus *Aster*, which with 17 HF species is the largest genus of dicots in our flora, has been divided into a series of small segregate genera in the recent treatment in the *Flora of North America.* In this treatment our species are found in the genera *Eurybia, Doellingeria, Ionactis, Oclemena, Sericocarpus*, and *Symphyotrichum.* None remain in *Aster*. This approach seems needlessly technical and divisive to us: it makes no important taxonomic distinctions, obscures the ecological and evolutionary unity of the group, and sets a bad precedent for the treatment of other large genera. We have retained the traditional name and circumscription here and think of the other names, when we think of them at all, as subgenera or tribes.

Aster acuminatus, ACUMINATE ASTER. (Asteraceae) Native herb of cool moist forests and forested swamps with white flowers and oval, acuminate leaves with widely separated teeth. First collected in 1933 by H.M. Raup from Prospect Hill; listed as "occasional in dry shaded areas" by C.E. Smith (1949); currently found throughout HF and locally common in mixed woods and at the edges of swamps and bogs. A number of other cool-forest plants (clintonia, bunchberry, starflower, goldthread, *Brachyeletrum*) are common here, suggesting that local site conditions (shade, moisture, acid soils) can meet their ecological needs, even in the absence of a boreal climate. Recently treated as *Oclemena acuminata* in the *Flora of North America.*

Aster cordifolius, HEART-LEAVED ASTER. (Asteraceae) Blue-flowered aster of moist, fertile, partly shaded soil, abundant in western Massachusetts but scarce in our area. The acuminate, sharply-toothed, heart-shaped leaves resemble those of the white wood aster, *A. divaricatus*, from which the heart-leaved aster is distinguished by its cylindrical rather than flat-topped inflorescence, pale blue rays, and slender involucral bracts with a green midrib and diamond-shaped green area at the tip. Rare at HF where it was not recorded until our study. We saw it, in very small quantities, in fertile rocky woods in S7, S8, and along Dugway Road at the south edge of Simes Tract. Recently treated as *Symphyotrichum cordifolium* in the *Flora of North America.*

Aster cordifolius

Aster divaricatus, WHITE WOOD ASTER. (Asteraceae) A white-flowered aster with sharply-toothed leaves and a flat-topped inflorescence, common in deciduous forests and forest edges. Separated from the heart-leaved aster, which has similar leaves, by the flat-topped inflorescence and the blunt, papery involucral bracts that are green only at the extreme tip. Common at HF where it was first collected in 1933 by H.M. Raup from the Tom Swamp Tract; locally abundant in our study, especially in openings and along woods roads, and found in nearly all compartments. Recently treated as *Eurybia divaricata* in the *Flora of North America.*

Aster divaricatus

Aster ericoides, HEATH ASTER. (Asteraceae) Small-flowered white aster with incurved hairs and hooked bracts, widely distributed but somewhat local in dry, open, often barren soil. Known at HF only from a single 1933 collection by H.M. Raup from the Prospect Hill Tract. Owing to confusion about Linnaean types*, this species was formerly called *A. multiflorus* and the name *A. ericoides* applied to the plants that we now call *A. pilosus.* Recently treated as *Symphyotrichum ericoides* in the *Flora of North America.*

Aster laevis, SMOOTH BLUE ASTER. (Asteraceae) A handsome, large-flowered, pale blue aster of dry, partly open soil, recognized by its clasping leaves with smooth, whitened surfaces. It seems to have a fairly wide tolerance for soil pH: in western New England it is often found on calcareous soils while in eastern New England it occurs on acid sites. At HF it is an uncommon but characteristic plant of clearings and partly shaded banks. It was first collected in 1933 by H.M. Raup from the Prospect Hill and Tom Swamp Tracts and still occurs in both areas today: we have records from P1, P2 and P9 on Prospect Hill and T2, T7, and T9 in Tom Swamp. Recently treated as *Symphyotrichum laeve* in the *Flora of North America.*

Aster laevis

[**Aster lanceolatus**, TALL WHITE ASTER. (Asteraceae) A tall, small-flowered aster of fields and the edges of wetlands and woods, with some preference for moist fertile sites. Occasional along roads in Petersham and occurring within a few hundred yards of the HF boundary, but thus far not recorded in HF, though one of our specimens (*HF 2005-649*) seems to mix the characters of *A. lanceolatus* and *A. novi-belgii*. Formerly called *A. simplex,* a name now thought to refer to a garden hybrid of *A. lanceolatus* and *A. laevis,* and before that *A. paniculatus,* a name that applies to a different species.]

*Aster nomenclature is quite messy both because many of the Linnaean type specimens seem to have been from garden hybrids, and because many American authors were unsure what plant the Linnaean types referred to.

Aster lateriflorus, CALICO ASTER. (Asteraceae) A low, small-flowered white aster with spreading branches, common in moist open ground and open woods. It is close to both *A. lanceolatus* and *A. racemosus*, and best distinguished from them by its more deeply lobed disk flowers which tend to turn purple as they age. Frequent along woods roads and at the edges of wetlands in HF: first collected in 1933 by H.M. Raup in the Prospect Hill and Tom Swamp Tracts; recorded from 15 compartments in our survey and probably present in a number of others. Recently treated as *Symphyotrichum lateriflorum* in the *Flora of North America.*

Aster lateriflorus

Aster linariifolius, STIFF-LEAVED ASTER. (Asteraceae) A distinctive aster with stiff narrow leaves and large, pale blue, solitary flowers on long stalks. A characteristic plant of dry sandy soil near the coast, becoming less common as you go inland. First collected by H.M. Raup in the Fay Lot (T9) in 1933, where a few plants were also seen in 2006. It differs from other asters in a few details (stiff leaves, keeled involucral bracts, slightly flattened seeds, etc.) and has been called *Ionactis linariifolia,* a pretty but unnecessary name that has recently been revived by the *Flora of North America.*

Aster linariifolius

Aster macrophyllus, LARGE-LEAVED ASTER. (Asteraceae) A colony-forming aster with large, rough-surfaced, basal leaves, typical of dry woods and openings and perhaps preferring slightly fertile soils. Generally similar to *A. divaricatus* (and rumored to form allopolyploids with it) but separated by the clasping leaf bases, rougher leaves, sterile leaves in large patches, and usually by the glandular involucral bracts. Occasional at HF; we have records from P9, T4, T6, T10, and Simes. Interestingly for a distinctive species it was not listed by H.M. Raup; the first collections are in 1947 by I.M. Johnston, from Tom Swamp. Recently treated as *Eurybia macrophylla* in the *Flora of North America.*

Aster macrophyllus

Aster nemoralis, BOG ASTER. (Asteraceae) A low, slender-leaved aster of sphagnum bogs, with large pink flowers and linear leaves that are glandular below. It resembles stiff-leaved aster, but the leaves are less stiff and the achenes and leaves have small glands. Rare at HF; collected once, at the edge of a boggy island near the east shore of Harvard Pond, in this survey. Recently treated as *Oclemena nemoralis* in the *Flora of North America.* It is known to hybridize with *A. acuminatus*, producing plants of intermediate morphology called *A. x blakei.* Hybrids were looked for at HF but not found.

Aster nemoralis

Aster novae-angliae, NEW ENGLAND ASTER. (Asteraceae) Tall and somewhat weedy aster with deep blue flowers and a glandular inflorescence, most often seen along roads and in rough meadows and small wetlands; absent or uncommon in undisturbed habitats. Rare at HF: collected by C.E. Smith in a meadow near the HF headquarters in 1947, and seen by the HF gate along Rt. 122 in T5 in our survey. Recently treated as *Symphyotrichum novae-angliae* in the *Flora of North America.*

Aster novae-angliae

Aster novi-belgii, NEW YORK ASTER. (Asteraceae) Tall, narrow-leaved, and taxonomically plastic aster with large blue flowers, characteristic of pond and river shores. Locally frequent on pond shores and around open

wetlands at HF: first collected in 1933 by H.M. Raup in the Prospect Hill and Tom Swamp Tracts; we have records from 12 compartments in all of the major tracts. It can approach smooth forms of *A. puniceus*, which grows with it in open wetlands and replaces it in shaded ones. The best distinctions are the broader leaf bases and narrower and more acuminate phyllaries of *A. puniceus.* The plant that C.E. Smith (1949) called *A. longifolius* (a name of variable and uncertain application) may well belong here. We have not been able to relocate his specimen and don't know for certain. Recently treated as *Symphyotrichum novi-belgii* in the *Flora of North America.*

Aster
novi-belgii

Aster paternus, FLAT-TOPPED ASTER. (Asteraceae) A low, few-rayed aster of dry open woods with blunt, rounded leaves and silky achenes. Collected by N.W. Hosley from P8 in 1933, by H.M. Raup from near Fisher House (P10) in 1934, and by C.E. Smith from Prospect Hill in 1947. C.E. Smith (1949) also listed collections from Dugway Road, Riceville Pond, and T8, based on specimens that we did not see. Looked for but not relocated in this study. Formerly called *Sericocarpus asteroides,* and treated under that name in the *Flora of North America.*

Aster pilosus, PILOSE ASTER. (Asteraceae) Slender-leaved native aster of dry open ground, with small white flowers with needle tips on the involucral leaves. In the common variety the upper leaves are small and slender and the plant looks skeletal. Common in dry, open habitats in western Massachusetts. Poorly known at HF: collected in T9 by H.M. Raup and N.W. Hosley in 1933. C.E. Smith's (1949) report of *A. polyphyllus,* now regarded as a synonym of *A. pilosus*, is based on a specimen (Johnston *285*) that is *A. novi-belgii*. Not observed in this study. Recently treated as *Symphyotrichum pilosum* in the *Flora of North America.*

Aster
puniceus

Aster puniceus, PUMICE or ROUGH-STEMMED ASTER. (Asteraceae) Large-flowered native blue aster of wetlands and shores, characterized by clasping leaf bases and slender phyllaries, and more common on minerotrophic wetlands than peatlands. Separated from the similar New York aster by the more clasping stem leaves, longer-tipped involucral bracts, and usually hairier stems. Frequent and locally common on pond shores and in wooded wetlands at HF; first collected by H.M. Raup in 1933 from the north end of Tom Swamp; we have records from nine compartments. Recently treated as *Symphyotrichum puniceum* in the *Flora of North America.*

Aster
racemosus

Aster racemosus, SMALL WHITE ASTER. (Asteraceae) A small-flowered, bushy, spreading-branched aster of thickets and moist open ground, uncommon and local at HF. We have records from nine compartments, all on roadsides or in open areas near ponds. The species is variable and not always easy to recognize; it is generally similar to the common *A. lateriflorus* but with narrower leaves, smaller heads on more one-sided branches, somewhat less deeply lobed corollas, and a more coastal distribution. A further complication is that, owing to the presence of horticultural hybrids in European herbaria, it is poorly typified, and has been called variously *A. fragilis* Willdenow and *A. vimineus* Lambert in recent floras. The differences are not just nomenclatural: each name is associ-

ated with a different type and a different description, and so requires that we place the boundaries between this species and its protean relatives *A. lanceolatus, A. tradescantii,* and *A. lateriflorus* in a slightly different way.

A. racemosus was apparently first found at HF by C.E. Smith at Riceville Pond in 1947, where it is still found sixty years later. He called his plants *A. ericoides*; as near as we can tell, from 60 years away, this means that he regarded them as what we would now call *A. pilosus.* The species is called *Symphyotrichum racemosum* in the *Flora of North America*. The new name is longer but unlikely to be any clearer, or any better at solving the problems attached to this taxon, than its predecessors were.

Aster umbellatus

Aster umbellatus, UMBELLATE ASTER. (Asteraceae) Tall white flat-topped aster of open and shaded wetlands, characterized by the narrow, untoothed leaves with ciliate margins, and a circle of short pappus hairs outside the longer inner ones. Common throughout our region, tending to replace *A. puniceus* on peaty soils and at higher elevations. Frequent at HF along woods roads, around beaver ponds, and along wooded streams; first collected here in 1933 by H.M. Raup from the Tom Swamp and Prospect Hill Tracts; we recorded it from 12 compartments. Recently treated as *Doellingeria umbellatum* in the *Flora of North America.*

Aster undulatus

Aster undulatus, WAVY-LEAF ASTER. (Asteraceae) A finely furry blue aster of dry open woods and shaded roadside banks. Separated from the generally similar *A. cordifolius* by the winged petioles and short velvety hairs on the leaves and stem. Apparently uncommon and scattered at HF: first collected in 1933 by H.M. Raup in the Prospect Hill Tract and later by C.E. Smith in T8; we relocated the species in T8, and have additional records from P10, S5, and T11. Recently treated as *Symphyotrichum undulatum* in the *Flora of North America.*

Athyrium filix-femina

Athyrium filix-femina, LADY FERN. (Aspleniaceae) Medium-sized, clump-forming fern of forests, thickets, shores, and fields, typical of moist sites of at least medium fertility. Common in open deciduous woods and along woods roads in HF; first collected here in 1912 by J.G. Jack on Prospect Hill; recorded from 24 compartments in our study. Formerly called *A. angustum.*

Aureolaria pedicularia

Aureolaria pedicularia, CUT-LEAVED FALSE-FOXGLOVE. (Scrophulariaceae) Sticky, late-flowering native herb of oak woods. Apparently rare at HF where it was first recorded in this survey from the summit of Choate Ledges in the southern portion of S8. Formerly called *Gerardia pedicularia.* The name *Gerardia* turns out to have had a previous use, in this case for a genus in a different family, and our species had to be renamed. The small purple ones, like *Gerardia tenuifolia,* are now in *Agalinis*; the large yellow ones, like *Gerardia pedicularia*, are now in *Aureolaria.*

Aureolaria virginica, DOWNY FALSE-FOXGLOVE. (Scrophulariaceae) A related species with less divided leaves and velvety rather than sticky hairs. First reported for HF in this study, from the upper slopes of Camel's Hump in the Simes Tract. Formerly called *Gerardia virginica*; *Gerardia* is now used for a different genus in a different family.

Barbarea vulgaris,* WINTERCRESS. (Brassicaceae) Weedy alien of fields, roadsides, shores and waste ground. Apparently uncommon at HF; first collected from the dump on Kitchen Road (Prospect Hill Rd.) by W.D. Beal in 1947, and seen in the open field along Rt. 32, in the gravel pit in P9, and on the filled-in pool by the Fisher House in our study.

Bartonia virginica, BARTONIA. (Gentianaceae) Delicate, almost leafless, semiparasitic herb of moist woods, often associated with oak or pine. First collected at HF from the woods east of Tom Swamp by H.M. Raup in 1933. Seen three times, in moist hardwood forests in P2 and P4 and along the sandy edges of a beaver pond in T7, in this study.

Berberis thunbergii,* JAPANESE BARBERRY. (Berberidaceae) Weedy alien shrub, spreading into woods from old plantings and dispersed by birds and other animals. Currently widespread but sporadic at HF, where we recorded it from 14 compartments, mostly in small quantities. Not previously collected or mentioned in any of the previous checklists, and so either overlooked or recently adventive.

[**Berberis vulgaris**,* EUROPEAN BARBERRY. (Berberidaceae) Weedy alien shrub, taller and more arching than the Japanese barberry, and also distinguished by its toothed leaves, strong, three-branched spines, and racemose fruits. A common weed on limy soils in western Massachusetts, but apparently less common in our area. Reported by J.G. Jack (1911) who said it was "occasionally naturalized in Harvard Forest." There are no subsequent records.]

Betula alleghaniensis, YELLOW BIRCH. (Betulaceae) Native forest tree of cool or moist woods, with aromatic twigs and shiny, yellow-tan bark that becomes shaggy and curly. It reproduces well on mineral soil and is often associated with windstorms or other disturbance. J.G. Jack (1911) said it was "frequent in rich moist or wet situations." We found it common at HF, especially in wooded wetlands and in association with hemlock, and recorded it from 27 compartments. A previous study of vegetation patterns on Prospect Hill found a strong association between the current abundance of yellow birch and the amount of damage from the 1938 hurricane. Formerly called *B. lutea*.

Betula lenta, BLACK BIRCH. (Betulaceae) Native forest tree, typical of sites of average moisture and moderate fertility at low elevations. The leaves and twigs are very similar to those of yellow birch and the best separation seems to be dark bark which doesn't curl. J.G. Jack (1911) said it was common on well-drained soils. We found it common in mixed woods at HF in almost all compartments. Like yellow birch it reproduces well after forest disturbance, and its current abundance correlates well with the amount of hurricane damage in 1938.

Betula papyrifera, PAPER BIRCH. (Betulaceae) Short-lived, white-barked forest tree of upland woods, associated with forest disturbance. J.G. Jack (1911) said it was frequent overall and most abundant in the Meadow Water (now Tom Swamp) Tract. We found it common in mixed woods at HF in nearly all compartments.


Aureolaria virginica


Barbarea vulgaris


Bartonia virginica


Berberis thunbergii


Betula alleghaniensis


Betula lenta

Betula populifolia, GRAY BIRCH. (Betulaceae) Small tree of open and somewhat sterile soils, common in postagricultural and successional habitats. Similar to paper birch but with slenderer twigs, more persistent lower branches, more triangular leaves, and tight bark that lacks red tones and never curls. J.G. Jack (1911) said that it was very common, and, with perhaps a trace of the professional forester's disdain for small trees, called it a "forest weed, in pastures, clearings, and in woods." Most of the pastures and clearings are gone now. It is still frequent in young woods in the northern parts of HF, but apparently absent in the older woods in much of the southern part.


Betula papyrifera


Betula populifolia

Bidens cernuus, NODDING BEGGAR'S-TICKS. (Asteraceae) Annual herb of moist soft soils, with showy ray flowers and slender leaves with tapering bases but no true leaf stalks; commonly found on river bars and ponds with variable levels. Occasional in the peaty wetlands at HF where it was first collected in 1933 by H.M. Raup from the margin of a pond in the Tom Swamp Tract. We found it in beaver wetlands in T3 and T5, along the utility right-of-way in T8, in streamside wetlands in S2, S3, and S6, at Harvard Pond (T11), and in a marsh in the Simes Tract. We treat *Bidens* as masculine here, contrary to American tradition but following Voss (1996) and the International Code of Botanical Nomenclature, which requires that generic names have their classical gender: hence *cernuus, connatus,* etc.


Bidens cernuus

Bidens connatus, SWAMP BEGGAR'S-TICKS. (Asteraceae) Native, somewhat weedy, annual herb of wetlands and shores. This is the common simple-leaved *Bidens* in the wetlands at HF. Its leaves are stalked and may be lobed (but not divided), and the ray flowers are short or absent. Not reported in previous floras; we have records from eight compartments (P1, S3, S4, S6, T2, T8, T10, Simes Tract), and it is probably present in others as well. Formerly treated as part of the Linnaean species *B. tripartitus,* now separated by most authors.


Bidens connatus

Bidens frondosus, BEGGAR'S-TICKS. (Asteraceae) Native, weedy, annual herb of open wetlands and waste ground, distinguished from our other species of *Bidens* by its compound leaves. First collected in HF by H.M. Raup on Prospect Hill in 1933; also known historically from a 1947 W.D. Beal specimen from Riceville Pond originally determined as *B. discoidea*. Frequent in wetlands, on shores, and along roads; currently reported from 15 compartments and likely present in others.


Bidens frondosus

Bidens vulgatus, TALL BEGGAR'S-TICKS. (Asteraceae) A large, native, weedy, compound-leaved annual herb, commonly found on roadsides and in waste ground. Very similar to *B. frondosus* but with smooth faces to the achenes and more outer involucral bracts. Widespread and generally frequent or common in wet ground but not reported previously from HF and only seen once, on a roadside in S7, in this study.


Bidens vulgatus

Boehmeria cylindrica, FALSE NETTLE, BOG HEMP. (Urticaceae) Native wetland herb with cylindrical fruit-clusters and silky fibers in the stems. A common plant of fertile minerotrophic wetlands in our area, and also common in the peaty wetlands at HF. Collected by H.M. Raup in Tom

Swamp in 1933 and by W.H. Drury along the Swift River (S10) in 1947; we found it in S2, S6, S10, T5, and T6 in this study.

Botrychium dissectum, DISSECTED GRAPE FERN. (Ophioglossaceae) A common grape fern of fields and successional woods; collected by W. Chi-Wu near HF headquarters in 1947, and by W.H. Lyford in P1 in 1967, from a field border under white pine. We saw a single fertile botrychium on the west side of the Simes Tract that may have been this species. E. Watkins also reported a single botrychium, at the top of the small ridge by the cellar hole near the entrance to the Simes Tract, in late summer 2007; we were unable to locate the plant and do not know what species it represents.


Boehmeria cylindrica

Botrychium lanceolatum, TRIANGLE GRAPE FERN. (Ophioglossaceae) Small delicate fern of fertile woods. Uncommon at HF. First collected in Tom Swamp by H.M. Raup in 1933, and later in T3 by W.H. Drury , K.A. Raup, and W. Chi-Wu; seen once in our study, in a swampy hardwood forest in P3. Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.


Botrychium sp.

Botrychium multifidum, LEATHERY GRAPE FERN. (Ophioglossaceae) An uncommon grape fern resembling *B. dissectum* but with more rounded lobes with shorter tips. Known at HF from a specimen collected by K.A. Raup in 1947 from a low swale in T8. Not seen in our survey.

Botrychium oneidense, BLUNT-LOBED GRAPE FERN. (Ophioglossaceae) Small grape fern of meadows and open woods, somewhat transitional between *B. dissectum* and *B. multifidum* and hence of disputed status. Credited to HF on the basis of a 1947 collection by I.M. Johnston from a swampy woodland southeast of HF headquarters. Not seen in our study. Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.

The identification of this specimen is, like many identifications in *Botrychium,* uncertain. The characters in the keys are simple, but the plants are complex and our experience is that the longer you study them and the more specimens you compare, the less clear the species lines become. As if to illustrate the difficulties in this group, Johnston's specimen was originally determined as *B. obliquum* var. *oneidense*; annotated to *B. dissectum* forma *obliquum* by the late Rolla Tryon (a fern expert from Harvard) in 1973, and then updated, following the synonymy in the *Flora of North America,* to *B. obliquum* var. *oneidense* by us.


Botrychium lanceolatum

Botrychium simplex, LEAST GRAPE FERN, DWARF GRAPE FERN. (Ophioglossaceae) Tiny grape fern of meadows and open woods, similar to juvenile forms of the more common *B. matricariifolium* and so difficult to identify with certainty. Collected by W. Chi-Wu in T3 and by K.A. Raup near the Community House, both in 1947; not seen in our study. Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.

Botrychium virginianum, RATTLESNAKE FERN. (Ophioglossaceae) Large, highly dissected grape fern of moist fertile woods. It was previ-

ously collected at HF by I.M. Johnston along Dugway Road on the south edge of the Simes Tract and by K. A. Raup, W. Chi-Wu, and I. M. Johnston in T3 and T4, all in 1947. It was also reported for the Camel's Hump cliffs (Simes Tract) by C.E. Smith (1948), based on a specimen that we did not see. We found it growing in two locations at the Simes Tract.

Brachyelytrum septentrionale, HAIRY WOODS GRASS. (Poaceae) Tall native rhizomatous grass with hairy leaves, characteristic of moist, mixed woods. Widespread at HF, where it was first collected in 1933 by H.M. Raup from the east side of the Tom Swamp Tract; found in almost every compartment in our survey. Our plants, which have 3- or 5-nerved lemmas with at most short hairs, are the northern form that is often called *B. erectum* var. *septentrionale.* Following the Massachusetts Checklist, we separate them as *B. septentrionale.*

Brasenia schreberi, WATER SHIELD. (Cabombaceae) Floating aquatic with oval leaves and a preference for circumneutral and alkaline waters. First collected in 1934 by H.M. Raup from a pond in the Tom Swamp Tract. Now common in Connor Pond, Harvard Pond, Riceville Pond, and even the tiny and relatively new Cow Pasture Pond in P2.

Brassica sp., A MUSTARD (Brassicaceae). C.E. Smith (1949) reported *Brassica arvensis* near the HF headquarters, citing a specimen labelled *B. nigra* that is immature and can't be determined conclusively. It looks like it could either be *B. nigra* or *B. juncea,* neither of which is known otherwise at HF.

Bromus ciliatus, FRINGED BROME. (Poaceae) Tall native grass of wetlands and shores with many-flowered spikelets and awned lemmas with a fringe of stiff hairs on their edges. Widespread in open, acid wetlands northward, less common southward and toward the coast. Apparently rare at HF: H.M. Raup collected it in the Prospect Hill Tract and the east part of Tom Swamp in 1933 and 1934; we saw it in P8 and in S6 (where the Swift River enters Connor Pond) in our survey.

Bulbostylis capillaris, SAND SEDGE. (Cyperaceae) Small, delicate, late-season sedge with tiny spikelets in umbels, found commonly on sandy roadsides and, much less commonly, on shores and ledges. Not collected in early surveys but now at least occasional along paved roads in HF; we have records from S6, T6, and T11, and it is likely to occur in other places as well.

Calamagrostis canadensis, COMMON BLUEJOINT GRASS. (Poaceae) Tall native colony-forming grass of open wetlands and shores. Especially common and characteristic of beaver meadows. Locally common around ponds and on river banks in HF where it was first collected in 1933 by H.M. Raup from a pond shore in the Tom Swamp Tract; we have records from nine compartments.

Calla palustris, WILD CALLA. (Araceae) Native wetland herb, commonly found in boggy ponds and at the edges of floating mats; occasional on pond shores and in both forested wetlands and open peatlands at HF; first


Botrychium virginianum


Brachyelytrum septentrionale


Brasenia schreberi


Bromus ciliatus


Bulbostylis capillaris


Calamagrostis canadensis

collected in 1933 by H.M. Raup from a pond shore in the Tom Swamp Tract; recorded from P2, P4, T7, T8, T9, T11, and the Simes Tract in this survey.


Calla palustris

Callitriche heterophylla, COMMON WATER-STARWORT. (Callitrichaceae) Floating or submersed aquatic herb, widely distributed in ponds and slow streams, near its northern range limits here. Widely distributed and generally common, but uncommon at HF. Collected in 1947 at Riceville Pond (T9) by I.M. Johnston and along the Swift River by C.E. Smith, and twice in backwater pools of the Swift River in S10 and twice in the Simes Tract in this survey,

This and the following species are very similar, differing only in their fruits and barely in those. The fruits of both species consist of four carpels, each of which has thin a crest or wing at maturity. In *C. heterophylla* the wings are short and those of adjacent carpels lie close together or touching; in addition the fruit is about as wide as long, and seems to be more deeply grooved on the sides and have a more conspicuous notch at the summit. In *C. verna* the wings extend farther down the sides of the fruit and the wings of adjacent carpels have a broad groove between them, looking something like the sheave of a pulley. In addition the fruits are clearly longer than wide and seem to be flatter on the sides and less notched at the summit. Immature fruits are very hard to identify. Some books say that the pits on the fruits form more regular lines in *C. verna*; we have not found this a reliable distinction in the HF material.


Callitriche heterophylla

Callitriche verna, MARSH STARWORT. (Callitrichaceae) Floating or submersed aquatic herb with a transcontinental distribution in northern North America. Uncommon at HF: collected at a pond in the Simes Tract northeast of Camel's Hump by I.M. Johnston and C.E. Smith and once in a pool in or near the Swift River by I.M. Johnston, all in 1947; not seen in this study. Part of a circumboreal complex and closely related to similar plants of northern Europe and Asia. We follow Crow and Hellquist (2000) in regarding it as a separate North American species; if it is considered as conspecific with its European relatives, it should be called *C. palustris.*

Calopogon tuberosus, GRASS-PINK. (Orchidaceae) A handsome bog orchid with slender leaves and bright pink flowers that are twisted so that the lip is up. Known at HF from a single fruiting specimen collected by H.M. Raup in 1937 from the bog at the north end of Tom Swamp. Not seen in this study. Formerly called C. *pulchellus*, a later name.


Caltha palustris

Caltha palustris, MARSH MARIGOLD. (Ranunculaceae) Early-blooming native herb of wooded swamps and open marshy ground; occasional at HF; first collected in 1934 by H.M. Raup along the river in the Slab City Tract; we recorded it in P8, S2, S3, S4, S5, S6, S10, T5, and also in a small wetland at the base of Camel's Hump in the Simes Tract, where it has been known since at least 1947.

Calystegia sepium, WILD MORNING-GLORY. (Convolvulaceae). A weedy, native herbaceous vine with white funnel-shaped flowers. Not previously

reported from HF; seen once in our survey, in the field on Rt. 32 in P9. Formerly called *Convolvulus sepium.*

Campanula aparinoides, MARSH BELLFLOWER. (Campanulaceae) A small, very delicate, pale blue bellflower of open wetlands, with a distinctive triangular stem that is rough on the angles. Rare at HF where it is only known from a collection among wetland vegetation along the bank of the Swift River in S6, just above Connor Pond, in this survey.

[**Campanula rapunculoides**,* GARDEN BELLFOWER. (Campanulaceae) Tall garden bellfower with large showy flowers. Locally spreading on the grounds of Lyford House but not truly naturalized. We have 1947 collections by I.M. Johnston and C.E. Smith from Leighton Road and by J. Canright from "Quaker Drive west of Chimney Hill." All of these are likely outside of HF.]

[**Campsis radicans**, * TRUMPET CREEPER. (Bignoniaceae) A cultivated vine with showy flowers, occasionally escaped from cultivation in our area. J.G. Jack (1911) said that it was escaped from cultivation at an old house site on the Prospect Hill Tract. There is no indication that it ever became truly naturalized.]

Capsella bursa-pastoris,* SHEPHERD'S PURSE. (Brassicaceae) Widespread weedy alien of fields, roadsides, and disturbed ground, with flattened, heart-shaped pods. Apparently uncommon at HF; listed for Petersham by H.M. Raup (1938); collected around the HF buildings by W.D. Beal in 1947; seen only once in our study, on the filled-in pool by Fisher House (P10).

Cardamine pensylvanica, PENNSYLVANIA BITTERCRESS. (Brassicaceae) Small amphibious herb of slow streams and shaded wetland pools. Occasional at HF: first collected by H.M. Raup in Slab City in 1934, and recorded from 6 compartments (S3, S4, S5, S9, T5, and Simes) in our study.

Carex abscondita, HIDDEN SEDGE. (Cyperaceae) A small, narrow-leaved sedge with a southern distribution, related to and closely resembling the more common *Carex digitalis*, but with the flowering spikes relatively short and overtopped by both the vegetative culms and the bracts of the lowest spikelets. Known at HF from a single 1947 collection by W.H. Drury, from along the highway in S10. The species is on the watch list of the Massachusetts Natural Heritage and Endangered Species Program; it was sometimes called *C. ptychocarpa,* a name that belongs to another species.

Carex albicans var. **emmonsii,** EMMON'S SEDGE. (Cyperaceae) A small woodland sedge, resembling *C. communis* but with narrower leaves and perigynia, found in open dry sandy or rocky woods. Uncommon at HF, and presenting some taxonomic problems. A 1938 collection by G. Turreson and C.G. Alm from open mixed woods in the Prospect Hill Tract is at HUH. A 1947 collection by I.M. Johnston from the Fay Lot (T9) where it was "forming a tuft in dry sandy soils" is definitely this species, as is our


Calystegia sepium


Campanula aparinoides


Capsella bursa-pastoris


Cardamine pensylvanica

2004 collection from P7; an immature 1934 collection by H.M. Raup from the Slab City Tract may also be. Several of our collections, from the edges of woods roads in P2, P4, and S9 may also be, but have the somewhat shorter pistillate scales we associate with *C. peckii.* Because *peckii* would not be expected on the acid soils here, we have called them *C. albicans*, pending more detailed study, preferably by someone else.

Carex annectens, YELLOW-FRUITED SEDGE. (Cyperaceae) Tall, long-leaved sedge of open meadows, often found on calcareous soils. Uncommon at HF. First collected in 1934 by H.M. Raup from the west side of Prospect Hill; also collected in a wet meadow in S8 by I.M. Johnston and by C.E. Smith from the foot of Prospect Hill, both in 1947. Recorded from T6 and along a trail in T7 near Harvard Pond in this study. Close to *C. vulpinoidea*, from which it differs mostly in the taller fruiting culms; also called *C. vulpinoidea* var. *ambigua* and, formerly, *C. brachyglossa.*

Carex appalachica, APPALACHIAN SEDGE. (Cyperaceae) Delicate sedge of moist deciduous woods. Occasional at HF: first collected in 1947 by C.E. Smith from Camel's Hump in the Simes Tract; reported in six compartments (S1, S7, S8, T1, T2, Simes) in our study. Close to its sister species *C. radiata,* and like it formerly considered a part (*C. rosea* var. *convoluta*) of a broadly defined *C. rosea* complex; it is most reliably separated from *C. radiata* by the thicker and more tightly coiled stigmas of *C. appalachica.* In our study, *appalachica* was about half as common as *radiata,* and perhaps restricted to sites of somewhat higher average fertility.

Carex arctata, ARCHING SEDGE. (Cyperaceae) Medium-sized sedge of moist deciduous woods, similar to *C. debilis* but with broader leaves and broader-based perigynia, and perhaps choosing more fertile sites. Collected in 1947 by K.A. Raup in the Prospect Hill Tract, and now frequent at HF; we found it in 17 compartments, in all the major tracts.

Carex argyrantha, SILVER-FLOWERED SEDGE. (Cyperaceae) Tall and sporadically occurring Ovalean sedge with long pistillate scales and minutely papillate achenes, found both in openings in dry acid woods and on rocky slopes in more fertile ones. First reported for HF in this survey, where it was collected along trails in T5, T6, and T8, and in the cleared boundary line at the summit of Camel's Hump in the Simes Tract. Formerly called *C. foenea*, a name which belongs to a different species.

Carex atlantica ssp. capillacea, HOWE'S SEDGE. (Cyperaceae) Delicate wetland sedge related to the common *C. echinata* but with broader perigynia and a more coastal distribution. Rare in HF: first collected here by W. Chi-Wu in T4 in 1947; seen twice in our survey, in sphagnum in wooded wetlands in P4 and T4. Formerly called *C. howei.*

Carex blanda, BLANDISHING SEDGE. (Cyperaceae) Broad-leaved Laxiflorean sedge of moist fertile woods, most common in maple woods on calcareous soils. Uncommon at HF; we have specimens from woodlands in S10, T10, the Grout Lot and the Simes Tract. The only valid record prior to this study is a 1938 collection by H.M. Raup, from dry woods in S5; three 1947 collections labeled *C. blanda* from T9, S8, and S10 are mis-


Carex albicans var.emmonsii


Carex annectens


Carex appalachica


Carex arctata


Carex argyrantha


Carex atlantica ssp.capillacea

identified specimens of *C. digitalis* and *C. laxiflora*; a fourth, also from S8, is too young to identify.*

Carex brevior, SHORT-HEADED SEDGE. (Cyperaceae) A large Ovalean sedge with round perigynia, generally uncommon and, like its relative *C. merritt-fernaldii*, rather unpredictable about where it appears. Known at HF from a 1934 collection by H.M. Raup from "ground near Mrs. Fisher's house" and by a collection of ours from a sandy thicket along the edge of Rt. 122 in T11.

Carex bromoides, BROME-LIKE SEDGE. (Cyperaceae) Slender, clump-forming sedge of stream banks and shaded wetlands; uncommon at HF where it is known from our survey from seeps with sphagnum in S4 and S5 and a wooded swamp in the Simes Tract. These may be the only HF collections; the single historical collection by I.M. Johnston from Tom Swamp Road says "0.5 miles west of the highway" and so would seem to be outside of HF; a collection by C.E. Smith from S8 is *C. tenera*.

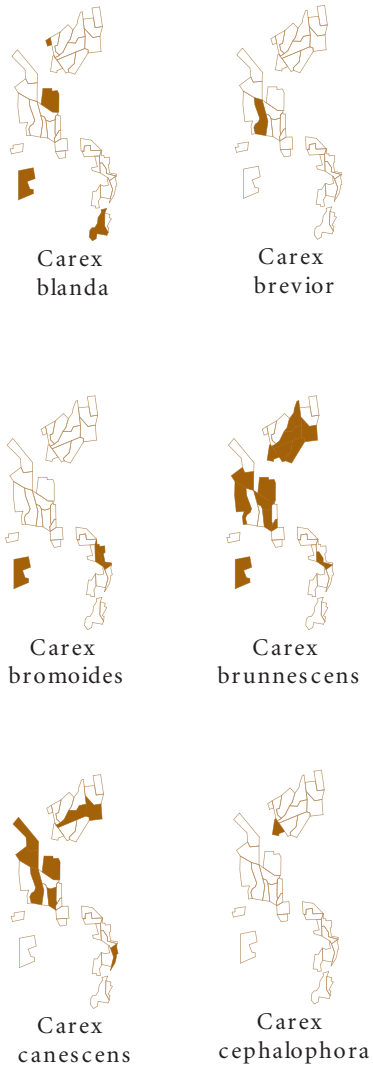
Carex brunnescens, BROWNISH SEDGE. (Cyperaceae) Slender sedge of moist woods and shaded wetlands, often found in hummocks of *Sphagnum* moss. Inconspicuous but ecologically consistent with the acid wetlands at HF: first collected in 1947 by W.H. Drury from a brook in the Tom Swamp Tract; we found it in 14 compartments, in every major tract. It is a variable and somewhat featureless sedge and so can be difficult to identify. Slender specimens with long bracts resemble *C. trisperma*, but have shorter perigynia. More robust specimens can resemble *C. canescens*, but generally have fewer perigynia, and do not have whitened foliage or spikes. The *Flora of North America* says that *C. canescens* has more ascending perigynia with more conspicuous sutures on the back of the beak; we have not been able to verify if this is true.

Carex canescens, SILVERY BOG-SEDGE. (Cyperaceae) White-green, tuft-forming sedge of pond shores and open wetlands, particularly common in beaver ponds and on the edges of floating mats. Locally frequent at HF where it was first collected in 1934 by H.M. Raup from a sphagnum swamp in the Prospect Hill Tract; we recorded it from eight compartments and all the major wetlands at HF.

Carex cephalophora, HEAD-BEARING SEDGE. (Cyperaceae) Tall sedge with closely aggregated inflorescences, characteristic of dry woods and open disturbed ground. Collected in 1938 by H.M. Raup from dry woods in S5, and seen once in our survey, by the gate to P9.

Carex communis, COMMON WOODLAND SEDGE. (Cyperaceae) Common low sedge of both fertile and acid woods, resembling *C. pensylvanica* but with broader leaves and a tufted habit. Scattered but frequent in deciduous woods and along woods roads in HF; first collected in 1934 by H.M. Raup from the east side of Prospect Hill, and later by C.E. Smith in 1947 from T8. Found in 20 compartments, in all the major tracts, in our study.

Carex comosa, BRISTLY SEDGE. (Cyperaceae) Large, broad-leaved sedge with bristly fruits, found in open wetlands and at the edges of marshy



*The genus *Carex*, which is technical and requires access to a good herbarium, gave previous HF botanists, and particularly the young C.E. Smith and the other students that worked with Dr. I.M. Johnston in 1947, some problems. Altogether they credited 21 more species of *Carex* to the flora than we do. Seventeen of these are, based on extant specimens, proven misidentifications. The specimens supporting the remaining four have been lost; we suspect, based on ecological considerations, that these were misidentifications as well.

ponds. Uncommon at HF; first collected in 1933 by H.M. Raup from the Barre Woods (Slab City Tract); also collected from Riceville Pond in 1982 by J. LaFrankie; found on the shore of Connor Pond in S6 and near the river in S9 in our survey.

Carex crinita, LONG-HAIRED SEDGE. (Cyperaceae) Tall wetland and pond-shore sedge with long leaves and drooping fruit. Closely related and formerly treated as conspecific with *C. gynandra*, but having smoother lower sheaths and truncate or lobed bodies on the pistillate scales. Uncommon at HF, and largely restricted to open shores and wetlands. First collected by H.M. Raup in 1933 along a stream in the Slab City Tract, and found in S5, S6, T2, and T10 in this survey; the other historical specimens from P3 and the west part of the Tom Swamp Tract have been re-determined as *C. gynandra.*

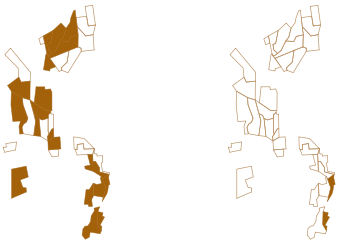
Carex cryptolepis, HIDDEN-SCALE SEDGE. (Cyperaceae) Small tufted sedge of softwater or acid pond shores, resembling the more calciphilic *C. flava* but with paler pistillate scales and shorter and smoother beaks on the perigynia. Known at HF from a collection by H.M. Raup from the Fay Lot (T9) in 1933, and collections by I.M. Johnston from the shores of Riceville Pond in 1947, originally determined as *C. flava* and referred by us to *C. cryptolepis;* we made trips looking for the species in 2004 and 2005 but could not relocate it.

Carex debilis, FEEBLE SEDGE. (Cyperaceae) Tall sedge with long narrow leaves and slender, drooping spikes, common in acid woods. It is similar to *C. arctata* but has narrower leaves, slightly more elongate perigynia, and achenes that are elevated above the perigynium base on a tiny stalk. This is one of the commonest woodland sedges in HF, found abundantly along trails and woods roads and also frequently on rocky slopes, in moist hardwood stands, and on hummocks in wooded swamps. It was first collected by H.M. Raup in 1933 from the Tom Swamp Tract; we have records from 27 compartments.

Carex deweyana, DEWEY'S SEDGE. (Cyperaceae) Clump-forming sedge of fertile woods, with slender basal leaves and long, somewhat arching culms. Uncommon at HF, where it is mostly in pockets of soil on ledge tops or on fertile rocky slopes; first collected in 1934 by H.M. Raup from "fertile woods" on the east side of Prospect Hill; we have records from S7, S8, S10, and Simes.

Carex digitalis, FINGER-LIKE SEDGE. (Cyperaceae) Small, narrow-leaved, Careyanean sedge with slender peduncles, commonest in fertile dry oak woods but sometimes found in moist or acid woods as well. Relatively common at HF, where it is found in at least 14 compartments. First collected at HF by H.M. Raup in 1938, from dry woods in S5; also represented in the HF herbarium by three specimens collected by I.M. Johnston and W. Chi-Wu in 1947: two from S8 and T9 were originally determined as *C. blanda,* and one from T4 was originally determined as *C. laxiculmis*.

Carex disperma, TWO-FRUITED SEDGE. (Cyperaceae) Delicate sedge with tiny, barrel-shaped fruits, commonly found in sphagnum in boggy


Carex communis

Carex comosa


Carex crinita


Carex debilis


Carex deweyana


Carex digitalis

woods. Rare at HF: 1947 collections by I.M. Johnston and C.E. Smith, both from woods, are actually *C. radiata.* Another 1947 collection by W. Chi-Wu from T4, originally determined as *C. digitalis,* is the only historical record of *C. disperma.* Seen once in our study, in a wooded wetland in S1.


Carex disperma

Carex echinata, PRICKLY SEDGE. (Cyperaceae) Tall tussock-forming wetland sedge with slender perigynia, common in beaver ponds and on the edges of bog mats. Frequent and locally common on pond shores and bog mats at HF; first collected by H.M. Raup in 1934 from the Prospect Hill Tract; and found in seven compartments in our survey. This species, formerly called *C. cephalantha* and *C. angustior,* is the only common member of *Carex* section *Stellullatae* in the acid wetlands at HF; *C. interior* was not seen, and *C. atlantica* ssp. *capillacea* was found at only two sites in our survey.


Carex echinata


Carex folliculata

Carex folliculata, FOLLICULATE SEDGE. (Cyperaceae) Tall, broad-leaved sedge with slender perigynia in dangling clusters, typically found in sphagnum swamps and on the shores of soft-water ponds. One of the characteristic sedges of HF, found commonly in sphagnum-shrub swamps with winterberry and highbush blueberry and also in floating mats and on pond shores. First collected by H.M. Raup in 1933 from the Tom Swamp Tract; found in 17 compartments in our study.

Carex gracillima, GRACEFUL SEDGE. (Cyperaceae) Tall sedge with slender nodding spikes and beakless perigynia, commonly found in moist deciduous woods of moderate fertility. Frequent at HF and recorded in 11 compartments in our survey. A 1934 collection by H.M. Raup labeled *C. gracillima* is immature and can't be determined accurately, but looks like *C. arctata*. The earliest collection (at HUH) that we could verify is from G. Turesson and C.G. Alm from Tom Swamp in 1938, with additional collections from Slab City in 1947 and from Camel's Hump (Simes Tract) in 1949.


Carex gracillima

Carex granularis, GRANULAR SEDGE. (Cyperaceae) Broad-leaved sedge with ball-shaped perigynia, usually found in grassy places or cultivated ground. A frequent species in the area but apparently rare at HF: known from a 1947 collection by I.M. Johnston near HF headquarters; he collected what he thought was *C. granularis* three times in this vicinity, getting *C. pallescens* twice and *C. granularis* once. Persistence is important. Not seen in our study. Includes *C. haleana* of C.E. Smith (1948).

Carex gynandra, GYNANDROUS SEDGE. (Cyperaceae) A tall, clump-forming sedge with dangling spikes and small, lens-shaped, water-dispersed perigynia, common in wet woods and on pond shores. Very close to *C. crinita,* from which it is separated by its rough sheath and pistillate scales that taper into their awns. Frequent and locally plentiful on pond shores, in wooded swamps, and along woods roads in HF; first collected by H.M. Raup in 1933 from the Prospect Hill and Tom Swamp Tracts; recorded in 20 compartments in our survey. Much more common here than its sister species *C. crinita*, which was recorded from only 4 compartments. Not distinguished by earlier botanists, who called everything *C. crinita.*


Carex gynandra

Carex intumescens, BLADDER SEDGE. (Cyperaceae) Narrow-leaved sedge with large inflated perigynia, found in wet acid woods and at the edges of wooded swamps. Now frequent at HF in both hardwood and mixed forest, but not listed by H.M. Raup (1938); the first records are 1947 collections by I.M. Johnston from P8 and the Fay Lot (T9). We recorded it in 19 compartments in this study. Some plants are quite large and resemble *C. lupulina*; they can be distinguished by their somewhat rounded achenes, which contrast with the diamond-shaped ones of *C. lupulina*.

Carex intumescens

Carex lacustris, LAKESHORE SEDGE. (Cyperaceae) A large, broad-leaved, colony-forming sedge of open, minerotrophic wetlands and swampy woods, often found in areas that flood seasonally. Uncommon at HF where the forested wetlands are typically peaty and have fairly constant water levels. First collected by H.M. Raup in 1938 in swampy woods in T2; seen once in this study, forming a colony at the edge of the large beaver meadow in T5. When fruiting the large spikes and shiny, spindle-shaped, short-beaked perigynia are distinctive. When not fruiting—and it often is not—the tall plants in large clones and ladder-fibrillose basal sheaths will usually identify it.

Carex lacustris

Carex lasiocarpa, DANCING SEDGE. (Cyperaceae) Tall, slender-tipped sedge of open bogs and fens, common northward and in the mountains, especially in wet floating mats. Somewhat surprisingly, a rare species at HF where it is known from a single 1933 collection by H.M. Raup from the edge of a pond in the Tom Swamp Tract and two observations, in Gould's Bog in P8 and south of the Tom Swamp causeway at the northeast edge of the bog in T11, in our survey.

Carex lasiocarpa

Carex laxiculmis, WEAK-STEMMED SEDGE. (Cyperaceae) Broad-leaved, white-green Careyanean sedge of fertile woods, often on trails or on moist rocky slopes. Uncommon at HF; reported by C.E. Smith (1948), but on the basis of a misidentified specimen of *C. digitalis* and another that we did not see; recorded in our survey from a rocky slope in S8, and along trails in S1 and T1.

Carex laxiculmis

Carex laxiflora, LOOSELY-FLOWERED SEDGE. (Cyperaceae) Broad-leaved Laxiflorean sedge with relatively slender spikes, characteristic of moist fertile woods. Occasional at HF, where it was first collected by H.M. Raup in 1938 in dry woods in S5. Also collected (under the name *C. blanda*) by I.M. Johnston in 1947. We recorded it at several fertile sites (S7, S8, the Simes Tract) and, interestingly, in a number of less obviously fertile compartments (P10, T4, T7, the Grout Lot) as well.

Carex laxiflora

Carex leptalea, DELICATE-STEMMED SEDGE. (Cyperaceae) Low slender sedge characteristic of open minerotrophic fens but also found in sphagnum bogs as well. Occasional in a variety of wetlands at HF where it was first found by H.M. Raup in Slab City in 1933. We have records from the river shore in S3, a small seepage wetland in S8, a pond shore in T4, and a seepy area in T9. A small wetland near the HF headquarters that yielded this and several other species in 1947 was not relocated and may no longer exist.

Carex leptalea

Carex leptonervia, FEW-NERVED SEDGE. (Cyperaceae) Unprepossessing Laxiflorean sedge with slender peduncles and few-nerved perigynia, found in moist hardwood and mixed forests. Frequent at HF: first collected by H.M. Raup in the Slab City Tract in 1934; seen in 11 compartments in our survey, especially in the Slab City and Tom Swamp Tracts, and often occurring in very slender forms with arching peduncles that have the aspect of *C. digitalis.* This is our most widely distributed and least fertility-dependent member of the *Laxiflorae.* It is largely replaced by the less common and more exigent *C. blanda* and *C. laxiflora* on the fertile rocky slopes in S7, S8 and the Simes Tract.

Carex leptonervia

Carex lucorum, GLADE SEDGE. (Cyperaceae) A close but much less common relative of *Carex pensylvanica* with rough culms and longer beaks on the perigynia. Known at HF from a specimen collected by H.M. Raup in Slab City in 1934. An additional H.M. Raup specimen (*5219*) is not fully mature but appears to be *C. pensylvanica* rather than *C. lucorum*. Formerly known as *C. pensylvanica* var. *lucorum*. As currently defined it is an eastern United States species of limited range, found in the same habitats as *Carex pensylvanica* and often growing with it.

Carex lupulina

Carex lupulina, COMMON HOP SEDGE. (Cyperaceae) Large sedge with cylindrical spikes and inflated perigynia, typically found in alluvial woods and in minerotrophic wetlands. Uncommon at HF: first collected from the Slab City Tract by H.M. Raup in 1937, and collected from Riceville Pond by I.M. Johnston and W.D. Beal in 1947; not relocated there in our study but seen twice nearby, near the edge of an open wetland in T5 and in a wooded swamp in T6.

Carex lurida, GARISH SEDGE. (Cyperaceae) Narrow-leaved sedge with cylindrical spikes and inflated, few-nerved perigynia, found in wet woods, roadside ditches, pond shores, and a variety of minerotrophic wetlands. Frequent at HF: first collected by H.M. Raup in 1933 from the Prospect Hill and Tom Swamp Tracts; recorded from 18 compartments in our survey, and likely found, at least in small quantities, in a number of others.

Carex lurida

Carex merritt-fernaldii, FERNALD'S SEDGE. (Cyperaceae) Tall Ovalean sedge of acid barren ground, with minutely papillose leaf sheaths with distinct ventral bands and large round perigynia which are nerved in the wing but have at most faint nerves on the upper side over the achene. Uncommon at HF: collected four times in the Tom Swamp Tract (T9) by W.H. Drury, C.E. Smith, and W.D. Beal, all within a few days of one another and all possibly from the same place; and seen twice in our survey, on a sandy roadside in T11 and by a trail in T5. Our material is quite close to *C. brevior*, differing only in the slightly thinner perigynia and slightly papillose sheaths.

All the historical collections were originally named *C. festucacea*, a name formerly used broadly for Ovalean sedges with wide, rounded perigynia and now restricted to a southern species with smaller perigynia. After struggling for many years to understand the differences between the plants we now call *brevior, merritt-fernaldii*, and *molesta*, we have considerable sympathy for (and some envy of) the simpler, if less detailed, taxonomy of sixty years ago.

Carex merritt-fernaldii

Carex muhlenbergii, MUHLENBERG'S SEDGE. (Cyperaceae) Uncommon sedge of dry sandy soils, with a compact inflorescence and papillose leaf blades. First collected from a field near Fisher House (P2), by H.M. Raup in 1934; found once in our survey, in the gravel pit in P9.

Carex normalis, RIGHT-ANGLE SEDGE. (Cyperaceae) A tall Ovalean sedge with relatively broad leaves and somewhat separated spikes, found in meadows and along grassy roads. Frequent at HF along woods roads, in moist grassy woods, and in open areas near buildings; first collected in 1947 by I.M. Johnston and W.H. Drury from P2, P4, and P7, and by R.S. Sigafoos from T3. This and *C. scoparia* are the commonest Ovalean sedges at HF; we currently have records of *normalis* from 15 compartments, and could probably find it in several others. *C. normalis* resembles several other species, particularly *C. tenera* and *C. projecta.* We distinguish it from *C. tenera* by the more compact inflorescence and somewhat wider leaves, and from *C. projecta* by the lower length-to-width ratio of the perigynia. The thickness of the perigynia and the width of the wing at the base, characters used in many keys, do not seem reliable distinctions in HF material.

Carex novae-angliae, NEW ENGLAND SEDGE. (Cyperaceae) Delicate, loosely tufted sedge of moist fertile woods, common at middle elevations. Rare or uncommon at HF and not reported prior to our survey; we have a mature specimen from along a stream in S4, and field observations of what appear to be immature plants of this species in P7, S3, S4, and S5.

Carex ormostachya, NECKLACE WOODLAND-SEDGE. (Cyperaceae) Laxiflorean sedge with purple leaf bases. A single 2005 collection, from a woods road in S3, appears to be this species. If so, it is the first record from Worcester County.

Carex pallescens, PALE SEDGE. (Cyperaceae) Low sedge with furry leaves and shiny round fruits, found in lawns and meadows. Uncommon at HF: first collected in 1934 by H.M. Raup from T1; recorded from fields near Fisher House (P2) and roadsides in P9 and P10 in our study.

Carex pedunculata, PEDUNCLED SEDGE. (Cyperaceae) Low, early blooming sedge with slender peduncles and sheathing bracts, found in moist fertile woods. Listed for Petersham by H.M. Raup (1938); no supporting vouchers were found. Uncommon at HF and restricted to the compartments with fertile woods; we found it on rocky slopes in S7, S8, and the Simes Tract, and on hummocks in a wooded seepage swamp in T4.

Carex pensylvanica, PENNSYLVANIA SEDGE. (Cyperaceae) Slender, early-blooming sedge that forms large patches in dry acid woods. A common and characteristic plant of slopes and summits in oak woods, found in almost all the compartments at HF. Collected by several botanists in 1947 but doubtless here before that; one of H.M. Raup's 1934 collections was the variety *lucorum*, now *C. lucorum*, a long-beaked relative that we looked for but did not find. A second H.M. Raup specimen is immature, but may be *C. pensylvanica*.


Carex muhlenbergii


Carex normalis


Carex novae-angliae


Carex ormostachya


Carex pallescens


Carex pedunculata


Carex pensylvanica

Carex plantaginea, PLANTAIN-LEAVED SEDGE. (Cyperaceae) Broad-leaved Careyanean sedge with pleated leaves and bright red sheaths on the flowering culms, commonly found in moist fertile rocky woods. Locally common on the talus slope of Camel's Hump, in the Simes Tract. Our 2004 collection is the first verified report from HF; there are 1947 records from T4 and the Simes Tract but the voucher specimens are immature and are poorly preserved and appear, so far as we can determine, to be other species.


Carex plantaginea

Carex platyphylla, BROAD-LEAVED SEDGE. (Cyperaceae) Broad-leaved Careyanean sedge with whitened leaves and slender flowering culms, characteristic of moist or, more often, dry fertile woods. It sometimes associates with its relative *C. plantaginea* on moist seepy ledges or slopes, but is more characteristic of dry knolls and ledges. First collected at HF on a "bank in shady dry woods" in T4 by I.M. Johnston in 1947. Not relocated there in our survey, but found once in fertile rocky woods in S7. Two other historical reports, from Camel's Hump (Simes Tract) and near the HF headquarters (P1) are based on misidentifications of other species.


Carex platyphylla

Carex prasina, LEEK-COLORED SEDGE. (Cyperaceae) Medium-sized but somewhat inconspicuous sedge of moist fertile woods, resembling *C. debilis* in its slender, dangling spikes, but with distinctive nerveless perigynia that are sharply triangular in cross-section. Not previously reported at HF; found once in our study, along a stream in T5.

Carex projecta, SEMINAR SEDGE. (Cyperaceae) Broad-leaved Ovalean sedge of meadows, roadsides and moist woods. First collected in HF by H.M. Raup in 1934, and apparently scattered and occasional here. We have records from roadsides, meadows, and streambanks in P9, P10, S5, T5, and T6. This species is part of a difficult group of species within a difficult section of *Carex*. It is close to the much more common *C. normalis*, and the differences in the width of the wings of the perigynia that are supposed to separate them often do not, especially with fresh material. In uncertain cases we have relied, with corresponding uncertainty, on the length-to-width ratio of the perigynia. Perigynia with *L/W* near 3 we call *projecta*; those with *L/W* near 2 we call *normalis,* and those with *L/W* in the middle we don't determine.


Care prasina


Carex projecta

Carex radiata, SPREADING-FRUITED SEDGE. (Cyperaceae) Delicate sedge of both moist and dry woods; frequent in hardwood stands and found in 13 compartments at HF in our study. It was formerly treated as variety *radiata* of a broadly defined *Carex rosea* complex, and currently seems to be the most common and widely distributed member of the *rosea* group in HF. First collected in 1938 by H.M. Raup from the Slab City Tract; also collected in 1947 by C.E. Smith and I.M. Johnston from T8 and from the Prospect Hill Tract.


Carex radiata

Carex rosea sensu strictu, ROSEATE SEDGE. (Cyperaceae) Slender sedge with widely spreading perigynia, often found in fertile rocky woods. In the sense we use it here (for plants with leaves near 2 mm wide and tightly coiled stigmas), it is both the largest member of the *C. rosea* complex and

the one that seems to require the most fertility. Uncommon and scattered at HF: collected in 1938 by H.M. Raup from dry woods in S5; we have records from P6, T9 and the Simes Tract. Only the last is in the fertile mesic woods that we consider typical of the species elsewhere.

Carex scabrata, ROUGH-STEMMED SEDGE. (Cyperaceae) Tall, rhizomatous, rough-fruited sedge of spring-fed wetlands, usually in partial shade. Widespread in our area though perhaps more common in the uplands. Scarce at HF, where there seems to be little suitable habitat. First found here in 1947 by I.M. Johnston along the Swift River in S10. Not relocated there in our study, but found in streambank wetlands in S5 and in small wetlands near woods roads in T5 and T8.

Carex scoparia, BROOM-SEDGE. (Cyperaceae) Slender and very common Ovalean sedge with large, lance-shaped, broadly- and asymmetrically-winged perigynia, typically found in open, seasonally wet, sandy ground. Frequent on the edges of woods roads and along pond shores at HF; first collected in 1933 by H.M. Raup from the Tom Swamp and Prospect Hill Tracts; we recorded it in 15 compartments in our study.

Carex stipata, STIPITATE SEDGE. (Cyperaceae) Tall, clump-forming sedge with soft winged culms and slender, lance-shaped perigynia, common in ditches, wet meadows, and other open mineral-soil wetlands. Occasional at HF, where the wetlands are typically shaded and peaty; first collected in 1934 by H.M. Raup from the Slab City Tract; we have records from wet roadsides and small wetlands in S3, S4, T1, T5, T6, and T10.

Carex stricta, COMMON TUSSOCK SEDGE. (Cyperaceae) Long-leaved, tussock-forming Phacocystian sedge of wet meadows, shores, bogs, and other wetlands. Abundant in the area but only occasional at HF, which has many forested wetlands and shrub-dominated peatlands but few open sedge meadows. Somewhat surprisingly, there seem to be no previous HF collections. H.M. Raup (1938) did not list it for Petersham; I.M. Johnston collected it several times in Petersham but not in HF. We have records from S4, S6, T6, T7, T8, and the Simes Tract and may have overlooked it elsewhere.

Carex swanii, SWAN'S SEDGE. (Cyperaceae) Light-colored, furry sedge of moist woodlands and thickets. Common in deciduous woods and at the edges of woods roads and trails in HF; it enters early in succession and is very characteristic of young woods with glades that still contain some meadow grasses and herbs. It was first collected in 1933 by H.M. Raup from the Tom Swamp Tract; found in 24 compartments in our survey. Close to and sometimes intergradent with *C. virescens*, from which it is separated by its denser and somewhat thicker spikes.

Carex tenera, SOFT SEDGE. (Cyperaceae) Narrow-leaved Ovalean sedge with well separated spikes along a slender nodding axis. First collected in HF by H.M. Raup in 1934, in Slab City and near the summit of Prospect Hill. Now occasional in meadows and along woods roads and trails; we have records from 7 compartments in our survey. Close to the much


Carex rosea

Carex scabrata


Carex scoparia

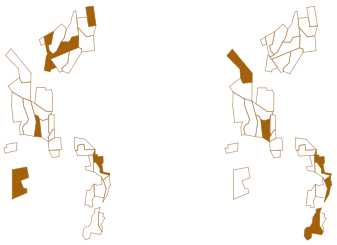

Carex stipata


Carex stricta


Carex swanii

commoner *C. normalis*, from which it is separated by the narrow leaves and very slender axis of the inflorescence.

Carex torta, TWISTED SEDGE. (Cyperaceae) Tussock-forming Phacocystian sedge of river shores with elongated perigynia with twisted beaks, mostly found on rocky rivers with a medium gradient. Not previously reported from HF but found in five compartments (S5, S6, S10, T5, T9) in our study. It much resembles *C. stricta*, which avoids fast-flowing streams and is best separated by its shorter perigynia and ladder-fibrils at the base of the culms.


Carex tenera

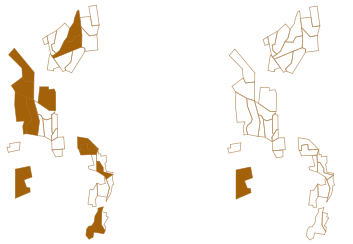
Carex torta

Carex tribuloides, BLUNT BROOM-SEDGE**.** (Cyperaceae) A broad-leaved Ovalean sedge with slender perigynia, similar to *C. projecta* and separated from it mostly by the less elongated inflorescence. A widespread species of wet meadows and moist open ground, perhaps commoner in the western part of the state than on the coastal plain. Rare at HF, where it was first collected in 1938 by G. Turesson and C. G. Alm from a roadside in the Prospect Hill Tract (specimen at HUH); we observed it once along a roadside in P8 in our survey. A 1947 collection by K.A. Raup along the Swift River in S10 is *C. projecta*; a specimen from Tom Swamp, cited by C.E. Smith (1948), was not found.


Carex tribuloides

Carex trisperma, THREE-SEEDED SEDGE. (Cyperaceae) Delicate sedge with small spikes and an open, long-bracted inflorescence, found in sphagnum in swamps and bogs. Frequent and locally plentiful in wooded swamps and open peatlands at HF; listed for Petersham by H.M. Raup (1938); first collected in 1947 by I.M. Johnston and W.H. Drury from the Tom Swamp Tract; recorded from 12 compartments in our study.

Carex tuckermanii, TUCKERMAN'S SEDGE. (Cyperaceae) Clump-forming sedge of shaded wetlands, with inflated perigynia and a distinctive notch in the achene. First collected at HF in 1947 by I.M. Johnston in a small pond northeast of the cliff on Camel's Hump (Simes Tract); relocated there in this survey. It is unclear whether specimens collected in 1947 by K.A. Raup and W.H. Drury from Nelson Road are from HF. Listed as an endangered species by the Massachusetts Natural Heritage and Endangered Species Program.


Carex trisperma

Carex tuckermanii

Carex umbellata, UMBELLATE SEDGE. (Cyperaceae) Low, stiff-leaved, semi-evergreen sedge of barren, exposed soil. It has red culm bases and small rounded perigynia on short spikes that are hidden among the leaf bases. Frequent in the region but uncommon at HF where suitable habitat is rare: first collected by H.M. Raup in Slab City in 1934; vegetative plants that were probably this species, but could have been the closely related *C. tonsa,* were seen in T7, T8 and T9 in our study.


Carex umbellata

Carex utriculata, BLADDER SEDGE. (Cyperaceae) Large, fat-based, rhizomatous bladder sedge that makes floating mats in open peatlands. Frequent and locally dominant in the bog ponds and wet peatlands in the Tom Swamp Tract where it was first reported by H.M. Raup in 1933; recorded from T5, T8, T9, T11, and the Simes Tract in our survey. For-

merly called *C. rostrata*, a name that was found to belong to another species.

Carex vesicaria, BLADDER SEDGE . (Cyperaceae) A large sedge of open wetlands of medium fertility, related to and resembling *C. utriculata* but clump-forming rather than creeping and with rougher upper culms and fewer rows of perigynia in the spikes. Widespread in sedge meadows in the region, but much less common in bogs and on floating mats than *C. utriculata.* Apparently rare at HF, probably for lack of habitat; first collected in 1947 by I.M. Johnston from near the dam at Riceville Pond; we observed it in beaver meadows in T5 and the Simes Tract in our survey.


Carex utriculata

Carex vesicaria

Carex vestita, CLOAKED SEDGE. (Cyperaceae) Tall, patch-forming sedge of open meadows and woods with coarse, acid soils. Near its northern range limits here and correspondingly rare. Only known at HF from three 1947 collections: one by I.M. Johnston in a blowdown "north of Kitchen Road (Prospect Hill Rd.), near garbage", one by W.H. Drury from a moist, roadside under hardwoods in P3, and one by W. Chi-Wu in woods in T4. Searched for but not relocated in this study. The species fruits infrequently and resembles the common *C. pensylvanica* vegetatively; it is quite possible that it is still present in a vegetative form.


Carex virescens

Carex virescens, GREENISH SEDGE. (Cyperaceae) Dark-green, furry sedge of moist woods, close to the commoner *C. swanii* but differing in the slenderer and more loosely flowered spikes. First collected by H.M. Raup in 1938 in dry woods in S5 and in S10. Also collected in a grassy clearing in P7 by I.M. Johnston in 1947. Now occasional along woods roads and in moist woods at HF; we recorded it from P3, S4, S5, S7, S9, S10, and the Simes Tract in our study.


Carex vulpinoidea

Carex vulpinoidea, FOXTAIL SEDGE. (Cyperaceae) Tall, clump-forming sedge with puckered ventral bands and a paniculate inflorescence, typically found in wet meadows, roadside ditches, and open wetlands on mineral soils in full sun. Uncommon at HF where it was first collected in 1934 by H.M. Raup from a woods road on Prospect Hill; there are other historical collections from a meadow in Slab City, and the edge of Tom Swamp Road, and we recorded it from open wet areas in P2 and P10 in our survey.


Carpinus caroliniana

Carpinus caroliniana, MUSCLEWOOD. (Betulaceae) Understory tree with fluted gray bark, often growing by streams; frequent in fertile areas but rare on sterile soils. Uncommon at HF: J.G. Jack (1911) said it was local and not as common as the hop hornbeam. The earliest collection, by W.A. Stalker in 1908, is labelled only as from HF; also collected from S8 by W.D. Beal and C.E. Smith in 1947; found in the Simes Tract and along the Swift River in S4, S5, and S10 in our survey.

Carum carvi,* CARAWAY. (Apiaceae) Aromatic garden escape, known in HF from a 1933 collection by H.M. Raup and a 1947 collection by J. Canright, both near the HF buildings in P1 and P2.

[**Carya cordiformis**, BITTERNUT HICKORY. (Juglandaceae) Forest tree of moist fertile soils, often associated with red oak and sugar maple. Not recorded at HF historically, and currently known only from a single recent sight record that we have not been able to relocate in the Simes Tract.]

Carya glabra, PIGNUT HICKORY. (Juglandaceae) Forest tree of dry acid soils, either uncommon or overlooked at HF. J.G. Jack (1911) said it was uncommon and sometimes found associated with shagbark hickory. There are no historical collections from HF, although we have early specimens from nearby Wilder's Farm. We recorded it in S5, S8, T10, and the Simes Tract in this study.


Carya glabra

Carya ovata, SHAGBARK HICKORY. (Juglandaceae) Tall forest tree of dry soils. Frequent in open woods at HF, where it is found in at least 10 compartments, many of which have indicators of fertile soils. J.G. Jack (1911) said that it was "Not common in HF but found more or less abundantly in neighboring woods and fields," suggesting that it is a successional species. First collected at HF in 1933 by H.M. Raup from the Barre Woods (Slab City Tract). Apparently absent from Prospect Hill; it may be that the soils there are too acid for it, or it may have been eliminated when the land was cleared and has not been able to re-establish itself since then.


Carya ovata

Castanea dentata, AMERICAN CHESTNUT. (Fagaceae) Formerly a canopy tree of open woods, now mostly a small understory tree persisting from root sprouts. J.G. Jack (1911) called it simply a "common and important tree." First collected at HF in 1911 by H.H. Tryon in the Slab City Tract; still common, though much diminished in importance, at HF today; we found it in 28 compartments in our study.


Castanea dentata

[**Castanea mollissima***, CHINESE CHESTNUT. (Fagaceae) An alien forest tree, resembling the American chestnut but with the leaves less strongly toothed and somewhat more rounded at base and summit. Formerly planted at HF; we found a few saplings, apparently of this species, in P1, in the immediate vicinity of trees planted in the 1980s. It has been reported escaped elsewhere in Massachusetts.]

Caulophyllum thalictroides, BLUE COHOOSH. (Berberidaceae) Tall, compound-leaved herb of moist fertile woods, especially characteristic of rocky slopes. Widespread in our region but much less common than in western Massachusetts where the soils are more fertile. Known at HF from the cliffs on Camel's Hump (Simes Tract), where it was first found by I.M. Johnston in 1947 and persists at present. Also occurs on a rocky slope in or immediately adjacent to S8.


Caulophyllum thalictroides

Celastrus orbiculatus,* ORIENTAL BITTERSWEET. (Celastraceae) High-climbing alien woody vine of hedgerows and edges, notoriously invasive in second-growth woods. Not recorded in previous surveys but now widespread and locally common; we recorded it from 13 compartments in our survey.


Celastrus orbiculatus

Celastrus scandens, COMMON BITTERSWEET. (Celastraceae) Twining native vine with red arillate fruits, widespread and locally common in

woods and thickets. J.G. Jack (1911) said it was occasional on the Prospect Hill Tract and in other places. It was first collected in the Prospect Hill Tract by an unknown collector in 1912 and by S.M. Dohanian in 1913, and re-collected on a wall near the administration building (P1) in 1947. It was not seen in our study but, since small plants can look quite similar to the invasive and now common *C. orbiculatus,* it may have been overlooked.

Centaurea biebersteinii,* SPOTTED KNAPWEED. (Asteraceae) Invasive European herb, widely established in dry fields and waste ground throughout the Northeast. Rare at HF and not previously reported; seen only once in our survey, in an old gravel pit in T6. Long called *C. maculosa*, a name now thought to apply to a different species.


Centaurea biebersteinii

Cephalanthus occidentalis, BUTTONBUSH. (Rubiaceae) Native wetland and pondshore shrub with whorled leaves and balls of white flowers. Locally common at all the large ponds in HF; we recorded it from S5, S6, T8, T9, T11, and the Simes Tract. J.G. Jack (1911) said it was found in "very wet boggy places" in the Meadow Water (Tom Swamp) Tract and elsewhere; it was first collected in 1913 by S.M. Dohanian from the Slab City Tract.


Cephalanthus occidentalis

Cerastium fontanum,* COMMON MOUSE-EARED CHICKWEED. (Caryophyllaceae) Ubiquitous European weed of lawns and waste grounds. Occasional at HF in lawns and open ground; first collected in 1934 by H.M. Raup from the east slope of Prospect Hill and a field by the HF school; found in compartments P1, P7, P9, T3, and T9 in our study and doubtless present elsewhere. The Linnaean names *C. vulgatum* and *C. viscosum*, long applied to this species, were used by Linnaeus for several different species and so have been deemed ambiguous and replaced with the later name *C. fontanum.*


Cerastium fontanum

Chamaedaphne calyculata, LEATHERLEAF. (Ericaceae) Slender-branched, evergreen, Ericaceous shrub of open peatlands, particularly common on and one of the architects of floating bog mats. Frequent and locally dominant in the large peatlands at HF, and occasional at some smaller ones as well. J.G. Jack (1911) said that it was very abundant on the Meadow Water (Tom Swamp) Tract and covered "many acres of the shallower parts of the pond." We have records from P7, P8, S6, T5, T7, T8, T9, T11, and the Simes Tract in our survey. Probably first collected at HF in 1908 by W.W. Cole, from "Meadow Pond," which we believe to be Harvard Pond. Later collected in 1933 by H.M. Raup from the Tom Swamp Tract.


Chamaedaphne calyculata

Chamaesyce maculata, COMMON SPURGE. (Euphorbiaceae) Small prostrate spurge, common and weedy in gardens, lawns, paved areas, and waste ground. First collected (as *Euphorbia vermiculata*, a related species) near Riceville Pond by I.M. Johnston in 1947, and also reported from near Harvard Pond by C.E. Smith (1949) citing a specimen that we did not see; seen around Shaler Hall (P1) in our study, and likely present on roadsides elsewhere. This is generally assumed to be a native species; it has also been called *Euphorbia maculata*, and, by those who consider the Linnaean *maculata* ambiguous, *Euphorbia supina.*


Chamaesyce maculata

Chelidonium majus,* CELANDINE POPPY. (Papaveraceae) Tall, weedy, yellow-flowered poppy, originally from Europe and now widely established in lawns, thickets, and open ground. First collected from HF at the dump on Kitchen Road (Prospect Hill Rd.) in 1947. Now occasional in open ground near roads; reported from P1, P6, P9, P10, and S9 in our survey.


Chelidonium majus

Chelone glabra, TURTLEHEAD. (Scrophulariaceae) Tall white-flowered figwort with dark, sharply toothed leaves, typically growing in shaded wetlands and along the shores of brooks and streams. Occasional and locally frequent at HF, especially along streams; we have records from 12 compartments. First collected at HF in 1933 by H.M. Raup from the Slab City Tract.

Chenopodium album,* PIGWEED. (Chenopodiaceae) Cosmopolitan weed of European origin, with whitened triangular leaves and small fruits with horizontal seeds. Most characteristic of cultivated ground and moist, fertile, recently bared soil. Present in Petersham (Wilder's Farm) since 1933 (and probably long before that), but apparently not common in our post-agricultural habitats; it was first collected at HF in 1947 by W.D. Beal, from behind the HF buildings; we have casual records from P1, S6, S10, and T11, and suspect that it is present in small amounts along roadsides elsewhere.


Chelone glabra


Chenopodium album

Chimaphila maculata, SPOTTED PIPSISSEWA. (Pyrolaceae) Low evergreen subshrub with handsome white and green leaves, commonest in mixed forests with acid soils. Currently frequent in HF and a characteristic plant of the mixed oak-pine woods; we recorded it from 16 compartments in our study. Interestingly, there are no previous records of it from HF. Either it was unaccountably missed by the earlier surveys (which did record its relative *C. umbellata*), or it is slow to recolonize post-agricultural habitats and has only recently spread here.


Chimaphila maculata

Chimaphila umbellata, PIPSISSEWA. (Pyrolaceae) Low shrub, similar to *C. maculata* but with uniformly dark-green leaves; also frequent at HF and widely distributed in mixed woods. Not mentioned by J.G. Jack (1911), who did list *Epigaea* and *Gaultheria* and so wasn't excluding dwarf shrubs. First collected in HF by Mrs. Gast in the Barre Woods (Slab City Tract) in 1928, and then by H.M. Raup from the Tom Swamp Tract in 1933. Now occasional at HF, where it was seen in ten compartments in our survey.


Chimaphila umbellata

Chrysanthemum leucanthemum,* OX-EYE DAISY. (Asteraceae) Familiar white-rayed European weed of meadows and roadsides. Listed for Petersham by H.M. Raup (1938). First collected at HF in 1947 by W.D. Beal from S8; recorded in ten compartments, mostly on roadsides, in our study.


Chrysanthemum leucanthemum

Chrysosplenium americanum, GOLDEN SAXIFRAGE. (Saxifragaceae) Small, succulent, opposite-leaved creeper, common in slow brooks and shaded pools in seepage wetlands. Uncommon in HF and not previously verified here: collected by H.M. Raup in 1934, at an unknown locality

that may or may not be from HF; reported by C.E. Smith (1949) from T1, citing a specimen that we did not see; seen three times in our survey, in a shaded pool in the Simes Tract and along the Swift River in S3 and S10.

Cichorium intybus,* CHICORY. (Asteraceae) A tall, stringy herb with sky-blue ray flowers, originally European and now a widely distributed weed of coarse disturbed soil. Common on roadsides throughout our area but not previously reported from HF; seen once in our survey, in the pasture in P2.

Cicuta bulbifera, BULBLET WATER-HEMLOCK. (Apiaceae) Delicate umbellifer of shores and open wetlands, bearing small bulbs in the upper axils. Uncommon at HF: first collected in 1933 by H.M. Raup from the Tom Swamp Tract; subsequently collected at Riceville Pond by I.M. Johnston and W.D. Beal in 1947; relocated there (T9), at Connor Pond (S6), and along the Swift River in S3 and S10 in this study.

Cicuta maculata, SPOTTED WATER-HEMLOCK. (Apiaceae) Compound-leaved, highly poisonous umbellifer of shores and open wetlands, differing from *C. bulbifera* in its broader leaf segments and in the absence of bulbs. Uncommon at HF and not previously verified here; reported by C.E. Smith (1949) from Riceville Pond, based on a misidentified specimen (Johnston *234*, cited as *244*) that is actually *Sium suave* and from a pool at the base of Camel's Hump in the Simes Tract where *S. suave* is currently common, based on a specimen that we did not see; recorded in our survey, from T1, T6, the shores of Connor Pond (S6), and along the Swift River in S10.

Cinna latifolia, DROOPING WOODREED. (Poaceae) Tall, broad-leaved woodland grass with slender spikelets in a panicle with drooping branches. Widely distributed in moist deciduous woods and especially common on fertile soils. Frequent at HF: first collected in Tom Swamp by H.M. Raup in 1933; recorded in 13 compartments in our study, and likely, because it develops late, found in others where we did not record it.

Circaea alpina, SMALL ENCHANTER'S NIGHTSHADE. (Onagraceae) Low opposite-leaved herb with bristly velcriform fruits that stick to socks, typically found in small wet hollows in woods. Apparently uncommon at HF; first collected by H.M. Raup in T1 in 1934 and found in P6, S7, S9, and the Simes Tract in our study.

Circaea lutetiana, LARGE ENCHANTER'S NIGHTSHADE. (Onagraceae) Our taller and commoner *Circaea*, typically found in moist deciduous woods of moderate or high fertility and sticking to pants rather than socks. Widely but somewhat locally distributed in woods and along woods roads at HF: first collected in 1933 by H.M. Raup from the east part of the Tom Swamp Tract; seen in 13 compartments in our survey. A circumboreal species or species complex; the American plants were formerly called *C. quadrisulcata.* That name apparently belongs to an Asian species or subspecies, and our plants are now usually included in the Linnaean *C. lutetiana.*


Chrysosplenium americanum


Cichorium intybus


Cicuta bulbifera


Cicuta maculata


Cinna latifolia


Circaea alpina


Circaea lutetiana

Cirsium arvense,* CANADA THISTLE. (Asteraceae) Alien, small-headed thistle that spreads by rhizomes and forms large patches in meadows and pastures. Elsewhere an aggressive agricultural weed but apparently scarce at HF. First collected by C.E. Smith on the top of Prospect Hill in 1947; found in relatively small populations in open areas in P1 and P9 in our survey.


Cirsium arvense


Cirsium vulgare

Cirsium vulgare,* COMMON THISTLE. (Asteraceae) Tall, large-headed, alien thistle with spiny decurrent wings on the stem, found mostly in waste ground. Uncommon at HF: first collected by H.M. Raup from the Prospect Hill Tract in 1933; reported by C.E. Smith (1949) from Harvard Pond, based on a specimen that we did not see; and found in open disturbed ground in P1, P2 and P9 in our study. Formerly called *C. lanceolatum,* a name that is now applied to another species.

Cladium mariscoides, TWIG RUSH. (Cyperaceae) Tall, smooth-leaved, rhizomatous sedge with v-shaped leaf sheaths, typical of peaty river and pond shores and wet floating mats. Not previously reported from HF but plentiful and locally dominant on low wet mats and the floating peat islands in Harvard and Riceville Ponds (T9, T11).


Cladium mariscoides

Clematis virginiana, VIRGIN'S BOWER. (Ranunculaceae) Herbaceous vine with white flowers and feathery seed heads, climbing by twining leafstalks and common in moist thickets along roads and near ponds and streams. Occasional at HF where the first verified record is a 1911 collection by H.H. Tryon from the Barre Woods (Slab City) Tract; we have records from P1, P3, P8, S5, S9, S10, and T9 in our survey,


Clematis virginiana

Clethra alnifolia, SWEET PEPPERBUSH. (Clethraceae) Tall, shiny-leaved coastal shrub with sweet white flowers, found on pond shores and in wet thickets. A characteristic species of the Massachusetts coast but rare and scattered inland. Rare at HF: W.D. Beal collected it on the shore of Riceville Pond in 1947, and we relocated it there in our study. Also planted in the courtyard by the schoolhouse in P10.


Clethra alnifolia

Clinopodium vulgare, WILD BASIL. (Lamiaceae) A slender, scentless, round-leaved mint, with small pink flowers and long, needle-like calyx lobes. Originally from Europe, now a common (though unassertive) weed of meadows, roadsides, and open dry woods. Not previously reported from HF. Seen twice in our survey along a rich, small stream in the Simes Tract and along a woods road in T7. The common name is a misnomer; the plant neither looks like, smells like, or is more than distantly related to basil. Long known as *Satureja vulgaris,* and hence sometimes called common savory.


Clinopodium vulgare

Clintonia borealis, CLINTONIA, BLUE-BEAD LILY. (Liliaceae) Low woodland flower with large shiny basal leaves and dark blue berries, characteristic of moist acid soils, common in wooded swamps and in openings in conifer forests. Generally associated with boreal forests but, like bunchberry, goldthread, starflower, dewdrop and several others, very common in low areas in the mixed woods at HF. First collected here in 1909 by


Clintonia borealis

W.A. Stalker from the Tom Swamp Tract; found in 27 compartments in our study.

Coeloglossum viride, LONG-BRACTED ORCHID. (Orchidaceae) A medium-sized, long-bracted rein orchid with greenish flowers with a rectangular, notched lip. An uncommon species of fertile woods, not previously known from HF.* We found a single plant in 2006 and 2007 in rocky woods on the slope of Camel's Hump in the Simes Tract. Included on the watch list of the Massachusetts Natural Heritage and Endangered Species Program. Long known as *Habenaria viridis.*


Coeloglossum viride

Comandra umbellata, BASTARD TOADFLAX. (Santalaceae) Low semi-parasitic herb with white flowers, wide-ranging in North America and so with a correspondingly variable ecology but often found in dry oak woods in our area. Rare at HF: first collected on Camel's Hump (Simes Tract) by H.M. Raup and C.E. and E.E. Smith in 1949; seen on the summit of Camel's Hump, which is just west of the western boundary of the Simes Tract, and so in the Quabbin Reservation and not in HF, in this study.

Commelina communis,* COMMON DAYFLOWER. (Commelinaceae) The common blue and yellow dayflower, widely cultivated and commonly escaped to meadows and moist thickets. Uncommon at HF and not previously reported here: we recorded it from the pasture in P2 and the gravel pit in P9.


Commelina communis

Comptonia peregrina, SWEETFERN. (Myricaceae) Low aromatic shrub with cut leaves, common in open, dry sandy soil. Frequent but very scattered along roadsides in HF: first collected at HF in 1909 by Blake on Prospect Hill; J.G. Jack (1911) said it was common and a weed in pastures and abandoned fields; we found it in 16 compartments in our survey, usually locally and in small amounts. Formerly called *Myrica asplenifolia*; its fruits are different from those of *Myrica*, and it is now placed in its own genus.


Comptonia peregrina


Convallaria majalis

[**Convallaria majalis**,* LILY-OF-THE-VALLEY. (Liliaceae) Cultivated, patch-forming lily, locally persistent from cultivation. Known at HF from a single large patch at an old farmstead in the woods in P10 first seen in this survey.]

Conyza canadensis, HORSEWEED. (Asteraceae) Weedy native composite with small flowers, common on waste ground and along the edges of roads. Listed for Petersham by H.M. Raup (1938) and C.E. Smith (1949), where it was said to be "common in waste places," but apparently not previously confirmed for HF; the only herbarium collection we found, by N.W. Hosley in 1933, is from Wilder's Farm, outside of HF. Recorded four times at HF in our study, near the Shaler Hall parking lot, in the pasture in P2, in the gravel pit in P9, and along Dugway Rd. in the Simes Tract. It is likely present along the margins of paved roads in other compartments. Formerly called *Erigeron canadensis.*


Conyza canadensis

Coptis trifolia, GOLDTHREAD. (Ranunculaceae) Low, trifoliate, shiny-leaved herb of wet forests and wooded swamps, often in sphagnum moss.

*A 1933 collection by H.M. Raup from the Prospect Hill Tract is *Platanthera psycodes.*

Common at HF, where it was first collected in 1933 by H.M. Raup from the Tom Swamp Tract. Found in 22 compartments in our survey. A wide-ranging species of North America and east Asia, treated, following the *Flora of North America* and others, under the Linnaean name. If you believe that the plants of eastern and western North America are distinguishable, and if the distinction matters to you, you may call our plants *C. trifolia* subsp. *groenlandica* or (as M.L. Fernald did) *C. groenlandica.*

Corallorhiza maculata, SPOTTED CORALROOT. (Orchidaceae) Saprophytic, leafless, blotchy-pink orchid of mixed forests. Apparently uncommon at HF: first collected by H.M. Raup from the Tom Swamp and Slab City Tracts in 1933; I.M. Johnston, M.H. Zimmermann, and others subsequently collected it from these tracts as well. Observed in the early 1990s by G. Motzkin west of Pierce Rd. in the Prospect Hill Tract and seen once, along the eastern part of Tom Swamp Road in T4, in our survey.

Corallorhiza trifida, EARLY CORALROOT. (Orchidaceae) Slender, pink or yellowish, saprophytic orchid with a northern distribution, commonest in fertile boggy mixed woods and wooded swamps. Previously collected twice at HF, both times in wet marshy woods, by R.S. Sigafoos and I.M. Johnston in T8 in 1947 and by C.E. and E.E. Smith in T7 in 1949. Seen in wet woods in P7 and in the Simes Tract in our survey.

Cornus alternifolia, ALTERNATE-LEAVED DOGWOOD. (Cornaceae) Spreading understory tree with distinctive relay branching, found in a variety of woods but commonest in moist hardwoods on fertile soils. Frequent at HF where it was first collected in 1911 by H.H. Tryon from the Slab City Tract. J.G. Jack (1911) said it was common along roadsides and in open woods; we found it in 17 compartments in our survey.

Cornus amomum, SILKY DOGWOOD. (Cornaceae) Red-stemmed, clump-forming dogwood of open wetlands and river shores. The leaves are very similar to those of the gray dogwood, *C. racemosa.* The two species are easily separated when flowers, fruit, or winter branches are present, but small summer plants with green twigs can be very similar. Our best characters for *amomum* are the hairier young twigs and the darker pith of the older branches. Apparently uncommon at HF, especially in comparison to its abundance elsewhere in the state: J.G. Jack, who collected it in 1908 from the "Swamp Meadow Tract" in Tom Swamp, said it was "rather rare in HF;" we recorded it, in small quantities, in P2, T5, T6, and T9. Our plants are the northern subspecies *obliqua*, and have been separated as *C. obliqua.*

Cornus canadensis, BUNCHBERRY. (Cornaceae) Low, barely woody, colonial shrub from creeping rhizomes, with whitish bracts and red, aggregated fruits. Frequent at the edges of swamps and in swampy pockets in mixed forests at HF, often in sphagnum moss. First collected at HF by R.R. Chaffee in 1908 from the Meadow Water Tract (an early name for the Tom Swamp Tract), though not mentioned by J.G. Jack (1911). Found in 20 compartments in our survey.


Coptis trifolia


Corallorhiza maculata


Corallorhiza trifida


Cornus alternifolia


Cornus amomum


Cornus canadensis

Cornus florida, FLOWERING DOGWOOD. (Cornaceae) Understory tree with arching branches and flowers with showy white bracts, typically found in dry, fertile woods and rare in our area. It was apparently present in Petersham in the early 1900s—the HF herbarium has unlabeled 1909 and 1910 collections by R.R. Chaffee, J.G. Jack (1911) said that it was in Petersham but had not been found at HF, and S.M. Dohanian collected it on "Dogwood Hill," an unknown locality, in 1913*. First definitely collected at HF by E.E. Smith, C.E. Smith, and H.M. Raup in 1949 on Camel's Hump (Simes Tract). Looked for on Camel's Hump and elsewhere in this survey but not relocated.

Cornus racemosa, GRAY DOGWOOD. (Cornaceae) Slender-twigged, colony-forming shrub of rough meadows and dry woods, common in the region. Apparently decreased in abundance in the last century and now scarce or absent at HF: J.G. Jack (1911) said it was "frequent, along roadsides and in woods;" H.M. Raup (1938) reported it from Petersham; S.M. Dohanian collected it in 1913 on Dogwood Hill, an uncertain location; and C.E. Smith collected it in 1947 near the HF administration building. We found one small plant along the edge of Connor Pond that may have been this species but could not be definitively identified, and another plant just off of HF property near the northern boundary of the Simes Tract that was definitely this species. Formerly called *C. paniculata*, a later name; sometimes called *C. foemina ssp. racemosa*, a name of uncertain application.

Cornus rugosa, ROUND-LEAVED DOGWOOD. (Cornaceae) Slender, purple-flecked shrub with round leaves with rough surface, most often found in dry fertile woods. Uncommon at HF: first collected in 1947 by E.P. Stephens from the Tom Swamp Tract, and by I.M. Johnston and W.D. Beal from the south slope and summit of Prospect Hill. Seen twice in our study, along a woods road in T2 and on the eastern slope of Camel's Hump (Simes Tract).

Cornus sericea, RED-OSIER DOGWOOD. (Cornaceae) A low, shrubby dogwood with creeping stems and bright red branches, frequent along streams and in open wetlands in western New England but apparently rare in HF. J.G. Jack (1911) said that it was planted in Petersham but had not yet been found wild there. H.M. Raup (1938) listed it for Petersham, but we have not seen a supporting specimen. C.E. Smith (1949) listed it incorrectly from Riceville Pond, citing a misidentified specimen of *C. amomum*. Seen once in our survey along the Swift River at the southern end of S10. Long called *Cornus stolonifera.*

Corydalis sempervirens, PALE CORYDALIS. (Fumariaceae) Blue-green, annual herb with lobed leaves, characteristically found in thin soil over exposed ledges and often abundant after fires. Known at HF from two historical records: a 1934 collection by H.M. Raup on rocks on the east side of Prospect Hill, and a 1947 collection by I.M. Johnston on ledges on the east side of Camel's Hump (Simes Tract). We found a few plants on open rocks on the slopes of Camel's Hump.

Cornus rugosa

Cornus sericea

Corydalis sempervirens

*Dohanian is the only HF collector to use the name "Dogwood Hill" and we don't know if the name was in local use or invented by him. R.R. Chaffee collected a specimen of flowering dogwood from the "Cornus florida Lot," which may have been the same location. Dohanian collected several species at Dogwood Hill, including: *Cornus florida, Cornus racemosa, Prunus nigra, Quercus alba, Ribes hirtellum, and Tilia americana.* The species suggest a rich flora and the site could have been Camel's Hump, where flowering dogwood was collected in 1949, or an unknown site. Camel's Hump did not become a part of HF until 1977. We know that it was visited by I.M. Johnston in 1947 and by H.M. Raup and C.E. and E.E Smith in 1949, but it was never mentioned by J.G. Jack (1911) or any of the early collectors, and there is no evidence from their collections that they visited it and called it by another name.

Corylus americana, AMERICAN HAZELNUT. (Betulaceae) Gray, catkin-bearing shrub of woods edges and open sandy thickets, distinguished by its short involucres, sharp-pointed male bracts, and minutely glandular twigs. Listed as "rare in Harvard Forest" by J.G. Jack (1911); collected at HF by W.D. Beal and C.E. Smith from S8 in 1947. Looked for there and elsewhere but not found in our study.

Corylus cornuta, BEAKED HAZELNUT. (Betulaceae) A similar but more northern species of thickets and forest understories, with less pointed and hairier male bracts, long tubular involucres, and smooth twigs. Frequent but scattered in moist woods at HF; J.G. Jack (1911) said it was common on roadsides and in woods and thickets; H.M. Raup made the first collection from the Tom Swamp Tract in 1933; and we found it in 17 compartments in our study. Formerly called *C. rostrata.*

Corylus cornuta

Crataegus sp., HAWTHORNS. (Rosaceae) Small, thorny, difficult trees of rough meadows and second-growth woods, common throughout HF but mostly not flowering and so not determined to species in our survey. The HF herbarium has specimens determined as *C. chrysocarpa, C. matura, C. pastorum, C. pruinosa,* and *C. streeteri*. Owing to both the limitations of the material and our limited knowledge of the genus we have not attempted to verify any of them: *C. chrysocarpa* and *C. pruinosa* are current names; the others are obsolete names whose synonymy we have not been able to trace.

Crataegus sp.

Crataegus macrosperma

Crataegus macrosperma, LARGE-SEEDED HAWTHORNS. (Rosaceae) We collected flowers and fruit from a small hawthorn in an old clear-cut in T4, which R. Bertin determined to be this species. He reports that it is common in the area.

[**Crocus sp.** (Iridaceae) A plant that is possibly a species of *Crocus* was apparently planted at the old tavern site on French Rd. in P10 and has persisted and spread locally near the cellar hole. We have not seen flowers and do not have a definite identification.]

Cuscuta gronovii, COMMON DODDER. (Cuscutaceae) Leafless, bright orange, parasitic, annual vine with white flowers, common on a variety of hosts in open moist thickets. Apparently rare at HF: collected along a stream in the Fay Lot (T9) by H.M. Raup in 1933, and seen along the west shore of Connor Pond (S6) and along the Swift River (S2, S5, S10) in this study.

Cuscuta gronovii

[**Cydonia oblongifolia**, QUINCE. (Rosaceae) A small cultivated tree with white flowers and a yellow fruit. J.G. Jack (1911) said that it was "introduced and persisting" in orchards on the Prospect Hill Tract. There is no evidence that it ever naturalized.]

Cynoglossum virginanum, WILD COMFREY. (Boraginaceae) An uncommon, broad-leaved, somewhat transient herb of dry fertile woods. Collected once at HF by C.E. Smith in 1947 in dry open woods in T8. Not seen in our study and considered rare throughout Massachusetts by the Natural Heritage and Endangered Species Program.

Cyperus bipartitus, RED-SCALED FLATSEDGE. (Cyperaceae) A small, tufted, annual *Cyperus* with lens-shaped achenes and red-pigmented scales, widely distributed on moist shores. Apparently uncommon at HF: collected by H.M. Raup and Steiger in 1938 along the causeway in Tom Swamp, and seen only once in our survey along a filled-in ditch at the edge of the pasture in P2. Late-developing and possibly overlooked elsewhere. Also called *C. rivularis.*

Cyperus erythrorhizos, REDROOT FLATSEDGE. (Cyperaceae) A wide-ranging annual *Cyperus* with a winged rachis and pistillate scales with the main nerves near the center. Occasional on shores and wet soil, near its northern range limit here and somewhat erratically distributed. Not previously reported from HF but now frequent on the peaty islands in Harvard Pond (T11).

Cyperus esculentus, NUT-SEDGE. (Cyperaceae) Perennial *Cyperus* with slender scaly rhizomes, small edible tubers, and large pale scales and long anthers. Common in our area in open, disturbed soils, sometimes an agricultural weed. Uncommon at HF: reported for Petersham by H.M. Raup (1938); a penciled question mark by the entry indicates that he considered the record doubtful. Found once in disturbed ground near the sawmill in P2 in our survey.

Cyperus lupulinus, SLENDER-STEMMED CYPERUS. (Cyperaceae) Small, dense-headed, perennial *Cyperus* of dry sandy open soils, common regionally along roadsides and in open sandy pine woods. Currently present in small amounts on roadsides at HF, where it was first verified in this survey. First collected in our area by H.M. Raup on a 'sandy knoll in old cemetery south of T6' and later by I.M. Johnston from a sandy place "near Riceville Pond, below dam;" both collections are just outside the boundary of HF. Also reported from near the HF headquarters by C.E. Smith (1948), based on a specimen we were unable to locate. We recorded it on the side of Rt. 122 by Harvard Pond in T11 and on the west side of Rt. 122, opposite Connor Pond, just outside the boundary of S6. Our plants were long considered a variety of *C. filiculmis*, a name now restricted to southern plants with yellow floral scales and slightly smaller achenes.

Cyperus strigosus, UMBRELLA-SEDGE. (Cyperaceae) Robust, weedy, rhizomatous *Cyperus* of sandy or muddy soil, found on stream and pond shores, in ditches, and in cultivated fields and waste ground. Uncommon at HF: collected by I.M. Johnston in a sandy place "near Riceville Pond, below dam," and thus just outside the boundary of T9. Seen once in our study, at the edge of the small pond in the cow pasture in P2.

Cypripedium acaule, PINK LADY'S SLIPPER. (Orchidaceae) Single-flowered orchid with large, furry basal leaves, found in open, acid woods. Common as scattered plants along trails and in hardwoods and mixed woods in HF; first collected in 1933 by H.M. Raup from the Tom Swamp Tract; we recorded it in 24 compartments in our survey.

Cystopteris fragilis sensu lato, FRAGILE FERN. (Dryopteridaceae) Small, round-lobed fern of moist, shaded, somewhat limy ledges. Uncommon


Cyperus bipartitus


Cyperus erythrorhizos


Cyperus esculentus


Cyperus lupulinus


Cyperus strigosus


Cypripedium acaule


Cystopteris fragilis s.l.

at HF: first collected by I.M. Johnston and E.P. Stephens on ledges in S8 in 1947; relocated there and also on ledges in S7 and on Camel's Hump (Simes Tract) in this survey. We use *C. fragilis* here in the broad sense for a complex of two allotetraploids and their hybrids. The *Flora of North America* separates the northern, montane, and transcontinental *C. fragilis* from the more southern, low-elevation, and eastern *C. tenuis* but notes that they are difficult to distinguish from each other and from their sterile hybrids in the Northeast. This has been our experience in southern Vermont and in western Massachusetts. Our HF specimens show mixed characters. There are both ascending and perpendicular pinnae, with ovate and deltoid outlines, sharp and rounded teeth, and truncate and cuneate basal pinules. Whether these can be sorted out into convincing species, and whether, once sorted, they would correspond to the *fragilis* and *tenuis* forms recognized in the *Flora of North America*, we have no idea. Given the general problems of identifying eastern material and the need to use uniform names throughout the region, it seems better, for now, to include our plants in a broadly defined *C. fragilis* complex.

Dactylis glomerata,* ORCHARD GRASS. (Poaceae) Tall, juicy grass with keeled sheaths and lobed panicles, commonly sown in moist pastures and escaped along roads and in lawns. Occasional and locally plentiful on roadsides and in open fields at HF; first collected in 1934 by H.M. Raup from a field near the forest school; recorded in nine compartments in our study.

Dactylis glomerata

Dalibarda repens, DEWDROP. (Rosaceae) Small, patch-forming, white-flowered woodland herb with violet-like leaves, found in moist conifer woods and at the edges of swamps. First collected at HF in 1933 by H.M. Raup from Tom Swamp, and then by M.H. Zimmermann in 1957 from P8. Now locally frequent, especially near swamps, and found in 13 compartments in our study.

Dalibarda repens

Danthonia compressa, OATGRASS. (Poaceae) Slender-leaved grass forming sparse lawns in moist open, acid woods. Apparently first collected near (but not in) HF by H.M. Raup in 1938, along Tom Swamp Road, and by J. Canright on a shaded roadside "near S4" in 1947; now common at HF, particularly along woods roads, and found in 26 compartments in our survey.

Danthonia compressa

Danthonia spicata, OATGRASS. (Poaceae) The common curly-leaved *Danthonia* of dry open woods, sterile fields, and barren ground, distinguished from *D. compressa* by its narrower and more curly leaves and by the longer teeth on the lemmas. Frequent and locally common at HF: first collected by H.M. Raup in 1934 from the east side of Prospect Hill and near Fisher House; found along roads, on ledges, and in clearings in 20 compartments in our survey.

Danthonia spicata

Daucus carota,* QUEEN ANNE'S LACE. (Apiaceae) Tall, white-flowered weedy umbellifer of meadows and roadsides. Apparently rare at HF: our 2005 collection from the pasture in P2 may be the first HF record.

Daucus carota

Decodon verticillatus, WATER WILLOW. (Lythraceae) Arching shore and deep-water shrub with whorled leaves and pink flowers, characteristic of flooded bogs and ponds with variable levels. First collected at HF by H.M. Raup in 1933, probably in Harvard Pond, and re-collected from there in 1947 and 1957. Common on shores and floating mats in Riceville and Harvard Ponds today; often co-dominant with sweetgale on floating peat islands.

Decodon verticillatus

Dennstaedtia punctilobula

Dennstaedtia punctilobula, HAY-SCENTED FERN. (Dennstaedtiaceae) Sticky, light-colored, patch-forming, allelopathic fern of open woods with infertile soils. A specimen collected by J.G. Jack in 1912 from the Prospect Hill Tract notes that it was "very common"; it is similarly common today in HF, occurring in all compartments.

Deparia acrostichoides, SILVERY GLADE FERN. (Dryopteridaceae) Silver-hairy, twice-cut, loosely clumped fern of moist fertile woods. Occasional at HF where it was first found in marshy woods in T4 by I.M. Johnston and W.D. Beal in 1947. We relocated it there and also found it in similar habitat in T5, at the edge of streams in P9, S1 and S2, on the fertile lower slopes of Camel's Hump (Simes Tract), and along the Swift River in S10. Formerly called *Athyrium thelypteroides*.

Deparia acrostichoides

[**Desmodium canadense**, SHOWY TICK-TREFOIL. (Fabaceae) Tall herb with showy purple flowers and large leaves, found unpredictably in disturbed open ground. Not known from HF: listed by H.M. Raup (1938) for Petersham; collected at the dam at Riceville Pond and thus just outside the HF boundary in our survey.]

Desmodium glutinosum, STICKY TICK-TREFOIL. (Fabaceae) Compound-leaved woodland herb with small purple flowers, jointed pods, and leaflets with long-acuminate tips most common in fertile, dry, oak-woods. Uncommon at HF: not collected historically and recorded at only two locations in this survey, the trail to the overlook above the Choate Ledges in S8, and the upper slopes of Camel's Hump, in the Simes Tract.

Desmodium glutinosum

Desmodium nudiflorum, COMMON TICK-TREFOIL. (Fabaceae) A related species of similar habitats in which the flowers and leaves are borne on separate stems and the leaflets have only a short-acuminate tip. Also uncommon at HF: reported by C.E. Smith (1949) from Camel's Hump (Simes Tract) and T8, citing specimens that we did not see; first collected by K.A. Raup in 1947 from a low swale in T8. Found in our survey primarily on rocky slopes of above average fertility; we have records from P6, the northern cobble in S7, the northeast side of S8, and the upper slopes of Camel's Hump in the Simes Tract.

Desmodium nudiflorum

Dianthus armeria,* DEPTFORD PINK. (Caryophyllaceae) Narrow-leaved annual or biennial pink with short-stalked flowers, escaped from gardens and widely naturalized in meadows and waste ground. Known at HF from a single 1947 collection by W.H. Drury from a sandy roadside in S10. Not seen in our study.

Dianthus barbatus, * SWEET WILLIAM. (Caryophyllaceae) A similar species, broader-leaved and perennial. Seen once in our survey, in the field by Fisher House.

Dianthus deltoides,* MAIDEN PINK. (Caryophyllaceae) A related species, also escaped and widely naturalized in meadows, with narrow leaves and long-stalked flowers. Collected in Petersham in 1947 but apparently first recorded at HF in 1957 by M.H. Zimmermann from a pasture near the HF headquarters. Locally common in a few meadows and roadsides today: we have records from P1, P2, P9, and P10.

Dianthus barbatus

Dianthus deltoides

Dicentra eximia,* BLEEDING HEART. (Fumariaceae) Common garden flower, occasionally escaped along roads. Rare at HF: first collected on a roadside in P9 by J. Canright in 1947; recorded once in our study, in waste ground near the sawmill in P2.

Dicentra eximia

Dichanthelium acuminatum, WOOLY PANIC GRASS. (Poaceae) Common and complicated group of grasses with basal rosettes, a ligule of long hairs, and small, minutely hairy spikelets in both spring and fall inflorescences; found in a wide variety of open habitats, from sandy roadsides to cliffs, pine barrens, shores and swamps. Formerly treated as a number of separate species in the genus *Panicum* (*P. columbianum, implicatum, lanuginosum, meridionale, spretum …*); now moved, with the other perennial species of *Panicum* that have both spring and fall inflorescences, to the genus *Dichanthelium* and placed in a single convenient transcontinental species, *D. acuminatum.*

The *D. acuminatum* complex, like the genus as a whole, is taxonomically complex. It contains a number of forms that grade into each other, and which also seem to hybridize with many of the other species of *Dichanthelium* in our region. The result is a "reticulate variation pattern," a dignified name for a messy situation in which everything seems connected to almost everything else. Earlier botanists, faced with this mess, had tried, unsuccessfully, to name it into submission. The result was a lot of poorly defined names and no agreement about which plants to attach them to. The recent *Flora of North America* treatment, by Robert Freckmann and Michael Lelong, has done a remarkable job of simplifying the taxonomy and making it workable. But it can not hide the fact that there are many intermediate or patchwork plants out there, and that anyone who works on *Dichanthelium* in eastern New England will encounter plants that can't, or perhaps can but shouldn't, be named.

The *D. acuminatum* group as a whole is frequent along woods roads and in open sandy soils at HF. Our collections may be divided, roughly, into four subspecies, which were treated as species in the past:

subsp. **columbianum.** (*Panicum columbianum, Dichanthelium sabulorum*) Distinguished by the "double vestiture," a combination of fine incurved hairs on the panicle branches and upper stem and spreading hairs on the lower sheaths. Uncommon at HF: first collected by R.S. Sigafoos along Kitchen Road (Prospect Hill Rd.) in 1947; found in S4 and T6 in this study.

Dichanthelium acuminatum ssp.columbianum

subsp. **fasciculatum**. (*Panicum lanuginosum* var. *fasciculatum* and var. *septentrionale*) Distinguished by papillose-based hairs on the sheaths, short hairs on the upper leaf surfaces, relatively wide primary leaves (over 6 mm), and relatively long primary spikelets (over 1.5 mm). Frequent at HF and probably the commonest subspecies here but grading into the next subspecies and so difficult to map accurately. First collected in 1947 by R.S. Sigafoos from the shores of Riceville Pond. We recorded it, with considerable taxonomic uncertainty, in 11 compartments in our study.

Dichanthelium acuminatum ssp. fasciculatum

subsp. **implicatum**. (*Panicum implicatum* and *meridionale*) Similar to subsp. *fasciculatum*, but with narrower leaves, shorter spikelets, and longer hairs on the upper leaf surfaces. Uncommon or less common than subsp. *fasciculatum* at HF: first collected by I.M. Johnston and W.H. Drury in the Fay Lot (T9) in 1947; found casually in P1, P9, T8 and the Grout Lot in this study.

Dichanthelium acuminatum ssp. implicatum

subsp. **spretum**. (*Panicum spretum*) A more-or-less hairless subspecies with a congested panicle. Known at HF from a 1933 collection by H.M. Raup from the Fay Lot. Not seen in this study.

Dichanthelium boreale, NORTHERN PANIC GRASS. (Poaceae) Typically a smooth, broad-leaved panic grass with a short ligule and small, minutely hairy spikelets, most commonly found on sandy shores and in open moist woods, and commoner in upland wetlands than most other members of the group. Uncommon or local in HF: first collected by H.M. Raup in the Slab City Tract in 1934; found 7 times in our study (P4, P10, S5, T7, T8, T9, and T11), often near wetlands or streams. Some of our specimens are typical broad-leaved *D. boreale*, and resemble plants from elsewhere in northern New York and New England. Others are quite narrow-leaved. They have the short ligules and hairy spikelets of *D. boreale* and so are included here, but may well be hybrids with *D. dichotomum* or something else. Also called *Panicum boreale.*

Dichanthelium boreale

Dichanthelium clandestinum, DEER-TONGUE GRASS. (Poaceae) Tall perennial grass with heart-shaped leaf bases and stiff hairs arising from bumps on the sheaths, widespread in open damp sandy ground. Frequent on roadsides, river shores, and pond shores at HF: a collection by H.M. Raup from 1938 from along Tom Swamp Road is probably not in HF; first collected from HF in 1947 by I.M. Johnston from a river shore and roadside in the Slab City Tract; recorded in 14 compartments in our survey. Also called *Panicum clandestinum.*

Dichanthelium clandestinum

Dichanthelium dichotomum, FORKED PANIC GRASS. (Poaceae) A complex group of short-ligule species with small, hairless spikelets. The common form, and the only member of this group collected at HF, is the narrow-leaved subsp. *dichotomum,* which is known here from a single 1947 collection by I.M. Johnston on the cliffs of Camel's Hump (Simes Tract). A variable species or species complex, also called *Panicum dichotomum* and including *Panicum microcarpon,* among others. We found one plant that resembled this species vegetatively but had pubescent spikelets and which we chose to regard as a narrow-leaved form of *D. boreale.*

Dichanthelium latifolium, BROAD-LEAVED PANIC GRASS. (Poaceae) A broad-leaved panic grass resembling the common *D. clandestinum* but lower and without the papillose-based hairs on the sheaths. Common in dry, fertile woods in western New England, less common eastwards. Reported by C.E. Smith (1948) from Slab City based on a specimen we did not see. Seen twice in our survey, in open, rocky woods in S8 and on the upper slopes of Camel's Hump in the Simes Tract. Also called *Panicum latifolium.*

Dichanthelium latifolium

Dichanthelium linearifolium sensu lato, NARROW-LEAVED PANIC GRASS. (Poaceae) Low, narrow-leaved, tussock-forming grass of dry sandy soils, found on shores, ledges, and roadsides, and in waste ground. Uncommon at HF: collected by H.M. Raup in 1934, and by I.M. Johnston and W.D. Beal in 1947, all in the Fay Lot (T9). Found casually in sandy open ground and along roadsides in P10, S4, S9, T6, and T9 in this study. Also called *Panicum linearifolium.*

This species is close to *D. depauperatum*, from which it is supposed to differ in its shorter and more rounded spikelets; in *depauperatum* the spikelets are over 3 mm long and the second glume and sterile lemma extend beyond the fertile lemma and form a beak. At HF (as elsewhere in the Northeast) these characters don't correlate very well, and many of our plants have short spikelets that are either pointed or have a distinct beak. Such plants don't fit either of the two traditional species very well. We have called them *D. linearifolium* because their spikelet length is consistently under 3 mm, but recognize that their spikelet shape is not the shape traditionally associated with this species (p. 57).

Dichanthelium linearifolium s.l.

Dichanthelium xanthophysum, YELLOW-FRUITED PANIC GRASS. (Poaceae) Large grass of dry acid woods, resembling *D. clandestinum* but with larger spikelets, a narrower panicle, and somewhat narrower leaves with less heart-shaped bases. Apparently rare or now absent from HF: collected by H.M. Raup in the Slab City Tract in 1934, and in P3 and on a road east of Tom Swamp by I.M. Johnston and W.H. Drury in 1947. Looked for in these and other places but not recorded in our study. Also called *Panicum xanthophysum.*

Diervilla lonicera

Diervilla lonicera, BUSH HONEYSUCKLE. (Caprifoliaceae) Low, opposite-leaved, somewhat sprawling shrub with toothed leaves, found on ledges, roadsides, and open dry woods, usually in acid soil. Frequent in HF; J.G. Jack (1911) said that it was common in dry woods, on roadsides, and in old fields. Now it is still widespread in dry woods and in rocky places, some of which may have been field's in Jack's time. First collected by S.M. Dohanian in 1913 in the Slab City Tract; found in 21 compartments in our study.

Digitalis sp.

Digitalis sp.,* FOXGLOVE. (Scrophulariaceae) Cultivated herbs with tubular flowers. A large yellow-flowered digitalis, perhaps *D. grandiflora,* is established along a woods road near the gate in T2. A pink-flowered species, likely *D. purpurea,* occurs near the schoolhouse in P2, but probably has not spread enough from where it was initially planted to be considered naturalized.

Digitaria ischaemum,* SMOOTH CRABGRASS. (Poaceae) Weedy annual Eurasian grass with a terminal cluster of slender spikes, widely distributed and often a late-season dominant on roadsides and in lawns and cultivated ground. Occasional at HF and not previously reported. Recorded in lawns and roadsides in eight compartments in our survey, and likely found in others as well.

D. ischaemum, though called smooth crabgrass, is often quite hairy and needs to be carefully distinguished from the next species. The safest distinction is technical: in *D. ischaemum* the second glume is about as long as the spikelet; in its relative *D. sanguinalis* (also weedy and alien) the second glume is only about half as long as the spikelet.


Digitaria ischaemum


Digitaria sanguinalis

Digitaria sanguinalis, TALL CRABGRASS. (Poaceae) Weedy annual grass, somewhat taller than the preceding species and usually with finely hairy leaves, with short second glumes. Occasional at HF and apparently somewhat less common than *D. ischaemum*; the only previous record is a report by C.E. Smith (1948), citing a specimen that we did not see. Currently we have records from five compartments, but it is doubtless found in others.

Diphasiastrum digitatum, GROUND CEDAR. (Lycopodiaceae) Low creeping evergreen clubmoss with flattened branches, common in open, second-growth woods under both hardwoods and conifers. Widespread and common at HF, where it was first collected by H.M. Raup in 1933 and recorded in 27 compartments in our study. Formerly called *Lycopodium complanatum* var. *digitatum* and *L. flabelliform.* The clubmosses with strongly flattened branches have now been moved to *Diphasiastrum,* and the name *Diphasiastrum complanatum* is now restricted to a much less common northern species with unequal branching. C.E. Smith (1948) said that *L. flabelliform* (= *D. digitatum*) was throughout HF and that *L. complanatum* was rare and represented by a single collection by I.M. Johnston from "between Leighton Road and Davenport Pond." The specimen (which may or may not be from HF) is actually *Diphasiastrum tristachyum.*


Diphasiastrum digitatum

Diphasiastrum tristachyum, GROUND CEDAR. (Lycopodiaceae) A narrower-branched and less common relative of *D. digitatum*, typically found on dry, somewhat sterile soils. Uncommon at HF: collected in 1933 by N.W. Hosley from the Prospect Hill Tract, and in 1947 by I.M. Johnston from a "dry, sunny rocky slope in open," in T8. Found casually in dry open woods in our study; we relocated it in T8 and also found it in P3, P4, and S4. Formerly called *Lycopodium tristachyum*; we follow the *Flora of North America* in calling this and the other flat-branched lycopodiums *Diphasiastrum* in public and some curmudgeonly friends who, like us, despise nomenclatural change, in calling them *Dicraziastrum* in private.


Diphasiastrum tristachyum

Dirca palustris, LEATHERWOOD. (Thymelaeaceae) Single-trunked shrub or small tree of moist, fertile woods, with untoothed leaves, fibrous bark and rubbery branches. Rare at HF where it is known from two locations: "along roadsides" in the Slab City Tract where it was reported by J.G. Jack (1911), collected by S.M. Dohanian in 1913, and observed by H. Woolsey


Dirca palustris

in the 1980s (in S8); and a few plants along the trail below the Camel's Hump ledges in the Simes Tract, observed in our survey.

Drosera intermedia, SPATULATE-LEAVED SUNDEW. (Droseraceae) The common sundew of bog hollows and wet, flooded mats, identical to the next species except for its longer leaves. Locally common on floating peat islands and the edges of bog mats at Riceville Pond, Harvard Pond, and Gould's Bog (P8). Not listed for Petersham by H.M. Raup (1938); first collected at HF in 1947 by W.D. Beal and E.P. Stephens, at Riceville Pond.

Drosera intermedia

Drosera rotundifolia

Drosera rotundifolia, ROUND-LEAVED SUNDEW. (Droseraceae) The common sundew of peaty shores and bog mats. First collected by H.M. Raup in 1933, at the north end of Tom Swamp. Locally common today on the shores of Connor Pond, Riceville Pond, and Harvard Pond, and in the bogs of the Tom Swamp Tract.

Dryopteris carthusiana, SPINULOSE WOOD FERN. (Dryopteridaceae) A lacy-cut, eglandular, evergreen wood fern that is usually found in wet acid soils. Locally frequent in wooded swamps at HF; credited to Petersham by H.M. Raup (1938); first collected here in 1947 by I.M. Johnston, from the Tom Swamp Tract; recorded in eight compartments in our survey. Formerly called *Dryopteris spinulosa,* a later name, or *D. spinulosa var. spinulosa* by authors that included the evergreen and mountain wood ferns (*D. intermedia* and *D. campyloptera*) in a broadly defined *D. spinulosa.*

Dryopteris carthusiana

Dryopteris cristata, CRESTED WOOD FERN. (Dryopteridaceae) A narrow, ladder-like wood fern with evergreen sterile leaves and deciduous fertile ones, always found in wet soils. Frequent in wooded swamps and occasional in bog hummocks at HF; listed for Petersham by H.M. Raup (1938), but apparently not vouched; first collected at HF in 1940 by P. Smith, from the Tom Swamp Tract; recorded from 11 compartments in our survey. *Dryopteris x boottii* (Boott's fern, *D. cristata x D. intermedia*), first recorded by H.M. Raup in swampy woods in T2 in 1938, was seen in our survey in swampy woods in P8. *Dryopteris x uliginosa* (= *D. carthusiana x D. cristata*) was recorded in our survey once in a swamp near the north end of Connor Pond (S6). *D. clintoniana,* a hexaploid derived from a *D. cristata x D. goldiana* cross, was looked for but not found. The swamps here are probably too acid for it.

Dryopteris cristata

Dryopteris intermedia, EVERGREEN WOOD FERN. (Dryopteridaceae) The common, lacy-cut, minutely glandular wood fern of moist woods. Although this is a characteristic species of primary woodlands it establishes easily on moist, shaded soil and is one of the first ferns to invade successional woodlands. Common at HF: first collected in 1933 by H.M. Raup from the Tom Swamp Tract; we recorded it in 31 compartments. Very close to *D. carthusiana,* and sometimes found with it. The two differ slightly and unreliably in the angles the leaflets make with the axis, and also slightly but more reliably in glandularity. They are often said to differ in the lengths of the inner, lower subleaflets of the lowest leaflets as well, but, as R. and A. Tryon showed in 1966, the variation in this character within each species swamps the variation between species. They also

Dryopteris intermedia

form a sterile hybrid *D. x triploidea*, which is known at HF from a 1947 collection by I.M. Johnston from a "wet bog" in P2, determined by R. Tryon. Formerly called *Dryopteris spinulosa* var. *intermedia.*

Dryopteris marginalis, MARGINAL WOOD FERN. (Dryopteridaceae) A twice-cut, dark-green, leathery looking wood fern of dry rocky woods. Frequent in open deciduous woods at HF, especially on rocky slopes; first collected in 1933 by H.M. Raup from the Tom Swamp Tract; found in 21 compartments in our survey.

Dulichium arundinaceum, THREE-WAY SEDGE. (Cyperaceae) A short-leaved, obviously three-ranked sedge of open peaty wetlands and shores. Locally common in the ponds and open bogs at HF; first collected in 1933 by H.M. Raup from the Tom Swamp Tract; found in nine compartments in our survey.

Echinochloa crus-galli,* BARNYARD GRASS. (Poaceae) A robust, alien, clump-forming, annual grass of waste ground and disturbed soil. Generally common in Massachusetts but uncommon at HF: collected near HF (Wilder's Farm) by N.W. Hosley in 1933, and by P. Stephens near the garage in P1 in 1947; recorded from the pasture in P10 in our survey.

Echinochloa muricata, COCKSPUR GRASS. (Poaceae) A similar native species, differing only in its slightly less abrupt transition between the shiny bodies and wrinkled tips of the fertile lemmas, and in lacking the minute hairs that occur near that transition in *E. crus-galli.* Frequent in wetlands and on shores in Massachusetts but uncommon at HF: not known historically, and recorded once, from the yard around the sawmill in P2, in our survey. Formerly called *E. pungens.*

Elaeagnus umbellata,* AUTUMN OLIVE. (Elaeagnaceae) Small tree with silvery scales on the leaves and branches, commonly cultivated, dispersed by birds, and widely escaped. Separated from its similar and only slightly less weedy relative *E. angustifolia* by having brown scales mixed with the silver ones on the branches, and the tops of the leaves dark green rather than silvery. First recorded for HF in this survey; we found it near Fisher House in P10, and also in P9 and T6.

Eleocharis acicularis, NEEDLE SPIKE RUSH. (Cyperaceae) A delicate, generally very common, carpet-forming perennial spike rush of river and pond shores. Apparently scarce at HF: collected by H.M. Raup on a pond shore in the Tom Swamp Tract in 1934 and by I.M. Johnston and C.E. Smith on the shore of Riceville Pond in 1947. We found it on the shores of Harvard Pond in T11 and along the Swift River in S10.

Eleocharis flavescens var. **olivacea**, OLIVE SPIKE RUSH. (Cyperaceae) A small annual spike rush of wet peat or mud. First collected at HF by C.E. Smith, as *E. flaccida* var. *olivacea*, from Riceville Pond in 1947. Now locally common on floating peat islands in Riceville Pond and Harvard Pond. Formerly called *E. olivacea* and considered as a northeastern U.S. species; now treated as a variety of the transcontinental *E. flavescens.*


Dryopteris marginalis


Dulichium arundinaceum


Echinochloa crus-galli


Echinochloa muricata


Elaeagnus umbellata


Eleocharis acicularis


Eleocharis flavescens var.olivacea

Eleocharis obtusa, BLUNT SPIKE RUSH. (Cyperaceae) Our commonest annual spike rush, typically found on wet mineral soil on shores and in temporary pools. Uncommon at HF: first found by H.M. Raup on shores in the Tom Swamp Tract in 1934; also found in a bog at the base of Camel's Hump (Simes Tract) by I.M. Johnston and C.E. Smith in 1947. We relocated it at Harvard Pond (T11) and also found it in the wet pasture in P2. Formerly called *E. ovata*, a name that is now used for a species with a narrower tubercle which has not been found at HF.

Eleocharis obtusa

Eleocharis palustris

Eleocharis palustris, MARSH SPIKE RUSH. (Cyperaceae) The common large perennial spike rush of marshy shores and shallow water. Uncommon at HF: collected by H.M. Raup in the Tom Swamp Tract in 1934, by K.A. Raup from the bog in P8 in 1947, and by C.E. Smith from Harvard Pond in the same year. We saw it, in fairly small amounts, at Riceville Pond (T9) and Connor Pond (S6). Our plants are currently treated as part of the circumboreal *E. palustris*; formerly they were treated more restrictively as a North American species *E. smallii*.

Eleocharis tenuis sensu lato, SLENDER SPIKE RUSH. (Cyperaceae) A common perennial spike rush of open wetlands and peaty shores, smaller than *E. palustris* and with a three-angled achene. Uncommon at HF and not seen prior to this survey; we recorded it from the gravel pit in P9 and from T7 and T8 along Tom Swamp Road.

The small species of *Eleocharis* with trigonous achenes and creeping rhizomes are quite similar and, according to Galen Smith and his co-authors in the *Flora of North America* account, it is "very difficult" to separate our common *E. tenuis* from the closely related *E. elliptica*. Most of our plants tend to have four-ridged stems and bright yellow achenes with about 10 horizontal rows of pits, and thus correspond with the *E. tenuis* of the *Flora of North America*. But it would take only a few tiny changes—mostly a few more ridges and pits—to make them correspond with *E. elliptica*, and thus we can shed no light on the old problem of whether *E. tenuis* and *E. elliptica* are or are not separate.

Eleocharis tenuis s.l.

Elymus hystrix, BOTTLE-BRUSH GRASS. (Poaceae) Tall grass with needle-like spikelets spreading at right angles to the culm, characteristic of dry fertile woods. Common in western Massachusetts but rare at HF and not previously reported here; we found a few plants on the rocky slope of the north cobble in S7 in 2005.

Elymus hystrix

Elytrigia repens,* QUACKGRASS. (Poaceae) A tall creeping alien grass of fertile ground and waste areas. Frequent in disturbed and cultivated ground at HF where it was first collected by H.M. Raup in 1934 from near the top of Prospect Hill. We recorded it along roadsides near Connor Pond and Harvard Pond, and on several sites near the buildings in the Prospect Hill Tract; it is particularly abundant in the pasture and in the common garden by Lyford House. Formerly called *Agropyron repens*.

Elytrigia repens

Epifagus virginiana

Epifagus virginiana, BEECH DROPS. (Orobanchaceae) A small, pink-purple, leafless, root-parasite of beech woods. Uncommon or rare at HF; collected twice on Prospect Hill, by H.M. Raup in 1934 and by C.E. Smith

in 1947, and seen in P2, P4, T10, and S10, in our survey. Beech trees, on the other hand, occur in at least 31 compartments, suggesting that in this case the parasite has spread into the post-agricultural landscape more slowly than its host. This is not the case with the hemiparasites and saprophytes in our flora: *Monotropa uniflora*, the common Indian pipe, is found in 29 compartments; *Monotropa hypopithys*, the pinesap, occurred in 14 compartments; and *Melampyrum lineare,* cows-wheat, in 18 compartments.

Epigaea repens

Epigaea repens, TRAILING ARBUTUS. (Ericaceae) A low evergreen creeper with oblong hairy leaves and sweet pink flowers in early spring. Frequent in HF where it was first found in 1910 by W.W. Cole, in the Meadow Water (Tom Swamp) Tract. Currently widespread in dry open oak and mixed woods; found in 16 compartments in our survey.

Epilobium ciliatum

Epilobium angustifolium, FIREWEED. (Onagraceae) A tall showy flowering herb of open, somewhat dry soils. Collected at the top of Prospect Hill by H.M. Raup in 1934, and near the HF buildings by W.D. Beal in 1947; also reported by C.E. Smith (1949) for Prospect Hill, citing a specimen that we did not see; not seen in our survey.

Epilobium ciliatum, CILIATE WILLOWHERB. (Onagraceae) This and the following species are the common, lanceolate-leaved willowherbs of ditches and open wetlands. They are barely distinguishable in fruit and probably not safely distinguishable the rest of the time, and have a history of taxonomic and nomenclatural confusion to prove it. This species has low remote leaf teeth and smooth seeds with white hairs. Apparently uncommon at HF. We confirmed this species from P2, S3, and T9 in our survey, found an unnamed 1947 specimen from P3 that was probably it, and saw an immature plant in the Simes Tract that may have been it. Now including the plants formerly called *E. adenocaulon* and *E. glandulosum* var. *adenocaulon,* which bring with them considerable variation in vegetative characters, and corresponding uncertainties in identification.

Epilobium coloratum

Epilobium coloratum, COLORED WILLOWHERB. (Onagraceae) A related species, differing from the previous in its more conspicuous leaf teeth, and papillate seeds with (Oh the wonder of it!) a faint brown tint to the seed hairs. Known at HF from a 1947 collection by I.M. Johnston near the dam at Riceville Pond and a specimen of ours from P9.

Epilobium leptophyllum

Epipactis helleborine

Epilobium leptophyllum, BOG WILLOWHERB. (Onagraceae) The slender, narrow-leaved willowherb with short incurved hairs, most commonly found in fens and peaty sedge meadows. First collected by H.M. Raup in the Fay Lot, at or near Riceville Pond in 1933; re-collected there by I.M. Johnston in 1947, and by ourselves in 2005; also seen in the Simes Tract and T8 in our survey. A specimen collected by H.M. Raup in 1934 from the north end of Tom Swamp, off the Fay Lot, appears intermediate between *E. palustre* and *E. leptophyllum.*

Epipactis helleborine,* HELLEBORINE. (Orchidaceae) A medium-sized orchid with a spike of green-white flowers, adventive from Europe about a hundred years ago and now widely established in woods of all sorts. Not

previously reported from HF. Now occasional; we found it in three compartments of the Prospect Hill Tract and two of the Tom Swamp Tract.

Equisetum arvense, COMMON HORSETAIL. (Equisetaceae) The common, singly-branched horsetail of roadsides, banks, and open ground. Occasional at HF, mostly near roads and buildings, where first recorded in 1934 by H.M. Raup from the Prospect Hill Tract. We have records from five compartments.

Equisetum arvense

Equisetum sylvaticum

Equisetum sylvaticum, WOOD HORSETAIL. (Equisetaceae) The delicate, multiply-branched horsetail of swampy woods. Rare at HF; collected by H.M. Raup on Prospect Hill in 1934 and I.M. Johnston in T8 in 1947; observed by us only twice, in S2 and T1.

Eragrostis pectinacea, LOVE GRASS. (Poaceae) A common, somewhat weedy tufted grass of sandy soils. Very variable in size, and close to or confluent with the following species. Known at HF only from the brick courtyard east of Shaler Hall, where we collected it in 2004 and 2005.

Eragrostis pectinacea

Eragrostis pilosa

Eragrostis pilosa,* INDIA LOVE GRASS. (Poaceae) A delicate, weedy, alien grass, similar to the native *E. pectinacea* and separated from it by characters that differ from book to book and, unfortunately, from plant to plant. We believe, based on the size of the spikelets and the presence of long hairs in the panicle axils, that at least some of the plants of sandy roadsides in S7 and likely elsewhere are this species. But the size of the lemmas is not well correlated with either the presence or absence of hairs or the number of panicle branches at the lower nodes, and so we are confused about where, if anywhere, the boundary between this species and *E. pectinacea* really lies.

Erechtites hieraciifolia, FIREWEED. (Asteraceae) A tall annual herb with sharply lobed leaves, inconspicuous flowers, and a bright white pappus. First collected at HF in 1933 by H.M. Raup (on Prospect Hill) and N.W. Hosley (in T8). Currently occasional on disturbed soil along woods roads and in gaps in woods; we recorded it from eight compartments.

Erechtites hieraciifolia

Erigeron annuus, DAISY FLEABANE. (Asteraceae) The larger and generally more common of our two daisy fleabanes, found along roads, in meadows, and in disturbed ground. Uncommon at HF: first collected near Riceville Pond by I.M. Johnston in 1947; found five times (P1, P6, P9, T3, T7,) along woods roads in our survey.

Erigeron annuus

Erigeron pulchellus, ROBIN'S PLANTAIN. (Asteraceae) An early-flowering, daisy-like composite with broad clasping leaves, common along shaded roadsides, especially in fertile soil. Definitely known at HF from a 1933 collection by H.M. Raup from "rich woods" in Slab City. An undated collection by Mrs. Gast from "Athol Road or French Place" is this species as well but not definitely from HF. A post-flowering collection of ours from P3 is either this species or *E. philadelphicus.*

Erigeron strigosus, DAISY FLEABANE. (Asteraceae) Our slenderer and less hairy fleabane, also found in meadows and open ground. Uncommon at HF. First collected by H.M. Raup near Fisher House in 1934; recollected near the buildings and at Riceville Pond by W.D. Beal in 1947; also collected by C.E. Smith in 1947 from Dugway Road (Simes Tract). We recorded it in the pasture in P2, near the dam at Riceville Pond, and at two other places in the Tom Swamp Tract in our survey. Formerly called *E. ramosus*.

Eriophorum virginicum, COTTON GRASS. (Cyperaceae) The common tall cotton grass of bogs and boggy meadows, with dense heads and red-brown bristles. First collected in the Tom Swamp Tract by H.M. Raup in 1933; common there, in T8, T9, and T11, today. Also recorded in a large wetland at the northern end of the Simes Tract and in Gould's Bog and the adjoining shrub swamp in P7 and P8 in our survey.

Erysimum cheiranthoides,* WORMSEED MUSTARD. (Brassicaceae) A small, weedy, yellow-flowered mustard of disturbed ground. First documented by C.E. Smith (1949) from near the HF headquarters; found near Shaler Hall, in the gravel pit in P9, and on the filled-in swimming pool by the Fisher House in our survey.

Erythronium americanum, TROUT-LILY. (Liliaceae) The common early-spring lily with yellow-colored flowers and spotted leaves. Rare at HF and not listed by either of the two previous floras. First collected at the "dump near the woodpile" by W.H. Hatheway in 1952 and then near the buildings by M.H. Zimmermann in 1958; a small population is still present in swampy woods along the small stream by the Pole Barn in P1 and by a ditch at the edge of the woods behind the Fisher House (P10).

Euonymus alatus,* WINGED EUONYMUS. (Celastraceae) An ornamental tree with green twigs with broad corky ridges, much planted for ornament and widely escaped and increasingly weedy in forests and thickets. Not previously reported from HF. Currently planted around the buildings and locally naturalized: we found it along the small stream behind the pole barn (P1) and along Locust Opening Road; also in P10, and in woods near the Benson House in P9.

[**Euonymus atropurpurea**,* BURNING BUSH. (Celastraceae) A small tree of the southeastern and central United States, introduced and rarely naturalized in our range. J.G. Jack collected in by Harvard House (P2) in 1908 and noted that it was planted and naturalized there. It has not persisted there and has not been found elsewhere at HF, and so there is no evidence that it ever was a naturalized species in our sense.]

[**Euonymus fortunei**, WINTER CREEPER. (Celastraceae) A commonly-planted ground cover with small, oblong, evergreen leaves and bright orange seed coverings (arils). Spreading from plantings at Raup and Higginson Houses and, though not naturalized yet, seems to be on the way.]

Eupatorium maculatum sensu lato, COMMON JOE-PYE WEED. (Asteraceae) Our common joe-pye weed of open wetlands. Common in open


Erigeron strigosus


Eriophorum virginicum


Erysimum cheiranthoides


Erythronium americanum


Euonymus alatus


Eupatorium maculatum s.l.

wetlands at HF: first collected by H.M. Raup in 1933; and found in 12 compartments in our survey.

Our joe-pye weeds are a variable bunch; the stems may be solid-colored or spotted, and may be solid or excavated, apparently by insects.* The leaves may be elongate, in which case they generally have narrow bases and lateral veins of equal strength, or somewhat broader, in which case the bases are less tapering and one pair of lower veins stronger than the ones above. Or, as often happens, they may have some leaves of each type. The flower cluster may be flat-topped, or domed; the flowering bracts may be pink or white, and the flowering heads may average from 6 to 9 flowers per head.

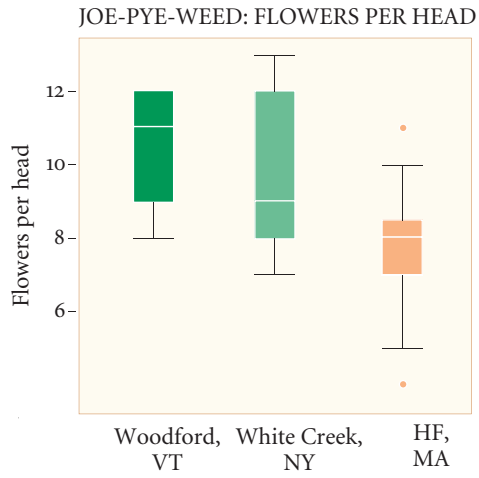
According to the manuals, these characters can be used to divide our joe-pye weeds into three or, if you count the insect tunnels as hollow stems, four species: *E. dubium* with strong lower veins and fewer than eight flowers per head; *E. maculatum* with more equal veins, flat-topped clusters, and 8 or more flowers per head; *E. purpureum* with unspotted stems, equal veins, a strongly convex flower-cluster with white or pale pink bracts and fewer than eight flowers per head; and *E. fistulosum*, like *E. purpureum* but with purple bracts and hollow stems. In practice, both at HF and elsewhere, these characters are anything but clear-cut, and vary both within plants and within populations. Our current opinion is that the plants of northern and central New England are best described as a common, variable, purple-flowered species of wetlands and shores (*E. maculatum*), and an uncommon, white-flowered species of fertile woodlands.

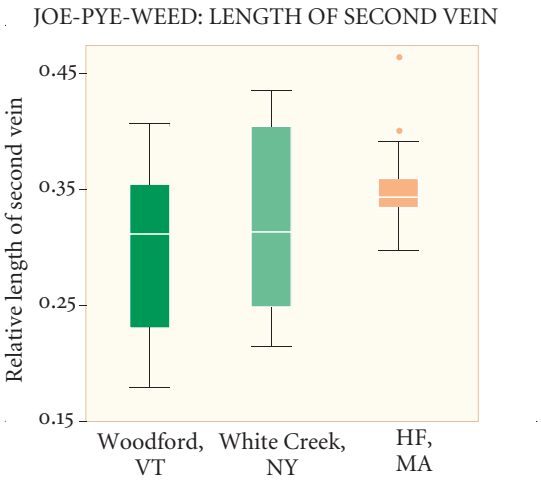
In particular, we include in our concept of *E. maculatum*, at least provisionally, the coastal-plain plants, often called *E. dubium,* with 8 or fewer flowers in the heads and a pair of strong lateral veins in the upper leaves. The problem is not that the differences don't exist but rather that there may be almost as much variation within individual plants as there is between the coastal and inland populations, and until this within-plant variation is accounted for it seems premature to recognize two species.

The results of a tiny quantitative study, explained and illustrated more fully on p. 62, suggest that:

> The HF plants tend to have fewer flowers than the inland ones but there is considerable variability and overlap.
>
> The lower leaves of both HF and inland plants have a strong pair of lateral veins.
>
> The strength of the strongest pair of lateral veins is related to the overall shape of the leaf, and is strong when the leaf is relatively narrow and weak when the leaf is relatively broad.
>
> The leaves of both HF and inland plants tend to increase in relative length as you move up the plant, and so the upper leaves in both have weaker lateral veins than the lower veins.
>
> The increase in relative length is faster in the inland than the HF plants, and so the inland plants tend to longer upper leaves with correspondingly weaker lateral veins than the HF ones.

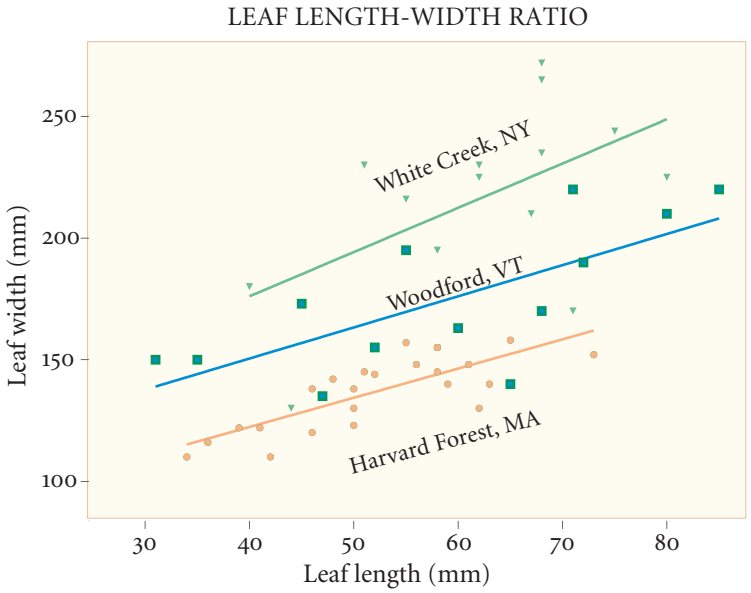
*The *Flora of North America* and other standard references all say that *Eupatorium fistulosum*, a large southern species, is distinguished by its naturally hollow stems. And so it may be. But every hollow-stemmed eupatorium that we have examined carefully, either in the herbarium or the field, has shown clear signs—irregular cavities or frass—that the hollows were made by beetles.





Boxplots of flower number and the relative length of the second vein (see p. 60 for definition) from joe-pye weed plants from Harvard Forest and two sites in Vermont and New York. The Harvard Forest plants have fewer flowers on average, but there is some overlap. The strength of the second vein in Harvard Forest plants is completely overlapped by that of inland plants.

Thus instead of a clear-cut separation of inland and HF populations on two characters we may have two quantitative tendencies, one towards longer upper leaves and one toward more flowers per head, in the inland plants. Or, given how allometry works, these may both be the same tendency. Either way, this seems to be the kind of situation best described as a cline within a single species rather than as a pair of species. We have, of course, too little data to show this conclusively but, lacking any evidence to the contrary, it seems prudent to leave them as one species (which is what many good botanists a century ago thought they were) for now.



Leaf length-to-width (*L/W*) ratios for joe-pye weed plants from three localities. The *L/W* ratio is related allometrically to the strength of the second vein. Harvard Forest plants have somewhat shorter leaves and relatively stronger second veins than inland plants, but the measurements overlap and there is much variation.

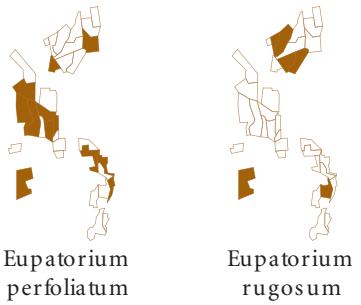
Eupatorium perfoliatum, WHITE BONESET. (Asteraceae) A medium-sized eupatorium with the leaves in each pair joined at their bases, common in wet meadows, open wetlands, and ditches on mineral soil. Locally common at HF; reported for Petersham by H.M. Raup (1938), and represented in the HF herbarium by a 1933 collection by N.W. Hosley without a location and a 1947 collection by W.D. Beal from near the HF buildings; we recorded it from 13 compartments.

[**Eupatorium purpureum**, PURPLE JOE-PYE WEED. (Asteraceae) A slender, white or pink Joe-pye weed of fertile upland woods. Known at HF from a single 1947 collection by C.E. Smith in a "wet field near creek" behind the HF buildings. The specimen has slender stems without spots and a cylindrical inflorescence of heads with white bracts and only 5-6 flowers per head. It seems to be this species but the habitat is more typical of *E. maculatum* and in fact C.E. Smith collected two specimens of *E. maculatum* there five days later. Lacking any other evidence that the species occurs in our area, we consider the record uncertain.]

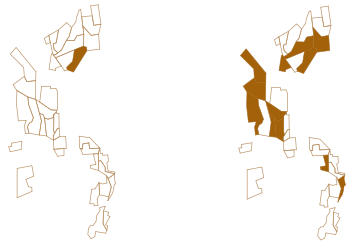
Eupatorium rugosum, WHITE SNAKEROOT. (Asteraceae) The common upland boneset of moist fertile woods in our area, characterized by its broad, long-stalked leaves and white flowers. First collected by H.M. Raup in the east part of the Tom Swamp Tract in 1933. Currently uncommon at HF; we did not relocate it at Tom Swamp but did find it in the Simes Tract, in S7, and in four compartments in the Prospect Hill Tract. Formerly called *E. urticaefolium* and treated by Sorrie and Somers (1999) and the Flora of North America as *Ageratina altissima.*

Euphorbia cyparissias,* CYPRESS SPURGE. (Euphorbiaceae) A narrow-leaved, colonial, Eurasian spurge, widely established in waste ground and fields in our area, but not previously reported from HF. Seen once in our survey, on a roadside in P8.

Euthamia graminifolia, GRASS-LEAVED GOLDENROD. (Asteraceae) A medium-sized, rhizomatous goldenrod with narrow leaves and a flat-topped flower cluster. Currently frequent in fields and along roads at HF;


Eupatorium perfoliatum

Eupatorium rugosum


Euphorbia cyparissias

Euthamia graminifolia

first collected in 1933 by H.M. Raup from the Tom Swamp Tract; recorded in 12 compartments in our survey.

Fagopyrum esculentum,* BUCKWHEAT. (Polygonaceae) An ancient Eurasian cultivar, occasionally planted and escaped in our area. Not previously reported from HF. Seen with a number of other attractive weeds on a newly graded bank west of Shaler Hall in 2005, where it was perhaps introduced with landscaping material; also abundant in and near the common garden at Lyford House (P1), where it also may have been planted.


Fagopyrum esculentum


Fagus grandifolia

Fagus grandifolia, AMERICAN BEECH. (Fagaceae) A common tree of primary forests, less common in post-agricultural woods and recently in decline at HF from an introduced disease. J.G. Jack (1911) said it was "occasional as individuals or groups in well-drained woods." We recorded it from 31 compartments and now regard it as common throughout HF in upland woods.

Fagus sylvatica, EUROPEAN BEECH. (Fagaceae) A cultivated tree formerly popular for formal grounds, rarely escaped to woodlands. Audrey Barker-Plotkin showed us a single small tree in the control plot of the pulldown experiment in T1; the seed may have come from any of several large planted trees in yards in Petersham. She also reports a sapling of this species from the north end of the Slab City Tract.


Fagus sylvatica

Fallopia cilinodis, FRINGED BINDWEED. (Polygonaceae) A sprawling, herbaceous vine with heart-shaped leaves and fringed stipular sheaths, common and often a local dominant in rocky woods and ridgecrests. Frequent in HF: collected by H.M. Raup from the eastern part of the Tom Swamp Tract and by N.W. Hosley from near the Forest Cottage in P1, both in 1933; abundant on the open bouldery talus at Camel's Hump (Simes Tract), and seen in nine other compartments in our survey. Long known as *Polygonum cilinode*; now separated, with the other polygonums with winged or keeled sepals, in the segregate genus *Fallopia.*


Fallopia cilinodis

Fallopia convolvulus,* BLACK BINDWEED. (Polygonaceae) A viny Eurasian weed of cropland and moist thickets, recognized by its heart-shaped leaves, small axillary flowers, and slightly keeled sepals. Collected twice at HF: by N.W. Hosley, near the Forest Cottage in the Prospect Hill Tract in 1933, and by J. Canright in a field near the HF headquarters in 1947. Not seen in our survey. Long known as *Polygonum convolvulus.*

Fallopia japonica,* JAPANESE KNOTWEED. (Polygonaceae) A tall, hollow-stemmed, formidably weedy cultivar that is now widely established on roadsides and river banks. Not previously reported for HF: seen twice in our survey, on roadsides in P10 and T5. Formerly *Polygonum cuspidatum,* now transferred to *Fallopia* under a new epithet. We may not be able to manage them or control them but we sure can name them.


Fallopia japonica


Fallopia scandens

Fallopia scandens, CLIMBING FALSE BUCKWHEAT. (Polygonaceae) A climbing vine with heart-shaped leaves much resembling those of the

black bindweed (*Fallopia convolvulus*) and the hedge bindweed (*Convolvulus spithamaeus*). A common plant of moist thickets by streams, occasionally seen in open fertile woods. Seen once in our survey on the upper slopes of Camel's Hump in the Simes Tract. This is probably the first verified report from HF. Two specimens from the "trail to Prospect Hill," collected by K.A. Raup in 1947 and M.H. Zimmermann in 1971, are *F. cilinodis.* Also reported from Prospect Hill by C.E. Smith (1949), based on a collection that we did not see. Formerly *Polygonum scandens.*

Festuca arundinacea

Festuca arundinacea,* TALL FESCUE. (Poaceae) A long-leaved, semi-evergreen, clump-forming grass widely planted as a soil-binder and commonly escaped along roadsides. It is similar to *F. pratensis*, from which it is distinguished by the longer and rougher lemmas and, when they are present, by a few long stiff hairs at the top of the leaf sheaths. Not previously collected from HF. Current abundances uncertain: we have a single specimen from P9 which is definitely this species and records from roadsides in P10, S10, and T11 that may be either this species or *F. pratensis.* Formerly called *F. elatior*, a name which applies to a different species. Recently transferred to *Schedonorus,* a genus near *Lolium,* by S.J. Darbyshire and L.E. Pavlick, the authors of the *Flora of North America* account, as *S. arundinaceus*. The transfer seems to make sense: *Festuca arundinacea,* with its flat leaf blades and slender auricles, is quite similar to *Lolium*, and not at all similar to typical wire-leaved fescues like *F. rubra.*

Festuca filiformis

Festuca filiformis,* HAIR FESCUE. (Poaceae) A somewhat weedy introduced fescue with compact panicles and unawned flowers, frequent on roadsides and sandy soils. Uncommon at HF: W.H. Hatheway collected it along Locust Opening Road in 1951; we did not find it there but did see it near the schoolhouse in P10 and in the field along the highway in P9. Formerly called *F. capillata*.

Festuca ovina,* SHEEP FESCUE. (Poaceae) A small, wiry, tuft-forming alien grass, formerly planted as a turf grass, and occasionally persistent along roadsides and in open areas. It resembles the native red fescue *F. rubra* and, even more closely, its former variety the hard fescue *F. trachyphylla,* from which it is distinguished by its shorter spikelets and lemmas, and fewer ridges on the leaves. All occur or have occurred at HF, but because they hard to tell apart in the field (and sometimes hard in the laboratory as well), we don't have a good sense of their comparative abundance and distribution.

Festuca ovina is apparently uncommon at HF and, according to S.J. Darbyshire and L.E. Pavlick, the authors of the *Flora of North America* account, currently rare in eastern North America, most of the published reports referring to what they separate as *F. trachyphylla.* We seem to have a single HF collection, by W.H. Hatheway along Locust Opening Road in the Prospect Hill Tract in 1951.

Festuca pratensis,* MEADOW FESCUE. (Poaceae) A long-leaved, clump-forming grass that was formerly planted for hay and widely escaped and spread along roadsides. Similar to *F. arundinacea*, from which it is sepa-

rated by the smooth auricles at the top of the sheaths and the smaller and smoother lemmas. First collected by H.M. Raup from a woods road in the Slab City Tract in 1934. Current status unknown because of confusion with *F. arundinacea* in the field: we have records from roadsides in P10, S10, and T11 that may be either species. Formerly called *F. elatior*, a name which applies to a different species; recently transferred to *Schedonorus* as *S. pratensis.*

Festuca rubra, RED FESCUE. (Poaceae) A variable native grass, generally tuft-forming but sometimes creeping, of both dry and moist sandy soils. Listed for Petersham by H.M. Raup (1938) and for HF by C.E. Smith (1948) but not vouchered: Raup's only specimen was *F. trachyphylla,* and Smith's specimens were not found. Frequent along roads and in open areas in our study; we have records from seven compartments.

Festuca trachyphylla,* HARD FESCUE. (Poaceae) A close relative and former variety of *Festuca ovina* with slightly larger spikelets and more ribs on the leaf blades. According to S.J. Darbyshire and L.E. Pavlick, the authors of the *Flora of North America* account, this is the common introduced hard fescue of the northeastern United States. Scarce or overlooked (because of its resemblance to the native *F. rubra*) at HF where it is known from specimens collected near Fisher House by H.M. Raup in 1934; from dryish woods along Locust Opening Rd. in the Prospect Hill Tract by W.H. Hatheway in 1951; and from two collections near Fisher House in P10 in our study. Formerly called *F. ovina* var. *duriuscula* and *F. duriuscula,* names that are now used for other species.

Fragaria virginiana, COMMON STRAWBERRY. (Rosaceae) The common wild strawberry of meadows and open ground. Frequent at HF, especially along streambanks and woods roads. First collected by W.A. Stalker in 1909, and found in 19 compartments in our survey.

Fraxinus americana, AMERICAN ASH. (Oleaceae) Common compound-leaved tree of mesic forests. J.G. Jack (1911) said it was common in rich soils and of commercial importance in HF; we found it in 27 compartments in our survey.

Fraxinus nigra, BLACK ASH. (Oleaceae) The basket-maker's ash, a small tree of wooded swamps. First reported for HF by J.G. Jack (1911), and also found in S10 by I.M. Johnston in 1947. We found it in swamps in S4, T4, and T10, and especially common in small wooded swamps in the Simes Tract. Interestingly, all of these compartments have somewhat fertile soils. Also reported by T. Zebryk (1991) from the Black Gum Swamp (P2) in the Prospect Hill Tract.

Galeopsis tetrahit,* COMMON HEMP-NETTLE. (Lamiaceae) A tall, weedy alien mint with a spiny calyx, common in barnyards and fertile waste ground. Uncommon at HF: first collected by W.D. Beal in 1947 from the dump on Kitchen Road (Prospect Hill Rd.), and seen in open areas in P1, P2, P9, and P10 in our survey. Our plants which differ slightly and not very consistently from the European type of this species are sometimes


Festuca sp.


Festuca rubra


Festuca trachyphylla


Fragaria virginiana


Fraxinus americana


Fraxinus nigra


Galeopsis tetrahit

separated as *G. bifida.* We follow Voss (1996) and others in keeping them in *G. tetrahit.*

Galinsoga quadriradiata, QUICKWEED. (Asteraceae) A small, annual, alien weed of waste and cultivated ground, originally from Central and South America, now cosmopolitan. Generally common in our area but known from HF only from a 1947 collection by C.E. Smith from Tom Swamp Road, where we also found it (T10), and from the edge of the pasture in P2 and the gravel pit in P9 in our survey.

Galium asprellum, ROUGH BEDSTRAW. (Rubiaceae) A tall, annual, early-season bedstraw with oval leaves and velcriform bristles, generally common in moist thickets. Occasional at HF, mostly along streams: first recorded by H.M. Raup in the Slab City Tract in 1933; found in S4, S5 and three other compartments in our survey. Sterile plants of this species are quite similar to those of *G. triflorum* and the two can grow in similar habitats. In *G. asprellum* the fruits are smooth and the teeth of both the midribs and edges of the leaves point downwards; in *G. triflorum* the fruits are bristly and the teeth of the leaf edges point upwards.

Galium circaezans, WILD LIQUORICE. (Rubiaceae) A four-leaved woodland bedstraw, separate from but easily mistaken for the next species, and like it characteristic of dry fertile oak woods. Known at HF from a 1947 collection by I.M. Johnston, originally determined as *G. lanceolatum,* from the cliff on the east side of Camel's Hump in the Simes Tract. We found it on the west side of S7.

Galium lanceolatum, LANCEOLATE WILD LICORICE. (Rubiaceae) Similar to the preceding species and often growing with it, but with the mature leaves longer and more lanceolate. Rare at HF; reported by C.E. Smith (1949) from the east slope of Camel's Hump in the Simes Tract, citing one specimen that we did not see and another (Johnston *198*) that was *G. circaezans.* Relocated at Camel's Hump and recorded in S7 and S8 in our survey.

Galium mollugo,* EUROPEAN BEDSTRAW. (Rubiaceae) The common, weedy bedstraw of meadows and lawns. Locally common in lawns and meadows at HF; we observed it in P1, P9, P10, and T2. Previously reported for HF by C.E. Smith (1949) based on a specimen we did not find, and collected by K.A. Raup at Riceville Pond in 1947.

Galium palustre, MARSH BEDSTRAW. (Rubiaceae) The common early-flowering, bright white, four-petaled bedstraw of open wetlands, distinctive when in flower but easily confused with the next species when in fruit. First collected at HF by W.D. Beal from around HF headquarters in 1947; other collections from Riceville Pond in the same year are *G. tinctorium.* Apparently uncommon at HF; we only observed it at four compartments, all in the Tom Swamp Tract.

Galium tinctorium, DYER'S BEDSTRAW. (Rubiaceae) The commonest small bedstraw of acid bogs, peaty wetlands, and shores, characterized by small three-petaled flowers on short peduncles. Similar to *G. trifidum*


Galinsoga quadriradiata

Galium asprellum


Galium circaezans


Galium lanceolatum

Galium mollugo


Galium palustre

Galium tinctorium

and *G. palustre* and frequently mistaken for them. Frequent and locally common in open wetlands and on pond shores at HF: first collected by H.M. Raup from the Tom Swamp Tract in 1933; recorded from 11 compartments and a wide variety of wetland habitats in our survey. Includes *G. claytoni.*

[**Galium trifidum**, SMALL MARSH BEDSTRAW. (Rubiaceae) A small bedstraw, characteristic of open fens. Very similar to *G. tinctorium,* from which it is distinguished by having some solitary flowers on long, arcing, minutely rough pedicels. Probably present at HF but needs confirmation. One of the two collections cited by C.E. Smith (1949) is *G. tinctorium*; the other was not found. We have field observations from P8 and T9, but did not confirm them with specimens.]

Galium triflorum, THREE-FLOWERED BEDSTRAW. (Rubiaceae) The large, common, perennial bedstraw of moist woods. Frequent at HF, especially in fertile woods: first collected by H.M. Raup from the Tom Swamp Tract in 1933, and observed in 11 compartments in our survey.

Galium triflorum

Gaultheria hispidula, CREEPING SNOWBERRY. (Ericaceae) A small evergreen creeper, common in bog hummocks and in boggy evergreen woods, often growing in sphagnum moss. Locally frequent in boggy wetlands at HF: first collected in the bog in P8 by A.B. Glidden in 1910; not relocated there in our survey, but found widely in the bogs in the Tom Swamp Tract, in a wetland in the Simes Tract, and in the Black Gum Swamp in P2. Also called *Chiogenes hispidula*.

Gaultheria hispidula

Gaultheria procumbens, WINTERGREEN. (Ericaceae) A small, shiny-leaved evergreen species, common in dry acid woods. Very widely distributed in deciduous and mixed woods at HF; J.G. Jack (1911) said it was locally abundant in woods and clearings; we recorded it in 29 compartments in our survey.

Gaultheria procumbens

Gaylussacia baccata, BLACK HUCKLEBERRY. (Ericaceae) A common shrub of dry oak and pine woods, resembling the lowbush blueberries but with resin dots on the leaves and buds. Reported as common in HF in "wet and dry situations, old pastures, etc." by J.G. Jack (1911), and as "occasional in bogs" by C.E. Smith (1949). We found it infrequently in dry upland woods and more frequently in and near swamps and bogs; our records are from P2, T3, T5, T7, T8, T9, T11, and the Simes Tract.

Gaylussacia baccata

Gaylussacia frondosa, DANGLEBERRY. (Ericaceae) A coastal-plain shrub of moist woods and wooded wetlands, resembling the black huckleberry but with bluer, more obovate leaves. Rare at HF: apparently first found in 1947 by I.M. Johnston on the "summits of rocky ridges" in T8; we relocated it in T8 and also in T9, but in and adjacent to shrubby wetlands rather than on ridges.

Gaylussacia frondosa

Gentiana clausa, COMMON BOTTLE GENTIAN. (Gentianaceae) The common broad-leaved bottle gentian of wet meadows and wetland edges. Only known at HF from two 1933 collections: by H.M. Raup along

a stream in the Slab City Tract, and by N.W. Hosley in the Tom Swamp Tract.

Gentiana linearis, NARROW-LEAVED GENTIAN. (Gentianaceae) The common narrow-leaved bottle gentian of beaver ponds and mountain wetlands. Rare at HF: first collected by H.M. Raup in the swamp in P2 in 1933; re-collected twice in the Prospect Hill Tract and along Tom Swamp Road (T8) by I.M. Johnston and R.S. Sigafoos in 1947; collected by C.E. Smith near Connor Pond in 1947; and seen once, in the beaver pond in T5, in our survey. Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.

Gentiana linearis

Gentianopsis crinita, FRINGED GENTIAN. (Gentianaceae) A showy biennial gentian with small leaves and four large fringed petals, commonly found in minerotrophic seepage in pastures and hillside wetlands. Known at HF from two collections: by N.W. Hosley from near the Forest Cottage (P1) in 1933, and by C.E. Smith, also from P1, in 1947. Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program. Formerly called *Gentiana crinita.*

Geranium maculatum

Geranium maculatum, WILD GERANIUM. (Geraniaceae) Our common tall wild geranium with lobed leaves, common in moist fertile woods and thickets. Apparently rare at HF; first collected by H.M. Raup in the Slab City Tract in 1934; collected by W.D. Beal in S8 in 1947 and by Mrs. Gast in the Tom Swamp Tract at an unknown date; and seen by us in the woods in P7 and at the Simes Tract.

Geranium robertianum, HERB ROBERT. (Geraniaceae) A smaller geranium with fully compound leaves, common in dry rocky fertile woods. Rare at HF: found on the east side of Prospect Hill (P5) by H.M. Raup in 1934, and relocated there by us in this survey. Also apparently planted in the courtyard by the schoolhouse in P10.

Geranium robertianum

Geum aleppicum

Geum aleppicum, YELLOW AVENS. (Rosaceae) A tall, fairly broad-leaved avens of fertile soils. Rare at HF, where it is known only from records in S7 and the east slope of Camel's Hump in the Simes Tract in this survey.

Geum canadense, WHITE AVENS. (Rosaceae) The common white avens of moist thickets and woods edges. Uncommon at HF and first confirmed in this survey: reported from S7 by C.E. Smith (1949), citing a specimen that we did not find; observed in the woods of S7 and the Simes Tract in this survey, and along a road in P9 and by the schoolhouse in P10.

Geum canadense

Geum rivale

Geum laciniatum, ROUGH AVENS. (Rosaceae) A small-flowered white avens with a southern distribution, typically found in wooded swamps. Known at HF only from a 1934 collection by H.M. Raup from the Slab City Tract.

Geum rivale, WATER AVENS. (Rosaceae) A large-leaved avens with nodding pink flowers, found in minerotrophic wetlands and swamps. Apparently rare at HF: listed for Petersham by H.M. Raup (1938); first collected

in 1947 by W.H. Drury from "damp, low ground" northeast of the HF buildings; seen once, in swampy woods in T2, in our survey.

Glechoma hederacea,* GROUND-IVY. (Lamiaceae) A small, very common, creeping alien mint of lawns, meadows, thickets, and open woods. Uncommon at HF: not listed for Petersham by H.M. Raup (1938); collected by C.E. Smith in 1947 from near HF headquarters; found in our survey in the lawns around Shaler Hall, and also along roads in P9 and T9. Also called *Nepeta hederacea.*

Glechoma hederacea

Glyceria borealis, NORTHERN MANNA GRASS. (Poaceae) A slender, partially aquatic grass with floating leaves, commonly found in softwater ponds. Known at HF only from a 1947 collection by I.M. Johnston from Riceville Pond.

Glyceria canadensis, CANADIAN MANNA GRASS. (Poaceae) Our common large-fruited manna grass of open wetlands, common in beaver ponds and on pond shores. Frequent in wetlands at HF: first collected by H.M. Raup in 1933 from a "swamp in back of school" near the HF headquarters, and from a pond in the Barre Woods (Slab City Tract); observed in ten compartments in our survey.

Glyceria canadensis

Glyceria melicaria, SLENDER MANNA GRASS. (Poaceae) A delicate manna grass with small fruits and a slender inflorescence, characteristic of wooded swamps and wet ditches along woods roads. Frequent in wet places at HF: first collected by H.M. Raup in Tom Swamp in 1933; observed in eight compartments in our survey.

Glyceria melicaria

[**Glyceria obtusa**, BLUNT MANNA GRASS. (Poaceae) A coastal-plain species with a distinctive dense, oblong panicle. Known at HF only from a 1947 collection by I.M. Johnston from Riceville Pond. R. Bertin notes that the Johnston specimen has long ligules and suggests that it may be an atypical *G. canadensis* rather than *G. obtusa*.]

Glyceria striata, FOWL MANNA GRASS. (Poaceae) Our most common manna grass, a narrow-leaved species with small fruits and an open inflorescence, common on pond shores and in open wetlands; also occurring in shaded wetlands but not as commonly as *G. melicaria.* Common in open wetlands at HF: first collected by H.M. Raup from the west side of Prospect Hill in 1934, and observed in 14 compartments in our survey.

Glyceria striata

Gnaphalium obtusifolium, FRAGRANT EVERLASTING. (Asteraceae) A low, silky-haired herb of dry open ground, resembling the pearly everlasting (*Anaphalis margaritacea*) but a little greener and with minute pustulate-based hairs on the upper leaf surfaces. Occasional along roads and in open sandy ground at HF: collected in Petersham (Wilder's Farm) by N.W. Hosley in 1933; also collected from the margin of Riceville Pond and the Kitchen Road (Prospect Hill Rd.) by C.E. Smith in 1947; found, very sporadically, in five compartments in our survey.

Gnaphalium obtusifolium

Gnaphalium uliginosum

Gnaphalium uliginosum, LOW CUDWEED. (Asteraceae) A small, much branched, straggly cudweed common in moist open mineral soil.

Uncommon at HF: first collected by H.M. Raup along a woods road in the Prospect Hill Tract in 1934; found in the cow pasture in P2, the gravel pit in P9, and in S3 and S10, in our survey.

Goodyera pubescens, DOWNY RATTLESNAKE PLANTAIN. (Orchidaceae) Generally the commonest of our rattlesnake plantains in deciduous woods, with fairly bright white markings on the leaves and a fat, almost globose pouch in the lip. Uncommon at HF: first collected in 1933 by H.M. Raup from the east side of the Tom Swamp Tract; found in P6, T8, T9, and the Simes Tract in our survey. There seemed to be nothing special about the places where it occurred, and it may be more widely distributed than our records indicate.

Goodyera pubescens

Goodyera tessellata, TESSELATED RATTLESNAKE PLANTAIN. (Orchidaceae) The common rattlesnakeplantain of conifer and mixed woods, with paler markings on the leaves and a more elongate pouch and beak than *G. pubescens*. Frequent in moist conifer woods at HF: first collected by H.M. Raup in 1933 from the Tom Swamp Tract; found in 10 compartments in our survey.

Goodyera tesselata

[**Gratiola aurea**, GOLDEN PERT. (Scrophulariaceae) A small, opposite-leaved plant with big yellow flowers, common on sandy pond shores on the coastal plain. Common at Tully Lake in Athol and along exposed shores at Quabbin Reservoir, but not suited to the peaty shores at HF where it is only known from a 1952 collection by W. Chi-Wu from a "swamp" in P6. Since this is an unlikely habitat, and since there are no real swamps in P6, it is possible that the specimen is mislabeled.]

Gymnocarpium dryopteris, OAK FERN. (Dryopteridaceae) A small, bright-green fern of moist, somewhat fertile woods, resembling a miniature bracken but more delicate. Rare at HF where the soils are probably not fertile enough for it: first collected by I.M.Johnston from the "southwest side of the Fay Lot" in 1947; not relocated there but observed in S10 and the Simes Tract in our survey.

Gymnocarpium dryopteris

Hamamelis virginiana

Hamamelis virginiana, WITCH HAZEL. (Hamamelidaceae) A small tree of moist woods, especially common near swamps and streams, but also found upslope in dryer woods. J.G. Jack (1911) said it was "a common shrub, found both in moist and fairly dry situations, chiefly in shady woods." It is still common today: we observed it in 27 compartments.

Helianthemum bicknellii, BICKNELL'S ROCKROSE. (Cistaceae) A small rockrose with multiple primary flowers in a narrow cluster, common in dry open sandy soil. Rare at HF where sandy openings are rare: first documented in this survey in openings near woods roads in P8 and S4.

Helianthemum bicknellii

Helianthemum canadense

Helianthemum canadense, CANADIAN FROSTWEED. (Cistaceae) A related and generally similar species, also common in dry, open, sandy soil, with solitary terminal flowers in an opening branching cluster. Rare at HF: known from specimens collected in 1933 by N.W. Hosley from the Prospect Hill Tract, originally determined as *H. bicknellii*, and in 1947

by K.A. Raup from a dry road in S8. Seen once in our survey in a small clearing along a woods road in T9.

Helianthus tuberosus,* JERUSALEM ARTICHOKE. (Asteraceae) A tall, colonial sunflower, commonly planted as an ornamental and occasionally persistent. Rare at HF: not recorded in previous surveys and seen once by us, along the driveway south of Shaler Hall.

Helianthus tuberosus

Hemerocallis fulva

Hemerocallis fulva,* ORANGE DAYLILY. (Liliaceae) The common cultivated daylily, persisting and spreading along roads and at former house sites. Rare at HF: H.M. Raup first collected it along Tom Swamp Road in 1934; we did not relocate it there but did see it near roads and former building sites in P8, P9, P10, and the Simes Tract.

Heracleum maximum, MASTERWORT, COW-PARSNIP. (Apiaceae) A large, furry umbellifer with multiply compound leaves and white flowers in flat-topped clusters. Known at HF from a single undated specimen from Mrs. Gast from the "Upham Place," which we believe to be what is now called the Benson House in P9, and which was the long-time home of former HF employee R. Upham.

Hesperis matronalis

Hesperis matronalis,* DAME'S-ROCKET. (Brassicaceae) A tall, showy mustard, escaped from cultivation and common in alluvial woods in many places. Rare at HF: not recorded in previous surveys; seen twice by us, in a field by the highway and along a woods road, both in P9.

Heteranthera dubia, WATER STAR-GRASS. (Pontederiaceae) A submerged aquatic, inconspicuous except when it flowers, resembling a small narrow-leaved pondweed but lacking a midrib. Not previously reported from HF; seen once, in Harvard Pond, in our survey. Also called *Zosterella dubia*. Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.

Heteranthera dubia

Hieracium aurantiacum

Hieracium aurantiacum,* ORANGE HAWKWEED. (Asteraceae) This is the common orange hawkweed of meadows, lawns, and roadsides. Occasional or, because of the many sterile hawkweeds that can't be determined, possibly frequent in lawns and along woods roads at HF: first collected by H.M. Raup from the Prospect Hill Tract in 1934; recorded from six compartments in our survey.

Hieracium caespitosum,* KING-DEVIL. (Asteraceae) Following Cronquist and others we use this name for the common yellow alien hawkweeds with stiff simple hairs on both sides of the leaves that earlier botanists called *H. pratense*. At least frequent and probably common in lawns and along woods roads at HF where it was first collected by H.M. Raup by Fisher House in 1934. We found flowering plants in six compartments and sterile plants, which are either this species or *H. aurantiacum*, in nine others.

Hieracium caespitosum

Hieracium paniculatum

Hieracium paniculatum, PANICLED HAWKWEED. (Asteraceae) A delicately branched native hawkweed of open deciduous woods, generally common in our area. Occasional at HF: first collected by H.M. Raup in

1933 on the east side of Tom Swamp; seen in eight compartments in our survey.

Hieracium piloselloides,* KING-DEVIL. (Asteraceae) A yellow, alien hawkweed, widely established but less common than *H. caespitosum*, from which it is distinguished by its whitened and less hairy leaves. Known at HF from a single record from P7 in this survey.

Hieracium scabrum, ROUGH HAWKWEED. (Asteraceae) Our common, stiff-hairy, elliptic-leaved hawkweed of dry sandy soil. Uncommon at HF: first collected by H.M. Raup and N.W. Hosley in the Prospect Hill Tract in 1933; seen along woods roads, in P2, P8, T3, T8, T11, and the Simes Tract, and in a small borrow pit in T9 in our survey.

Hieracium umbellatum, CANADA HAWKWEED. (Asteraceae) A native hawkweed of dry sandy woods, with coarsely-toothed leaves. Known at HF, somewhat anomalously, from a single 1947 collection by C.E. Smith from a meadow near the HF buildings. This species, long known as *H. canadense* and more recently as *H. kalmii*, is treated in the *Flora of North America* as a part of the Linnaean species *H. umbellatum*, now very broadly defined and covering plants from much of northern North America.

Hieracium venosum, VEINED HAWKWEED. (Asteraceae) An uncommon native hawkweed of dry soils, found on open sands near the coast and in fertile rocky woods inland. Rare at HF: collected by H.M. Raup from "rich woods" in the Slab City Tract in 1934 and by C.E. Smith along Dugway Road and so adjacent to the Simes Tract in 1947; seen once in our survey, on the upper slopes of Camel's Hump in the Simes Tract.

Holcus lanatus,* VELVET GRASS. (Poaceae) A weedy alien grass of roadsides, distinguished by its velvety fur and dense fruiting panicle. Rare at HF: not recorded previously; seen once in our survey, on a roadside by the Simes Tract.

Houstonia caerulea, BLUETS. (Rubiaceae) A delicate herb of meadows, lawns, and riverbanks, with a small rosette of basal leaves and blue and white flowers on slender stalks. Common in lawns, along woods roads and on river banks at HF: first collected by H.M. Raup in 1933 on the east side of Tom Swamp; recorded from 16 compartments in our survey.

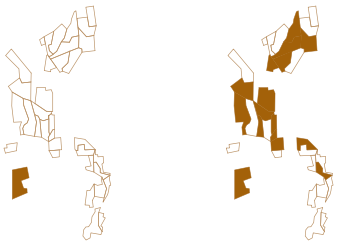
Humulus lupulus,* HOPS. (Cannabaceae) A high-climbing, rough-leaved vine, apparently native to both Europe and eastern North America, cultivated since antiquity in Europe and widely escaped from cultivation in North America. Generally believed to be an introduced plant in Massachusetts but since the morphological distinctions between the native and the introduced genotypes are, as M.L. Fernald politely said, "evasive," no one seems to know for certain. Rare at HF where it is known only from a 1933 collection by H.M. Raup from the Prospect Hill Tract.

Huperzia lucidula, SHINING CLUBMOSS. (Lycopodiaceae) The common shaggy, relatively broad-leaved clubmoss of moist acid woods. Common

Hieracium piloselloides

Hieracium scabrum

Hieracium venosum



Holcus lanatus

Houstonia caerulea

Huperzia lucidula

in mixed woods and near swamps at HF: first collected by H.M. Raup in 1933 in the Tom Swamp Tract; found in 20 compartments in this survey. Long called *Lycopodium lucidulum*; now placed in the segregate genus *Hupzeria* which differs from *Lycopodium* in lacking fruiting cones and possessing reduced bulblet-bearing branches.

Hydrangea arborescens,* WILD HYDRANGEA. (Hydrangeaceae) A shrub or small tree with showy heads of white flowers, native to the southern and central Appalachians, cultivated and occasionally escaped with us. Known at HF from a few plants seen near the sawmill in P2 in our survey.

Hydrocotyle americana, PENNYWORT. (Apiaceae) A small round-leaved creeper with tiny flowers in the leaf axils. Common in swamps, wet woods, and on pondshores at HF: first collected by H.M. Raup in 1933 in the Tom Swamp Tract; found in 19 compartments in this survey.

Hypericum boreale, NORTHERN ST. JOHN'S-WORT. (Clusiaceae) A small-flowered St. John's-wort with leafy bracts, common northwards and in bogs but tending to be replaced by *H. mutilum* southwards and in minerotrophic wetlands. Uncommon at HF: first collected by H.M. Raup in Tom Swamp in 1933; we relocated it on shores and floating peat islands in Harvard Pond (T6, T11), and also at Connor Pond (S6).

Hypericum canadense, CANADIAN ST. JOHN'S-WORT. (Clusiaceae) A small, linear-leaved St. John's-wort of sandy shores and open wet mineral soils. Occasional at HF. First collected in 1934 by H.M. Raup from a "damp, sandy roadway" on the west side of Prospect Hill, a very typical habitat. We found it in similar habitat near the sawmill in P2 and in the gravel pit in P9, and also widely distributed on shores and peat islands in the Tom Swamp Tract.

Hypericum ellipticum, ELLIPTIC ST. JOHN'S-WORT. (Clusiaceae) A medium-sized St. John's-wort of marshy shores and open wetlands, often very common in beaver ponds and along marshy rivers, and making handsome displays in midsummer. Less abundant at HF and not seen in quantity here: first collected in 1934 by H.M. Raup on a woods road in the Prospect Hill Tract; not relocated there in our survey, but seen at Connor Pond (S6), along the Swift River in S5 and S10, and in three compartments in the Tom Swamp Tract.

Hypericum gentianoides, PINEWEED. (Clusiaceae) A small wiry St. John's-wort of dry barren soil with clustered stems and tiny, needle-like leaves. Most commonly found on highways and along railroads; although it is a native species it is almost never seen in native habitats. Known at HF only from two 1947 collections by I.M. Johnston from a sandy roadside near Riceville Pond, which may or many not have been within HF.

Hypericum mutilum, DWARF ST.-JOHN'S-WORT. (Clusiaceae) A small-flowered species, differing from *H. boreale* only in the needle-like bracts below the flowers and its greater preference for recently disturbed soil. Uncommon at HF where it was first collected in 1947 by I.M. Johnston


Hydrangea arborescens


Hydrocotyle americana


Hypericum boreale


Hypericum canadense


Hypericum ellipticum


Hypericum mutilum

from the beach at Riceville Pond. Seen four times in our survey: in the pasture and the yard of the sawmill in P2, in a small beaver marsh in S3, in the large beaver pond in T5, and on the causeway that crosses Tom Swamp in T8.

Hypericum perforatum,* COMMON ST. JOHN'S-WORT. (Clusiaceae) The small-leaved St. John's-wort with the large yellow flowers, a European weed that is widely established on meadows, shores, and open rocky slopes. Occasional at HF in disturbed areas and on roads: first collected by H.M. Raup in 1934 from the yard of Fisher House; currently found in at least 11 compartments, throughout HF.

Hypericum perforatum

Hypericum punctatum

Hypericum punctatum, SPOTTED ST. JOHN'S-WORT. (Clusiaceae) A widespread St. John's-wort of upland forests, with rounded leaves with broad bases and medium-sized flowers. It is not an uncommon plant, but seems a very unpredictable one; it is present in some woods and not in many others and that seems about all that can be said about it. Apparently rare at HF: reported from moist woods in T1 by C.E. Smith (1949), citing a specimen that we did not see; seen once in our survey, in woods in T4.

Hypochaeris radicata

Hypochaeris radicata,* SPOTTED CAT'S EAR. (Asteraceae) A Eurasian weed, resembling a dandelion but with less sharply toothed leaves, more wiry flower stalks that may fork, flower heads with papery bracts among the flowers, and feathery pappus bristles. Common and to some extent replacing the dandelion on the outer Massachusetts coast but only occasional inland. Not previously reported for HF; now common in the lawn behind the Torrey Laboratory in P1.

Ilex laevigata

Ilex verticillata

Ilex laevigata, SMOOTH WINTERBERRY. (Aquifoliaceae) A deciduous holly of wooded swamps, distinguished from our common winterberry by its smoother, shinier, and more remotely toothed leaves and smooth margins to the sepals. It is largely a coastal plain species and uncommon this far north. Apparently rare at HF. J.G. Jack (1911), who seems not to have missed much, said it was local but common in the Prospect Hill and Meadow Water (Tom Swamp) Tracts. Collected in 1908 from the "Northeast Tract" (Prospect Hill) by R.R. Chaffee; in 1940 from an "island at the south end of Tom Swamp bog by P. Smith; in 1947 from the Fay Lot (Tom Swamp Tract) by M. Ward and from near the dam at Riceville Pond by W.D. Beal. We found several plants in the Black Gum Swamp in P2, and in compartments T8 and T9 of the Tom Swamp Tract, much where J.G. Jack had found them but apparently, if his "local but common" can be believed, less common than in his day.

Ilex verticillata, WINTERBERRY HOLLY. (Aquifoliaceae) Our common winterberry, usually a twiggy, multi-stemmed shrub under ten feet high. Common at HF in wooded swamps and on pond shores, also occasionally seen in dryer woods. J.G. Jack (1911) said it was very common and very variable. We concur with both: we have records from 27 compartments, and have noted considerable variation in the shape of the leaves and how prominent their teeth are.

Impatiens capensis, ORANGE JEWELWEED. (Balsaminaceae) The common orange-flowered jewelweed of wet woods and acid wetlands. Common at HF: first collected by N.W. Hosley (under the name *I. biflora*); found in 22 compartments in our survey.

[**Inula helenium,** ELECAMPANE. (Asteraceae) A tall, alien, sunflower-like herb with large rough leaves, formerly grown in medicinal gardens and now widely but somewhat casually escaped to fields. Collected by I.M. Johnston from the east end of Leighton Road in 1947; not seen in our survey. Leighton Road now forms the north border of the Grout Lot, a part of the Prospect Hill Tract. The Grout Lot had not been acquired when Johnston made his collection, and it is not clear whether he collected his plant in HF or not. Also collected by C.E. Smith from Leighton Road near Nelson Road, and thus off HF.]

Iris pseudacorus,* YELLOW FLAG IRIS. (Iridaceae) A large, weedy, yellow iris that escapes from cultivation and spreads aggressively on pond and river shores. Not previously reported from HF. Its current status is uncertain because we have no certain way of telling it from the native blue flag when it is not in flower. We saw flowering specimens of yellowflag iris at Connor Pond (S6) and along the Swift River at the north end of S10, and sterile or post-flowering irises in another twelve compartments that we were unable to identify.

Iris versicolor, BLUE FLAG IRIS. (Iridaceae) The only native iris of inland New England, common on shores and in open marshy wetlands. Generally somewhat smaller than the introduced yellowflag iris and with narrower leaves and pods but the measurements overlap and the petal color seems the only reliable distinction. Blueflag iris is probably frequent at HF; it was first collected here in 1934 by H.M. Raup from a swamp in the Prospect Hill Tract; we confirmed it in four compartments and think it likely, based on plant size and habitat, that many of the sterile plants we saw in other compartments are this species.

Juglans cinerea, BUTTERNUT. (Juglandaceae) A spreading tree of fertile upland woods, formerly much planted in farmsteads for its nuts. Now declining rapidly from a fatal canker, and listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program. First collected by A.B. Glidden near Harvard House in 1910, and listed as frequent in woods and on roadsides by J.G. Jack (1911). Now rare at HF: we saw it by Locust Opening Rd. in P1, by the HF gate along Rt. 122 in T5, and in two locations on the rich slopes of Camel's Hump in the Simes Tract.

[**Juglans nigra**,* BLACK WALNUT. (Juglandaceae) A tree with dark bark and spreading branches, native to the southeastern United States and planted and escaping here but not definitely naturalized. Rare at HF: reported as planted in Petersham by J.G. Jack (1911); notes on a 1940 specimen from P9 collected by J.W. Johnston indicate that the plant was a seedling, apparently from a seeding experiment. Represented in our survey by a single seedling growing on the HF grounds by the Community House, near a planted tree.]

Impatiens capensis

Iris pseudacorus

Iris versicolor

Juglans cinerea

Juncus acuminatus, ACUMINATE RUSH. (Juncaceae) A southern species with septate leaves and nonappendaged seeds, separated from the commoner and more northern *J. articulatus* by having three rather than six stamens. Apparently rare at HF: first collected in 1947 by W.D. Beal at Riceville Pond; seen once in our survey, in the little pond in the cow pasture in P2.

Juncus articulatus, ARTICULATE RUSH. (Juncaceae) The common rush with septate leaves and nonappendaged seeds of open wetlands in our area, distinguished from the more southerly *J. acuminatus* by having six stamens. Uncommon or overlooked at HF and perhaps not as comfortable in the peaty wetlands here as other species. Not recorded in previous surveys, and found only twice, on wetland and pond shores in T8 and T9, in our survey.

Juncus brevicaudatus, SHORT-TAILED RUSH. (Juncaceae) A septate-leaved rush with short appendages on it seeds, very common on pond shores, in beaver ponds, and on wet disturbed soil in ditches and borrow pits. Occasional at HF: first collected by H.M. Raup in 1937 from the north end of Tom Swamp; also collected by I.M. Johnston in 1947 from Riceville Pond; found on the shores of Riceville and Connor Ponds, and in wet spots near the sawmill in P2 and the gravel pit in P9 in our survey.

Juncus bufonius, TOAD RUSH. (Juncaceae) A small, wiry, annual rush that commonly grows in moist sandy or muddy soil on shores and along paths, often in somewhat disturbed areas. Apparently uncommon but perhaps overlooked at HF; first collected by H.M. Raup on a woods road in the Prospect Hill Tract in 1934; reported by C.E. Smith (1948) from S8 and T1, based on specimens we were not able to locate; and seen twice in our study, in the cow pasture in P2 and the gravel pit in P9.

Juncus canadensis, CANADIAN RUSH. (Juncaceae) A large, septate-leaved rush with long appendages on the seeds, common on shores and in shallow-water emergent marshes. Closely related to *J. brevicaudatus* but with more flowers in each head and longer tails on the seeds. It matures late in the season and can be hard to identify in midsummer surveys. Occasional on pond shores and in beaver ponds at HF: first collected by H.M. Raup on a pond shore and along a stream in the Tom Swamp Tract in 1933; found on the shores and floating islands of Harvard Pond and Riceville Pond in our survey, and also in beaver ponds in S3, T5, and T7.

Juncus effusus, COMMON RUSH. (Juncaceae) The common large, clump-forming rush with lateral flower clusters, very common in wet meadows, marshes, and on marshy shores. Frequent in meadows, on wet roadsides, and in open wetlands at HF: first collected by H.M. Raup in the Prospect Hill and Tom Swamp Tracts in 1933; found in 12 compartments in our survey.

Juncus greenei, GREENE'S RUSH. (Juncaceae) A flat-leaved rush with fairly distinctive oblong capsules, found in open, dry, sandy or rocky soils. Frequent in eastern Massachusetts but only known at HF from a 1934 collection by H.M. Raup from the top of Prospect Hill, which has


Juncus acuminatus


Juncus articulatus


Juncus brevicaudatus


Juncus bufonius


Juncus canadensis


Juncus effusus

since grown in and is now mowed and apparently without suitable habitat. The herbarium also contains a 1947 collection by I.M. Johnston from rocks at the summit of Chimney Hill, which is near Quaker Drive and thus not in HF.

Juncus marginatus, MARGINATE RUSH. (Juncaceae) A distinctive small, flat-leaved rush with clustered flowers and short rounded capsules, common in open wetlands and on moist mineral soil. Uncommon or occasional at HF: first collected in 1947 by I.M. Johnston on the shore of Riceville Pond; relocated by us there, and also found on the causeway in T8 and in a small beaver pond in S3.

Juncus pelocarpus, PONDSHORE RUSH. (Juncaceae) A slender rush with threadlike leaves and solitary, sharp-pointed fruits, common in softwater lakes and ponds, and often growing submerged. Not previously collected at HF but locally plentiful on peaty shores and floating islands in Harvard Pond and Riceville Pond.

Juncus tenuis, PATH RUSH. (Juncaceae) A small, flat-leaved, much-forked rush with delicate translucent auricles where the leaf sheaths meet the blades, found in meadows and along dirt roads and paths throughout our area and usually one of the commonest rushes. Very widespread and common at HF: first collected by H.M. Raup from the Tom Swamp Tract in 1933; found in 21 compartments in our survey.

Juniperus communis, COMMON JUNIPER. (Cupressaceae) Sprawling bushy juniper with prickly mature foliage, common in pastures and on rocky sterile soils. Frequent at HF. J.G. Jack (1911) said it grew in abandoned pastures. These are long gone, but it persists in partial shade in second-growth woods, and we recorded it from 12 compartments. Called *J. nana* by J.G. Jack and a few other turn-of-the-century botanists, an odd and temporary substitute for the long-established *J. communis*.

Juniperus virginiana, RED CEDAR. (Cupressaceae) Considered "rather rare" as a pasture plant by J.G. Jack (1911), and very rare in HF today: we found one tree, almost overtopped, near an old farm site at the north end of the Simes Tract. A single tree also occurs near the Fisher House in P10, but we do not know whether this tree was planted.

Kalmia angustifolia, SHEEP LAUREL. (Ericaceae) The common, low, evergreen laurel with whorled leaves, found in acid soils in woods, on shores, and in the hummocks of open peatlands. J.G. Jack (1911) said it was common in old fields and wet ground; we recorded it from 22 compartments and found it common in wetlands, along woods roads, and in dry successional woods.

Kalmia latifolia, MOUNTAIN LAUREL. (Ericaceae) Our tall, alternate-leaved laurel of dry mixed woods. Common at HF: J.G. Jack (1911) said that it was plentiful in a few localities and that scattered individuals were frequent. We found it in 15 compartments, occurring mostly as relatively small individuals and generally not forming dense continuous colonies.

Juncus marginatus

Juncus pelocarpus

Juncus tenuis

Juniperus communis

Juniperus virginiana

Kalmia angustifolia

Kalmia latifolia

Kalmia polifolia, BOG LAUREL. (Ericaceae) A small laurel of open sphagnum peatlands, recognized by the narrow, paired, dark-green leaves with inrolled edges and white undersides. Rare at HF where it is known only from the bog at Tom Swamp where it was probably collected by P. Haynes in 1910 and definitely collected by H.M. Raup in 1933. J.G. Jack (1911) said it was occasional in cold sphagnum swamps; we saw it in the main Tom Swamp bog and along the utility right-of-way in T8 in this survey.

Lactuca biennis, BLUE LETTUCE. (Asteraceae) A common, very tall, weedy native lettuce of roadsides and waste ground. Separated from the equally common but somewhat smaller *L. canadensis* by its blue flowers, unbeaked achenes, and often wider and less deeply lobed leaves. Probably frequent at HF where either this or the following species were present in 14 compartments, but its abundance is uncertain because of the large number of records of immature or sterile plants. First collected by H.M. Raup in Slab City in 1934; confirmed in four compartments in our survey and, if the leaf lobing is a reliable guide, present in many others. Formerly called *L. spicata*, a name that applies to another species.

Lactuca canadensis, WILD YELLOW LETTUCE. (Asteraceae) A similar but smaller and apparently less common species, growing in the same habitats as *L. biennis* and often with it, with yellow flowers, beaked achenes, and often very slender lobes on the leaves. Occasional or possibly frequent at HF: first collected by H.M. Raup on Prospect Hill in 1933; confirmed from roadsides and meadows in five compartments in our survey.

Lactuca hirsuta, HAIRY LETTUCE. (Asteraceae) An uncommon lettuce of dry sandy soils, resembling *L. canadensis* but with taller involucres and hairier leaves, and perhaps with sharper teeth on the leaf lobes. Known at HF from a single collection "on the road behind the HF headquarters," by C.E. Smith in 1947. Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.

Laportea canadensis, WOOD NETTLE. (Urticaceae) The common alternate-leaved stinging nettle of moist, shaded fertile soils. Uncommon at HF: first collected by H.M. Raup from the Slab City Tract in 1934; not seen by C.E. Smith and his associates in the 1940s; relocated by us along the Swift River in S2 and S6, and on a fertile boulder slope in S7.

Larix laricina, TAMARACK. (Pinaceae) Our native larch, a skinny, sparse conifer with deciduous, light blue-green needles in sprays from the tips of short stubby branches. J.G. Jack (1911) said it was "found in groups or scattered individuals on swamps or bogs, usually small." Currently known at HF only from the bogs and boggy thickets in the Tom Swamp Tract, where it was first collected in 1933 by H.M. Raup.

Larix sp.,* LARCH. (Pinaceae) Several European and Asiatic larch species were planted in T7 and elsewhere, and have occasionally established near these plantations.

Lechea intermedia, COMMON PINWEED. (Cistaceae) A small, slender-leaved, wiry herb of dry, open, sandy soil, common on the coastal plain


Kalmia polifolia


Lactuca biennis


Lactuca canadensis


Laportea canadensis


Larix laricina


Larix sp.


Lechea intermedia

and widely distributed but more erratic inland. Occasional at HF, mostly along roads and in disturbed open ground. First collected by H.M. Raup in the Prospect Hill and Tom Swamp Tracts in 1933; found in eight compartments in our survey.

Lechea mucronata, HAIRY PINWEED. (Cistaceae) A small, softly-hairy herb of open dry sandy soil, similar to *L. intermedia* but with broader leaves and more spreading hairs. Rare at HF: we have a single 2005 record from a sandy roadside in S7, opposite Connor Pond. Formerly called *L. villosa*, a later though better typified name.

Ledum groenlandicum, LABRADOR TEA. (Ericaceae) A low, evergreen shrub of dry bogs and boggy thickets, distinguished by its aromatic smell and the matted hairs on the lower sides of its leaves. Uncommon at HF where it is restricted to the bogs and swamps between Harvard Pond and Riceville Pond. Not mentioned by J.G. Jack (1911). First collected by H.M. Raup at the north end of Tom Swamp in 1933; relocated there (T8 and T11) and in the large conifer swamp in T9 in this survey.

Leersia oryzoides, RICE CUTGRASS. (Poaceae) A light-green, sprawling, annual grass of open muddy soil, with rough-edged leaves and sheaths that will cut your skin. Occasional and locally frequent on muddy shores at HF: listed for Petersham by H.M. Raup (1938); apparently first collected by I.M. Johnston in 1947 from Riceville Pond; seen on pond and river shores in eight compartments in our survey.

Leontodon autumnalis,* AUTUMN DANDELION. (Asteraceae) A Eurasian relative of the common dandelion with deeply lobed leaves and wiry, forking stems, now widely established in lawns and along roads in our area. Only know at HF from a few plants in the lawn at Lyford House (P1), found in our survey. The cat's ear *Hypochoeris radicata* is similar but has papery bracts between the flowers.

Leonurus cardiaca,* MOTHERWORT. (Lamiaceae) A tall, alien, non-aromatic mint with lobed leaves and spiny calyx lobes, common in fertile moist open soil in yards and waste ground. Rare at HF; collected near HF (Wilder's Farm) by N.W. Hosley in 1933 and in "sandy waste ground" in P1 by J. Canright in 1947; seen once in our survey, in the field in P9.

Lepidium densiflorum,* DENSELY-FLOWERED PEPPERGRASS. (Brassicaceae) One of several small weedy white-flowered mustards with short, round, flattened pods that are found in lawns and waste ground. This species is marked by the very short petals, and, when in fruit, by having the cotyledons within the seed turned with their sides toward the embryonic stem. Rare or casual at HF: first collected (as *L. virginicum*) by W.D. Beal in 1947, from near the HF buildings; found twice in our survey, in the gravel pit in P9 and in P3.

Lepidium virginicum, VIRGINIA PEPPERGRASS. (Brassicaceae) A related species with larger petals and flattened cotyledons with their edges toward the embryonic stem. Known at HF from a single collection in this

Lechea mucronata

Ledum groenlandicum

Leersia oryzoides

Leontodon autumnalis

Leonurus cardiaca

Lepidium densiflorum

Lepidium virginicum

survey at the edge of Rt. 122 in S7. A previous collection by W.D. Beal in 1947, is *L. densiflorum*.

Lespedeza capitata, COMMON BUSH-CLOVER. (Fabaceae) Our commonest bush-clover, a tall species with a dense, wand-like flower cluster, found in sandy soils, often on roadsides or in abandoned fields, throughout our area. Uncommon at HF, owing to the lack of suitable habitat. Collected by N.W. Hosley in the Tom Swamp Tract in 1933 and by W.D. Beal near Riceville Pond in 1947; seen twice in our survey, along a woods road by the gravel pit in T6 and along Locust Opening road in P8.

[**Leucothoe racemosa**, FETTERBUSH. (Ericaceae) A small wetland shrub of the coastal plain, with blueberry-like flowers in one-sided terminal racemes. Reported by J.G. Jack (1911) as "uncommon or rare, wet places," and listed for Petersham by H.M. Raup (1938); no specimens were found to support either record, and neither author specifically credits it to HF. Also called *Eubotrys racemosa.*]

Ligustrum vulgare, PRIVET. (Oleaceae) Common ornamental shrub with stiff twigs, opposite leaves, and black berries, commonly planted for hedges and widely escaped. J.G. Jack said it was "rarely naturalized from cultivated plants." Listed for Petersham by H.M. Raup (1938) but not vouchered; seen once in our survey, in an old field in the Simes Tract.

Lilium canadense, CANADA LILY. (Liliaceae) A tall, multi-flowered, nodding lily of wetlands and shores. Known at HF only from a collection by E. Stephens from Connor Pond in 1947 and an observation along the Swift River in S10 in our survey.

Lilium philadelphicum, WOOD LILY. (Liliaceae) A shorter, single-flowered lily of dry woods and open ground, with erect flowers of a very intense orange red. It is to some extent a fugitive species, occurring in small populations and often not persisting for more than a few years at a station. Known at HF from two collections from near the "Forest Cottage (N.W. Hosley, 1933; Mrs. Gast, n.d.), and one labeled only Prospect Hill (J. Wright, 1940). We could not relocate it near the top of Prospect Hill, where G. Motzkin recorded it in 1992, but did find a few plants in the southwestern portion of the Simes Tract.

Linaria vulgaris,* YELLOW TOADFLAX, BUTTER-AND-EGGS. (Scrophulariaceae) An alien herb with slender leaves and bright yellow-and-orange flowers with long spurs, generally common on roadsides and in waste ground. Rare at HF where it has not been previously reported; we found it once, in P1 near Shaler Hall.

Lindera benzoin, SPICEBUSH. (Lauraceae) A tall, aromatic shrub of shaded wetlands, often on mucky soils, with untoothed leaves and small yellow flowers in early spring. J.G. Jack (1911) said it was frequent in wet places. It was first collected by H.H. Tryon in 1911 in the Meadow Water (Tom Swamp) Tract ; we found it in nine compartments, around all the major swamps in the Prospect Hill and Tom Swamp Tracts, but not along


Lespedeza capitata


Ligustrum vulgare


Lilium canadense


Lilium philadelphicum


Linaria vulgaris


Lindera benzoin

the river or near the temporary ponds in the Slab City Tract. Formerly called *Benzoin aestivalis.*

Lindernia dubia, FALSE PIMPERNEL. (Scrophulariaceae) A small creeping herb with tubular, blue-white flowers, found on muddy shores. Known at HF from a collection by I.M. Johnston in 1947, from the shore of a muddy pond northeast of Camel's Hump in the Simes Tract, and from a report by C.E. Smith (1949) from a field near Tom Swamp Road, citing a specimen that we did not see. We did not relocate it in these locations, but found it to be abundant in moist soil near an old drainage ditch along the edge of the pasture in P2.

Lindernia dubia

Linnaea borealis, TWIN-FLOWER. (Caprifoliaceae) A small, partly evergreen, opposite-leaved creeper, with small nodding flowers in pairs. A characteristic plant of hummocks in moist boreal forests, known at HF from collections by H.M. Raup and Mrs. Gast from the Fay Lot in Tom Swamp. We searched several swampy spruce woods in Tom Swamp trying to relocate it but did not. Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.

Liriodendron tulipifera

Liriodendron tulipifera, TULIP TREE. (Magnoliaceae) A tall tree of moist fertile soils, native in western and southern New England and widely planted and occasionally naturalized elsewhere. Not recorded historically at HF. It is planted near the buildings and perhaps elsewhere and sparingly naturalized. We saw a small sapling near the old tannery site in the woods in P1, and two small saplings near a few overstory trees (which may have been planted) along the woods road at the east side of T5.

Lobelia cardinalis, CARDINAL FLOWER. (Campanulaceae) A tall streamside herb with deep red, long-tubed flowers pollinated by humming birds and hovering moths. Locally plentiful along streams in the Tom Swamp and Slab City Tracts, and also in the small pool on Dugway Road in the Simes Tract and doubtless in other small wetlands. First collected by H.M. Raup on the east side of Tom Swamp in 1933; we have records from seven compartments. In late summer cardinal flower, Joe-pye weed, turtlehead, and blue and white asters bloom in great profusion along the Swift River in the Slab City Tract, producing what is probably the best display of flowers at HF, and one that is all the more remarkable for occurring late in the season and within a shaded forest. A white cardinal flower, with only a slight tinge of pink, was observed in 2006 and 2007 just off of HF on property of The Trustees of Reservations, near the foot bridge over the Swift River north of Quaker Drive.

Lobelia cardinalis

Lobelia inflata, INDIAN-TOBACCO. (Campanulaceae) A small native lobelia of weedy habits, distinguished by the small whitish flowers and inflated calyces, common in meadows and along paths and roads. Occasional at HF: first collected by H.M. Raup on the Tom Swamp and Prospect Hill Tracts in 1933; observed, mostly as scattered plants along woods roads, in 12 compartments in our survey.

Lobelia inflata

Lobelia spicata

Lobelia spicata, PALE-SPIKE LOBELIA. (Campanulaceae) A small pretty lobelia with a terminal spike of pale blue flowers, usually found on mead-

ows and shores and commonest on limy soils. Rare at HF; collected by H.M. Raup in open woods in the Tom Swamp Tract in 1934, and by C.E. Smith from Tom Swamp Road and S10 in 1947; seen once in our study, in T3.

Lolium perenne,* ITALIAN RYEGRASS. (Poaceae) A common soil-binding grass, looking like quack-grass with the spikelets twisted so that their edges face the culm. Not previously reported at HF; seen once in our study, in a recently landscaped area near the front parking lot at Shaler, where it may have come in with fill or been sown.

Lonicera canadensis, CANADA HONEYSUCKLE. (Caprifoliaceae) A low native honeysuckle of mixed woods and rocky slopes, recognized by the oval leaves with rounded or squared-off bases and long hairs on their edges. Frequent in a variety of forest types at HF: first collected by K. Mills in 1910 from a swamp in the "Northeast Tract" (Prospect Hill); listed as occasional in woods by J.G. Jack (1911), and found in 17 compartments, far more than occasionally, in our survey.

Lonicera dioica, LIMBER HONEYSUCKLE. (Caprifoliaceae) A distinctive, somewhat viny honeysuckle with oblong leaves that are bright white below, most commonly found on limy hills but also occurring in swamps. Listed by J.G. Jack (1911), who said it was rare in woods, and for Petersham by H.M. Raup (1938). We found a few plants on the slope of Camel's Hump in the Simes Tract.

Lonicera morrowii,* EUROPEAN BUSH HONEYSUCKLE, MORROW'S HONEYSUCKLE. (Caprifoliaceae) The tall, highly invasive, bush honeysuckle that has colonized second-growth woods throughout southern and western New England. A relatively new weed in much of New England, arriving in the first half of the 20th century, and expanding and becoming a woodland dominant in the second. Its early history at HF is not known. It was not recorded in any of the earlier surveys, but it is quite similar to *L. tartarica* and it is possible that the unvouchered records of that species in J.G. Jack (1911) and H.M. Raup (1938) may refer to *L. morrowii* instead. In any event, it was rare enough in the 1940s that it was never seen by C.E. Smith (1949) or his colleagues. Currently it is frequent at HF: we have records of it from 15 compartments (a little less than half of the compartments we visited). Most records are of scattered plants. We observed dense populations in successional woods near the HF buildings in P1 and P2, in a former conifer plantation that was clearcut in P1, near Rt. 122 at the southeast corner of Harvard Pond, near a small cellar hole at the south end of T8, and in a partially cut plantation west of Harvard Pond in T7.

Lonicera villosa, NORTHERN FLY HONEYSUCKLE. (Caprifoliaceae) A small native honeysuckle of bogs and swamps with dark-green, hairy leaves and dark-blue berries. Currently rare at HF, where we know it only from a few plants in the swamp at the north end of Connor Pond, in S6. Likely first collected by R.R. Chaffee in 1909 or S.M. Dohanian in 1913, (their specimens lack localities) and perhaps commoner then: J.G. Jack (1911) said it was common in wet meadows and swamps. The species is

Lolium perenne

Lonicera canadensis

Lonicera dioica

Lonicera morrowii

Lonicera villosa

part of a circumboreal complex; if, as here, the North American plants are separated from the Eurasian ones the correct name is *L. villosa;* if they are identified with the Eurasian ones the correct name is *L. caerulea.*

Ludwigia palustris, WATER PURSLANE. (Onagraceae) Small, somewhat fleshy creeper with small, four-petaled, axillary flowers, common on muddy shores and in open shallow wetlands. First collected in 1933 by H.M. Raup at the margin of a pond in the Slab City Tract; also collected in 1947 at Riceville Pond by I.M. Johnston; not relocated there but seen at Harvard Pond, Connor Pond, a beaver pond in S3, the wet pasture in P2, and along the Swift River in S10 in our survey.

Lupinus sp.,* CULTIVATED LUPINE. (Fabaceae) A showy cultivated lupine, perhaps *L. polyphyllus*, was seen in the field on the west side of Rt. 32 (P9) in our survey.

Luzula multiflora, COMMON WOODRUSH. (Juncaceae) The common woodrush of average woods, with broad hairy leaves and clustered flowers. Common in deciduous and mixed forests and especially along the banks of woods roads at HF: first collected by H.M. Raup from the east part of the Tom Swamp Tract in 1933; observed in 24 compartments in our survey. *L. multiflora* is a wide-ranging species, native to Europe and North America; it was formerly treated as a variety of *L. campestris*, which is now considered to be a related but slightly different species that is native to Europe and a rare weed in North America.

Lychnis flos-cuculi,* RAGGED ROBIN. (Caryophyllaceae) A European garden flower with slender leaves and dissected pink petals, now widely naturalized in eastern North America. Not previously reported from HF; seen once in our survey, at the edge of the parking lot behind the Torrey Laboratory in P1.

Lycopodiella inundata, BOG CLUBMOSS. (Lycopodiaceae) A flattened, creeping clubmoss, more often found on peaty sands than in bogs. Uncommon at HF: first collected by H.M. Raup in 1937 at the north end of Tom Swamp; also recorded on a grassy beach at Riceville Pond in 1947; relocated there and found at Connor Pond, Harvard Pond, and in the gravel pit in P9 in our survey. *Lycopodiella* is a recent (and perhaps unnecessary) segregate from *Lycopodium* containing species with flattened horizontal sterile shoots and photosynthetic gametophytes.

Lycopodium sp., CLUBMOSSES. The old genus *Lycopodium* has lost the species with adnate leaves to *Diphasiastrum*, the species with sporangia on leafy shoots to *Huperzia,* and the species with flattened creeping stems to *Lycopodiella.* At present the only lycopodiums left in our flora are the members of the *clavatum, annotinum*, and *obscurum* groups, which have slender leaves and sporangia in cones with reduced leaves. There have been recent suggestions, reflecting the curious and unlinnaean desire to have genera as small and homogenous as possible, to move the *obscurum* group to the genus *Dendrolycopodium* and the *annotinum* group to the genus *Spinulum.* Thus far they have not prevailed.


Ludwigia palustris


Lupinus sp.


Luzula multiflora


Lychnis flos-cuculi


Lycopodiella inundata

Lycopodium annotinum, BRISTLY CLUBMOSS. (Lycopodiaceae) An erect, little branched, stiff-leaved clubmoss with its spores in terminal cones. Common in deciduous and mixed woods at HF where it was first collected by J.G. Jack in 1908; we recorded it from 21 compartments in our survey. Recently renamed *Spinulum annotinum* by Arthur Haines; we use the traditional name here.

Lycopodium clavatum, STAGHORN CLUBMOSS. (Lycopodiaceae) A creeping, vertically branched clubmoss with hair-like tips on the leaves and spores in stalked cones. Common in open and often successional woods at HF; first collected by H.M. Raup in the Tom Swamp Tract and N.W. Hosley in the Prospect Hill Tract, both in 1933; recorded in 20 compartments in our survey.

[**Lycopodium lagopus,** NORTHERN STAGHORN CLUBMOSS. (Lycopodiaceae) In the *Flora of North America,* Wagner and Beitel separate the northern *Lycopodium lagopus* (single cones, shorter and more erect leaves, fewer and more spreading branches) from the southern *L. clavatum* (multiple cones, longer and more spreading leaves, more numerous and more spreading branches.) By these characters the common plant at HF is *L. clavatum*, and *L. lagopus* is uncommon but has been collected at least twice: by N.W. Hosley from the Prospect Hill Tract in 1933, and by M.H. Zimmermann, near headquarters, in 1957. We note however that while the specimens of "good" *lagopus* do seem to have distinctive upright branches with short leaves, there are also multiple-cone specimens with similar leaves and branches that seem to be "bad" *clavatum,* and we need to make a more thorough investigation of the local variation pattern before we decide how to place our material.]

Lycopodium obscurum sensu lato, TREE CLUBMOSS. (Lycopodiaceae) The erect, much branched, needle-leaved clubmosses, here treated broadly as a single variable species. Very common in dry open woods at HF: recorded from 31 compartments in our survey.

Our treatment of these plants is the traditional one of Fernald (1950) and Gleason and Cronquist (1991). Newer works, particularly the *Flora of North America* treatment (Wagner and Beitel, 1993) and a number of regional floras that have followed it (Haines and Vining, 1998; Sorrie and Somers, 1999, Magee and Ahles, 1999) separate the former *L. obscurum* var. *dendroideum* as *L. dendroideum*, recognize *L. hickeyi* (a new segregate first described in 1989), and restrict *L. obscurum* to plants with flattened shoots and a single row of reduced ventral leaves.

The new treatment, though widely accepted, may not have been tested on population samples. When we tried such a test at HF, it failed badly. The characters used to define the segregate species were unstable, and the distribution of character states strongly suggested that we had a single variable species rather than three separate ones. The results seem interesting to us, especially because the segregates are now widely accepted, and we give them in some detail.

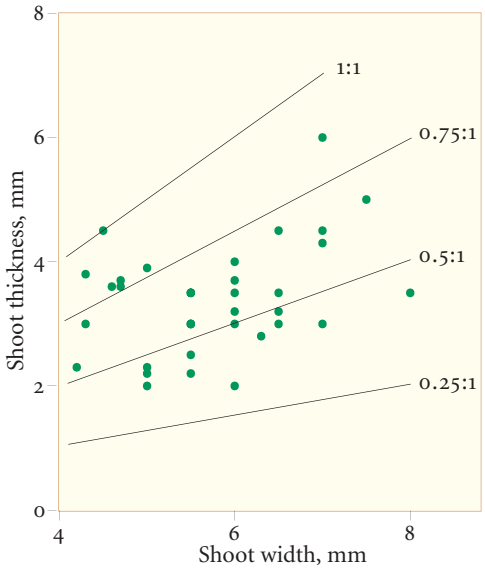
The *Flora of North America*, following Hickey (1977) and Wagner, Beitel, and Moran (1989), uses four characters to define the segregate species. The characters are illustrated on p. 65. Three of the characters are related

Lycopodium annotinum

Lycopodium clavatum

Lycopodium obscurum s.l

DEGREE OF FLATTENING OF TREE CLUBMOSS SHOOTS



The flattening of the stems, which, along with phyllotaxy is one of the characters relied on to separate *L. obscurum s.s.* from its segregates, varies continuously rather than discretely. The thickness/width distribution is clustered around 0.6 and shows no evidence that separate populations of flat-branched and round-branched plants are present.

to the arrangement of the branch leaves; the fourth concerns the angle of the stem leaves. The characters are supposed to associate as follows:

	stem lvs. appressed	branches flattened	M1 phyllotaxy	reduced ventral lvs.
obscurum s.s	+	+	+	+
hickeyi	+	–	+	–
dendroideum	–	–	–	–

The usefulness of this table depends on three assumptions: that the characters have discrete states, that their states are relatively constant within clones, and that the 13 other possible combinations of these characters (like – + – +) either do not occur or are rare compared to the three named ones.

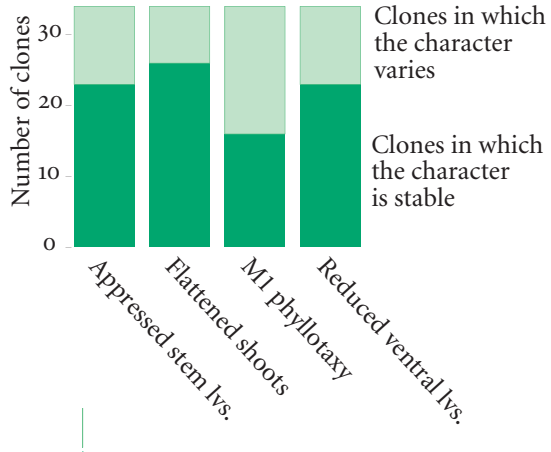
None of these assumption seems to be true at HF. We found that several of the characters varied continuously rather than discretely; that all the characters varied within clones (and in fact, often within single stems); and that unnamed character combinations were in fact commoner than the named ones.

Our evidence comes from a population survey in which we collected 3 stems from each of 34 clones along random transects on the three main tracts in HF. The samples were examined while they were still fresh; drying and pressing tend to distort the branch shapes and leaf arrangements, and make it much harder to assess the characters accurately. We scored each clone for the four characters and calculated an overall morphological index on a gradient from forms with all *dendroideum* characters (index = 0) to forms with all *obscurum s.s* characters (index = 4).

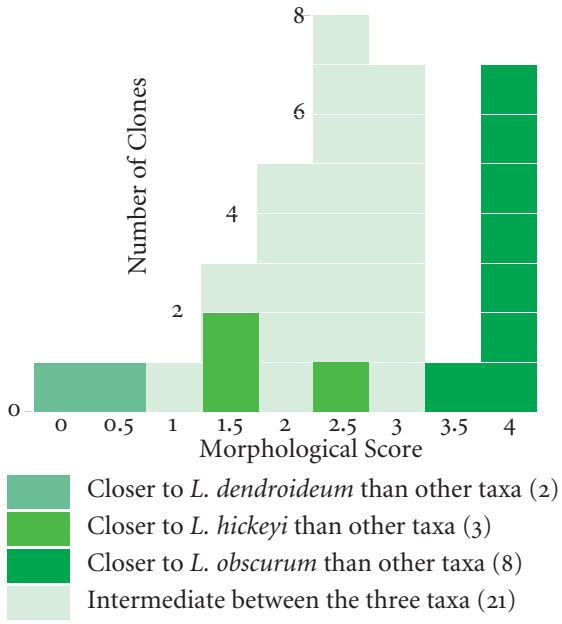
The most striking feature of the results was the instability of the characters which were supposed to define the species. The angle of the stem leaves varied significantly both within clones and on single stems: we judged that 21 of the clones had clearly appressed stem leaves, two of them had clearly divergent ones, and 11 of them – slightly less than a third – had a mixture of appressed and divergent leaves. The flattening of the stem was basically a continuous character: it varied from 1:1 to 0.3:1, had a mean of 0.6:1, and suggested that our plants are a single variable population. The anisophylly was more discrete, but tended to vary within clones: 15 clones had isophyllous ventral leaves, 8 had uniformly anisophyllous ones, and 11 had various mixtures of isophylly and anisophylly.

The phyllotaxy, which many authors use as a basic character that separates *obscurum* and *hickeyi* from *dendroideum*, was, surprisingly, the least stable of all. Over half of the clones had stems with both phyllotactic arrangements. (Illustrations on p. 65.) It was common to find branches of different phyllotaxies on the same stem, and not uncommon to find both phyllotaxies on a single branch.

STABILITY OF CHARACTERS USED IN THE *LYCOPODIUM OBSCURUM* COMPLEX



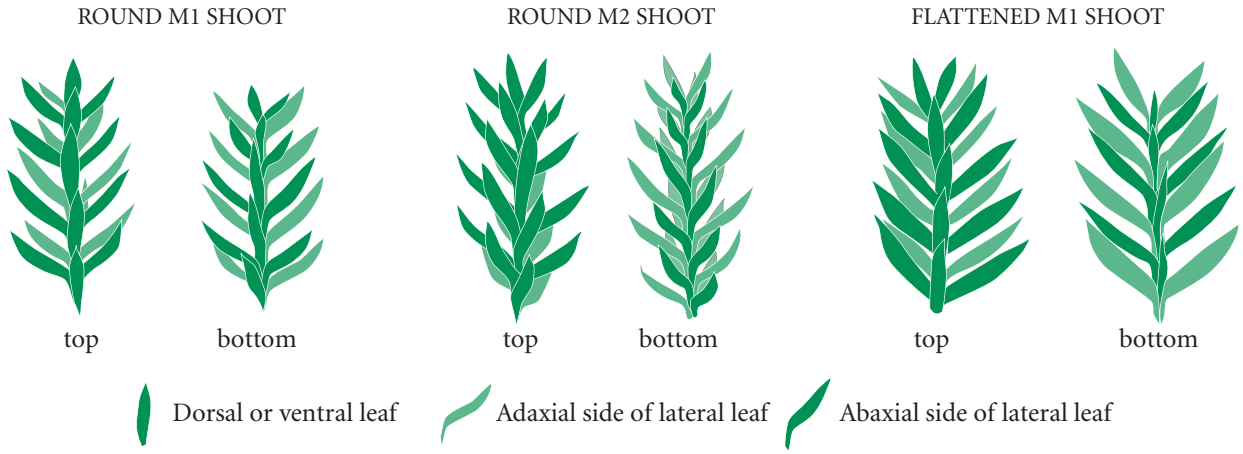
MORPHOLOGICAL SCORES OF TREE CLUBMOSS CLONES FROM HARVARD FOREST

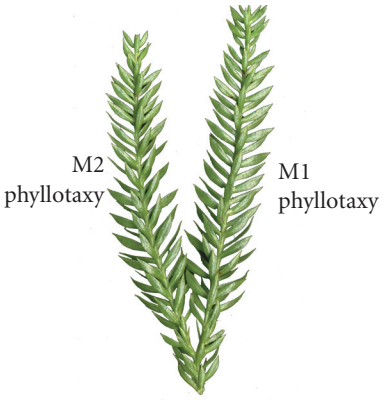


Top of page, stability of characters used to define tree clubmoss species. All four characters used to define species vary in 25% of the clones or more. Phyllotaxy, the worst of the characters, varies in 50% of the clones

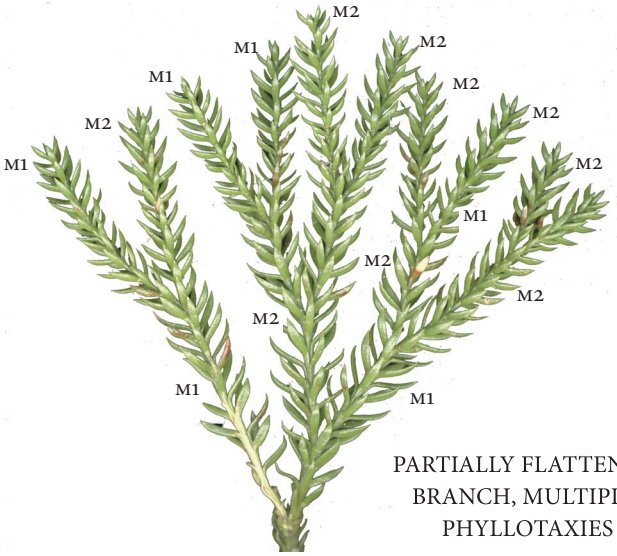
Middle of page, morphological scores for 34 clones. The clones are scored on a scale in which pure *L. dendroideum* is 0 and pure *L. obscurum* is 4. Only 13 out of the 34 clones (darker bars) could be assigned to one of the three conventional species.

A GALLERY OF TREE CLUBMOSS SHOOTS

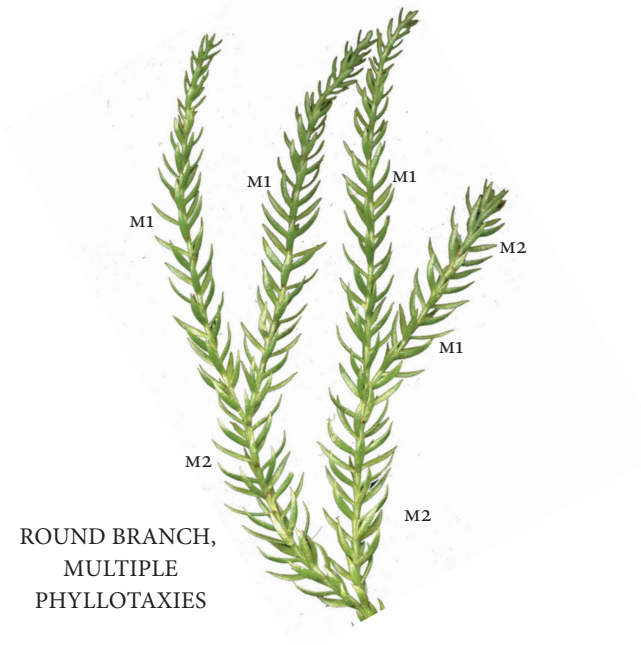




FLAT BRANCH, TWO PHYLLOTAXIES



PARTIALLY FLATTENED BRANCH, MULTIPLE PHYLLOTAXIES



ROUND BRANCH, MULTIPLE PHYLLOTAXIES

Above, drawings of shoots of tree clubmosses from Harvard Forest, showing different leaf arrangements. The differences between M1 and M2 phyllotaxies are subtle, and best seen with magnification. In flattened shoots it is easy to tell which leaf rows are lateral and which ventral, and there is usually no doubt about whether the pattern is M1 or M2. In round shoots it is hard to tell the ventral rows from the lateral ones, and the best character is leaf orientation: M1 shoots have three rows of leaves with their abaxial faces upwards, and M2 shoots have four rows.

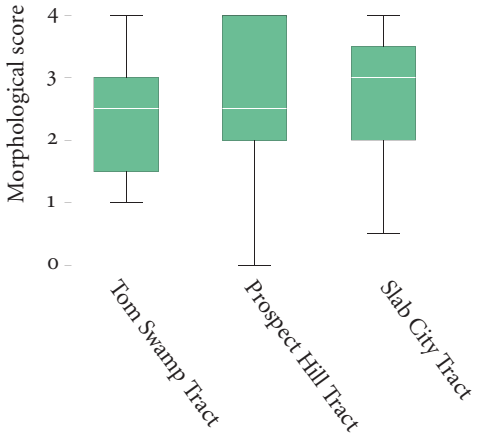
Below, three branches of clubmosses from Harvard Forest with unstable phyllotactic patterns. The upper two have flattened shoots. The M1 portions of them correspond to what the *Flora of North America* calls *L. obscurum* sensu strictu; the M2 portions do not correspond to any *FNA* species. The plant at left has rounded shoots. Its M1 portions correspond to what the *Flora of North America* calls *L. dendroideum* and its M2 portions to *L. hickeyi*. This kind of instability is quite common, and occurred in 18 of the 34 clones we examined.

The second striking feature in our survey was that the four characters were poorly correlated and occurred in many combinations that could not be referred to *any* of the three *Flora of North America* species. We found 8 clones that corresponded closely to the *Flora of North America* description of *L. obscurum s.s,* 3 corresponding to *L. hickeyi*, and 2 to *L. dendroideum.* The remaining 21 clones, 62% of those we sampled, were either in between the *FNA* taxa or had so many indeterminate characters that they couldn't be placed at all. The overall distribution of morphologies peaked at an index of 2.5, roughly equidistant between *obscurum* and *dendroideum.* Some of the plants in the middle resembled *hickeyi*, but far more had character combinations that are not supposed to occur in that species.

Putting these results together, it appears that, as best can be determined from morphology alone, what we have at HF is a single species in which both the morphological characters and the combinations in which they occur vary within and between clones. The result is a continuously varying population whose average morphology lies somewhere between that of *L. obscurum s.s* and *L. dendroideum*, and which exhibits none of the morphological discontinuities we would expect if three species were present.

An interesting and still open question is whether the variation we saw has an ecological or geographic component. We compared the morphological indices for the three tracts we sampled (upper right) and found no systematic variation, though we did find a few more flattened-anisophyllous forms on Prospect Hill than in the other tracts. It might be interesting to repeat the sampling along ecological gradients and see if any systematic variation occurs.

MORPHOLOGICAL SCORES OF TREE CLUBMOSS CLONES FROM THREE TRACTS



A boxplot of the morphological scores of 10 clubmoss clones each from the Prospect Hill and Tom Swamp Tracts, and 14 from the Slab City Tract. The boxes give the range of the middle 50% of the data and the white lines the median. The differences between the medians are not significant.

Recently Arthur Haines has moved this species to *Dendrolycopodium*, leaving *Lycopodium clavatum* and its segregate *L. lagopus* as the only northeastern lycopodiums. We follow the *Flora of North America* here and keep it in *Lycopodium*. Certainly there are structural differences between *L. clavatum* and *L. obscurum,* but the Linnaean concept of a genus allows plants with structural differences, and if we divided every genus with differences of similar magnitude we would end up adding hundreds of new genera to our flora.

Lycopus americanus

Lycopus uniflorus

Lycopus americanus, AMERICAN WATER-HOREHOUND. (Lamiaceae) A common water-horehound of open mineral-soil wetlands, distinguished by the sharp calyx-lobes and the lobing of the lower leaves. Apparently rare at HF: collected once by W.H. Drury from Riceville Pond in 1947, and seen there and in the cow-pasture pond in P2 in our survey.

Lycopus uniflorus, COMMON WATER-HOREHOUND. (Lamiaceae) The most common water-horehound in wetlands in New England as a whole, characterized by the short calyx lobes, relatively flat nutlets with low tubercles, and tubers on the rhizome. Frequent in open wetlands and shores at HF: first collected by H.M. Raup in the Tom Swamp Tract and N.W. Hosley in the Prospect Hill Tract, both in 1933; found in 12 compartments in our survey.

[**Lycopus virginicus**, VIRGINIAN WATER-HOREHOUND. (Lamiaceae) This is a related species with bigger tubercles and no tubers, frequent on the coastal plain and scarcer inland. It is only known at HF from a 1933 specimen collected by H.M. Raup at the edge of a pond in the Tom Swamp Tract. The specimen looks generally like this species but has lower tubercles than typical *L. virginicus*; it may be an odd *L. virginicus* or may be something else.]

Lyonia ligustrina, MALEBERRY. (Ericaceae) A tall shrub, much resembling highbush blueberry but with dry fruits, coarser hairs on the leaves, and different buds. It is a common but somewhat erratically distributed plant of moist shrubby meadows, successional woods, and wooded swamps. Frequent and locally common at HF: J.G. Jack (1911) said it was "common throughout the region;" we recorded it in 16 compartments, finding it common in moist open woods and absent from darker and dryer ones.

Lysimachia ciliata, FRINGED LOOSESTRIFE. (Primulaceae) A broad-leaved loosestrife of shady moist fertile woods, particularly common in alluvial soils. Uncommon at HF, probably because of the lack of habitat: recorded twice on Tom Swamp Road by R.S. Sigafoos and W.H. Drury in 1947, and seen sporadically in moist places (S10, T1, Dugway Road by the Simes Tract) in our survey.

Lysimachia nummularia,* MONEYWORT. (Primulaceae) A round-leaved, alien, creeping herb, escaped from cultivation and now common in wet shady soil, especially along brooks and in alluvial woods, throughout our area. Uncommon at HF: listed for Petersham by H.M. Raup (1938), but not previously reported from HF; seen three times in our survey, in P8, P10 and T5.

Lysimachia quadrifolia, WHORLED LOOSESTRIFE. (Primulaceae) A common herb of dry woods with axillary yellow flowers and leaves in whorls of four. Frequent in open oak woods and along trails in HF: recorded in 19 compartments in our survey.

Lysimachia terrestris, SWAMP CANDLES. (Primulaceae) A related species with opposite leaves and flowers in a terminal raceme, common in open wetlands and shores, usually on peaty soils. Frequent and locally common at HF where it occurs plentifully on pond shores, on the edges of bog mats, in beaver ponds, and occasionally (and often as small sterile plants) in wooded swamps. First collected in 1933 by H.M. Raup from the Tom Swamp Tract; found in 16 compartments in our survey.

Lysimachia vulgaris,* GARDEN LOOSESTRIFE. (Primulaceae) A common garden loosestrife, resembling the whorled loosestrife but with larger leaves and flowers, widely but very casually escaped along roads and in disturbed ground in our area. Not previously reported for HF: we saw it once, near the schoolhouse in P10.

Lythrum salicaria,* PURPLE LOOSESTRIFE. (Lythraceae) The tall, aggressively weedy loosestrife with purple flowers and opposite-leaves, origi-


Lyonia ligustrina


Lysimachia ciliata


Lysimachia nummularia


Lysimachia quadrifolia


Lysimachia terrestris


Lysimachia vulgaris


Lythrum salicaria

nally a garden flower and now an invader of fields, river shores, and wetlands throughout our area. Uncommon at HF and not previously reported here: we found it, in small amounts, along the shore of Connor Pond in S6, along the Swift River in S10, and along the shores of Harvard Pond, where it has been controlled by hand-pulling since 2002.

Maianthemum canadense, CANADA MAYFLOWER. (Liliaceae) A small forest herb will parallel-veined leaves with heart-shaped bases, forming large colonies from delicate creeping rhizomes. Very common at HF and with great ecological amplitude. First collected by Mrs. Gast in 1928 from Barre Woods (Slab City Tract); we recorded it from 32 compartments, and from at least seven different forest and wetland communities: oak forests, maple forests, pine forests, hemlock forests, deciduous swamps, conifer swamps, and open sphagnum-sedge bogs.

Maianthemum canadense

Maianthemum racemosum, COMMON FALSE SOLOMON'S-SEAL. (Liliaceae) An arching, parallel-veined herb with a terminal cluster of small white flowers, common in open woodlands and on shaded banks by roads. It is commonest and largest on moist fertile soils, but is not restricted to them. Generally common but somewhat local at HF, where it occurred in 29 compartments, preferring the open moist sites and avoiding the driest, darkest, or most acid ones. First collected in 1933 by H.M. Raup from the Tom Swamp Tract. Long called *Smilacina racemosa* and separated by its six-petaled flowers from its sister-genus *Maianthemum* which has four-petaled ones. Recently transferred to *Maianthemum* on the basis of general similarities in leaves and flowers and treated as *Maianthemum racemosum* in the Flora of North America.

Maianthemum racemosum

Maianthemum trifolium, BOG FALSE SOLOMON'S-SEAL. (Liliaceae) A small Solomon's-seal of sphagnum bogs and boggy thickets, distinguished from other species of *Maianthemum* by its clasping leaves, but easily confused with small plants of several species of *Platanthera* orchids that live in bogs. Rare in sphagnum bogs at HF: first collected by H.M. Raup in the Fay Lot (T9) in 1933; found along the utility cut in T8 and in two locations in T9 in our survey (in the wooded swamp south of Riceville Pond and in a small bog near Riceville Pond). Also reported from the Black Gum Swamp in P2 by T. Zebryk (1991). This plant was long called *Smilacina trifolia* and, like *M. racemosum,* has only recently been transferred to *Maianthemum.* Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.

Maianthemum trifolium

Malaxis unifolia, GREEN ADDER'S-MOUTH. (Orchidaceae) A small, delicate, white-green orchid of swamps, woods, and bogs, with a single leaf and a spike of small flowers, distinguished by its threadlike petals and broad lip with large lateral lobes and a small middle one. Either uncommon or overlooked because of its small size. Known at HF from two 1947 collections both under pines: by J. Canright in P1, southeast of the HF headquarters, and by R.S. Sigafoos in P2. Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.

Malus pumila

Malus pumila,* APPLE. (Rosaceae) The cultivated apple, adventive in abandoned fields and persisting for some time after cultivation but never well established in closed forests. Occasional at HF: J.G. Jack (1911) noted

that it was naturalized in roadsides, fields, and woods; we found it more sporadically in open ground and along roads, in 6 compartments. Also called *Pyrus malus*, and *Malus sylvestris.* Botanists have never been much for consensus, but even so it is a little disheartening that two hundred and fifty years after Linnaeus we still can't agree on what to call the apple.

Malus sieboldii,* SIEBOLD CRAB. (Rosaceae) We have several collections of an alien shrub with variably lobed leaves from P1, P9, and S5 that we believe, on the advice of R. Bertin and P. Del Tredici, are this species. None were seen with flowers or fruit.

Malva neglecta,* CHEESES. (Malvaceae) The commonest of several small, round-leaved mallows that occur as weeds in barnyards, lawns, and fertile waste ground. This species is recognized by the sprawling growth, relatively long pink-white petals, and smooth fruits. Rare at HF: first collected by H.M. Raup and N.W. Hosley in 1933 from the Prospect Hill Tract. We found it once, in the pasture in P2. Formerly called *M. rotundifolia*; that name is now applied to a related species with wrinkled fruits.

Malva cf. moschata,* MUSK MALLOW. (MALVACEAE) An erect mallow that looked generally like *M. moschata*, musk mallow, but had the broader bracts and stellate hairs of *M. alcea*, vervain mallow, was seen once near the sawmill in P2. We puzzled over it for some time but couldn't decide what to call it.

Matricaria matricarioides,* PINEAPPLE-WEED. (Asteraceae) A small European herb with highly-divided leaves and small yellow composite flowers without rays, common in barnyards and waste ground. Uncommon at HF: first collected by W.D. Beal near the HF headquarters in 1947; found in P1 and P2 near the buildings and in the gravel pit in P9 in our survey.

Matteuccia struthiopteris, OSTRICH FERN. (Dryopteridaceae) A tall, long-tapering fern that forms dense colonies in moist alluvial soil. Surprisingly rare at HF: there is a 1947 collection by I.M. Johnston from a "large colony at roadside," a half mile west of Rt. 32 on Tom Swamp Rd.; if the location is correct this was outside of HF. A 1947 collection by R.S. Sigafoos at the Harvard University Herbaria (NEBC) is from 'woods along roadside' in Tom Swamp. We located small colonies along the Swift River in S2 and S10.

Medeola virginiana, WILD CUCUMBER. (Liliaceae) A familiar forest herb with whorled leaves, parallel veins, and small, nodding flowers with lovely arching red stigmas. One of the commonest herbs of moist deciduous and mixed forest, found on all but the driest soils. First collected by Mrs. Gast in 1928 from Barre Woods (Slab City Tract); we found it in 30 compartments in our survey.

Medicago lupulina,* BLACK MEDICK. (Fabaceae) A small, weedy relative of alfalfa, resembling a small yellow clover but with coiled pods and toothier leaves. Generally common in our area but not previously reported from HF: we saw it once in the grounds of Shaler Hall (P1).


Malus sieboldii


Malva neglecta


Malva cf. moschata


Matricaria matricarioides


Matteuccia struthiopteris


Medeola virginiana


Medicago lupulina

Medicago sativa,* ALFALFA. (Fabaceae) A common forage crop, casually and usually temporarily escaped to roadsides and waste ground. Not previously reported from HF; we saw it in and near the pasture in P10.

Melampyrum lineare, COW-WHEAT. (Scrophulariaceae) A small hemiparasitical herb of oak woods, with lanceolate leaves and yellow-white flowers. Frequent in dry oak woods at HF, usually in small amounts: first collected by H.M. Raup in 1933 from the east part of the Tom Swamp Tract; recorded in 18 compartments in our survey.

Melilotus alba,* WHITE SWEET CLOVER. (Fabaceae) A tall weedy European adventive with small white flowers in dense racemes. Common along roads and in waste ground in our region but rare at HF: an undated collection from Tom Swamp Road by Mrs. Gast may or may not be in HF; we found it once in our survey, in waste ground in P1.

Melilotus officinalis,* YELLOW SWEET CLOVER. (Fabaceae) A related species of similar habits with yellow flowers. Not previously reported from HF: we found it twice, near the pole barn in P1 and in the cow pasture in P2.

Mentha arvensis sensu lato, FIELD MINT. (Lamiaceae) A furry, strongly aromatic, native mint of stream banks and moist meadows, with small white flowers in axillary clusters. Uncommon or under-reported at HF: first collected by H.M. Raup in 1933 from the Fay Lot (T9); seen three times in our survey, along the Swift River in S3, S5, and S6.

Following Voss (1996) and Gill et al. (1973) we use the Linnaean name *M. arvense* for both the European plants with $n = 78$ and the North American plants with $n = 96$. The two apparently overlap morphologically and in populations like ours, which are believed to contain both European and North American elements, can't be reliably separated without chromosome counts. Other authors, including Sorrie and Somers (1999), reserve *M. arvense* for the European plants and call the North American plants *M. canadense.*

Mentha spicata,* SPEARMINT. (Lamiaceae) A European cultivar once widely grown in kitchen gardens and considered essential for jams, sauces, and juleps, now widely but locally escaped in wet meadows in our area. Uncommon and not previously reported at HF: we found it in wet places in P2 and P9.

Menyanthes trifoliata, BOG-BEAN. (Menyanthaceae) A widespread species of wet bogs with ternately compound leaves and racemes of hairy white flowers. Rare at HF: first collected in 1947 by E.E. Smith from the "Forest Pond" (Gould's Bog) in P8 and seen there and nowhere else in our survey.

Mimulus ringens, COMMON MONKEY-FLOWER. (Scrophulariaceae) A medium-sized perennial herb with winged stems, opposite stalkless leaves, and blue flowers with closed throats, common on muddy shores at low elevations. Occasional on ponds and river shores at HF: first collected by W.D. Beal from T4 in 1947; seen at Harvard Pond, Connor Pond,


Medicago sativa


Melampyrum lineare


Melilotus alba


Melilotus officinalis


Mentha arvensis


Mentha x spicata


Menyanthes trifoliata


Mimulus ringens

beaver ponds in S3 and T5, and along the Swift River in S2, S5, and S9 in our survey.

Mitchella repens, PARTRIDGE BERRY. (Rubiaceae) A low evergreen creeper of moist woods, with dark green leaves, tubular, white, four-petaled flowers, and red berries. Not mentioned by J.G. Jack (1911); first collected in 1933 by H.M. Raup from the Tom Swamp Tract; now common in deciduous woods at HF and found in 30 compartments in our survey.


Mitchella repens

Mollugo verticillata,* CARPETWEED. (Molluginaceae) A small, wide-ranging European weed of waste ground, with whorled leaves and small white flowers with green-veined sepals and no petals. Rare at HF: first collected by J. Canright from near the Community House (P2) in 1947; seen twice in our survey, in the courtyard behind Shaler and along the road in S6.


Mollugo verticillata

Moneses uniflora, ONE-FLOWERED PYROLA. (Pyrolaceae) A small woodland herb of conifer forests, widely distributed but never common, with shiny dark green leaves and single flowers that resemble those of the pyrolas. Known at HF from an undated collection by Mrs. Gast from the Fay Lot (T9) and from a collection by K.A. Raup in 1947 from a woodland near the top of Prospect Hill. Reported for Petersham by H.M. Raup (1938) and from near the HF headquarters by C.E. Smith (1949), citing a specimen that we did not see. Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.

Monotropa hypopithys, PINESAP. (Monotropaceae) The yellow or pinkish, multi-flowered, less common relative of Indian pipes, often found in conifer forests but occurring in deciduous woods as well. Occasional at HF in a variety of forest types: reported for Petersham by H.M. Raup (1938), possibly based on a 1933 collection by N.W. Hosley without locality information; first definitely collected in HF by R.S. Sigafoos and W.D. Beal in 1947; found in 14 compartments in our survey.


Monotropa hypopithys


Monotropa uniflora

Monotropa uniflora, INDIAN PIPES. (Monotropaceae) The common white, single-flowered Indian pipes of woodlands everywhere. Common at HF in both deciduous and conifer woods: first collected in 1933 by H.M. Raup from the Tom Swamp Tract, and found in 29 compartments in our survey.

Muhlenbergia frondosa, LEAFY MUHLENBERGIA. (Poaceae) A common grass of lawns and shaded roadsides, separated from related species by the much-forked stems, smooth internodes, and axillary flower clusters. Generally common in our area but not previously reported from HF: we found it, late in the season, along woods roads in P2, P7, T8, and the Simes Tract, and suspect that it occurs in others.


Muhlenbergia frondosa


Muhlenbergia tenuiflora

Muhlenbergia tenuiflora, SLENDER-FLOWERED MUHLENBERGIA. (Poaceae) A late-flowering, arching grass with conspicuous awns, separated from several other woodland muhlenbergias by its slender panicles and broad second glume. Frequent but somewhat local in dry, fertile woods

in western New England. Not previously reported from HF. Seen once in our survey on a rocky slope on Camel's Hump in the Simes Tract.

Muhlenbergia uniflora, FOG GRASS. (Poaceae) A very delicate grass of open peaty shores and wetlands, with the panicle branches so slender as to be almost invisible until they have dew on them. Uncommon at HF: first collected by H.M. Raup along a stream in the Fay Lot (T9) in 1933; subsequently collected by R.S. Sigafoos and I.M. Johnston at Riceville Pond and in wet places in the Prospect Hill Tract; seen twice in our survey, by Connor Pond (S6) and in T7.

Muhlenbergia uniflora

Myosotis scorpioides

Myosotis scorpioides,* COMMON FORGET-ME-NOT. (Boraginaceae) A familiar European cultivar, widely escaped in wet ditches and along streams. Rare at HF: collected by K.A. Raup in 1947 from S8, and reported by C.E. Smith (1949) from Connor Pond, citing a specimen that we did not see; collected along the Swift River by W.H. Hatheway in Barre Woods (Slab City Tract) in 1951; seen along the Swift River in S10 in our survey.

Myrica gale, SWEET GALE. (Myricaceae) A common, low, aromatic shrub of open wetlands, tolerant of widely varying water levels and often found submerged. Local at HF despite the large number of wetlands. J.G. Jack (1911) said it was found "In swamps and borders of ponds and streams" but did not say how common it was. H.M. Raup collected it on a pond shore in the Tom Swamp Tract in 1933; we found it three times, at Connor Pond, at Harvard Pond, where it was common, and in a wetland at the north end of the Simes Tract.

Myrica gale

[**Myrica pensylvanica**, BAYBERRY. (Myricaceae) A low shrub with oblong leaves, waxy berries, and an aromatic smell, abundant along the coast and scattered inland. J.G. Jack (1911) reported bayberry from pastures and abandoned fields but did not indicate whether the pastures and fields were in Harvard Forest; H.M. Raup (1938) listed it for Petersham. We have found no specimens and did not see it in our survey. Formerly called *Myrica carolinensis*.]

Myriophyllum humile, SMALL WATER-MILFOIL. (Haloragaceae) A small native milfoil with alternate axillary flowers and smooth fruits, commoner near the coast than inland. Not currently known from HF: first collected in Harvard Pond in 1933 by H.M. Raup; re-collected there in 1947 by W.D. Beal and in 1957 by M.H. Zimmermann; looked for several times in our survey but not relocated.

Najas flexilis

Najas flexilis, COMMON NAIAD. (Naiadaceae) The common naiad of lakes and ponds, with sloping shoulders on the leaf sheath and smooth shiny fruits. Not previously reported from HF; seen twice, in Harvard Pond and Riceville Pond, both times in small amounts, in our survey.

Nemopanthus mucronatus

Nemopanthus mucronatus, MOUNTAIN HOLLY. (Aquifoliaceae) A tall shrub of swamps and peatlands, with yellow-gray bark, rounded leaves with purple stalks, and bright red berries with a mat surface. Common on shores and in wooded swamps at HF: R.R. Chaffee made the first HF

collection from the Prospect Hill Tract in 1908; J.G. Jack (1911) said it was common in swamps and wet woods; we found it in 12 compartments, in all the large ponds and most of the wooded swamps we examined.

Nuphar variegata, YELLOW WATER LILY. (Nymphaeaceae) This is the large, aquatic, yellow water lily of our area. Common in Harvard, Connor, and Riceville Ponds and in a pond in the Simes Tract. First collected in Harvard Pond by H.M. Raup in 1933. C.E. Smith (1949) called the HF plants *N. advena*, and other authors, following E.O. Beal (1956), have called all our yellow water lilies *N. lutea.* We, like many recent American authors, reserve *N. advena* for a large emergent species with rounded petioles that is common southwards and in estuaries, and call our common aquatic species *N. variegata.*

Nuphar variegata

Nuttallanthus canadensis, BLUE TOADFLAX. (Scrophulariaceae) A low, very skinny herb with blue-and-white flowers and slender leaves, common in open sandy soils, especially near the coast. An uncommon species at HF: first collected in 1947 by W.D. Beal from near the HF buildings in P1; relocated there and found in the gravel pit in P9 and along a roadside in S6 in our survey. This species was long known as *Linaria canadensis*. It was transferred, along with three other blue linarias, to the newly-made genus *Nuttallanthus* by D.A. Sutton in 1988. We follow Sorrie and Somers (1999) in using *Nuttallanthus* but note that the change is not universal and that the *Manual of Vascular Plants of the Northeastern United States and Adjacent Canada* (Gleason and Cronquist 1991), the *Jepson Manual* (Hickman, 1993), the *Michigan Flora, Part III* (Voss 1996) and the *Revised Checklist of New York State Plants* (Mitchell and Tucker 1997) all use *Linaria.*

Nuttallanthus canadensis

Nymphaea odorata, WHITE WATER LILY. (Nymphaeaceae) The common white water lily. Common in the large ponds at HF: first collected by H.M. Raup in Harvard Pond in 1933; common there and in Riceville and Connor Ponds in our survey; we also recorded it from ponds in T7 and in the Simes Tract.

Nymphaea odorata

Nyssa sylvatica, BLACK GUM. (Nyssaceae) A tree with short-shoots and untoothed leaves, called gum here and tupelo in the south. Frequent in swamps and on shores in coastal New England, less common inland and northward. Locally common in swamps at HF: J.G. Jack (1911) said it was "Frequent, chiefly in moist or wet ground;" We found it in four compartments of the Prospect Hill Tract and one of the Tom Swamp Tract, in or near swamps.

Nyssa sylvatica

Oenothera biennis sensu lato, COMMON EVENING PRIMROSE. (Onagraceae) A tall native herb of weedy habits, common on roadsides, in thickets and abandoned fields, and in waste ground. Uncommon at HF because of lack of suitable habitat: first collected by H.M. Raup and N.W. Hosley from the Prospect Hill Tract in 1933; found in the fields and the gravel pit there in our survey, and along Rt. 122 in S6.

We include, after some reflection, *O. parviflora,* the small-flowered evening-primrose, a closely related species differing, as best we can tell, only in that the appendages (false tips) of its sepals arise about a millime-

Oenothera biennis s.l.

ter below the sepal tip, which is then visible as a small point. *Parviflora*-like plants are known at HF from a specimen collected in 1933 by N.W. Hosley from near the HF buildings which he determined as *O. biennis* and we revised to *O. parviflora*, and from a specimen collected by M.H. Zimmermann in 1957 near HF headquarters. The difference is small at best, and intermediates seem to be common. We recognize that the evening primroses in this group have a complicated genetic system involving mitotic rings and "balanced" lethal genes that allows them to generate microspecies which have more or less distinct genetic identities. But we also note that these entities, though genetically separable, have very weak morphological identities and can be unsettlingly close. As practical botanists, we insist that our species be morphologically distinct and prefer that they express this distinctness in several ways. *O. parviflora,* distinguished by a single tiny and variable character, doesn't make the cut.

Oenothera perennis, SUNDROPS. (Onagraceae) A low and rather attractive species of meadows and open moist ground, recognized by the narrow leaves and ridged ovaries. Uncommon at HF: first collected in 1933 by H.M. Raup in the Fay Lot (T9); later collected at Riceville Pond (I.M. Johnston and W.D. Beal, 1947) and near the HF headquarters (M.H. Zimmermann, 1957); relocated by us in the pasture in P2 and the gravel pit in P9.

Oenothera perennis

Onoclea sensibilis, SENSITIVE FERN. (Dryopteridaceae) A broad-leaved, incompletely compound, patch-forming fern found in wet meadows and open and shaded wetlands. Common at HF in wet woods and a wide variety of wetlands; first collected by Mrs. Gast (in one of her few dated collections) in 1928 from the Barre Woods (Slab City) Tract; recorded by us in 29 compartments.

Onoclea sensibilis

Orobanche uniflora, ONE-FLOWERED CANCER-ROOT. (Orobanchaceae) A small, white saprophyte, something like a smaller and more delicate Indian pipe, with a leafless stem that bears a single curved tubular flower. A widespread but uncommon species of meadows and moist woods. Apparently rare at HF where it is known only from three 1947 collections in the Slab City Tract (C.E. and E.E. Smith, W. Chi-Wu) and T9 (W.D. Beal) and a report by C.E. Smith (1949) from T9, which cities a specimen that we did not see.

Orthilia secunda, ONE-SIDED SHINLEAF. (Pyrolaceae) A small pyrola of dry or moist conifer woods, with a straight style and flowers in a one-sided cluster. Known at HF from a 1933 collection by H.M. Raup from the Tom Swamp Tract, a 1934 collection, also by H.M. Raup, from the Slab City Tract, a 1947 collection by I.M. Johnston from T8, and a report by C.E. Smith (1949) from S10, citing a specimen that we did not see. Generally resembling the pyrolas and long treated as *Pyrola secunda,* but differing in the straight style and non-coherent pollen and now, since real botanists don't use subgenera any more, separated as *Orthilia secunda.*

Oryzopsis asperifolia, ROUGH-LEAVED RICEGRASS. (Poaceae) A common evergreen grass of dry, moderately fertile woods, most often found in deciduous forests but occurring under conifers as well. Occa-

sional and somewhat erratic at HF: first collected by H.M. Raup from the Slab City Tract in 1934; reported from T8 by C.E. Smith (1948) on the basis of a specimen that we were not able to locate; seen in 11 compartments, most commonly in the Slab City, Tom Swamp, and Simes Tracts, in this survey.

[**Oryzopsis pungens**, RICE-GRASS. (Poaceae) A characteristic narrow-leaved grass of pine barrens and sand plains that also occurs in dry, somewhat fertile oak woods on rocky soils. Rare at HF: not reported historically, and seen only once in our survey, growing with *Comandra* and *Amelanchier stolonifera* on the top of Camel's Hump, just west of the western boundary of the Simes Tract and so in the Quabbin Reservation rather than HF.]


Oryzopsis asperifolia

Oryzopsis racemosa, BROAD-LEAVED RICEGRASS. (Poaceae) A medium-sized, broad-leaved grass characteristic of dry fertile woods. Uncommon and local at HF and not previously reported here. We found it on fertile rocky slopes in S7, S8, and the Simes Tract. Treated as *Piptatherum racemosum* in the *Flora of North America. Piptatherum* is a segregate genus, now containing all the former species of *Orysopsis* except *O. asperifolia*, that differs in its one-veined lodicules and some details of spikelet development too arcane for *FNA* to mention. Thus our sweet science marches on.


Oryzopsis racemosa

Osmunda cinnamomea, CINNAMON FERN. (Osmundaceae) A tall, twice-cut, clump-forming fern of shaded wetlands, river shores, and moist soil in woods. Common at HF where it was first collected on the Prospect Hill Tract by J.G. Jack in 1912; we found it very widespread in both wooded wetlands and small wet depressions in woods, and recorded it from 31 compartments.


Osmunda cinnamomea

Osmunda claytoniana, INTERRUPTED FERN. (Osmundaceae) A close relative of the cinnamon fern, differing in its less pointed and shiny leaves, and its preference for dryer sites. Also common at HF and also first collected by J.G. Jack in 1912; we found it very widespread in moist deciduous woods and recorded it from 28 compartments.


Osmunda claytoniana

Osmunda regalis, ROYAL FERN. (Osmundaceae) Our third and last osmunda, broader leaved and more divided than the previous two and somewhat more restricted in its habitat preferences and so a bit less common. In the region as a whole it grows in bog hummocks, around kettlehole ponds, along rocky, high-energy rivers, and around temporary ponds in woods. At HF, where it is frequent, it grows mostly on pond shores, in bogs, and at the edge of wooded swamps; it was first collected here by H.M. Raup from a pond in the Slab City Tract in 1933; we recorded it from 16 compartments in our survey.


Osmunda regalis

Ostrya virginiana, HOP HORNBEAM. (Betulaceae) A small understory or subcanopy tree of dry woods, especially common on rocky fertile hilltops under oaks, but also invading old pastures and persisting into young successional woods. J.G. Jack (1911) said it was frequent at HF. We, looking at a more closed forest 95 years later, found it somewhere between frequent

and occasional: we recorded it from 11 compartments, throughout HF but more commonly on fertile soils than on acid ones.


Ostrya virginiana

Oxalis dillenii, DILLEN'S YELLOW WOOD-SORREL. (Oxalidaceae) A native sorrel of weedy habits with a confused nomenclatural history, less common than *Oxalis stricta* but found in much the same habitats. Its best marks are the downwardly angled fruiting pedicels and the appressed simple hairs on pedicels and leafstalks. Widely distributed but not previously reported for HF: we saw it once, in the parking lot of Shaler Hall in P1.

The nomenclature of our two yellow species of *Oxalis* is confused by uncertainties about which species should be given the Linnaean name *O. stricta*. Up to 1963 it was generally applied to this species; the common yellow sorrel, which we call *O. stricta* here, was called *O. europaea.* After 1963, when George Eiten published a controversial revision of *Oxalis*, some botanists began calling this species *O. dillenii,* others continued to call it *O. stricta,* and others decided that *stricta* was muddied beyond repair, and should no longer be used.


Oxalis dillenii

An attempt was made to settle the matter in the old-fashioned way at the Sixteenth International Conference on Botanical Nomenclature in Nuremburg when Lazlo Versenyi, a champion of the traditional typification of *stricta*, fought Karel Polanyi, of the revisionists, in the last nomenclatural duel of the 20th century. The duel took place in a poorly lit courtyard at dusk and was to be in three bouts. Both contestants wore black. Versenyi's seconds carried a 1754 folio edition of the *Species Plantarum* that they had brought from Budapest. Polany's carried a bound copy of Eiten's doctoral dissertation from the University of Milan. Owing perhaps to the light or perhaps to the general decline in the martial arts, the swordplay was not inspired. In the first bout, with sabers, Versenyi removed a small and, the judges felt, insufficiently important part of Polanyi's ear. In the second, with épées and using a stroke that the traditionalists felt was as objectionable as his taxonomy, Polanyi drew blood from the wrist of one of the judges. Fearing more of the same, the judges suspended the match and ruled it a tie. This was fortunate for the participants, who were both awarded the red-and-white Taxonomist's Union ribbon (*Ad valoremque fanaticem nomenclatore*). It was less so for *Oxalis*, whose Linnaean and contra-Linnaean typifications were both let stand, as they do to this day.


Oxalis montana

Oxalis montana, MOUNTAIN SORREL. (Oxalidaceae) The common sorrel of moist conifer woods, with large leaves and solitary white flowers with pink veins. Common in boreal forests and wetlands northward and westward, especially in older or less disturbed forests. Occasional and rather local in moist conifer woods at HF: listed for Petersham by H.M. Raup (1938) and C.E. Smith (1949), the later on the basis of a specimen that we did not see; and represented in the HF herbarium by an undated collection by Mrs. Gast from the Slab City Tract; seen in eight compartments in our survey. This species is part of a circumboreal complex and may be called either *O. acetosella*, which is the Linnaean name and implies that the American and European plants are the same species, or *O. montana*, which implies that the American are separate from the European.

We have no opinion one way or the other and simply follow Sorrie and Somers (1999) here.

Oxalis stricta, COMMON YELLOW WOOD SORREL. (Oxalidaceae) This is the common yellow wood sorrel of lawns and roadsides, distinguished from Dillen's sorrel by the spreading, septate hairs and the ascending fruiting pedicels. Common in lawns and along the edges of woods roads at HF: collected in 1933 near HF (Wilder's Farm) by N.W. Hosley; observed in 20 compartments in our survey. This species was long called *O. europaea*. The name is now out of favor, and it is now called *O. stricta* by those who accepted the revised typification referred to above, or *O. fontana* by those who don't.

Oxalis stricta

[**Pachysandra terminalis**,* JAPANESE PACHYSANDRA. (Buxaceae) Asiatic evergreen ground cover; widely cultivated, frequently persistent after cultivation, and very sparingly escaped. We found a few small patches in P10 near Fisher House, which may or may not have been cultivated.]

Panax quinquefolius, GINSENG. (Araliaceae) A palmately compound herb with small white flowers and red berries, widespread but uncommon in moist fertile woods. The root is medicinal and has long been gathered commercially, which has reduced its abundance in some areas where it was once common. Not reported by H.M. Raup (1938) or C.E. Smith (1949) from HF: found in our survey in the Simes Tract. Often called *P. quinquefolium,* following Linnaeus who treated *Panax* as neuter; the International Code of Botanical Nomenclature recommends that generic names be given their classical gender and so we use *P. quinquefolius* here.

Ginseng is listed as a species of special concern by the Massachusetts Natural Heritage and Endangered Species Program. The colony at HF has been known since the early 1980s, and seems to have declined since then. In 1981, 46 individuals were found; in 1989, 4 plants; in 2002, 15 plants; in 2004, 3 plants, and in 2005, a single plant, and that in a different place from the previous 3. In 2006, 9 additional plants were found nearby.

Panax quinquefolius

Panax trifolius, DWARF GINSENG. (Araliaceae) A small, trifoliate species of moist deciduous and coniferous woods, not used for medicine and not requiring high fertility soils. Uncommon at HF: first collected by W.A. Stalker from the Prospect Hill Tract in 1909; collected twice more from the Prospect Hill Tract in 1949 by C.E. and E.E. Smith; seen in our survey, always in small quantities, in P1, S3, S4, T3, T10, and the Simes Tract. Also called *P. trifolium.*

Panax trifolius

Panicum capillare, WITCH GRASS. (Poaceae) A weedy native grass of sandy soil, with hairy sheaths and small spikelets in a large, much branched panicle. Common in our area and often a weed in gardens and fields. Apparently rare at HF: collected once by I.M. Johnston, in disturbed soil near Riceville Pond in 1947, though apparently outside of HF as he refers to a "former CCC camp," which we believe was in Petersham State Forest. We found it once in the pasture in P10.

Panicum capillare

Panicum dichotomiflorum, FALL PANIC-GRASS. (Poaceae) A large, annual panic-grass with membranous ligules and flattened sheaths, typically sprawling and rooting at the nodes. While the sprawling mature plants are distinctive, young erect plants are easily mistaken for *P. rigidulum*; the safest distinctions are the shorter first glume of *P. dichotomiflorum* and the one-sided branches of *P. rigidulum*. Not previously collected at HF – a 1947 collection by I.M. Johnston from Riceville Pond is *P. rigidulum*. Seen twice in our survey, at the edges of Rt. 122 in S10 and T11.

Panicum dichotomiflorum

Panicum rigidulum

Panicum rigidulum, STIFF PANIC GRASS. (Poaceae) A similar perennial species of moist, often sandy soils, differing in the one-sided branches and longer first glumes. Rare at HF: collected by H.M. Raup from a stream in the Fay Lot (T9) in 1933 and by I.M. Johnston (as *P. dichotomiflorum*), in 1947; seen once in our survey, in the pasture by the Lyford House in P1.

Parthenocissus quinquefolia sensu lato, WOODBINE, VIRGINIA CREEPER. (Vitaceae) Our familiar, palmately compound, high-climbing woody vine of thickets and dooryards, also a common and much less obviously woody plant of deciduous forest floors. Listed as common in HF by J.G. Jack (1911) and still common in our survey, where we found it in 23 compartments. Formerly called *Psedera quinquefolia*, and here used in a broad sense to include the related species *P. vitacea*, which we do not believe can be reliably distinguished in a survey of this sort.

Parthenocissus vitacea, also called *P. inserta*, is a closely related species said to differ in its shinier leaves, tendrils without adhesive disks, and more diffuse inflorescence. It was reported for HF by J.G. Jack (1911) who said it occurred on "Roadsides, apparently native, perhaps established from cultivation;" and from Petersham by H.M. Raup (1938). No specimens were found to support either report. The two species are very similar, and to tell them apart you need either inflorescences, or tendrils in contact with a substrate. Since most of the plants we see in the field have none of these and so can't be determined, we use the name *P. quinquefolia* in a broad sense to cover both species.

Parthenocissus quinquefolia s.l.

[**Pastinaca sativa**,* WILD PARSNIP. (Apiaceae) A tall, weedy, alien umbellifer with pinnately compound leaves and small yellow flowers, common in barnyards and along roadsides in farm country. Collected on Tom Swamp Road by W.D. Beal and W.H. Drury in 1947, probably just outside the HF boundary.]

Pedicularis canadensis, LOUSEWORT. (Scrophulariaceae) A small woodland snapdragon with pinnately divided leaves and a head of elongate yellow flowers. Frequent in dry, fertile woods but rare at HF: first reported at HF in 1914 by J. Murdoch (specimen at HUH). Collected by H.M. Raup from a woods road on the Prospect Hill Tract in 1933; subsequently collected by W.D. Beal from T4 in 1947, and reported by C.E. Smith (1949) from woods near the HF headquarters, citing a specimen that we have not been able to locate; not seen in our survey.

Peltandra virginica, ARROW ARUM. (Araceae) An aquatic arum with shiny, sharp-lobed, triangular leaves, common in ponds of medium fer-

tility. Collected in Harvard Pond by H.M. Raup in 1933 and M.H. Zimmermann in 1957, and locally common there today.

Persicaria arifolia, HALBERD-LEAVED TEARTHUMB. (Polygonaceae) The larger of our two tearthumbs, with sharply triangular leaves with outward pointing rear lobes. A common species of open minerotrophic wetlands, but apparently rare in the peaty wetlands at HF: first collected by P. Smith from the southwest side of Tom Swamp in 1940; seen twice in our survey, near Connor Pond (S6) and in the Simes Tract. Long called *Polygonum arifolium;* now moved, with the other species of *Polygonum* with unspecialized sepals, to the segregate genus *Persicaria.*

Peltandra virginica

Persicaria arifolia

Persicaria careyi, CAREY'S SMARTWEED. (Polygonaceae) A large, distinctive smartweed with stems that are hairy below and glandular above. Known at HF only from a 1947 collection by I.M. Johnston from the shores of Riceville Pond. Formerly called *Polygonum careyi.*

Persicaria hydropiper, WATER-PEPPER. (Polygonaceae) The water-peppers are smartweeds with glandular dots on the sepals and a peppery taste. This is the weedier of our two species, distinguished by the pink flowers, some of which are enclosed by the lower sheaths. Not previously reported for HF: we saw it once, along a road in P10. Formerly called *Polygonum hydropiper.*

Persicaria hydropiper

Persicaria hydropiperoides, SMARTWEED. (Polygonaceae) A tall smartweed with perennial roots and rough hairs on the sheaths. In its typical form at HF it is a tall roadside plant with nodding spikes, and quite distinctive. But first year plants without the perennial roots are common and need to be carefully distinguished (by the longer bristles on the sheaths and uniformly three-angled achenes) from *P. maculosa.* Occasional along the paved roads at HF: first collected by N.W. Hosley (as *P. persicaria*) near HF (Wilder's Farm) in 1933; noted in a recently landscaped bank in P1 and on roadsides in P10 and T11 (and likely occurring elsewhere) in our survey. Formerly *Polygonum hydropiperoides.*

Persicaria hydropiperoides

Persicaria lapathifolia

Persicaria lapathifolia, DOCK-LEAVED SMARTWEED. (Polygonaceae) A tall, annual smartweed with smooth sheaths and loose, nodding white-green flower clusters, common in moist fertile soil, especially around buildings and in pastures. Not previously reported from HF: seen once, in the cow pasture in P2, in our survey. Formerly *Polygonum lapathifolium.*

Persicaria longiseta,* LONG-BRISTLED SMARTWEED. (Polygonaceae) A small species from eastern Asia with rose colored sepals and long bristles on the sheaths below the flowers. It arrived in Massachusetts early in the 20th century and is now found throughout the state, mostly along roads and most abundantly in developed areas. Not previously reported from HF: we found it along paved roads in four compartments in our survey. Formerly called *Polygonum cespitosum* and *P. longisetum.*

Persicaria longiseta

Persicaria maculosa,* LADY'S THUMB. (Polygonaceae) Probably the commonest and most weedy of the smartweeds, common in fertile moist soils, mostly along roads, in farmyards, and in waste grounds. Best dis-

tinguished by the compact spikes of pink flowers, relatively short bristles on the sheaths, and mixture of two-sided and three-sided achenes. Occasional on roadsides and managed grounds at HF: listed by H.M. Raup (1938) and C.E. Smith (1949) and doubtless here then, but one of the substantiating specimens was misidentified and the other was not found. Seen four times, in the pasture in P2 and along roads in P10, S10, and T11, in our survey. Formerly *Polygonum persicaria.*

Persicaria pensylvanica, PENNSYLVANIA SMARTWEED. (Polygonaceae) A common smartweed found both in wetlands and in cultivated and waste ground, distinguished by the smooth sheaths and glands on the peduncles. Not previously reported from HF: seen once, on the shore of Harvard Pond, in our survey. Formerly *Polygonum pensylvanicum.*

Persicaria punctata, WATERPEPPER. (Polygonaceae) The common waterpepper of pond shores and minerotrophic wetlands, distinguished by its green-white flowers in slender, interrupted spikes. Occasional at HF: first collected near Harvard Pond by H.M. Raup in 1933; located at Connor Pond and in S3, T5, and T8 in our survey. Formerly *Polygonum punctatum* and before that *Polygonum acre.*

Persicaria sagittata, TEARTHUMB. (Polygonaceae) Our smaller tearthumb, with rounded leaves with backward-pointing lobes, common in open wetlands. Frequent at HF: first collected by H.M. Raup in the Tom Swamp Tract and N.W. Hosley near the Forest Cottage in the Prospect Hill Tract, both in 1933; observed in wetlands in 13 compartments in our survey. Formerly *Polygonum sagittatum.*

Phalaris arundinacea, REED CANARY GRASS. (Poaceae) A tall, coarse, broad-leaved creeping grass, believed to contain both European and North American genotypes, that is sown for hay in wet fields and has spread or occurs naturally in shallow wetlands and along rivers. Apparently rare at HF where it has not been previously reported; we found it three times, in disturbed areas in P1, P9 and S9.

Phegopteris connectilis, NARROW BEECH FERN. (Thelypteridaceae) A small, scaly, twice-cut fern in which leaflets are connected by wings of leaf tissue. Frequent in our area but often in colder or more fertile woods than occur at HF. Occasional here, mostly near streams and swamps or on rocky slopes: first collected in 1933 by H.M. Raup from woods near a stream in the Slap City Tract; seen in nine compartments in our survey. The beech ferns have had, even for ferns, a large number of names. Previous HF botanists called the narrow beech fern *Dryopteris thelypteris* and *Lastrea phegopteris. Dryopteris phegopteris* is an earlier name that was widely used, and *Thelypteris phegopteris* and *Phegopteris polypodioides* occur in the recent literature.

Phellodendron sp.,* CORK TREE. (Rutaceae) Phellodendrons are medium-sized trees with opposite compound leaves that are occasionally cultivated in our area and even more occasionally escape. A few small trees, about six inches in diameter, of some cultivated species of phel-


Persicaria maculosa


Persicaria pensylvanica


Persicaria punctata


Persicaria sagittata


Phalaris arundinacea


Phegopteris connectilis

lodendron (*amurense, japonicum, sachalinense?*) are recent adventives in an opening in P1 (near post 17 of the nature trail) where a former plantation was cut. We have not found flowers or fruit and are unable to determine the species.

Philadelphus coronarius,* MOCK-ORANGE. (Hydrangeaceae) A common cultivated European shrub with opposite leaves and showy flowers, occasionally escaped along roads. Rare at HF: listed by J.G. Jack (1911) as an occasional escape at HF, and represented in the herbarium by a single collection by S.M. Dohanian from Prospect Hill in 1913; we collected a specimen, which we believe to be this species because it has more than three flowers per cluster, from a small group of shrubs by Rt. 32 near Lyford House, in P1.

Phleum pratense,* TIMOTHY. (Poaceae) A European forage grass with a dense cylindrical spike of flowers, resembling a small cattail. Widely planted in hay meadows and pastures and commonly escaped to roadsides and waste ground. Occasional at HF: the first herbarium specimen was collected in 1947 by W.D. Beal from near an abandoned farm site in S8, but the species must certainly have been here long before that. Seen seven times, in disturbed ground near Shaler Hall and along paved roads, in our survey.

Phlox paniculata,* SUMMER PHLOX. (Polemoniaceae) A tall phlox, likely this species has escaped or persisted from cultivation near the Community House in P2.

Phragmites australis, COMMON REED, PHRAGMITES. (Poaceae) The tall, broad-leaved grass with plumose heads that invades ditches and wet meadows and makes dense colonies. The species includes both European and American genotypes; the European genotypes are believed to be the most invasive. Rare at HF and not reported in previous surveys: a population that has occurred in a beaver wetland in T5, opposite the town dump, for the past 20 years has expanded substantially over the past two years; we also recorded it along the utility right-of-way in T8 and in a marshy wetland at the Simes Tract. Formerly called *P. communis*.

Phytolacca americana, POKEWEED. (Phytolaccaceae) A tall, red-stemmed, annual herb with racemes of white flowers and inky black berries. A common fugitive species on disturbed soils, especially in fertile woods and around farms. Rare on the acid soils at HF: collected once by N.W. Hosley on the Prospect Hill Tract in 1933; seen once, on a recently landscaped slope near Shaler Hall (P1) in our survey.

Picea abies,* NORWAY SPRUCE. (Pinaceae) A common ornamental and plantation conifer, sparsely naturalized in our area. Occasionally planted and naturalized at HF: J.G. Jack (1911) said it is "rarely naturalized" in Petersham; we found saplings at several locations on the Prospect Hill Tract.


Phellodendron sp.


Philadelphus coronarius


Phleum pratense


Phlox paniculata


Phragmites australis


Phytolacca americana


Picea abies

Picea glauca,* WHITE SPRUCE. (Pinaceae) A native spruce of northern New England, widely planted and occasionally naturalized in our area. Occasional at HF: we observed it in 6 compartments in our survey.


Picea glauca

Picea mariana, BLACK SPRUCE. (Pinaceae) A small spruce of peatlands and boreal forests, common and transcontinental in the north, rare in southern New England. Close to and likely an ancestor of the red spruce, and not always separable from it. Its best characters are the short, light, blunt needles, the glandular hairs on the twigs, and the small, long-persistent cones with somewhat roughened scales. Uncommon in peatlands at HF and often seeming transitional to red spruce: collected on the Prospect Hill Tract by H.H. Tryon in 1911; reported from the Tom Swamp Tract by J.G. Jack (1911), who commented that the black spruce here was not "exactly typical but appears as if in transition from red spruce to black spruce as the former extends from dry slopes into the swamp;" seen in six compartments in our survey. We have seen the same gradation between red and black spruce around other New England peatlands and suspect that intergrades are common.


Picea mariana

[**Picea pungens**,* BLUE SPRUCE. (Pinaceae) A tall conical spruce with sharp blue-green needles, commonly planted as an ornamental and occasionally escaped. Rare at HF: we have records from P1 and P9, but have not confirmed that it has naturalized.]

Picea rubens, RED SPRUCE. (Pinaceae) The common upland spruce of New England and the northern Appalachians, similar to black spruce and often intergrading with it. Occasional at HF: J.G. Jack (1911) noted it from Prospect Hill, the swamps in the Prospect Hill Tract, and the Meadow Water Tract (Tom Swamp Tract). This is largely true today. The largest spruce stands are in the north part of the Tom Swamp Tract, between the utility right-of-way and Riceville Pond, in T8 and T9. We also found it in P2, P3, P4, S1, T10, and the Simes Tract.


Picea rubens

Pilea pumila, CLEARWEED. (Urticaceae) A small native herb of moist fertile ground, common in lawns and barnyards, occasional in wetlands and by streams. Apparently rare at HF: collected once in 1933 by H.M. Raup from along a stream in the Barre Woods (Slab City Tract); seen once in our survey, near a stream in S6.


Pilea pumila

Pinus resinosa, RED PINE. (Pinaceae) A tall, two-needled pine, common on rocky fire-prone hills in northern and western New England, widely planted as a fast-growing timber tree elsewhere. Status at HF uncertain: it is definitely planted, but may be native as well. J.G. Jack (1911) reported "a small colony in the Prospect Hill Tract and individuals in other parts. Other small groups in the vicinity of Petersham." There is no way of knowing whether these were native trees or escapes from cultivation. We recorded individuals in 10 compartments, and confirmed that it has naturalized in at least T6, T8, and several locations on the Prospect Hill Tract.


Pinus resinosa

Pinus rigida, PITCH PINE. (Pinaceae) Our common three-needle pine, found in sandy soils near the coast and on rocky ridges inland. A single

specimen (HUH) was collected by J. Murdoch, in 1914, from an unidentified location in HF. J.G. Jack (1911) said it "occurs in a few small colonies in dry situations" at HF. H.M. Raup (1938) included it in his list of the plants of Petersham, and C.E. Smith (1948) said it was "known from a site on the Turnpike," presumably in Petersham but outside of HF. Currently rare at HF: a single tree was found in our study, upslope of Prospect Hill Road in P4, in an area that burned in 1957. A few others occur nearby, just outside of the HF boundary, below French Road. Until recently, one or two pitch pines occurred in the Schwarz Tract; one of these was dead but still standing in 2005.


Pinus rigida

Pinus strobus, WHITE PINE. (Pinaceae) Our common five-needle pine of forests and old fields. A hundred years ago, when much of HF was recently abandoned fields and young woods, it was very abundant here; J.G. Jack (1911) noted that it was the most important commercial species in HF, and "Found abundantly in almost all situations except deep swamps." Ninety-five years later much of the first generation of old-field pines has died, blown down, or been cut, but it is still a very common tree; we found it in 33 compartments in our survey.


Pinus strobus


Pinus sylvestris

Pinus sylvestris,* SCOTS PINE. (Pinaceae) A slender, quick-growing European pine often used as a plantation tree and now widely naturalized as scattered trees. Common in old plantings at HF: H.M. Raup collected a specimen from a plantation at the north end of Tom Swamp in 1933, and C.E. Smith (1948) noted that it was "Planted extensively at HF" but had not yet naturalized here. We recorded naturalized plants twice, in S6 and T8.


Plantago lanceolata

Plantago lanceolata,* ENGLISH PLANTAIN. (Plantaginaceae) The plantain with narrow strap-like leaves and short spikes on long stalks. Common in our general area but rare at HF and, somewhat surprisingly, not previously reported here. Observed twice in our survey, on a recently landscaped slope near Shaler Hall (P1), and in a field in P9.

Plantago major,* BROAD-LEAVED PLANTAIN. (Plantaginaceae) The common broad-leaved European plantain, a long established and weedy species that is common in lawns, along roads and trails, and in disturbed areas. Listed for Petersham by H.M. Raup (1938) and as "common in disturbed ground" by C.E. Smith (1949), who cites a specimen from Tom Swamp Road that we did not see. Common in lawns and along woods roads in our survey: we recorded it in 16 compartments, and probably overlooked it in others.


Plantago major


Plantago rugelii

Plantago rugelii, RUGEL'S PLANTAIN. (Plantaginaceae) A native species, much like the preceding but with smooth leaves, red color on the petioles, and capsules that open below the middle. Uncommon at HF, where it grows in much the same habitats as *P. major*: First collected by H.M. Raup in 1934 from the Prospect Hill Tract; also collected in 1947 by W.D. Beal from a sandy field behind the HF buildings; seen three times in our survey, on roadsides by T6 and the Simes Tract, and by Shaler Hall.

Platanthera clavellata, CLUB-SPUR ORCHID. (Orchidaceae) A small, green-white orchid with a long spur that widens at its base, frequent on wet sphagnum-sedge mats in open peatlands. Uncommon at HF: first collected at Riceville Pond by W.D. Beal , W. Chi-Wu, and I.M. Johnston in 1947; also collected, if the label data are correct, by W. Chi-Wu in 1947 from "hardwoods, back of weather box" behind the buildings in the Prospect Hill Tract; seen three times in our survey, at Connor Pond, Riceville Pond, and Gould's Bog in P8. This and our other species of *Platanthera* were formerly treated as species of *Habenaria*.


Platanthera clavellata

Platanthera hookeri, HOOKER'S ORCHID. (Orchidaceae) An uncommon orchid of dry, often somewhat fertile woods, with yellowish flowers, a pair of round basal leaves, and a flowering stem without bracts. Known at HF from a single collection by I. M. Johnston in 1947; the specimen label says "one plant in dry woods, T8." Not seen in our survey. Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.

[**Platanthera hyperborea**, NORTHERN GREEN ORCHID. (Orchidaceae) A small, widespread orchid of moist woods with a leafy stem and small green flowers with slender lips and spurs. Not previously reported from HF: recorded once in our survey, from near Riceville Pond in T9. Treated as a bracketed species because it is uncommon in eastern Massachusetts and we did not collect or confirm it.]


Platanthera hyperborea


Platanthera lacera

Platanthera lacera, RAGGED-FRINGED ORCHID. (Orchidaceae) A medium-sized white orchid with a lip that is divided into deeply fringed lobes. Rare at HF: first collected by H.M. Raup in 1938 from a meadow on "Waldo's Farm," which may have been in T10; collected twice in 1947, by W.D. Beal from a moist field "behind HF buildings, near creek," and by C.E. Smith from "rich woods" in T2; seen once in our survey, near the pond in the pasture in P2.

Platanthera psycodes, PURPLE-FRINGED ORCHID. (Orchidaceae) A tall, pale-purple orchid of wet woods, ditches and open wetlands, widespread in our area but not particularly common. Known at HF from a 1933 collection by H.M. Raup* from the east part of the Tom Swamp Tract, and a 1947 collection by I.M. Johnston in "damp, shady, bottom land" in T8.

[**Platanus occidentalis**, SYCAMORE. (Platanaceae) A tall tree with flaky bark that falls off, common in the flood plains of medium-gradient rivers and widely planted as a street tree. Listed as "Very rare in Harvard Forest, rich soil" by J.G. Jack (1911); also reported for Petersham by H.M. Raup (1938); not seen by C.E. Smith (1949) and his co-workers and not relocated in our survey.]

Poa annua,* ANNUAL BLUEGRASS. (Poaceae) A low, turf-forming grass with small panicles and a long blooming period, widely sown in pastures and lawns, and commonly naturalized in disturbed soils. Either uncommon or overlooked away from managed grounds at HF: not reported prior to our survey; seen five times in our survey, in lawns and along roads in P1, P2, P7, T9, and T11.

* The Raup collection was originally determined as *Habenaria bracteata* (= *Coeloglossum viride*).


Poa annua

Poa compressa,* CANADIAN BLUEGRASS. (Poaceae) A sparse wiry grass with flattened stems and small panicles, introduced from Europe and widely naturalized in woods and along river shores. Uncommon at HF: first collected by H.M. Raup on Prospect Hill in 1934; found twice in our survey, along roads in S6 and T9.

Poa nemoralis,* WOODLAND BLUEGRASS. (Poaceae) An uncommon European *Poa*, straggly and somewhat resembling *P. compressa,* found along roads, in open woods, and occasionally on river and lake shores. Not previously reported from HF: we found it in disturbed woods near Lyford House (P1), and along Dugway Road in the Simes Tract.

Poa palustris, MARSH BLUEGRASS. (Poaceae) A tall grass of open wetlands and shores, generally common but erratically distributed, marked by its open panicle, small spikelets and long ligule. Apparently uncommon at HF: reported but not vouchered by H.M. Raup (1938); collected once, in 1947, by W.H. Drury, I.M. Johnston, and W.D. Beal, from the edge of Tom Swamp Road; seen three times in our survey, in P2, P10, and S6.

Poa pratensis,* COMMON BLUEGRASS. (Poaceae) The common tall turf-forming bluegrass of meadows and lawns, planted throughout our area and naturalized along roads and on river banks. Occasional away from cultivated grounds at HF: first collected by H.M. Raup in 1934 from fields near HF headquarters; seen there and in six other compartments in our survey.

Pogonia ophioglossoides, ROSE POGONIA. (Orchidaceae) A small, pink, single-flowered orchid with slender, spreading petals and a fringed lip, common on open floating sphagnum-sedge mats. Rare at HF: first collected by H.M. Raup in 1937 from a bog at the north end of Tom Swamp; collected by W.H. Drury , W.D. Beal , and C.E. Smith from Riceville Pond in 1947; reported by Jesse Butler from Harvard Pond in 2004; seen at Riceville Pond and at Gould's Bog in P8 in our survey.

Polygala paucifolia, GAY WINGS. (Polygalaceae) A woodland polygala with dark shiny leaves and bright rose-pink flowers that look like small airplanes. Widely distributed in our area and seemingly most common in acid woods. Occasional at HF: first collected in the Fay Lot (T9) by H.M. Raup in 1934; found, very haphazardly, in five compartments in our survey.

Polygala polygama, BITTER MILKWORT. (Polygalaceae) A slender, graceful herb of open, moist sandy soils, with narrow leaves and a raceme of small pink flowers. Common nearer the coast but rare at HF: first collected by H.M. Raup on a gravel road on the west side of Prospect Hill in 1934; subsequently collected at Riceville Pond by J. Canright in 1947; seen once in our survey, in the old gravel pit in T6.

Polygala sanguinea, ROSE MILKWORT. (Polygalaceae) A related species with pink flowers in a terminal head, frequent or common in moist fields and along sandy roads. Occasional and local at HF: first collected by H.M.


Poa compressa


Poa nemoralis


Poa palustris


Poa pratensis


Pogonia ophioglossoides


Polygala paucifolia


Polygala polygama


Polygala sanguinea

Raup on the east side of Tom Swamp in 1933; relocated along woods roads in four compartments in the Tom Swamp Tract in our survey.

Polygonatum pubescens, SMALL SOLOMON'S-SEAL. (Liliaceae) Our common Solomon's-seal, a low woodland herb with an arching stem, parallel-veined leaves, and small yellow flowers hanging from the leaf axils. Common in open deciduous woods at HF, where it was first collected in 1933 by H.M. Raup from the Tom Swamp Tract; we recorded it from 23 compartments.


Polygonatum pubescens


Polygonella articulata

Polygonella articulata, JOINTWEED. (Polygonaceae) A small, wiry jointweed of open sandy soil, with linear leaves and spikes of small white flowers. Generally common on sandy roadsides in our area but local at HF: reported from dry disturbed ground near the HF headquarters by C.E. Smith (1949), citing a specimen that we did not see; seen twice, on sandy roadsides by Harvard Pond and in the gravel pit in S9, in our survey.

Polygonum spp., SMARTWEEDS, KNOTWEEDS, BINDWEEDS AND TEARTHUMBS. (Polygonaceae) In the *Flora of North America* treatment, the species of *Polygonum* with flowers in spikes and keeled sepals have been moved to the segregate genus *Fallopia*, and those with flat sepals and flowers in spikes to *Persicaria. Polygonum* sensu strictu, now much diminished, holds only the knotweeds, small species with delicate silvery sheaths and axillary flowers.

Polygonum aviculare,* KNOTWEED. (Polygonaceae) The commonest of the small knotweeds, a sprawling annual of pavement, yards, and waste ground. Common in our area but scarce at HF, mostly from lack of habitat: not reported in previous surveys, and seen four times, in yards and along roads in P1, S10, T10, and T11, in our survey. Our plants are part of a self-fertile, polyploid complex that is found throughout Europe and North America and which, following the *Flora of North America*, we treat inclusively. The complex includes both native and introduced elements; so far as we can tell all the HF material is introduced.


Polygonum aviculare

Polypodium virginianum sensu lato, VIRGINIA POLYPODY. (Polypodiaceae) This species is part of a polyploid complex and more work will be required to establish what elements we have at HF and whether they are distinguishable. The current story is that *P. appalachianum*, a diploid found in the Appalachian Mountains, somehow hybridized with *P. sibiricum*, a subarctic species of boreal Canada, to produce the allotetraploid *P. virginianum,* which now has a wide eastern North American range. *P. appalachianum* and *P. virginianum* differ in spore size, but not that much else. *P. appalachianum* is supposed to have more sporangiasters, more uniformly colored scales, and leaves that are more triangular and have more sharply pointed leaflets. We did a brief examinations of the HF collections, and found much mixing of the characters that are supposed to separate the two species (p.56). The first records are 1933 collections by H.M. Raup from the Slab City and Tom Swamp tracts. One species or the other occurred in 18 compartments in our survey.


Polypodium virginianum

Polystichum acrostichoides, CHRISTMAS FERN. (Dryopteridaceae) A common, once-cut, evergreen fern of deciduous and mixed woods, preferring moist and moderately fertile soils. Like the evergreen wood fern, it colonizes young woods easily and can be common in successional woods. Common at HF, where it was first collected in 1933 by H.M. Raup from "rich woods" in the Tom Swamp Tract, and found in 23 compartments in our survey. His phrase is interesting because we have seen nothing in the Tom Swamp Tract that seems rich to us.


Polystichum acrostichoides

Pontederia cordata, PICKEREL WEED. (Pontederiaceae) A robust emergent of softwater ponds, with rounded triangular leaves and spikes of blue flowers. First collected by H.M. Raup from the Slab City Tract in 1933 and later by W.D. Beal from Riceville Pond in 1947; relocated at Riceville Pond and at Connor Pond in our survey.


Pontederia cordata

Populus deltoides, COTTONWOOD. (Salicaceae) A large tree with heart-shaped leaves and coarse glands on the leaf-stalk, common in river floodplains and moist lowlands and also found in old fields and disturbed sites; native in the western parts of the state and assumed to be introduced in the eastern. Its status in Worcester County is uncertain. Not previously recorded from HF. A single stem (3-4" dbh) was seen in our survey in a former conifer plantation in T4 that was clearcut in the 1990s. The sapling appears to be this species, but given that several varieties of hybrid poplars have been planted in HF in the past, we can not be sure.


Populus deltoides

Populus grandidentata, BIG-TOOTHED ASPEN. (Salicaceae) The larger and more coarsely toothed of our two aspens, more persistent in forests than the quaking aspen and reaching larger diameters. Listed as common in "Clearings, roadsides, dry and wet ground," by J.G. Jack (1911) in the young forests of the early 20th century. Now in the early 21st century it is at most occasional: we have records from only five compartments or one compartment out of every six we surveyed.


Populus grandidentata

Populus tremuloides, QUAKING ASPEN. (Salicaceae) Our smaller and barely-toothed aspen, more tolerant of acid soils than the big-tooth, and reaching higher elevations. Considered "very common," in clearings and dry ground by J.G. Jack (1911); less so but still widespread today, where it was seen in 10 compartments in our survey.


Populus tremuloides

[**Populus x jackii,** JACK'S POPLAR. (Salicaceae) This is a balsam poplar -cottonwood hybrid that is one of many hybrid poplars that have been developed for horticulture and forestry. The HF herbarium has specimens collected by I.M. Johnston in T5 and W.D. Beal in S10, both collected in 1947 and both near roads. Whether they were planted or adventive is unknown. Also called *P. x candicans.*]

Portulaca oleracea,* COMMON PURSLANE. (Portulacaceae) A common, fleshy herb of cultivated ground. Not previously confirmed for HF: an undated specimen from N.W. Hosley has no location information. Seen once in our survey, in the courtyard behind Shaler Hall.


Portulaca oleracea

Potamogeton bicupulatus, BICUPULATE PONDWEED. (Potamogetonaceae) A delicate pondweed with small floating leaves, slender submerged leaves, adnate stipules, and flattened achenes. Known at HF only from Harvard Pond, where it was first collected by H.M. Raup in 1933, re-collected there by I.M. Johnston, W.D. Beal, and C.E. Smith in 1947 and M.H. Zimmermann in 1957, and seen there, in small quantities, during our survey. Also called *P. diversifolius* var. *trichophyllus*; formerly called *P. capillaceus,* a name now thought to belong to a different species.


Potamogeton bicupulatus


Potamogeton epihydrus

Potamogeton epihydrus, RIBBONLEAF PONDWEED. (Potamogetonaceae) A very common pondweed of softwater ponds, with linear submerged leaves with a broad band of air chambers in the center. Common in all the large ponds at HF: first collected by H.M. Raup at Connor Pond in 1933; seen there and also at Harvard Pond, Riceville Pond and in beaver ponds in T5 and the Simes Tract in our survey.

Potamogeton natans, FLOATING PONDWEED. (Potamogetonaceae) A common pondweed with broad floating leaves and bladeless submerged ones. Apparently uncommon here where it is only known from a 2004 report by M. Hickler from Harvard Pond. We tried to relocate it in our survey but did not.


Potamogeton natans


Potamogeton pulcher

Potamogeton pulcher, SPOTTED PONDWEED. (Potamogetonaceae) A distinctive pondweed, commonest on the coastal plain, with rounded leaves and black spots on the stem and leaves. Known only from Harvard Pond, where it was first collected by M.H Zimmermann in 1957, relocated by M. Hickler in 2004, and seen in our survey in 2005.

Potamogeton pusillus var. **tenuissimus**, SMALL PONDWEED. (Potamogetonaceae) A very slender-leaved pondweed with delicate, free stipules. Not previously reported for HF: seen twice in our survey, in Riceville Pond and Harvard Pond.


Potamogeton pusillus var. tenuissimus


Potentilla argentea

Potentilla argentea,* SILVERY CINQUEFOIL. (Rosaceae) A small, creeping, European cinquefoil with deeply cut leaves with silvery hairs below, common in sandy ground and waste areas. Rare at HF: first collected by W.H. Drury from near the HF buildings in 1947; seen once, also near the buildings in P1, in our survey.

Potentilla canadensis, CANADA CINQUEFOIL. (Rosaceae) A poorly marked and unconvincing species, distinguished from the common *P. simplex* only by its smaller size and habit of flowering from the axil of the lowest leaf rather than the second lowest. Collected by H.M. Raup from the Slab City Tract in 1934; reported from Camel's Hump in the Simes Tract by C.E. Smith (1949), citing a specimen by H.M. Raup, C.E. Smith and E.E. Smith that we did not see. Had we enough material to make a careful study we might end up including this in *P. simplex*; as it is, and perhaps like too many other rare plants, we have let it stand more because of its uncommonness than its distinctness.


Potentilla norvegica

Potentilla norvegica, NORWAY CINQUEFOIL. (Rosaceae) An erect, native cinquefoil with small flowers and ternately compound leaves, usually

found in disturbed and often somewhat fertile open ground. Uncommon at HF: first collected in 1933 by H.M. Raup from the Prospect Hill Tract; seen three times in our survey, near Shaler Hall in P1, in the gravel pit in p9, and on a boulder slope in the Simes Tract.

Potentilla recta,* ROUGH CINQUEFOIL. (Rosaceae) A common, erect, European cinquefoil with long, coarsely toothed leaflets and sulfur-yellow flowers, found in abandoned fields and along roadsides. Uncommon at HF: first collected by W.H. Drury from a sandy bank in S10 in 1947; found four times, near buildings, in a pasture, and along roads, in our survey.

Potentilla recta

Potentilla simplex

Potentilla simplex, COMMON CINQUEFOIL. (Rosaceae) Our common, five-leaflet, creeping cinquefoil, found in rough meadows, open bare ground, and open woods. Common at HF, where it was first collected in 1934 by H.M. Raup from a field near the HF buildings; recorded from 29 compartments in our survey.

Prenanthes altissima, COMMON RATTLESNAKE-ROOT. (Asteraceae) The rattlesnake-roots are tall, late-flowering composites with variably divided triangular leaves, nodding heads of white or cream-colored ligulate flowers, and milky juice. They are common, especially along woods roads, at HF and were recorded in 28 compartments in our survey. They are difficult to determine until they are in flower or fruit (and not very satisfying then), and so many of our records are not assigned to a species.

P. altissima, with eight or less flowers per head, is the common rattlesnake-root of moist woods and streams at HF. It was first collected by H.M. Raup in the Slab City Tract in 1933; we confirmed it from three compartments at HF and think, based on its ecology and tendency to have undivided basal leaves, that it is present in many others.

Prenanthes altissima

Prenanthes trifoliolata, GALL-OF-THE-EARTH. (Asteraceae) This is the common *Prenanthes* of dry acid woods at HF. It has more flowers and bracts than *P. altissima*, and tends to have more divided leaves as well, though this is a variable and unreliable feature. It was first collected by N.W. Hosley and H.M. Raup from the Prospect Hill Tract in 1933; we confirmed it from seven compartments and believe, based on ecology and habit, that it is present in many more.

Prenanthes alba, a related species of dry fertile woods that has not been found at HF, seems to differ only in its mature pappus, which is cinnamon-brown rather than pale brown or gray as in *P. trifoliolata.* This seems a thin distinction to make a species on, especially since many of the plants that we ended up calling *P. trifoliolata* had, after flowering but while the pappus was still enclosed in the involucre, some cinnamon color on their pappus bristles. The color faded after the involucres opened and the pappus expanded, but it still made us wonder how sound the distinction between *alba* and *trifoliolata* really is. Might it be, for example, that *alba* doesn't really have a different color but simply a more intense and thus more persistent one? And if so, is a few micrograms of pigment in a few bristles really enough to make a species from?

Prenanthes trifoliolata

Proserpinaca palustris, MERMAID WEED. (Haloragaceae) A submerged aquatic or emerged with alternate, variably dissected leaves, most common

in circumneutral or alkaline waters. Known at HF from three collections from Riceville Pond and Connor Pond by I.M. Johnston, J. Canright, and W.D. Beal, all in 1947. Looked for but not seen in our survey.

Prunella vulgaris, SELF-HEAL. (Lamiaceae) A blue-flowered, non-aromatic mint with rounded leaves and distinctive heart-shaped floral bracts, common in moist lawns, along trails, and in shaded wetlands. Our plants are believed to contain both American and European genotypes. Frequent in moist places at HF: first collected by H.M. Raup and N.W. Hosley from the Tom Swamp Tract in 1933; seen in 13 compartments in our survey.

[**Prunus avium***, SWEET CHERRY. (Rosaceae) The common garden cherry in our area, occasionally naturalized along roads. J.G. Jack (1911) noted that it occasionally escaped in woods. The HF herbarium has a 1911 specimen from near Harvard House (P2); there is no way to tell whether this was planted or naturalized. We saw plants resembling this species in S8 and T1 but did not confirm the identification.*]

[**Prunus nigra**, CANADA PLUM. (Rosaceae) A tall shrub or small tree, blooming from bare branches in early spring, and later with rounded leaves with acuminate tips and glandular teeth. Occasional along roadsides and in old fields in our area but only rarely seen in the woods. Not seen in our survey, and known in the HF area only from old reports and two specimens. J.G. Jack (1911) said it was "occasional along roadsides and fences," and thought that our plants were escapes from cultivation, but did not say whether it occurred in HF; collected in 1913 from "Dogwood Hill," an unknown location, by S.M. Dohanian; reported for Petersham by H.M. Raup (1938), and by C.E. Smith (1949) who cited a J. Canright collection from "along the Swift River." The Canright collection says only "near SC1," which may or may not have been in HF.]

Prunus pensylvanica, PIN CHERRY. (Rosaceae) A small, short-lived tree with slender leaves, reproducing from buried seeds and forming thickets after fires and cuts. J.G. Jack (1911) said that it was "Very common on old pastures, on old burned areas, along roadsides, and in open woods with quaking aspen." We consider it occasional rather than common, and recorded it from nine compartments in our survey.

Prunus persica,* PEACH. (Rosaceae) The cultivated peach, formerly widely planted and escaped, now rarely seen outside of cultivation. Escaped plants were reported at HF by J.G. Jack (1911); we saw a single plant along Locust Opening Rd. in P2 in our survey.

Prunus serotina, BLACK CHERRY. (Rosaceae) Our common woodland cherry, a tall forest tree with scaly bark and bluntly-toothed leaves. Common in deciduous woods at HF, as it has been for at least 100 years: J.G. Jack (1911) said it was common in woods, along roadsides, and in pastures; we saw it in 30 compartments in our survey.

Prunus virginiana, CHOKE CHERRY. (Rosaceae) A tall shrub or small tree with broad-shouldered leaves with sharp teeth, common along roads, in


Prunella vulgaris


Prunus avium


Prunus pensylvanica


Prunus persica


Prunus serotina


Prunus virginiana

*Jack also listed *Prunus cerasus* as "occasionally becoming wild along fences" but there is no way to tell if this was in HF; we have no field observations and have seen no specimens of the species.

abandoned pastures, and in thickets. J.G. Jack (1911) said it was frequent in open woods and along roads at HF: we found it only occasional, and recorded it in nine compartments in our survey.

Pteridium aquilinum, BRACKEN. (Dennstaedtiaceae) A large, leathery, patch-forming triangular fern with a worldwide distribution, common on dry acid soils in our area. Common throughout HF in open dry woods; J.G. Jack collected it from an unknown locality in 1912; H.M. Raup collected it in the Barre Woods (Slab City) Tract in 1933; we saw it in 31 compartments in our survey.


Pteridium aquilinum

[**Puschkinia libanotica**, STRIPED SQUILL. (Liliaceae) A garden plant with striped petals, native to Asia. This species as well as the similar-looking *Scilla sibirica* were planted and are spreading in the lawn in front of Shaler Hall, but are not as yet truly naturalized.]

Pyrola americana, ROUND-LEAVED PYROLA. (Pyrolaceae) The pyrolas are low, more-or-less evergreen herbs with waxy green-white flowers. This species has narrow sepals and round, shiny leaves, and is usually found in dry oak or conifer woods. It is occasional at HF where it was first collected by H.M. Raup from woods roads in the Prospect Hill Tract and the west side of Prospect Hill in 1934 and was seen in six compartments in our survey. Part of a circumboreal complex, and closely related to *Pyrola rotundifolia* of Europe. Many botanists treat our plants as *P. rotundifolia* var. *americana.*


Pyrola americana


Pyrola chlorantha

Pyrola chlorantha, GREEN SHINLEAF. (Pyrolaceae) A small pyrola of moist, often somewhat fertile woods, with broad sepals and slender tubes, like periscopes, on top of the anthers. Rare at HF: first collected by H.M. Raup from the Slab City Tract in 1934; seen in moist woods in the Simes Tract, in hemlock woods in T8, and on the west side of S7 in our survey. Also called *Pyrola virens.*

Pyrola elliptica, COMMON SHINLEAF. (Pyrolaceae) A common, relatively large pyrola with elliptic leaves, a down-curved style, and broad sepals. Occasional in moist woods at HF: first collected by H.M. Raup from the Tom Swamp Tract in 1933; seen in nine compartments in our survey.


Pyrola elliptica

[**Pyrus communis**,* PEAR. (Rosaceae) The common pear is widely planted but is at most a very rare escape from cultivation. It was listed by J.G. Jack (1911) as a rare escape, and as present in Petersham by H.M. Raup (1938). We have a 1911 specimen from Harvard House, which may well have been cultivated, but no clear evidence that it has ever naturalized at HF.]

[**Pyrus x soulardii,** SOULARD CRAB. (Rosaceae) A cultivated hybrid of an old-world apple and a new-world crab apple. Planted in an orchard on the Prospect Hill Tract "by former owners" (J.G. Jack, 1911) and collected there by K. Mills and P. Haynes in 1910. There is no evidence that it ever naturalized.]


Quercus alba

Quercus alba, WHITE OAK. (Fagaceae) A tall forest tree with scaly bark and round-lobed leaves, common on dry soils at HF for at least a century:

J.G. Jack (1911) said it was common in various soils and situations; we found it in 27 compartments in our survey.

Quercus coccinea, SCARLET OAK. (Fagaceae) A red oak of the south and the coastal plain, recognized by the half-hairless buds and leaves with narrow lobes and deep sinuses. Listed as rare by J.G. Jack (1911) and still rare today: we saw it in P2, P4, and P8, and it probably occurs in small amounts in other areas.

Quercus prinus, CHESTNUT OAK. (Fagaceae) A slow-growing oak of acid, rocky sites, with oblong leaves with rounded teeth and characteristic long hairs in the axils of the main veins. Widespread and locally common in the region but not previously documented from HF. We found one tree, about 10 inches in diameter and about 10 small saplings in T5, at the southeast corner of a plot established to document the effects of the 1938 hurricane (HF 40.1 plot F).

Quercus rubra, NORTHERN RED OAK. (Fagaceae) The common red oak of the Northeast and the commonest oak at HF: J.G. Jack (1911) said it was "Common, especially in rich soil and protected situations;" we found it in 32 compartments in our survey.

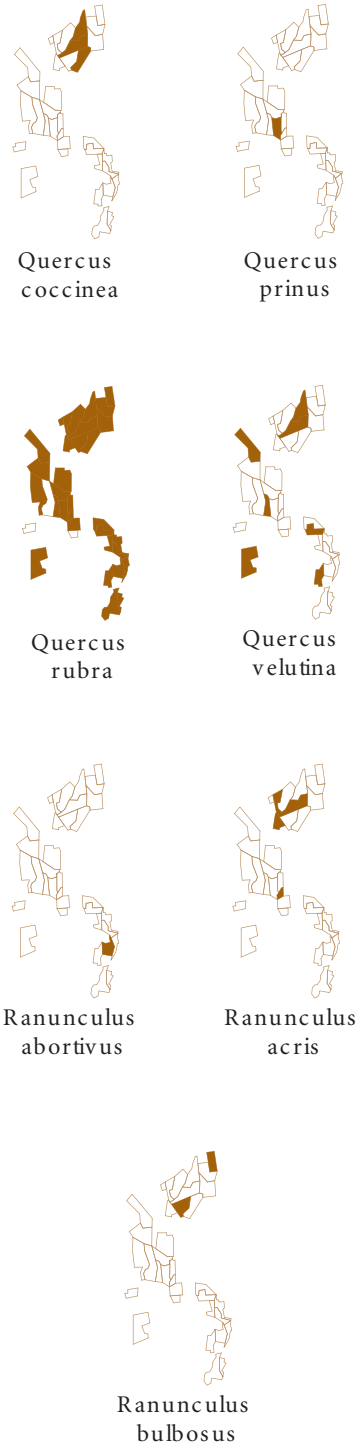
Quercus velutina, BLACK OAK. (Fagaceae) A southern oak of dry woods, close to the red oak but with furrier buds and leaves and yellow inner bark that is intensely bitter. J.G. Jack (1911) said it was "Common throughout the drier or better drained parts" of HF; we saw it in seven compartments, but may well have missed it in others.

Ranunculus abortivus, DWARF BUTTERCUP. (Ranunculaceae) A small buttercup of fertile woods, with undivided lower leaves and divided upper ones. Seen once in our survey, on a fertile rocky slope in S7; not previously reported from HF.

Ranunculus acris,* COMMON BUTTERCUP. (Ranunculaceae) The common, tall, deeply cut European buttercup of meadows everywhere. Occasional at HF, where there are relatively few meadows: first collected by H.M. Raup from the edge of a pond in the northern part of the Slab City Tract in 1933; found in meadows and along woods roads in four compartments in our survey.

Ranunculus aquatilis, WHITE WATER CROWFOOT. (Ranunculaceae) An aquatic species with much-divided leaves. Known at HF from a single collection in a pond in S1 by H.M. Raup in 1933.* This is a variable circumboreal species; our plants may also be segregated, at the risk of considerable taxonomic confusion, as *R. longirostris* and *R. trichophyllus.*

Ranunculus bulbosus,* BULBOUS BUTTERCUP. (Ranunculaceae) A low, weedy, European buttercup with a bulbous base, fat stems, and somewhat pinnately divided leaves. Known at HF from a 1940 collection by J. Wright from the Prospect Hill Tract, and small populations in the front lawn of Shaler Hall and in P6, seen in this survey.



*Raup also found *R. ambigens,* which he called *R. laxicaulis* and someone whimsically annotated to *R. texensis*, north of the Tom Swamp Tract and so not in HF.

Ranunculus recurvatus, HOOKED BUTTERCUP. (Ranunculaceae) A furry woodland buttercup with shallowly lobed leaves, small flowers, and hooked beaks on the achenes; common in moist, fertile shaded soil. Occasional at HF: first collected by H.M. Raup from the Tom Swamp Tract in 1933; not seen by C.E. Smith (1949) and his colleagues who treated it only as "reported;" seen in six compartments, mostly in moist soil or near streams, in our survey.

Ranunculus repens,* CREEPING BUTTERCUP**.** (Ranunculaceae) A European species with showy flowers, deeply divided leaves, and creeping stems, much increased in our area over the last 50 years and now common in ditches, lawns, and shores. Quite similar to creeping forms of the native *R. hispidus*, from which it is distinguished by its spotted leaves and the short styles with very short stigmatic areas. Not previously reported from HF. Seen once in our survey, along a riverbank in S5.

Rhamnus cathartica,* COMMON BUCKTHORN. (Rhamnaceae) A small spiny tree, cultivated for hedges and now escaped to fields and successional woods everywhere. Rare at HF , though known here for a century; J.G. Jack (1911) said that it was frequently naturalized, and the earliest collection is by S.M. Dohanian in 1913; we saw it, in small quantities, in three compartments in our survey.

Rhamnus frangula,* EUROPEAN OR GLOSSY BUCKTHORN. (Rhamnaceae) A later-arrived and even more invasive European species with furry buds, smooth bark and leaf margins, and glossy leaves. Also rare at HF; not reported by previous surveys and found in small amounts in six compartments in ours. Also called *Frangula alnus*.

Rhododendron canadense, RHODORA. (Ericaceae) The bog azalea of northeastern North America, a low shrub of sphagnum-heath bogs with blunt bluegreen leaves, glaucous branches and capsules, and rose-purple flowers. Common in the open bogs of the Tom Swamp Tract, where it was first collected by S.M. Dohanian in 1913; collected once, by W.W. Cole in 1908, from a "swamp west of Prospect Hill;" this is the only record for the Prospect Hill Tract.

Rhododendron maximum, GREAT LAUREL. (Ericaceae) This is the large-leafed, evergreen laurel of the coves of the Appalachians, with a very scattered distribution, mostly in swamps, in glaciated New England and correspondingly rare. Also widely cultivated and occasionally escaped to roadsides and fields. Known at HF from a single 1947 collection by W.D. Beal, which we suspect was an introduction or escape, along a woods road "north of and parallel to" the Swift River in S10; looked for but not relocated in this survey.

Rhododendron prinophyllum, COMMON PINKSTER FLOWER. (Ericaceae) The common inland azalea with softly furry leaves, pink flowers, and glandular pedicels and capsules, formerly called *R. roseum, R. nudiflorum* var. *roseum*, and (perhaps only by J.G. Jack) *R. canescens.* Common at HF, both in uplands and wetlands: J.G. Jack (1911) said it was "common in swamps, also in higher ground;" H.H. Tryon collected it in 1911 from


Ranunculus recurvatus


Ranunculus repens


Rhamnus cathartica


Rhamnus frangula


Rhododendron canadense


Rhododendron prinophyllum

the Slab City Tract; we confirmed it in 8 compartments and have records of azaleas in 13 others that we think are mostly this species.

Because, however, most of the plants we saw were sterile, their identifications are uncertain. In theory, *R. prinophyllum* has two kinds of hairs on its leaves—stiff hairs on the veins and margins and soft hairs on the surfaces— while *R. viscosum* and *R. periclymenoides*, the other two azaleas with which it might be confused, have only the stiff hairs. In addition, *R. prinophyllum* has glandular pods and pedicels and the other two have eglandular pedicels and at most sparsely glandular pods. But in fact there is considerable variation in both hairiness and glandularity (these are plants after all); some specimens of *prinophyllum*, for example, are less softly furry than they should be, and some specimens of *periclymenoides* more furry. And glands of course, as every botanist beyond a certain age knows, follow no rules at all.

For this reason, many older botanists treated *prinophyllum* and *periclymenoides* as a single species. Eighty years ago Karl Wiegand, an extremely careful botanist, said in the *Flora of the Cayuga Lake Region* that he had tested the distinctness of *R. roseum* (= *R. prinophyllum*) and *R. nudiflorum* (*R. periclymenoides*) and "after an inspection of a large number of specimens it seems impossible to follow Rehder, since all the characters given by him as distinguishing *R. nudiflorum* from this plant [*R. roseum*] apparently break down."

[**Rhododendron viscosum**, WHITE AZALEA. (Ericaceae) The tall white swamp azalea with the sticky glandular flowers, common near the coast and rarer inland. The white flowers distinguish it immediately from our other two species, but the twigs, buds, leaves, and pods are quite similar to those of *R. periclymenoides,* and hence (see above) to those of our common *R. prinophyllum*. Its status at HF is currently uncertain and needs more field work. J.G. Jack (1911) said it was "uncommon, in swampy situations," H.M. Raup (1938) listed it for Petersham, and T. Zebryk (1991) reported it from the Black Gum Swamp in P2; no specimens have been found to support these records. We have looked for it in all the swamps at HF, and have thus far not found it. We have, however, seen two sterile collections of azaleas from T4 (*Raup 5159*; Motzkin et al. *HF 2005-115*), that appear less hairy than typical *R. prinophyllum* and thus might be either *R. viscosum* or *R. periclymenoides.*

On balance, we think it likely that *R. viscosum* did occur here— good botanists saw it and a white azalea is, after all, a white azalea—but we do not know whether it currently occurs at HF and we would welcome better evidence.

While the swamp-pink (*R. periclymenoides*, formerly *R. nudiflorum* var. *nudiflorum*) could occur here, we have no evidence that it did or does. J.G. Jack (1911) said that "true *R. nudiflorum*" does not occur here; H.M. Raup (1938) and C.E. Smith (1949) concurred: they listed *R. nudiflorum* var. *roseum* (= *R. prinophyllum*) but not *R. nudiflorum* var. *nudiflorum.*]

Rhus copallina

Rhus copallina, DWARF SUMAC. (Anacardiaceae) A small sumac with winged leaf axes and a coastal distribution. J.G. Jack collected it from the Tom Swamp Tract in 1908 and said in 1911 that it was "Not common, in old pastures and open woods." We saw it once, in the gravel pit in P9, in

our survey, and it has recently been reported from an experimental clear-cut plot in the Simes Tract.

Rhus glabra, SMOOTH SUMAC. (Anacardiaceae) A small, thicket-forming tree with compound leaves and thick, pithy, smooth branches. This is the less common of our two tree-sized sumac, and the more southerly in distribution. J.G. Jack (1911) said it "Often occurs with staghorn sumac" and was about equally common; he collected a specimen in 1908, without noting a location. W.D. Beal collected it behind the HF buildings in 1947 and C.E. Smith (1949) said that it was "Occasional in fence rows" and woods margins. We looked for it but did not find it at HF, though it occurs nearby at the Petersham Curling Club. Currently it is hard to think of a fence row anywhere in HF, and the only edges of the woods are where they meet wetlands, waterbodies, pastures, and paved roads.

Rhus hirta, STAGHORN SUMAC. (Anacardiaceae) A related and often more common species with furry branches and fruits. J.G. Jack (1911) said it was common in old fields, clearings and along roads and fences. Today the fields, clearings, and fences are almost completely gone; we recorded it along paved roads and around buildings in 11 compartments, but rarely saw it within the woods. Long called *Rhus typhina*. Linnaeus seems to have named it *Datisca hirta* in 1753 and then *Rhus typhina* in 1760. *Typhina* is the oldest name in *Rhus*, but *hirta* is older overall and so trumps it.

Rhus hirta

Rhynchospora alba, WHITE BEAK RUSH. (Cyperaceae) A slender, creeping sedge with conical spikelets with white or pale brown scales, very common on floating sphagnum-sedge mats in open peatlands. Locally common on bog mats in the Tom Swamp Tract, where it was first collected by H.M. Raup in 1933.

Rhynchospora capitellata, BEAK RUSH. (Cyperaceae) A dark-scaled species of wet meadows and open minerotrophic wetlands, generally common in our area. It closely resembles the next and is best separated by technical characters; the barbs on the bristles surrounding the achene point down, and the tubercle is brown rather than green. Occasional at HF: first collected by H.M. Raup from three sites (a woods road in the Prospect Hill Tract, a pond in the Slab City Tract, and a swamp in the Tom Swamp Tract) in 1933; recorded three times in our survey, from the pasture in P2 and from Riceville and Harvard Ponds.

Rhynchospora alba

Rhynchospora capitellata

Rhynchospora fusca, DARK BEAK RUSH. (Cyperaceae) A similar species with a more northerly distribution, most commonly found on peaty shores. Its best marks are the upward-pointing barbs on the bristles and the greenish tubercle with a sharp margin. Not previously reported at HF; we found it locally plentiful on peaty islands in Harvard Pond, Riceville Pond, and in T8.

Rhynchospora fusca

[**Ribes cynosbati**, PRICKLY GOOSEBERRY. (Grossulariaceae) A common native gooseberry of fertile rocky woods, differing from the next species in its spiny fruits and broader leaf bases. J.G. Jack (1911) said is was "Occasionally found in and along fences," and H.M. Raup (1938) listed it

for Petersham; neither of these records is necessarily from HF. We did not see it in our survey and were not able to find any specimens to support these records.]

Ribes glandulosum, SKUNK-CURRANT. (Grossulariaceae) A small native currant with shallowly-lobed leaves, bright red buds, and a pleasant musty odor, like a freshly washed skunk. A northern species of moist upland woods, common in western Massachusetts but more scarce and more restricted to swamps in our area. Not previously reported from HF. Seen in our survey, always in small quantities, on a rocky slope just above Route 122 in S7, in wet woods in S6 and S9, and in the swamp at the north end of Connor Pond in S6.


Ribes glandulosum

Ribes hirtellum, NORTHERN GOOSEBERRY. (Grossulariaceae) A native gooseberry, with relatively narrow, wedge-shaped leaves and a smooth ovary and fruit, found both in bogs and on rocky hills. Known at HF from collections by P. Haynes from the Meadow Water (Tom Swamp) Tract in 1910 and by S.M. Dohanian from Dogwood Hill, which may or may not be on HF, in 1913.


Ribes rubrum

Ribes rubrum,* GARDEN RED CURRANT. (Grossulariaceae) The cultivated red currant, with rounded, shallowly lobed, non-glandular leaves. It was widely planted in the 19th century and then, with other *Ribes,* subject to an extirpation campaign in the early 20th century intended to prevent the white pine blister rust. It is now widely but sporadically established in second-growth forests in our area. Reported as an occasional escape, by J.G. Jack (1911); also listed by H.M. Raup (1938) and C.E. Smith (1949), the last citing a voucher that we did not see. Neither of these records was necessarily from HF. Seen twice in our survey, in woods in P10 and T10. Formerly called *R. sativum* and *R. vulgare*, both later names.


Robinia pseudoacacia

Robinia pseudoacacia,* BLACK LOCUST. (Fabaceae) A clump-forming tree with hard wood and deeply furrowed bark, native to the southern United States; much planted for ornament and fence posts, and widely naturalized in thickets and second-growth in our area. Listed as naturalized in HF by J.G. Jack (1911) but scarce here and mostly by roads: we found it below the cemetery in P1, by a roadside in P8, and by the road in T11.

Rosa carolina, CAROLINA ROSE. (Rosaceae) The wild roses of the Northeast are an interbred jumble without stable character combinations or any respect for the species lines in the manuals. They are also rare at HF: we saw few in our survey, and there are only a few historical records. We have annotated these as consistently as we can, but naming roses is a mug's game and doesn't mean much.

Rosa carolina, in our concept, is a rose with straight nodal thorns, moderately wide stipules, coarsely toothed leaves, and a glandular ovary. Two specimens, collected by I.M. Johnston from the cliffs of Camel's Hump (Simes Tract) and by W.D. Beal from S8, both in 1947, fit these characters. We saw a few plants on the slopes of Camel's Hump in rocky areas.


Rosa carolina

[**Rosa cinnamomea**,* CINNAMON ROSE. (Rosaceae) A European cultivar of old-fashioned gardens with hooked thorns, erect sepals, and smooth fruits. J.G. Jack (1911) said that it occurred "on the Meadow Water Tract (Tom Swamp Tract) and other parts near sites of former homesteads." There is no indication that it ever became naturalized.]

Rosa multiflora,* MULTIFLORA ROSE. (Rosaceae) A white-flowered, very thorny, Asiatic rose, widely introduced as a hedgerow and wildlife plant and now an aggressive invader of fields and second-growth thickets, especially on limy soils. Rare at HF, which may be too acid or may have been largely reforested by the time *R. multiflora* was being widely planted: not reported in previous surveys, and seen in small quantities, in T8, T10, and the Simes Tract, in ours.

Rosa multiflora

Rosa palustris, SWAMP ROSE. (Rosaceae) In our concept this is a rose like *R. carolina* but with down-curved thorns, narrower stipules, and finer teeth on the leaves. Two herbarium collections, by W.H. Drury from a brook in the Tom Swamp Tract and by I.M. Johnston from the east shore of Harvard Pond, both in 1947, show these characters fairly well. We found it once along the eastern shore of Harvard Pond.

J.G. Jack (1911) said that *Rosa nitida* occurred in Meadow Water (Tom Swamp), but no specimens support the record. *R. nitida* is said to resemble *R. palustris* in its fine-toothed leaves, but to have abundant slender prickles between the nodes and flaring stipules, both features that can be found in *R. carolina*. In practice it seems to be a weakly defined species, even by rose standards, and to be hard to recognize in the field. We found nothing corresponding to it in our survey.

Rosa palustris

[**Rosa sp.,** ROSE. (Rosaceae) In 2005 we collected a low-growing rose in rocky woods in S9 that had coarsely toothed leaves with glandular margins and petioles, slender, strongly glandular stipules without flaring tips, a few slender, slightly deflexed thorns, and smooth, round fruits with exerted styles. The fruits and exerted styles resemble those of our native species (and it is not impossible, given the slender thorns and habitat, that this is some odd variant of *R. carolina* or *R. blanda*) but the character combination does not fit any of our species particularly well. With roses our experience is that if you seek you will indeed find, and that is the problem.]

Rubus allegheniensis, COMMON BLACKBERRY. (Rosaceae) The common tall, thorny blackberry of fields and thickets, distinguished from related species by its hairy leaves and glandular pedicels. Listed as common by J.G. Jack (1911), and frequent along roads and in openings today: we found it in 14 compartments in our survey.

Rubus allegheniensis

Rubus canadensis, CANADA BLACKBERRY. (Rosaceae) A slender, largely thornless blackberry of mountain and conifer woods. Uncommon at HF: first collected by J.S. Ames along the Barre Road in the Slab City Tract in 1908, and noted from there and along the banks of the Swift River by J.G. Jack (1911). Seen twice in our survey, in S2 and T1.

Rubus canadensis

Rubus flagellaris, PRICKLY DEWBERRY. (Rosaceae) The dewberries are creeping blackberries. This is the common thorny dewberry of open fields. It was listed as common by J.G. Jack (1911) but not collected until 1947, by J. Canright in a field by the Community House in P2. We consider it currently uncommon at HF: we relocated it in the fields in P2 and near the abandoned pool at Fisher House in P10, and also saw it in S6 and T5. Called *R. villosus* by J.G. Jack (1911); it is part of a species complex and has many synonyms.

Rubus hispidus, BRISTLY DEWBERRY. (Rosaceae) A creeping, somewhat evergreen dewberry with stiff bristles on the stems but no thorns, found in swamps, along trails, and in moist woods. Common at HF: first listed (as common in low woods) by J.G. Jack (1911); likely first collected by J.S. Ames in 1908, though the specimen lacks a locality; very widely distributed in our survey, where it was seen in 29 compartments.

Rubus idaeus, RED RASPBERRY. (Rosaceae) The common wild raspberry of the Northeast, recognized by the pinnately divided leaves that are whitened beneath and stems with bristles rather than thorns. Frequent along woods roads and in clearings at HF: listed as common by J.G. Jack (1911) and found in 13 compartments in our survey.

Rubus occidentalis, BLACK RASPBERRY. (Rosaceae) The black-cap raspberry, resembling the red raspberry but with black fruit, hooked thorns instead of bristles, and a tendency to grow in somewhat more fertile soils. Listed as frequent by J.G. Jack (1911), and collected from the Prospect Hill Tract by S.M. Dohanian in 1913, and from near the HF buildings by W.D. Beal in 1947. Currently rare at HF: we found it near the cemetery in P1, and near Camel's Hump in the Simes Tract.

Rubus odoratus, PURPLE-FLOWERING RASPBERRY. (Rosaceae) The common thimbleberry of roadsides, a tall rubus with broad, maple-like leaves, shreddy bark, wine-purple petals, and red, furry, raspberry-like fruits. Uncommon at HF in openings and near roads: listed as "Not common" by J.G. Jack (1911); first collected on the Prospect Hill Tract by S.M. Dohanian in 1913; subsequently collected along the main road in the Slab City Tract by H.M. Raup in 1933 and W.D. Beal in 1947; also collected by B.N. Gates from an unknown location at HF in 1948 (CUW; fide R. Bertin). Seen three times in our survey, in T1, T5, and the Simes Tract.

[**Rubus pensilvanicus**, PENNSYLVANIA BLACKBERRY. (Rosaceae) A tall thorny blackberry resembling the common *R. allegheniensis* but with eglandular pedicels. Uncommon or, more likely, overlooked because we don't look very hard at blackberries. Reported as occasional on roadsides by J.G. Jack (1911), and listed for Petersham by H.M. Raup (1938); neither record is definitely from HF. We found no vouchers and we did not find it in our survey.]

Rubus pubescens, DWARF BLACKBERRY. (Rosaceae) A trifoliate, herbaceous blackberry with creeping stems and red fruits, common in wooded swamps. Common at HF: first collected by W.A. Stalker from the Tom


Rubus flagellaris


Rubus hispidus


Rubus idaeus


Rubus occidentalis


Rubus odoratus


Rubus pubescens

Swamp Tract in 1909; seen in 21 compartments in our survey. Formerly called *R. triflorus.*

Rubus setosus, BRISTLY BLACKBERRY. (Rosaceae) A low blackberry with arching stems and a dense armature of stiff bristles, resembling a larger and even more bristly bristly dewberry. It is an uncommon species which is almost always associated with the common bristly dewberry, and almost seems as if it were a variant of it or a hybrid of it and something else. Known at HF only from a 1910 specimen (HUH) collected by C.E. Faxon from Brooks (Harvard) Pond, and a 1947 collection by I.M. Johnston from the shores of Riceville Pond.


Rudbeckia hirta

Rudbeckia hirta,* BLACK-EYED SUSAN. (Asteraceae) The common black-eyed susan of meadows and roadsides, native in the southern and western United States but introduced to the Northeast around the middle of the 19th century. Uncommon at HF where open habitats are scarce: first collected from near Fisher House by H.M. Raup in 1934; seen near Shaler Hall (P1) and in three other compartments in our survey.


Rumex acetosella

Rumex acetosella,* SHEEP SORREL. (Polygonaceae) The small, fleshy, pleasantly sour sorrel with arrow-shaped leaves, adventive from Europe and widely established in fields, along roads, and in barren rocky or sandy ground. Occasional at HF: first collected by H.M. Raup in 1933; seen sporadically along roads and in open grounds in 10 compartments in our survey.

Rumex crispus,* CURLY DOCK. (Polygonaceae) The commonest of the European docks, distinguished by its crisped leaves and swollen midribs on several but not all of the outer sepals. Generally common in open ground on moist fertile soils but apparently rare at HF: collected once in 1947 by I.M. Johnston on Tom Swamp Road (which may or may not have been in HF), and seen once in disturbed ground near Shaler Hall (P1) in our survey.


Rumex crispus


Rumex longifolius

Rumex longifolius,* LONG-LEAVED DOCK. (Polygonaceae) A less common species, also European and also preferring moist open ground, distinguished by the veined, broadly heart-shaped outer sepals without swollen midribs. Not previously reported at HF: seen twice in our survey, from near the buildings in P1 and near the pool at Fisher House in P10. Formerly called *R. domesticus.*

Rumex obtusifolius,* BLUNT-LEAVED DOCK. (Polygonaceae) A third European species, resembling *R. crispus* but with broader leaves and a few small, slender teeth on the edges of the sepals. Uncommon at HF: reported for Petersham by H.M. Raup (1938) but not vouchered for HF; seen three times in our survey, in the gravel pit in P9, along a road in P10, and in the Simes Tract.


Rumex obtusifolius

[**Rumex orbiculatus**, GREAT WATER DOCK. (Polygonaceae) A very tall native species of open wetlands, recognized by the large leaves and rounded sepals with the swelling beginning a small distance above the base. Apparently absent from the wetlands at HF: collected once, in "dis-

turbed ground, at roadside" from the west end of Tom Swamp Road, by I.M. Johnston in 1947. The locality is probably outside of HF.]

Sagina procumbens,* PERENNIAL PEARLWORT. (Caryophyllaceae) A delicate creeping perennial with small green-white flowers, found in cracks in rock in native situations and lawns and pavement in man-made ones. Not previously reported from HF: we found it in lawns around Shaler Hall and Fisher House (P1 and P10) and along Rt. 122 in S6 and S10.


Sagina procumbens


Sagittaria latifolia

Sagittaria latifolia, BROAD-LEAVED ARROWHEAD. (Alismataceae) Our common arrowhead of ponds and pools in swamps and bogs, highly variable in leaf shape and best distinguished by the beaks which point sideways from the achenes. Locally common in ponds and in slow places in streams at HF: first collected by H.M. Raup from a stream in the Slab City Tract in 1933; we found it in nine compartments in our survey, including the three large ponds, several places along streams, and the little mudhole in the pasture in P2.

Salix bebbiana, BEBB'S WILLOW. (Salicaceae) A common willow of wet, successional meadows with rounded, hairy, veiny leaves with somewhat revolute edges, pale catkin scales and long-stalked, slender ovaries. Flowering plants are easily distinguished; vegetative plants resemble *S. humilis* and present a much more difficult problem that may not have a good solution. We have assumed in this project that plants with rather short rounded leaves are *S. bebbiana* and those with longer and flatter leaves are *S. humilis* but, willows being willows, we use these characters without trusting them. J.G. Jack (1911) said that Bebb's willow was common in moist and dry situations, and it was collected at least six times at HF between 1912 and 1947; today it is rare: we saw it only twice, by the Swift River on Quaker Dr. in S4 and in the gravel pit in P9, which seems to be functioning as a refuge for a number of successional species that no longer have much habitat in HF as a whole.


Salix bebbiana

Hugh Raup, the fourth director of HF, was a careful student of willows and listed seven native species in his 1938 checklist of the plants of Petersham. We were able to relocate five of these, but only in small quantities and with some effort. Willows are an early-successional genus. Our Petersham is much more forested than his, and the open streambanks and thickets where willows likely grew in abundance are now alluvial woods and swamps where they rarely grow at all.


Salix discolor

Salix discolor, COMMON PUSSY WILLOW. (Salicaceae) Our earliest and one of our commonest shrubby willows, distinguished by untoothed leaves with vaguely wavy edges and large catkins with black scales. "Very common" at HF in the early 20th century according to J.G. Jack (1911), and indeed, his students or co-workers collected it four times in 1910 and 1911. Currently rare: we saw only a few plants in P2, T3, T6, and at the Simes Tract. One specimen from the parking lot at the southwest corner of Harvard Pond (T7) resembles *S. discolor* but has the short fine hairs and somewhat less wavy leaves of *S. humilis.*


Salix eriocephala

Salix eriocephala, WOOLY-HEADED WILLOW. (Salicaceae) A very common shrubby willow with smooth, evenly toothed leaves with some-

what rounded bases, conspicuous stipules, and catkins with pale scales and smooth ovaries. J.G. Jack (1911) said it was common at HF in wet ground; we, in sharp contrast, found it rare and recorded it only once, on a woods road in T4 in our survey. (We also have a 2005 collection from T3 which had the leaf shape of *S. eriocephala* but blackened when dried like *S. sericea* and had the silvery hairs of that species.) Formerly called *S. cordata* Muehlenberg, a name that has been rejected because Michaux had already used it for a different species, and *S. rigida,* a name that has now been merged with *S. eriocephala*.

[**Salix humilis**, SMALL PUSSY WILLOW. (Salicaceae) A shrubby willow, close to *S. discolor* but with smaller catkins and furrier and more rugose leaves, typically found in open sandy or rocky soil. Flowering plants are usually easy to identify. Vegetative plants closely resemble *S. bebbiana*, but with longer leaves and usually some copper-colored hairs on the upper surface. As with most vegetative identifications in *Salix*, variability gets in the way and neither of these characters is really trustworthy.

Status at HF uncertain: credited to HF by J.G. Jack (1911), who said it was not uncommon in dry ground, and to Petersham by H.M. Raup (1938); represented in the herbarium by two old collections: a 1908 specimen by W.A. Stalker saying only "HF," which could be either *S. humilis* or *S. discolor* or something in between; and a 1913 specimen from the Prospect Hill Tract by S.M. Dohanian, which has the leaf characters of *S. humilis* but lacks fruits and cannot be confirmed. Also possibly represented by a 2006 collection of ours from a plant from the parking lot at the southwest corner of Harvard Pond (T7) that has the fine hairs of *S. humilis* but the flat leaves of *S. discolor.*]

Salix lucida, SHINING WILLOW. (Salicaceae) A distinctive species with glossy, long-pointed leaves with rounded bases and petiolar glands, commonly found in wet meadows and open land by streams. Credited to HF by J.G. Jack (1911) who said it was rare here, and to Petersham by H.M. Raup (1938); represented in the HF herbarium by a single collection from the Barre Woods (Slab City Tract) by S.M. Dohanian in 1913; and seen once in our survey along the Swift River in S10.


Salix
lucida

Salix sericea, SILKY WILLOW. (Salicaceae) A common shrubby willow of wet meadows and river shores, recognized by the slender leaves with fine, appressed, silky hairs on the lower surface. Credited to HF by J.G. Jack (1911), who said it was common near streams, and to Petersham by H.M. Raup (1938); collected on Tom Swamp Road, though not necessarily in HF, by W.A. Stalker in 1908; and seen only once in our survey, near Connor Pond in S6.

Salix petiolaris, a similar species that is less persistently hairy and usually has a few coppery hairs on the young leaves, was credited to HF or Petersham by J.G. Jack (1911), H.M. Raup (1938), and C.E. Smith (1949). We found no supporting specimens and, because species concepts have changed and the species can be very easily mistaken for *S. sericea,* we did not credit the species to HF.


Salix
sericea

Sambucus canadensis, WHITE ELDERBERRY. (Caprifoliaceae) The common white-flowered, early summer elderberry of open wetlands.


Sambucus
canadensis

Credited to HF by J.G. Jack (1911), who said it was common in moist places, and first collected by H.M. Raup in the Slab City Tract in 1934. Currently uncommon near streams and in open wetlands; we found it in 7 compartments.

Sambucus racemosa, RED ELDERBERRY. (Caprifoliaceae) Our early elderberry of rocky slopes and moist fertile woods, distinguished by its brown pith, foetid smell, rounded flower clusters, and bright red berries. Occasional at HF: first collected by H.M. Raup from the Prospect Hill Tract in 1933; seen in eight compartments in our survey. It is most plentiful on the fertile rocky slopes in S7, S8 and the Simes Tract but also occurs sporadically in more ordinary woods as well. Formerly called *S. pubens.*


Sambucus racemosa

Sanguinaria canadensis, BLOODROOT. (Papaveraceae) A familiar, brilliant white, early spring flower with orange-red latex and single, large palmately lobed leaves. Typically a plant of open, fertile, often rocky woods and roadsides, though sometimes seen in the open in meadows. Rare at HF: first collected along the road by the forest school by H.M. Raup in 1934; later collected along Dugway Road (adjacent to the Simes Tract) by H.M. Raup, C.E. Smith, and E.E. Smith in 1949. We found plants at or near both of these locations in our survey, an interesting illustration of the ability of rhizomatous herbs to persist.


Sanguinaria canadensis

Sanicula marilandica, MARYLAND SNAKEROOT. (Apiaceae) A woodland umbellifer with palmately compound, sharply toothed leaves and small green-white unisexual flowers in male and female clusters. Generally frequent in open, moist, somewhat fertile woods. Apparently rare at HF: first collected by H.M. Raup from the Tom Swamp Tract, east of Harvard Pond, in 1933 and then from a woods road in the Slab City Tract in 1934; reported by C.E. Smith (1949) from S4 and T8, citing specimens that we did not see. Not recorded in our survey.


Saponaria officinalis

Saponaria officinalis,* BOUNCING BET. (Caryophyllaceae) A European garden plant, widely escaped to open habitats and particularly common in coarse soils along railways and near roads and streams. Uncommon at HF: collected once by H.M. Raup from the north end of the Tom Swamp Tract in 1933; seen once in our survey, along the highway in S6.

Sarracenia purpurea, PITCHER PLANT. (Sarraceniaceae) The only northeastern pitcher plant, a common and distinctive species of bog mats with tubular, water-holding leaves and large flowers with maroon petals that hang downwards like curtains. Common in the bogs of the Tom Swamp Tract at HF: first collected by H.M. Raup from the Fay Lot (T9) in 1933; still common there and in the bogs north of Harvard Pond in our survey.


Sarracenia purpurea


Sassafras albidum

Sassafras albidum, SASSAFRAS. (Lauraceae) A forest tree, near its range limits in New England and not growing very tall, with green twigs, relay branching, and variably lobed leaves. J.G. Jack (1911) said it was "rather rare, on dry ground, usually small." The herbarium has a 1910 collection by P. Haynes from Petersham with no locality, and a 1949 specimen from E.E. and C.E. Smith and H.M. Raup from "near Camel's Hump Hill" in the Simes Tract. We found small amounts in three locations: by a small

stream between Lyford House and the cemetery in P1, along an old roadbed in T5, and a single tree along the utility right-of-way in T10.

Saxifraga pensylvanica, SWAMP SAXIFRAGE. (Saxifragaceae) A large, broad-leaved, scapose saxifrage of open wetlands and pools in swamps, widely but erratically distributed and most common in minerotrophic situations. Rare at HF: first collected by W.D. Beal and R.S. Sigafoos from the Fay Lot (T9) in 1947; also collected by C.E. and E.E. Smith and H.M. Raup from a pool at the base of Camel's Hump Hill in the Simes Tract; seen, most likely in the same wetland, in our survey, and also in a seepy wetland at the south end of T2.

Saxifraga pensylvanica

Saxifraga virginiensis

Saxifraga virginiensis, EARLY SAXIFRAGE. (Saxifragaceae) A common rosette-forming herb of calcium-rich ledges, bearing white flowers in the early spring. Rare at HF: first reported by C.E. Smith (1949), based on a collection by C.E. Smith, E.E. Smith, and H.M. Raup from "near Camel's Hump Hill" (Simes Tract) that we did not see; seen twice in our survey, on a fertile cobble in S7 and on the ledges at Camel's Hump (Simes Tract).

Schizachne purpurascens, FALSE MELIC. (Poaceae) A slender, clump-forming grass of dry, rocky, fertile woodlands, recognized by the closed sheaths, sharp-pointed blades, and nodding, long-awned spikelets marked with purple. Rare and not previously reported at HF: we saw it once, on the fertile talus of Camel's Hump (Simes Tract).

Schizachne purpurascens

Schizachyrium scoparium, LITTLE BLUESTEM. (Poaceae) A common, clump-forming grass of prairies, burns, and dry open woods; locally dominant in coastal grasslands and still common but more scattered in sandplains, pine barrens, and rocky, south-facing woods inland. Occasional on roadsides and trails at HF: first collected by H.M. Raup along a woods road in the Prospect Hill Tract in 1933; seen in 7 compartments in our survey. Long called *Andropogon scoparius*; the segregate genus *Schizachyrium* differs from *Andropogon* in being harder to spell and in having convex lower glumes and concave tips to the joints of the flowering axis.

Schizachyrium scoparium

Schoenoplectus purshianus, PURSH'S BULRUSH. (Cyperaceae) A slender, clumped bulrush with small lateral spikelets, frequent on open peat or mud. Known at HF only from a 1947 I.M. Johnston collection from the shores of Riceville Pond. Looked for there on a number of trips in our survey but not found. Formerly called *Scirpus purshianus.* The species of *Scirpus* with leafless culms and lateral spikelets make a natural group and were transferred to *Schoenoplectus* by the *Flora of North America.*

Schoenoplectus subterminalis, BUG-ON-A-STICK BULRUSH. (Cyperaceae) An aquatic bulrush of soft slow water and peaty soils, with slender culms that barely rise above the surface of the water and limp, trailing, submerged leaves. Collected by H.M. Raup in 1933 in Tom Swamp; now locally common in the shallow, boggy parts of Harvard and Riceville Ponds.

Schoenoplectus subterminalis

Schoenoplectus tabernaemontani, SOFTSTEM BULRUSH. (Cyperaceae) A common large bulrush of shores and open wetlands, found on both mineral soils and peat and separated from the closely related *S. acutus* by the uniformly solitary spikelets and the smoother, darker brown scales on the spikelets. Uncommon at HF: first collected by H.M. Raup in 1933 at a pond in the Barre Woods (Slab City Tract) and along a stream in the Fay Lot (T9); seen four times in our survey, along the Swift River in S10, in open fens in Riceville and Harvard Ponds (T9 and T11), and by a pond in the Simes Tract. Long known as *Scirpus validus*.

Schoenoplectus tabernaemontani

[**Scilla sibirica**, SIBERIAN SQUILL. (Liliaceae). A widely-planted garden plant, native to Asia, escaping from cultivation locally but not broadly established as an exotic. This species and the similar-looking *Puschkinia libanotica* were planted and are spreading in the lawn in front of Shaler Hall but are not as yet truly naturalized.]

Scirpus atrocinctus, BLACK-BANDED WOOLGRASS. (Cyperaceae) One of three closely-related species of tall, leafy sedge with long inflorescence bracts, small spikelets in umbels and cymes, and long crinkly bristles that give the spikelets a wooly appearance when mature. The three species (*S. atrocinctus, S. cyperinus,* and *S. pedicellatus*) are closely related and reported to hybridize extensively, producing partly sterile hybrids. But they also flower and fruit at different times, suggesting that despite the hybridization each keeps some individuality of its own. But they are very similar morphologically: E. Schuyler, who has studied them and written about them for many years, says in his *Flora of North America* account that "it is often difficult to identify isolated herbarium specimens with confidence." Since all herbarium species are, by definition, isolated from the populations they represent, and since if Schuyler can't identify them it is unlikely that anyone else can, this suggests to us that we should treat our plants broadly and cautiously.

Scirpus atrocinctus

Woolgrasses are common in open wetlands, on shores, and along streams at HF. We saw one species or another in 16 compartments in our survey. *S. atrocinctus* is the earliest species, fruiting in late June or early July, and often smaller than the other two. It has pedicelled lateral spikelets and black at the base of the inflorescence bracts and on the tips of the pistillate scales. It was first collected at HF (but misdetermined as *S. pedicellatus*) by H.M. Raup from near the forest school (P2) and elsewhere on the Prospect Hill Tract in 1934. We recorded it from four compartments (P2, P10, T5, T8) and may have missed it in others because of the early fruiting. It is generally common in our area.

Scirpus cyperinus sensu strictu, WOOLGRASS. (Cyperaceae) This is a tall late-flowering species with long leaves and inflorescence bracts and a tendency to form big hummocks in open wetlands. Its technical characters are quite variable. Inland populations (formerly called variety *pelius*) tend to have black on the inflorescence bracts and stalkless spikelets with short scales with blackish tips. Coastal populations (formerly called *S. rubricosus*) have red-brown bracts, longer scales without black tips, and at least some stalked spikelets. Both forms occur at HF, and, as elsewhere, intermediates are common; Whittemore and Schuyler say in their *Flora*

Scirpus cyperinus sensu strictu

of North America account that the "two morphologies intergrade so extensively that it is not practical to recognize them at any rank."

S. cyperinus is a very common plant in both open and shaded wetlands in our area. It was first collected in 1933 by H.M. Raup from the Tom Swamp Tract; we confirmed it from five compartments at HF (P7, S3, S6, T5, T11) and suspect that it is present in a number of others. Some of our plants with paler bases to the bracts and stalked spikelets may be transitional to *Scirpus pedicellatus.* See the account for that species.

Scirpus expansus

Scirpus expansus, WOODLAND BULRUSH. (Cyperaceae) A large, leafy, rhizomatous bulrush with red lower sheaths, found in both open and shaded wetlands, mostly on mineral soils. Closely related and very similar to *S. microcarpus*, but with three styles, plumper achenes, and less persistent bristles. Rare or overlooked at HF: not seen in previous surveys and seen only once, along a stream in S5, in ours.

Scirpus hattorianus

Scirpus hattorianus, HATTORI BULRUSH. (Cyperaceae) A very common, clump-forming bulrush of open wet soil, lacking the red sheath bases of the previous species and additionally characterized by flowers with three styles, trigonous achenes, and relatively short bristles with very tiny teeth that surround the achenes.

Common along woods roads and in wet ditches and pastures at HF, but needing to be verified microscopically to avoid confusion with its sister species *S. atrovirens* and *S. georgianus.* First collected by H.M. Raup from the Prospect Hill Tract in 1933: confirmed from eight compartments in our survey and, since we found neither of its sister species, likely represented by vegetative plants in a number of others.

This plant is a member of the *Scirpus atrovirens* complex, which includes most of our clump-forming bulrushes with small spikelets, trigonous achenes, and smooth inflorescences. The complex includes three members, formerly treated as varieties of a broad *S. atrovirens*, now treated as three microspecies. The three are almost identical vegetatively, differing only in the strength of their teeth and the length of the bristles, with *S. georgianus* having the smallest and *S. atrovirens* the longest. Throughout most of New England *S. hattorianus* (mid-sized bristles) is by far the commonest species, and if it had inherited the old epithet *atrovirens* when the species broke up we could forget this pilpul about bristles and go home. That, however, could not happen: the type specimen of *S. atrovirens* corresponded to the less common, long-bristled form so that the long-bristled plants, which we almost never see, now have the old name. Our common medium-bristle plants then needed a new name, and it turned out that the next available epithet was *hattorianus*, which had been bestowed in 1933 by Dr. Tomitaro Makino—a sharp-eyed 71 at the time—on an American bulrush that had been discovered growing as a weed at the Hattori airport. As a result, in a reversal of the usual colonial process, the commonest dark bulrush of northeastern North America is named for a Japanese town. The whimsy of it all comes close to making up for the nomenclatural fuss.

Scirpus microcarpus

Scirpus microcarpus, SMALL-FRUITED BULRUSH. (Cyperaceae) A large, early-flowering, red-based bulrush resembling *S. expansus* but with two styles and flatter achenes. It is a much commoner species than *S. expansus*,

and elsewhere in our area is often a dominant species in sedge meadows and open, minerotrophic wetlands. At HF it is apparently uncommon: it was collected once in 1947 by K.A. Raup from a wet meadow behind the HF buildings; and seen twice in our survey, from wet spots in the pasture in P2 and a wetland edge in T8. Formerly interpreted as an eastern North American species and called *S. rubrotinctus*; now considered part of a transcontinental species under the older name *S. microcarpus*.

[**Scirpus pedicellatus**, PEDICELED WOOLGRASS. (Cyperaceae) This is the least well marked of our wool grass species, and consequently the one that gives us the most problems in the field. Formally it is a medium-sized plant with stalked lateral spikelets and no black on the bract bases and scales, blooming later than *S. atrocinctus* and earlier than *S. cyperinus.* According to the *Flora of North America* it resembles the coastal form of *S. cyperinus* in its stalked spikelets and relatively long scales and differs in the paler brown scales and earlier blooming time (p. 54).

Defined this way, late-summer plants with sessile spikelets, black bract bases and short scales are clearly *S. cyperinus*; mid-summer plants with brown bracts, stalked spikelets, and longer scales may still be *S. cyperinus,* or, if they are early enough and pale enough they may be *S. pedicellatus.* This seems hardly enough to make a variety, much less a species, and accordingly we treat *S. pedicellatus* as a bracketed species.

Plants with pale bracts and at least some staked spikelets are occasional at HF; they are a variable bunch and often seem transitional to *S. cyperinus.* The first collection, and the one that looks most like the textbook description of *S. pedicellatus* was H.M. Raup *5192* from the north end of the Tom Swamp Tract in 1933. Our 2005 collections *222, 237,* and *458*, from the Tom Swamp causeway, the gravel pit in P9, and the beaver pond in T7, are closer to ordinary *S. cyperinus*, but still differ enough that we have placed them here.]

Scleranthus annuus,* KNAWEL. (Caryophyllaceae) A small, weedy, Eurasian caryophyll, with a sprawling habit, paired linear leaves joined at their bases, small green-white flowers without sepals, and bundles of leaves at the branch tips which give the plant a spiny appearance. Occasional in waste ground in our area, especially in sidewalks and by paved roads. Uncommon at HF: first collected by W.D. Beal from the field behind the HF buildings in 1947; found twice, near the buildings in P1 and along Rt. 32 just to the north in P10, in our survey.


Scleranthus annuus

Scutellaria galericulata, MARSH SKULLCAP. (Lamiaceae) A common wetland herb with sessile leaves and deep blue flowers in pairs in the axils. Occasional along streams and in open wetlands at HF: first collected by H.M. Raup from the shore of Harvard Pond in 1934; collected again by W.D. Beal from a field near the beginning of Kitchen Road (Prospect Hill Rd.) and from the shore of Riceville Pond, both in 1947; reported by C.E. Smith (1949) from Tom Swamp Road, citing a specimen that we did not see; and seen twice by us, in a field in P2 and near Connor Pond in S6. *S. galericulata* is the Linnaean name for a circumboreal species of Europe, Asia, and North America. If the North American plants, which differ very slightly from the European ones, are separated, they are called *S. epilobiifolia.*


Scutellaria galericulata

Scutellaria lateriflora, MAD-DOG SKULLCAP. (Lamiaceae) Our other common skullcap, with stalked leaves and small, pale-blue flowers in axillary racemes. Frequent on pond shores and in open and shaded wetlands at HF: first collected by H.M. Raup from woods in the east part of the Tom Swamp Tract in 1934; seen in 12 compartments in our survey.

Secale cereale,* RYE. (Poaceae) A common cultivated cereal grain, also included in seed mixtures as a soil binder; seen once on a recently landscaped bank near Shaler Hall in P1, where it may have been sown or may have come in with landscaping materials.

Sedum telephium,* LIVE-FOREVER, FROG-BELLIES. (Crassulaceae) The common erect, pale-green, succulent sedum, widely cultivated as a garden plant and equally widely escaped, usually in small quantities, to roadsides and moist successional woods. Occasional at HF: collected by J. Murdoch, in 1914; reported but apparently not vouchered by H.M. Raup (1938); seen in eight compartments in our survey, mostly along woods roads. Formerly called *S. triphyllum*, a later name.

[**Sedum ternatum**,* MOUNTAIN STONECROP. (Crassulaceae) A small creeping garden plant with spoon-shaped leaves in whorls of three, widely planted and casually escaped in our area. Formerly planted and currently spreading in the grounds of Raup House but not truly naturalized.]

Selaginella apoda, MEADOW SPIKEMOSS. (Selaginellaceae) A small, bright green, creeping, spikemoss with flattened leaves and shoots, common in moist grassy soil. Known at HF only from the front lawn of Shaler Hall, where it was first collected by Alice Tryon in 1975 and where it still occurs.

[**Selaginella rupestris**, ROCK SPIK-MOSS. (Selaginellaceae) A darker green, erect species with needle leaves, similar in size and aspect to the moss *Polytrichum juniperinum*. Found, rather unpredictably, on open ledges and in open, dry rocky woods, often but not always in calcareous areas. Not known from HF; we saw it once, on the top of Camel's Hump, just west of the western boundary of the Simes Tract, and so in the Quabbin Reservation and not in HF. Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.]

Senecio aureus, GOLDEN RAGWORT. (Asteraceae) A common composite of fertile, minerotrophic wetlands, with heart-shaped leaves with rounded teeth and small flower heads with bright-yellow rays. Uncommon in the acid swamps at HF: probably first collected by Mrs. Gast along Tom Swamp Road, likely in 1928; subsequently collected by C.E. Smith from S4, W.D. Beal from S8, and W.H. Drury from T8, all in 1947. The Beal specimen says it was from the cliffs in S8, an odd place to find it. We saw it four times, in wetlands in P6, S4, T4, and the Simes Tract.

Senecio obovatus, OBOVATE-LEAVED RAGWORT. (Asteraceae) A characteristic composite of dry fertile woods, with yellow ray flowers and undivided basal leaves. Not previously reported from HF and uncommon in


Scutellaria lateriflora


Secale cereale


Sedum telephium


Selaginella apoda


Senecio aureus


Senecio obovatus

Worcester County (R. Bertin). Seen once in our survey, in hickory woods on the west side of S7.

Senecio vulgaris,* EUROPEAN GROUNDSEL. (Asteraceae) A weedy annual senecio with leafy stems and small flowering heads, common in waste ground and in paved areas. Not previously reported from HF: seen once, at the edge of the parking area in P2, in our survey.

Setaria faberi,* NODDING FOXTAIL. (Poaceae) Our foxtails are weedy annual grasses with rounded spikelets in dense bristly panicles. *S. faberi* is a tall, softly hairy foxtail with a large, nodding panicle, introduced from China in the 1920s and now common in cultivated fields and occasional along roads. Not previously reported from HF; seen twice in our survey along Route 122, by Harvard and Connor Ponds.

Setaria pumila,* YELLOW FOXTAIL. (Poaceae) A very common foxtail of roadsides, lawns, and waste areas, distinguished by its smooth leaves and numerous yellow bristles. Occasional at HF; first collected by N.W. Hosley near HF (Wilder's Farm) in 1933; seen three times, near Shaler Hall in P1 and P2 and along Rt. 122 in T11, in our survey. Formerly called, somewhat cyclically, *S. lutescens* and *S. glauca.*

Setaria viridis,* GREEN FOXTAIL. (Poaceae) Another common weedy foxtail, with rougher leaves and fewer, darker bristles than *S. pumila.* Generally common in our area, especially in dry gravelly soil. Not previously reported for HF; seen once in our survey near the new maintenance shop (P3).

Silene latifolia,* COMMON WHITE CAMPION. (Caryophyllaceae) The tall white hairy campion with an inflated, veiny calyx, common as a field weed and along roads and in waste ground everywhere. Currently uncommon at HF, mostly through lack of habitat: first collected by E.P. Stephens from S10 in 1947; seen four times in our survey, in P1 near Shaler Hall, near the pastures in P2 and P10, and in the gravel pit in P9. Formerly called *Lychnis alba.*

[**Sinapsis arvensis*** CHARLOCK. (Brassicaceae) A common weedy mustard of fields and waste grounds, with rounded, rough-hairy leaves, large yellow flowers and three-veined pods. Known from an undated collection by Mrs. Gast from Wilder's Farm (outside of HF) and reported for Petersham by H.M. Raup (1938). Reported from "near headquarters" at HF by C.E. Smith (1949), based on a specimen that we did not see. Often called *Brassica arvensis.* Not found in our survey.]

Sisymbrium altissimum,* TUMBLE MUSTARD. (Brassicaceae) A tall, branchy, alien mustard with small yellow flowers and deeply lobed leaves with narrow segments, found sporadically in fields and in waste ground throughout our area. Known at HF from collections by E.P. Stephens (1947) and W.H. Hatheway (1951), both from around a woodpile east of headquarters. Not found in our survey.


Senecio vulgaris

Setaria faberi


Setaria pumila


Setaria viridis


Silene latifolia

Sisymbrium officinale,* HEDGE-MUSTARD. (Brassicaceae) A similar species, also branchy, weedy, and common in waste ground, with shorter pods, broader leaf lobes, and a tendency for the branches to diverge at right angles. Collected near the Quabbin by I.M. Johnston in 1947 but not previously reported from HF; we saw it in the pasture west of Fisher House and the filled-in pool nearby, both in P10.


Sisymbrium officinale

Sisyrinchium atlanticum, BLUE-EYED GRASS. (Iridaceae) The blue-eyed grasses are slender herbs of wet meadows with flattened stems and small, deep-blue flowers with yellow centers subtended by a pair of clasping bracts. The species are quite similar and blurred by variation and intergradation; it is not uncommon to find stems with the supposed characters of two different species growing in a single colony, or even in a single clump. *S. atlanticum,* a common species of the coastal plain, is distinguished by its narrow stems, compound inflorescences, and dark ovaries and capsules. Stems with simple inflorescences occasionally occur mixed with the compound ones, inviting confusion with *S. montanum* or *S. mucronatum.*

S. atlanticum is rare at HF where it has been known for 75 years from moist fields near the buildings: H.M. Raup found it in a field north of the forest school in 1934; K.A. Raup collected it in a meadow behind the administration building in 1947; M.H. Zimmermann re-collected it near HF headquarters in 1958; and we found it near the pond in the pasture in P2 and along Locust Opening Road, in an area that was used as a landing during a logging operation in 1990 and is now mowed annually.


Sisyrinchium atlanticum

Sisyrinchium montanum, COMMON BLUE-EYED GRASS. (Iridaceae) This is the common blue-eyed grass of inland New England, distinguished by a simple inflorescence, stems about 2 mm wide which are distinctly winged, and a green ovary. Surprisingly rare at HF: collected by K.A. Raup in 1947 from a dry woods road on the Prospect Hill Tract, and reported by C.E. Smith (1948) from near HF headquarters, based on two specimens that we did not see; we saw it once, near the saw mill in P2. Also occurs by an old cellar hole in the Schwarz Tract. None of the HF specimens is really typical—the stems tend to be narrow and the ovaries dark—and we think they may be intermediates with, or even single-spathe forms of, *S. atlanticum.*


Sisyrinchium montanum

Sium suave, WATER PARSNIP. (Apiaceae) An aquatic umbellifer with pinnately compound leaves that become limp and highly divided when it grows submerged. Uncommon at HF: first collected by H.M. Raup from the Fay Lot (T9) in 1933. Seen in three compartments in our survey: along the Swift River and in Connor Pond (S5 and S6), in a pool by Dugway Road, and in a number of pools and wetlands in the Simes Tract. The variability in leaf shape has confused more than one botanist: one of the HF collections was originally identified as *Cicuta bulbifera* and another as *C. maculata.*


Sium suave

Smilax herbacea, CARRION FLOWER. (Smilacaceae) A high-climbing, thornless *Smilax* of moist thickets and shores, with rank-smelling flowers and umbels of blue berries. Occasional near streams and ponds at


Smilax herbacea

HF: first collected by H.M. Raup along a woods road in the Prospect Hill Tract in 1933; seen in ten compartments in our survey.

Solanum dulcamara,* COMMON NIGHTSHADE. (Solanaceae) The common climbing nightshade with irregularly lobed leaves, purple-blue flowers, and red berries. Occasional around buildings and in moist thickets at HF: J.G. Jack (1911) said it was occasional; H.M. Raup (1938) reported it for Petersham; W.D. Beal made the first HF collection at the edge of woods in S10 in 1947; and we saw it in five compartments in our survey.


Solanum dulcamara


Solanum nigrum s.l.

Solanum nigrum sensu lato, BLACK NIGHTSHADE. (Solanaceae) A related nonclimbing species with white flowers and black berries, found on open, fertile, recently disturbed piles of dirt. Generally frequent in our area but rare and not previously reported at HF: we saw it in open ground near Lyford House in P1 and in the gravel pit in P9. Our northeastern plants are said to contain both American and European elements. There is a long-standing debate about whether these elements can be distinguished morphologically and, if so, whether they should be treated as separate species. We have not studied the matter and treat the group inclusively here. If the European and American plants are distinguished, the European plants are still called *S. nigrum* and the American plants are called *S. ptychanthum.*


Solidago arguta

Solidago arguta, CUT-LEAVED GOLDENROD. (Asteraceae) An attractive goldenrod of dry rocky woods and open ground, found both on acid and limy soils. It is a clump-forming goldenrod with arched inflorescences, resembling *S. juncea* but with rounder and more sharply toothed basal leaves. The commonest goldenrod of rocky woods and the banks of woods roads at HF and, with *Aster divaricatus,* one of our commonest fall woodland flowers: first collected in 1933 by H.M. Raup from the Tom Swamp Tract; we saw it in 22 compartments in our survey.


Solidago bicolor

Solidago bicolor, SILVER-ROD. (Asteraceae) A wand-like goldenrod with a softly hairy stem and cream-colored flowers, typically found in open dry woods and on dry, partially shaded banks. At least occasional at HF: first collected by H.M. Raup from the Prospect Hill and Tom Swamp Tracts in 1933; confirmed from eight compartments in our survey. This is a late-blooming species that is not easy to identify in early summer, and it may be commoner than our records show.


Solidago caesia


Solidago canadensis

Solidago caesia, BLUE-STEMMED GOLDENROD. (Asteraceae) An arching goldenrod of dry fertile woods with slender, sharply toothed leaves and flowers in an interrupted wand-like cluster. Occasional at HF and perhaps not accurately mapped yet: collected by H.M. Raup from the northern portion of the Slab City Tract in 1937 but apparently not seen by C.E. Smith (1949) or his co-workers; seen seven times in our survey, both on fertile rocky slopes in S7, S8 and the Simes Tract, and in more ordinary woods in P2, P5, P10, and T10.

Solidago canadensis, CANADA GOLDENROD. (Asteraceae) A common, tall, colonial goldenrod with three-veined leaves and arching flower clus-

ters, common in sunny moist fields, more rarely in partial shade along streams and around wetlands. Occasional along streams and in open areas at HF: not collected or reported by H.M. Raup (1938), though doubtless here in his time; collected by C.E. Smith and I.M. Johnston from the Tom Swamp Tract and by I.M. Johnston and R.S. Sigafoos from meadows on Prospect Hill, all in 1947; seen four times in our survey, along woods roads in T3, T9, and the Simes Tract, and on a riverbank in S5. Includes *S. altissima.*

Solidago flexicaulis

Solidago flexicaulis, ZIG-ZAG GOLDENROD. (Asteraceae) A distinctive goldenrod with angled stems, round leaves with sharp teeth, and large flowering heads in an interrupted spike. It is a common plant of rich moist woods but rare and not previously reported at HF where suitable habitat is rare: we confirmed it from the lower slopes of Camel's Hump in the Simes Tract, and saw a young plant that may have been this species but couldn't be confirmed in a small wetland in T2.

Solidago gigantea

Solidago gigantea, GIANT GOLDENROD. (Asteraceae) A common, tall, colonial goldenrod that resembles *S. canadensis* but has whitened, hairless stems and tends to grow in wetter sites. Occasional in pastures and along woods roads at HF: reported for Petersham by H.M. Raup (1938); first collected at HF in 1947 by C.E. Smith from the shore of Riceville Pond; seen five times in our survey, in the pasture in P2, the gravel pit in P9, and openings in P3, S3, and T9. Formerly called *S. serotina,* a name that was previously used for a different species.

Solidago juncea

Solidago juncea, EARLY GOLDENROD. (Asteraceae) A common, clump-forming goldenrod of fields, banks, and open woods, distinguished by the large size, long-tapering basal leaves, and arching flower clusters. Frequent at HF: first collected by H.M. Raup from the eastern part of the Tom Swamp Tract in 1933; seen in 13 compartments in our survey.

Solidago nemoralis

Solidago nemoralis, GRAY GOLDENROD. (Asteraceae) A small, gray-hairy goldenrod with rounded, more-or-less untoothed basal leaves and an arching flower cluster. Vegetative or immature plants without the characteristic arching cluster strongly resemble *S. bicolor* and *S. puberula* and must be carefully distinguished from them. Frequent in old sandy fields and on open, dry roadside banks in our area but scarce at HF: not reported by H.M. Raup (1938); listed as "occasional in dry open fields" by C.E. Smith (1949) and collected four times by him and his colleagues from the Prospect Hill and Tom Swamp Tracts; seen four times, along roads in S6, S9, T6, and T8, in our survey. This was one of a number of old-field species that were collected in a meadow at the top of Prospect Hill in the 1930s and 1940s but are now gone from that location. The meadow has grown in and been reduced to a small patch of mowed grass around the fire tower. Mowed grass is all very well but, as the number of species that we have lost from here shows, it is not a meadow.

Solidago odora, ANISE GOLDENROD. (Asteraceae) A medium-sized, clump-forming goldenrod with arching flowering branches and untoothed leaves which have a strong, pleasant, liquorice smell. Frequent in sandy soils near the coast, uncommon inland. Known at HF from a

single collection by C.E. Smith from the banks of Riceville Pond in 1947. Formerly called *S. suaveolens*.

Solidago puberula, DOWNY GOLDENROD. (Asteraceae) A common goldenrod of dry sandy and rocky soils, with small round leaves, minute stubby hairs on the stem and leaves, and a wand-like inflorescence. Occasional along the main roads and in gravel pits and openings at HF: first collected by H.M. Raup from Prospect Hill in 1933; seen in eight compartments, including the pasture in P2 and the gravel pit in P9, in our survey.


Solidago puberula


Solidago rugosa

Solidago rugosa, ROUGH-STEMMED GOLDENROD. (Asteraceae) A common, colony-forming goldenrod of wide ecological and morphological amplitude, found on roadsides, in fields, in moist woods, and in both open and shaded wetlands. Best distinguished by the arching flower clusters and coarsely toothed stem leaves with pinnate veins. Overall the most common goldenrod at HF where it is somewhat variable but does not resolve into the well-marked varieties that occur on the outer coast; first collected by H.M. Raup from Prospect Hill in 1933; recorded in 31 compartments in this survey.


Solidago uliginosa

Solidago uliginosa, BOG GOLDENROD. (Asteraceae) A medium-sized, clump-forming goldenrod of sphagnum bogs and peaty meadows, often found around bog ponds or in the flooded portions of bog mats. Much like *S. juncea* but with the petiole bases sheathing more of the stem and, at least in some populations, a mixture of arching and wand-like inflorescences. Rare at HF and previously collected only once, by H.M. Raup in 1937, at the north end of Tom Swamp; found in our survey along the causeway in Tom Swamp, and at the east end of the utility right-of-way that crosses T8. The plants here are variable; some look like typical *S. uliginosa*, some seem closer to *S. juncea*. Formerly called *S. uniligulata* and including *S. purshii*.


Sonchus asper

Sonchus asper,* SPINY SOW-THISTLE. (Asteraceae) A weedy annual composite with large heads of ligulate yellow flowers and spiny leaves with rounded auricles. A widespread roadside weed in our area but not previously reported from HF; observed twice, on a roadside bank by Connor Pond and in the pasture in P2, in our survey.

Sorbaria sorbifolia,* FALSE SPIRAEA. (Rosaceae) A cultivated shrub with leaves resembling the mountain ash and sprays of small white flowers resembling a spiraea. Frequently cultivated in old-fashioned gardens and widely but casually escaped to roadsides, woodland openings, and waste ground. Known at HF only from a single record, along Rt. 32 near Lyford House and in nearby woods (P1), in our survey.


Sorbaria sorbifolia


Sorbus americana

Sorbus americana, AMERICAN MOUNTAIN ASH. (Rosaceae) A small native tree of moderate and high elevations, widely cultivated and spread by birds and seen commonly, mostly as small seedlings, in lowland woods. J.G. Jack (1911) said it was "Rather rare, in woods and along roadsides;" we found it frequent throughout HF, and recorded it in 21 compartments.

Sparganium americanum, AMERICAN BUR-REED. (Sparganiaceae) This is the common large bur-reed of open wetlands in our area, distinguished by broad leaves and axillary heads of flowers and fruits. It is locally common at HF where it was first collected by H.M. Raup from the shore of Harvard Pond in 1933; we confirmed it from eight compartments and saw sterile plants that were likely this species in three others.

Sparganium americanum

[**Sparganium angustifolium**, NARROW-LEAVED BUR-REED. (Sparganiaceae) A floating-leaved species in which the flowering heads are raised above the leaf axils. Listed by H.M. Raup (1938), likely based on a specimen (Raup *4905*) collected in 1933 from Tom Swamp. The specimen seems to be this species but cannot be confirmed. Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.]

Sparganium erectum, GREEN-FRUITED BUR-REED. (Sparganiaceae) A smaller bur-reed, growing as an emergent or in shallow water, distinguished from *S. americanum* by its narrower leaves, supraxillary pistillate heads, and long-beaked achenes. Very common in open wetlands and softwater ponds in the mountains but less common in the lowlands and near the coast. Apparently rare at HF where it was first collected by I.M. Johnston and W.D. Beal from Riceville Pond in 1947; we saw it nearby, in T8 and also at Connor Pond (S6) in our survey. Also called *S. chlorocarpon.*

Sparganium erectum

Spergularia rubra

Spergularia rubra,* COMMON SAND-SPURRY. (Caryophyllaceae) One of the small, opposite-leaved miniweeds of sandy roadsides, resembling its co-familials *Sagina procumbens, Scleranthus annuus,* and *Arenaria serpyllifolia* and often growing with one or more of them. Its distinguishing marks are its papery stipules and rose-pink flowers. Occasional along roads at HF but not reported in previous studies; seen in P1, P2, P9, S10, and T11 in our survey.

Sphenopholis obtusata var. **major**, SLENDER WEDGEGRASS. (Poaceae) Delicate, silvery, nodding mid-summer grass of moist fertile woods, looking something like a poa but with the characteristic broad second glume of *Sphenopholis.* Not previously reported from HF; seen once, on a fertile rocky cobble with a number of other rich woods indicators in S7, in our survey. Formerly called *S. intermedia* and treated as a separate species; now demoted to a variety of *S. obtusata.* All that has really changed is the name.

Sphenopholis obtusata var.major

Spiraea alba, MEADOW-SWEET. (Rosaceae) The native white spiraea of meadows and open wetlands, listed as common in "pastures, open woods, moist ground, and roadsides" by J.G. Jack (1911) and remaining so today. The pastures he found it in are gone but it has persisted along woods roads and in open wetlands: we found it in 26 compartments in our survey. Also called *S. latifolia*, a name which assumes that the relatively broad-leaved spiraeas of New England are a separate species from the narrower leaved plants of western New York and the Midwest. We, like many other botanists, see the two as intergrading varieties of a single species and use the Linnaean name *S. alba* for them both.

Spiraea alba

Spiraea tomentosa, STEEPLEBUSH. (Rosaceae) The native pink-flowered spiraea of wet meadows and hummocks in wetlands. Listed as common in pastures and low grounds at HF by J.G. Jack (1911). It is only occasional today and, in sharp contrast to meadowsweet, has retreated to what may have been its original habitat and is now found mostly in or near wetlands: we recorded it in nine compartments, all but two of which were in the Tom Swamp Tract.


Spiraea tomentosa


Spiranthes cernua

Spiranthes cernua, COMMON LADY'S TRESSES. (Orchidaceae) The common lady's tress of moist open ground, with a relatively thick inflorescence containing several spirals of flowers. Apparently uncommon at HF: collected from the Fay Lot (T9) and a woods road in the Prospect Hill Tract by H.M. Raup in 1933, and near the Forest Cottage (P1) by N.W. Hosley in the same year; also collected in T8 by C.E. Smith in 1947, and near HF headquarters by M.H. Zimmermann in 1957. Seen only once, in the gravel pit in T6, in our survey.

Spiranthes lacera, SLENDER LADY'S TRESSES. (Orchidaceae) A more delicate species of open dry ground, with small flowers in a single spiral. Known at HF from a 1938 H.M. Raup collection from the Fay Lot (T9), a specimen from a "dry, sunny, rocky slope in open" in T8 by I.M. Johnston in 1947, and one by C.E. Smith from open dry woods on Prospect Hill, also in 1947. Also called *S. gracilis*.


Sporobolus vaginiflorus

Sporobolus vaginiflorus, SHEATHED DROPSEED. (Poaceae) A small annual native grass of dry sandy soils, with the flowers partially concealed in the leaf sheaths. Frequent along sandy roadsides in our area. Apparently uncommon at HF: collected by I.M. Johnston from a "former CCC camp" near Riceville Pond in 1947, presumably in Petersham State Forest and not on HF property; we saw it once, on the side of Rt. 122 in S7, in our survey.


Stellaria graminea

Stellaria borealis, NORTHERN STICHWORT. (Caryophyllaceae) A small, native chickweed, very erratically distributed along brooks and in open wetlands, distinguished by its small flowers, green bracts, short petals, and smooth seeds. It is a species seen most frequently in the mountains that becomes scarce in the lowlands and near the coast. Known at HF only from a 1933 collection by H.M. Raup, from the Fay Lot (T9). Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.


Stellaria media

Stellaria graminea,* GRASS-LEAVED CHICKWEED. (Caryophyllaceae) The common slender-leaved chickweed of wet meadows, weedy and common in hay meadows throughout our region but scarce at HF where the meadows are largely gone. Somewhat surprisingly, not listed for Petersham by H.M. Raup (1938). Collected near the woodpile behind the HF buildings by W.D. Beal in 1947, and in the field in P9 in our survey.

Stellaria media,* COMMON CHICKWEED. (Caryophyllaceae) The weedy annual chickweed of cultivated ground, with rounded leaves and a single line of hairs on the stems. Occasional at HF, mostly in cultivated ground and near the buildings: listed for Petersham by H.M. Raup (1938) and col-

lected by W.D. Beal from the east part of Tom Swamp Road in 1947, which may or may not have been within HF. Seen in four compartments (P1, P2, P9, P10) in our survey, all near the HF headquarters.

Streptopus roseus, ROSE TWISTED-STALK. (Liliaceae) A common herb of moist fertile woods, resembling Solomon's seal but with sharper leaves with ciliate margins and rose-pink flowers. Rare in the acid soils at HF: first collected by H.M. Raup in the eastern part of the Tom Swamp Tract in 1933, and then by W.D. Beal near the Swift River in S10; seen once in our survey, on the lower slopes of Camel's Hump in the Simes Tract. Includes *S. longipes*, a form alleged to have a longer rhizome and fewer cilia on the leaves.

Streptopus roseus

Symphoricarpos albus var. **laevigatus,*** CULTIVATED SNOWBERRY. (Caprifoliaceae) A white-berried shrub with opposite leaves occurring in western New England as a small native shrub of dry fertile woods and in our area as a large cultivar that occasionally escapes. Rare at HF: J.G. Jack (1911) said it was a rare escape from cultivation; H.M. Raup (1938) listed it for Petersham, but did not collect any vouchers; C.E. Smith (1949) said it occurred in S10, citing a voucher that we did not see. We saw it once, in the pasture by Lyford House in P1.

Symphoricarpos albus var.laevigatus

Symplocarpus foetidus, SKUNK CABBAGE. (Araceae) A common, early-flowering herb of wooded swamps, with large fleshy leaves and balls of yellowish flowers in thermogenic spathes. Uncommon at HF and not reported by previous surveys; we found it in swampy ground near the Swift River in S2, S4, and S5, and in P2.

Symplocarpus foetidus

[**Syringa vulgaris**,* LILAC. (Oleaceae) A common cultivar that can persist for a hundred years or more around an abandoned cellarhole, but only rarely is truly adventive. J.G. Jack (1911) said that it had escaped from cultivation, but whether he meant that it persists without cultivation or spreads to new places is unclear. We saw it once, at the edge of the meadow in P9, and could not tell whether it was naturalized or not.]

Tanacetum vulgare,* TANSY. (Asteraceae) A tall, strong-smelling, weedy composite with divided leaves, small yellow heads in a flat-topped cluster, and a taste for gravelly soils and railroad ballast. Generally common on roadsides and old railroad grades in our area but rare at HF: reported for Petersham by H.M. Raup (1938) but not vouchered; seen in P1 and P2, both near Shaler Hall, in our survey.

Tanacetum vulgare

Taraxacum officinale,* COMMON DANDELION. (Asteraceae) The common dandelion of meadows and lawns everywhere. Common in lawns and on the grassy edges of roads at HF but, as is often the case with very common plants, poorly vouchered here. Listed for Petersham by H.M. Raup (1938) and C.E. Smith (1949); collected by Mrs. Gast from the 'French Place', possibly in P10, at an unknown date; and seen in 17 compartments in our survey. Formerly called *T. palustre* var. *vulgare* and, since the naming of variant dandelions was a cottage industry among botanists in the early 20th century, many other things before that.

Taraxacum officinale

Taxus canadensis, CANADA YEW. (Taxaceae) Our native yew, frequent in the understory of fertile woods but often much browsed and reduced by deer. Listed as frequent in "shady woods" (Aren't they all?) by J.G. Jack (1911); first collected by S.M. Dohanian in 1913 in the Slab City Tract; collected by H.M. Raup from "woods on height of land" at the north end of the Tom Swamp Tract in 1933; also collected along Dugway Road (Simes Tract) by C.E. Smith, probably in 1947, in a collection we did not see; found in nine compartments in the Slab City, Tom Swamp, and Simes Tracts in our survey. Also recorded from P7 in 1992, where it probably still occurs but was missed in this survey.


Taxus canadensis


Thalictrum pubescens

Thalictrum pubescens, TALL MEADOW-RUE. (Ranunculaceae) A tall herb with multiply ternate leaves, rounded leaflets, and sprays of petalless white flowers with showy stamens and styles. Common at HF, as elsewhere, on the shores of streams and ponds: first collected by H.M. Raup from the Tom Swamp Tract in 1933; found in ten compartments, along the whole length of the Swift River and around all the major ponds, in our survey. Formerly called *Thalictrum polygamum.*


Thelypteris noveboracensis

Thelypteris noveboracensis, NEW YORK FERN. (Thelypetridaceae) The common double-tapered, light-green fern that forms large patches in open woods. Very common at HF where it was found in 31 compartments in our survey. Like all the Dryopteroid and Thelypteroid ferns it has spent time in many different genera and families. H.M. Raup (1938) called it *Dryopteris noveboracensis,* C.E. Smith called it *Lastrea noveboracensis,* and others in the same period called it *Aspidium noveboracense.* Twentieth century botany, lacking an uncertainty principle of its own, made do with what it had.


Thelypteris palustris

Thelypteris palustris, MARSH FERN. (Thelypteridaceae) A common, twice-cut patch-forming fern of open wetlands, recognized by its narrowly triangular outline and long leaf stalks with dark bases. Common on pond shores and around the edges of bogs at HF were it was first collected in 1933 by H.M. Raup from the Tom Swamp Tract; also found on stream banks and some wooded wetlands. We recorded it in 13 compartments in our survey. Also called *Aspidium thelypteris, Dryopteris thelypteris,* and *Lastrea thelypteris.*


Thelypteris simulata

Thelypteris simulata, MASSACHUSETTS FERN. (Thelypetridaceae) A characteristic fern of coastal plain swamps, becoming less common but still widely distributed inland. Resembling marsh fern but more clumped and with the blades more tapered to the base, the veins of the sterile leaves unforked, and the indusia covered with tiny glandular hairs. Occasional in wooded swamps and at the edges of bogs in HF: first collected by H.M. Raup in 1934 in Tom Swamp; re-collected by P. Smith from the western portion of the Tom Swamp bog in 1940 and by I.M. Johnston in 1947 from a pool in P2. Seen in six compartments, including P2, S4, three places in the Tom Swamp Tract, and a pool at the Simes Tract, in our survey. Like the other thelypteroid ferns, also placed in *Dryopteris* and *Lastrea.*


Thuja occidentalis

Thuja occidentalis, NORTHERN WHITE CEDAR. (Cupressaceae) A common tree of northern shores and wetlands, planted and occasionally

escaped in our area. Known at HF from a 1958 collection by H. Swope from the Kitchen Road (Prospect Hill Rd.), and a few small trees, possibly the same ones seen by Swope, observed in P4 in our survey. A few small trees were also found in wet woods behind Lyford House in P1.

Thymus pulegioides,* WILD THYME. (Lamiaceae) A small, sweet-scented garden creeper, widely naturalized and forming low patches in lawns and on grassy roadsides. Not previously reported from HF; currently known from a single large patch at the south end of the lawn of Shaler Hall and a small patch in the lawn behind the Torrey Laboratory, both in P1. Formerly *T. serpyllum*, the Linnaean name for a different thyme.

Thymus pulegioides

Tiarella cordifolia, FOAM FLOWER. (Saxifragaceae) A common spring wildflower of moist fertile ground with heart-shaped and slightly angular basal leaves and a raceme of delicate white flowers. Uncommon at HF where the soils are mostly too acid for it. Listed by H.M. Raup (1938) for Petersham but not vouchered for HF; first collected here by C.E. and E.E. Smith from a swamp near Camel's Hump (Simes Tract) in 1949; found there and in seven compartments along the Swift River in our survey, but not in the Prospect Hill or Tom Swamp Tracts.

Tiarella cordifolia

Tilia americana, BASSWOOD. (Tiliaceae) A common forest and hedgerow tree of fertile soils. Occasional and scattered at HF: J.G. Jack (1911) said it occurred mixed with other trees in rich situations; R.R. Chaffee collected it in 1908 from the Meadow Water (Tom Swamp) Tract, and S.M. Dohanian collected it in 1913 on what he (but apparently no one else) called Dogwood Hill, which may or may not have been on HF; we located it on Camel's Hump but also found it in eleven other compartments in all three of the major tracts, sometimes in association with other fertile-soil species and sometimes in what appeared to be ordinary woodlands.

Tilia americana

Torreyochloa pallida, PALE MANNA GRASS. (Poaceae) A wetland grass, occurring in both erect and creeping forms, with small, elongate, many-nerved lemmas with papery tips. It is reasonably common in open wetlands and pond shores in our area, especially near the coast. Not previously reported from HF but at least occasional here: we found it around ponds and in small swampy wetlands in six compartments, in all the major tracts. Also called *Glyceria pallida* and *Puccinellia pallida*. Both are good tries but neither really fits. On the one hand, it generally resembles several species of *Glyceria* but differs in technical characters; on the other it agrees in many technical characters with *Puccinellia* but has a different ecology and doesn't look much like other species in that genus. Splitting the difference, it probably deserves its own genus.

Torreyochloa pallida

Toxicodendron radicans, POISON IVY. (Anacardiaceae) The common viny poison ivy of inland New England. Common but somewhat local at HF where it is usually near water, and more common on the forest floor than in the open or up in trees. J.G. Jack (1911) said it was "very common" at HF and that while it usually trailed or climbed it was "sometimes bushy or shrub-like." This may indicate that the bushy poison ivy of the New England coast once occurred here*. We found poison ivy in 30 compart-

Toxicodendron radicans

* *Toxicodendron* taxonomy is a bit muddled, partly because the leaves and inflorescences vary greatly, partly because a plant that doesn't have tendrils in the shade may develop them in a gap, and partly because very few botanists go out of their way to collect them. The bushy poison ivy of the New England coast agrees in a general way with the segregate species *T. rydbergii*, but thus far is not usually called that. Sorrie and Somers (1999) list *T. rydbergii* for Massachusetts, but not for the outer coast.

ments in our survey, always creeping or climbing and never as an erect shrub. Formerly called *Rhus radicans*; now placed with the other poisonous rhuses with white flowers and waxy berries in the segregate genus *Toxicodendron*.


Toxicodendron vernix

Toxicodendron vernix, POISON SUMAC. (Anacardiaceae) A small poisonous tree of wetlands and wet thickets with pithy branches and alternate compound leaves which often have red petioles. Commonest in limy swamps but also found in acid swamps and even, occasionally, on hummocks in bogs. J.G. Jack (1911) said it was frequent in wet ground and in swamps, and C.E. Smith (1949) noted that it was occasional in swamps on the Prospect Hill Tract and in the Fay Lot (T9); we found it four times, in swamps in P2, S6, and T8, and once out on an open bog mat in T9. Formerly called *Rhus vernix*.


Tragopogon pratensis

Tragopogon pratensis,* YELLOW GOAT'S-BEARD. (Asteraceae) A tall, glaucous, slender-leaved composite with yellow ligulate flowers and wonderfully puffy heads of achenes with webbed bristles. A common European weed of waste ground and roadsides. Not previously reported from HF: seen twice in our survey, in the field by Rt. 32 in P9 and along the highway in T6.


Triadenum virginicum

Triadenum fraseri, MARSH ST. JOHN'S-WORT. (Clusiaceae) The two marsh St. John's-worts, *T. fraseri* and *T. virginicum*, are very similar plants with oblong, rounded, opposite leaves that meet at their bases and small clusters of pink flowers at the top of the plant. The two species differ by about a millimeter in the length of their sepals and styles, and perhaps by a tiny amount in the roundness of the sepal tips. They often grow together in open peatlands, and to tell them apart you need either a very good eye or a ruler. Even Fernald (1950), who had no qualms about listing 207 species of blackberries and 107 of hawthorns, considered them varieties of a single species. The common practice today, however, is to treat them as two species, and we follow that here.

Triadenum fraseri is the smaller, more rounded, and more northerly of the two, and apparently scarce at HF where it is represented by a single collection from "Tom Swamp, east of the Fay Lot" by I.M. Johnston in 1947. It was formerly called *Hypericum virginicum* var. *fraseri* and *Triadenum virginicum* var. *fraseri*.


Trichostema dichotomum

Triadenum virginicum, LARGE MARSH ST. JOHN'S-WORT. (Clusiaceae) This is the slightly larger species that is common southwards and at lower elevations. It appears to be the common *Triadenum* in marshes and peaty shores at HF: we have records of one species or another at nine wetlands and ponds at HF. Thus far we have confirmed *T. virginicum* at six of them, but probably need to make a more systematic study.

Trichostoma dichotomum, BLUE CURLS. (Lamiaceae) A small, densely glandular and strongly aromatic mint of dry soil, with rounded leaves and blue flowers with the stamens in a spectacular ram's-horn curl. Frequent in coarse disturbed soils in our area but rare at HF: a 1947 Johnston collection from a "dry sandy place at roadside, near Riceville Pond" is

probably outside of HF; we saw it once, on the HF edge of the gravel pit at the southern boundary of S9.

Trientalis borealis, STARFLOWER. (Primulaceae) A common wildflower of acid woods and wetlands, found throughout HF under both conifers and hardwoods: first collected in 1909 by W.A. Stalker in the Tom Swamp Tract; we recorded it in 31 compartments. Our plants were formerly called *Trientalis americana.*

Trifolium arvense,* RABBIT-FOOT CLOVER. (Fabaceae) A small, narrow-leaved clover with inconspicuous pink flowers in furry-looking heads, common along roadsides and in disturbed ground. Uncommon at HF where it was first collected in 1947 by W.D. Beal from near the woodpile in P1 and seen twice in our survey, near the sawmill in P2 and by Rt. 122 in T11.

Trifolium aureum,* LARGE YELLOW HOP-CLOVER. (Fabaceae) The largest of our yellow clovers, formerly cultivated and now a familiar weed in many habitats. Uncommon at HF: first collected in 1934 by H.M. Raup from a field near the forest school; seen three times in our survey, near the buildings in P2, in the gravel pit in P9, and along Rt. 122 in T6. Formerly called *T. agrarium*, a Linnaean name that was also applied to the next species and is now rejected as an ambiguous name.

Trifolium campestre,* LOW HOP-CLOVER. (Fabaceae) A smaller species with a longer stalk on the terminal leaflets than on the lateral ones. It is weedy and common in waste places in our general area but uncommon at HF, where it has not been previously reported: we found it twice, near Shaler Hall in P1 and near the sawmill in P2. It was formerly called *T. agrarium* and *T. procumbens,* two poorly typified Linnaean names that have been applied to other species as well and are now rejected as ambiguous names.

Trifolium pratense,* RED CLOVER. (Fabaceae) This is the common large red clover, long cultivated as a nitrogen-fixer and forage crop and established in meadows and roads throughout our area. First collected near HF by N.W. Hosley (Wilder's Farm) in 1933. Now common in meadows and pastures and occasional along woods roads; we saw it in nine compartments in our survey.

Trifolium repens,* WHITE CLOVER. (Fabaceae) The common creeping white clover of meadows and lawns, long cultivated and widely escaped along roads. Not listed for Petersham by H.M. Raup (1938), and first collected by W.D. Beal from the Fay Lot (T9) in 1947. Now common in lawns and meadows and occasional along woods roads at HF: we saw it in ten compartments in our survey.

Trillium erectum, RED TRILLIUM, WAKE-ROBIN. (Liliaceae) The deep-red trillium of mesic woods, common on fertile soils but uncommon or occasional on the acid ones at HF: first collected by W.A. Stalker from the Tom Swamp Tract in 1909; listed for Petersham by H.M. Raup (1938) but not, surprisingly, by C.E. Smith (1948); seen in small quantities in P6,


Trientalis borealis


Trifolium arvense


Trifolium aureum


Trifolium campestre


Trifolium pratense


Trifolium repens


Trillium erectum

P10, S3, T2, T4, and T5, and more plentifully in rocky fertile woods in S8 and in the Simes Tract. A few plants at the edge of woods behind the Lyford House in P1 may have naturalized from garden plantings.

Trillium undulatum, PAINTED TRILLIUM. (Liliaceae) The small, wavy-petaled trillium with white petals marked with red of swamps and moist conifer woods, common in our area and preferring acid soil. Frequent at HF: first collected by W.A. Stalker from the Prospect Hill Tract in 1909; found in 18 compartments in our survey.

Tsuga canadensis, EASTERN HEMLOCK. (Pinaceae) A tall, feathery evergreen of moist soils and middle elevations, common at HF and locally dominant on many sites. J.G. Jack (1911) said that it was "common on cool north situations and occasionally as an understory to white pine." In the last hundred years the understory trees have matured, and it is now common on sites of many different aspects. We found it in 32 compartments in our survey.

Typha angustifolia, NARROW-LEAVED CATTAIL. (Typhaceae) The smaller and better tasting of our two cattails, common near the coast and in calcareous wetlands inland, and distinguished by the narrower leaves and spikes and the separation between the male and female spikes. Not previously reported from HF; seen once in our survey, from a wetland at the north end of the Simes Tract.

Typha latifolia, BROAD-LEAVED CATTAIL. (Typhaceae) The common broad-leaved cattail of ditches and marshes, frequent in actively sedimenting wetlands and in situations that receive saline or mineral-rich runoff. Uncommon in the peatlands at HF: not listed for Petersham by H.M. Raup (1938); said to occur occasionally in marshes and ponds by C.E. Smith (1948), citing a specimen from T9 that we did not see; seen three times, in T7, T8, and the Simes Tract, in our survey.

Ulmus americana, AMERICAN ELM. (Ulmaceae) Our common elm, formerly a tall tree of streets and pastures, now much reduced by disease and mostly seen as small trees in hedgerows and thickets. J.G. Jack (1911) said it was "common, in woods and fields" at HF; we found it at most occasional, absent from the few remaining fields and mostly in forest edges rather than interiors, in eight compartments in our survey.

Urtica dioica, COMMON STINGING NETTLE. (Urticaceae) The opposite-leaved stinging nettle of farmyards, wet thickets, and waste ground, believed to be a mixture of European and American forms, and commonest around settlements. Typically preferring fertile soils and thus uncommon at HF: reported by H.M. Raup (1938) but apparently first collected by I.M. Johnston from the east side of Prospect Hill in 1947. Seen in small quantities in P10 in our survey. Formerly the American plants were separated from the European and called *U. gracilis* and *U. procera*; these separations, which were at best very weak, have now been abandoned and all our nettles are included in the Linnaean *U. dioica*.


Trillium undulatum


Tsuga canadensis


Typha angustifolia


Typha latifolia


Ulmus americana


Urtica dioica


Utricularia cornuta

Utricularia cornuta, HORNED BLADDERWORT. (Lentibulariaceae) This is the large, bright yellow, terrestrial bladderwort that grows on wet peat mats and in hollows in bogs. Somewhat surprisingly it has not been previously reported from HF; currently it is locally common on the floating peat islands at Harvard Pond but not, so far as we know, at either Riceville Pond or Connor Pond.

Utricularia geminiscapa, TWINSCAPE BLADDERWORT. (Lentibulariaceae) A small aquatic bladderwort of bog ponds, resembling *U. vulgaris* but more delicate and with the leaves less forked and the leaf segments less spiny. It commonly produces cleistogamous underwater flowers but only rarely surface ones, and is easy to overlook if you don't know the leaves. Not previously reported from HF but present in Gould's Bog, in beaver ponds in T5 and in the Simes Tract, and in the three major ponds; locally common in shallow pools among the bog mats in Harvard and Riceville Ponds.


Utricularia geminiscapa

Utricularia gibba, GIBBOUS BLADDERWORT. (Lentibulariaceae) A very delicate aquatic bladderwort with slender leaves that only fork once or twice, found in bog ponds in both soft and hard water. Typically grows mixed with other vegetation and only flowers when it is washed ashore or stranded by dropping water levels. Apparently rare at HF where it was first collected by H.M. Raup from Harvard Pond in 1933 and then recollected there by W.D. Beal and I.M. Johnston in 1947; looked for there several times but not relocated in our survey; and finally found flowering on the shore of Connor Pond (S6) in 2005.


Utricularia gibba

Utricularia purpurea, PURPLE BLADDERWORT. (Lentibulariaceae) An aquatic bladderwort with whorled branches and pale rose-purple flowers, common in softwater ponds. This is probably the most common bladderwort at HF: it was first collected by H.M. Raup at Harvard Pond in 1933, and was seen in Harvard, Riceville, and Connor Ponds in our survey.


Utricularia purpurea

Utricularia radiata, INFLATED BLADDERWORT. (Lentibulariaceae) A distinctive aquatic bladderwort in which the flowering stalks are supported by a whorl of inflated leaves. Not previously reported from HF, but now locally common in Harvard and Riceville Ponds. Formerly treated as the northern variety *minor* of the coastal plain species *U. inflata*; now considered a separate species.


Utricularia radiata

Utricularia vulgaris, COMMON BLADDERWORT. (Lentibulariaceae) Our largest bladderwort, an aquatic species with dense, fat, snaky, underwater branches and bright yellow flowers, common in a variety of types of ponds. Locally plentiful at Harvard Pond, where it was first collected by H.M. Raup in 1934; also seen in our survey in Connor Pond and in beaver ponds in the Simes Tract and in T5, but not thus far in Riceville Pond. If our plants are separated from the European ones they are called *U. macrorhiza*; if, as here, they are combined with them they get the Linnaean name *U. vulgaris*.


Utricularia vulgaris


Uvularia perfoliata

Uvularia perfoliata, PERFOLIATE BELLWORT. (Liliaceae) A bellwort with smooth, clasping leaves and flowers with petals that are roughened inside, commonly found in fertile dry woods. Known from HF from a 1951 collection by W.H. Hatheway from Camel's Hump, where we relocated it in this survey.

Uvularia sessilifolia, BELLWORT. (Liliaceae) The common bellwort of deciduous woods, tolerant of logging and acidity and so very widely distributed in our area. It is found throughout HF, usually in fairly small quantities; first collected in 1933 by H.M. Raup from the Barre Woods (Slab City) Tract; we recorded it from 28 compartments in our survey. Formerly called *Oakesia sessilifolia.*

Uvularia sessilifolia

Vaccinium angustifolium, EARLY LOWBUSH BLUEBERRY. (Ericaceae) The common lowbush blueberry of open acid woodlands, very common at HF: J.G. Jack (1911) said it was common in dry situations, woods and fields; we found it in 32 compartments in our survey. Formerly called *V. pensylvanicum.*

Our blueberries form a polyploid series. *Vaccinium pallidum* and *V. myrtilloides* are diploids, as are the northern *V. boreale* and several southern species. The diploids tend to occupy separate ranges but are interfertile and hybridize when they meet. The hybrids tend to be local, but some have produced polyploid derivatives with wider ranges than their parents. *V. angustifolium* is a wide-ranging hybrid tetraploid, one of whose parents is likely *V. boreale. V. corymbosum* is a genetic complex that includes diploid, tetraploid, and hexaploid forms and may have four diploid species, including *V. myrtilloides* and *V. pallidum*, as its ancestors.

Vaccinium angustifolium

Vaccinium corymbosum, HIGHBUSH BLUEBERRY. (Ericaceae) Our common highbush blueberry of swamps, fields, pond shores and moist woods. As befits its multiply hybrid origins, it is a variable species in which it is easy to find distinctive forms but hard to assign them any fixed taxonomic identity.* It is common at HF: J.G. Jack (1911) said that it was common in swamps or dry situations; we found it in all compartments in our survey. Plants with black fruit and very furry leaves were formerly called *V. atrococcum*; they now are included, with many other forms, in a broadly defined *V. corymbosum.*

Vaccinium corymbosum

Vaccinium macrocarpon

Vaccinium macrocarpon, LARGE CRANBERRY. (Ericaceae) The common large cranberry of bogs and wet peaty sands, locally common at HF. J.G. Jack (1911) said it was "Plentiful on some sphagnum covered-bogs;" we found it in the bogs at Riceville and Harvard Ponds in our survey.

Vaccinium myrtilloides, VELVET-LEAF BLUEBERRY. (Ericaceae) A small northern blueberry of conifer swamps and cold barren fields, recognized by the furry leaves and twigs. Rare at HF: J.G. Jack (1911) said it was "apparently uncommon;" I.M. Johnston collected it among evergreens in the south end of T9 in 1947; we saw there and in T6 in our survey. Formerly called *V. canadense*, a later name.

Vaccinium myrtilloides

Vaccinium oxycoccos

*Despite the difficulty many have tried. Van der Kloet (1988) lists 28 species-level synonyms for *Vaccinium corymbosum* and an additional 16 named varieties and forms.

Vaccinium oxycoccos, DWARF CRANBERRY. (Ericaceae) The wren's-egg cranberry of bog mats, recognized by the small, triangular leaves with involute margins. Rare at HF: reported for the Meadow Water Tract (Tom Swamp Tract) by J.G. Jack (1911) and collected by him in the "Riceville Swamp" in 1912; re-collected in the same general area by H.M. Raup in 1933 and W.H. Drury and W.D. Beal in 1947; and seen twice, on the bog mat at Harvard Pond and on the utility right-of-way in T8, in our survey.

Vaccinium pallidum, LATE LOWBUSH BLUEBERRY. (Ericaceae) A common lowbush blueberry of both dry and moist woods, similar to the early lowbush blueberry *V. angustifolium* and perhaps one of its ancestors, and best distinguished by the broader, paler, and less regularly toothed leaves. None of these characters works all the time, and individual plants occur which seem impossible to distinguish. Widely distributed and frequent at HF but definitely less common than *V. angustifolium*: J.G. Jack (1911) said it was "Common, dry soil;" we found it in 27 compartments in our survey. Formerly called *V. vacillans,* a later name.

Veratrum viride, WHITE HELLEBORE, AMERICAN HELLEBORE. (Liliaceae) A large-leaved herb of bottomlands and alluvial soil, less poisonous than the black hellebore of Europe and unrelated to it. Frequent at HF, most commonly in gravely soil near streams: listed for Petersham by H.M. Raup (1938) and as "common in wet woods and along streams" by C.E. Smith (1948); apparently first collected by K.A. Raup in 1947 along the Swift River, at the south end of the Slab City Tract. Seen in 13 compartments in our survey.

Verbascum thapsus,* COMMON MULLEIN. (Scrophulariaceae) The common mullein with the gray-hairy leaves and tall fruiting spikes, found in disturbed soil on roadsides, in woods, and in waste ground. Uncommon at HF: first collected by N.W. Hosley in 1933 from near the Forest Cottage; seen four times, on roadsides and near buildings, in P1, P9, P10, and T6, in our survey.

Verbena hastata, BLUE VERVAIN. (Verbenaceae) The common blue vervain of wet meadows, ditches and shores. Uncommon at HF: listed for Petersham by H.M. Raup (1938); first collected by I.M. Johnston from T4 in 1947; seen twice near there, in T5 and T6, in our survey.

Veronica arvensis,* FIELD SPEEDWELL. (Scrophulariaceae) A small, weedy, annual speedwell with hairy stems, oval leaves, and flowers in leafy racemes. Not previously reported from HF; seen twice in our survey, from near the buildings in P1 and in the gravel pit in P9.

Veronica officinalis,* COMMON SPEEDWELL. (Scrophulariaceae) A small, creeping, somewhat evergreen speedwell with furry, oblong leaves, widely established in woods and thickets. Frequent in open woods at HF: first collected from a woods road in the Tom Swamp Tract by H.M. Raup in 1933; seen in 11 compartments in our survey.


Vaccinium pallidum


Veratrum viride


Verbascum thapsus


Verbena hastata


Veronica arvensis


Veronica officinalis


Veronica scutellata

Veronica scutellata, MARSH SPEEDWELL. (Scrophulariaceae) A native speedwell of open marshes and shallow streams and pools, recognized by its narrow leaves and long-stalked flowers. Apparently rare at HF: first collected on the shore of Riceville Pond by W.D. Beal in 1947; reported from Dugway Road by C.E. Smith (1949); relocated there, in a small pool on the border of the Simes Tract, and in S6 in our survey.

Veronica serpyllifolia,* THYME-LEAVED SPEEDWELL. (Scrophulariaceae) A small, weedy speedwell of lawns and waste ground with perennial roots, stems that creep at the base, small elliptical leaves, and terminal racemes of small flowers. Uncommon at HF: first collected by H.M. Raup from the Slab City Tract in 1933; seen three times in our survey, near buildings or by roads in P1, P9, and P10.


Veronica serpyllifolia


Viburnum acerifolium

Viburnum acerifolium, MAPLE-LEAVED VIBURNUM. (Caprifoliaceae) A shrub with lobed, softly hairy, opposite leaves, common in oak and pine forest on dry soils. J.G. Jack (1911) said it was common in "dry woods, openings, and roadsides;" we recorded it in 29 compartments in our survey.

Viburnum dentatum var. **lucidum,** SMOOTH ARROWWOOD. (Caprifoliaceae) A tall viburnum with angled twigs and toothed oval leaves, common in thickets and open wetlands. While basically a wetland species, it is also common in abandoned pastures, and seems to have persisted in the understory as these pastures turned into woods. J.G. Jack (1911) said it was common in open woods and on roadsides. We found it in 26 compartments in our survey. Our plants are the more northern and less hairy members of a wide-ranging complex, and are often separated from the southern *V. dentatum* as *V. recognitum.*


Viburnum dentatum var.lucidum

Viburnum lantanoides, HOBBLEBUSH. (Caprifoliaceae) A more northerly species with furry buds and large oval leaves, commonest in moist woods at medium elevations. J.G. Jack (1911) said it was represented by "numerous colonies and individuals, mainly in rich shady woods." We might quarrel about the richness but not the abundance: we saw it in 26 compartments in our survey. Often called *V. alnifolium.*


Viburnum lantanoides

Viburnum nudum var. **cassinoides**, WILD RAISIN. (Caprifoliaceae) A distinctive opposite-leaved shrub with glossy elliptic leaves and elongate orange-red buds with two outer scales. It is most commonly found on pondshores and in shrubby peatlands, but where the soils are acid enough it also occurs in ordinary moist woods. Common and very widely distributed at HF: J.G. Jack (1911) said it was very common in "rich moist soils and swamps." Again we might disagree about the richness. We found it in woods, along roads, on shores, and in wetlands, in 26 compartments in our survey. Often, and with considerable justice, treated as the distinct northern *V. cassinoides* rather than as a variety of the southern *V. nudum*.


Viburnum nudum

Viburnum opulus, HIGHBUSH CRANBERRY. (Caprifoliaceae) A tall, sparse viburnum with heart-shaped leaves and red berries, found along roads, in hedgerows, and in open wetlands. The species is circumboreal

and some of its European relatives are cultivated here; our wild plants are generally believed to be American natives, but whether there is really evidence for this is unclear. Known at HF only from a 1913 collection from the Prospect Hill Tract by S.M. Dohanian. The American plants in the complex were formerly called *V. trilobum*. Now they are generally included in the Linnaean *V. opulus.*

Viburnum sp.

Vicia cracca

Viburnum sp.,* UNKNOWN CULTIVAR. (Caprifoliaceae) A shrub with large, round, opposite leaves, found once along the Swift River in S3 during this survey, appears to be an alien viburnum, presumably escaped from cultivation. We did not find flowers and have not determined the species.

Vicia cracca,* COW-VETCH. (Fabaceae) The commonest of several European vetches that are widely established in lawns and waste ground in our area, distinguished by the incurved hairs on the stem and racemose flowers with moderately symmetrical bases. Occasional along roads and around buildings at HF: first collected from near the HF buildings by K.A. Raup in 1947; seen in small quantities in five compartments in our survey.

Vicia sativa

Vicia sativa,* NARROW-LEAVED VETCH. (Fabaceae) A less common vetch, also European, with paired blue flowers in the leaf axils. A rare and probably sporadic weed at HF where it is known from a 1933 collection by H.M. Raup from the north end of the Tom Swamp Tract, and a 2005 collection by us from the field by the Lyford House (P1). Formerly called *V. angustifolia*, a name that refers to small-seeded forms which are now included in a broadly defined *V. sativa.*

Vicia tetrasperma

Vicia tetrasperma,* FOUR-SEEDED VETCH. (Fabaceae) A small, reasonably common vetch, resembling *V. cracca* and like it having blue flowers in pedunculate racemes, but differing in the smaller leaves, fewer flowers, and smaller fruit. Uncommon at HF: first collected from around the HF buildings by W.D Beal and W.H. Drury in 1947, and also collected in T8 by K.A. Raup in the same year; seen three times by us, near the buildings in P1 and P10, and in the field in P9.

[**Vinca minor,*** COMMON PERIWINKLE. (Apocynaceae) A cultivated ground cover, often persistent and spreading locally around old house sites but rarely adventive away from the places where it has been cultivated. Probably long cultivated at HF but not listed in previous floras. We saw it four times, in P1, P9, P10, and the Simes Tract. We suspect that these occurrences are plants that have persisted from cultivation and so are not truly naturalized, but have no way of knowing for sure.]

Viola spp., VIOLETS. (Violaceae). Violets of one sort or another are widespread (we saw violet leaves in 31 of the 33 compartments that we inventoried) but not particularly common at HF. Many seem to need some degree of disturbance or at least a certain amount of light: we saw them most commonly along woods roads, on rocky slopes, and on hummocks in wetlands and much less commonly in continuous woods.

Naming violets is more difficult than finding them (p. 63). The species lines are famously weak and, equally troubling but less often noted, many sterile plants are encountered which can't be accurately determined. In what follows we discuss the plants that we were able to confirm, but note that this is only a partial account, and that the group could use more study.

Viola blanda, SWEET WHITE VIOLET. (Violaceae) We include in *Viola blanda* all white violets of upland woods, which generally have some hairs somewhere on their leaves and often a tiny beard on the lateral petals. This includes the plants called *V. incognita*, but not the wetland plants called *V. macloskeyi*. Uncommon at HF, with some preference for fertile woods. First collected by H.M. Raup from the east part of the Tom Swamp Tract in 1933. Seen in five compartments in our survey; most plentiful in fertile rocky woods in S8 and the Simes Tract where it formed handsome colonies on top of boulders; otherwise it was casual along trails in P1, P5 and T7. We find this a vague species here (p. 64); many specimens have a distinct beard and lack the red flower stalks and twisted petals supposed to characterize this species.


Viola blanda

Viola conspersa, DOG VIOLET. (Violaceae) A blue violet with erect stems and flowers from the axils of stem leaves, resembling the hooked-spur violet *V. adunca*, which so far as we know does not occur at HF. Occasional at HF, mostly along trails; it seems to be an early successional plant of roadsides and thickets and not really at home in dense woods. First collected by W.A. Stalker in the Slab City Tract in 1909; re-collected there by H.M. Raup in 1933, and reported from S3 by C.E. Smith (1949) based on a collection that we did not see. Seen in small amounts in the same area (S1 and S3) and in the Simes Tract in our survey. Given its rarity in HF as a whole, its persistence for ninety-five years in the Slab City Tract seems noteworthy.


Viola conspersa

Viola cucullata, MARSH BLUE VIOLET. (Violaceae) A handsome, pale-blue violet of swamps and marshes, recognized in theory by long flower-stalks, well developed auricles on the sepals, and clubbed beard hairs. In practice, because it intergrades with other violets and all these characters vary, many botanists call any blue wetland violet with clubbed beard hairs *cucullata*. Probably frequent in the swamps at HF, but we tended to visit them later in the season and weren't able to confirm it's status. First collected by H.M. Raup from the Prospect Hill Tract in 1933; subsequently collected in Gould's Bog (P8) by C.E. and E.E. Smith in 1949 and several times in T8 by the Smiths, W.D. Beal , and I.M. Johnston, about the same time. We confirmed it five times, along the Swift River in S3, S4, and S10, in P1, and in the Simes Tract. Our specimens tend to have some hairs on the leaves and weakly clubbed beard hairs and so are not sharply distinct from what we have called *V. sororia* (p. 64).


Viola cucullata

Viola lanceolata, LANCE-LEAVED VIOLET. (Violaceae) A distinctive lance-leaved white violet of sandy pond shores. Apparently local or uncommon at HF: reported for Petersham by H.M. Raup (1938) but not vouchered; K.A. Raup collected a specimen in 1947 from Riceville Pond near the dam, and C.E. Smith (1949) said it was "common in wet open


Viola lanceolata

sites," but only cited a single 1949 collection by I.M. Johnston from Riceville Pond; seen once in our survey, again at Riceville Pond.

Viola macloskeyi, MACLOSKEY'S MARSH VIOLET. (Violaceae) A common, relatively small, and almost completely hairless white violet of pond shores, swamps, and bogs. It is very close to *V. blanda*, from which it differs by lacking hairs and, according to Voss (1985), by having slightly flatter teeth on the leaves. This is not much to build a species on, especially in a genus where hairs come and go freely. The leaf hair distinctions that were the traditional way of separating *V. blanda* and *V. incognita* are now rejected by many botanists, doubtless (as we know from trying to apply them for many years) with some relief. It may well be that those separating *V. blanda* and *V. macloskeyi* are the next to go.

Small vegetative plants resembling *V. macloskeyi* are frequent along streams and in wetlands at HF, but thus far we have not seen very many flowering. Flowering specimens were first collected by H.M. Raup in the Slab City Tract in 1934, and then by C.E. and E.E. Smith in P1 and in a small woodland pool in the Simes Tract in 1949, and by W.H. Hatheway in T6 in 1952. We confirmed the species in S3 and in P1 (near Gould's Bog) in our survey. Formerly called *V. pallens*, an eastern United States species that has now been merged with the transcontinental *V. macloskeyi.*

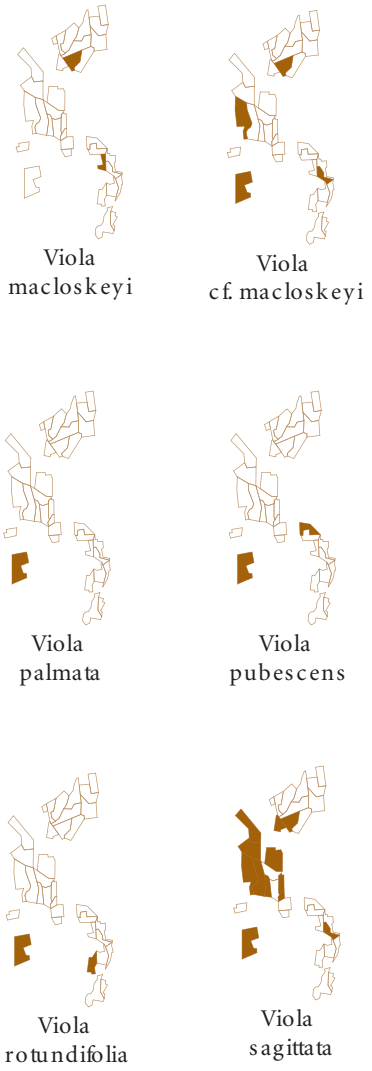
Viola palmata, PALMATE VIOLET. (Violaceae) To us, any stemless blue violet generally resembling *V. sororia* but with some lobing at the base of the leaves. We include *V. triloba* here and do not worry about how many leaves are lobed or how lobed they are, as long as the lobes do not get so narrow that they approach *V. brittoniana.*

Not previously reported from HF; seen once in our survey, from the dry rocky slopes of Camel's Hump (Simes Tract), which is the typical habitat for at least some forms of this species*.

Viola pubescens, STEMMED YELLOW VIOLET. (Violaceae) A stemmed violet with large stipules, broadly heart-shaped leaves, and yellow axillary flowers, common in fertile woods. Our plants vary greatly in hairiness and include the smooth forms that used to be called *V. pensylvanica.* Apparently rare in HF: first collected by W.A. Stalker from Tom Swamp in 1909;. reported by H.M. Raup (1938) and by C.E. Smith (1949), the later citing a collection from T8 that we did not see; seen twice in our survey, in S1 and the Simes Tract.

Viola rotundifolia, EARLY YELLOW VIOLET. (Violaceae) The stemless, round-leaved, very early violet of moist woods. Common in woods of average and moderate fertility, but rarer on the acid soils of HF: listed for Petersham by H.M. Raup (1938); first collected by E.P. Stephens from S10 in 1947, and then by W.H. Hatheway from T1 in 1952; reported from Camel's Hump (Simes Tract) by C.E. Smith (1949), citing a specimen that we did not see; seen twice in our survey, on fertile rocky slopes in S8 and Camel's Hump.

Viola sagittata, ARROW-LEAF VIOLET. (Violaceae) Following several recent authors we use *V. sagittata* for all our stemless blue violets with arrow-shaped leaves which are at least twice as long as wide and do not



*When you look at collections of violets from the eastern United States as a whole you see every imaginable degree of lobing and unlobing. What we call *V. palmata* is most likely a mixed bag, including on the one hand the typical plants of calcareous ridges, whose lobing seems to increase as you move south in the mountains, and on the other hand plants of acid sandy soils that are intermediate between deeply lobed coastal plain species and common unlobed species like *V. sororia* and *V. sagittata.*

have heart-shaped bases. Some of these are densely furry and coarsely toothed or shallowly lobed at the leaf base and are classical *V. sagittata*. Many at HF are shorter and less toothed but still very furry and correspond to what was long called *V. fimbriatula*. And still others have long but rather smooth leaves, and may be what has been called *V. emarginata*, or may be transitional between this group and something else.

Our field observations suggest that this group is locally frequent on sandy soils, especially along trails in the Tom Swamp Tract: it was first collected in the Slab City Tract by H.M. Raup in 1934; re-collected there and in the Prospect Hill Tract by C.E. and E.E. Smith in 1949; and seen in 12 compartments in our survey.


Viola sororia

Viola sororia, COMMON BLUE VIOLET. (Violaceae) In our sense, a group of stemless blue violets of average leaf shape and variable bearding and pubescence, without the long leaves of the *V. sagittata* group or the lobed leaves of the *palmata* group, or the distinctive beard and auricles of *V. cucullata*. As such it includes, at a minimum, the smooth plants called *V. papilionacea* and the ciliate ones called *V. septentrionalis*. It may also include the skinny-leaved plants called *V. affinis* and much of what has passed for *V. nephrophylla* in southern New England, but neither of these is at issue here.

While generally one of the commonest violets of inland New England, *V. sororia* prefers moist fertile soils and is replaced by *V. sagittata* on the acid sandy soils at HF: we found no previous records, and saw it only twice, in P1 and in S7, in our survey. Our specimens all had a beard on the lower petal (p.64), a trait usually associated with other species, but this didn't seem to us enough reason to throw another name at them.


Vitis aestivalis

Vitis aestivalis, SUMMER GRAPE. (Vitaceae) A widespread grape with a southern range, distinguished by the strongly whitened under-surface of the leaves with soft, cobwebby hairs near the veins. Apparently uncommon at HF but not searched for carefully and perhaps more common than our records indicate. J.G. Jack (1911) said it grew on stone walls and was apparently native; he collected it in Petersham but not in HF; also listed by H.M. Raup (1938) and C.E. Smith (1949), the latter citing a collection that we did not see; recorded four times in our survey, from P9, T8, T10, and the Simes Tract. Includes *V. lecontiana*.


Vitis labrusca

Vitis labrusca, FOX GRAPE. (Vitaceae) The common grape of riverbanks and wet thickets in southern and eastern Massachusetts, distinguished by its rounded teeth, densely wooly undersides to the leaves, and tendrils at every node. Occasional or frequent at HF: listed as common by J.G. Jack (1911); collected by P. Haynes from an unknown location in 1910 and by H.M. Raup from the Slab City Tract in 1933; listed as occasional in thickets and hedgerows by C.E. Smith (1949) and seen in eight compartments, in all three major tracts, in our survey.


Vitis riparia

Vitis riparia, RIVERBANK GRAPE. (Vitaceae) A common woodland grape of western Massachusetts, resembling *V. aestivalis* but with sharper teeth and finely ciliate margins and without the strongly whitened undersides and cobwebby hairs. Reported from HF by J.G. Jack (1911) who said it was occasional on stone walls and fences, and from Petersham by H.M. Raup

(1938). No specimens support these records. We believe that a hairless and barely whitened grape with deep rounded sinuses and ciliate margins that we collected from a small stream in the Simes Tract in 2005 is this species. R. Bertin disagrees, and thinks it is a form of *V. aestivalis*. We aren't persuaded but acknowledge that grapes are variable and that this is not the first time their species lines have been in doubt. Formerly called *V. vulpina*, a name now applied to a closely related southern species.

Woodwardia virginica, VIRGINIA CHAIN FERN. (Blechnaceae) A distinctive twice-cut fern with netted veins and a black stalk base that forms large patches in acid peatlands. Locally common in the north end of the Tom Swamp Tract, where it was first collected by I.M. Johnston in 1947 and where we saw it twice, in a swamp at the south end of Riceville Pond in T9 and along the utility right-of-way in T8, in our survey.

Woodwardia virginica

Xyris difformis, YELLOW-EYED GRASS. (Xyridaceae) The yellow-eyed grasses are small bog and shore plants with flattened leaves, wiry stems, and yellow flowers in bracteate heads. The species are technical, and difficult to tell in the field. This species has relatively broad leaves, bracts with a green spot in the middle, and ragged keels on the lateral sepals. It occurs on the floating peat islands in Riceville Pond, where it was reported by C.E. Smith (1948), based on a specimen that we did not see, and relocated in our survey. Formerly called *X. caroliniana*, a name now used for a species of the southeast United States.

Xyris difformis

Xyris montana

Xyris montana, NORTHERN YELLOW-EYED GRASS. (Xyridaceae) A similar species with narrower leaves, no green spots, and smoother keels on the lateral sepals. Locally common on floating peat islands in Riceville Pond: first collected by H.M. Raup in a "swamp near the Fay Lot" in 1933; relocated in Riceville Pond in our survey. Listed on the watch list of the Massachusetts Natural Heritage and Endangered Species Program.

Zanthoxylum americanum, PRICKLY ASH. (Rutaceae) A small, thorny shrub with aromatic bark and pinnately compound leaves, common in western Massachusetts where it forms successional thickets on dry fertile soils; rare this far east. Known at HF from a single 1949 collection by E. Smith and E. Stephens from S1.

Zizia aurea

Zizia aurea, GOLDEN ALEXANDERS. (Apiaceae) A common, yellow-flowered umbellifer of wet ditches and open wetlands, usually on mineral soils. Uncommon at HF: collected by H.M. Raup from a field near the forest school in the Prospect Hill Tract in 1934, and from a wet meadow in the same general area by W.D. Beal and R.S. Sigafoos in 1947; seen four times in our survey, along streams and in wetlands in S4, S5, T2 and T9.

APPENDIX I: SPECIES EXCLUDED FROM THE MAIN LIST

This section includes species that have been credited to HF by their collectors or in the lists of J.G. Jack (1911), H.M. Raup (1938), or C.E. Smith (1948, 1949) but which we have excluded because we could not find supporting specimens or because the specimens we could find were misidentified. The list only includes plants that are not otherwise known from Harvard Forest. Thus *Agalinis tenuiflora* and *Acalypha tenuiflora*, neither of which is currently known from HF are on the list, but *Cicuta maculata*, which was wrongly credited to HF by Smith (1949) on the basis of a misidentified specimen but then found in our survey, is not.

In the following notes we place citations of publications in parentheses and citations of specimens in italics. Thus, Smith (1948) is C. Earle Smith's *Survey of the Petersham Flora*, and Smith *500* is his five-hundredth specimen.

Misidentified Species

The following species, as far as we know, were wrongly credited to HF and do not occur here at present.

Agalinis tenuiflora, SLENDER GERARDIA. (Scrophulariaceae). A 1947 collection by W.D. Beal from Riceville Pond is *A. paupercula.* C.E. Smith may have corrected the determination but not annotated the specimen: he listed this collection as *Gerardia paupercula* in his 1949 *Survey of the Petersham Flora.*

Amelanchier bartramiana, BARTRAM'S SHADBUSH. (Rosaceae) Smith (1949). This is a northern species which is very rare in Massachusetts. A 1947 collection by K.A. Raup from the Fay Lot (T9) is *A. canadensis;* a 1947 collection by I.M. Johnston from Doe Valley Road (outside of HF) is a hybrid of *A. canadensis* with a shrubby species.

Aster pilosus var. **pringlei,** PRINGLE'S ASTER. (Asteraceae) Smith (1949) cites (as *A. polyphyllus*) an I.M. Johnston collection that is *A. novi-belgii*.

Aster solidagineus, NARROW-LEAVED ASTER. (Asteraceae) C.E. Smith's specimen *2514*, from a road in back of the administration building, is *A. paternus.*

Aster schreberi (*A. glomeratus*), SHREBER'S ASTER. (Asteraceae) Smith (1949). Three 1947 collections by I.M. Johnston and C.E. Smith from Tom Swamp Road and a meadow near the HF headquarters are all *A. divaricatus.*

Bidens discoidea, SMALL BEGGAR'S-TICKS. (Asteraceae) Smith (1949). A 1947 collection by W.D. Beal from Riceville Pond is *B. frondosus*. C.E.

Smith's *2112* from the same locality was not found. This species is close to *B. frondosus*, differing in its smaller heads with fewer outer involucral bracts and achenes with upward pointing barbs. Much that has been called *B. discoidea* in our area seems actually to be small-headed plants of *B. frondosus.*

Callitriche terrestris (*C. deflexa*), TERRESTRIAL STARWORT. (Callitrichaceae) Smith (1949). Two 1947 collections by I.M. Johnston and C.E. Smith from a pool near the base of Camel's Hump are both probably *C. verna.*

Carex albursina, WHITE BEAR SEDGE. (Cyperaceae) A 1934 collection by H.M. Raup from Prospect Hill is *C. laxiflora.*

Carex alopecoidea, FOXTAIL SEDGE**.** (Cyperaceae) Smith (1948). A 1947 collection by I.M. Johnston is *C. normalis* and is from outside HF.

Carex baileyi, BAILEY'S SEDGE. (Cyperaceae) Smith (1948). A 1947 collection by C.E. Smith from P9 is *C. lurida*.

Carex bicknellii, BICKNELL'S SEDGE. (Cyperaceae) Smith (1948). A 1947 collection by C.E. Smith from S8 is *C. tenera*.

Carex caryophyllea, VERNAL SEDGE. (Cyperaceae) Smith (1948). A 1947 collection by C.E. Smith is *Carex pensylvanica*.

Carex cristatella (*C. cristata*), CRESTED SEDGE. (Cyperaceae) Smith (1948). A 1947 collection by I.M. Johnston from T4 is *C. vulpinoidea.*

Carex festucacea, HAY-LIKE SEDGE. (Cyperaceae) Smith (1948). Three 1947 collections, by W.D. Beal and W.H. Drury from the Fay Lot (T9) and by C.E. Smith from the Tom Swamp Tract, are *C. merritt-fernaldii.*

Carex flava, YELLOW SEDGE. (Cyperaceae) Raup (1938), Smith (1948). A 1933 collection by H.M. Raup from the Fay Lot and three 1947 collections by I.M. Johnston from Riceville Pond (both t9) are *C. cryptolepis.*

Carex houghtoniana, HOUGHTON'S SEDGE. (Cyperaceae) Raup (1938), Smith (1948). A northern species not known from Massachusetts. A 1933 collection by H.M. Raup from a stream in the Fay Lot (T9) is *C. scabrata.* A 1947 collection by C.E. Smith (*1654*) from T8 is *C. communis.*

Carex leporina, HARE'S-FOOT SEDGE. (Cyperaceae) Smith (1948). A 1947 I.M. Johnston collection from near the HF headquarters in *C. tenera*; another Johnston collection from Tom Swamp Road is immature and can't be determined. A 1947 collection by K.A. Raup from near the summit of Prospect Hill is *C. annectens*.

Carex michauxiana, MICHAUX'S SEDGE. (Cyperaceae) Smith (1948). A 1947 collection by I.M. Johnston from T4 is *C. intumescens.*

Carex pellita, WOOLY SEDGE. **(Cyperaceae)** A 1947 collection by W.H. Drury from P3 is *C. vestita.*

Carex straminea, STRAW-COLORED SEDGE. (Cyperaceae) Smith (1948). Two 1947 collections by W. Chi-Wu from Tom Swamp are *C. normalis* and either *C. normalis* or *C. tenera.*

Carex tenuiflora, SLENDER-FLOWERED SEDGE. (Cyperaceae) Smith (1948). Two 1947 collections by K.A. Raup from a swamp in P8 are *C. canescens.*

Carex tetanica, STIFF SEDGE. (Cyperaceae) Smith (1948). A 1947 collection by I.M. Johnston from a swampy woods southeast of HF headquarters is *C. leptalea.*

Carex wiegandii, WIEGAND'S SEDGE. (Cyperaceae) Smith (1948). Several 1947 collections by W.H. Drury and I.M. Johnston from Riceville Pond (T9), a bog under hemlocks in S8, and a bog at the west end of Doe Valley Road (not HF) are all *C. echinata.*

Chamaesyce vermiculata (*Euphorbia v., Euphorbia hirsuta*), HAIRY SPURGE. (Euphorbiaceae) Smith (1949). A 1947 specimen collected by I.M. Johnston at Riceville Pond (T8) is *C. maculata.*

Crataegus sp., HAWTHORNS. (Rosaceae) Jack (1911). A series of hawthorn species gathered between 1908 and 1913 by J.G. Jack, J.S. Ames, and S.M. Dohanian have obsolete names (*C. matura, pastorum, pruinosa,* and *streeterae*). We do not know the hawthorns well enough to redetermine these or establish the correct synonomies.

Dichanthelium ovale (Panicum villosissimum), OVAL PANIC GRASS. (Poaceae) Smith (1948). A 1947 collection by I.M. Johnston from Riceville Pond (T9) is *Dichanthelium acuminatum var. spretum.*

Diphasiastrum complanatum (*Lycopodium complanatum* sensu strictu*),* NORTHERN GROUND CEDAR. (Lycopodiaceae) Smith (1948). A 1947 collection by I.M. Johnston from "between Leighton Road and Davenport Pond," which may or may not be from HF, is *Diphasiastrum tristachyum.*

Eleocharis intermedia, INTERMEDIATE SPIKE-RUSH. (Cyperaceae) A 1947 specimen collected by I.M. Johnston from Turnpike Road (and probably not in HF) is *E. tenuis.*

Eleocharis ovata, OVATE SPIKE-RUSH. (Cyperaceae) Smith (1948). The taxonomy is complicated because *E. obtusa* and *E. ovata*, treated as separated species in the *Flora of North America*, have each at various times been regarded as varieties of the other. Three HF collections by H.M. Raup and I.M. Johnston from Tom Swamp and the pond at the base of Camel's Hump (Simes Tract) were determined as *E. obtusa* by their collectors and then annotated to *E. ovata* (rather than *E. ovata* var. *obtusa* which would have been less confusing). They are all *E. obtusa.* Two other

collections by K.A. Raup and C.E. Smith from Tom Swamp and Riceville Pond (T9) are misdetermined and are *E. tenuis* sensu lato.

Equisetum pratense, MEADOW HORSETAIL. (Equisetaceae) Smith (1948). C.E. Smith's 1947 collection (Smith *2164)* from T1 is sterile and can't be definitively identified, but the low spicules suggest *E. arvense.*

Erigenia bulbosa, HARBINGER OF SPRING. (Apiaceae) Smith (1949) mentions this species as occasional in open bogs, Prospect Hill Tract, citing Smith and Smith *46*, which is the dwarf ginseng *Panax trifolius;* also called harbinger of spring. *Erigenia bulbosa,* a rich-woods species of the central United States, does not occur in New England and does not grow in bogs.

Erysimum repandum, TREACLE MUSTARD. (Brassicaceae) Smith (1949). C.E. Smith's 1947 record from near HF headquarters (Smith *2026*) is *Capsella bursa-pastoris*.

Galinsoga parviflora, QUICKWEED. (Asteraceae) Smith (1949). A 1947 specimen collected by C.E. Smith from Tom Swamp Road (Smith *1820*) is *G. quadriradiata,* as is **a** record from near HF headquarters (Smith *2046*).

Impatiens pallida, YELLOW JEWELWEED. (Balsaminaceae) Smith (1949). A 1947 collection by C.E. Smith from the margin of Riceville Pond has some orange color and suggests *I. capensis*; his collection from Tom Swamp Road is immature and can't be determined.

Lycopus rubellus, GYPSYWORT. (Lamiaceae) Smith (1949). A 1947 collection by C.E. Smith, along **a** brook margin near Harvard Pond, is *Mentha arvensis.*

Malva rotundifolia, ROUND-LEAVED MALLOW. (Malvaceae) Raup (1938). Two 1933 collections by H.M. Raup and N.W. Hosley from Prospect Hill and Wilder's Farm are *M. neglecta*.

Muhlenbergia mexicana, SATIN MUHLY. (Poaceae) Smith (1948). The I.M. Johnston and R.S. Sigafoos collections from Prospect Hill are both *M. uniflora.*

Myosotis laxa, SMALL FORGET-ME-NOT. (Boraginaceae) Smith (1949). A 1947 collection by C.E. Smith from the Swift River at Connor Pond is *M. scorpioides*.

Nasturtium nasturtium-aquaticum, WATER CRESS. (Brassicaceae) Raup (1938): presumably based on H.M. Raup *5100,* which cannot be definitively determined but is likely *Cardamine* sp.

Nuphar advena, YELLOW WATER LILY. (Nymphaeaceae) Smith (1949). Two 1947 collections by W.D. Beal and W.H. Drury from Harvard and Riceville Ponds are *N. variegata.*

Populus balsamifera, BALSAM POPLAR. (Salicaceae) A 1947 collection by W.D. Beal from S10 was annotated to P. x jackii (P. x gileadensis) by W.H. Hatheway in 1952.

Ribes rotundifolium, ROUNDLEAVED GOOSEBERRY. (Grossulariaceae) A 1911 collection by J.G. Jack from "Waldo's Farm" appears to be *R. hirtellum*.

Rosa acicularis, BRISTLY ROSE. (Rosaceae) Smith (1949). A 1947 collection by I.M. Johnston from the east cliffs of Camel's Hump (Simes Tract) is *R. carolina*.

Rosa virginiana, VIRGINIA ROSE. (Rosaceae) Smith (1949). The record is based on two 1947 collections by I.M. Johnston from Harvard Pond. One is typical *R. palustris*, the other is one of the indistinct variants that are common in *Rosa.* Neither has the coarse leaf teeth of typical *R. virginiana.*

Sisyrinchium angustifolium, NARROW-LEAVED BLUE-EYED GRASS. (Iridaceae) Raup (1938). A 1933 collection from H.M. Raup from the Tom Swamp Tract is probably a variant of *S. atlanticum*; in any case it is not *S. angustifolium.*

Solidago patula, ROUGH-LEAVED GOLDENROD. (Asteraceae) A 1937 collection by H.M. Raup is *S. rugosa*.

Stellaria alsine (*S. uliginosa*), BOG STICHWORT. (Caryophyllaceae) Smith (1949). A collection from S9 (C.E. Smith *1709*) is *S. graminea*.

Viola nephrophylla, BOG VIOLET. (Violaceae) Raup (1938). *Viola nephrophylla* is an ambiguous name, used differently by different authors for plants that are slightly smoother, more bearded, more palustrine, or more narrowly flowered than our common *V. sororia.* Current authors tend to use the name for a northern and western calciphile with smooth leaves and sepals and deep violet flowers with a bearded lower petal. Two 1934 collections by H.M. Raup (*5222, 5201*), one from the Slab City Tract, one with no locality but with a "Flora of Harvard Forest" label, have bearded lower petals but also ciliate sepals and some short hairs on the leaf margins. They probably corresponded fairly well to what was called *V. nephrophylla* at the time; today they seem to fit better into a broadly defined *V. sororia.*

Viola scabriuscula (*V. pubescens*), SMOOTH YELLOW VIOLET. (Violaceae) Smith (1949). The report is based on a specimen that is *V. rotundifolia.*

Species For Which No Herbarium Specimens Were Found

These are species credited to HF or Petersham by Jack (1911), Raup (1938) or Smith (1948-1949) for which we have not been able to find a supporting specimen. In some cases there may never have been a specimen; in

other cases there was, but it may or may not have been correctly identified, may or may not have been from Harvard Forest, and may or may not have represented a naturalized plant.

The plausibility of these records varies: we think it quite likely that J.G. Jack saw bayberry, fetterbush, and small shadbushes of the *Amelanchier spicata* complex here; but we think it very unlikely that C.E. Smith saw *Carex peckii, seorsa,* or *sterilis*, at least in the sense in which we understand the species today.

Several of these records that seem plausible and historically interesting are included as bracketed entries in the main species accounts.

Acalypha virginica, VIRGINIA COPPERLEAF. (Euphorbiaceae) Reported by C.E. Smith (1949) from a roadside by headquarters, citing a specimen (Smith *2057*) that we did not find.

Acorus calamus, SWEET FLAG. (Acoraceae) Raup (1938) indicates a specimen at NEBC; all the *Acorus* collections are currently on loan and we could not verify this. A C.E. Smith specimen (*1905*) is from Nichewaug in Petersham, not HF.

Aesculus hippocastanum, HORSECHESTNUT. (Hippocastaneaceae) Jack (1911), "occasionally escaped in woods;" Raup (1938).

Amelanchier spicata, SHADBUSH. (Rosaceae) Jack (1911), "Uncommon, Prospect Hill and other places."

Amelanchier humilis, SHADBUSH. (Rosaceae) Raup (1938).

Baptisia tinctoria, DYERS INDIGO. (Fabaceae) Raup (1938); Smith (1949) reported it from outside of HF.

Berberis vulgaris, COMMON BARBERRY. (Berberidaceae) Jack (1911), "Planted in Petersham and occasionally naturalized in HF."

Campsis radicans, TRUMPET CREEPER. (Bignoniaceae) Jack (1911), "Escaped from cultivation, old house site on Prospect Hill Tract;" Raup (1938). Formerly *Tecoma radicans.*

Carex laevivaginata, SMOOTH-SHEATHED SEDGE. (Cyperaceae) Smith (1948), based on C.E. Smith *1564*, which was not found.

Carex peckii, PECK'S SEDGE. (Cyperaceae) Smith (1948), based on C.E. Smith *2169*, which was not found.

Carex seorsa, SWAMP PRICKLY SEDGE. (Cyperaceae) Smith (1948), based on C.E. Smith *1611*, which was not found.

Carex sterilis, DIOECIOUS SEDGE. (Cyperaceae) Smith (1948), based on C.E. Smith *1580*, which was not found.

Cimicifuga racemosa, BLACK SNAKEROOT. (Ranunculaceae) Raup (1938).

Conium maculatum, POISON HEMLOCK. (Apiaceae) Smith (1949): Tom Swamp I, based on C.E. Smith *2178*, which was not found.

Cotinus obovatus, CHITTAM-WOOD. (Anacardiaceae) Raup (1938). This is a tree of the southern and central United States; it may have been planted in town, or been a misidentification of the more common planted *Cotinus coggygria*, the smoke tree of Europe. A Mrs. Gast specimen has no collection information.

Cydonia oblongifolia, COMMON QUINCE. (Rosaceae) Jack (1911), "Introduced and persisting in abandoned orchards, Prospect Hill Tract."

Cyperus dentatus, TOOTHED FLATSEDGE. (Cyperaceae) Raup (1938).

Datura stramonium, JIMSON-WEED. (Solanaceae) Reported by C.E. Smith (1949) without citing a specimen.

Desmodium cuspidatum (*D. grandiflorum*), LARGE-BRACTED TICK-TREFOIL. (Fabaceae) Smith (1949): dry open woods in Tom Swamp VIII, based on Smith *2016*, which was not found.

Dichanthelium polyanthes (*Panicum microcarpon*), TINY-FRUITED PANIC GRASS. (Poaceae) Smith (1948): T9, Riceville Pond, based on Smith *2139*, which was not found.

Epilobium palustre, MARSH WILLOWHERB. (Onagraceae) Raup (1938). Raup *8247* appears to be intermediate between *E. palustre* and *E. leptophyllum*.

Fimbristylis autumnalis, AUTUMN FIMBRY. (Cyperaceae) Smith (1948): margin of Riceville Pond, based on Smith *2293*, which was not found.

Galium obtusum, BLUNT BEDSTRAW. (Rubiaceae) Smith (1949): "Few along margin of Riceville Pond", based on Smith *1662*, which was not found.

Galium trifidum, TRIFID BEDSTRAW. (Rubiaceae) Smith (1949): Tom Swamp Rd., based on Smith *1846*, which was not found.

Glyceria grandis, TALL MANNAGRASS. (Poaceae) Smith (1948): Slab City VIII, based on Smith *1904*, which was not found. A 1931 specimen from Petersham, at HUH, was collected by A.S. Goodale, S.F. Potsubay, and F.R. St. John, and is stamped "Flora of the Swift River Watershed." This may or may not be from HF.

Helianthus divaricatus, WOODLAND SUNFLOWER. (Asteraceae) Raup (1938). There is a collection by Mrs. Gast without data in the HF herbarium.

Hieracium pilosella, MOUSE-EAR HAWKWEED. (Asteraceae) Smith (1949): Tom Swamp 1, based on Smith *2088*, which was not found.

Leucothoe racemosa, FETTERBUSH. (Ericaceae) Jack (1911), "Uncommon or rare, wet places."

Lonicera tartarica, TARTARIAN HONEYSUCKLE. (Caprifoliaceae) Jack (1911), "rarely found escaped from cultivation;" Raup (1938).

Muhlenbergia mexicana, SATIN-MUHLY. (Poaceae) Raup (1938).

Myrica pensylvanica, BAYBERRY. (Myricacaceae) Jack (1911), "In pastures and abandoned fields."

Phegopteris hexagonoptera, BROAD BEECH FERN. (Thelypteridaceae) Smith (1948) notes a sight record from T1 by a Mrs. Greene of Petersham. No specimens are known; the species occurs in Worcester County but is not otherwise known in Petersham.

Physalis heterophylla, CLAMMY GROUND-CHERRY. (Solanaceae) Smith (1949): open field near headquarters, based on Smith *2110*, which was not found.

Parthenocissus inserta, WOODBINE. (Vitaceae) Jack (1911) "Roadsides, apparently native, perhaps escaped from cultivation."

Platanus occidentalis, SYCAMORE. (Platanaceae) Jack (1911), "Very rare in Harvard Forest, rich soil;" H.M. Raup (1938). There is a 1912 collection of a sycamore seedling in the HF herbarium with a note saying that it was sown.

Potamogeton gramineus, GRASSLIKE PONDWEED. (Potamogetonaceae) Smith (1948) based on Smith *1712*, which was not found.

Prunus cerasus, SOUR CHERRY. (Rosaceae) Jack (1911) "cultivated and occasionally becoming wild along fences, roadsides, etc."

Ribes cynosbati, PRICKLY GOOSEBERRY. (Grossulariaceae) Jack (1911), "Occasionally found in and along fences;" Raup (1938).

Ribes rotundifolium, ROUND-LEAVED GOOSEBERRY. (Grossulariaceae) Raup (1938).

Rosa cinnamomea,* CINNAMON ROSE. (Rosaceae) Jack (1911), "on the Meadow Water Tract and other parts near sites of former homesteads."

Rosa nitida, SHINING ROSE. (Rosaceae) Jack (1911), "In Meadow Water Swamp" (=Tom Swamp); Raup (1938).

Rosa rubiginosa, SWEETBRIER. (Rosaceae) Jack (1911), "Occasional, escaped from cultivation into old pastures."

Rubus pensilvanicus, PENNSYLVANIA BLACKBERRY. (Rosaceae) Jack (1911), "Occasional. Roadsides;" Raup (1938).

Salix petiolaris, SLENDER WILLOW. (Salicaceae) Jack (1911); Raup (1938); Smith (1949): P9, based on Smith *1717*, which was not found.

Spergula arvensis, SPURREY. (Caryophyllaceae) Raup (1938).

Trillium cernuum, NODDING TRILLIUM. (Liliaceae) Raup (1938) indicates a specimen at NEBC. A 1931 specimen from Petersham, located in the HUH, was collected by A.S. Goodale, S.F. Potsubay, and F.R. St. John, and is stamped "Flora of the Swift River Watershed." This may or may not have been from HF. The species is currently known in Petersham on the property of The Trustees of Reservations below the dam at Connor Pond, adjacent to HF, and so certainly could have occurred within HF in the past.

Ulmus campestris, ENGLISH ELM. (Ulmaceae) Jack (1911), "rarely found escaped from cultivation;" Raup (1938).

Viola affinis (*V. latiuscula*), LECONTE'S VIOLET. (Violaceae) Reported by C.E. Smith (1949) from Dugway Road (Simes Tract) citing a specimen (Smith and Smith *26*), which was not found.

Viola renifolia, KIDNEY-LEAVED VIOLET. (Violaceae) Raup (1938).

APPENDIX II: MISSING AND NEW SPECIES

The missing list gives the species found by previous surveys that were not seen in our survey. The list of new species gives the species we found that had not been seen previously. The letters after each species gives the preferred habitat in our region: F = forest, O = open, and W = wetland. Following our convention here, *Rhododendron maximum* is listed with the natives, even though it is likely an introduction in Petersham.

Missing Native Species

Actaea rubra	F
Agalinis paupercula	W
Amelanchier stolonifera s.l.	O
Asarum canadense	F
Aster ericoides	O
Aster paternus	F
Aster pilosus	O
Botrychium multifidum	F
Botrychium oneidense	O F
Botrychium simplex	O F
Callitriche verna	W
Calopogon tuberosus	W
Carex abscondita	F
Carex cryptolepis	W
Carex granularis	O
Carex lucorum	F
Carex merritt-fernaldii	O
Carex vestita	F
Celastrus scandens	O
Comandra umbellata	F
Cornus florida	F
Cornus racemosa	O
Corylus americana	O
Cynoglossum virginianum	F
Dichanthelium acuminatum ssp. spretum	O
Dichanthelium dichotomum	F
Dichanthelium xanthophysum	F
Epilobium angustifolium	O
Erigeron pulchellus	F
Gentiana clausa	W
Gentianopsis crinita	W
Geum laciniatum	W
Glyceria borealis	W
Heracleum maximum	O
Hieracium umbellatum	O F
Hypericum gentianoides	O
Juncus greenei	O
Lactuca hirsuta	O
Linnaea borealis	W
Malaxis unifolia	F
Moneses uniflora	F
Myriophyllum humile	W
Orobanche uniflora	F O
Orthilia secunda	F
Pedicularis canadensis	F
Persicaria careyi	W
Platanthera hookeri	W
Platanthera psycodes	W
Platanus occidentalis	F
Potentilla canadensis	O
Proserpinaca palustris	W
Ranunculus aquatilis	W
Rhododendron maximum	O
Rhus glabra	O
Ribes hirtellum	F
Rubus setosus	W
Salix humilis	O
Sanicula marilandica	F
Schoenoplectus purshianus	W
Solidago odora	W
Sparganium angustifolium	W
Spiranthes lacera	O
Stellaria borealis	W
Triadenum fraseri	W
Viburnum opulus	O
Zanthoxylum americanum	O

Missing Alien Species

Agrostis canina	O
Alopecurus pratensis	O
Berberis vulgaris	F O
Brassica sp.	O
Carum carvi	O
Dianthus armeria	O
Fallopia convolvulus	O
Festuca ovina	O
Festuca pratensis	O
Humulus lupulus	O
Sisymbrium altissimum	O

New Native Species

The number after each species is the number of compartments in which we found it. The letter is the main habitat: F = forests, O = open areas, W = wetlands.

Acalypha rhomboidea	2	O
Alisma plantago-aquatica	1	W
Amaranthus retroflexus	2	O
Andromeda glaucophylla	1	W
Angelica atropurpurea	1	W
Arabis glabra	1	O
Arceuthobium pusillum	1	W
Asplenium trichomanes	1	F
Aster cordifolius	3	F
Aster nemoralis	1	W
Aureolaria pedicularia	1	F
Aureolaria virginica	1	F
Bidens connatus	8	W
Bidens vulgatus	1	O
Bulbostylis capillaris	3	O
Calystegia sepium	1	O
Campanula aparinoides	1	W
Carex argyrantha	4	O
Carex bromoides	3	W
Carex laxiculmis	3	F
Carex novae-angliae	4	F
Carex ormostachya	1	F
Carex pedunculata	4	F
Carex plantaginea	1	F
Carex prasina	1	F W
Carex stricta	6	W
Carex torta	5	W
Chimaphila maculata	16	F
Cicuta maculata	4	W
Cladium mariscoides	2	W
Clinopodium vulgare	2	O
Coeloglossum viride	1	F
Conyza canadensis	4	O
Cornus sericea	1	W
Crataegus macrosperma	1	F
Cyperus erythrorhizos	1	W
Cyperus esculentus	1	W
Cyperus lupulinus	1	O
Cyperus strigosus	1	W
Desmodium glutinosum	2	O
Dichanthelium latifolium	2	F
Echinochloa muricata	1	O
Eleocharis tenuis	3	W
Elymus hystrix	1	F
Eragrostis pectinacea	1	O
Fallopia scandens	1	F W
Galium lanceolatum	3	F
Geum aleppicum	2	F
Helianthemum bicknellii	2	O
Heteranthera dubia	1	W
Juncus articulatus	2	W
Juncus pelocarpus	2	W
Lechea mucronata	1	O
Lepidium virginicum	1	O
Liriodendron tulipifera	2	F
Muhlenbergia frondosa	4	O
Muhlenbergia tenuiflora	1	F
Najas flexilis	2	W
Oryzopsis racemosa	3	F
Oxalis dillenii	1	O
Panax quinquefolius	1	F
Panicum dichotomiflorum	2	O
Persicaria arifolia	2	W
Persicaria hydropiper	1	O
Persicaria hydropiperoides	3	O
Persicaria lapathifolia	1	O
Persicaria pensylvanica	1	W
Phalaris arundinacea	3	O
Phragmites australis	3	O W
Populus deltoides	1	F
Potamogeton natans	1	W
Quercus prinus	1	F
Ranunculus abortivus	1	F
Rhynchospora fusca	3	W
Sagina procumbens	4	O
Schizachne purpurascens	1	F
Scirpus expansus	1	W
Senecio obovatus	1	F
Solanum nigrum	2	O
Solidago flexicaulis	2	F
Sphenopholis obtusata var. maj	1	F
Sporobolus vaginiflorus	1	O
Symplocarpus foetidus	4	W
Torreyochloa pallida	6	W
Typha angustifolia	1	W
Utricularia cornuta	1	W
Utricularia geminiscapa	6	W
Utricularia radiata	2	W
Viola palmata	1	F
Viola sororia	2	F

New Alien Species

Abutilon theophrasti	2	O
Aegopodium podagraria	4	O
Agrostis gigantea	6	O
Agrostis stolonifera	3	W
Ajuga reptans	3	O
Aquilegia vulgaris	1	F
Arctium minus	2	O
Artemisia vulgaris	3	O
Berberis thunbergii	14	F
Celastrus orbiculatus	13	O
Centaurea biebersteinii	1	O
Chenopodium album	4	O
Cichorium intybus	1	O
Commelina communis	2	O
Daucus carota	1	O
Dianthus barbatus	1	O
Digitalis sp.	1	O
Digitaria sanguinalis	6	O
Digitaria ischaemum	8	O
Elaeagnus umbellata	3	O
Epipactis helleborine	5	F
Eragrostis pilosa	1	O
Euonymus alatus	3	O F
Euphorbia cyparissias	1	O
Fagopyrum esculentum	1	O
Fagus sylvatica	1	F
Fallopia japonica	2	O
Festuca arundinacea	1	O
Helianthus tuberosus	1	O
Hesperis matronalis	1	W
Hieracium piloselloides	1	F
Holcus lanatus	1	O
Hydrangea arborescens	1	O
Hypochaeris radicata	1	O
Iris pseudacorus	2	W
Larix sp.	1	P
Leontodon autumnalis	1	O
Linaria vulgaris	1	O
Lolium perenne	1	O
Lonicera morrowii	15	O F
Lupinus sp.	1	O
Lychnis flos-cuculi	1	O
Lysimachia vulgaris	1	O
Lythrum salicaria	3	W
Malus sieboldii	3	F O
Malva cf. moschata	1	O
Medicago lupulina	1	O
Medicago sativa	1	O
Melilotus officinalis	2	O
Mentha x spicata	2	W
Persicaria longiseta	4	O
Phellodendron sp.	1	O
Phlox paniculata	1	O
Picea glauca	6	F
Plantago lanceolata	2	O
Poa annua	5	O
Poa nemoralis	2	O
Polygonum aviculare	4	O
Portulaca oleracea	1	O
Rhamnus frangula	6	F
Rosa multiflora	3	F
Rumex longifolius	2	O
Rumex obtusifolius	3	O
Secale cereale	1	O
Senecio vulgaris	1	O
Setaria faberi	2	O
Setaria pumila	3	O
Setaria viridis	1	O
Sisymbrium officinale	1	O
Sonchus asper	2	O
Sorbaria sorbifolia	1	O
Spergularia rubra	5	O
Thymus pulegioides	1	O
Tragopogon pratensis	2	O
Trifolium campestre	2	O
Trifolium pratense	9	O
Veronica arvensis	2	O
Viburnum sp.	1	W

APPENDIX III: NEW GENERIC NAMES

In order to follow, or seem to follow, the nomenclature of Sorrie and Somers (1999) and the *Flora of North America* we have had to replace some familiar genera with new ones. This list gives the old genus first, and its new name or names second. Where only one name is listed, we chose to stick with the old genus and not use the new name.

Agropyron	Agropyron, Elytrigia
Andropogon	Andropogon, Schizachyrium
Aster	(not changed)
Brassica	Brassica, Sinapsis
Diplazium	Deparia
Eupatorium	(not changed)
Euphorbia	Euphorbia, Chamaesyce
Festuca	(not changed
Gentiana	Gentiana, Gentianopsis
Glyceria	Glyceria, Torreyochloa
Habenaria	Coeloglossum, Platanthera
Hypericum	Hypericum, Triadenum
Linaria	Nuttallanthus
Lycopodium	Lycopodium, Diphasiastrum, Huperzia, Lycopodiella
Oryzopsis	(not changed)
Panicum	Panicum, Dichanthelium
Polygonum	Polygonum, Fallopia, Persicaria
Pyrola	Pyrola, Orthilia
Rhus	Rhus, Toxicodendron
Satureja	Clinopodium
Scirpus	Scirpus, Bulboschoenus, Schoenoplectus
Smilacina	Maianthemum
Solidago	Solidago, Euthamia
Zosterella	Heteranthera

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