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JOURNAL OF THE PHILADELPHIA BOTANICAL CLUB

Since its founding in 1891, the Philadelphia Botanical Club has offered outstanding programs, field trips and other opportunities for those with an interest in plants to meet and exchange information. Monthly meetings feature speakers from various botanical backgrounds. They are held at 8 p.m. on the fourth Thursday of the month (in September, October, January through May) or third Thursday (in November and December) at the Philadelphia Academy of Natural Sciences. Each year from April to October, expert field botanists lead numerous field trips in the mid-Atlantic region and occasionally elsewhere in North America or overseas.

Bartonia, in publication since February 1909, was named for William P. C. Barton, Professor of Botany at the University of Pennsylvania and author of the first local flora (1818), *Compendium Florae Philadelphicae*. The journal began as an annual abstract of the Club's proceedings with short articles on the plants of the Philadelphia area. Its scope has broadened to encompass original research in plant systematics, plant ecology and plant conservation biology with articles on floristics, distribution, methods, biography, bibliography, history of botanical exploration, and other topics of botanical interest ranging throughout—and well beyond—the mid-Atlantic region.

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One Hundred Lost Plants Found

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In the first issue of *Caesarian Flora and Fauna*, privately published in 1956 and later reprinted in *Bartonia*, David Fables (1962) authored an article entitled "20 'Lost' Plants."[1] Clearly Fables' list was not meant to be comprehensive; such a listing would have been at least six times as long. Instead, it was to bring to the readers' attention that a number of indigenous plant species once known to occur in New Jersey, could no longer be found.

Fables' stated intent was simple: "In hopes that future search may uncover one or more of these species a list of twenty 'lost' plants has been prepared . . . It presents a challenge for future activity in the field." That challenge was admirably met by a number of dedicated plant hunters, particularly Frank and Robert Hirst and Vincent Abraitys. Within ten years, seven of Fables' lost plants had been rediscovered: *Rhexia aristosa* in 1957 (*B. Hirst s.n.* PH), *Rhynchospora knieskernii* in 1957 (Hirst and Hirst 1963), *Scirpus longii* in 1958 (*F. Hirst s.n.* PH), *Dicentra canadensis* in 1959 (rediscovered by Abraitys, see Snyder 1984), *Eleocharis equisetoides* in 1960 (*A. Hoiberg 1000* CHRB), *Castanea pumila* prior to 1962 (rediscovered by the Hirsts, fide Abraitys 1975), and *Asimina triloba* in 1965 (rediscovered by Abraitys, see Snyder 1984). The eighth and most recent rediscovery was of *Aeschynomene virginica* in 1973 (*W. R. Ferren 1289* PH).

Learning that *Aeschynomene virginica*, *Rhexia aristosa*, *Rhynchospora knieskernii*, and *Scirpus longii* were not long ago considered to be lost plants and the focus of a considerable amount of field work to relocate extant populations, may be surprising to some. Although each is still rare, locations for these species are now generally well known and they are often visited on field trips led by the Philadelphia Botanical Club. None of these rediscovered species had been truly lost, at least in the sense of having been extirpated. What had been lost was the knowledge of its exact location and a thorough understanding of the species' preferred habitat. This is the key distinction between lost, or more accurately, historical species, and those species considered to be extinct or extirpated. With historical species there exists the expectation that with sufficient searching they will be rediscovered, while extinct and extirpated species are believed to be no longer a part of the flora. For a detailed discussion of the concept and conservation value of historical species see Snyder (1993).

[1] Fables' list of lost New Jersey plants predated Edgar Wherry's lecture, "One Hundred 'Lost' Local Plants" presented to the Philadelphia Botanical Club in 1957 and published two years later (Wherry 1959). To my knowledge, Fables' list is the first listing for New Jersey of what are now generally referred to as historical plant species.

Manuscript submitted 29 January 1998.

Fourteen of the species listed by and ardently sought by Fables (*Cryptgramma stelleri*, *Eleocharis equisetoides*, *Scirpus longii*, *Rhynchospora knieskernii*, *Platanthera hyperborea*, *Castanea pumila*, *Ulmus thomasii*, *Asimina triloba*, *Dicentra canadensis*, *Dalibarda repens*, *Aeschynomene virginica*, *Eryngium yuccifolium*, *Gentiana villosa*, *Linnaea borealis*) were known to four botanists who were actively collecting during the late nineteenth century and early part of the twentieth century, N. L. Britton, B. Long, K. K. Mackenzie, and C. S. Williamson. The remaining species[2] (*Corallorhiza wisteriana*, *Rhexia aristosa*, *Glaux maritima*, and *Polemonium van-bruntiae*) had been collected by C. D. Lippencott, E. H. Kilmer, A. H. Smith, and T. C. Porter, field botanists who were most active in the middle part of the nineteenth century. These last four species were among the lost species sought by Long and Mackenzie, as I have inferred from their choice of collecting localities listed in their journals and on their specimen labels. In recent years, I have devoted much of my field work to relocating species known to Fables and his field companions, Vincent Abraitys, Lee Edwards, Estill Green, Lou Hand, and Frank and Robert Hirst.

As a person immersed in relocating historical species, it is sadly apparent to me just how much of the field knowledge accumulated by earlier generations has been lost. Fables collected virtually nothing[3] and if he made field notes or kept a journal of his finds, their whereabouts are presently unknown (F. Hirst pers. comm.). All that we know of his discoveries amount to a few, not very detailed articles published in *Bartonia* and *New Jersey Audubon*, several years of field trip reports published in the *Bulletin of the Torrey Botanical Club*, and whatever information he passed on to his colleagues. Much the same can be said of Green and Hand (F. Hirst; T. Gordon pers. comm.). Abraitys vouchered some of his later discoveries, but his specimen labels were typically not very detailed, and sometimes deliberately cryptic, although always accurate. He also kept notes on every plant that he saw in New Jersey. For each species seen, its name was typed onto the top line of a four-by-six index card, followed by a location and date of the observation. But like his specimen labels, the information was rarely very detailed, and mostly nothing more than a place name, many of which were recorded in a personal shorthand, e.g., "the swamp near Greendell" or "my Musconetcong woodlot" or "woods at Jacob's buzzard trap." Some of these kinds of entries I have been able to figure out and relocate the plants in the field, but many remain as tantalizing mysteries to be solved.

The list that follows is the result of my twenty years of botanical sleuthing in New Jersey. Like Fables' list, my list is intended to encourage some much needed field work in the Garden State. It has been my experience that many people have difficulty in seeing the value in searching for historical plants, especially in a state as heavily developed as is New Jersey. The thinking has been that if a plant has not been seen in thirty or forty years, it is probably gone. As I have stated elsewhere (Snyder 1993), my philosophy is that if the habitat for a plant still exists, then there is a better than even chance that the historically documented plant species is still present. Of the 100 species included on this list, I have

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[2] I exclude two species on Fables' list, *Limnobium spongia* and *Platanthera* (*Habenaria*) *dilatata*, because I believe they have been erroneously reported for New Jersey.

[3] I know of only a single specimen collected by Fables, that of *Jeffersonia diphylla* collected at Pine Lake Park, Ocean Co. (*s.n.* PH) in 1936. It was the first collection of the species from the state, and since, according to Fables' specimen label, the site was destroyed in 1938, it is the only record of this remarkably disjunct occurrence.

relocated 52 of them at or near (within two miles) a historical location. One species (*Cercis canadensis*) was found to have persisted at the same historical location for 105 years. For all the species on this list, the average number of years since they had been last collected or seen anywhere in the state is 41, with a low of nine and a high of 122. The current quality of the habitat, and not the number of years since a species was last documented, should be the most significant factor considered when searching for historical species.

For practical reasons, the list includes only those species that I discovered. Each species listed has been vouchered by a specimen, although only small fragments (e.g., a single flower, a leaf, etc.) were collected for a few of the rarer species. Specimens for all species collected are, at present, in my collection. Duplicates for most species collected prior to 1984 are at CHRB, with some additional ones at NY and PH. The locations for some of the collections have been simplified to save space or protect species that are vulnerable to overcollection. The species are arranged chronologically by date of discovery with any additional collections of the same species then arranged alphabetically by county. Nomenclature follows Gleason and Cronquist (1991) except for *Rubus ascendens* Blanchard, *Crataegus holmesiana* Ashe, *Oenothera oakesiana* Robbins, *Rhexia mariana* L. var. *ventricosa* (Fernald & Griscom) Kral & Bostick, *Carex aggregata* Mackenzie, and *Platanthera peramoena* (A. Gray) A. Gray. My use of "lost" in the title is intentional, since the use of "historical" as a conservation rank was not used in New Jersey until 1984, the year the Natural Heritage Program was established.

FLORA

1. *Viola hirsutula*. Hunterdon Co.: Cushetunk Mountain (2 May 1977, *D. Snyder 41;* 7 May 1979, *41-2*). New population. First collection since 1938 (*F. M. Small s.n.* CHRB). Subsequent collections: Mercer Co.: Summit of Pennington Mountain, 1.3 mi. SE of Harbourton (5 May 1989, *D. Snyder 2573*). Morris Co.: W side of Wills Brook, 0.8 mi. WNW of Stanhope (6 May 1984, *D. Snyder 1364*, first found by T. Halliwell). Union Co.: Seeleys Pond (13 May 1982, *D. Snyder 41-3*). Warren Co.: Johnsonburg (7 May 1983, *D. Snyder 41-5*). Although specimens are frequently misidentified, this species is one of the more distinctive stemless blue violets occurring in New Jersey, differing from all others in its thickish, round-ovate leaves that lie flat on the ground and form a small rosette. This southern species is near the northern limit of its range and is apparently quite rare in the state with collections known from eight additional historical locations in Middlesex, Somerset, and Sussex Cos. (specimens at CHRB, NY).

2. *Polygala polygama*. Middlesex Co.: East Brunswick (1 Jul 1978, *D. Snyder 204*; 15 Jul 1979, *D. Snyder 204-3*). New population, but in general vicinity of M. A. Chrysler's 1942 collection, "abandoned orchard near school, Riva Ave. below Milltown" (*s.n.* CHRB). First collection since 1947 (*R. Sim* s.n. PH). Still present 29 Jun 1986. Abraitys has a 1962 sight record from Gloucester Co. but this site apparently was destroyed (V. Abraitys pers. comm.). Subsequent collection: Cumberland Co.: 0.3 mi. WNW of jct. Rt. 47 and Arbor Ave., North Vineland (*S. Field & D.Snyder 4003*, discovered by S. Field). Recently reported from Burlington Co. (T. Gordon pers. comm.), Gloucester (J. Arsenault pers. comm.), and Ocean (W. Wander pers. comm.) Cos. Historically this species has been documented from approximately 41 locations in eleven counties (specimens at BKL, CHRB, NY, PH), most of which were collected prior to 1926. The species' present rarity is puzzling.

3. *Penstemon laevigatus*. Hunterdon Co.: 0.5 mi. S of Stockton (9 Jul 1978, *D. Snyder 221*); edge of active quarry, 0.4 mi. SE of Brookville (3 Jul 1991, *D. Snyder 3022*). Both collections are from the same location. New population. First collection since 1938 (*L. P. Hynes s.n.* PH). I place Abraitys' (unpublished) 1960 sight record about two miles south of my site. By 1991, much of the original

colony had been destroyed by the expansion of the quarry. Subsequent collection: Mercer Co.: 0.3 mi. E of jct. Rt. 29 and Fiddler Creek Rd., Titusville (8 Jun 1993, *D. Snyder 4209*). Similar to *P. digitalis* and sometimes confused with it.

4. *Platanthera hookeri*. Sussex Co.: 1 mi. SW of Springdale (17 Jun 1979, *D. Snyder 488*; *30 May 1981, D. Snyder 488-2*). New population, although only about 0.5 mi. W of where H. W. Pretz collected it in 1909 (*1881* PH). First collection since 1950 (*W. Niering s.n.* CHRB). Vincent Abraitys (unpublished) had a 1960 sight record from Johnsonburg, Warren Co., but he had been unable to relocate plants in later years (V. Abraitys pers. comm.). This site relocated 30 May 1981(*D. Snyder 488-2*). Johnsonburg site originally discovered by K. K. Mackenzie in 1921 *s.n.* NY).

5. *Triphora trianthophora*. Morris Co.: Splitrock Reservoir (19 Aug 1979, *T. Halliwell & D. Snyder 586*). New population, but about 0.6 mi. NE of the site discovered in the 1940s or 1950s by J. L. Edwards (E. Green unpublished). Despite repeated searches by Edwards, and in more recent years, Abraitys, the original population could not be found (V. Abraitys pers. comm.; Snyder 1993). Fernald (1950) states that *Triphora* usually develops "only at remote periods." This has not been the case for this population. From 1979 to 1989, there was only one year in which I did not find plants (and this could have very well been due to predation). Population size did vary considerably from year to year with a high of 41 plants to a low of one or two plants. Still present in 1997, although one of the colonies was destroyed by off-road vehicles.

6. *Utricularia minor*. Warren Co.: Johnsonburg (8 Jun 1980, *D. Snyder 721*). Relocation of R. T. Clausen and J. L. Edwards' 1934 collection site (*1289* BH). Last collected at White Lake, Marksboro, Warren Co. in 1938 (*R. H. True 5710* PH). Subsequent collections: Warren Co.: White Lake, 0.8 mi. N of Marksboro (1 Aug 1982, *T. Halliwell & D. Snyder 721-3*). Sussex Co.: ca. 1 mi. NW of cemetery at Huntsville (6 Jul 1990, *T. Breden, T. Halliwell & D. Snyder 2872*); 0.4 mi. S of Twin Lakes and ca. 0.7 mi. N of Andover Junction (21 Jun 1989, *D. Snyder 2605*), E side of Pequest River, 0.35 mi. SE of Big Spring, 1.3 mi. SW of jct. Rt. 206 and Rt. 611, Springdale, (14 Sep 1994, *D. Snyder 4706*). My field experience has been that *U. minor* flowers abundantly only after there has been a drawdown in water levels. Unless in flower, this species is very easy to overlook.

7. *Salix lucida*. Morris Co.: 0.6 mi. NE of Russia (25 Jul 1982, *D. Snyder 1178*, discovered, but not collected, 4 Jul 1980). New population. First collection since 1917 *(E. B. Bartram s.n.* PH). Subsequent collections: Sussex Co.: 1.2 mi. NNE of Tuttles Corner (9 Jun 1985, *D. Snyder 1652*); 0.4 mi. SW of Buckmire Pond (10 Aug 1986, *T. Halliwell & D. Snyder 2024*). Vegetative collections have been sometimes confused with *S. serissima*, which in some New Jersey specimens have leaf tips that are atypically long-acuminate.

8. *Spiraea alba* var. *alba*. Sussex Co.: 0.4 mi. N of Montague (13 Jul 1980, *D. Snyder 776*). New population. Perhaps first collection since 1861 (Camden, *C. F. Parker s.n.* CHRB). Subsequent collections: Sussex Co.: 0.4 mi. N of Flatbrookville (8 Aug 1982, *D. Snyder 776-2*). Warren Co.: ca. 0.8 mi. N of railroad bridge, Delaware (29 Jun 1985, *D. Snyder 1668*); ca. 1.6 mi. SSW of Hope (9 Aug 1989, *D. Snyder 2647*). At CHRB, NY, and PH there is only a handful of New Jersey specimens of which only the above-cited Parker specimen appears to be typical *S. alba* var. *alba* (finely toothed, narrow leaves with distinctly pubescent inflorescences). The others all seem to be misidentifications or specimens intermediate between var. *alba* and var. *latifolia*. A critical study of these specimens is needed.

9. *Pycnanthemum clinopodioides*. Warren Co.: Johnsonburg (20 Jul 1980, *D. Snyder 798*). New population. First collection since 1891 (*C. D. Lippencott* CHRB). A globally rare and taxonomically perplexing taxon (Snyder 1994). Subsequent collections: Passaic Co.: W side of the Clove (9 Aug 1994, *D. Snyder 4661*). Sussex Co.: SW corner of main quarry and just NE of Noble Pit, Sterling Hill Mine,

Ogdensburg (9 Oct 1992, *T. Breden* and *D. Snyder 4116*). Warren Co.: Phillipsburg Bluffs, ca. 1.5 to 1.7 mi. SE of New Jersey Central railroad crossing Delaware River, Phillipsburg (5 Sep 1990, *D. Snyder 2940*).

10. *Aster radula*. Middlesex Co.: Outcault (29 Aug 1980, *D. Snyder 888*). New population. First collection since 1935 (*J. A. Drushel & H. K. Svenson 6694* BKL). Subsequent collections: Middlesex Co.: Helmetta (29 Aug 1980, *D. Snyder 888-2*), which is possibly a relocation of Drushel and Svenson's "Pine barren swamp, Helmetta" (*6694* BKL). Morris Co.: Ironia (4 Sep 1982, *D. Snyder 888-5*), presumably a relocation of K. K. Mackenzie's "Border of swampy woods, Ironia" (*7852* CHRB, NY, PH). The Outcault population has been destroyed by a housing development, the Helmetta population may have succumbed to habitat succession, and the Ironia population has been partially destroyed by roadside grading.

11. *Viburnum alnifolium*. Sussex Co.: 1 mi. NE of Canistear Reservoir (24 Jul 1981, *T. Halliwell & D. Snyder 1014*). First collection since J. L. Edwards' 1956 collection, Sussex Co.: 1 mi. ENE of Canistear Reservoir on E side of Cherry Ridge Brook (*s.n.* CHRB). Presumably both are the same collecting localities. One of four documented locations for the species in New Jersey. Typically this species is a low shrub forming tangled thickets, but this population consists mostly of arborescent forms reaching 2.5 - 3.5 meters high.

12. *Lespedeza stuevei*. Cumberland Co.: ca. 1.3 mi. NNE of Manumuskin (4 Sep 1981, *D. Snyder 1051*). First collection since 1938 (*B. Long 52926* PH). Subsequent collections: Atlantic Co.: ca. 1.4 mi. W of McKee City (23 Aug 1995, *D. Snyder 4976*). Cape May Co.: ca. 0.9 mi. NE of jct. Corsons Tavern Rd. and South Seaville Rd., South Seaville (29 Jul 1991, *D. Snyder 3060*). Cumberland Co.: S of Rt. 49, ca. 0.6 mi. NW of cemetery, Cumberland (20 Sep 1985, *J. Stasz & D. Snyder 1845*). In the past, this species has been confused with *L.* × *neglecta* (= *L. stuevei* var. *angustifolia*), which is the basis for some other recent collections and reports (e.g., Cape May Co.: ca. 1.4 mi. NW of Cape May Court House, 1 Sep 1984, *D. Snyder 1500*, discovered by T. Halliwell).

13. *Myriophyllum tenellum*. Ocean Co.: Old Sams Pond [Point Pleasant] (6 Sep 1981, *D. Snyder 1056*). Relocation of a site apparently discovered in 1882 by E. Day (*s.n.* CHRB, NY). Most early collections from this site are labeled "Point Pleasant," as are Day's, or "pond south of the station, Point Pleasant" (specimens at CHRB, NY, PH). Only specimens collected by K. K. Mackenzie in 1910 (*4831* GH, NY) and 1912 (*5102* NY) are labeled, "Old Sam's Pond, Point Pleasant." Although the pond is still locally known as Old Sams Pond, it appears on current maps as Lake of the Lilies. The species was apparently last collected at this site in 1942 (*M. A. Chrsyler & E. P. Killip s.n.* CHRB) and last collected in the state in 1971 (*W. R. Ferren 773* PH) at Spring Lake, Monmouth Co., where it appears to be no longer present. Some populations of *M. tenellum* appear to be ephemeral, such as the two Atlantic Co. Pine Barren sites discovered by F. and R. Hirst (PH), but the Point Pleasant locality clearly documents the species' potential longevity. Subsequent collection: Middlesex Co.: N finger of McCormack Lake, 1.3 mi. NNW of Scotts Corner (13 Jul 1994, *J. Fishback & D. Snyder, 4595*; 31 Aug 1994, *J. Fishback, A. E. Schuyler & D. Snyder 4684*).

14. *Triosteum angustifolium*. Somerset Co.: Chimney Rock (9 Sep 1981, *D. Snyder 1060*; 26 May 1982, *D. Snyder 1060-2*); above dam on West Branch Middlebrook, W of East Branch Reservoir, Chimney Rock (8 Jun 1985, *D. Snyder 1644*). New population. First collection since 1937 (*W. M. Benner 7914* PH), and one of five verified collections for the state. Verified collections are from a small area of Hunterdon and Somerset Cos., where it has been collected from diabase, traprock, and possibly shale substrates. The three species of *Triosteum* occurring in New Jersey are all variable in leaf shape and pubescence, making vegetative collections difficult to identify with certainty. An unidentified vegetative specimen collected from Mercer Co. by B. Long (*39895* PH) appears to be *T. angustifolium*,

but a vegetative specimen identified as this species by Long from Monmouth Co. (*s.n.* PH) is less convincing.

15. *Pluchea foetida*. Cape May Co.: 1.5 mi. NNW of Green Creek (12 Sep 1981, *D. Snyder 1068;* 18 Sep 1981, *D. Snyder 1068-3*; 25 Sep 1983, *D. Snyder 1068-4*). New population. One of six locations documented for the state and first collection since 1960 (N side of main bog, Bennett Bog, 1 km W of Erma, *J. D. Montgomery s.n.* CHRB). The Bennett Bog population has been extirpated. When first found, the Green Creek population consisted of about 30 robust plants growing in a wet, mucky, cleared area in a recently cut-over portion of a lowland hardwood forest. Succession and regrowth of this site proceeded rapidly, so that by 1984 only 12 plants were located. By 1989, the site had become so densely overgrown with young red maples and sweetgums that no plants persisted. A careful search of open thickets along the ecotone of an adjacent salt marsh, produced a new population of four plants, which possibly was the seed source for the original population (Cape May Co.: 0.9 mi. SSE of Pierces Point Pond and 1.5 mi. NNW of Green Creek, 8 Sep 1989, *D. Snyder 2685*). The species is restricted to Cape May Co., where it reaches the northeastern limit of its range.

16. *Lycopodium annotinum*. Sussex Co.: Wawayanda Lake (6 Dec 1981, *T. Halliwell & D. Snyder 109*); 18 October 1982, *D. Snyder 1093-4*; 8 Nov 1982, *J. Montgomery & D. Snyder 1093-5*). Relocation of a site discovered in 1933 by J. L. Edwards (*s.n.* CHRB) and last collected by B. Hirst in 1960 (*s.n.* PH). Just how many separate colonies Edwards located at this site is unclear; at least two, perhaps three. The colony that Halliwell and I found apparently was not the one known to Abraitys (pers. comm.) who had gotten the location from Edwards. This is one of two locations documented for the state. The other location is in Morris Co. *(J. L. Edwards s.n.* CHRB).

17. *Phlox divaricata*. Monmouth Co.: Walnford (24 Apr 1982, *D. Snyder 138-2*). Relocation of a 1959 sight record of Abraitys (unpublished). One of three collections of apparently indigenous populations. The others were collected along the Delaware River in Warren Co. by B. Long in 1952 (*74894* PH) and from the Raritan River by W. A. Wistendahl in 1954 (*468* CHRB). The species is frequently cultivated and other collections and reports appear to me to be based on garden escapes.

18. *Aster infirmus*. Somerset Co.: Pluckemin (immature specimen 14 Jun 1982, *D. Snyder 1143*; flowering specimens 27 Jul 1982, *D. Snyder 1143-2*). New population. First collection since 1959 (*R. L. Schaeffer, Jr., 59657* PH). Subsequent collections: Bergen Co.: WNW of Hawk Rock, Ramapo Mountains, ca. 0.8 mi. NW of jct. Rt. 282 and Darlington Ave., Darlington (17 Jul 1991, *D. Snyder 3025*). Passaic Co.: W slope of Beech Mountain, 0.4 mi. SSE of Franklin Lake (21 Aug 1995, *D. Snyder* and *K. Waltz 4968*). Somerset Co.: 1 mi. WNW of Watchung (5 Sep 1983, *D. Snyder1143-4*). Sussex Co.: ca. 0.5 mi. W of Big Spring, ca. 2.1 mi. SW of Springdale (14 Jun 1985, *D. Snyder 1661*); ca. 1 mi. S of Lake Grinnell (10 Jul 1986, *D. Snyder 1991*); Heaters Pond, Ogdensburg (19 Jul 1986, *D. Snyder 1992*). Widely scattered in the northern counties with a few isolated collections from the Coastal Plain in Monmouth, Gloucester, Salem, and Cumberland Cos., none more recent than 1935 (specimens at PH). Despite considerable searching, I have failed to discover any Coastal Plain occurrences.

19. *Physalis pubescens* var. *grisea*. Sussex Co.: Mud Pond, Ogdensburg (18 Jun 1982, *D. Snyder 1146*). New population. First collection since 1934 (*H. N. Moldenke 8141* NY). A particularly obscure taxon with unstable nomenclature. The genus is poorly collected in the state. Subsequent collection: Sussex Co.: 0.5 mi. SE of Springdale (24 Aug 1985, *D. Snyder 1774*).

20. *Kuhnia eupatorioides*. Sussex Co.: Mud Pond, Ogdensburg (immature specimens 13 Jul 1982, *D. Snyder 1168*; flowering specimens 22 Aug 1982, *D. Snyder 1168-2*). New population. First collection since 1973 (Warren Co.: Johnsonburg, *V. Abraitys s.n.* CHRB). Abraitys' population consisted of a few plants (V. Abraitys pers. comm.) and by 1980, it could no longer be found. Its loss was apparently a result of woody succession of its open habitat. Subsequent collections: Sussex Co.: SW corner of

Passaic Pit, Sterling Hill Mine, Ogdensburg (1 Oct 1991, *D. Snyder 3180*); N rim of Noble Pit, Sterling Hill Mine, Ogdensburg (1 Oct 1991, *D. Snyder 3185*).

21. *Monarda clinopodioides*. Hunterdon Co.: 1.2 mi. E of Raven Rock (23 Jul 1982, *D. Snyder 1173*). New population. One of eight documented locations for the state and the first collection since 1956 *(R. L. Schaeffer, Jr. 51813* PH). The plants were growing in open thickets in a successional field (Snyder 1985). By 12 Aug 1987, the openings had succeeded to the point that no plants were located. A more thorough search of suitable habitats in the general area is needed to confirm that this species has once again been lost to the state flora.

22. *Aster tradescantii*. Warren Co.: 0.9 mi. NE of Dimicks Ferry (15 Aug 1982, *D. Snyder 1204*). New population. This species reaches the southern limit of its range along the Delaware River in Warren Co. (Snyder 1985) and this collection is the basis of the New Jersey record cited in Gleason and Cronquist (1991). Previous to this discovery, the southern limit had been reported as northern Massachusetts and northern New York (Fernald 1950; Gleason and Cronquist 1952). The species was first collected in New Jersey in the 1950s by R. L. Schaeffer, Jr. (*30730* CHRB) but the specimen had been misidentified. Subsequent collections: Sussex Co.: 1 mi. NE of Smith Ferry (5 Oct 1982, *D. Snyder 1204-2*; 26 Aug 1983, *D. Snyder 1204-6*); 0.4 mi. S of Flatbrookville (26 Aug 1983, *D. Snyder 1204-10*); W of Walpack Center (4 Sep 1983, *D. Snyder 1204-15*). Warren Co.: opposite Tocks Island (4 Sep 1983, *D. Snyder 1204-18*); Delaware Water Gap (4 Sep 1983, *D. Snyder 1204-19*); ca. 0.4 mi. E of S end of Depue Island, Worthington State Forest (2 Sep 1992, *D. Snyder 4051*).

23. *Aster praealtus*. Hunterdon Co.: 1.2 mi. E of Raven Rock (18 Sep 1982, *D. Snyder 1217*; 26 Sep 1982, *D. Snyder 1217-2*). New population. First collection since 1896 (*H. L. Fisher s.n.* PH) and second documented occurrence. Subsequent collections: Somerset Co.: 1 mi. N of Mount Bethel (10 October 1982, *D. Snyder 1217-5*). All the locations cited in Britton (1889), Taylor (1915), and Hough (1983) that are backed with specimens are based on misidentifications, and are mostly the superficially similar *A. lanceolatus* (Snyder 1985).

24. *Sparganium minimum*. Warren Co.: 0.6 mi. S of Squires Corner (vegetative specimens, 8 Sep 1983, *D. Snyder 1286*; fruiting specimens, 3 Aug 1985, *D. Snyder 1752*). Relocation of the only documented New Jersey location collected in 1961 by J. L. Edwards and R. Hirst (*s.n.* CHRB) and last collected in 1962 (*R. Hirst s.n.* PH). Vincent Abraitys, who also knew this site, told me that he thought the population probably had been destroyed because the pond had been partially filled and ditched in a feeble attempt to drain it (also see: Abraitys 1980). In both 1983 and 1985 the population formed large patches in the southern portion of the pond, with many hundreds of individuals. Subsequent collection: Morris Co.: NE end of Lake Denmark, ca. 1 mi. ENE of the westernmost end of the lake, Picatinny Arsenal (8 July 1993, *D. Snyder, J. Van de Venter & A. Windisch 4268*). This is an enormous and vigorous population.

25. *Melanthium viginicum*. Sussex Co.: Sterling Hill (16 Sep 1983, *D. Snyder 1294*; 22 Jul 1984, *D. Snyder1431*). Relocation of a site discovered by either Abraitys or Edwards (*J. L. Edwards & V. Abraitys s.n.* CHRB) and last collected 1965. By 1996, this site had been destroyed by the flooding of its habitat by beavers. Subsequent collections: Sussex Co.: along tributary to Wallkill River, 0.1 mi. N of Sparta Station (22 Jul 1984, *D. Snyder 1432*; 28 Apr 1994, *D. Snyder 4480*) Relocation of a 1965 sight record by V. Abraitys (unpublished). This population has significantly declined due to flooding by beavers and habitat succession by *Phragmites australis*. Morris Co.: Mount Freedom (26 Jul 1994, *D. Snyder 4638*, discovered by D. Nelson).

26. *Triglochin maritima*. Sussex Co.: S of Newton (25 May 1984, *D. Snyder 1357*; 23 Sep 1984, *D. Snyder 1542*). Still present in 1997. Discovered and last collected at this site in 1920 by K. K. Mackenzie (*s.n.* CHRB, NY). Relocated, but not collected, at this site in 1969 by Abraitys (Snyder 1984). A

decade later, Abraitys (1980; pers. comm.) considered *Triglochin* to be no longer present, having probably succumbed to succession of its habitat by woody vegetation, possibly because of a general lowering of the water table. Only six additional historical locations have been documented by collections, the most recent made in 1945 (*J. A. Small s.n.* CHRB). An extremely rare and declining species in the state.

27. *Xyris caroliniana*. Burlington Co.: ca. 1 mi. SSE of Hampton Furnace (18 Aug 1984, *T. Gordon & D. Snyder 1467*; 26 Oct 1995, *D. Snyder 5080*). Presumably a relocation of the site discovered by Abraitys in 1968 (between High Crossing and Batsto River, *s.n.* CHRB, PH), however, the labels of Abraitys' specimens describes the habitat as "dry sand," while the colony found in 1984 was growing in damp sand in the center of a very overgrown sand road. Abraitys (unpublished) described his site as having a "strong colony" and in 1970 he noted that it was "still in good shape." Just a handful of plants were present in 1984, and as of 1995, the colony was all but gone due to woody succession. This colony is not the one discovered in 1911 by S. Brown, B. Long, and W. Stone on the west side of the Batsto River, south side of the railroad (*B. Long 6164* PH) as detailed in Stone (1912) and then rediscovered in 1966 by V. Abraitys (unpublished). Nor is it a more recent site, near to the last but on the N side of the railroad, apparently discovered in 1952 (Fables 1963), and known at least to Lou Hand and Ted Gordon (T. Gordon pers. comm.). Both these sites are now gone. In 1985, Jim Stasz, with T. Gordon and D. Snyder, found (but did not collect) a few spindly plants on an overgrown trail along a tributary to Tulpehocken Creek, W of Hawkins Bridge. This site is now completely overgrown and no plants were located in a recent search. Subsequent collection: Atlantic Co.: ca. 2 mi. SW of jct. Berlin Ave. and Duerer St., Egg Harbor City (17 Aug 1992, *D. Snyder 4037*). A few plants in dry sand along a ditch in oak and pine woods.

28. *Liatris scariosa* var. *novae-angliae*. Monmouth Co.: S side Rt. 35, ca. 0.35 mi. SE of Matawan Creek, Keyport (7 Oct 1984, *D. Snyder 1572*). Relocation of Abraitys' (unpublished) 1965 sight record (Snyder 1984), which was apparently a relocation of a site collected by J. L. Edwards in 1934 (*s.n.* CHRB), which may be the same site reported in Britton's catalog (1889). The site was destroyed in 1987 by road widening, but not before I rescued a few of the plants and sent them to Bill Brumback at the New England Wild Flower Society for captive propagation (Snyder 1989). Through Bill's legendary propagation wizardry, six plants were soon transformed into sixty. These plants were then planted in seemingly suitable habitat in Cheesequake State Park, Middlesex Co., where they were promptly vandalized. All the largest plants were dug up and removed. In subsequent years the remaining plants have been run over, deer browsed, and had their habitat overgrown with woody vegetation. Today, only one or two plants survive of this showy, globally rare plant. *C'est la vie.*

29. *Rhododendron atlanticum*. Cape May Co.: ca. 0.9 mi. E of Kay Pond and ca. 1.9 mi. NNW of Wildwood Junction (24 May 1985, *D. Snyder & J. Stasz 1628*). First collection since 1940 (*B. Long 54440* PH) although some later sight records have been reported (Snyder 1986). When I first saw this plant, I was about 20 feet away from it, and I remember remarking to Jim Stasz, "Isn't it early for *R. viscosum* to be blooming?" Jim, who knew *R. atlanticum* from the Coastal Plain of Maryland, suspected otherwise. In all the years that I had spent searching for *R. atlanticum*, I had been looking for a pink-flowered plant, not the white-flowered color form *confusum* that we discovered that day. I have yet to find the pink-flowered form growing in the state, although that is the only color form reported by Fernald (1950) to occur in New Jersey. Subsequent collections: Cumberland Co.: S side of Rt. 47, within 0.3 mi. W of Christian Rd., Delmont (11 Jun 1996, *D. Snyder 5122*). Ocean Co.: ca. 1 mi. WSW of Giffordtown (4 Jun 1993, *D. Snyder 4193*). Salem Co.: 1.1 mi. N of Friesburg (2 Aug 1989, *D. Snyder 2643*; also 23 May 1990, *D. Snyder 2798*).

30. *Euphorbia purpurea*. Cape May Co.: 2.5 mi. NNW of Wildwood Junction (24 May 1985, *D. Snyder 1629*; 24 May 1986, *D. Snyder 1912*). Relocation of O. H. Brown's 1919 site (*s.n.* GH, PH). The most recent record for the state was collected at this site in 1946 (*O. H. Brown s.n.* PH). There are three

other historical sites documented, one in Salem Co. and two in Cape May Co. (Snyder 1986). I have searched all these sites but, so far, without success. This is a striking plant, and the most imposing of all our native euphorbias, with some individuals growing nearly two meters high (Snyder 1986). It is rare throughout its limited range.

31. *Vicia caroliniana*. Sussex Co.: east-facing slope of Sparta Mountain, ca. 0.15 mi. E of the SW corner of Morris Lake, Sparta (26 May 1985, *D. Snyder 1635*). Relocation of K. K. Mackenzie's 1910 site (*4515* GH, NY) which had been the most recent collection. Vincent Abraitys' 1964 report from Warren Co. (Snyder 1984;1986) is based on vegetative material, and in his later years, he was less certain of his identification (V. Abraitys pers. comm.). I have tried a number of times to relocate this site, which was discovered by T. C. Porter in 1882 (CHRB).

32. *Carex jamesii*. Hunterdon Co.: southern tip of Holcombe Island, Lambertville (1 Jun 1985, *D. Snyder 1639*; 29 May 1986, *D. Snyder 1918*). New population. First collection since 1924 (*B. Long 30383 PH*). A Warren Co. site discovered in 1913 by K. K. Mackenzie (*5363* NY) and relocated by V. Abraitys in 1969, has not been found since, despite much searching (Snyder 1986). Subsequent collection: Hunterdon Co.: SW end of Treasure Island, ca. 0.6 mi. SSW of Kingwood Station (16 May 1987, *T. Halliwell* and *D. Snyder 2153*, found by T. Halliwell). A few plants precariously located on a high, eroding alluvial bank of the Delaware River.

33. *Scutellaria nervosa*. Hunterdon Co.: near summit of Goat Hill, ca. 1.3 mi. S of bridge crossing Delaware River, Lambertville (2 Jun 1985, *D. Snyder 1641*; 29 May 1986, *D. Snyder 1916*). Relocation of R. E. Schuh's 1886 site (*s.n.* CHRB, NY). The most recent collection had been made from Warren Co. in 1955 (*R. L. Schaeffer, Jr., 48167*). Subsequent collections: Hunterdon Co.: SW end of Treasure Island, ca. 0.6 mi. SSW of Kingwood Station (16 May 1987, *T. Halliwell* and *D. Snyder 2155*). Mercer Co.: Herrontown Woods, ca. 0.3 mi. SW of jct. Snowden Lane and Herrontown Rd., Princeton (17 May 1993, *D. Snyder 4150*). Warren Co.: ca. 0.3 mi. NW of Shuster Pond (15 Jun 1986, *Irv Black, T. Halliwell, D. Snyder 1955*); 0.5 mi. S of Jacksonburg (30 Jun 1988, *D. Snyder 2385*). Sussex Co.: 1.5 mi. NW of Prices Switch (7 Oct 1996, *D. Snyder 5318*). In New Jersey, *Scutellaria nervosa* is almost exclusively a plant of limestone or mafic (diabase or traprock) substrates.

34. *Triadenum walteri*. Cape May Co.: branch of Bidwell Creek, ca. 1.2 mi. NE of Miller Pond and 2.4 mi. N of Cape May Court House (immature specimens, 24 Jul 1985, *D. Snyder* and *J. Stasz 1727*; fruiting specimens, 20 Sep 1985, *D. Snyder 1844*). New population. First collection since 1927 (*O. H. Brown s.n.* PH) and third documented location (Snyder 1986). Subsequent collections: Cape May Co.: branch of Fishing Creek, Rio Grande (12 Aug 1986, *T. Breden, G. Cavileer, T. Halliwell, K. Seager*, and *D. Snyder 2030*, new population, discovered by Cavileer and Seager); along Dias Creek, ca. 2.6 mi. NNW of Wildwood Junction (23 Aug 1986, *D. Snyder 2047*, discovered by D. Cristol). The latter is a relocation of the previously cited Brown collection.

35. *Alisma triviale*. Warren Co.: 1.3 mi. WSW of Southtown (8 Aug 1985, *I. Black, T. Halliwell*, and *D. Snyder 1764*; 7 Sep 1985, *D. Snyder 1791*). New population. First collection since 1932 (*H. N. Moldenke 7390* NY). Erroneously reported as an addition to the state flora by Snyder (1986). At NY there are specimens from three different locations in Essex, Somerset, and Sussex Cos.

36. *Solidago rigida*. Sussex Co.: 0.5 mi. SE of Springdale (24 Aug 1985, *D. Snyder 1776*). Relocation of G. H. Morton's 1974 station (*5536* NY). Part of this population has been lost through woody succession of its habitat. Subsequent collections: Sussex Co.: Mud Pond, Ogdensburg (9 Sep 1991, *D. Snyder 3135*); NE corner of Passaic Pit, Sterling Hill Mine (1 Oct 1991, *D. Snyder 3182*); 0.5 mi. NE of jct. Rt. 517 and Rt. 94, McAfee (7 Oct 1996, *D. Snyder 5325*).

37. *Triadenum fraseri*. Morris Co.: between abandoned railroad and Lamington River, ca. 0.1 mi. SE of Horseshoe Lake, Succasunna (9 Sep 1985, *D. Snyder 1798*). New population. First collection since 1952 (*R. L. Schaeffer, Jr., 41559* PH). Recent field work has shown this species to be more frequent than I first believed (Snyder 1986). Subsequent collections include: Morris Co.: W side of Splitrock Reservoir (18 Aug 1993, *D. Snyder 4350*). Sussex Co.: ca. 0.3 mi. NE of Armstrong (10 Aug 1989, *D. Snyder 2653*); Delaware River shore ca. 1.3 mi. SW of Walpack Center (22 Jul 1991, *D. Snyder 3041*); 1 mi. NE of jct. Ackersons Rd. and Rt. 94, Monroe (30 Aug 1995, *T. Breden, D. Snyder, G. Steidl, J. Tesauro 5000*); ca. 0.2 mi. SW of Mud Pond, Sterling Hill, Ogdensburg (22 Aug 1996, *D. Snyder 5258*).

38. *Trichostema setaceum*. Salem Co.: ca. 1 mi. N of Friesburg (15 Sep 1985, *D. Snyder* and *J. Stasz 1811*; 2 Aug 1989, *D. Snyder 2642*). Apparently a relocation of B. Long's 1934 collection (*45141* PH). First collection since 1950 (*J. A. Small s.n.* CHRB). Subsequent collections: Burlington Co.: ca. 0.6 mi. W of Rt. 206, Ewansville (24 Sep 1989, *D. Snyder 2714*). Cape May Co.: E side of R R, ca. 1.7 mi. NNE of jct. Mechanic St. and railroad, Cape May Court House (20 Sep 1985, *J. Stasz & D. Snyder 1842).*

39. *Hydrocotyle ranunculoides*. Salem Co.: ca. 0.7 mi. NW of Harrisonville (15 Sep 1985, *J. Stasz & D. Snyder 1815*). Relocation of V. Abraitys' 1967 collection (*s.n.* CHRB) at its then only documented New Jersey location (Snyder 1984). Some time after Abraitys' discovery, the species' wetland habitat had been filled to expand an agricultural field and Abraitys thought that the population was probably gone (V. Abraitys per. comm.). Only a few plants were located in 1985, and these were depauperate, without flowers or fruit, and growing under the dense, weedy vegetation that had succeeded the little remaining wetland habitat. I doubt whether any *Hydrocotyle* has survived. Subsequent collections: Middlesex Co.: E shore of Farrington Lake, Patricks Corner (23 Aug 1994, *D. Snyder 4669*; 31 Oct 1996, *D. Snyder 5350*). Locally common at this site with robust plants and abundant flowers and fruit.

40. *Eupatorium aromaticum*. Cape May Co.: ca. 0.7 mi. N of intersection of Rt. 47 and Seashore Ave., Rio Grande (20 Sep 1985, *D. Snyder 1833*). New population. First collection since 1951. Subsequent collection: Cape May Co.: 1.5 SW of Cold Spring Church, Cold Spring (29 May 1987, *D. Snyder*). Both sites with few plants. This species has been collected from all Coastal Plain counties except Mercer, Ocean, and Salem and from isolated single collections from Morris (9 Sep 1874, *B. Heritage s.n.* PH) and Union Cos. (23 Sep 1916, *K. K. Mackenzie 7404* CHRB, NY, PH). At CHRB, NY, and PH there are specimens representing at least 48 distinct historical sites. Habitats at many of these historical sites still seem suitable, which makes the species' present rarity hard to explain.

41. *Muhlenbergia capillaris*. Union Co.: ca. 0.3 mi. S of Seeleys Pond, First Watchung Mountain, Scotch Plains (22 Sep 1985, *D. Snyder 1851*). New population. First collection since 1918 (*W. D. Miller 1098* NY, PH). Subsequent collections: Passaic Co.: E side of the Clove, ca. 1.4 mi. NW of summit of High Mountain (4 Oct 1985, *T. Breden & D. Snyder 1860*). Sussex Co.: ca. 0.2 mi. N of Wrights Pond (4 Sep 1987, *D. Snyder 2248*). The latter a relocation of a site collected once by K. K. Mackenzie (*1121* NY) in 1904 (Snyder 1993). This species is extremely rare in the northeastern United States (Snyder 1986).

42. *Crataegus calpodendron*. Sussex Co.: ca. 1 mi. NNE of Drakes Pond, Newton (29 Sep 1985, *D. Snyder 1855*). New population. First collection since 1920 (*K. K. Mackenzie s.n.* NY). This population has been since destroyed by the logging of its habitat. Subsequent collections: Sussex Co.: Delaware River shore, within 0.5 mi. S of Dingmans Ferry Bridge (14 Jun 1986, *D. Snyder 1944*). Warren Co.: Delaware River shore, ca. 0.7 mi. W of Hutchinson (8 Jul 1988, *D. Snyder 2397*).

43. *Diodia virginiana*. Cape May Co.: NW side of jct. Parkway and Rt. 109, ca. 0.7 mi. SW of Cold Spring (12 Oct 1985, *D. Snyder 1866*; 23 Aug 1986, *Snyder 2042*). Presumably a relocation of Abraitys' (unpublished) 1960 sight record, but he described his site as a "pond," whereas my collection was from

a series of small, temporary pools in low woods. First collection since 1936 *(W. Tullner s.n.* CHRB), although Abraitys (unpublished) has a 1971 sight record. Subsequent collections: Cape May Co.: 0.9 mi. NNE of jct. Bayshore Rd. and Sunset Blvd., West Cape May (21 Aug 1990, *D. Snyder 2914*); a relocation of Abraitys' 1971 sight record, a site that he thought probably destroyed; roadside ditch, N side Rt. 109, immediately W of its jct. with the Garden State Parkway, Cold Spring (14 Aug 1996, *D. Snyder 5239*); ca. 0.1 mi. S of Sunset Blvd., Cape May Meadows, West Cape May (14 Aug 1996, *D. Snyder 5240*, found by K. Seager). Frequent at this site. One patch measured ca. 5 by 7 meters.

44. *Linum sulcatum*. Sussex Co.: 0.2 mi. SW of intersection of Cork Hill Rd. and railroad, Ogdensburg (17 Oct 1985, *T. Breden & D. Snyder 1871*; 19 Jul 1986, *D. Snyder 1995*). New population. First collection since 1914 (*K. K. Mackenzie 6157* NY). There are four additional historical collections (specimens at BKL, NY, PH). The Camden Co. record cited by Snyder (1986) is based on a misidentified specimen of *L. intercursum* (11 Jul 1888, New Jersey Pine Barrens, Atco, *J. B. Brinton s.n.* PH). Subsequent collections: Sussex Co.: S side of Ding Dong Open Cut, N of Buckwheat Open Cut, and ca. 0.05 mi. SE of Boro Hall, Franklin (16 Jul 1987, *D. Snyder 2210*); 0.1 mi. NE of Franklin Pond, Franklin (6 Aug 1991, *D. Snyder 3086*); floor of fill quarry, Sterling Hill Mine, Ogdensburg (1 Oct 1991, *D. Snyder 3191*). All collections were made from limestone glades on outcrops of Franklin Marble.

45. *Geum vernum*. Burlington Co.: 0.3 mi. N of jct. Church Rd. and South Branch of Rancocas River, Vincentown (20 May 1986, *Snyder 1902*). A relocation of B. Long's (*9783*, PH) 1914 site (Snyder 1989) which was last collected by J. M. Fogg in 1936 (*10259*, PH). Subsequent collections: Burlington Co.: W side of the Southwest Branch of the Rancocas River, ca. 0.6 mi. N of Church Rd., Kirbys Mill (3 May 1988, *D. Snyder 2311*). Mercer Co.: along an unnamed creek, ca. 0.5 mi. S of jct. Church Rd. and Brickyard Rd., Washington Crossing State Park (4 May 1989, *D. Snyder 2568*). Sussex Co.: ca. 0.9 mi. N of Big Spring, Springdale (25 May 1988, *D. Snyder 2329*); W side of first Muckshaw Pond, 0.9 mi. WNW of Rt. 206, Springdale (29 May 1990, *D. Snyder 2799*); W base of Kittatinny Mountain, 0.8 mi. SSE of jct. Rt. 645 and Rt. 206, Hainesville (24 May 1994, *D. Snyder 4530*). Warren Co.: high bank of the Delaware River, about opposite Macks Island, ca. 1.2 mi. NNE of bridge crossing Delaware River, Belvidere (23 Jun 1989, *D. Snyder 2614*). Species is apparently spreading in New Jersey.

46. *Rubus ascendens*. Morris Co.: ca. 0.5 mi. NNW of jct. Rt. 10 and Hillside Ave., Succasunna (3 Jul 1986, *D. Snyder 1974*). Presumably a relocation of the site discovered by R. T. Clausen, and last collected in 1944 (*M. A. Chrysler* and *J. L. Edwards s.n.* CHRB). This population is actually the microspecies *R. clausenii*, and the site is the type locality. The microspecies is endemic to New Jersey (Fernald 1950) and is known only from this site. Fernald (1950) recognizes *R. clausenii* as a valid species but Davis and Davis (1968) lump it with *R. ascendens*. Typical *R. ascendens* is also a globally rare plant having been collected from only Connecticut and Massachusetts (Davis and Davis 1968). I have typical *R. ascendens* from these stations: Middlesex Co.: along access road under powerline, within 0.4 mi. SW of Rt. 130, Pigeon Swamp (29 Jun 1986, *D. Snyder 1973*). Sussex Co.: Jefferson Lake (26 Jul 1994, *D. Snyder 4636*); along W side of Lubbers Run, ca. 1.7 mi. SW of Seneca Lake, Sparta (21 June 1995, *D. Snyder 4831*).

47. *Crataegus punctata*. Sussex Co.: ca. 1.4 mi. SSW of Sawmill Pond (4 Aug 1986, *D. Snyder 2011*; 13 May 1994, *D. Snyder 4514*). New population. First collection since 1956 (*R. L. Schaeffer, Jr. 52496* PH). Subsequent collections: Somerset Co.: ca. 0.6 mi. ENE of Rt. 206 bridge crossing of Raritan River, N side of river, Somerville (13 May 1994, *D. Snyder 4511*). Sussex Co.: S side of Big Flatbrook, ca. 1 mi. NNE of Tuttles Corner (13 May 1994, *D. Snyder 4517*).

48. *Crataegus holmesiana*. Somerset Co.: 0.2 mi. E of Peters Brook and 0.5 mi. ENE of Rt. 206 bridge crossing of Raritan River, N side of river, Somerville (22 Aug 1986, *D. Snyder 2042*; 13 May 1994,

D. Snyder 4510). New population. Previously documented from a single 1940 collection (*W. M. Benner 9500* PH). In the "rough and more than ordinarily tentative" treatment adopted by Cronquist (Gleason and Cronquist 1991), *C. holmesiana* is lumped under *C. coccinea*, as are most of the other taxa comprising series *Coccineae*. Even in this broader sense, there are no New Jersey collections more recent than 1940.

49. *Rhynchospora globularis* var. *recognita*. Cape May Co.: 0.5 mi. NW of Bennys Landing, Cape May Court House (8 Aug 1986 *D. Snyder 2026*). Relocation of Abraitys' 1972 sight record. Species grew abundantly in moist sand along trails through an abandoned sand pit. Much of the site has since succeeded into dense woody thickets and no plants were located during a recent search. An extensive population of this species was discovered at Deer Park, Camden Co. in early August of 1992 by John Cochnar. It was collected by Ted Gordon at this site on 6 September 1992 (specimen in T. Gordon's private collection).

50. *Crataegus succulenta*. Sussex Co.: SW side of the Buckwheat Open Cut, due W of jct. Taylor Rd. and Buckwheat Rd., Franklin (30 Aug 1986, *D. Snyder 2064*). New population. First collection since 1948 (*R. L. Schaeffer, Jr. 30812* PH) and third collection for the state. Subsequent collections: Sussex Co.: within 1 mi. S of Dingmans Ferry Bridge (7 Sep 1986, *D. Snyder 2075*). Warren Co.: ca. 0.1 mi. N of Musconetcong River, 0.4 mi. W of bridge crossing of the River, Asbury (5 Sep 1990, *D. Snyder 2932*).

51. *Chenopodium berlandieri* var. *macrocalycium*. Ocean Co.: southern terminus of Seven Bridges Rd., ca. 1.4 mi. W of southern tip of Long Beach Island (14 Sep 1986, *D.* Snyder *2080*; 21 Oct 1988, *D. Snyder 2549*). First collection since 1937 (Ludwig *643* PH). Subsequent collections: Cape May Co.: ca. 0.8 mi. SSE of toll bridge on Ocean Drive, SW end of Two Mile Beach (15 Oct 1993, *D. Snyder 4449*). Monmouth Co.: Plum Island, Sandy Hook (21 Sep 1986, *D. Snyder 2098*). Primarily restricted to sea beaches (Snyder 1994).

52. *Galium hispidulum*. Cape May Co.: E of Sunset Beach and ca. 0.2 mi. W of NW corner of Lake Lily, Cape May Point (16 Sep 1986, *D. Snyder 2087*). Presumably a relocation of A. Commons' 1874 station (*s.n.* CHRB, GH, NY, PH) where it was last collected in 1930 (*W. Witte s.n.* CHRB). Last collected in the state in 1961 (*B. Hirst s.n.* PH). Abraitys (unpublished) had a 1967 sight record of a single plant from a sand dune above Town Bank, but this site has been since destroyed by house construction. Subsequent collections: Cape May Co.: outlet to Pond Creek, ca. 0.1 mi. SW of Daveys Lake, Sunset Beach (11 Oct 1986, *D. Snyder 2119*); NW side of Daveys Lake, Higbee Beach (11 Oct 1986, *D. Snyder 2120*). The last may be a relocation of the previously cited Hirst collection.

53. *Heteranthera multiflora*. Camden Co.: N side of Fish House Cove, ca. 0.6 mi. SW of Delair Jct (7 Oct 1986, *D. Snyder 2115*; 11 Sep 1987, *T. Breden, A. E. Schuyler*, and *D. Snyder 2260*). First collection since 1953 (Snyder 1988). Subsequent collections: Burlington Co.: NE of Linden St., Edgewater Park (23 Oct 1986, *D. Snyder 2127*); N side of Rancocas Creek, ca. 0.5 mi. SE of railroad bridge, Delanco (20 Oct 1992, *D. Snyder 4124*). Mercer Co.: dam spillway, S end of Spring Lake, Trenton (19 Aug 1993, *D. Snyder 4356*).

54. *Oenothera oakesiana*. Monmouth Co.: N of South Beach parking lot, Sandy Hook (4 Nov 1986, *D. Snyder 2135*). New station. First collection since 1915. Subsequent collection: Atlantic Co.: SW of Rum Point, South Brigantine Island (17 Sep 1990, *D. Snyder 2959*). Seen, but not collected at Island Beach, Ocean Co. and Two Mile Beach, Cape May Co. A distinctive taxon, but apparently overlooked.

55. *Valerianella radiata*. Cape May Co.: 1.8 mi. SW of Cold Spring Church, Cold Spring (29 May 1987, *D. Snyder 2171*). Presumably a relocation of O. H. Brown's 1943 station (*s.n.* PH), which was

also the last known collection. Only 13 plants were located at the site, and all were being smothered by *Lonicera japonica* (Snyder 1989). A few plants seen 3 June 1988, but none collected. Subsequent collection: Cumberland Co.: immediately S of Sheppards Branch, 0.8 mi. SSW of Haleyville (11 Jun 1996, *D. Snyder 5121*, location from G. Moore). A large colony, with very robust plants.

56. *Onosmodium virginianum*. Cumberland Co.: ca. 0.9 mi. NE of jct. Rt. 49 and Union Rd., Cumberland (28 Jun 1987, *D. Snyder 2190*). Relocation of B. Long's 1932 station (*38679* PH) and first collection since 1941 (*B. Long 56734* PH). Historically collected from at least 32 locations in 11 counties (Snyder 1989). Despite much searching, this small colony remains the only documented extant population.

57. *Sagittaria australis*. Monmouth Co.: 0.2 mi. NE of bridge crossing of Crosswicks Creek and 1.4 mi. W of Hornerstown (15 Sep 1987, *D. Snyder 2263A*). Relocation of B. Long's 1949 site (*70130 PH*), which had been the most recent collection. Subsequent collections: Middlesex Co.: E side of Devils Brook, 1.5 mi. NNW of Scotts Corner (5 Oct 1994, *J. Fishback* and *D. Snyder 4755*); SW corner of McCormack Lake, 1.2 mi. NW of Scotts Corner (5 Oct 1994, *J. Fishback and D. Snyder 4752*). Primarily a Coastal Plain species in New Jersey.

58. *Desmodium sessilifolium*. Atlantic Co.: ca. 0.2 mi. SW of intersection of Rt. 561 and Eighth St., Da Costa. (18 Sep 1987, *D. Snyder 2265*). First collection since 1945 (*H. Koster D15-80-1 PH*). The species is rare throughout the eastern portion of its range (Snyder 1989A). This station has been vandalized. Nearly every mature plant has been dug up and removed. Subsequent collection: Atlantic Co.: along Rt. 542, Hammonton (23 Aug 1995, *D. Snyder 4981*). A new population, with 72 large clumps. A large portion of the sandy field in which the species grew was being developed for housing. It's unknown whether the population is still extant.

59. *Cuscuta cephalanthi*. Hunterdon Co.: Between railroad and canal, N end of Holcombe Island, Lambertville (22 Sep 1987, *D. Snyder 2269*). First collection since 1948 (*R. L. Schaeffer 30683* PH). Presumably a relocation of B. Long's 1932 station (*38585* PH). Subsequent collections: Burlington Co.: shore of Delaware River, W side of cove, NE of Linden Ave., Edgewater Park (20 Oct 1992, *D. Snyder 4122*). Mercer Co.: S side small stream, between Delaware River and canal, ca. 0.3 mi. NW of jct. Rt. 29 and Rt. 546, Washington Crossing (20 Aug 1990, *D. Snyder 2911*). Sussex Co.: S side Rt. 631, NW corner of Franklin Pond, Franklin (6 Aug 1991, *D. Snyder 3088*).

60. *Polygonum glaucum*. Ocean Co.: southernmost end of the Northern Natural Area at Island Beach, ca. 2.4 mi. S of the park's entrance. (26 Sep 1987, *D. Snyder 2275*). New population. First collection since 1969 (*Prodromo s.n.* CHRB). What I take to be the site of the last collection was relocated: Monmouth Co.: just NE of the end of First Ave., S side of Shark River Inlet, Belmar (29 Sep 1987, *D. Snyder 2276*). Both sites had few plants, and I have been unable to relocate either population. It is likely that the Island Beach population was destroyed by recreational vehicles (Snyder 1989). Subsequent collection: Monmouth Co.: N of South Beach parking lot, Sandy Hook (1 Jul 1993, *D. Snyder 4241*). New population. Three plants grew in an overwash flat behind a foredune breached by a storm surge. This is a fugitive species and the size and location of populations are constantly shifting.

61. *Schizachne purpurascens*. Sussex Co.: ca. 0.25 mi. NW of Branchville Cemetery, Branchville (26 May 1988, *D. Snyder 2334*). Presumably a relocation of H. N. Moldenke's 1935 station (*8528* NY). This is the only documented site for the species, and the second collection (Snyder 1989).

62. *Asclepias variegata*. Cape May Co.: S side of canal, 1.5 mi. SW of Cold Spring (3 Jun 1988, *D. Snyder 2356A*; discovered, but not collected, 29 May 1987). New population. First collection since 1961 (*D. E. Fairbrothers* and *J. M. Bernard s.n.* CHRB). Rick Radis (1994) has a Burlington Co. sight

record from the late 1970s, but this site has not been relocated. Ted Gordon (pers. comm.) collected a specimen from a small population near Pleasant Mills, Atlantic Co., on 27 June 1991 (specimen in T. Gordon's private collection) and reports two additional populations in Burlington and Gloucester Cos. which were discovered in the 1980s. Historically, this plant has been collected from at least 47 separate localities, scattered throughout nearly all Coastal Plain counties and at isolated sites in Somerset and Sussex Cos. (specimens at CHRB, NY, PH). An extensive amount of seemingly suitable habitat is still present at many of these historical sites, as well as throughout much of the Coastal Plain. Despite considerable searching, the species remains elusive.

63. *Carex oligocarpa*. Sussex Co.: ca. 1.5 mi. SW of Balesville and 1 mi. SE of Myrtle Grove (8 Jun 1988, *D. Snyder 2358*). First collection since 1919 (*K. K. Mackenzie s.n.* NY) although Abraitys had more recent sight records (Snyder 1989). This species is often confused with taxa in the *amphibola* complex, as were all New Jersey collections at CHRB. Subsequent collections: Sussex Co.: ca. 0.3 mi. N of Buckmire Pond (16 Jun 1988, *D. Snyder 2368*); SE of Newton (19 May 1994, *D. Snyder 4525*). Warren Co.: ca. 0.1 mi. N of White Lake, Marksboro (19 Jun 1990, *D. Snyder 2850*). Most populations I have seen consist of a few isolated plants.

64. *Veronica catenata*. Warren Co.: ca. 1 mi. NNE of Paulina, Blairstown (29 Jul 1988, *D. Snyder 2437*). New population. One of two locations and first collection since 1907 (Snyder 1989). Seen in 1992, but not collected.

65. *Prunus angustifolius*. Gloucester Co.: SW of SW corner of Grenloch Lake, Grenloch Terrace. (10 Aug 1988, *D. Snyder 2456*). New population. First collection since 1938 (*B. Long 52460* PH), although Abraitys (unpublished) had a 1967 sight record. I relocated what I presume to be Abraitys' location, which is also likely the same location discovered by O. H. Brown in 1919 (*s.n.* PH): Cape May Co.: 0.3 mi. due S of the church at Swain (19 March 1990, *D. Snyder 2738*). I have a number of additional collections, but these all may have spread from cultivation.

66. *Vernonia glauca*. Gloucester Co.: Along Chestnut Branch of Mantua Creek, 1.7 mi. SE of jct. Rt. 45 and Main St., Mantua 12 Aug 1988, *D. Snyder 2460*). First collection since 1935 (*B. Long 47378* PH). Presumably a relocation of B. Long's 1923 collection (*26848* PH). Not found at many other historical sites, despite much searching (Snyder 1989).

67. *Cuscuta polygonorum*. Salem Co.: ca. 0.3 mi. NE of jct. railroad and Mowers Station Rd., Riddleton (23 Sep 1988, *D. Snyder 2524*). New population. First collection since 1908 (*Stone 10587* PH) and only third documented location. Subsequent collections: Burlington Co.: Nellys Pond, Delanco (15 Aug 1991, *D. Snyder 3101*). Cape May Co.: 0.5 mi. SSE of toll bridge on Ocean Drive, Two Mile Beach (15 Oct 1993, *D. Snyder 4451*). Gloucester Co.: ca. 0.3 mi. N of Hardingville (22 Aug 1990, *D. Snyder 2921*). Mercer Co.: southernmost tip of Duck Island, immediately NW of Bordentown (10 Aug 1990, *D. Snyder 2882*). Salem Co.: 0.5 mi. ESE of jct. Penton Station Rd. and Dolbow Rd., Penton (3 Sep 1992, *D. Snyder 4057*), 0.4 mi. SE of railroad crossing Perkintown Rd., Perkintown (9 Sep 1993, *M. Rapp & D. Snyder 4381*). Warren Co.: SE shore of Dildine Island, ca. 0.9 mi. SW of Manunka Chunk (13 Jul 1993, *D. Snyder 4277*).

68. *Cercis canadensis*. Mercer Co.: 1 mi. NW of jct. Fiddler Creek and Rt. 29, Titusville (3 May 1989, *D. Snyder 2564*). Presumably a relocation of A. C. Apgar's 1884 collection (*s.n.* CHRB) and first collection since 1935 (M. A. Chrysler *s.n.* CHRB). This last collection subsequently relocated: Somerset Co.: mid-slope of S face of the First Watchung Mountain, ca. 0.3 mi. NW of jct. Cramer Ave. and Rt. 22, Greenbrook, (14 Jun 1989, *D. Snyder 2591*). These are the only locations that I have no difficulty accepting as native occurrences (Snyder 1994).

69. *Pyrola chlorantha*. Sussex Co.: 1.3 mi. SW of where Rt. 23 crosses N.J./N.Y. state line in Duttonville (15 Jun 1989, *D. Snyder 2593*). A relocation of E. T. Wherry's 1948 collection (*s.n.* PH) which also had been the most recent collection (Snyder 1994). Despite continued searching, no additional extant populations have been discovered.

70. *Puccinellia fasciculata*. Cape May Co.: N side of 38th St., E of its jct. with Sounds Rd., Sea Isle City (19 Jun 1989, *D. Snyder 2603*). First collection since 1959 (*D. E. Fairbrothers s.n.* CHRB). New population, but very near to Fairbrothers' site. Abraitys (unpublished) had a 1975 sight record from Goshen Landing, a site I have failed to relocate. *Puccinellia fasciculata* is reported to occur indigenously in salt marshes along the coasts of Europe and northeastern North America and occasionally adventive elsewhere, as in the southwestern United States (Hitchcock 1950, Fernald 1950, Gleason and Cronquist 1991). In more recent years there has been debate what North American occurrences, if any, are indigenous (L. Morse 1994). For example, the New York Natural Heritage Program (S. Young pers. comm.) no longer tracks the species as indigenous, yet the type specimen was collected by Torrey in "salt marshes in vicinity of New York" (Fernald 1916). The status in Massachusetts is equally uncertain (P. Somers pers. comm.). It is considered native in Virginia and eastern North America by Weakley (unpublished). In New Jersey it has been treated as an indigenous species by Britton (1889), Stone (1912), and Taylor (1915). New Jersey collections go back to at least 1833 (Fernald 1916). Fernald (1916) was unequivocal in his opinion of the species' native distribution "Though occasionally found on ballast and there presumably a recent introduction from Europe, *P. fasciculata* is clearly indigenous upon our coast as well as in Europe." I see no compelling argument to exclude *P. fasciculata* as a part of New Jersey's indigenous flora.

71. *Cyperus lancastriensis*. Gloucester Co.: 0.2 mi. NE of Repaupo Station (1 Aug 1989, *D Snyder 2627*). First collection of a naturally occurring population since 1955 (*V. L. Frazee s.n.* PH). In 1985, Jim Stasz showed me this species growing in a garden at his home in Audubon, Camden Co. Although not planted, Jim was uncertain whether it occurred spontaneously or had been unintentionally introduced with other plantings. Subsequent collection: Burlington Co.: Along E side of railroad spur, SW end of Nellys Pond, Delanco (15 Aug 1991, *D. Snyder 3102*).

72. *Hypericum gymnanthum*. Cumberland Co.: ca. 0.9 mi. SE of Garton (2 Aug 1989, *D. Snyder 2636A*). Presumably a relocation of B. Long's 1934 site (*44278* PH). Species previously last collected near Mays Landing, Atlantic Co. by F. Hirst in 1961 *(55* PH) but this site appears to have been destroyed. Subsequent collection: Salem Co.: 1.5 mi. NNE of Olivet (*7* Aug 1995, *D. Snyder 4913*). Specimens were last collected at this site in 1959 by B. Hirst (PH), which appears to be the same site discovered by B. Long in 1935 (*46408* PH). *Hypericum gymnanthum* is extremely rare in New Jersey with only seven collected localities (one in Burlington Co., one in Atlantic Co., one in Salem Co., and four in Cumberland Co.; specimens all at PH). The species is often misidentified (as were all New Jersey specimens at CHRB and NY). It is a southern taxon nearing the northeasternmost limit of its range. It formerly occurred on Long Island, but it is now considered extirpated from New York State (S. Young 1997).

73. *Agrimonia microcarpa*. Warren Co.: NW corner of Francis Lake, Johnsonburg (24 Aug 1989, *D. Snyder 2671*). Previously last collected 30 Aug 1975 from the Milford Bluffs, Hunterdon Co. (*V. Abraitys s.n.* CHRB), a site that I have so far failed to find. Subsequent collections: Mercer Co.: Herrontown Woods, Princeton (30 Aug 1996, *D. Snyder 5282*). Passaic Co.: foot of SE slope of High Mountain, Second Watchung Mountain, 15 Aug 1990, *D. Snyder 2896*). New Jersey collections show that *A. microcarpa* is primarily a plant of calcareous soils, with most occurrences on mafic (traprock and diabase), limestone, and greensand marl substrates.

74. *Quercus imbricaria*. Gloucester Co.: N slope of ravine along Monongahela Brook (a tributary of Mantua Creek), Wenonah (18 Sep 1989, *D. Snyder 2700*). A relocation of a site first collected by G.

Hastings in 1904 (*s.n.* NY) and relocated in 1962 by B. Hirst (*s.n.* PH). Although the species is sometimes planted, this is the only documented occurrence of what appears to be an indigenous population. Other New Jersey reports of *Q. imbricaria* are based on planted trees or on hybrid taxa involving *Q. phellos* (Snyder 1994).

75. *Cuscuta coryli*. Cumberland Co.: intersection of railroad and Vine Rd., Main Ave. Station (17 Oct 1989, *D. Snyder 2728*). Relocation of B. Long's 1935 site (*47168* PH). First collection since 1939 *(H. N. Moldenke 11269* NY). Subsequent collections include Atlantic Co.: ca. 0.3 mi. SW of jct. Berlin Ave. and Duerer St., Egg Harbor City (17 Aug 1992, *D. Snyder 4034*). Bergen Co.: summit of the Palisades, Rockefeller Lookout, Englewood Cliffs (11 Aug 1992, *D. Snyder 4021*). Cape May Co.: ca. 0.9 mi. NE jct. Corsens Tavern Rd. and South Seaville Rd., South Seaville (29 Jul 1990, *D. Snyder 3061*); 0.5 mi. SE of King Crab Landing and ca. 0.45 mi. WNW of Pierces (15 Oct 1991, *D. Snyder & A. Windisch 3211A*). Cumberland Co.: ca. 0.8 mi. SE of Garton (26 Aug 1991, *D. Snyder 3118*). Passaic Co.: below and to the SW of summit of High Mountain, Second Watchung Mountain (15 Aug 1990, *D. Snyder 2898*). Salem Co.: ca. 1.5 mi. NNE of Olivet (14 Aug 1990, *D. Snyder 2891*). The last a relocation of B. Long's 1935 collection (*47635 PH*). The keys of Fernald (1950), Gleason (1952), Yuncker (1965), Godfrey and Wooten (1981), Gleason and Cronquist (1991), Voss (1996), etc., all stress that the corollas of *C. coryli* are, or mostly are, 4-merous, while their text descriptions indicate that the corollas are sometimes 5-merous. In my experience, New Jersey specimens are typically 5-merous. Of the above cited specimens, only the Pierces, Cape May Co. collection had corollas that were 4-merous. Specimens with corollas 5-merous will run to *C. indecora* in the above cited keys. *Cuscuta coryli* differs from *C. indecora* in its smaller corolla lobes (2 mm vs. 2-5 mm) and its scales that are bifid and few toothed (vs. not bifid and deeply fringed).

76. *Callitriche verna*. Gloucester Co.: mouth of small stream at its confluence with Raccoon Creek, ca. 0.6 mi. SSE of intersection of Paulsboro Rd. and Kings Highway, Swedesboro (23 May 1990, *D. Snyder 2792*). New population. First collection since 1975 (*W. F. Ferren 1390* PH). Species apparently very rare in New Jersey and previously documented from five locations in Gloucester, Hunterdon, and Warren Cos. (PH). County records given in Hough (1983) are based on specimens at CHRB. Some of these specimens lack flowers or fruit, others appear to be misidentified. All need critical reexamination. Specimens at PH have been verified by C. T. Philbrook. Subsequent collection: Sussex Co.: pond 0.4 mi. NE of Stickle Pond, Newton (29 Jul 1993, *D. Snyder 4316*).

77. *Pycnanthemum torrei*. Passaic Co.: High Mountain, Second Watchung Mountain, ca. 1.4 mi. NW of jct. High Mountain Rd. and Overlook Ave., North Haledon (15 Aug 1990, *D. Snyder 2900*). First collection since 1931 and a relocation of H. K. Svenson's collection site (13 Jun 1931, near summit of High Mountain, Haledon *4530* BKL, GH). A globally rare plant, with few extant occurrences throughout its range (Snyder 1994). Subsequent collections: Passaic Co.: E slope of the Clove, ca. 1 mi. NNE of Barbour Pond (14 Jun 1993, *D. Snyder 4215*); ca. 0.2 mi. W of entrance to The Clove and ca. 0.4 mi. SW of SW corner of Franklin Lake (9 Aug 1994, *D. Snyder 4663*).

78. *Linum intercursum*. Burlington Co.: 1.7 mi. E of Allens Bridge and 0.2 mi. W of Sim Place (17 Aug 1990, *T. Gordon & D. Snyder 2907*). Relocation of Stone's 1913 collection site (*14525* PH). Last collected in the state at this site by B. Long (*53083* PH) in 1939 (Snyder 1993, 1994). Subsequent collections: Atlantic Co.: ca. 1.6 mi. WSW of McKee City (23 Aug 1995, *D. Snyder 4977*). Cape May Co.: 2.5 mi. N of jct. Rt. 550 and Rt. 550 Spur, Belleplain (19 Jul 1994, *D. Snyder 4609*). Some early New Jersey collections of *L. intercursum* were confused with *L. floridanum*, a southern taxon that does not occur in the state, although an apparent intermediate between it and *L. medium* var. *texanum* does (Rogers 1963).

79. *Cornus amomum* var. *schuetzeana*. Warren Co.: Along Delaware River, ca. 0.5 mi. NW of toll bridge crossing of Delaware River, Columbia (10 Sep 1990, *D. Snyder 2947*; 2 Sep 1992, *D. Snyder*

4056). New population. Second New Jersey collection (Snyder 1994) and first since 1948 (*R. L. Schaeffer, Jr., s.n.* PH). Subsequent collections: Sussex Co.: Delaware River shore, ca. 1.4 mi. WSW of Walpack (28 Jun 1994, *D. Snyder 4580*); Delaware River shore, ca. 1.6 mi. SW of bridge crossing the Flatbrook, Flatbrookville (6 Jul 1994, *D. Snyder 4590*). Warren Co.: Delaware River shore, S of Macks Island, Belvidere (2 July 1993, *D. Snyder 4246*); along Delaware River on N shore of northernmost tip of Dildine Island (13 Jul 1993, *D. Snyder 4276*).

80. *Rubus canadensis*. Warren Co.: 0.4 mi. SW of Poxono Island and 0.4 mi. E of Dimicks Ferry (10 Sep 1990, *D. Snyder 2950*). New population. First collection since 1919 (*K. K. Mackenzie s.n.* NY). A common and widespread species north of New Jersey, but becoming infrequent to rare in the southern portion of its range, where it is largely restricted to the Appalachians. Although one of the more nomenclaturally and taxonomically stable *Rubus* taxa, most New Jersey specimens at CHRB, NY, and PH either are obvious misidentifications or are various species of Sect. *Flagellares* labeled *R. canadensis* T. & G., not *R. canadensis* L. That this nomenclatural error was corrected by Bailey (1932) more than a century ago, but remains uncorrected in these herbaria, is another reminder of the abysmal condition of *Rubus* collections. Subsequent collection: Warren Co.: Copper Mine Ravine, ca. 0.3 mi. SW of Poxono Island (29 May 1992, *D. Snyder 3251*).

81. *Lechea tenuifolia*. Passaic Co.: ca. 1.5 mi. SW of Lake Erskine and ca. 1.5 mi. SSE of old Ringwood Junction (18 Sep 1990, *D. Snyder 2974*). Second New Jersey location (Snyder 1993, 1994) and first collection since 1917 (*K. K. Mackenzie 7608* CHRB, NY, PH).

82. *Panicum aciculare*. Cape May Co.: along E side of railroad, opposite cemetery, South Dennis (21 Sep 1990, *D. Snyder 2981*). A relocation of K. K. Mackenzie's 1916 collection site (*6999* NY). Last collected in 1942 at Cold Spring (*O. H. Brown s.n.* PH).

83. *Ammannia latifolia*. Cape May Co.: S shore of Tuckahoe River, 1.9 mi. N of jct. Rts. 50 and 585, Middletown (12 Oct 1990, *D. Snyder 2983*). First collection since 1868 (*Leggett s.n.* NY) and second documented location (Snyder 1994). Subsequent collection: Cape May Co.: W side of Cedar Swamp Creek, 1.3 mi. NE of Petersburg (18 Jul 1991, *D. Snyder 3033*; discovered by S. Field).

84. *Carex albursina*. Sussex Co.: ca. 0.7 mi. SSW of Stillwater Station (1 Jul 1991, *D. Snyder 3017*). New population. First collection since 1974 (Hunterdon Co.: Milford Bluffs, *V. Abraitys s.n.* CHRB). Not found at Abraitys' site despite repeated searches. A distinctive and handsome species restricted to Sussex, Warren, and Hunterdon Cos. where it grows in moist, rich woods on limestone, and less frequently, on shale or diabase. The statement in Hough (1983) that *C. albursina* is "common on the Coastal Plain" is without foundation. Subsequent collections: Sussex Co.: ca. 0.6 mi. NNW of Shuster Pond (12 Sep 1991, *D. Snyder 3147*); 1 mi. NE of Walpack Center (24 May 1994, *D. Snyder 4531*). Warren Co.: 0.2 mi. W of Cedar Lake and 0.7 mi. SW of jct. Rts. 94 and 521, Blairstown (15 May 1996, *D. Snyder 5095*). The last may be relocation of K. K. Mackenzie's 1919 collection (*s.n.* NY) labeled "Blairstown."

85. *Carex amphibola* var. *amphibola*. Hunterdon Co.: ca. 0.4 mi. SSE of jct. Rt. 29 and Brookville Hollow Rd., Brookville (3 Jul 1991, *D. Snyder 3020;* 8 Jun 1993, *D. Snyder 4207*). New population. First collection since 1921 (*K. K. Mackenzie s.n.* NY) and second New Jersey location (Snyder 1994). This taxon is recognized as a distinct species by R. Naczi (pers. comm.) but has not been formally published.

86. *Carex lousianica*. Morris Co.: Great Piece Meadow, N side of Passaic River, ca. 0.65 mi. NW of jct. Fairfield Rd. and Two Bridges Rd., Two Bridges (6 Sep 1991, *D. Snyder 3129*; 9 Sep 1991, *D. Snyder 3132*). New population. First collection since 1918 (*K. K. Mackenzie s.n.* NY) and second documented New Jersey location (Snyder 1994).

87. *Cypripedium reginae*. Sussex Co.: Sparta Township (9 Sep 1991, *D. Snyder 3143*). New population. First collection since 1936 (*J. A. Drushel 11129* PH) although there are reliable sight records until about 1971 (V. Abraitys pers. comm.). In the 1950s there were about six locations still known for *C. reginae* (D. Fables 1962; V. Abraitys pers. comm.). Most of these sites have been lost, either through flooding by beavers or by digging by collectors. One of the few species in New Jersey whose precipitous decline can be directly attributed to overcollection (Abraitys 1980; Fables 1962; Radis 1996; Wherry 1962). In 1991, my site consisted of a single plant with the dry remains of a flower. In 1992, this plant produced two stems, neither of which flowered. No plants were found in 1993 nor in any subsequent year.

88. *Rhexia mariana* var. *ventricosa*. Cape May Co.: 0.4 mi. NW of Kay Pond, Pierces (15 Oct 1991, *D. Snyder & A. Windisch 3209*). New population. First collection since 1936 (*O. H. Brown s.n.* CHRB). Only recently recognized as a part of New Jersey's flora (Snyder 1994, 1996). Subsequent collections: Cape May Co.: Higbee Beach, 0.4 mi. NE of Daveys Lake (29 Jul 1992, *D. Snyder 3284*); Petticoat Bridge, just SE of North Cape May, (30 Jul 1992, *D. Snyder 3289*); NNW of Cold Spring (30 Jul 1992, *D. Snyder 3287*); Goshen Sports Complex, ca. 1 mi. N of Cape Court House (30 Jul 1992, *D. Snyder 3295*); within 0.1 mi. E of Sunray Beach and 0.3 mi. S of terminus of Millman Rd., Norburys Landing (10 Oct 1996, *D. Snyder 5333*). This last collection is significant because it is the only site where I have found the species growing in undisturbed habitat, all previous collections have been made from inactive sand and gravel pits. At Norburys Landing, it grows in shallow water of a small, wooded swamp located behind some low sand dunes on the Delaware Bay shore. The question remains whether this taxon has been simply overlooked in past or whether it has been expanding its range northward in recent years.

89. *Eleocharis tortilis*. Cape May Co.: ca. 0.7 mi. NE of Burleigh Church and 0.5 mi. SW of Shellbed Landing (18 Aug 1992, *D. Snyder 4029*). New population. First collection since 1973 (*V. Abraitys s.n.* CHRB). I have unsuccessfully searched for Abraitys' site, as well as several other historical sites in Cape May. Many of these sites appear to have been destroyed by filling, ditching, or succession of the wetland habitat. The population at the site I discovered consisted of a single, large clump, growing on a mossy hummock along the ditched portion of a small stream in wet woods at the ecotone with a salt marsh. A wall of *Phragmites australis* was advancing up the ditch toward the population.

90. *Xyris jupicai*. Cape May Co.: S side of gravel pits, S of terminus of Cresse Rd., ca. 0.8 mi. NE of jct. Rt. 9 and Weeks Landing Rd., Erma (18 Aug 1992, *D. Snyder 4030*). New population. First collection since 1940 (cedar bog at Dennisville, *J. M. C.* and *W. H. L. s.n.* GH). Apparently the second collection of the species in New Jersey. Identification verified by R. Kral. Subsequent collections: Cape May Co.: gravel pits E side of Railroad Ave., 0.7 mi. NE of jct. Rt. 47 and Railroad Ave., Rio Grande (19 Jul 1994, *D. Snyder 4616*); gravel pit ca. 1.6 mi. NW of jct. Indian Trail Rd. and Seashore Railroad, Burleigh (3 Aug 1994, *D. Snyder 4648*). Species may be adventive in the northern portion of its range.

91. *Bidens eatonii*. Middlesex Co.: E side of the South River, East Spotswood (14 Sep 1992, *D. Snyder 4074*; 31 Aug 1994, *A. E. Schuyler & D. Snyder 4688*). Presumably a relocation of H. K. Svenson's 1937 collection site (*8494* BKL, PH), although his specimens are labeled "Old Bridge," which is a little north of where I collected it. This is the only documented location in New Jersey for *B. eatonii*, and Svenson's 1937 specimens are the only previous collection. The population consisted of 45 plants in two subpopulations growing at a shaded edge of a freshwater tidal marsh. A globally rare, as Fernald (1950) puts it, "locally segregated estuarine species." The documented range of *B. eatonii* is Quebec, Maine, Massachusetts, Connecticut, and New Jersey (modified from Fernald 1950; Gleason and Cronquist 1991). Although reported for New York State by Fernald (1950), Steve Young (pers. comm.) tells me that the specimens were misidentified. As of 1996, there was a total of 15 confirmed extant occurrences of this species throughout its range (The Network of Natural Heritage Programs

pers. comm.; also see Brumback and Mehrhoff, et al. 1996). It astonishes me that such a distinctive species, at this remarkably disjunct location, went unreported for New Jersey in the all of the northeastern regional manuals.

92. *Antennaria neglecta* var. *canadensis*. Sussex Co.: ca. 0.3 mi. W of the High Point monument, High Point State Park (28 May 1993, *D. Snyder 4181*; 13 May 1994, *D. Snyder 4516*). New population and second collection for the state. Previously known from a single specimen collected in 1913 by K. K. Mackenzie at Columbia, Warren Co. (*5345* NY).

93. *Lechea intermedia*. Hunterdon Co.: S side of the South Branch of Raritan River, 0.6 mi. SE of Flemington Junction (22 Sep 1993, *D. Snyder 4416*). Presumably a relocation of Abraitys' (unpublished) 1976 sight record. First collection since 1935 (*R. True 761* PH). A distinctive species. Subsequent collection: Sussex Co.: along abandoned railroad right-of-way at the old Thomas A. Edison mine works, 0.3 mi. WNW of Edison Pond, Edison (28 Sep 1994, *D. Snyder 4743*).

94. *Carex alopecoidea*. Sussex Co.: W side of the Paulins Kill, ca. 0.65 mi. SE of jct. Rt. 521 and Pond Brook Rd., Middleville (7 Jun 1995, *D. Snyder 4803*). New population. First collection since 1923 (*L. Griscom* and *K. K. Mackenzie 12056* GH; *K. K. Mackenzie s.n.* NY). Previously documented from six historic locations, all of which I have searched. Subsequent collection: S side of the Paulins Kill, 0.35 mi. SW of dam at S end of Paulins Kill Lake, Paulins Kill (7 Jun 1995, *D. Snyder 4809*). This site is a little over a quarter of mile downstream from the well-documented station discovered by W. D. Miller in 1916 (*483* CHRB, NY, PH), which was later destroyed by the damming of the Paulins Kill River. Further searching along the Paulins Kill may be productive.

95. *Carex aggregata*. Mercer Co.: ca. 0.9 mi. SE of jct. Church and Brick Rds., Washington Crossing State Park, Titusville (19 Jun 1995, *D. Snyder 4823*). New population. First collection since 1932 (*R. True 33* PH). Subsequent collections: Burlington Co.: Along W bank of South Branch of Rancocas Creek, 2.5 mi. N of jct. Mill St. and Red Lion Rd., Vincentown (17 Jun 1996, *D. Snyder 5135*). Warren Co: immediately N of Calno School, 0.6 mi. NE of Poxono Island (16 Jul 1996, *D. Snyder 5197*). The former collection is a relocation of the site collected by B. Long in 1915 (*9793* PH). The species is locally abundant at this site.

96. *Cypripedium candidum*. Sussex Co.: Sparta Township (21 Jun 1995, *D. Snyder 4846*; 22 May 1996 *D. Snyder 5103*). New population, and second documented site for the state. First collection since 1921 (*K. K. Mackenzie s.n.* NY). In my estimation, *C. candidum* is the quintessential lost plant, having been lost at least four times since its initial discovery. It was first collected in June of 1885 by F. Schwartz at "Green's Pond, Warren Co." (*s.n.* CHRB). The last documented observation at this site was in 1952 by J. L. Edwards, D. Fables, and E. Green (Green unpublished). In 1958 and 1961, Edwards, Fables, and Green could not relocate the population (F. Hirst pers. comm.). I have repeatedly searched this site since 1979 and I suspect that this colony is no longer extant. At the Sussex Co. population I counted in 1996 about 160 plants, 29 of which were in flower or bud. The plants were growing in black, mucky soil in fairly dense shade of *Juniperus virginiana* at the edge of a calcareous swamp. *Cypripedium candidum* is primarily a Midwestern species that is disjunct and exceedingly rare in the Northeast.

97. *Potamogeton obtusifolius*. Morris Co.: 0.1 mi. E of Manor House Rd., S side of the South Branch of the Raritan River, SW corner of Budd Lake (27 Jun 1996, *T. Breden & D. Snyder 5160*; 1 Aug 1996, *D. Snyder 5228*). New population. First collection since 1907 (*C. S. Williamson s.n.* PH) and second New Jersey location. This is the southernmost occurrence in eastern North America.

98. *Platanthera peramoena*. Monmouth Co.: Upper Freehold Township (24 Jul 1996, *D. Snyder 5224*). Relocation of a Frank and Robert Hirst sight record discovered in the 1950s (F. Hirst pers. comm.).

Early in my search, Vincent Abraitys, who knew the site, showed me where he had last seen a few flowering plants in 1968. No plants were found then, and none were found during the subsequent fifteen year search of this site. By 1996, I pretty much had given up on the site, but I decided to try one last time before abandoning the site for good. In less than fifteen minutes of searching, I found six plants, three in flower and one in tight bud, all growing in a spot I know unequivocally that I had searched several times before. The location is about a tenth of a mile downstream of where Abraitys had last observed plants. Subsequent collection: Monmouth Co.: near Red Valley (24 Jul 1996, *D. Snyder 5225*). This is a relocation of what I presume to be the site discovered by Estill Green in 1954 (Fables 1962A) and collected the same year by J. L. Edwards and C. H. Nichols (*s.n.* NY). It was last seen at this site in 1972 by Abraitys (unpublished). I found a single flowering plant after only a few minutes of searching. Like the previous location, I had spent many hours searching this site in past years. In 1997, I did not find any plants at this site, and at the previous site, I found only two trampled and deer-browsed plants. Luer (1975) notes that *P. peramoena* "has a habit of disappearing as quickly as it came." This is the challenge presented by many of our terrestrial species of orchids.

99. *Myriophyllum sibiricum*. Sussex Co.: ca. 0.5 mi. NNE of S end of New Wawayanda Lake, along its E shore, ca. 1.8 mi. NE of Andover Junction (25 Sep 1996, *T. Breden & D. Snyder 5308*). New population and second collection. Previously known from Swartswood Lake, Sussex Co., where it was discovered and last collected by K. K. Mackenzie in 1920 (*s.n.* NY). Swartswood Lake is now heavily infested with the very similar looking Eurasian introduction, *M. spicatum*. In past years, the lake was herbicided in an attempt to control this invasive species. Intensive surveys conducted in the late 1980s and early 1990s failed to relocate Mackenzie's population, and *M. sibiricum* is now likely extirpated from Swartswood Lake. It is perhaps more than coincidental that other rare dissected-leaved aquatics (e.g., *Armoracia lacustris*, *Bidens beckii*, *Ranunculus longirostris*) collected from Swartswood Lake prior to 1920, are also now apparently extirpated. The New Wawayanda Lake population was growing in about one meter of water and associated with other rare aquatic plant species: *Bidens beckii*, *Potamogeton illinoensis* and *P. zosteriformis*. This is a cold, calcareous, deep-water lake. *Myriophyllum spicatum* is present and has a patchy distribution throughout most of the lake.

100. *Myriophyllum pinnatum*. Cape May Co.: ca. 0.1 mi. S of Sunset Blvd., Cape May Meadows, West Cape May (2 Oct 1996, *D. Snyder 5314*). New population. First collection since 1962 (B. Hirst *s.n.* PH). Not seen in Cape May Co. since 1919 (*B. Long 21511* PH; *K. K. Mackenzie s.n.* CHRB, NY). Abraitys (unpublished) reported a site for Salem Co. in 1965. He revisited this site in 1978, but his notes are unclear whether the pond it was growing in had been drained. In any case, his directions to the site are not precise and relocating the site will be difficult.

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Noteworthy Native Plant Collections from the Delmarva Peninsula

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In Robert Tatnall's publication, the *Flora of Delaware and the Eastern Shore* (1946) he states that "the Peninsula of Delaware, Maryland and Virginia is a natural geographic unit of exceptional interest botanically with a flora exceeding in variety most areas of like extent in the eastern United States."

Traditionally, the Delmarva Peninsula has been defined as an area composed of two separate physiographic provinces, the Piedmont of northern Cecil County, Maryland and northern New Castle County, Delaware, and the coastal plain of Delaware, the Eastern Shore of Maryland, and the Eastern Shore of Virginia (Tatnall 1946, Phillips 1978, Dill et al. 1987). For the purposes of this paper, and future research (McAvoy, in prep.), the Delmarva Peninsula is defined as an area lying entirely within one distinct physiographic province, the Atlantic coastal plain. Geologically, a peninsula is defined as a body of land surrounded by water and narrowly connected to a mainland (Hamblin 1985), the mainland in this case being the Piedmont of Cecil County, Maryland and New Castle County, Delaware. Major differences in soils, hydrology, and floristics are unquestionable between the Piedmont and coastal plain provinces; thus, the Delmarva Peninsula is defined here as one distinct geographic and ecological unit.

The Delmarva Peninsula lies south of the fall line (the boundary between the Appalachian Piedmont province and the Atlantic coastal plain) and is bordered on the east by the Delaware River, Delaware Bay and the Atlantic Ocean, and on the west by the Chesapeake Bay. Its length north to south is ca. 200 miles (320 km), its greatest width is ca. 70 miles (110 km), its narrowest width is ca. 10 miles (16 km), and total land area is ca. 5,800 square miles (15,000 km^2; Dill et al. 1987). It includes the coastal plain province of the state of Delaware (three counties), the Eastern Shore of Maryland (nine counties), and the Eastern Shore of Virginia (two counties).

Nearly 2,400 species and varieties of native and naturalized vascular plants are known to occur on the Delmarva Peninsula (McAvoy, in prep.). Delmarva's flora has strong affinities to the Southeast; over 20% of species are at or near their northern limits of geographic distribution here (McAvoy, in prep.). The peninsula's rich species diversity is a result of the variety of habitat types, including sea-level fens, Atlantic white-cedar swamps, baldcypress swamps, coastal plain ponds, tidal and non-tidal rivers and streams, fresh, brackish and salt

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marshes, xeric sand-ridges, Delaware Bay and Chesapeake Bay estuaries, and the beaches, dunes and barrier islands of the Atlantic coast.

The following noteworthy native plant collections are contributions to an atlas of the flora of the Delmarva Peninsula which is now in progress (McAvoy, in prep.). Development of this atlas is intended to combine all information, both historical and modern, into one current and reliable document that will add to the overall knowledge of the distribution of coastal plain plant species in eastern North America and help to outline the phytogeography of the region.

Nomenclature for taxa listed in this paper generally follows Gleason and Cronquist (1991). Herbaria acronyms follow Holmgren et al. (1990). Delmarva and state record determinations were based primarily on literature reviews of Tatnall (1946), Reed (1964), Phillips (1978), Brown and Brown (1984), Harvill et al. (1992), Kolb (1991, 1994), and Redman (1995); data from the Natural Heritage Programs of Delaware, Maryland, and Virginia; and specimen searches at BALT, DOV, CHRB, FARM, MARY, ODV, PH, US, VPI, and WILLI.

Many of the collections discussed in this paper are currently housed in the reference herbarium of the Delaware Natural Heritage Program (DNHP) and will later be deposited at the Claude E. Phillips Herbarium (DOV) in Dover, Delaware (a new building to house this collection is currently under construction).

Several of the taxa listed in this paper were discovered by botanists other than myself, but have not been previously reported in the literature. I have gratefully received permission from these individuals to report on their findings. Two botanists of note, Frank Hirst and Ron Wilson, have made many significant discoveries on the Delmarva Peninsula and several of their more important collections are presented below.

Agalinis skinneriana (Wood) Britt. (SCROPHULARIACEAE)

Dorchester County, Maryland: abundant on moist to dry edge of sand road through clear-cut, in sun, south of Brookview, 28 August 1998, *McAvoy with F. Hirst and R. Wilson 4007* (NLU); same locality, 28 August 1998, *Hirst with W. McAvoy and R. Wilson 1203* (NLU).

These collections document a new addition to the flora of the Delmarva Peninsula and establish the eastern limit of its geographic distribution in North America. *A. skinneriana* is primarily a species of the central and south-central states and is considerably disjunct on Delmarva. This species is considered to be rare throughout its range with extant populations known from the Canadian province of Ontario and the states of Arkansas, Louisiana, Kansas, Michigan, Missouri, Ohio, Tennessee, Wisconsin, Kentucky, Illinois, Indiana, and Maryland (The Nature Conservancy 1999a). In Maryland, it is known from a single occurrence west of the Chesapeake Bay. These collections were initially identified as *A. setacea* (J. F. Gmelin) Raf., but were later determined as *A. skinneriana* by Dr. John Hays of Northeast Louisiana University (NLU).

Arctostaphylos uva-ursi (L.) Sprengel (ERICACEAE)

Sussex County, Delaware: medium-sized colony (ca. 10 × 10 m) on sand in a pitch pine-scrub community, adjacent to open dunes at Cape Henlopen State Park, 11 September 1997, *Clancy 4801* (DNHP); same locality, 29 September 1997, *McAvoy 3108 with K. Clancy* (DNHP).

This collection marks a southern range extension for the species on the Atlantic coastal plain and a new addition to the flora of the Delmarva Peninsula and the state of Delaware. Keith Clancy discovered this population growing in a semi-open pitch pine scrub community on Delaware's Atlantic coast, Cape Henlopen. On the coastal plain, it was

formerly known as far south as southern New Jersey (Gleason and Cronquist 1991). The southern extreme in eastern North America for *A. uva-ursi* is in the mountains of Page County, Virginia (Harvill et al. 1992). Its overall geographic distribution is circumboreal, from Labrador to Alaska, south to Virginia, northern Indiana, northern Illinois, New Mexico and California (Gleason and Cronquist 1991). The discovery of *A. uva-ursi* at Cape Henlopen State Park adds to a list of taxa from the park that are characteristic of the Pine Barrens of southern New Jersey. *A. uva-ursi* in the central Pine Barrens is "frequent" (Stone 1911) and "characteristic of the plains of the Pine Barrens" (Stone 1911). The dominant canopy tree of the sandy pine lands of Cape Henlopen is *Pinus rigida*. According to Stone (1911), *P. rigida* is "*the* Pine of the New Jersey Barrens." Two rare Delmarva species found growing in the pine lands of Cape Henlopen, *Minuartia caroliniana* (*McAvoy 2455* DNHP) and *Hudsonia ericoides* (*McAvoy 277* DNHP), occur nowhere else on the Delmarva Peninsula. *M. caroliniana* is "frequent" in the Pine Barrens of New Jersey (Stone 1911), "but not found elsewhere in the state" (Stone 1911). *H. ericoides* is "common" in the Pine Barrens (Stone 1911), and "reported" from Middlesex County, New Jersey (Stone 1911).

Arundinaria gigantea (Walt.) Muhl. (POACEAE)

Northampton County, Virginia: dense, pure stand (ca. 30 × 60 m.) on edge of small stream in swampy, bottomland woods, with *Pinus taeda* and *Nyssa biflora*, east of Townsend, 15 August 1996, *McAvoy 1792* (DNHP, WILLI); Dorchester County, Maryland: non-tidal portion of floodplain swamp, with *Pinus taeda, P. serotina, Acer rubrum, Nyssa biflora, Clethra alnifolia* and *Magnolia virginiana*, west side of Marshyhope Creek south of Federalsburg, covering ca. 10 acres (4 ha) in size and dominating the understory, 23 July 1997, *McAvoy 2695* (DNHP); same locality, 4 October 1997, *McAvoy 3138 with Frank Hirst and Ron Wilson* (DNHP).

The Northampton County, Virginia collection was the first documented, native occurrence of *Arundinaria gigantea* from the Delmarva Peninsula. An unconfirmed report was made of *A. gigantea* from a farm in Sussex County, Delaware in 1976, but its significance was not recognized at the time and as a result, a specimen was not made and locational data has been lost (Redman 1995; A. Tucker, pers. comm.). The second population discovered of *A. gigantea* on Delmarva from Dorchester County, Maryland, resembles the "canebrakes" of the southeastern coastal plain described by Platt and Brantley (1997). They note that the largest canebrakes once occurred in alluvial floodplains and covered "vast" and "extensive" areas (Platt and Brantley 1997). The overall geographic distribution for *A. gigantea* is primarily within the southeastern coastal plain and ranges from Maryland, south to Florida and to east Texas (Gleason and Cronquist 1991, Redman 1995). Redman (1995) reports the northernmost occurrence of *A. gigantea* to be in Baltimore County, Maryland on the Western Shore of the state.

Carex decomposita Muhl. (CYPERACEAE)

New Castle County, Delaware: restricted to *Carex stricta* tussocks, ca. 30 tussocks with 50 to 75 fruiting culms per tussock, seepage swamp at extreme western end of Noxontown Pond/Appoquinimink River, south of Middletown, with *Carex straminea* and *Sphenopholis pensylvanica*, 3 June 1999, *McAvoy 4363* (DNHP).

This discovery documents a new addition to the flora of Delmarva and the state of Delaware, and establishes the extant northeastern limit of its distribution in the United States. *C. decomposita* is primarily a southern sedge once ranging from New York to Michigan and south to northern Florida and west to eastern Texas (The Nature Conservancy 1999b). It is possibly extirpated from New York, Michigan and Maryland (The Nature

Conservancy 1999b). *C. decomposita* is considered to be globally rare by The Nature Conservancy. The common name for *C. decomposita* is "cypress-knee sedge," which is appropriate due to its occurrence on baldcypress knees and bases in the south (Weakley 1996). At this Delmarva station, baldcypress (*Taxodium distichum*) does not occur. As a result, *C. stricta* tussocks provide the necessary substrate for its establishment.

Carex grayi Carey (CYPERACEAE)

Kent County, Maryland: small patch (ca. 1.5 × 1.8 m) with many flowering culms in shady swamp near shoreline of bay, north of Copeland, 16 July 1996, *McAvoy 1671* (DNHP).

This species is uncommonly known from the coastal plain of Maryland's Western Shore, as well as from the Piedmont of Cecil County, Maryland (Maryland Natural Heritage Program), but this is the first collection of the species from Delmarva. With this collection, the entire section *Lupulinae* is now represented on the Delmarva Peninsula (*C. gigantea* Rudge *McAvoy 2007* DNHP, *C. grayi* Carey, *C. intumescens* Rudge *McAvoy 1060* DNHP, *C. louisianica* Bailey *McAvoy 1130* DNHP, *C. lupuliformis* Sartwell *McAvoy 1134* DNHP, and *C. lupulina* Muhl. *McAvoy 1297* DNHP). In the eastern United States, this sedge is known from Vermont, south to Georgia and west to Mississippi (Jones and Hatch 1990, Gleason and Cronquist 1991, Thomas and Allen 1993).

Desmodium fernaldii Schubert (FABACEAE)

Dorchester County, Maryland: sandy roadside east of Hurlock, 19 August 1995, *Wilson and Hirst 0819957* (personal herbarium); Worcester County, Maryland: dry roadside north of Pocomoke City, 14 October 1995, *Wilson and Hirst 1014951* (personal herbarium). Identifications confirmed by Duane Isely, Iowa State University (ISC).

These collections establish *Desmodium fernaldii* as a new addition to the flora of the Delmarva Peninsula and the state of Maryland, and mark a northern range extension for the species. Harvill et al. (1992) list *D. fernaldii* as being present on the peninsula from Accomack County, Virginia, but the specimen (at GMUF) on which this report is based was misidentified (Gary Fleming, pers. comm.). Frank Hirst and Ron Wilson first discovered this species in Dorchester County while doing survey work for the Maryland Natural Heritage Program, and then collected it again in Worcester County the same season. *D. fernaldii* is distributed on the coastal plain from southeastern Virginia, south to Florida (Isley 1990).

Echinodorus cordifolius (L.) Griseb. (ALISMATACEAE)

Caroline County, Maryland: abundant on bare, muddy shore of the Choptank River, north of Greensboro, 19 August 1995, *McAvoy 1247 with J. Ebert and J. Holt* (DNHP); Northampton County, Virginia: abundant in seepy head of stream with an open canopy, south of Cape Charles City, 22 August 1997, *McAvoy 2883* (WILLI).

Janet Ebert and Jack Holt first discovered *Echinodorus cordifolius* in Caroline County, Maryland in 1995 which established a new addition to the flora of the Delmarva Peninsula. The Northampton County, Virginia collection is only the second known station for this species on the peninsula. *E. cordifolius* on Delmarva is near its northern limit of distribution in the eastern United States. Its overall geographic distribution is along the coastal plain from Maryland and Virginia south to Florida and west to Texas, and north in the interior to southern Indiana, Illinois, Missouri and Kansas and south to tropical America (Gleason and Cronquist 1991).

Euphorbia purpurea (Raf.) Fern. (EUPHORBIACEAE)

Kent County, Delaware: seepage area in swamp at the base of a rich wooded slope, north of Cheswold, 7 May 1997, *McAvoy 2131* (DNHP).

This collection represents a very rare coastal plain occurrence for the species, which is extant on the Atlantic coastal plain only on Delmarva and in southern New Jersey (Snyder 1986, Ostlie 1990). Associated species here include: *Caltha palustris, Solidago patula, Cornus racemosa, Sagittaria australis, Carex mitchelliana* and *Saxifraga pensylvanica*. *E. purpurea* is considered to be rare throughout its range (Ostlie 1990) and is extant in Pennsylvania, New Jersey, Maryland, Ohio, Virginia, West Virginia and North Carolina (Ostlie 1990), and historical in Alabama (Ostlie 1990). In Cecil County, Maryland, *E. purpurea* is extant on the fall line within a kilometer of the coastal plain (Maryland Natural Heritage Program). This species was thought to be extirpated in Delaware (McAvoy 1996) and was known from only a single collection in the Piedmont of New Castle County ("swamps west of Hockessin," 8 June 1881, *A. Commons s.n.*, PH).

Hierochloe odorata (L.) Beauv. (POACEAE)

Sussex County, Delaware: ecotone of scrub and high salt marsh on east end of Thompson Island in Rehoboth Bay, 11 May 1994, *McAvoy 544* (DNHP).

This is the first collection of this species from a native population on the Delmarva Peninsula. *Hierochloe odorata* is cultivated in herb gardens in the U.S., including Delaware (A. Tucker, pers. comm.), but its overall natural distribution in North America is Maine south to southern New Jersey, west through Pennsylvania, West Virginia and Indiana, and in the southwest to Arizona (Gleason and Cronquist 1991). It is also disjunct and rare in North Carolina where it occurs in high-elevation pastures and openings (Weakley 1996). The presence of *H. odorata* on the Delmarva Peninsula may be a result of it being dispersed here by native Americans. Native Americans consider *H. odorata* to be a sacred plant and it is used in ceremonies and carried in medicine bundles (Tantaquidgeon 1942, Moerman 1986, Duke 1986). Archeological studies on the island site where this collection was made have determined that native Americans utilized this area as early as eight to nine thousand years ago and continued up until the time of European contact (Blume 1992). Many ancient, native artifacts have been discovered here, as well as a small burial plot (Blume 1992). *H. odorata* has also been collected from west of the Chesapeake Bay in Maryland at Soldiers Delight Serpentine Barren in Baltimore County (*Farley & Monteferrante 485* BALT; Maryland Natural Heritage Program).

Hydrastis canadensis L. (HYDRASTIDACEAE)

New Castle County, Delaware: a population of over 100 plants in a rich woods pocket west of Blackbird, 26 July 1995, *McAvoy 1172* (DNHP).

This Delmarva collection represents a very rare coastal plain occurrence for the species. *Hydrastis canadensis* is primarily restricted to deep, rich woods of the mountains and Piedmont (Gleason and Cronquist 1991). In the Piedmont province of Delaware, *H. canadensis* is fairly frequent with at least 50 known occurrences (Delaware Natural Heritage Program). *H. canadensis* is historical from the coastal plain of New Jersey and represented by a single collection (David Snyder, pers. comm.; "near Camden," 1852, *J.J. Seal s.n.* PH). In Mississippi, there are two extant occurrences of *H. canadensis*, both on the "upper coastal plain" (Ken Gordon, pers. comm.). Based on herbaria searches and a review of the literature, this collection and the two occurrences from the coastal plain of Mississippi may be the only extant populations for this species from the southeastern coastal plain. Habitat for the New

Castle County population is a "rich woods pocket", which is an uncommon habitat type for the coastal plain of Delmarva. This habitat type contains moist, dark loamy soils that often support a flora that is more typically found in the Piedmont. Also found growing with *H. canadensis* at this site is *Panax quinquefolius* (first collected on Delmarva from Cecil County, Maryland, 6 August 1938, *L.R. Holmes s.n.*, PH), which is another rare coastal plain occurrence for a species that is more typically found within the Piedmont and mountain physiographic provinces. *H. canadensis* is rare to uncommon throughout its range, which is from Vermont to Michigan and Minnesota, south to Georgia, Alabama, Mississippi, and Arkansas (Fernald 1950, Duncan and Kartesz 1981, Gleason and Cronquist 1991).

Lilium canadense L. (LILIACEAE)

Talbot County, Maryland: one small patch with several stems that have been browsed by deer, on a rich wooded slope, northeast of Trappe, 30 May 1996, *McAvoy 2068* (DNHP); Kent County, Delaware: abundant in a rich-woods east of Smyrna, 7 May 1996, *McAvoy 1429* (DNHP).

These two collections are rediscoveries of rare coastal plain populations on the Delmarva Peninsula. Elizabeth Earle first collected *Lilium canadense* from Talbot County, Maryland in 1949 from "woods 3 miles NE of Trappe" (*2765* PH). Albert Commons first discovered *L. canadense* in Kent County, Delaware from "woods, Woodland Beach" in 1898 (*s.n.* PH) and it was later collected in 1932 from the same locality by Robert Tatnall (*1461* PH). Both of these sites remained unexplored until rediscovered in 1996. Many of the associated species common to both sites are more typical of the Piedmont (e.g. *Cardamine concatenata, Agrimonia gryposepala, Geranium maculatum, Uvularia perfoliata, Sanguinaria canadensis, Osmorhiza longistylis, Collinsonia canadensis, Cimicifuga racemosa*, and *Phegopteris hexagonoptera*). In addition to the previously mentioned species, other typical Piedmont taxa that occur at the Kent County, Delaware site include *Sanicula gregaria, Aquilegia canadensis* and *Thalictrum revolutum*, and at the Talbot County, Maryland site, *Panax quinquefolius, Adiantum pedatum, Galearis spectabilis, Cynoglossum virginianum,* and *Hepatica nobilis* var. *obtusa*. The overall geographic distribution of *L. canadense* is primarily in the mountains and Piedmont, and ranges from Maine to Maryland and Virginia, west to Ohio, Kentucky, Indiana and Alabama (Gleason and Cronquist 1991). *L. canadense* is also known from the coastal plain of New Jersey (David Snyder, pers. comm.; Dr. David Fairbrothers, pers. comm.). Based on herbaria searches and a review of the literature, it appears that on the Atlantic coastal plain, *L. canadense* may only be known from the Delmarva Peninsula and southern New Jersey.

Liparis loeselii (L.) L.C. Rich. (ORCHIDACEAE)

Worcester County, Maryland: scattered and infrequent in swampy woods adjacent to a salt marsh, southeast of Stockton, 12 September 1993, *Hirst 824* (personal herbarium).

This discovery by Frank Hirst and Ron Wilson marks a first for the Delmarva Peninsula. Habitat here is a swampy woods that receives ground water seepage from the adjacent uplands and is ca. 15 m from the edge of a *Spartina alterniflora* marsh (personal observation made by the author while visiting the site with Hirst and Wilson in 1996 when five flowering plants of *L. loeselii* were observed and photographed [DNHP]). The canopy is composed of *Pinus taeda* and *Acer rubrum* with *Myrica cerifera* in the understory. In the description that Luer (1975) gives for *L. loeselii*, he states that "it shuns acid situations, preferring alkaline ones instead." High tides from the adjacent salt marsh at this site may be influencing soil chemistry to the point where conditions are suitable to support *L. loeselii* (R. Wilson, pers. comm.). *L. loeselii* is only known on the coastal plain from Cape Cod,

Massachusetts, southern New Jersey, Delmarva and southeast Virginia (Stone 1911, Svenson and Pyle 1979, Gleason and Cronquist 1991, Harvill et. al 1992). Its overall distribution is Nova Scotia, Quebec, Manitoba, Maine, south to North Carolina and Tennessee in the mountains, and Ohio, Indiana and Michigan (Gleason and Cronquist 1991).

Ludwigia leptocarpa (Nutt.) H. Hara (ONAGRACEAE)

Wicomico County, Maryland: seven robust plants were observed in a fresh tidal marsh of Pemberton Historical Park, southwest of Salisbury, 26 October 1996, *Wilson 1026961* (personal herbarium); same locality, 31 October 1996, *McAvoy with F. Hirst 2041* (DNHP).

This collection establishes a new northern coastal plain extension (*L. leptocarpa* occurs further north than Wicomico County, Maryland in the Piedmont in Virginia [Harvill et. al. 1992]) and a new addition to the flora of the Delmarva Peninsula, as well as the state of Maryland. It was first discovered and collected at this site by John Dennis of Princess Anne, Maryland in October of 1996 and was identified by Ron Wilson (pers. comm.). Habitat here is somewhat artificial; a tidal emergent marsh has developed after creation of a power-line cut across the Wicomico River and a nature trail and boardwalk run along the edge of the marsh. Despite the origin of this site and habitat, I feel that this population is native and future survey work of the surrounding natural wetlands may uncover additional populations. The overall geographic distribution of *L. leptocarpa* is from Virginia, south to Florida and west to Texas, and in the interior to southeast Missouri and southern Illinois (Gleason and Cronquist 1991). In 1865, a single collection was made of *L. leptocarpa* on "ballast ground" from Philadelphia County, Pennsylvania, but is not considered to be part of the state's native flora (Rhoads and Klein 1993).

Mitella diphylla L. (SAXIFRAGACEAE)

Kent County, Delaware: ten flowering plants observed in filtered sun in a rich-woods pocket northwest of Cheswold, 8 May 1996, *McAvoy 1419* (DNHP).

This collection from Delmarva represents a very rare Atlantic coastal plain occurrence. *M. diphylla* is known on the coastal plain only from Delmarva (Kent County, Delaware), Charles City County, Virginia (Ware and Ware 1992), Calvert County, Maryland (*McAvoy 435*, DNHP), and Ocean County, New Jersey (D. Snyder, pers. comm.; "Low ground, not common, New Egypt," 29 April 1905, *J. Grove s.n.*, PH; "rich wooded slope along Crosswicks Creek, ca. 1 mile NNW of New Egypt," 20 November 1947, *B. Long 66832*, PH). Habitat at this collection site is an isolated rich-woods pocket at the base of a moderate slope adjacent to a small stream. Co-occurring at this site are *Solidago flexicaulis* and *Trillium cernuum*, as well as other species that are more typical of the Piedmont, such as *Cardamine concatenata*, *Sanicula gregaria* and *Osmorhiza longistylis*. The overall geographic distribution of *M. diphylla* is from the Piedmont and mountains of the New England states, south to Virginia, the Carolinas, Georgia and Missouri (Gleason and Cronquist 1991, Weakley 1996).

Rhynchospora filifolia A. Gray (CYPERACEAE)

Sussex County, Delaware: abundant on edge of seasonal, wetland depression (coastal plain pond), southwest of Bethany Beach, 10 August 1984, *Hirst 435* (personal herbarium), confirmed by Richard LeBlond; same locality, 22 October 1992, *McAvoy 242* (DNHP).

This collection, made by Frank Hirst while doing a botanical survey of coastal plain seasonal ponds on Delmarva, was the first documentation for the species on the peninsula and fills in the distributional gap between Virginia and southern New Jersey. Frank also made collections that he labeled as *Rhynchospora filifolia* from two other Sussex County,

Delaware sites, as well as one site from Worcester County, Maryland. North Carolina botanist Richard LeBlond visited one of Frank's stations for *R. filifolia* and determined it to actually be *R. harperi* (Richard LeBlond, pers. comm.). He also examined specimens from Hirst's other three stations for *R. filifolia* and all but one (from the above mentioned site) were *R. harperi* (Richard LeBlond, pers. comm.). Richard discusses the distribution of *R. harperi* in *Castanea* 62(4): 278-280, December 1997. Albert Commons, in 1899, made a collection from Sussex County, Delaware that he labeled *R. axillaris* (Lam.) Britt. (= *R. cephalantha* A. Gray var. *cephalantha*). This specimen ("along rail road tracks, east of Ellendale," 17 August 1899, *A. Commons s.n.*, PH) was later annotated as *R. filifolia* by Dr. Shirley Gale in 1941 and included in her 1944 publication on *Rhynchospora* (Gale 1944). Shortly after the identification and confirmation of *R. harperi* on the Delmarva Peninsula by Richard LeBlond, I examined the A. Commons specimen at PH and annotated it as *R. harperi* based on spikelet length and achene features. Therefore, the Frank Hirst collection of *R. filifolia* is the first documentation of this species from the Delmarva Peninsula. *R. filifolia* occurs on the coastal plain from southern New Jersey, south to Florida and west to east Texas (Kral 1996).

Rhynchospora inexpansa (Michx.) Vahl (CYPERACEAE)

Sussex County, Delaware: 100 to 500 fruiting culms scattered on the north edge of power-line cut on moist ground, north of Dagsboro, 16 August 1996, *McAvoy 1858* (DNHP).

This collection establishes a new northern range extension for this southeastern coastal plain sedge and documents its northernmost extreme in North America. *Rhynchospora inexpansa* was first collected on the Delmarva Peninsula in 1935 by Fernald in Northampton County, Virginia ("wet depression in pine woods, south of Townsend," 14 October 1935, *M.L. Fernald, B. Long and Fogg 5246*, PH) and again from the same locality by R. Tatnall in 1936 (18 October 1936, *R. Tatnall 3216*, DOV). The site where Fernald and Tatnall made their collections appears to have been destroyed, but I collected *R. inexpansa* from moist swales in a loblolly pine woods due east of Townsend in 1996 (*McAvoy 1794*, DNHP). After the Northampton County collection, I then discovered *R. inexpansa* that same season in Sussex County, Delaware ca. 120 miles (190 km) north from the Northampton County population. The overall geographic distribution of *R. inexpansa* is chiefly on the coastal plain, from southeast Virginia south to Florida, and west to east Texas and Arkansas (Gleason and Cronquist 1991).

Saxifraga pensylvanica L. (SAXIFRAGACEAE)

Kent County, Delaware: seepage area in swamp at base of a rich wooded slope, north of Cheswold, 7 May 1997, *McAvoy 2132* (DNHP).

This Delmarva collection documents a rare occurrence for the species on the Atlantic coastal plain. The overall geographic distribution of *Saxifraga pensylvanica* is primarily within the Piedmont and mountains, from Maine to Minnesota, south to North Carolina and Missouri (Gleason and Cronquist 1991). *S. pensylvanica* infrequently occurs on the coastal plain of Cape Cod, Massachusetts (Svenson and Pyle 1979), southern New Jersey (Stone 1911), and southeastern Virginia (Harvill et al. 1992). Associated species include: *Caltha palustris, Solidago patula, Cornus racemosa, Carex mitchelliana, Sagittaria australis* and *Euphorbia purpurea*. In the Piedmont of New Castle County, Delaware, *S. pensylvanica* was last collected in 1937 ("2.1 miles north of Rockland, margin of streamlet in rocky woods," 26 May 1937, *R. Tatnall 2936*, PH).

Sideroxylon lycioides L. [*Bumelia lycioides* (L.) Pers.] (SAPOTACEAE)

Accomack County, Virginia: small population in semi-opening of mesic woods, south of Middlesex, with *Viburnum prunifolium*, *Cornus florida*, and *Polystichum acrostichoides*, September 26 1997, *McAvoy 3073* (WILLI), determined by Gary Fleming, Virginia Natural Heritage Program; Sussex County, Delaware: large, widely scattered population in a thin, sandy mesic woods at Cape Henlopen State Park, 8 October 1997, *McAvoy 3175* (DNHP).

The Accomack County collection was the first documented and verified occurrence of *Sideroxylon lycioides* on the Delmarva Peninsula. *S. lycioides* was seen in 1975 at Cape Henlopen State Park, Sussex County, Delaware and reported by Fleming (1978), but a voucher specimen was not made and the report was never confirmed. The Cape Henlopen State Park collection verifies Fleming's report and documents the northern extreme for the species in North America. Its overall geographic distribution is from southern Virginia south to Florida and east to Texas, southern Indiana and southern Missouri (Gleason and Cronquist 1991).

Silphium trifoliatum L. var. *trifoliatum* (ASTERACEAE)

Accomack County, Virginia: border of mixed oak flatwoods along road east of AEGIS facility, 1.25 miles (2.0 km) east-southeast of Wattsville, one large colony, 8 September 1994, *G.P. Fleming 9851* (GMUF, WILLI); Accomack County, Virginia: abundant on power-line east of Wattsville, 19 August 1997, *McAvoy 2841* (WILLI).

Gary Fleming's collection in 1994 marked a new addition to the flora of the Delmarva Peninsula. The collection was made from a site with a unique assemblage of species for the coastal plain, such as *Aster patens* (*McAvoy 3016* WILLI), *Prenanthes serpentaria* (*McAvoy 3020* DNHP), *Vernonia glauca* (*McAvoy 3039* WILLI), *Solidago juncea* (*McAvoy 2941* DNHP), *Eupatorium aromaticum* (*McAvoy 3019* WILLI), *Eupatorium godfreyanum* (*McAvoy 2849* DNHP), *Verbesina virginica* (*McAvoy 3038* WILLI), *Cacalia atriplicifolia* (*McAvoy 2842* DNHP), *Matelea carolinensis* (*McAvoy 2847* WILLI), *Ruellia caroliniensis* (*McAvoy 2846* DNHP), *Anemone virginiana* (*McAvoy 2843* DNHP), *Pycnanthemum incanum* (*McAvoy 2848* DNHP), *Aristolochia serpentaria* (*McAvoy 2854* WILLI), and *Sanguinaria canadensis* (*McAvoy 2926* DNHP). The overall geographic distribution of this typical northern variety of *S. trifoliatum* is southeastern Pennsylvania to Ohio and Indiana, south to Virginia and in the mountains to Georgia (Cronquist 1980). *S. trifoliatum* var. *trifoliatum* on Delmarva is a rare coastal plain occurrence. The literature suggests that on the Atlantic coastal plain, *S. trifoliatum* occurs only in southeastern Virginia and on the Delmarva Peninsula (Cronquist 1980, Duncan and Kartesz 1981, Brown and Brown 1984, Gleason and Cronquist 1991, Harvill et al. 1992). The southern variety, var. *latifolium* A. Gray, is found on the Atlantic coastal plain of North Carolina and the Gulf coastal plain of Alabama and Mississippi (Cronquist 1980).

Solidago flexicaulis L. (ASTERACEAE)

Kent County, Delaware: abundant in a rich woods pocket northwest of Cheswold, 11 September 1996, *McAvoy 1919* (DNHP).

Prior to this discovery, *Solidago flexicaulis* was only known on the Atlantic coastal plain from southern New Jersey (Stone 1911; D. Snyder, pers. comm.) and southeastern Virginia (Harvill et al. 1992; Gary Fleming, pers. comm.). In Virginia, *S. flexicaulis* is "extremely rare and local on the coastal plain" and is "isolated in sheltered, north facing calcareous ravines" (G. Fleming, pers. comm.). Co-occurring at this collection site are *Mitella diphylla* and *Trillium cernuum*. The overall geographic distribution of *S. flexicaulis* is primarily in the

Piedmont and mountains, ranging from Nova Scotia and New Brunswick to North Dakota, south to Virginia, Kentucky, Tennessee and Missouri and in the mountains to North Carolina, Georgia and Arkansas (Cronquist 1980).

Solidago tarda Mackenzie (ASTERACEAE)

Sussex County, Delaware: dry sandy roadside, southwest of Kings Crossroads, 1 October 1990, *Hirst 1023* (personal herbarium); same locality, 13 October 1995, *McAvoy 1329* (DNHP); Worcester County, Maryland: dry sandy power-line cut northwest of Snow Hill, 21 October 1994, *Wilson 1001941* (personal herbarium); Wicomico County, Maryland: southwest of Mardela, 9 October 1996, *Hirst and Wilson 1185* (personal herbarium).

The Delaware collection marks the first report of this taxon from the state and the Maryland collections are new county and Eastern Shore records. *Solidago tarda* was first collected on the Delmarva Peninsula by Fernald ("dry pine-woods NW of Oyster," 14 October 1935, *M.L. Fernald, B. Long and Fogg 5512* PH) from Northampton County, Virginia and was first collected in Maryland from the Piedmont in Cecil County by Bayard Long "barrens, Bald Friar," 17 October 1913, *B. Long s.n.*, PH). Both of these collections were labeled *S. ludoviciana* (A. Gray) Small, but this name was misapplied and both specimens have been annotated as *S. tarda* by the author. *S. ludoviciana* and *S. tarda*, both within the *Solidago arguta* complex, are distinct entities (Cronquist 1980; Gleason and Cronquist 1991; Dr. J. Semple, pers. comm.), with *S. ludoviciana* having a distribution in Louisiana, Arkansas and Texas (Cronquist 1980; Gleason and Cronquist 1991). The overall geographic distribution of *S. tarda* is primarily coastal plain from southern New Jersey and southeastern Pennsylvania, south to northern Florida and Alabama (Cronquist 1980, Gleason and Cronquist 1991).

Staphylea trifolia L. (STAPHYLEACEAE)

Talbot County, Maryland: small grove of ca. 25 plants on moist ground near stream, Three Bridges Branch, northeast of Longwoods, 16 June 1998, *McAvoy 3628* (DNHP); Queen Anne's County, Maryland: rich seepage swamp on Reed Creek, southwest of Centerville, 3 June 1999, *McAvoy 4370* (DNHP).

These collections represent rare coastal plain occurrences of a species that is primarily found in the Piedmont, with infrequent inner coastal plain occurrences in southern New Jersey south to Georgia (Stone 1911, Radford et al. 1968, Duncan and Kartesz 1981, Brown and Brown 1984, Duncan and Duncan 1988, Harvill et al. 1992, Weakley 1996). Small (1933), notes that *S. trifolia* occurs in "various provinces, but rarely on the coastal plain." *S. trifolia* is disjunct in Liberty County, Florida and is considered endangered in the state (Clewell 1985). The overall geographic distribution of *S. trifolia* is from southern Quebec to Minnesota, south to Georgia, western Florida and Oklahoma (Gleason and Cronquist 1991).

Thalictrum revolutum DC. (RANUNCULACEAE)

Kent County, Delaware: rich woods east of Smyrna, 20 June 1996, *McAvoy 1556* (DNHP).

This rare coastal plain collection was made from a large, widely scattered population in a rich woods pocket immediately adjacent to a *Spartina alterniflora* marsh of the Delaware Bay. Albert Commons collected *Lilium canadense* from this very site in 1898 as did Robert Tatnall in 1932 (see *Lilium canadense* discussion above). It is surprising that both of these outstanding field botanists could miss this plant. Based on the size of the population, it must have established itself prior to A. Common's day (1898). The overall geographic distribution of *Thalictrum revolutum* is from Massachusetts south to Florida and Arkansas (Gleason and

Cronquist 1991). *T. revolutum* also occurs in the Piedmont in New Castle County, Delaware where it is considered to be rare (Holt and Ebert 1994; Delaware Natural Heritage Program).

Trillium cernuum L. (LILIACEAE)

Kent County, Delaware: rich woods (of the coastal plain), 15 to 20 non-flowering plants, northwest of Cheswold, 8 May 1996, *McAvoy 2082* (DNHP), determination by Tom Patrick, Georgia Natural Heritage Program; same locality, 7 May 1997, *McAvoy 2128* (DNHP); Kent County, Delaware: rich wooded slope west of Cheswold, 13 May 1997, *McAvoy 2167* (DNHP).

These collections document very rare coastal plain occurrences at the southeastern limit of the species range. *Trillium cernuum* is primarily a plant of the Piedmont and mountain provinces with rare coastal plain occurrences on Cape Cod, Massachusetts (Svenson and Pyle 1979), several counties on Long Island, New York (Steve Young, pers. comm.), and in southern New Jersey (Stone 1911). The first discovery and collection in 1996 was made from a small, sterile population and was identified (based on vegetative characters and habitat) by Tom Patrick, a noted *Trillium* expert. This population was revisited in the spring of 1997 and was found to be flowering, thus confirming Tom Patrick's determination. A field search in other areas within the same drainage where the first population was discovered proved to be fruitful. A second station was discovered in 1997 approximately 3.5 miles west of the first. The overall geographic distribution of *T. cernuum* is Newfoundland and Quebec, south to Maryland (in the Piedmont and mountains, Brown and Brown 1984), the Piedmont of Delaware (Gleason and Cronquist 1991, Delaware Natural Heritage Program), and in the mountains of Virginia (Harvill et al. 1992).

Trillium grandiflorum (Michx.) Salisb. (LILIACEAE)

Cecil County, Maryland: abundant in rich, moist woods on south bank of Great Bohemia Creek, Middle Neck, 3 May 1995, *McAvoy 979* (DNHP); Cecil County, Maryland: frequent, scattered throughout rich, moist woods, Little Bohemia Creek, northeast of Cecilton, 12 May 1995, *McAvoy 1010* (DNHP); Kent County, Maryland: abundant on rich, steep wooded slopes of ravine, Woodland Creek, west of Galena, 6 May 1998, *McAvoy 3371* (DNHP).

The Cecil County collections represent rediscoveries of very rare coastal plain populations. The Kent County collection is new to the county and expands its Delmarva distribution further south. In 1928, Hugh Stone first documented *T. grandiflorum* on the peninsula from Cecil County, in the Great Bohemia Creek, Middle Neck area ("rocky wood, Middle Neck," 1928, *H. Stone s.n.*, PH). Robert Tatnall collected it from the same locality in 1929 ("woods bordering Great Bohemia Creek," 5 May 1929, *R. Tatnall 251*, PH) and again in 1932, 1933, and 1936 (A. Tucker, pers. comm.). Bayard Long also made a collection from the same locality in 1932 ("moist, sandy loam, wooded slope along Great Bohemia Creek, Middle Neck," 7 May 1932, *B. Long 37271*, PH). A final collection was made by Edgar Wherry in 1941 ("wooded slopes of first large ravine back from point on north side of Middle Neck," 23 July 1941, *E. Wherry s.n.*, PH). The second Cecil County site, on the Little Bohemia Creek, may have been visited first by Robert Tatnall in 1937. A Tatnall specimen of *T. grandiflorum* from this site has not been seen, but in his *Flora of Delaware and the Eastern Shore* (1946) he cites two colonies in Cecil County, Maryland; one was Middle Neck (listed above) and the other was "n.e. of Cecilton." My collection from Little Bohemia Creek is exactly 2.5 miles (4.0 km) northeast of Cecilton where Tatnall collected *Cypripedium pubescens* ("rich woods, estate of R.R.M. Carpenter, 2.5 miles ne by n of Cecilton, 9 plants were seen in bloom," 13 May 1937, *R. Tatnall 3286*, PH). Due to its

abundance, Tatnall could not have missed the *Trillium grandiflorum* at this site while he was collecting *C. pubescens*. These collections of *T. grandiflorum* may be the only known Atlantic coastal plain occurrences for the species (Tom Patrick, pers. comm.). The overall natural geographic distribution of *T. grandiflorum* is in the Piedmont and mountains from Quebec, Maine and Minnesota, south to Pennsylvania, Ohio, northern Georgia and northeastern Alabama (Gleason and Cronquist 1991).

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A GIS-Based Threat Analysis of *Helonias bullata* Populations Within Big Timber Creek Watershed, New Jersey

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ABSTRACT. We explored two questions regarding the distribution of *Helonias bullata* (swamp-pink) populations within the Big Timber Creek watershed of New Jersey. First we examined the relationship between landscape attributes and *Helonias* population presence and quality, using data at the subwatershed level (U.S.G.S. HUC14 boundaries). Land use/land cover proportions were found to differ between subwatersheds with and without documented *Helonias* populations. Specifically, the presence of documented *Helonias* populations is negatively associated with the percentage of urban land within its subwatershed. The percentage of forested land in a subwatershed, on the other hand, is positively associated with both the presence of documented *Helonias* populations and the quality of those populations. Barren land is also positively associated with the presence of documented *Helonias* populations, although the relationship is less clear. Well number and density, and the total subwatershed area, however, were not different between *Helonias* presence and quality categories.

We examined Big Timber Creek watershed for potential sites of undocumented populations of *Helonias*, based on soil affinities and land use/land cover. Our results indicate that additional *Helonias* populations may be found more widely through the Big Timber Creek watershed. An area of 10.71 km^2 was indicated where soil and land use/land cover conditions may be conducive to *Helonias* population success. These results are expected both to help in the development of protection plans for the documented populations, and to assist in *de novo* searches for undocumented populations of *Helonias* within the watershed.

INTRODUCTION

New Jersey contains many of the last remaining populations of *Helonias bullata*, a federally threatened monotypic genus of the lily family. Commonly known as swamp-pink, *Helonias* is an obligate wetland species restricted to frequently or constantly saturated soils with an intact woody canopy. It is a perennial, evergreen, rhizomatous herb that grows in a low rosette in freshwater swamps and bogs along the Atlantic Coastal Plain (Gleason and Cronquist 1963). *Helonias* appears to rely primarily on vegetative means of reproduction, although it does produce a striking pink inflorescence atop a single flowering stalk that can reach 1.5 meters (Sutter 1982).

Much of the habitat available for successful *Helonias* populations has been lost over the years by direct habitat destruction, such as draining and filling of wetlands, and timbering and clearing activities (U.S. Fish and Wildlife Service 1990). With the enactment of several

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laws to protect wetlands, secondary impacts resulting from off-site disturbances have supplanted direct habitat loss as the major threat to *Helonias*. Off-site disturbances are often detrimental to a population because the habitat lacks an adequate surrounding buffer for protection (T. Hampton, New Jersey Department of Environmental Protection, cited in U.S. Fish and Wildlife Service 1991).

Wetland sedimentation, through runoff from urban and agricultural lands, is suspected to increase the rate of succession and colonization by opportunistic species, which can outcompete *Helonias* through shading (U.S. Fish and Wildlife Service 1991). *Helonias*, with its vulnerable basal rosette leaves, can be buried through excessive wetland sedimentation. High particulate loads in the water column commonly result from inadequate soil erosion control of off-site industrial, urban, or agricultural disturbances (U.S. Fish and Wildlife Service 1991). Additionally, extensive off-site well drawdown can cause dramatic fluctuations of the water table, which subject *Helonias* to adverse hydrologic conditions. Further, developed watersheds have an altered hydrology, leading to increased floodwater elevations, increased flow rates, and increased deposition of floatables and sediments (L. Torok, New Jersey Department of Environmental Protection, cited in U.S. Fish and Wildlife Service 1991).

In a series of demographic studies, Peterson (1990, 1991) compared "disturbed" and "undisturbed" *Helonias* populations, based on their proximity to and impacts from developed lands. "Disturbed" populations had fewer and smaller leaves, demonstrating that plant size differed based on habitat quality. However, all populations appeared to be stable over a three-year period, suggesting that population fluctuations occur over longer time periods. Additionally, 90% of seeds were found to be viable, suggesting that establishment is likely to be limited by seeds landing in unsuitable habitat.

Helonias appears to be sensitive to surrounding land uses, particularly those that alter the quality and quantity of water in its environment. Given these observations, we suspected that high proportions of urban and agricultural land use within the local watershed would lead to degraded populations, but that high proportions of forested or wetland habitat within the local watershed would aid in sustaining healthy populations. Further, we suspected that *Helonias* populations would be fewer, and of lower quality, in watersheds of high well density, due to greater water-table fluctuations from water withdrawal. In this study we employ a watershed-based landscape analysis to examine the relationship of documented *Helonias* populations to their landscape, at the subwatershed level.

The purpose of this study was to use the New Jersey Department of Environmental Protection's (NJDEP) geographic information system (GIS) to analyze current and imminent threats to the *Helonias* populations within the Big Timber Creek watershed of New Jersey. This second-order watershed, roughly 60 square miles, straddles the border between Camden and Gloucester counties and drains into the Delaware River (Figure 1). Big Timber Creek watershed contains 19 documented *Helonias* populations, the highest density of known occurrences in New Jersey. The accuracy of the locations is known to either one-second or one-minute accuracy in longitude and latitude for each of these 19 populations.

We specifically ask: 1) Are the quantity and quality of documented *Helonias* populations associated with land use and well density at the subwatershed level? 2) Where are there likely to be undocumented populations of *Helonias* in the watershed? The results of this study are expected both to help in the development of protection plans for the documented populations, and to assist in *de novo* searches for undocumented populations of *Helonias* within the watershed.

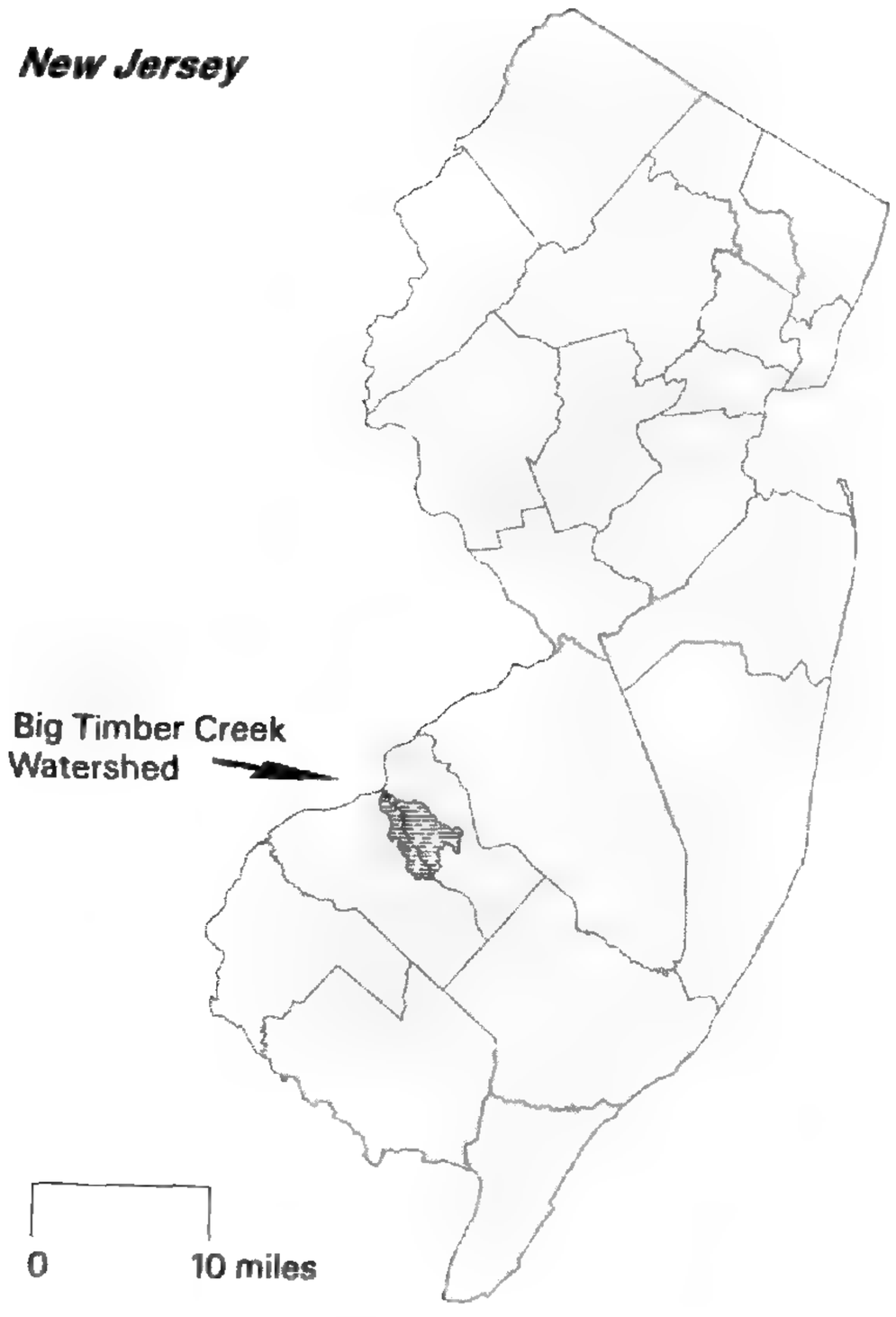

Figure 1. Big Timber Creek watershed (HUC14 boundaries) is located within the counties of Camden and Gloucester in New Jersey.

METHODS

The NJDEP GIS is a Unix-based ArcInfo (7.0) system that incorporates state and regional data from many offices within and outside the department (e.g., U.S. Geological Survey, U.S. Fish and Wildlife Service). The quality of the data in the system is insured by quality control standards of the Bureau of Geographic and Spatial Analysis (BGSA). All the coverages used in this analysis were projected with NAD 83 coordinates. Intermediate coverages were created using the following master coverages: The Big Timber Creek watershed boundaries were taken from the U.S.G.S. watershed polygon coverage (1992). The HUC14 boundaries, the finest level of delineation, were used for subwatersheds. Land use/land cover data and soil data were taken from the integrated terrain units (ITU) polygon coverages for Camden and Gloucester counties, as interpreted, digitized, and compiled by BGSA staff in 1993 using aerial photography from 1986 and 1991. Land use/land cover data were provided at the fine scale of a Level 4 Anderson classification, whereby forest cover, for example, is often reported at the scale of tree species and cover density. Well data were taken from a 1992 point coverage dataset provided by the Bureau of Water Allocation of the U.S.G.S. Locational and informational data on *Helonias* populations were obtained from a 1995 point coverage from the Natural Heritage Database of the NJDEP, Office of Natural Lands Management.

Question 1: Methods

The first question we addressed was whether the quantity or quality of documented *Helonias* populations was associated with land use and well density at the subwatershed level. A buffered (1,000 m) template of the Big Timber Creek watershed was used to create a spatial boundary for analysis. Each of the 37 subwatersheds within Big Timber Creek were coded with well density (for total and each type), land use and soil data. The watersheds were then separated into three classes: 1) those with no documented *Helonias* populations, 2) those with only documented *Helonias* populations of low quality (C and D occurrences), 3) those with documented *Helonias* populations of high quality (A and B occurrences). These ranks, assigned by the Natural Heritage Program, generally refer to both the quality and size of populations (Table 1). As seen in Table 2, *Helonias* population sizes in Big Timber Creek watershed are larger in high quality populations than in low quality populations.

Table 1. Definitions of element occurrence (EO) ranking system, adapted from the Natural Heritage Database.

Rank	Habitat	Population size and vigor
A	Pristine or near pristine wetland complexes with no or minimal hydrological impacts and stable conditions. No management necessary to maintain long-term viability. No ditching, agricultural runoff, artificial manipulation of water table, and no evidence of siltation. No logging or clearing of forest canopy. Aggressive exotic plant species none or easily controlled. Upstream of surrounding land in sufficient wooded or other buffer to insure long-term viability.	1,000 or more individual clumps (individual rosettes or clusters of rosettes) occupying 2 or more acres (either scattered or essentially throughout) of contiguous habitat.
B	In near pristine condition with only minor impacts or disturbances, none of which are directly impacting long-term viability of population or essential habitat. Site may have trails or be bisected by road. May be adjacent to agricultural or cleared lands but no direct impacts observable. Minor or localized siltation but not directly impacting population. Evidence of clearing or logging but not in immediate area of population. All impacts can be mitigated with minimal effort and expense. Reasonable amount of wooded or other buffer in upstream of adjacent areas to insure long-term viability.	500 or more clumps occupying less than 2 acres. Populations of 200-500 clumps in A-ranked habitat
C	Significantly disturbed and fragmented with declining conditions. Site often located in urban or high density residential areas. Portions of habitat ditched, dammed, or cleared in areas occupied by plants. Remaining buffer less than optimal. Population recoverable with substantial expense.	100-499 clumps, regardless of acreage occupied. Some plants may show signs of reduced vigor (small plants with few to no clonal offshoots). Populations of 50-199 plants in A- or B- ranked habitat.
D	Heavily, and possibly irreversibly impacted. Hydrological impacts significant and directly impacting population. Siltation severe and ongoing. Little or no buffer remaining. Population with little or no potential for recovery.	Any population regardless of numbers or size. These are populations of obviously reduced vigor, often consisting entirely of few, or widely scattered individual rosettes, lacking the characteristic clumps of healthy populations. Populations of less than 50 plants in A-, B-, or C-ranked habitat.

Because the locations of *Helonias* populations did not show fine patterns of affinity to the Level 4 cover classes as mapped, the statistical watershed analysis was conducted using broad Level 1 categories: urban land, agriculture, forest, open water, wetlands, and barren land. Although barren land may refer to beaches, exposed rock, and generally altered lands, many

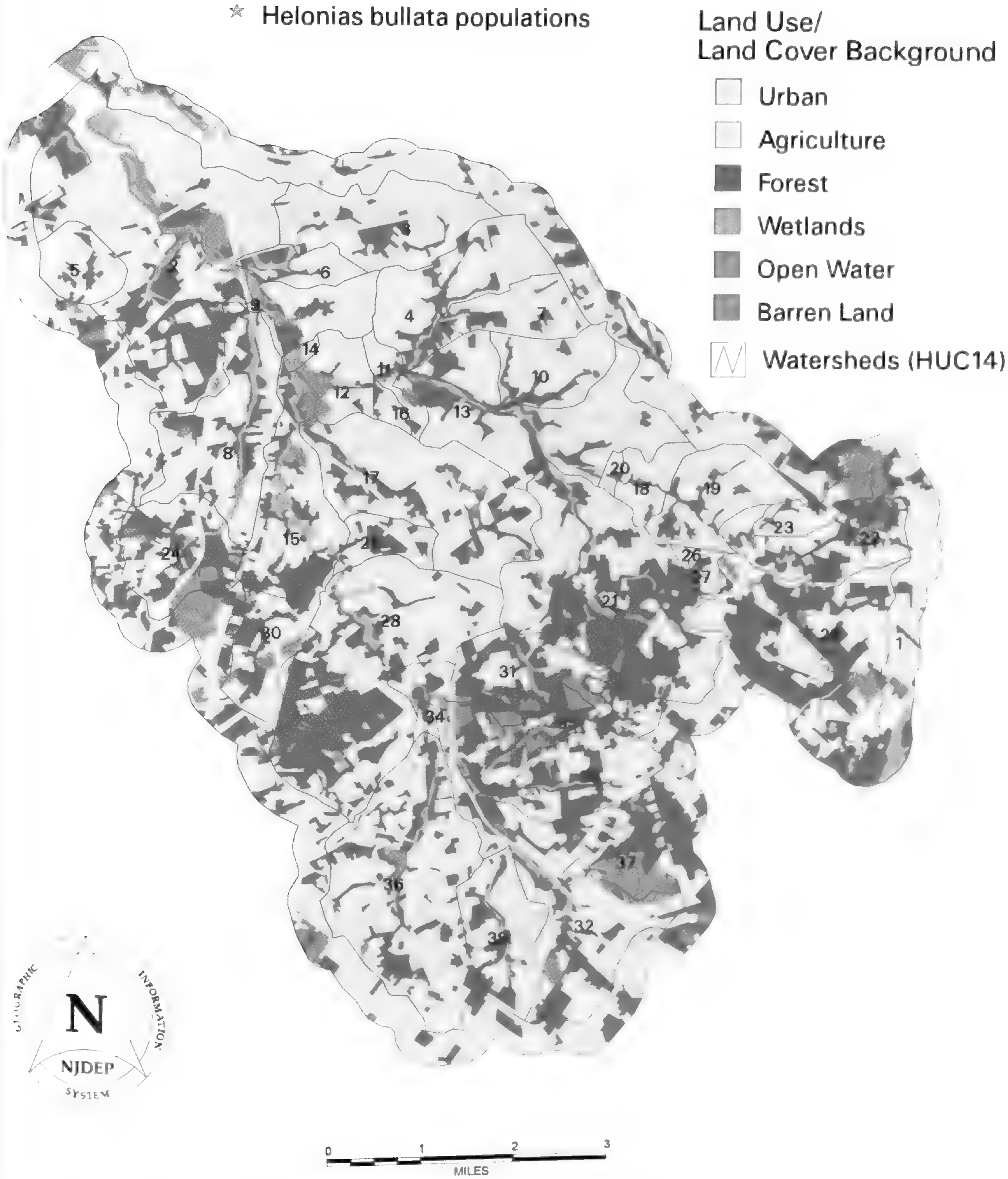

Figure 2. Map of land use/land cover and documented populations of *Helonias bullata* within the Big Timber Creek watershed.

Table 2. Information on the 15 *Helonias* populations within the Big Timber Creek study area whose locations are known to one-second precision.

ID#	EO #	EO Rank	Number of Rosettes	Last Observation Date	Land Use/Land Cover (from GIS analysis)
1	46	A	>3000	1994-09-26	Coniferous/deciduous forest
2	79	C	<100	1985-??-??	Deciduous forest
3	122	D	6	1989-05-18	Deciduous/coniferous forest
4	44	C	600–800	1989-11-20	Coniferous/deciduous forest
5	101	B	>1000	1985-04-20	Deciduous forest
6	123	D	15	1989-05-09	Recreational land (actually in forest)
7	45	B	3500	1993-09-08	Deciduous/coniferous forest
8	118	D	14	1988-06-16	Deciduous/coniferous forest
9	167	D	<50	1991-06-24	Deciduous/coniferous forest
10	116	A	>3000	1989-11-28	Deciduous/coniferous forest
11	115	B	>2000	1990-08-29	Deciduous wooded wetland
12	128	D	117	1990-01-03	Residential land
13	114	D	<50	1994-06-06	Coniferous/deciduous forest
14	141	D	<20	1991-02-20	Deciduous wooded wetland
15	159	C	300–400	1992-11-24	Deciduous wooded wetland

of the barren land patches in the upper portion of Big Timber Creek watershed are active or defunct gravel mines. For each of the 37 subwatersheds (Figure 2) in Big Timber Creek, we calculated the following landscape attributes to compare between the three watershed classes: 1) number of wells, 2) well density, 3) total subwatershed area, 4) percent urban, 5) percent agriculture, 6) percent forest, 7) percent water, 8) percent wetlands, and 9) percent barren land.

These landscape attributes were compared between the watersheds in two ways. First, watersheds with at least one high quality population ($n = 4$) were compared to those with only low quality populations of *Helonias* ($n = 4$). Second, watersheds with *Helonias* populations ($n = 8$) were compared with those without populations ($n = 29$). Despite the small sample size of watersheds with populations of *Helonias*, variances were low and similar between the watershed classes and the power of the *t*-tests ($1 - \beta$) was not reduced below 95%. Landscape attributes were either parametrically distributed or arcsine transformed to meet the assumptions of parametric distributions. Each landscape attribute was analyzed with an *F*-test of variances between the watershed categories, followed with adjusted *t*-tests, to determine differences in parameter means. Statistical tests were performed using Microsoft Excel 4.0.

Question 2: Methods

The second question we asked was where in the Big Timber Creek watershed are there likely to be undocumented populations of *Helonias*. To address this question, we examined the soil and land use/land cover classifications associated with the documented populations of *Helonias*.

To reduce errors due to locational inaccuracy, we limited our analysis to those populations with locations of "one second" precision. Because only 15 populations within the Big

Table 3. Formula for landscape model to predict the occurrence of *Helonias* populations based on soil and land use/land cover.

	Criteria		
Probability	Positive Soil Affinity (χ^2 significance level)		Land Use
Low	$P > 0.05$	OR	Urban, agriculture, open water
Moderate	$0.05 > P > 0.01$	AND	NOT urban, agriculture, open water
High	$P < 0.01$	AND	NOT urban, agriculture, open water

Timber Creek watershed boundaries were accurately located to one second, the analysis was broadened to include all of Camden and Gloucester counties, which together contained 22 precisely located populations. Differences in soil nomenclature between county soil surveys precluded the inclusion of additional counties into the analysis.

We coded these 22 *Helonias* populations of Camden and Gloucester counties with their specific soil and land use/land cover classifications. Due to the large areas associated with land use/land cover at broad Level 1 scales, the land cover for each population was noted, but the spatial associations were not analyzed statistically. The relationship between *Helonias* populations and soil associations was analyzed for positive associations only, using a modified contingency table. We calculated the proportion of land area in the two counties combined that was covered by each of the selected soil types, and calculated the expected frequencies of populations on each soil type assuming a Poisson distribution of populations. The data were compared to a chi-squared distribution, and the relationships were deemed highly significant if $P < 0.01$, and marginally significant if $0.01 < P < 0.05$. To avoid type II errors associated with inflated chi-squared statistics due to low numbers of expected frequency, only soils with two or more *Helonias* populations were considered to have significant relationships with the species. Statistical tests were performed directly with ArcInfo software.

From these affinities to specific soil and land use/land cover classifications, we created a landscape model to predict the occurrence of undocumented *Helonias* populations (Table 3). Our predictive model includes only sites with soil types with highly significant associations with *Helonias*. Since the populations were found only within forest, wetland, and barren land covers (e.g., shrub communities), we used land cover as a criterion for elimination, under the assumption that *Helonias* populations may be in any land class except urban, agriculture, and open water. Using these soil affinities and land use associations, we used the model to create a map of areas with a high probability or moderate probability for supporting *Helonias* populations.

Question 1: Results

The presence or absence of *Helonias* populations is significantly affected by land use (Table 4; Figure 2). Subwatersheds with documented *Helonias* populations had much lower proportions of urban land than those subwatersheds without populations (36% vs. 66%; $P = 0.0007$). Percent forest was also higher in subwatersheds with *Helonias* populations (40% vs. 20%; $P < 0.0001$). Percent barren land was also found to be associated with the presence of *Helonias* populations (9.8% vs. 2.2%; $P = 0.0033$). Variances, however, were also greater for percent barren land in the subwatersheds with populations ($s^2 = 0.01228$ [$\bar{x} = 0.098$] vs.

Table 4. Summary information on subwatersheds within the Big Timber Creek watershed study area. Landscape attributes are reported with mean and, in parantheses, standard deviation. Probability values (*P*) are reported for *t*-tests between landscape attributes and (1) the presence of *Helonias*, and (2) the quality of *Helonias* populations.

	Means and Standard Deviations			*P* Value for *t*-Tests	
Watershed Factors	Subwatersheds with no *Helonias* ($n = 29$)	Subwatersheds with low quality *Helonias* ($n = 4$)	Subwatersheds with high quality *Helonias* ($n = 4$)	Subwatersheds with no *Helonias* vs. documented *Helonias*	Subwatersheds with high quality *Helonias* vs. low quality *Helonias*
Well count	3.1 (3.75	5 (3.91	3.25 (2.06)	0.877	0.230
Well density (wells/km^2)	0.69 (1.42)	0.94 (0.74)	0.54 (0.01)	0.212	0.167
Subwatershed area (km^2)	3.63 (4.09)	4.90 (3.65)	6.16 (4.07)	0.128	0.331
Percent urban	66.86 (1.61)	36.21 (1.54)	36.64 (1.53)	0.0007*	0.485
Percent agriculture	4.43 (0.06)	11.10 (0.09)	5.49 (0.04)	0.368	0.160
Percent forest	20.72 (0.09)	34.71 (0.04)	46.00 (0.05)	<0.0001*	0.0082*
Percent open water	2.32 (0.19)	2.80 (0.08)	1.23 (0.01)	0.312	0.173
Percent wetlands	3.31 (0.07)	2.44 (0.02)	3.52 (0.04)	0.478	0.293
Percent barren land	2.24 (0.05)	12.70 (1.50)	7.11 (0.07)	0.0042*	0.335

* Significant for Dunn-Šidák adjusted $\alpha = 0.05$.

0.00245 [$\bar{x} = 0.020$]; $P = 0.0009$) than in those without.

The quality of *Helonias* populations was also associated with the subwatershed land use/land cover. The subwatersheds with high quality *Helonias* populations had higher percent forest cover than those watersheds with only low quality *Helonias* populations (34% vs. 20%; $P = 0.008$).

Well number, well density and total subwatershed area did not appear to affect the presence or the quality of *Helonias* populations at the subwatershed level.

Table 5. Positive relationships between *Helonias* populations and soil associations. For Dunn-Šidák adjusted $\alpha = 0.05$, critical χ^2 value = 20.24; for Dunn-Šidák adjusted $\alpha = 0.01$, critical χ^2 value = 29.14.

Soil Type	Soil Code	Number Expected	Number Observed	χ^2 Value	*P*
Sandy alluvial land	Sv	0.087	3	97.54	<0.0001
Muck	Mu	0.233	4	60.90	0.0009
Leon sand	Lo	0.074	2	50.13	0.0024
Lakewood fine sand, 0–5% slope	LfB	0.410	4	31.43	0.004
Alluvial land	Ad	0.118	2	31.02	0.007
Fallingston sandy loam	Fd	0.146	2	23.54	0.020
Loamy alluvial land	Lv	0.309	3	23.44	0.021
Pasquotank fine sandy loam	Pa	0.322	3	22.27	0.034
Westphalia soils, 10–20% slope	WhD	0.543	4	22.01	0.040

Question 2: Results

The soil types which were found to be strongly associated with *Helonias* populations were sandy alluvial land, muck, Leon sand, Lakewood fine sand (0-5% slope) and alluvial land ($P < 0.01$; Table 5). Fallsington sandy loam, loamy alluvial land, Pasquotank fine sandy loam, and Westphalia soils were all marginally associated with *Helonias*.

The model identified 10.71 km^2 in the Big Timber Creek watershed as sites with moderate to high probabilities for containing undocumented *Helonias* populations. High probability lands totalled 0.64 km^2 and moderate probability lands totalled 10.07 km^2 (Figure 3). Both the high and moderate probability lands are clustered in the upper subwatersheds of Big Timber Creek. Subwatersheds 21, 28, and 32 each had a total of over 1 km^2 area flagged as high or moderate probability. Just outside of the Big Timber Creek watershed boundary, southeast of Subwatershed 29, another high probability area was detected. Because this area falls outside of the study area and is located within the Pinelands region on the Outer Coastal Plain, it was not further analyzed.

DISCUSSION

Some of the hypothesized relationships between land use/land cover and *Helonias* population quality were verified by this watershed analysis. The subwatersheds with documented *Helonias* populations had a smaller proportion of urban land, a greater proportion of forest cover, and a greater proportion of barren land. Additionally, subwatersheds with high quality *Helonias* populations had a greater proportion of forest cover than those with low quality *Helonias* populations. The relationship between *Helonias* population quality and these landscape attributes, however, is still difficult to interpret.

When examining the subwatersheds independently, the relationship between the *Helonias* population quality and the landscape attributes becomes vague. The quality of most *Helonias* populations reflects certain landscape attributes of their watersheds. For example., Subwatershed 33 contains a "high quality" landscape (15% urban, 51% forest) and a B-ranked *Helonias* population, and Subwatershed 22 contains a "low quality" landscape (48% urban, 39% forest) and C- and D-ranked *Helonias* populations. However, many subwatersheds do not fit so nicely into the pattern. For example, Subwatershed 37 contains one D-ranked

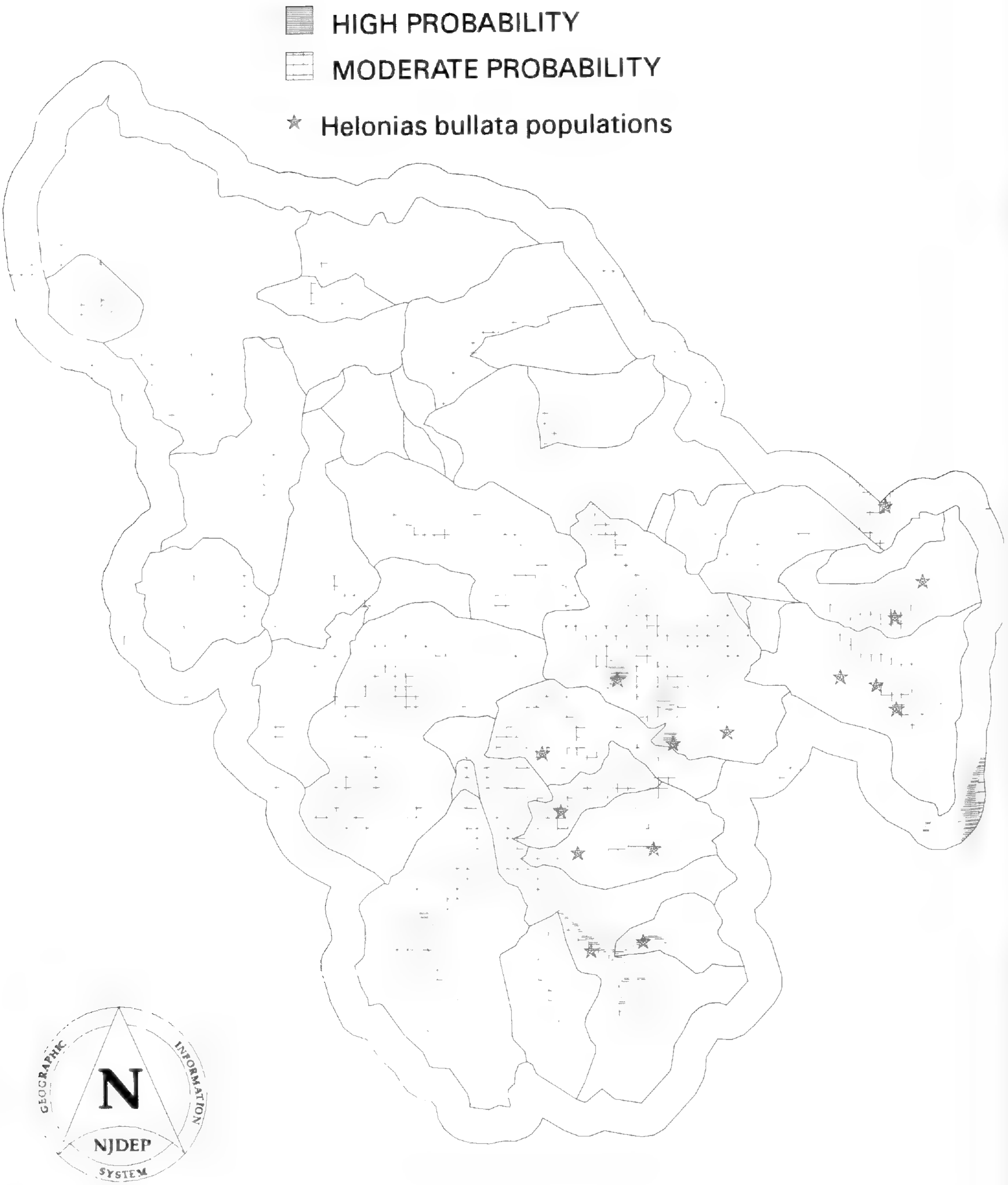

Figure 3. Map of areas with a moderate to high probability of containing undocumented *Helonias* populations, based on land use and soil associations.

Helonias population, and yet its land use/land cover distribution (16% urban, 30% forest) suggests that the watershed provides high quality habitat.

A closer look at the individual subwatersheds also demonstrates the importance of land use/land cover at a finer scale. The location of a land use type, whether beneficial or detrimental, will clearly impact the *Helonias* population more if it is upstream of the site, rather than downstream or unconnected with the waterflow. For example, Subwatershed 21 contains three populations ranked B, D and D, the highest number of populations within a single subwatershed. As a whole, Subwatershed 21 has conflicting landscape qualities: a high percentage of urban lands (50%) but also a high percentage of forested lands (45%). When examining the distribution of the populations and the landscape types (Figure 2), it becomes apparent that the D-ranked sites are both in close proximity to large tracts of urban lands, whereas the B-ranked site is mostly enclosed in a forest and wetland matrix. While several of the subwatershed relationships seem to hold true, finer examination of the land use/land cover arrangement within the subwatershed may be illuminating.

The association of *Helonias* populations with barren land is not straightforward. Barren land would appear to be detrimental to neighboring *Helonias* populations, particularly through increased soil erosion and runoff. In fact, *Helonias* population #14 (EO 141), located in Subwatershed 37, is directly downstream from a large tract of barren land and is ranked D. The positive association between barren land and *Helonias* populations is probably due to a coincident association with the underlying soil types. Many of the barren land areas in this analysis are classified as sand and gravel mines. These highly porous sandy soils can present conditions for groundwater recharge that leads to groundwater seepage downstream. Because *Helonias* is particularly sensitive to water-table fluctuations and sedimentation, it is probably most successful in constantly saturated soils without much overland flow. Based on these habitat constraints, groundwater seepage areas may be preferential for *Helonias* because of the consistency of water levels and water quality. *Helonias* populations #10 (EO 116) and #11, for example, are located on sloping loamy soils (Westphalia and Loamy alluvial land) downstream from sand and gravel mines. The high variance in barren land associated with the presence of *Helonias* populations stems from the proportionally larger tracts of barren land within watersheds containing *Helonias*.

Some predicted relationships were not observed at the subwatershed scale. For example, agricultural land and practices are commonly referred to in the literature as detrimental to *Helonias* populations, due to effects on both water quality and quantity. No relationship emerged in this analysis, however, which suggests that perhaps the effects of agriculture are more localized and more related to the position of agricultural lands within the watershed.

Well density was also predicted to be a detriment to *Helonias* populations, but the analysis did not demonstrate any relationship. This is most likely due to the wide variation in the volume of water drawn from each well. Though each well was classified by type (unused, public, industrial, commercial, domestic), the drawdown rate is highly variable within types (R. Clawges, U.S. Geological Survey, pers. comm.). Further, a water budget was not available for the subwatersheds, and the relative importance of well drawdown in the landscape hydrology was difficult to ascertain. Since well density may be unrelated to the volume of water drawdown, in retrospect, it is not surprising that there is no relationship with *Helonias* population presence and quality.

Another difficulty in interpreting these analyses comes from the static nature of the data. We do not have information on the dates and rates of change of the land use/land cover within a subwatershed, nor do we have systematic records of temporal changes in the

Helonias populations. Therefore, it is difficult to determine to what degree the landscape parameters directly impact the *Helonias* population quality. Additionally, the land use/land cover mosaic of Big Timber Creek watershed is changing rapidly, especially on the subwatershed scale of 1 to 10 km. The results of a similar analysis 10 years from now may therefore differ from those of this study.

One clear pattern of *Helonias* populations is their concentration in the upper reaches of the Big Timber Creek watershed. From a landscape perspective, this may be the result of a higher density of preferred soils in these watersheds and a less urban and more forested landcover. This, however, is probably not the sole reason. This area also provides the headwaters of the watershed, and therefore, the hydrology may be more strongly influenced by groundwater seepage than by overland flow. As suggested above, groundwater seepage areas may be preferential for *Helonias* because of the consistency of water levels and water quality.

This analysis demonstrates the utility of a GIS in performing landscape and watershed-scale analyses. Further examination of the impact of landscape parameters on *Helonias* success should include finer-scale analyses and consideration of the relative importance of upstream land uses and buffer zones.

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Bartonia No. 60: 49–56, 2000

Knowlton Hop-Hornbeam Revisited (*Ostrya knowltonii* Cov.)

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A basic principle of ecology is the concept of the "life zone." Based on the distribution of plant communities by altitude, life zones were first scientifically described by C. Hart Merriam (1890), from field studies in northern Arizona. Between the top of Humphreys Peak, in the San Francisco Peaks and the highest point in the state of Arizona (12,633 ft/3,851 m), and the bottom of the eastern part of the Grand Canyon (2,560 ft/780 m at the foot of Hance Trail, at the Colorado River), is a distance of just 50 miles (80 km); but the elevational difference is 10,000 feet (3,000 m). There, Merriam described seven life zones, ranging from alpine floral communities above timberline, to desert communities in the Little Colorado River valley and the Grand Canyon.

In the summer of 1889, Merriam (1855–1942) and his field party focused on the San Francisco Peaks and the high desert plateau north and east of Flagstaff, Arizona, but they did take a trip northward to visit the Grand Canyon. They collected animals and plants, and contributed the first faunal and floral surveys of the canyon, discovering new species in the process. Most of the collections were sent to the Smithsonian Institution. Working conditions in this region were spartan even for the late 1800s. Short of bivouacking on the sparsely vegetated high plateau between the peaks and the canyon, or in the forested elevations along the canyon rim, only the most basic of accommodations could be had at the fledgling village of Grand Canyon, or at the tourist camp operated by John Hance. It was Hance who hosted Merriam's field party at the Grand Canyon's south rim, in the ponderosa pine forest near the head of Hance Canyon, 60 miles (100 km) north-northwest from Flagstaff.

Frank Hall Knowlton (1860–1926), professor of botany at Columbian (now George Washington) University in Washington, D.C., joined Merriam's pioneering environmental survey in northern Arizona. From 9–16 September 1889, he accompanied the party to the Grand Canyon, arriving at Hance's camp 3 miles (5 km) east-southeast of Grandview Point, near a tank (natural water cistern) called Cañon Spring. At the canyon rim northeast of Hance's cabin and tent hotel was the head of a trail to the Colorado River that Hance had developed from an old Indian route. On 10 September, Knowlton collected a branch of an unidentified tree by the top of the trail, which he sent to Frederick Vernon Coville (1867–1937), assistant botanist with the Department of Agriculture, in Washington. Coville

Manuscript submitted 14 November 1997.

Figure 1. Coville's (1894, fig. 23) illustration of the holotype of *Ostrya knowltonii* Cov.

provided identifications of many of the more difficult plants from the survey. The tree from which Knowlton's cutting was taken did not have fruits, but it did have the male catkin buds for the succeeding year; these allowed Coville to recognize it as an undescribed species of *Ostrya*, or hop-hornbeam.

In 1892, James William Toumey (1865–1932), professor of botany at the University of Arizona, in Tucson, traveled to the Grand Canyon. In Flagstaff, he joined a group that had come by wagon from Las Cruces, New Mexico, to collect insects and plants in the canyon, using Hance's camp as a base of operation (Townsend 1893). Toumey may have made the trip at the request of Coville, who at the time was working actively towards the establishment of the Desert Botanical Laboratory. According to Townsend, the first order of business upon arriving at Hance's place was a hazardous recreational climb to an outlying butte just inside the canyon, called Sinking Ship (see Fig. 2A). After spending a couple of days in the depths of the canyon, Toumey revisited Knowlton's locality near the head of Hance's trail and on 10 July collected a fruiting specimen of the hop-hornbeam, but it was not delivered to Coville until January 1894. Coville (1894) then described it as a new species, *Ostrya knowltonii*.[1]

Coville named the new species for his friend Knowlton not only for first collecting it, but to praise the zeal with which Knowlton conducted his field work in 1889. Despite the privations of the field trip, compounded by the high altitude and ill health caused by chronic bronchial asthma, Knowlton made significant contributions to science in an amazing breadth of fields (White 1927). In fact, he is best remembered for his work as a paleobotanist and an ornithologist, and among his accomplishments is the first description of the fossil wood *Araucarioxylon arizonicum* (see Knowlton 1888), which today is the State Fossil of Arizona. However, it was Toumey's collection of the hop-hornbeam from the Grand Canyon that is the type material (holotype J. W. Toumey No. 272, in the U. S. National Herbarium [US; Fig. 1]; isotype in the University of Arizona Herbarium [ARIZ], where Toumey worked). Knowlton never published on any of his work on Merriam's survey.

Ostrya knowltonii is related to the American or eastern hop-hornbeam, *O. virginiana* (Mill.) K. Koch, of which today there are two recognized varieties. During Coville's time, *O. virginiana* was known to occur from the Atlantic states westward to the Mississippi Valley, reaching the southwestern limit of its range in eastern portions of Nebraska, Kansas, Oklahoma, and Texas. Its northern range extends into Canada. The discovery of a second species of the genus was of some interest because it was separated from the eastern species by nearly a thousand miles.

Hop-hornbeam, birch, alder, blue-beech or hornbeam, and hazelnut or filbert, are members of the Betulaceae (birch family). "Hornbeam" refers to the heavy, close-grained, hard, or horny nature of the wood, similar to "ironwood." The name *Ostrya* Scopoli (1760) comes from the Greek *ostryos*, meaning a scale, in reference to the scaly catkins. In the Southwest, the common name ironwood has also been used for *Olneya tesota* Gray (Leguminosae) and *Robinia neomexicana* Gray (Leguminosae); both are plants of widespread ethnobotanical use. *O. virginiana*, the eastern species, is often used for fuel, fence posts, tool handles, or specialty items where great strength is required.

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[1]Coville spelled the specific epithet "*knowltoni*", by which it usually cited, although occasionally as "*knowltonii*." The *-ii* ending is used here for a masculine name ending after a consonant other than "-er" as mandated by the *International Code of Botanical Nomenclature* (Greuter 1994, Art. 60.11, Rec. 60C.1(b)).

Knowlton hop-hornbeam, also called canyon ironwood and western hop-hornbeam, is one of the most interesting and graceful trees in the Grand Canyon. It has fruiting "cones" which make it easy to recognize. These pistillate or female catkins open in April and May. They develop into "strobiles" consisting of bracts which enclose a single nut. Each nut is enclosed by a flattened, pale green, papery, deciduous, bladder-like husk. The husks hang in groups and resemble a cluster of hops. The seeds mature from early August, throughout the fall, and the nuts are dispersed when the strobiles fall apart. Trees do not produce abundant seeds until they are about 25 years old. The staminate, or male, catkins group 1 to 3 together and hang pendulously at the tips of branches.

The birch-like leaves of the Knowlton hop-hornbeam are nearly oval and are dark yellow-green in color. They are simple, alternate, about 1 to 2 inches (1.5 to 5 cm) long, and finely hairy beneath. The margins are doubly serrate or saw-toothed. In the fall, the leaves turn yellow just before dropping. The bark is light gray. Most individuals are generally small and shrub-like, but large specimens may grow to 30 feet (9 m) tall with a trunk diameter of 15 to 18 inches (38 to 46 cm).

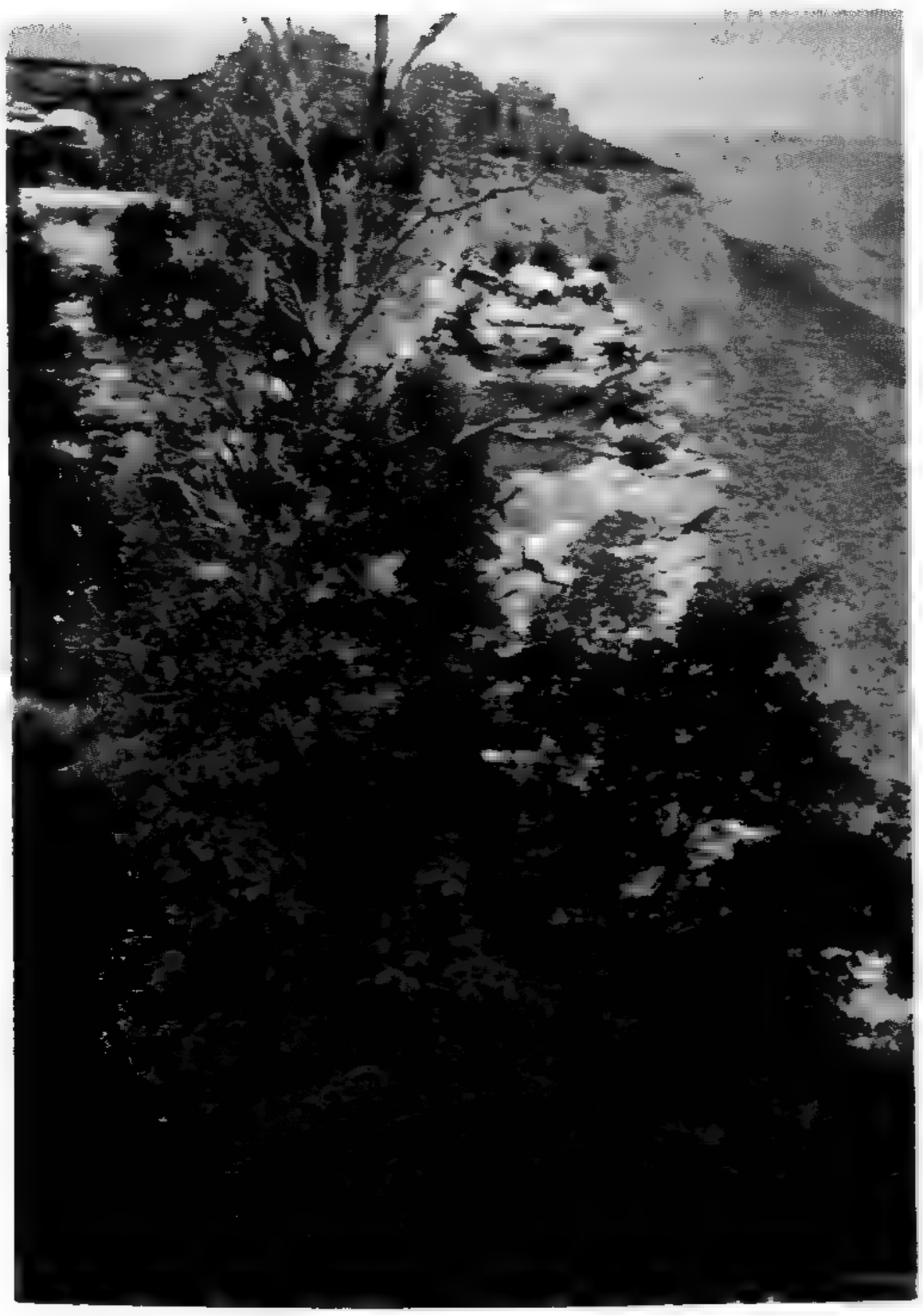
The Knowlton hop-hornbeam is a rare tree. It is found between 4,000 and 7,000 feet (1,200–2,100 m) elevation, in isolated canyons, at the bases of monoliths, and in defiles and hanging gardens, on sandstone and limestone substrata. The species distribution is intermittent, spanning the area from southeastern Utah and northern Arizona on the north, to the Guadalupe Mountains of southeastern New Mexico and the Davis and Chisos Mountains of western Texas on the east, and southward into Mexico. In Arizona it is known from the Grand Canyon, the San Francisco Peaks, Oak Creek Canyon southwest of Flagstaff, and northern Yavapai County. Since 1914, the species has been introduced as an ornamental tree in areas where the annual minimum temperature is above –10° F (–23° C).

Ostrya knowltonii has a long historical record in the Grand Canyon (see citations summarized in Spamer 1992: 415, 843). Fossil specimens preserved in radiometrically dated indurated packrat middens in caves and cloistered sites show that it formerly grew throughout the Grand Canyon during the last full glacial period, 14,000 to 22,000 years ago, in a mixed woodland-desert community dominated by juniper and single-leaf ash. But by 8,000 years ago, woodland species, including the Knowlton hop-hornbeam, vanished from the deeper inner canyon due to gradual warming (Phillips et al. 1987).

After the establishment of Grand Canyon National Park in 1919, rangers and botanists returned to find the type locality for *Ostrya knowltonii*, but they failed; some feared the plant was extinct (Sturdevant 1928). However, by the late 1920s it had been found at other places in the Grand Canyon, northern Arizona, and southern Utah. In 1928, Vernon Bailey (1864–1942), chief field naturalist of the U.S. Biological Survey (who coincidentally was also a member of the Knowlton field party that discovered *O. knowltonii*) found hundreds of these trees in the canyon, on the Kaibab and Bright Angel Trails near the village of Grand Canyon. But the trees of the type locality remained elusive.

That the type locality could not be reidentified is a particularly curious claim because Coville's original description locates it precisely. Coville wrote (1894: 116; square brackets are his):

> "The following communication from Professor Toumey, under the date of February 5th, 1894, will serve to direct others to the exact station of the original tree, which is, with little doubt, the same specimen from which Mr. Knowlton obtained his material:
>
> "'The Ostrya, which you inquire further in regard to, and specimens of which were sent to



A

B

Figure 2. Views of the type locality for *Ostrya knowltonii* (ca. 6,800 ft/2,100 m elevation, ca. 75 ft/23 m downslope from the canyon rim, at the top of Hance Canyon, NE of Buggeln Hill picnic area, East Rim Drive [Arizona route 64], Coconino Co., Arizona, T30N, R4E, Sec. 15, Grand Canyon National Park, 23 May 1997). *O. knowltonii* is seen in both photographs below a snag; each is a different tree, as are the snags. **A.** Location of the type locality with respect to the geographic feature called Sinking Ship (skyline in back). **B.** View from above of the terrain and plant community at the type locality. The substratum is limestone. Photographs by Nancy Brian.

> the Department of Agriculture a year ago, was found north of Flagstaff, on the rim of the Grand Cañon of the Colorado River. It is growing at the left, a few rods after beginning the descent to the river over John Hance's trail. The tree is much smaller than its eastern relative and more spreading. I found only the one specimen, which was about twelve feet high, growing with Oak grubs [Scrub Oaks] and Cercis occidentalis. Pinus ponderosa Scopulorum at this place is not infrequent. I remember the tree quite distinctly, as I observed at the time that it differed considerably from the eastern species.'"

Perhaps later misses of the type locality can be attributed to confusion over the reference to "John Hance's trail." When Knowlton found the first specimen in 1889 (and when Toumey revisited the site in 1892), Hance's trail to the Colorado River left the canyon rim at the bottom of Buggeln Hill, southeast of Sinking Ship; today there is a roadside picnic area alongside the East Rim Drive (Arizona route 64). In 1895, however, the upper part of the trail was destroyed by landslides, and Hance built a new trail that left the rim further to the east, rejoining the original trail down in Red Canyon. The second trail, now known

as the New Hance Trail, Red Canyon Trail, or just Hance Trail, is rough, steep, and not maintained. The original upper trail, called the Old Hance Trail when it is referred to at all, is not even a route today. The correlation between the older trail and the type locality may not have been recognized by the twentieth century botanists who looked for the Knowlton–Toumey site.

Brian (1997) published an article on potential record-holding large trees in Grand Canyon National Park and listed state records for others. *Ostrya knowltonii* is a tree without a state "champion," and no large specimen of the species has been nominated to the National Register of Big Trees. Brian listed the type locality as Dripping Springs, in Hermit Canyon, based on information in the Arizona Game and Fish Department (AGFD) Heritage Data Management System, which listed a specimen, "J. W. Toumey #272, June 1892." Spamer's interest in the Grand Canyon led him to investigate the original description of the species and there discovered the reference to the Merriam survey of 1889. Unaware that the survey party had gone anywhere other than the Hance Trail area (Hermit Canyon is 16 miles/26 km northwest of that area), he asked Brian to verify the data; he pointed out the discrepancy and suggested that the specimen in Tucson could be an isotype (which it turned out to be). Spamer also asked Brian whether or not the original locality could be found, based on the precise data given by Coville (1894).

On 23 May 1997, Brian located the head of the Old Hance Trail and descended into the canyon. She saw the distinctive dark yellow-green color of a deciduous tree nestled amongst the darker foliage of the surrounding Rocky Mountain Douglas-firs and white firs (Figs. 2A, B). Such a "window box" habitat is frequently found just below the north-facing slope of the canyon wall. It is a shaded, moist, steep environment which allows forest-dwelling species to grow well below their usual elevational range. Scrambling down the steep slope, at ca. 6,800 feet (2,100 m) elevation, Brian located about 25 trees of *Ostrya knowltonii*. Other plants of the community include scattered shrubs such as snowberry and Utah serviceberry, along with an occasional pinyon pine, ponderosa pine, mutton grass, and phlox. No redbuds were in the immediate vicinity, as Toumey had described, although Gambel oak was found upslope on the canyon rim. Most of the Knowlton hop-hornbeams were shrub-like, with up to ten branches originating from ground level. A few trees were saplings, indicating a measure of reproductive success. Collections were made for the National Herbarium (US), the University of Arizona (ARIZ), the Desert Botanical Garden (DBG) in Phoenix, and the Academy of Natural Sciences of Philadelphia (PH; Fig. 3).

In the eastern part of Grand Canyon, *Ostrya knowltonii* is also known on the south side from Hermit Canyon, Garden Creek along Bright Angel Trail, Grandview Trail, and Hance Creek (Red Canyon); and on the north side from lower Saddle Canyon, upper Nankoweap Canyon, Roaring Springs Canyon, Bright Angel Canyon along North Kaibab Trail, and the upper slopes of Deva Temple. In the western Grand Canyon, it was reported from Tuweep (Toroweap), but it has not been relocated. Specimens from the Grand Canyon recorded in the AGFD database are at ARIZ, the Grand Canyon National Park herbarium (GCH), and the Museum of Northern Arizona (MNA). PH holds two unrecorded Grand Canyon specimens which lack specific locality data, from collections made 28 June 1898 (D. T. MacDougal), and 29 July 1928 (Vernon Bailey).

Encountering a new plant species is a rare event. The golden age of plant hunters and botanical exploration in the West ended about 1925. However, for a botanist or a plant enthusiast, there is a tingling sensation and thrill of standing in the "footsteps" of noted botanists a century later, more so when the footsteps blazed the way toward such a basic

Figure 3. Specimen of *Ostrya knowltonii* from the type locality (herbarium sheet in PH). Coll. Nancy J. Brian, no. 97-49, 23 May 1997. Deposited by the National Park Service, Grand Canyon National Park.

ecological concept as the life zone. Luckily, the view from the head of the Old Hance Trail has not changed from the time of Merriam, Knowlton and Toumey. The Grand Canyon has been protected by various legislative acts since the late 1800s, and today it is a national park. The fate of Knowlton hop-hornbeam in upper Hance Canyon has significantly improved since the early botanists were there. From Knowlton's one "fruitless" specimen in 1889, *Ostrya knowltonii* at the type locality is well established and thriving.

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Range Expansion of *Polygonum caespitosum* var. *longisetum* in the United States

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Polygonum caespitosum Blume var. *longisetum* (DeBruyn) A. N. Steward, a member of the Polygonaceae (buckwheat) family, is commonly known as bristly lady's-thumb or creeping smartweed. *Polygonum caespitosum* was first named by Blume in 1825; a second species, *P. longisetum*, was described by DeBruyn in 1854. Later, Steward (1930) changed the name to *P. caespitosum* var. *longisetum*. Lists of previous and alternate names are in Steward (1930) and Li (1976). The plant is distinguished by its small, dark pink perianth and long bristles on the ocreae and bracts (Fig. 1).

A rice paddy and riverbank weed in parts of its original Asian range, where it inhabits moist grassland, ditch borders, and grassy roadsides, it is now an American urban/country weed of wet habitats and waste places, where it is naturalized in the eastern, southeastern, and midwestern United States. First recorded in the United States near Philadelphia in 1910, plants of the variety *longisetum* had colonized many eastern seaboard cities from Massachusetts to Delaware by the 1940s, as reviewed from herbarium specimens by Moldenke (1941, 1946). The present study reviews over 900 herbarium records from herbaria in the states where the plant was present to 1991. Locality descriptions were analyzed by date, urban or rural site, and temperature zone. This study suggests a progressive range expansion southward and westward in the United States associated with geographic temperature ranges. This association is evident when the plant's collection sites are plotted on the United States Department of Agriculture plant hardiness zones map (Agric. Res. Serv. 1990; Figs. 2–5).

MORPHOLOGICAL FEATURES

Polygonum caespitosum var. *longisetum* (Fig. 1) has slender, deep pink inflorescences; long, pink ocreal and bract bristles; small, dark brown to black, triangular achenes; and often reddish-purple stems. Detailed descriptions are in numerous identification manuals and state floras, including Moldenke (1941), Fernald (1950), and Gleason and Cronquist (1991). The major difference between *Polygonum caespitosum* and its variety *longisetum* lies in the greater length of the ocreal and flowering spike bristles in the variety. *Polygonum caespitosum* var. *caespitosum* has shorter bristles on both the flower bracts (1–2.5 mm) and ocreae (6–8 mm). This plant is recorded as present in the United States, but does not appear to be spreading (Moldenke 1941). Variety *longisetum*, which is spreading vigorously in the United States, has longer bristles of both types (flowering spike bristles 2–4.5 mm, ocreal bristles 8–12 mm), and is generally a more robust plant. Backer and Bakhuizen Van Den Brink considered the two as separate species (1963).

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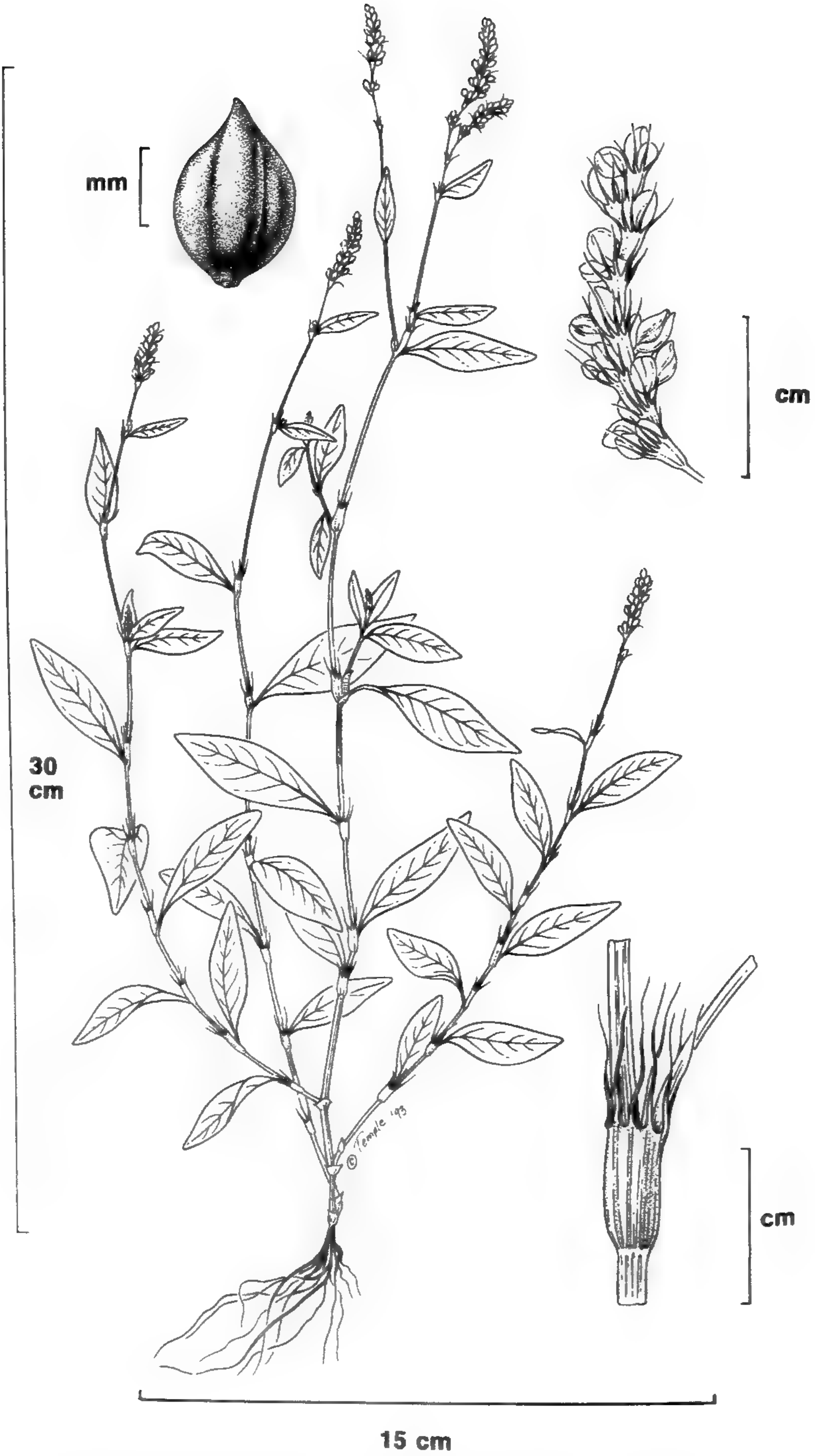

Figure 1. *Polygonum caespitosum* Blume var. *longisetum* (DeBruyn) Steward.

Two other species of *Polygonum* with which variety *longisetum* might be confused because of morphological similarities are *P. persicaria* and *P. hydropiperoides*. Both have larger seeds. In the variety *longisetum* "the achenes are smaller than any native species with which it could be confused, being only 1.8–2 mm long" (Moldenke 1941). *Polygonum caespitosum* var. *longisetum* is distinguishable from *P. persicaria* by the "slender and usually basally interrupted spikes, small and always trigonous shining achenes (1.8–2 mm long) and, particularly by the long, firm bristles terminating the ocreae . . ." (Blake 1932). Voss (1985) noted that variety *longisetum* "closely resembles . . . [*P. persicaria*] and may grow with it. The bristles at the summit of the ocreae are also long (about equaling the sheath, whereas they are shorter in *P. persicaria*). Besides the longer bristles and consistently 3-sided achenes, this smartweed has a deeper pink flower color and the inflorescence tends to be more slender and less dense than in most plants of *P. persicaria*. The latter usually has stronger, more prominent nerves toward the base of the tepals." *P. caespitosum* var. *longisetum* differs from *P. hydropiperoides* in "the smaller achenes, annual habit, differently shaped leaves, shorter inflorescences, and generally darker rose to rose-purple instead of pink, white, or greenish-white or dull purplish sepals" (Steyermark 1963).

A slight uncertainty in the herbarium data forming the basis of this study arises from the fact that in the early years of the spread of *P. caespitosum* var. *longisetum* in the United States, when collectors were not accustomed to finding it, some specimens were misidentified as *P. hydropiperoides*. Many of these specimens have since been redetermined by reliable authorities, but probably not all of them.

World Distribution

Polygonum caespitosum var. *longisetum* is native to subtropical and tropical eastern Asia. It grows from India, China, and Japan through the Philippine Islands to Java and Sumatra. The type locality is Mount Gede on the island of Java, where at 3,000 to 5,000 feet in altitude, it flowers from December to February (Blake 1932; Jones and Fuller 1955; Moldenke 1941; Steward 1930). In the United States, it blooms from June through October (Steyermark 1963).

It is not known how variety *longisetum* entered the United States, but it was first recorded in 1910 by Edwin B. Bartram near Philadelphia, at Wayne, Delaware County, Pennsylvania (Moldenke 1941). Fernald (1935) speculated that *P. caespitosum* var. *longisetum* accompanied other plants from the Far East, such as *Cyperus difformis*, *C. iria*, and *C. amuricus*, saying, "It is most probable that these oriental weeds have come in in [sic] rice straw used as packing." A primary land use in the western part of the island of Java, where Mount Gede is located, is rice cultivation. Blake (1932) had noted earlier: "My suspicion that it might be an ingredient in commercial bird seed is not borne out by the experience of the Seed Laboratory of the U. S. Department of Agriculture, which has never found it in samples of bird seed."

Distributional Chronology in the United States

The range expansion of *Polygonum caespitosum* var. *longisetum* in the United States is shown by mapping with dots the year and site of earliest collection of the taxon in each state. Using the locality for each state's first record illustrates in a preliminary way the plant's distributional chronology and possible movement (Figs. 2–4).

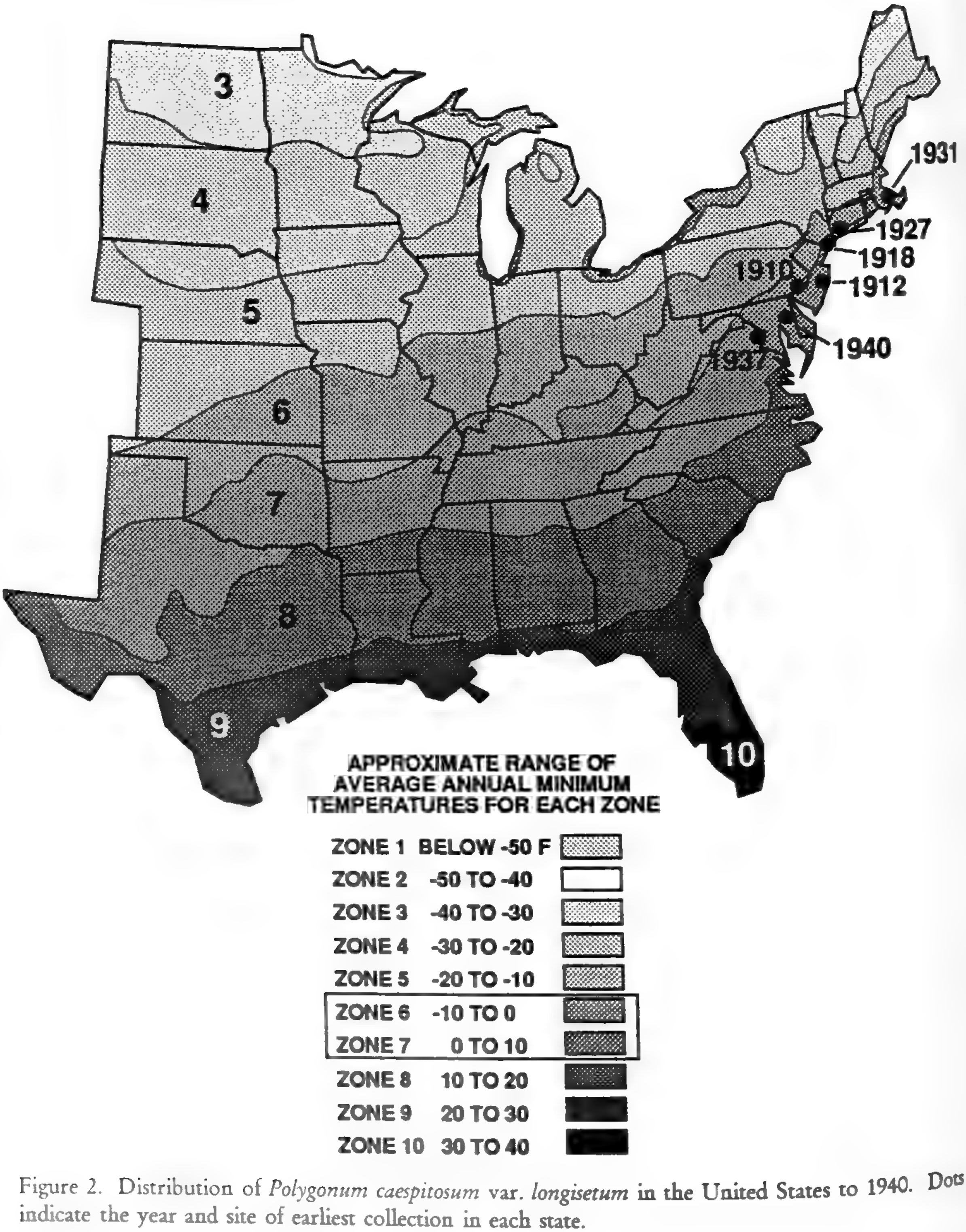

Figure 2. Distribution of *Polygonum caespitosum* var. *longisetum* in the United States to 1940. Dots indicate the year and site of earliest collection in each state.

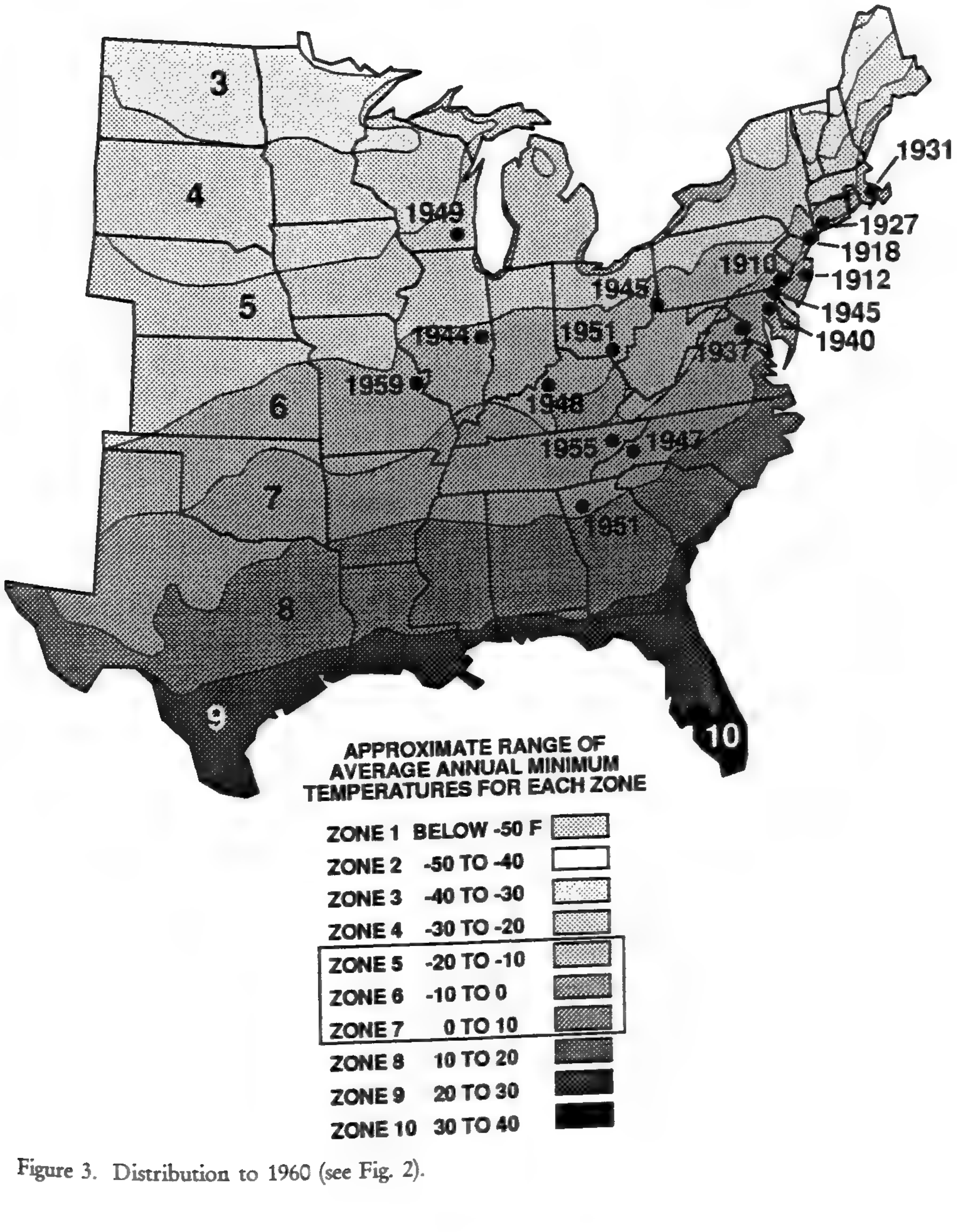

Figure 3. Distribution to 1960 (see Fig. 2).

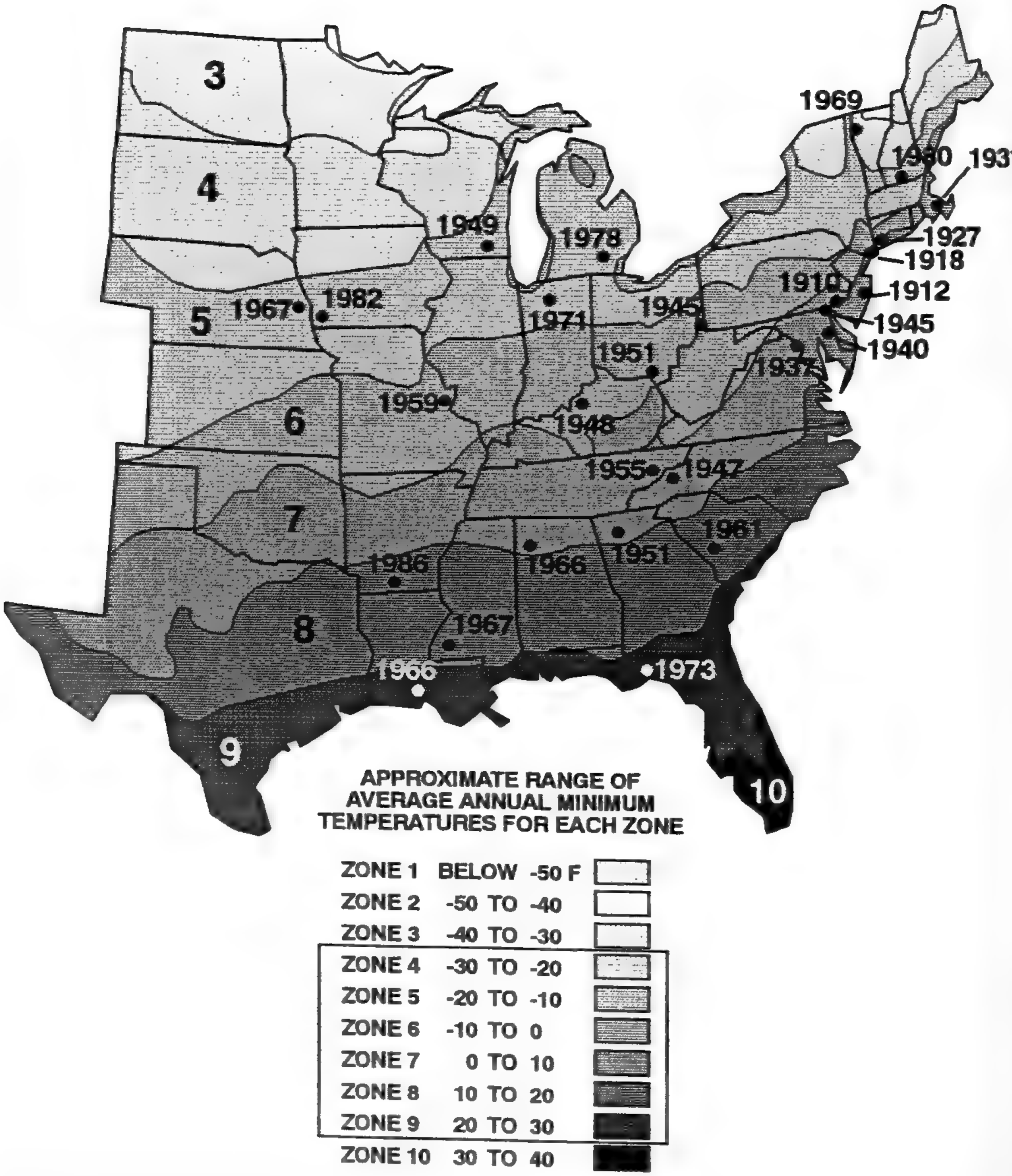

Figure 4. Distribution to 1982 (see Figs. 2 and 3).

Expansion in Eastern Seaboard States 1910–1940

From Philadelphia, in 1910 through the early 1940s, variety *longisetum* was recorded throughout the mid-Atlantic and southern New England states (Fig. 2). Chronologically, these were New Jersey (1912), New York (1918), Connecticut (1927), Massachusetts (1931), Virginia (1937), and Maryland (1940). It was confined at this time to U.S. Department of Agriculture plant hardiness zones 6 and 7, which typically have average annual minimum temperatures of –10° F to 10° F (–23° C to –12° C). In this early period, all the localities were clustered along the eastern seaboard, with the exception of one known outlier in zone 6 almost 250 miles (400 km) inland, where plants were recorded at Pittsburgh, in October 1931.

Expansion in Midwestern and Southern States 1940–1960

From about 1940 to 1960, *P. caespitosum* var. *longisetum* spread to 10 more states farther westward and southward (Fig. 3). Chronologically, these were Illinois (1944), West Virginia (1945), Delaware (1945), North Carolina (1947), Kentucky (1948), Wisconsin (1949), Ohio (1951), Georgia (1951), Tennessee (1955), and Missouri (1959). These invasions were at localities in plant hardiness zones 5, 6, and 7, where temperatures reach average minimums of –20° F to 10° F (–29° C to –12° C). The westward expansion appears to have been uneven. In 1944, variety *longisetum* was in Urbana, Illinois, a considerable distance from the established eastern populations. It was not known from Ohio and Indiana until many years later. The single record in zone 5 during this time is anomalous. Norman C. Fassett obtained a specimen in Madison, Wisconsin, in 1949, noting on the label that it was there in 1945, forming dense mats on North Orchard Street. No additional specimens have been recorded from this apparently adventive population.

Expansion Further Southward and Northward 1960–1982

During the period 1960–1982, variety *longisetum* invaded an additional 12 states (Fig. 4). Chronologically, these were South Carolina (1961), Alabama (1966), Louisiana (1966), Mississippi (1967), Nebraska (1967), Vermont (1969), Indiana (1971), Florida (1973), Arkansas (1974), Michigan (1978), New Hampshire (1980), and Iowa (1982).

By the end of this period, the plant's first state records indicate its present distribution, ranging from the northern zone 4, with average annual minimum temperatures of –30° F to –20° F (–34° C to –29° C) to the southern zone 9, with average annual minimum temperatures of 20° F to 30° F (–7° C to –1° C). Expansion from zone 6 through zone 5 into the colder zone 4 appears slow, as approximately 60 years separate the plant's initial entry point near Philadelphia in zone 6 to its occurrence at Burlington, Vermont, in zone 4. During this most recent phase of expansion, the variety *longisetum* appeared elsewhere in zone 4, in Iron County, northern Michigan, where plants were growing at the edge of Indian Lake in stones at a boat access site in July 1988. The plants at this northernmost locality may be adventive like the earlier Madison, Wisconsin, site.

Records in Ohio also show the plant's slow spread north from zone 6 through the colder zone 5 (Fig. 5). During the 1960s, most Ohio records are from counties bordering the Ohio River, many from tributaries of the Ohio, in zone 6. Records from the 1960s are also in a strip of zone 6 in Huron, Erie, and Lorain counties in the state's north, bordering Lake

Figure 5. Distribution of *Polygonum caespitosum* var. *longisetum* in Ohio, to 1991, by year and site. Multiple records from the same township in the same year are given by one dot.

Erie. The plant's slow passage through the intervening zone 5 is indicated, for example, by its arrival in eastern Ohio in Columbiana and Jefferson counties in 1964 to 1968 and its appearance 15 years later in neighboring Carroll County in 1983. Similarly, the plant's slow western spread into and through zone 5 is evident in its appearance in the eastern and central areas of Portage, Summit, and Crawford counties in 1968 to 1973 compared to its 1990 arrival in the more western Champaign County. The absence of records from northwestern counties, mostly in zone 5, emphasizes this relationship (see also Hobbs 1992).

The locations in Indiana are mostly in northwestern counties near Chicago, bordering southern Lake Michigan. This "clustering" of localities is similar to that along southern Lake Erie in Ohio (Figs. 5 and 6). These clusters occur in portions of zone 6, which has average minimums of -10° F to 0° F (-23° C to -18° C). They constitute a "lake effect" or a warmer zone in the states around the southern edges of the lakes, being located north of zone 5, which has minimums of -20°F to -10°F (-29° C to -23° C).

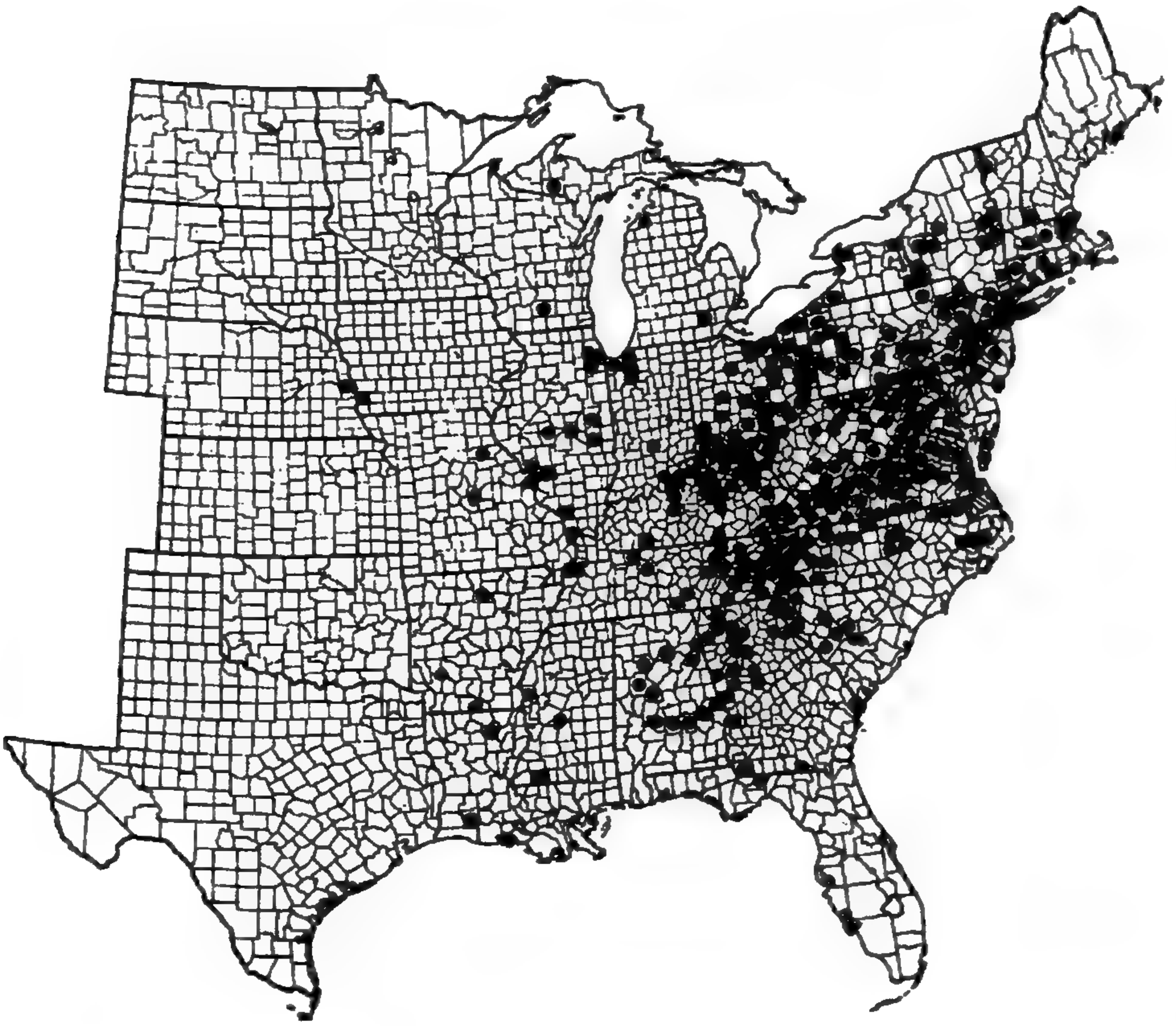

Figure 6. Distribution of *Polygonum caespitosum* var. *longisetum* in the United States to 1991, by county.

Expansion into the warmer, southern zones seems faster. The plant was present in zone 7 in North Carolina in 1947, in the warmer zone 8 in South Carolina in 1961 (14 years later), and in zone 9 in Florida in 1973 (12 years later). It took only 26 years to traverse these three warm zones.

Establishment in Rural and Urban Sites

In about half the states the plant has entered, its typical way of spreading has been to begin in a city, where it would be expected to be more sheltered and slightly warmer due to industries and houses, than in the countryside. Among the 29 first state records are, chronologically: the cities and suburbs of Philadelphia; Newark, New Jersey; Garden City, New York; Greenwich, Connecticut; Staughton, Massachusetts; Arlington, Virginia; Urbana, Illinois; Arden, Delaware; Wheeling, West Virginia; Madison, Wisconsin; Atlanta; St. Louis; Omaha, Nebraska; Burlington, Vermont; and Ann Arbor, Michigan, 15 in all. In other states, however, the first record suggests a more rural habitat type. As the range of *Polygonum caespitosum* var. *longisetum* expanded north, west, and south from the mid-

Atlantic seaboard region, localities shifted from mostly urban sites early on to more rural ones later as the plant became naturalized, at least in parts of the midwestern and southern areas of its range.

As used here, the terms "urban" and "rural" do not coincide exactly with those of the Bureau of the Census, which refers to places of 2,500 or more persons as urban, and places of less than 2,500 persons as rural, and also has a "not in places" category comprising "outside incorporated and census designated places and the rural portions of extended cities" (Dept. Commerce 1990). For the purposes of this study, the latter two categories are combined.

The urban and rural categories blend into each other in the cases of extended urban areas, technically defined as a "central place and the adjacent densely settled surrounding territory or urban fringe that together have a minimum of 50,000 persons" (Dept. Commerce 1990). Within such citified landscapes, many rural sites exist, particularly on the fringes. Rural locality descriptions attached to specimens are so classified in this study, even though technically these sites may now be annexed within the boundary of an "extended city." Wetland plants are constrained by their habitat, not by political boundaries. While a few locality descriptions are judgment calls, at the extremes, the categories are clear. A 1931 locality record of variety *longisetum* on the summit of a hill near the monkey and condor cages at the National Zoological Park in Washington, D.C. is clearly urban; a 1981 record of the plant on an island in the channel of the Obed River, half a mile downstream from Potter Ford in Cumberland County, Tennessee, is clearly rural.

In eastern cities and towns where the plant began to spread, records list such habitats as city streets, ditches, and gutters; pathways, lawns, gardens, and yards; along railroads, canals, and abandoned roads; under river bridges; in waste dumps and city parks; and other sheltered spots. Midwestern outliers with early dates have similar city localities, a pattern preserved in the recent invasion of a Plains state (Omaha, Nebraska). In rural localities, the plant inhabits nature preserves, marshes, and woods, growing along creeks, rivers, and lake shores, often in gravelly or sandy substrates. These patterns suggest that the plant may have at least two modes of spreading, one possibly involving transportation routes between major cities, such as railroads and highways, and another, more subtle way of spreading via waterways such as rivers and creeks.

Early Urban Sites

With the possible exception of the first Maryland record, the first state records from the seven eastern seaboard states mention urban localities (Fig. 2), as recorded by Moldenke (1941, 1946). These locality data are: the suburb of Wayne, near Philadelphia (1910); South Orange, in a New Jersey garden (1912); Garden City, New York, roadsides (1918); Greenwich, Connecticut, on an old estate (1927); Stoughton, Massachusetts, in a railroad yard and waste ground (1931); and Arlington Farm, Virginia (1937). The Maryland record could be considered either urban or rural, as it is a roadside 1/4 mile (0.4 km) outside Rowlandsville in Cecil County (1940).

Of the ten states where variety *longisetum* appeared from 1940 to 1960, six are urban localities (Fig. 3). These are the two already noted in Urbana, Illinois, (1944) and Madison, Wisconsin (1945), and also in Wheeling, West Virginia (1945), as a garden weed in Arden, Delaware (1945), in a wooded lot on Pritchard Way in Atlanta (1951), and along a sidewalk on Tower Grove Avenue in St. Louis (1959). The three western outliers of the plant's range

at this time (Madison, Urbana, and St. Louis) are all cities. The remaining four first state records from this latter 20-year period appear to be more rural localities: on a cliffbase along a stream near the small Madison County town of Marshall in North Carolina (1947), in a Jefferson County woods along U.S. 42 in Kentucky (1948), in Shawnee Forest on a mudflat where Pond Run meets the Ohio River in Ohio (1951), and at a wood's edge at Sinking Creek and by a roadside at the French Broad River Narrows near Newport in Tennessee (1955). The three southern states invaded during this period (North Carolina, Tennessee, and Kentucky) present primarily rural localities.

Later, More Rural Sites

Of the 12 states where variety *longisetum* appeared from 1960 to 1982, the first state records present only three clearly urban localities, all northern ones: at a ravine's edge in Memorial Park, Omaha, Nebraska (1967); in Burlington, Vermont (1969); and beside a Maiden Lane sidewalk in Ann Arbor, Michigan (1978). The 1982 Iowa first state record could also be semi-urban, being beside a road in Mills County not far across the river from Omaha. All the other localities are semi-rural or rural. While not in cities, they are sometimes near small towns or in recreational areas. Chronologically they are:

- Along a swamp forest logging road near Wrights Spring Branch in Aiken County, South Carolina (1961)
- Along a county road to the Public Lake in Tuscaloosa County, Alabama (1966)
- In a roadside ditch 1/2 mile (0.8 km) south of Lacassine, Louisiana (1966)
- In a forest along the Amite River's East Fork, Mississippi (1967)
- In a campground north of Winemak, Indiana (1971)
- In sandy alluvium bordering a woodland on the Ochlockonee River west of Tallahassee, Florida (1973)
- In large colonies at a thicket's edge below the Connecticut River dam at Bellows Falls near North Walpole, New Hampshire (1980)
- In a shaded garden 2 miles (3 km) south of Calion, Union County, Arkansas (1986)

A reported specimen from Stone County, Arkansas, in 1974 was regarded as dubious by atlas editor Edwin Smith as being outside the then-known range of the taxon. This specimen can no longer be located in herbaria.

The northern states into which the variety spread during this last phase (Nebraska, Vermont, and Michigan) show urban localities, while the southern states (Louisiana, Mississippi, Florida, and Arkansas) show more rural ones.

It appears that *P. caespitosum* var. *longisetum* spread through the Midwest and in southern directions, preferentially occupying rural habitat types even though urban ones were available. For example, Ohio is a highly urbanized state, yet it has a first state record in a rural habitat and of the state's 102 total records, fewer than one-third (30) are clearly of urban habitats. Of these 30, 11 are fluvial habitats along watercourses. (A map dot indicates all specimens in a year in the same area; there are more specimens than dots.) Ohio's urban habitat records include university campuses, city parks, streets, gardens, preserves, and railroad tracks. The state's 72 rural habitat records include many of the earlier ones, for example, along the Ohio and Vermilion rivers, along creeks in state parks, in swamps, and around lakes. A clear majority of Ohio sites (61) are fluvial, lacustrine, or wetland habitats, including the state's earliest zone 5 record "in 3 inches [8 cm] of muddy water on the north side of Mogadore Reservoir," Portage County on 6 August 1968.

CONCLUSIONS

Prior to 1940, the distribution of *Polygonum caespitosum* var. *longisetum* in the United States was confined to zones 6 and 7 with annual minimum temperatures between -10° F and 10°F (-23° C and -12° C). By 1960, its range had expanded into the cooler zone 5 in Midwestern and Appalachian states where minimums fall between -20°F and -10°F (-29° C to -23° C). By the 1980s, it had spread north to zone 4 in Vermont with minimums of -30°F to -20°F (-34° C to -29° C); south through the warmer zone 8 with minimums of 10°F to 20°F (-12° C to -7° C) to zone 9 in Florida with minimums of 20°F to 30°F (-7° C to -1° C); and had reached the Plains states west to Nebraska in zone 5.

Of 29 first state records for the variety, at least 15, about half, are clearly from urban sites, but substantial naturalization of plant populations in rural areas occurred during the 1960s through '80s, particularly in the southern, warmer zones. Spreading appears faster through warmer, southern zones and slower through colder, northern zones. Populations in extreme northern areas (in zone 4) may be purely adventive and plants in these localities should be watched to see if they remain or disappear.

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Chemical Grubbing for Control of Exotic Kudzu-Vine

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ABSTRACT. A stump treatment was applied to the cut stubs of kudzu-vine (*Pueraria montana* [Lour.] Merr.). Three herbicides, applied full strength, and a cut treatment were selected for trial and each treatment was replicated 10 times: AMS (ammonium sulfamate) 95% soluble crystal (Ammate), isopropylamine salt of glyphosate (N-[phosphonomethyl] glycine) 480 g/L (Roundup), and fosamine ammonium (ammonium ethyl carbamoylphosphonate) 480 g/L (Krenite). AMS has long been used in stump treatments and the other treatments were compared to it. Evaluation was made eight months after treatment. All three herbicides were equally effective. An evaluation about one year after treatment showed no significant differences in rates of disintegration of chemically treated stubs.

INTRODUCTION

One of the principal objectives of the National Park Service in managing wild lands is to maintain or restore dynamic indigenous biotic communities and ecosystems. The presence of exotic species that become ecological dominants thwarts this objective. In Rock Creek Park in the District of Columbia, the Clara Barton Parkway and Oxon Hill Farm in Maryland, and the George Washington Memorial Parkway in Virginia, the semi-woody kudzu-vine (*Pueraria montana* (Lour.) Merr.) is one such exotic. Kudzu-vine is aggressive and forms a canopy over all vegetation that it can climb upon, suppressing many native species.

Several methods have been tested to control kudzu-vine. Hand grubbing the root crown by removing the vine and a "piece" of the root or a "piece" of the tuber with a grubbing hoe or pulaski below the surface of the soil is one method. With large crowns and large-diameter vines it causes extreme soil disturbance and requires considerable labor. With small-diameter vines the roots at the nodes are usually removed as well. This paper compares the use of three herbicides and a manual method to kill root crowns. The process described with herbicides is analogous to the chemical stump treatment on trees and shrubs. On trees and shrubs the treated area may be close to the principal root system and the vascular tissue has phloem external to xylem with dead heartwood. With the kudzu-vine, the point of treatment is often far from the principal roots because of the nature of the vine in producing vertical and horizontal stems. Metcalfe and Chalk (1950) list the genus *Pueraria* as one that has anomalous vascular tissue consisting of successive layers of xylem and phloem tissue. A transverse section through the stem verified the anomaly for this species of *Pueraria* as well as showing no dead heartwood.

Small kudzu-vines with diameters of about 1 cm (0.4 in) or less are more quickly treated by hand grubbing. The vines in these experiments were generally larger than this with the

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largest being 7.6 cm (3.0 in) in diameter (average of long and short diameters).

The three herbicides selected for trial are moderately toxic to almost nontoxic to people: AMS (ammonium sulfamate), glyphosate, and fosamine ammonium (Beste 1983, Miller 1980). These herbicides generally degrade in the soil (Beste 1983) and do not leach away and cause problems in other areas. AMS has been in use for over five decades as a stump treatment on trees and is one of the few herbicides that has been around long enough that its long-term effects have been studied. None have been reported (Beste 1983). The other two trial herbicides are newer compounds whose long-term effects are unknown. Since AMS is no longer commercially available for herbicide use in the United States of America, one of the objectives of the trial was to compare the newer herbicides with AMS.

Materials and Methods

A completely random experimental design was used involving kudzu-vine colonies in four of the National Capital Parks of the National Park Service. Four treatments were made: cut, AMS, glyphosate, and fosamine ammonium. Each treatment was replicated 10 times, that is, 10 vertical vines were given each treatment. Vines were randomly selected with the proviso that they be large enough to produce soil disturbance if manually grubbed. The rule of thumb was that they be over 1 cm in diameter. Most of the vines were less than 5.5 cm diameter at the cut.

The vines were cut with a saw between 21 October and 3 November 1986 to make a horizontal surface at or near the soil surface depending upon the growth form of the vine. Since the vines are not actually vertical, the leaning horizontal area is larger than the vertical. The vertical stems ("stumps") were isolated by cutting surface horizontal runners.

Herbicides were applied to the cut stem the same day the vines were cut. Since the concentrated (full strength) herbicide is a common stump treatment with AMS (DuPont 1987), all herbicides were tested in concentrated form. The surface area of the vines after the cut varied from 4.7 cm^2 to 566.2 cm^2. Whether in liquid or crystal form, the herbicide was applied to the entire cut surface. Glyphosate is highly viscous; fosamine ammonium is not. Fosamine ammonium was applied three times to treated surfaces, allotting time to soak in after each application. Absorption was immediate. AMS was applied in crystalline form to cover all surfaces to 2 mm thick. About 5.9 ml (2.8 g ai)/cm^2 of fosamine ammonium, 4.4 ml (2.1 g ai)/cm^2 of glyphosate, and 2.8g (2.7 g ai)/cm^2 of AMS were applied (the symbol ai means active ingredient).

Slatted fruit boxes were placed over AMS-treated stubs to prevent rain or snow from washing crystals off. Since the liquids were readily absorbed, they needed no rain covers.

Treatments were evaluated on 10 and 13 July and 29 and 30 October 1987. Live or dead status was determined qualitatively by presence or absence of chlorophyll in the bark and whether the semi-woody tissue was moist or dry.

The effect of treatment was measured by comparing the four treatments with a chi-square test in 2 × 4 contingency tables with the two rows being either stub live or dead, or stub intact or disintegrated. Chi-square was partitioned within the tables to compare treatments according to the method and formulas of Kimball (1954).

Table 1. Evaluation of treatment results on killing *Pueraria montana* stubs after ⅔ growing season (July). FA = fosamine ammonium; G = glyphosate.

Treatments	FA	G	AMS	Cut
Live	0	0	0	9
Dead	10	10	10	1
Totals	10	10	10	10

$\chi^2_{3df} = 34.838$ ($P \leq 0.001$)

Table 2. Evaluation of treatment results on stub distintegration of *Pueraria montana* after ⅔ growing season (July).

Treatments	FA	G	AMS	Cut
Intact	7	4	4	9
Distintegrated	3	6	6	1
Totals	10	10	10	10

$\chi^2_{3df} = 7.500$ ($0.05 < P < 0.1$). Partitioned χ^2_{1df} comparing FA and G = 1.875 ($P > 0.1$); FA and G versus AMS = 0.625 ($P > 0.1$); FA, G, AMS versus Cut = 5.000 ($P < 0.05$).

Table 3. Evaluation of treatment results on stub distintegration of *Pueraria montana* after a full growing season (October).

Treatments	FA	G	AMS	Cut
Intact	2	0	1	9
Distintegrated	8	10	9	1
Totals	10	10	10	10

$\chi^2_{3df} = 23.809$ ($P \leq 0.001$). Partitioned χ^2_{1df} comparing FA and G = 0.952 ($P > 0.1$); FA and G versus AMS = 0 ($P > 0.1$); FA, G, AMS versus Cut = 22.857 ($P \leq 0.001$).

RESULTS

By July one cut stub (no herbicide) was dead, one was alive without resprouts and eight had resprouts. All the chemically treated stubs were dead without resprouts. There were no significant differences among herbicide treatments, but herbicide treatments differed as a group from the cut treatment by killing the stubs (Table 1).

Stub disintegration was evaluated both in July and October. At both times the stubs were classified as intact or disintegrated. At the July evaluation one cut stub, three fosamine ammonium treated stubs, six stubs treated with glyphosate, and six treated with AMS had disintegrated. When these differences (Table 2) were analyzed in a contingency table the probability of type I error ($0.05 < P < 0.1$) was deemed sufficiently low to justify partitioning the chi-square. The chemically treated stubs as a group disintegrated at a

significantly higher rate than the cut stubs ($P < 0.05$). There were no significant differences among chemically treated stubs.

At the October evaluation, still only the one cut stub had disintegrated but more of the herbicide treated stubs had disintegrated. The same pattern held under partitioned chi-square as in the July evaluation, but significance was much stronger (Table 3).

Discussion

These experiments show that all three herbicides are equally effective in killing kudzu-vine stubs. Initiation of this study was most convenient in the late autumn and carried out concurrently with similar studies on another exotic, Chinese wisteria (Thomas 1993), with similar results. These three herbicides were all equally effective in killing the stubs of these two species and could be considered effective in stump treatments as well.

One cut vine died and completely disintegrated. Vine longevity is unknown. Although vines of kudzu, wisteria (Thomas 1993) and other species have, on occasion, been observed to die after a single cut, single cutting of vines in these two species has been shown to be ineffective in their control. Although a cut vine (stem) may die, the plant may be alive and send up a sprout elsewhere. It is possible that the trauma of the cut itself with or without subsequent bacterial or fungal infection may kill some vines and plants.

Another aspect of the treatments from the standpoint of ecosystem restoration is the rate of nutrient release. These herbicides apparently did not preserve the dead vines and all the tissues (all herbicide treatments) were well into decomposition a year after treatment. There was no significant difference in decomposition rates among herbicide treatments eight months after treatment, thus all these herbicides allow the kudzu-vine to disintegrate rapidly and recycle nutrients in the ecosystem.

Conclusions

AMS, fosamine ammonium, and glyphosate are all effective in killing *Pueraria montana* when applied to the cut end of a stub and all these herbicides allow the kudzu-vine to disintegrate rapidly, thus promoting the recycling of nutrients in the ecosystem. The results of this study should be of value to private and public landowners or managers who have problems with the invasive kudzu-vine in environmentally sensitive areas.

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Clarification of Distance Measurements in the Random Pairs and Other Plotless Distance Sampling Methods

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After extensively applying the random pairs and point-centered quarter methods in ecological vegetation surveys, questions arose whether the measured distance between trees or trees and points were quite accurate. Several authors describe these plotless distance methods (Moore and Chapman 1986, Lemon 1962, Phillips 1959), but none describe exactly how to measure the distances.

In the random pairs method, the nearest tree to the sampling point is determined. The observer faces this tree. The second tree is the closest to the first but behind the observer, that is, outside the 180° angle that includes the first tree. The distance between these trees is measured.

In the point-centered quarter method, four quarters are described at the sampling point, often delineated by lines parallel and perpendicular to the line of travel. Distance is measured to the nearest tree in each quarter. The distances are used for calculating the absolute tree spacing densities from the mean area occupied by an individual.

In the point-centered quarter method a difference in distance to the point from the same large or irregularly shaped tree trunk (generally canopy trees) was noticed, depending upon the side of the tree from which the measurements were being taken. This difference in distance measurements varied up to and occasionally exceeded one decimeter. These discrepancies occurred even when the precise tree centers were located with calipers.

Distance measurement accuracy in application of these plotless distance methods shows wide variation. In the Bitterlich plotless method used by foresters, distance is not measured (the objective being basal area) except in borderline cases, in which the horizontal distance from point to tree center is measured to the nearest 0.1 ft (0.03 m) (Wenger 1984). Cottam and Curtis, the originators of the plotless *distance* methods (1956), showed distances on the mapped stands measured to hundredths of a foot (about 0.3 cm). However, they suggested the use of an optical range-finder with accuracy to within half a foot (15 cm) at 40 feet (12 m), in which case a discrepancy of a decimeter may be tolerable.

Lindsey *et al.* (1958) used a range-finder when they tested field efficiencies on several forest sampling methods including the point-centered quarter method. A range-finder, however, does not measure to the center of the tree unless one flags the center at the side of the tree.

Slope may also be a problem. Trials with and without a level attached to the tape indicated that there may be some problems with the tape being level, particularly with a solitary worker on slopes, variable terrain, or even on floodplains.

The following three factors were investigated to determine their effect on distance errors. One, with what precision should the tape be read for distance? Two, since the formulas for

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tree density are based on measuring to tree centers (Cottam *et al.* 1953; Cottam and Curtis 1949), how accurately must these be determined (even for a leaning tree)? Three, how level must the tape be, since absolute density is based on area measurements, which are dependent on horizontal distances (Theroux and Smith 1950)?

METHODS

To clarify the first factor (precision), a course was laid out for measuring distances between 99 tree pairs. The tape was first read to the nearest centimeter and then to the nearest decimeter. A plumb bob was used on slopes or when distances were longer than the tape. The two readings were compared statistically.

Subsequently these same tree distances were remeasured to the nearest decimeter more precisely for a control against which comparisons were made to clarify the second and third factors. The course covered the sloping terrain of the upland (51 pairs) and the relatively flat terrain of the adjacent floodplain (48 pairs). The center of each tree was determined in the direction of measurement by the use of calipers; in the case of leaning trees, an adjustment was made so that this center at ground level was transferred by plumb bob up the trunk away from interference with ground layer vegetation. A tape bubble-level was used on all distance measurements, and a plumb bob was used when these measurements had to be made on slopes or were longer than the tape. A tape that is inclined measures a greater distance than a horizontal tape between the same two points. When measuring the distance between two points on a steep slope, horizontal measurements were taken in increments with the use of a plumb bob, and a line was laid on or close to the ground as a target for the plumb bob; otherwise the distance measured would be greater than the true distance.

To clarify the second factor (tree center accuracy), two tests were made. First, before placing the calipers on the 99 pairs of trees, the location of each center was estimated. Second, 75 of the 99 distances were measured using only a tape level, with no calipers or special adjustments for leaning trees, thus allowing only tree centers to vary. (These 75 distances were available from another study). These two readings (i.e., the control course and tape level only) were statistically compared. Those distances, which occurred in one first-order watershed, were broken into analysis of upland only (29 distances) and floodplain only (30 distances). The remaining 16 distances of the 75 were all in a floodplain in a much larger watershed, and so they were not used in this analysis to avoid heterogeneity and discrepancy of sample size comparison.

To clarify the third factor (level tape), distances between trees (99 distances) were measured without a tape level, without calipers, or any special regard for obvious leaning trees. These tree distances were statistically compared with the control course and then analyzed separately for upland only (51 distances) and floodplain only (48 distances).

The populations of all distances to be compared were tested for normality by histogram, a variance ratio test was performed, and either a *t*-test (for normal populations) or Kruskal-Wallis test (for nonnormal populations) was done as appropriate. Significance was set at $\alpha = 0.1$ to insure that no trends toward differences between measuring techniques would be missed.

Table 1. Comparison of distances measured using tape level only with control course (meters).

Data Set	Mean	Median	Variance	Number
Control course (C)	12.4	11.6	25.4	75
Tape level only (L)	12.5	11.7	25.8	75
Upland only				
C	12.6	11.9	25.1	29
L	12.7	11.9	25.5	29
Floodplain only				
C	10.7	10.4	19.5	30
L	10.7	10.5	19.8	30

Table 2. Comparison of distance measurements without a tape level with the control course (meters).

Data Set	Mean	Median	Variance	Number
Control course (C)	9.4	9.1	12.4	99
No instruments and adjustment (N)	9.5	9.1	12.6	99
Upland only				
C	9.8	9.1	11.9	51
N	9.9	9.3	11.9	51
Floodplain only				
C	9.0	9.0	12.8	48
N	9.1	9.1	13.2	48

RESULTS

For the factor of precision, the *t*-test showed no significant difference ($P > 0.1$) between measuring to the nearest centimeter and nearest decimeter. When rounded to the significant digits, the means (9.52 m) and standard deviations (3.54 m) were identical. The variances were slightly different. For the 0.01 m the rounded variance was 12.55 m, and for the 0.1 m the rounded variance was 12.56 m. Since there was no statistically significant difference between these readings, all subsequent tests were with data measured to 0.1 m.

For the second factor of tree center accuracy, the visual estimate before applying calipers consistently came within a few centimeters of the tree center. The second test compared measurements taken with a tape level only with the control, so the only variation was with tree center location: with and without instruments. The *t*-test showed that differences were not significant ($P > 0.1$). Upland (sloping) and floodplain (flat) samples were analyzed separately to see whether differences in habitat might be revealed. With this separation, the distributions of some of the distance populations were no longer normal, but reverse J-shaped. The Kruskal-Wallis test on upland data as well as on floodplain data compared identical population forms, and tests on both habitats were not significant ($P > 0.1$; Table 1).

For the third factor of a level tape—comparison with and without a tape level—the *t*-test

revealed no significant differences ($P > 0.1$). When the data were separated into upland and floodplain categories to determine possible habitat differences, the distributions of some distance populations were reverse J-shaped. The Kruskal-Wallis test of both upland and floodplain still showed no significant difference ($P > 0.1$; Table 2).

Discussion

Since the means were identical whether one measures to the nearest centimeter or to the nearest decimeter, measurements should be made to the nearest decimeter (0.1 m), since it takes less time. The nonsignificant variation in the tests was never more than 0.1 m for the means and seldom more for the medians (Tables 1 and 2). Reading the tape to the nearest 0.1 meter generally accommodates differences in point to tree measurements involving large or irregularly shaped trunks, and as shown in this study also accommodates the few centimeters' variation involved in estimating tree centers without calipers.

Although the results between the control course and the uncontrolled measurements show no statistically significant differences, there is a pattern in the results (compare means and medians, Tables 1 and 2). Uninstrumented or less instrumented measurements tend to be greater than the control measurements. The consistent overmeasurement may be important, depending upon the objectives of the survey. Statistical tests are based on probabilities, not absolutes, and occasionally the statistical tests will lead to a wrong conclusion. Distances, then, will be recorded as longer than they really are, and this holds regardless of habitat. One explanation for longer distances to be recorded when instruments are not used is the tendency in any sloping area of failing to raise the tape high enough. Slope distances are always greater than horizontal distances. A sagging tape also results in a longer recorded distance. If the tape is raised too high, the distance recorded will also be longer. A hand-held laser distance-measuring device would accurately measure horizontal distances; it would also be much more expensive.

A range-finder targeted on the closest tree surface would, with canopy trees, shorten the distance by at least two decimeters, and frequently by nearly half a meter. For example, in the point-centered quarter method a canopy white oak (*Quercus alba*) had an average dbh (long and short axis) of 119.5 cm. This is about 60 cm between the center and the outside of the tree. A canopy tuliptree (*Liriodendron tulipifera*) had an average dbh of 103 cm, which is about 52 cm between center and outside. A canopy northern red oak (*Quercus rubra*) had an average dbh of 86 cm, which is a distance of 43 cm between the center and outside. When many trees are this large, the distance from tree to point may be shortened 0.4 m or more when targeted to the closest tree surface. If the average distance point to center of tree is 7.6 m, then there are 173 canopy trees per hectare. If that distance is shortened by 0.4 m ($\bar{x} = 7.2$ m), then there are 193 canopy trees per hectare, a difference of 20 trees (12 percent). In calculating the density for the random pairs or point-centered quarter method the mean distance is squared and this becomes the denominator: number/hectare = 10,000/(mean distance)^2 (Phillips 1959). In small forests and fragmented areas errors in distance measurements may be important and an error of 10 trees may be critical.

On leaning trees, the center will be the center of the tree at ground or soil level, not at breast or some convenient height. A tree that leans perpendicular to the line of sight will usually cause no problem, but one that leans toward or away from the observer will shorten or lengthen the distance recorded. On large floodplains trees frequently lean downstream (Sigafoos 1964). In all forested habitats they may lean into canopy light gaps.

RECOMMENDATIONS

It is suggested that distances be measured to the nearest 0.1 m. This accommodates well any error in judging tree centers of vertical trees and discrepancies encountered in tree to point distances in the point-centered quarter method. As the tests showed, there was never more than 0.1 m difference in any mean, and the differences were not statistically significant.

Tree centers can be located without resorting to calipers, but special care needs to be exercised with obviously leaning trees. These tree centers are located at the point where the trees emerge from the ground. A plumb bob will facilitate locating tree centers on leaning trees so measurements can be taken on the trunk at more convenient heights above the vegetation on the forest floor.

Without a level, a horizontal line is difficult to impossible to determine on sloping ground. Since the differences in means were consistently longer without instruments and adjustment for leaning trees, it would be well to use a bubble-level on the tape on slopes and make adjustments for obviously leaning trees. Even with the use of a level, the tape over long distances may sag a little in the middle, but the level still will help to approach horizontality.

A plumb bob is an absolute necessity when measuring horizontal distances on slopes where the tape cannot be held high enough to measure the distance between the trees. When one has to measure on a slope, it will be easier to measure going down the slope in short increments. A straight line on the ground is needed as a target for the plumb bob; otherwise, the line will measure longer than the true distance because the line of descent down the slope will not be straight. It is convenient to use a fiberglass tape as a target that can be attached on one tree with an ice pick and wrapped around the other tree at ground level or just above the ground layer. The two trees should always be measured on the same side, as a cross-over measurement will record a longer distance than actuality.

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An Annotated Bibliography of the Floristic and Vegetation Publications of the Delmarva Peninsula, 1524–1970

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The botanical explorations of the Delmarva Peninsula date from 1524 with the voyage of Giovanni da Verrazzano. Thus, for over 474 years, floristic notes have been prepared by numerous authorities, from amateur explorers to professional botanists. For the period of 1851-1970, an average of one floristic work per year was published. After 1970, this jumped to an average of eight floristic publications per year; many of these originated from government agencies and had limited distribution. Thus, this annotated bibliography only encompasses the period from 1524 to 1970; later floristic works must await a future annotated bibliography.

The Delmarva Peninsula, commonly defined as a political unit (Tatnall, 1946), includes parts of three states: Delaware, Maryland (Eastern Shore), and Virginia (Eastern Shore). Delaware comprises three counties: New Castle, Kent, and Sussex. The Eastern Shore of Maryland comprises nine counties: Cecil, Kent, Queen Annes, Talbot, Caroline, Dorchester, Wicomico, Worcester, and Somerset. The Eastern Shore of Virginia comprises two counties: Accomack and Northampton. Three physiographic zones constitute the Delmarva Peninsula: the Piedmont (New Castle and Cecil Cos.), the Fall Zone (New Castle and Cecil Cos.), and the Coastal Plain (Tatnall, 1946).

Our annotations of the reports are enclosed in parentheses following the bibliographic citations, with the putative year(s) of activity and the principal(s) in bold, arranged chronologically. We have included floras, monographs, and revisions when these treatments included Delaware, Maryland, or Virginia in the title or when these treatments discussed potentially endangered, threatened, or rare plants of the Delmarva Peninsula. Our definition of "vegetation" includes those organisms studied by botanists, from cyanobacteria and fungi to flowering plants, in both fossil and modern assemblages, and both native and naturalized (and, sometimes, cultivated plants, noteworthy because of their size, uniqueness, or potential invasiveness). We have also included accounts of traditional uses of plants by Native Americans on Delmarva because this undoubtedly influenced plant distribution.

This bibliography was started in 1978 as a supplement to the rare and endangered reports for Delaware and Maryland. The reactivated interest in the flora of the Delmarva Peninsula by botanists at Claude E. Phillips Herbarium at Delaware State University (DOV), the U.S.

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Fish and Wildlife Service, The Nature Conservancy, and the state Natural Heritage Programs, prompted us to prepare this publication.

The bibliography consists of 169 articles. We do not claim that this list is all-inclusive. The publications listed below are varied and scattered, and undoubtedly we missed some. We would be interested in hearing of any additional floristic publications on the Delmarva Peninsula.

ANNOTATED BIBLIOGRAPHY

1524. Wroth, L. C. 1970. The voyages of **Giovanni da Verrazzano**, 1524-1528. Yale Univ. Press, New Haven, CT. (In the voyage of 1524, Verrazzano and his men encountered "Arcadia," now identified as Worcester/Accomac Co., and later "Lanzone," now identified as Cape Henlopen, Delaware, according to Wroth. In Arcadia they penetrated inland about nine miles and reported great forests full of grape vines, wild roses, violets, and lilies.)

1654-1656. Lindeström, P. 1925. Geographia Americae with an account of the Delaware Indians. Transl. Amandus Johnson. Swedish Col. Soc. Philadelphia. (Peter Lindeström made his observations while living at Fort Christina in New Sweden. The native flora and uses of plants by the Indians in Delaware were recorded from Wilmington to Cape Henlopen.)

1681/1682. Weslager, C. A. 1956. Cedar Swamp and the lost Cedar Creek. Delaware Hist. 7:3-16. (An annotated survey by **Richard Noble**, discovered in the files of the Pennsylvania Historical Society, allowed an approximation of the location and extent of an Atlantic white-cedar swamp and associated trees southwest of Liston Point in New Castle Co. Longtime local residents, **Orville Newnom** and **Frederick Bell**, recently recorded on tape under the auspices of the Delaware Folklore Society, told of an associated cranberry bog and other plants, now extirpated.)

1711-1724. [Hesselius, A.]. Johnson, A. 1947. Introduction. Delaware Hist. 2:68.

1711-1724. Hesselius, A. 1947. The remarks of Andreas Hesselius, Provost in Gagnes, about some strange occurrences which he encountered during his journey to America, etc. Transl. A. Johnson. Delaware Hist. 2:69-113. (Between 1711 and 1724, Andreas Heselius, a missionary to the Swedish churches on the Delaware and based in Wilmington, recorded the birds, animals, insects, plants, and fishes that he observed on his voyage from Sweden to the New World. This twentieth-century publication of his remarks was annotated by Frank Morton Jones.)

1737. Berkeley, E., and D. S. Berkeley. 1982. The life and travels of **John Bartram**: From Lake Ontario to the River St. John. Univ. Press Florida, Tallahassee.

1737. Berkeley, E., and D. S. Berkeley. 1992. The correspondence of **John Bartram** 1734-1777. Univ. Press Florida, Gainesville. (In the fall of 1737, John Bartram rode south along the Delaware to the Eastern Shore of Maryland and Virginia, as far as Cape Charles. He sent Peter Collinson two boxes of seeds, two boxes of plants, and one box of specimens from this expedition.)

1748. Kalm, P. 1753-1761. En resa til Norra America. Lars Salvii, Stockholm.

1748. Kalm, P. 1770. Travels into North America. Transl. J. R. Forster. William Eyres, Warrington. (In 1748, while based in Philadelphia, Peter Kalm ventured into New Castle and Wilmington and described the trees nearby.)

1759. **Acrelius, I.** 1759. Description of the former and present condition of the Swedish Churches, in what was called New Sweden, afterwards New Netherlands, but at the present time Pennsylvania, together with the adjacent places on the River De La Ware, West Jersey, and New Castle County, in North America. Harberg & Hasselberg, Stockholm. (Israel Acrelius, provost of the Swedish Churches in America and rector of the Old Swedes' Church in Wilmington, listed 21 of the "most remarkable kinds of trees in Pennsylvania," which included New Castle Co. in that era.)

1764. **[Jones, J.]**. Mifflin, B. 1928. Journal of a journey from Philada. to the cedar swamps & back, 1764. Pennsylvania Mag. Hist. Biogr. 52:130-140.

1764-1782. **[Jones, J.]**. Jones, F. M. 1949. Introduction. Delaware Hist. 3:123-125.

1764-1782. **[Jones, J.]**. 1949. Description of the cypress swamps in Delaware and Maryland states (1797). Delaware Hist. 3:126-137.

1764-1782. **[Jones, J.]**. 1965. Bell, W. J. 1965. Patriot-improvers: Some early Delaware members of the American Philosophical Society. Delaware Hist. 11:195-207. (The "Description of the cypress swamps in Delaware and Maryland states" was originally published anonymously in the The American Universal Magazine for Monday, July 10, 1797, Vol. III, No. 1 but written in 1782. From the sleuthing by Whitfield J. Bell, the author was obviously Col. John Jones. The 1764 and 1797 publications were the first comprehensive botanical analyses of the 500,000 acre Cypress Swamp between Gumboro and Selbyville.)

1771. **Jones, J.** 1771. Mr. John Jones, of Indian River, Worcester County, Maryland, gives the following account of a species of grape vines, which he had discovered, different from all others he had ever seen. Trans. Amer. Phil. Soc. 1:339-340. (This report discussed Col. John Jones' description of a grape from the Cypress Swamp, which seems to match *Vitis rotundifolia* Michx.)

1777-1778. **Wangenheim, F. A. J. von.** 1781. Beschreibung einiger Nordamerikanischen Holz- und Buscharten, mit Anwendung auf teutsche Forsten. Johann Christian Dieterich, Göttingen.

1777-1778. **Wangenheim, F. A. J. von.** 1787. Beytrag zur teutschen holzgerechten Forstwissenschaft, die Anpflanzung Nordamerikanischer Holzarten. Johann Christian Dieterich, Göttingen. (Friedrich Adam Julius von Wangenheim, trained as a forester in the Georgenthal Forest in the Turinger Wald, served as a "Hessian" with the auxiliary corps solicited by the English crown. He sailed from New York City in 1777 to Cape Henlopen, Delaware, then traveled by ship to Cape Henry, Virginia, up the Chesapeake Bay to Turkey Point, Cecil Co., Maryland, then overland by foot to later fight in Pennsylvania and New Jersey. He collected plants from his landing at Turkey Point to Sandy Hook, New Jersey.)

1804. Tucker, A. O., and N. H. Dill. 1989. **Rafinesque**'s *Florula Delawarica.* Bartonia 55:4-14. (This is a reconstructed "florula," or small flora of Delaware, which had been sent to Benjamin Barton but suppressed by him. Constantine S. Rafinesque's florula of 1804 included, at a minimum, 55 vascular plants, eight fungi, and one lichen.)

1809. **Nuttall, T.** 1818. The genera of North American plants, and a catalogue of the species to the year 1817. T. Nuttall, Philadelphia, PA.

1809. Tatnall, R. R. 1940. **Nuttall**'s plant collections in southern Delaware. Bartonia 20:1-6.

1809. Graustein, J. E. 1967. **Thomas Nuttall**, naturalist: Explorations in America 1808-1841. Harvard Univ. Press, Cambridge, MA.

1809. McDowell, M. 1989. Cypress, sea rockets, and **Nuttall**'s trip to Delaware. Delaware Conservationist 32(3):4-7. (In 1809, Thomas Nuttall explored Delaware from Lewes, through the Cypress Swamp, to Dagsboro and the Nanticoke River.)

1844. Tatnall, E. 1844. Phaenogamous and filicoid plants of New Castle County. Bot. Soc. Wilmington., Wilmington, DE. (This listed 110 families.)

1852. Harvey, W. H. 1853. Nereis boreali-americana. Part II.—Rhodospermae. Smithsonian Inst., Washington, DC. 258 p., pl. 13-16. (This reported *Callophyllis laciniata* Kütz. at Cape Henlopen, Delaware.)

1857. Harvey, W.H. 1858. Nereis boreali-americana. Part III.—Chlorospermae. Smithsonian Inst., Washington, DC. 140 p., pl. 37-50. (This reported *Cladophora morrisiae* W. H. Harvey at Elsinborough, Delaware).

1860. Tatnall, E. 1860. Catalogue of the phaenogamous and filicoid plants of Newcastle County, Delaware. Wilmington Inst., Wilmington, DE. (This listed 1,106 species.)

1861-1901. Tucker, A. O., and N. H. Dill. 1993. The collections of **Albert Commons** on Delmarva, 1861-1901, with attention to August 4-5, 1874 and September 9-10, 1875. Bartonia 57(Suppl.):9-15. (A computerized index of Albert Commons' herbarium specimens allowed a reconstruction of an itinerary of his botanical travels.)

1864. Canby, W. M. 1864. Notes of botanical visits to the lower part of Delaware and the Eastern Shore of Maryland. Proc. Acad. Nat. Sci. Philadelphia 1864:16-19. (This described 14 species in Sussex Co., Delaware and Worcester and Somerset Cos., Maryland)

1864-1927. Long, B. 1929. Some noteworthy indigenous species new to the Philadelphia area. Bartonia 10:30-52. (This listed five species collected by A. Commons and H. E. Stone from New Castle Co., Delaware and Cecil Co., Maryland: *Poa chapmaniana* Scribn., *Poa alsodes* Gray, *Carex uberior* Mackenzie [*C. stipata* Muhl. ex Willd. var. *maxima* Chapman], *Rhynchospora glomerata* (L.) Vahl., and *Antennaria solitaria* Rydb.)

1874. Canby, W. M. 1874. *Desmodium*. Bull. Torrey Bot. Club 5:19-20. (This was a report of *Desmodium humifusum* Beck from New Castle Co., Delaware and *D. ochroleucum* M. A. Curtis from near Felton, Delaware.)

1875. Canby, W. M. 1875. *Symplocos* and *Alnus*. Bull. Torrey Bot. Club 6:171. (This reported *Symplocos tinctoria* with a 28 in. [71 cm] trunk circumference at base and *Alnus maritima* with a 16.75 in. [42.5 cm] trunk circumference at base in southern Delaware.)

1875. Canby, W. M. 1875. *Peteris* [sic] *aquilina* var. *caudata; Cyperus ovularis* var. *cylindricus*. Bull. Torrey Bot. Club 6:332. (Specific sites were absent beyond "Delaware.")

1878. Chickering, J. W. 1878. A season's botanizing. Field & Forest 3:151-155. (A collection in 1878 on the Eastern Shore of Maryland, accompanied by William M. Canby and Albert Commons, was documented.)

1881. Canby, W. M. 1881. Notes. Bot. Gaz. 6:279-271. (This reported exceptionally large specimens of *Magnolia grandiflora, Taxodium distichum, Quercus stellata, Pinus taeda, P. mitis* [*P. echinata* Mill.], *P. inops* [*P. virginiana* Mill.], and *Alnus maritima* plus occurrence of mistletoe on *Nyssa multiflora* [*N. sylvatica* Marsh.] and *Acer rubrum* in Delaware.)

1884. Sargent, C. S. 1884. Report on the forests of North America (exclusive of Mexico). Govt. Printing Off., Washington, DC. (This described the primary forest species and their uses in Delaware, Maryland, and Virginia.)

1885-1896. Dix, W. L. 1961. The Delaware lichens collected by Commons. Bryologist 64:371-378. (This report re-examined and determined 600 lichen specimens at PH.)

1887. Coulter, J. M., and J. N. Rose. 1887. Notes on Umbelliferae of E. United States. IV. Bot. Gaz. 12:102-104. (This named *Hydrocotyle canbyi*, sp. nov. [*H. verticillata*

Thunb. var. *triradiata* (A. Rich.) Fern.] from New Jersey and Maryland, after the Delaware botanist, William M. Canby.)

1891. **Rusby, H. H.** 1891. A botanical excursion to Assateague Bay. Bull. Torrey Bot. Club 18:250-255. (This reported 70 species of fields, swamps, and woodlands in the Assateague Bay area on the boundary between Maryland and Virginia.)

1892. **Commons, A.** 1892. Bartram's oak. Bot. Gaz. 17:125-126. (This identified Bartram's oak in Delaware and New Jersey as *Quercus imbricaria* Michx. var. *heterophylla* (Michx.).)

1893. **Sollers, B.** 1893. The flora of Maryland, p. 218-235. *In* Johns Hopkins University. Maryland: Its resources, industries and institutions. John Hopkins Univ., Baltimore, MD. (This reported on the geological and botanical regions of Maryland, including the Eastern Shore. Plants were grouped into categories including: forest trees, climbers, weeds, larger orders, plants with especially attractive flowers, plants of particular habits, shore and water plants, orchids, grasses, ferns, and medicinal plants.)

1899. **Palmer, W.** 1899. Ferns of the Dismal Swamp, Virginia. Proc. Biol. Soc. Wash. 13:61-70. (This reported *Polypodium polypodioides* near Cape Charles City, Northampton Co., Virginia.)

1900. **Canby, W. M.** 1900. *Coreopsis involucrata* on the Atlantic Coast. Rhodora 2:34. (This species, considered conspecific with *Bidens aristosa* (Michx.) Britt., was reported in reclaimed tide-water marshes near Wilmington, Delaware.)

1900. **Coulter, J. M., and J. N. Rose.** 1900. Monograph of the North American Umbelliferae. Contr. US Natl. Herb. Vol. 7, No. 1. (*Oxypolis filiformis canbyi*, var. nov. [*O. canbyi* (Coult. & Rose) Fern.], was described from Ellendale, Delaware, as was *Hydrocotyle canbyi* [*H. verticillata* Thunb. var. *triradiata* (A. Rich.) Fern.], from Collins Beach, Delaware.)

1901-1930. **Norton, J. B. S.** 1930. Maryland grasses. Maryland Agr. Exp. Sta. Bull. 323:251-326. (This recorded 240 grass species found wild in Maryland.)

1901. **Sargent, C. S. 1901.** New or little known North American trees. II. Bot. Gaz. 31:1-16. (This described *Crataegus canbyi*, sp. nov. [*C. crus-galli* L.] from hedges and thickets near Wilmington, Delaware.)

1901. **Snow, L. M.** 1902. Some notes on the ecology of the Delaware coast. Bot. Gaz. 34:284-306. (This described the geography, physiography, and climatology as correlated to plant distribution: treeless vs. wooded regions from Cape Henlopen to one mile south of Rehoboth, Delaware. Comparisons were made to Ocracoke Island, North Carolina and the coast of New Jersey.)

1902. **Curran, H. M.** 1902. The forests of Cecil County, p. 295-314. *In* Maryland Geological Survey. Cecil County. Johns Hopkins Press, Baltimore, MD. (This reported the geological features, acreages, and oceanic uses of the forests of Cecil Co., encompassing 27 species of barrens timber and 39 species of shore timber.)

1902. **Sargent,** C. S. 1902. The silva of North America. Vol. 13. Houghton, Mifflin and Co., Boston. (This described *Crataegus canbyi* Sarg. from Wilmington, Delaware and the shores of Chesapeake Bay at Perryville, Cecil Co., Maryland.)

1903. **Sargent,** C. S. 1903. The genus *Crataegus* in Newcastle County, Delaware. Bot. Gaz. 35:99-110. (These notes were based on collections and observations by W. M. Canby concerning descriptions of 16 species of *Crataegus* in New Castle Co., Delaware.)

1903. **Shull, G. H.** 1903. Geographic distribution of *Isoetes saccharata*. Bot. Gaz. 36:187-202. (This report provided eight sites for this species in Delaware and the Eastern Shore of Maryland, in addition to ten other locations in western Maryland and Virginia. This

species was noted to have a limited distribution in the Chesapeake Bay drainage related to water current dispersal.)

1904. Clark, H. L. 1904. Notes on Maryland plants. Rhodora 6:176-177. (This reported on collections of *Aspidium cristatum clintonianum* D. C. Eaton [*Dryopteris clintoniana* D.C. Eaton) Dowell], *Tipularia discolor* Nutt., *Desmodium pauciflorum* DC., and *Pluchea petiolata* Cass. [*P. camphorata* (L.) DC.] from Talbot Co. and *Potamogeton mysticus* Morong. [*P.* × *mysticus* Morong.] From near Ocean City, Maryland, which expanded the known ranges for each respective species.)

1905. Keller, I. A., and S. Brown. 1905. Handbook of the flora of Philadelphia and vicinity. Philadelphia Bot. Club. (This provided taxonomic keys to pteridophytes and spermaphytes for New Castle Co., Delaware, in addition to nine counties in Pennsylvania and 13 counties in New Jersey.)

1905. Norton, J. B. S., and E. P. Walls. 1905. The wild legumes of Maryland and their utilization. Maryland Agr. Exp. Sta. Bull. 100:97-127. (The economic value of 77 wild legumes in Maryland was explored.)

1907-1926. Besley, F. W. 1926. The forests of Kent County, p. 161-180. *In* Maryland Geological Survey. Kent Co. Johns Hopkins Press, Baltimore, MD. (This reported on the acreage of woodlands, including percentage of saw timber, its value, usage, destructive agencies, and management. A list of 58 native species and five common, introduced species is given.)

1907. Sterrett, W. D. 1907. Report on forest conditions in Delaware and a forest policy for the state. Univ. Delaware Agr. Sta. Bull. 82. (This reported on the physiography, geology, and climate of Delaware in relation to acreage of forests and farmland. The forest product usage and occurrence of 15 common commercial and 41 infrequent or inferior commercial trees is given.)

1907-1912. Tidestrom, I. 1913. Notes on the flora of Maryland and Virginia,— I. Rhodora 15:101-106. (This reported observations of eight species of *Pinus* plus *Tsuga canadensis* and *Taxodium distichum* in Maryland and Virginia, including Delmarva.)

1908. Ames, O. 1908. Notes on *Habenaria.* Rhodora 10:70-71. (This reported *Habenaria* × *canbyi* hybr. nov. as *H. cristata* × *H. blephariglottis* from Lewes, Delaware and collected by W. M. Canby.)

1909-1926. Besley, F. W. 1926. The forests of Queen Anne's County, p. 161-171. *In* Maryland Geological Survey. Queen Anne's County. Johns Hopkins Press, Baltimore, MD. (This documented the acreage of woodlands, including the percentage of saw timber, its value, usage, destructive agencies, and management. A list of 69 species was given.)

1909. Harper, R. M. 1909. Car-window notes on the vegetation of the Delaware Peninsula and southern Virginia. Torreya 9:217-226. (This noted the geology and vegetation of the Delmarva Peninsula from Wilmington, Delaware to Cape Charles, Virginia. It listed common trees, shrubs, and herbs by county.)

1909. Williamson, C. S. 1909. Notes on the flora of central and southern Delaware. Torreya 9:160-166. (This noted the occurrence of 126 species of terrestrial and aquatic plants in Sussex Co., Delaware.)

1910-1926. Besley, F. W. 1926. The forests of Talbot County, p. 163-174. *In* Maryland Geological Survey. Talbot County. Johns Hopkins Press, Baltimore. (This documented the acreage of woodlands, including saw timber, its value, usage, destructive agencies, and management. A list of 69 native and introduced species was given with a special note on the Wye Oak at Wye Mills.)

1910. Shreve, F. 1910. List of plants collected and observed, p. 382-497. *In* F. Shreve, M. A. Chrysler, F. H. Blodgett, and F. W. Besley [eds.], The plant life of Maryland. Maryland Weather Serv. Spec. Publ. Vol. III. (This listed 1,400 species and varieties of plants and their locations in Maryland.)

pre-1911-1912. Pennell, F. W. 1912. Further notes on the flora of the Conowingo or serpentine barrens of southeastern Pennsylvania. Proc. Acad. Nat. Sci. Philadelphia 64:520-539. (This reported 28 species from a serpentine area near Centerville, New Castle Co., Delaware based on recent collections by the author and earlier collections of Albert Commons.)

1911. Snow, L. M. 1913. Progressive and retrogressive changes in the plant associations of the Delaware coast. Bot. Gaz. 55:45-55. (This was a ten-year update of Snow's original study done in 1901 on the hydrology and plant associations of Cape Henlopen to south of Rehoboth, Delaware.)

1913. McAtee, W. L. 1918. Note on the plants of Wallop's Island, Virginia. Torreya 18:70-71. (This was a fragmentary list of 56 species collected on Wallops Island, Virginia.)

1914. Otis, J. P. 1914. Notes from "The Eastern Shore." Bartonia 7:17-21. (This reported 114 species along the Nanticoke River and its tributaries in Delaware and Maryland, with comparisons to southern New Jersey.)

1914. Tidestrom, I. 1914. Notes on the flora of Maryland and Virginia,—II. Rhodora 16:201-209. (The author discussed *Populus alba, P. heterophylla, P. grandidentata, P. tremuloides,* and *P. dilatata* in Maryland.)

1915. Speck, F. G. 1915. The Nanticoke Community of Delaware. Contrib. Mus. Amer. Indian, Heye Found., New York. Vol. 11, No. 4. (A limited number of herb cures were recorded on four pages. Of particular note, "Myrtle [*Leiophyllum buxifolium*] berries are made into wine and tonic.")

1916. Besley, F. W. 1916. The forests of Maryland. Maryland Board of Forestry, Baltimore. (This reported 29 species of native forest trees on the Eastern Shore of Maryland with notes on their economic uses.)

1919. Coville, F. V. 1919. The threatened extinction of the box huckleberry, *Gaylussacia brachycera.* Science 50:30-34. (This was a report of an attempt by E. T. Wherry to relocate a station reported by "W. M. Canby" [actually A. Commons in 1875] in Sussex Co., Delaware. While exact site information was not given for this site on the Indian River, the soil and associated plants of this 20 foot [6 m] square colony were described in detail.)

1919. Harper, R. M. 1919. A forest reconnaissance of the Delaware Peninsula. J. Forest. 17:546-555. (This provided descriptions of soil types, along with forest [with 30 species], salt marsh, and open field acreages on the Delmarva Peninsula.)

1920. Small, J. K. 1929. Peninsula Delmarva. J. New York. Bot. Gard. 30:62-71. (This article described *Opuntia polardi* [*O. humifusa* (Raf.) Raf. var. *austrina* (Small) Dress] and another variety of prickly-pear on Delmarva. A comparison of the vegetation of the "twin peninsulas," southern New Jersey and Delmarva, was given with special emphasis on the dominant *Pinus* species, *P. rigida* in the former, *P. taeda* in the latter. Many of the other 78 species were noted as being on the northern limit for typically southern species or the southern limit for typically northern species.)

1923. Holloway, H. V. 1923. Common forest trees of Delaware: A pocket manual. Delaware Dept. Public Instruction, Dover, DE. (This was a handbook for teachers and school children with descriptions and uses of 44 forest tree species.)

1924. Sargent, C. S. 1924. Some remarkable buckeye trees. Horticulture 1(N.S.):208-209. (This reported large specimens of non-native *Aesculus* species and a possible hybrid of *A. neglecta* × *A. pavia* [named here *A. Dupontii*] on the property of Eleuthere Irene duPont de Nemours in New Castle Co., Delaware.)

1926. Hamilton, C. C. 1926. Maryland, p. 401-410. *In* V. E. Shelford [ed.], Naturalist's guide to the Americas. Williams and Wilkins Co., Baltimore, MD. (This gave a description of the climate and the original and present biota of Maryland, including Delmarva counties. Five natural areas on the Eastern Shore of Maryland were given special attention.)

1926. Jones, F. M. 1926. Delaware, p. 398-401. *In* V. E. Shelford [ed.], Naturalist's guide to the Americas. Williams and Wilkins Co., Baltimore, MD. (This gave a general description of original and present biota from the Piedmont and Coastal Plain areas of Delaware. Eight natural areas were given special attention.)

1927. Emery, E. C., W. Springer, A. L. Waller, and G. W. Butz. 1926. Report of Commission for the Conservation of Forests in Delaware to the Delaware General Assembly of 1927. Milford Chronicle Publ. Co., Milford. (The first part of this report, concerning general descriptions of Piedmont and Coastal Plain areas, was conspicuously plagiarized from an unattributed publication of 1926 by Frank Morton Jones. The remainder of the report gave acreages of forest lands, amount of saw lumber, value, and usages. A list of 72 forest tree species was given with special descriptions of important commercial species.)

1929. Blake, S. F. 1929. A new estuarine *Bidens* from Chesapeake Bay. Rhodora 31:87-90. (This reported on a new species from Havre de Grace and Charlestown, Maryland closely related to *Bidens bidentoides* (Nutt.) Britt., here named *B. mariana*, nov. sp.)

1930. Pennell, F. W. 1930. On some critical species of the serpentine barrens. Bartonia 12:1-23. (Species of *Cerastium*, *Thalictrum*, *Viola*, *Senecio*, and *Lactuca* were listed for New Castle Co., Delaware.)

1930-1932. Redmond, P. J. 1932. A flora of Worcester County, Maryland. Contrib. Biol. Lab. Catholic Univ. Amer. No. 11. (The first half of this publication was a key to species, while the latter half was a checklist with few specific locations.)

1932. Obrist, J. 1932. Trees of Maryland and the District of Columbia. M.S. Thesis. Catholic Univ. Amer., Washington, DC. (This thesis included previous citations of trees on the Eastern Shore, but the author's observations were mainly from the Brookland section of D.C.)

1934. Larsen, E. L. 1934. Distribution of *Lilaeopsis* in Delaware. Bartonia 16:56-58. (The stations and ecological conditions of this species were outlined.)

1934. Wherry, E. T. 1934. The box huckleberry as an illustration of the need for field work. Bull. Torrey Bot. Club 61:81-84. (More precise information of the site in Sussex Co., Delaware, reported by Coville in 1919, was presented, along with a map of the total geographic distribution.)

1935-1936. Fernald, M. L. 1936. Plants from the outer coastal plain of Virginia. Rhodora 38:376-404, 414-452. (Selected species were reported from the Eastern Shore of Virginia.)

1935. Herlihy, T. J. 1935. A partial check list of the flora of Cecil County, Maryland. M.S. Thesis. Catholic Univ. Amer., Washington. (This thesis included 47 pages of cataloged flora.)

1935. Tatnall, R. R. 1936. *Conium maculatum* in the Brandywine Valley. Bartonia 17:23. (This species was noted in New Castle Co., Delaware.)

1936-1937. **Torrey, R. H.** 1937. Collecting Cladoniae south of the Delaware Capes. Castanea 2:82-86. (Species of *Cladonia* were collected from Sussex Co., Delaware and Chincoteague Island, Virginia.)

1937. **Taber, W. S.** 1937. Delaware trees: A guide to the identification of native tree species. Delaware State Forest. Dept., Dover. Publ. 6. (Photographs and line drawings provided aids to identification to the approximately 115 species of trees native to Delaware.)

1938. **Smith, A. V. P.** 1938. The ecological relations and plant successions in four drained millponds of the Eastern Shore of Maryland. Catholic Univ. Amer., Biol. Serv. 27. (Four millponds in Wicomico Co., Maryland were dominated by either *Taxodium distichum* or *Chamaecyparis thyoides*; in the latter, a surface mat of fibrous peat was comparatively weak, while strong in the former. A tabulated list contained a total of 320 different species.)

1939. **Beaven, G. F., and H. J. Oosting.** 1939. Pocomoke Swamp: A study of a cypress swamp on the Eastern Shore of Maryland. Bull. Torrey Bot. Club 66:367-389. (The flora and ecology of this system indicated a relationship closer to that of southern swamps than northern bogs. The forest of Worcester Co., Maryland and Sussex co., Delaware, was dominated by baldcypress, swamp blackgum, and red maple with nearly pure stands of Atlantic white-cedar and baldcypress. The transition from swamp to upland had the greatest variety in species of shrubs and herbs.)

1939. **Drouet, F.** 1939. The Myxophyceae of Maryland. Field Mus. Nat. Hist., Bot. Ser. 20:3-14. (Many sites on the Eastern Shore were listed for 61 species of "blue-green algae.")

1939. **Fernald, M. L.** 1939. *Oxypolis Canbyi* (Coult. & Rose), comb. nov. Rhodora 41:139. (Fernald elevated Coulter & Rose's variety of *O. filiformis*, a "local plant of Delaware," to specific status.)

1939. **Smith, A. V.** 1939. Some noteworthy plants recently found in the coastal plain of Maryland and Delaware. Rhodora 41:111. (Seventeen species of ferns, fern-allies, grasses, sedges, rushes, and dicots were listed. Of particular note, *Micranthemum micranthemoides* [Nutt.] Wettst. was reported from "the edge of a pond near Galestown, Dorchester County, Maryland.")

1939. **Tatnall, R. R.** 1940. *Dirca palustris* in New Castle County, Delaware. Bartonia 20:24. (Ten specimens of this rare shrub were counted from the only known population in Delaware.)

1940. **Smith, A. V.** 1940. Some plants recently found in the coastal plain of Maryland. Rhodora 42:277-280. (This listed 29 species of mosses, ferns, lycopods, grasses, sedges, and dicots.)

1942. **Howe, H.** 1942. Our common trees: How to know and use them. Nat. Hist. Soc. Maryland, Baltimore, MD. (This 98-page mimeographed handbook emphasized the Western Shore of Maryland but with some reference to the Eastern Shore.)

1942. **Massey, A. B.** 1942. Medicinal plants: Native and naturalized plants of Virginia which have been officially used in the preparation of drugs. Bull. Virginia Polytechn. Inst. Vol. 35, No. 13. (Some 140 plants in Virginia have been officially used in medicines; this listed 105 native or naturalized species.)

1942. **Moldenke, H. N.** 1942. Noteworthy plant records and nomenclatural notes. Castanea 7:123-125. (This reported 14 species from Delaware and the Eastern Shore of Maryland.)

1942. Reynard, G. B., and J. B. S. Norton. 1942. Poisonous plants of Maryland in relation to livestock. Maryland Agric. Exp. Sta. Tech. Bull. A-10. (This publication emphasized taxa of Western Maryland but included the Eastern Shore.)

1942. Tantaquidgeon, G. 1942. A study of Delaware Indian medicine practices and folk beliefs. Pennsylvania Hist. Comm., Harrisburg. (Herb cures were recorded from first-person accounts. However, this, like all twentieth century attempts to determine historical uses from current testimonies, suffers from a blending of Native American and European traditions.)

1943. Massey, A. B., and R. D. Hatch. 1943. Poisonous plants: Native and naturalized plants of Virginia with special reference to livestock poisoning. Bull. Virginia Polytechn. Inst. Vol. 36, No. 8. (This 52-page pamphlet provided a discussion of 32 native and naturalized species.)

1943. Reed, C. F. 1943. County distribution of the ferns and fern-allies in Maryland, Delaware and District of Columbia. Bull. Nat. Hist. Soc. Maryland 13:47-54. (This listed 119 species.)

1943. Weslager, C. A. 1943. Delaware's forgotten folk. Univ. Pennsylvania Press, Philadelphia. (Herb cures were recorded from interviews of the Delaware "Moors," whose ancestry apparently includes the Delawares and Nanticokes.)

1944. Gale, S. 1944. *Rhynchospora*, section *Eurhynchospora*, in Canada, the United States and the West Indies. Rhodora 46:89-134. (This revision identified two of A. Commons' collections from Sussex Co., Delaware as *R. knieskernii* Carey, as well as many other collections of *Rhynchospora* from Delmarva Peninsula.)

1944. Massey, A. B. 1944. The ferns and fern allies of Virginia. Bull. Virginia Polytechn. Inst. Vol. 37, No. 7. (This 110-page pamphlet provided keys and descriptions for 110 species, accompanied by herbarium records sorted by county.)

1944. Massey, A. B., and C. R. Ball. 1944. The willows of Virginia. Bull. Virginia Polytechn. Inst. Vol. 37, No. 9. (*Salix longipes* var. *Wardii* [Bebb] Schneider [*S. caroliniana* Michx.] was listed from Accomack and Northampton Cos., Virginia.)

1945. Moldenke, H. N. 1945. A contribution to our knowledge of the wild and cultivated flora of Delaware—I. Torreya 45:106-109. (This paper comprised an annotated list of 66 collections, representing 60 species and subspecific taxa.)

1946. Norton, J. B. S., and R. G. Brown. 1946. A catalog of the vascular plants of Maryland. Castanea 11:1-51. (This listed 2,416 species and subspecific taxa growing without cultivation in Maryland.)

1946. Tatnall, R. R. 1946. Flora of Delaware and the Eastern Shore of Maryland: An annotated list of the ferns and flowering plants of the Peninsula of Delaware, Maryland and Virginia. Soc. Nat. Hist. Delaware, DE. (This classic checklist, still eminently useful today, was complied from a card file [now at DOV] of 20,000 individual entries for about 2,200 species.)

1947. Proctor, G. R. 1949. Notes on *Isoëtes* in Maryland. Amer. Fern J. 39:86-87. (Three species were listed from the gravelly eastern shore of the Susquehanna River in Cecil Co.: *I. riparia*, *I. saccharata*, and *I. Engelmanni* [*I. engelmannii*])

1947. Wherry, E. T. 1947. Notes on the vegetation of Delaware, p. 17-20. *In* H. C. Reed, ed. Delaware: A history of the first state. Lewis Hist. Publ. Co., NY. (This paper discussed four vegetation types and listed plants at the limits of their ranges.)

1949. Owens, A. 1949. A preliminary list of Maryland mosses and their distribution. M.S. Thesis. Univ. Maryland, College Park, MD. (The annotated list of this thesis listed

198 species and varieties in 70 genera and 22 families. Of particular note, two disjunct mosses were noted on the Eastern Shore: *Hypnum fertile* Sendt. in Wicomico Co. and *Ptychomitrium drumondii* Sull. in Somerset and Wicomico Cos.)

1949. **Wherry, E. T.** 1949. *Trillium pusillum* in Maryland. Bartonia 25:71. (This species was found in Worcester Co., Maryland.)

1949-1953. **Witman, H. W.** 1954. The flora of Cecil County, Maryland: A preliminary survey. M. Ed. Thesis. Pennsylvania State University, University Park. 134 p. (A collection of 984 specimens provided the basis for a listing with no site locations.)

1950. **Spangler, W. B., and J. J. Peterson.** 1950. Geology of the Atlantic Coastal Plain in New Jersey, Delaware, Maryland, and Virginia. Bull. Amer. Assoc. Petroleum Geol. 34:1-100. (This provided a broad look at the paleobotany in relation to the stratigraphy.)

1951. **Reed, C. F.** 1951. New or unusual forms of ferns from Maryland and Pennsylvania. Castanea 16:65-71. (Ten *formae* of ferns and a lycopod, 8 of them new descriptions or combinations, were listed. *Athyrium filix-femina* var. *asplenioides* f. *ellipticum* (Wherry) Reed was noted from Talbot Co., Maryland.)

1952. **Dorf, E.** 1952. Critical analysis of Cretaceous stratigraphy and paleobotany of the Atlantic Coastal Plain. Bull. Amer. Assoc. Petroleum Geol. 36:2161-2184. (This reviewed the geology and paleobotany of the Potomac Group in Delaware-Maryland-Virginia and the Raritan Formation in Delaware and Maryland.)

1952. **Reed, C. F.** 1952. The lycosphens of Maryland, Delaware and the District of Columbia. Castanea 17:128-136. (Eleven species of *Lycopodium*, two species of *Selaginella*, two species of *Isoetes*, and four species of *Equisetum* were listed, accompanied by distributional dot-maps.)

1953-1963. **Brenner, G. J.** 1967. Early angiosperm pollen differentiation in the Albian to Cenomanian deposits of Delaware (U.S.A.). Rev. Palaeobot. Palynol. 1:219-227. (A palynological investigation of numerous core samples from a well near Delaware City included horizons of the Potomac Group and Raritan Formation.)

1953. **Massey, A. B.** 1953. Orchids in Virginia. Castanea 18:107-115. (This provided an annotated list of the orchids of Virginia with occurrences in Accomac Co., Virginia.)

1953. **Reed, C. F.** 1953. The ferns and fern-allies of Maryland and Delaware including District of Columbia. Reed Herbarium, Baltimore. (An estimated 5000 records were examined to provide history, keys, descriptions, maps, and illustrations.)

1953. **Rhoads, J. E.** 1953. Delaware's natural history, p. 85-93. *In* Proceedings of the Delaware Conference on Natural Resources, February 4, 1953, Hotel Du Pont, Gold Ballroom, Wilmington, DE. (The history of natural history collections was outlined.)

1954. **Phillips, C. E.** 1954. 100 Weeds — Aids to their identification by basal leaf characteristics. Delaware Agric. Exp. Sta. Misc. Pap. 184. (While written as a general guide, this was written from experience in Delaware.)

1955. **Mahr, A. C.** 1955. Semantic analysis of eighteenth-century Delaware Indian names for medicinal plants. Ethnohistory 2:11-28. (Besides a semantic analysis, this also provided a demonstration of the principle surrounding the coining of these names.)

1955. **Reed, C. F.** 1956. New county records for *Botrychium matricariaefolium* in Maryland and Delmarva. Amer. Fern J. 46:148-151. (A collection of *B. matricariifolium* from Accomack Co., Virginia was reported.)

1956. **Drouet, F., and W. A. Dailey.** 1956. Revision of the Coccoid Myxophyceae. Butler Univ. Bot. Stud. 12:1-218. (This included two species of cyanobacteria from Delaware, two species from Maryland, and three species from Virginia.)

1956. Reed, C. F. 1956. Contributions to the flora of Maryland, 2. The genus *Trillium*. Castanea 21:145-150. (A total of eight species were listed. *Trillium pusillum* var. *virginianum* was listed for Worcester Co., Maryland and Accomack Co., Virginia, while *T. grandiflorum* was listed for Cecil Co., Maryland.)

1957. Moul, E. T. 1957. Algae of Chincoteague Bay, Maryland. Chesapeake Biol. Lab. Ref. No. 57-24. (Seventeen species were listed.)

1958. Lewis, W. H. 1958. The roses of Virginia and West Virginia. Castanea 23:77-88. (*Rosa palustris* Marsh. was listed for Accomac Co., Virginia.)

1958. Moul, E. T. 1958. Algae of Chincoteague Bay, Maryland. Chesapeake Biol. Lab. Ref. No. 58-9. (This updated the report from 1957 to 23 species.)

1958. Rasmussen, W. C. 1958. Geology and hydrology of the "bays" and basins of Delaware. Ph.D. Thesis. Bryn Mawr College, Bryn Mawr, PA. (Twenty hypotheses on the origin of bays were reviewed and a compound origin, the "water table-sinkhole-lacustrine-aeolian" theory, was proposed. The unique flora of bays was essentially ignored, but a palynological examination of a 10-foot [3-m] core from the Borthwick Basin near Blackbird, Delaware indicated that basin silt began to form in the Late Pleistocene with a pine-spruce flora, followed by a spruce-pine maximum, which gave way to a mixed oak forest of Recent times.)

1959-1962. Dill, N. H. 1962. An annotated list and study of the geographical affinities of the flora of the Rodney Scout Reservation. M.S. Thesis. Rutgers Univ., New Brunswick, NJ. (A total of 435 species, 335 of them native, were documented in Camp Rodney, on the Elk Neck Peninsula in Cecil Co., Maryland.)

1959. Rasmussen, W. C. 1959. Origin of the bays and basins of the Atlantic Coastal Plain. Geol. Soc. Amer. Bull. 70:1660. (This abstract of a paper summarized the thesis of 1958: basins are forerunners of bays and "those basins situated most favorably on the hydraulic grade line retain ponded water in a lacustrine phase, to become rounded and oriented by the wind into the form of a bay. The water is not artesian, however, but part of the shallow unconfined water body.")

1960. Groot, J. J., and J. S. Penny. 1960. Plant microfossils and age of nonmarine Cretaceous sediments of Maryland and Delaware. Micropaleontology 6:225-236. (Samples were obtained from six different sites, one near Delaware City, Delaware and one near Salisbury, Maryland. Spores and pollen from the Lower and lowermost Upper Cretaceous represented ferns and fern-allies, the Pinaceae, Cupressaceae, Taxodiaceae, Cycadales, Gingkoales, and angiosperms.)

1960. Reed, C. F. 1960. The ferns and "fern-allies" of Accomack and Northampton Counties, Virginia and adjacent Maryland. Castanea 25:109-116. (This is a listing of 28 ferns and eight fern-allies from Accomack and Northampton Counties with some additional records from southern Somerset and Worcester Cos., Maryland.)

1960. Taber, W. S. 1960. Delaware trees: A guide to the identification of the native tree species. Ed. 2. Delaware State Forestry Dept., Dover, DE. (This was essentially a reprinting of the 1937 edition.)

1961. Massey, A. B. 1961. Virginia flora. Virginia Agric. Exp. Sta. Techn. Bull. 155. (Accomack and Northampton Cos. were represented in this checklist, with appended county occurrences.)

1962-1964. Zaneveld, J. S. 1966. The benthic marine algae of Delaware: A preliminary check list. Old Dominion Univ. Sci. Ser. No. 2. (Sixty-six species were listed; the Corallinaceae were omitted because of the absence of identifications.)

1963. Dill, N. H. 1963. Plants of Bull Mt. *In* C. M. Hoff, ed. Bull Mountain Wilderness. Rodney Scout Reservation, Del-Mar-Va Council, Boy Scouts of America, Wilmington, DE. (Two unnumbered pages list and picture the predominant plants of Bull Mountain in Cecil Co., Maryland.)

1964-1967. Higgins, E. A. T. 1969. A floristic and ecological survey of Assateague Island, Maryland. M.S. Thesis. Univ. Maryland, College Park. (This catalog of the vascular plants included 441 species.)

1964. Reed, C. F. 1964. Orchidaceae of Maryland, Delaware and the District of Columbia. Castanea 29:77-109. (This checklist, with accompanying distributional dot-maps, documented 46 species and varieties of orchids.)

1965. Harrison, W., R. J. Malloy, G. A. Rusnak, and J. Terasmae. 1965. Possible Late Pleistocene uplift: Chesapeake Bay entrance. J. Geol. 73:201-229. (While offshore to Delmarva proper, this paper clarifies the paleobotanical history of the Peninsula. In examining 98 borings for the Chesapeake Bay highway crossing, plant remains were examined and C^{14} ages were determined. Pollen diagrams for sites that range from 10,340±130 to 15,280±200 years before the present included spores and pollen of mosses, ferns and fern-allies, gymnosperms, and angiosperms, listed by genus. Additionally, peat and wood fragments were recorded from 730±70 to 15,280±200 years before the present.)

1965. Harvill, A. M. 1965. The vegetation of Parramore Island, Virginia. Castanea 30:226-228. (Six different vegetation types were described from Parramore Island, about four miles southeast of Wachapreague in Accomack Co., Virginia.)

1965. Phillips, C. E. 1965. Problem grasses. Univ. Delaware, Newark. (The gross characteristics of nine species of weedy grasses in Delaware were presented in this mimeographed handout for farmers and agricultural agents.)

1965. Reed, C. F. 1965. *Isoetes* in southeastern United States. Phytologia 12:369-400. (Thirteen species and varieties were recorded in an area that included Delmarva.)

1966. Brodo, I. M. 1968. *Herpothallon sanguineum* (Sw.) Tobl. and some associated lichens from southern Delaware. Bryologist 71:120-121. (Fifteen lichens were identified from Trap Pond State Park, Sussex Co., Delaware. The identification of *Herpothalloon sanguineum* was corrected in 1994 by the author (Evansia 11(3):87) to *Pertusaria paratuberculifera* Dibben, parasitized by the granular, coral-colored parasite *Illosporium corallinum* Roberge in Desm.)

1966. Gray, T. C., and J. J. Groot. 1966. Pollen and spores from the marine Upper Cretaceous formations of Delaware and New Jersey. Palaeontographyica, Abt. B, Paläophytol. 117:115-134. (Twenty-four samples from eight localities revealed spores of ferns and fern-allies and pollen of gymnosperms and angiosperms.)

1966. Sussex Gardeners. 1966. Delaware's wildflowers. Delaware Game & Fish Commiss., Dover, DE. (Three ferns, two lycopods, 23 showy flowering plants were illustrated.)

1966. Lesser, C. A. 1966. Aquatic vegetation survey. 1966. Federal Aid in Fish Restoration Project No. F-21-R. Delaware Game and Fish Commission, Dover. (Fifty-five freshwater impoundments, each separately mapped, were surveyed for aquatic vegetation and weed problems as related to fishing.)

1966. Phillips, C. E. 1966. How to know troublesome lawn weeds. Univ. Delaware Extens. Bull. 93. (This extension bulletin of six pages included 30 species.)

1966. Wulff, B. L., E. M. T. Wulff, and H. J. Humm. 1968. Summer marine algae of the jetty at Ocean City, Maryland. Chesapeake Sci. 9:56-60. (About 25% of the 34 species collected reached their southern limit in Maryland.)

1966. Zaneveld, J. S. 1966. The marine algae of the American coast between Cape May, N.J. and Cape Hatteras, N.C. I. The Cyanophyta. Bot. Mar. 9:101-128. (A historical survey of the literature and specimens of algae accompanied keys and descriptions of 27 species of "blue-green algae.")

1967. Harvill, A. M. 1967. The vegetation of Assateague Island, Virginia. Castanea 32:105-108. (Three vegetation types were identified with a list of species.)

1967. Little, E. L., S. Little, and W. T. Doolittle. 1967. Natural hybrids among pond, loblolly, and pitch pines. USDA Forest Serv. Res. Pap. NE-67. ("In Delaware there seems to be a tendency to grade from typical pond pine in Sussex County toward pitch pine in the vicinity of Dover." Natural hybrids and intergrades between loblolly pine and pond pine were also reported from Delaware and the Eastern Shore of Maryland.)

1967. Phillips, C. E. 1967. Guide to Delaware wildflowers. Claude E. Phillips, Univ. Delaware, Newark. (This mimeographed guide of 78 pages included 700 taxa of "colorful" wildflowers.)

1967. Wildflower Identification Committee, Delaware Nature Education Center. 1967. Preliminary list of wildflowers found blooming at Indian Spring Nature Center, Brandywine Creek State Park. Delaware Nature Ed. Center, Greenville, DE. (This nine-page mimeographed list was compiled from the Committee's card file, chaired by Mrs. Henry N. Marsh.)

1968-1969. Camp, C. J. A. 1970. A guide to the study of nonflowering plants of the Delaware Nature Education Center. M.S. Thesis. Cornell Univ., Ithaca, NY. (This report listed the mosses, lichens, fungi, ferns, and club mosses of Brandywine Creek State Park, New Castle Co., Delaware.)

1968. Clovis, J. F. 1968. The vegetation of Smith Island, Virginia. Castanea 33:115-121. (Six vegetation types, with a list of species, were identified on this island in Northampton Co., Virginia.)

1968. Vokes, H. E. 1968. Flora of Maryland. Maryland Geol. Surv. Bull. 19:161-173. (This publication emphasized predominant forest trees in Maryland.)

1969. Dorf, E. 1969. Angiosperm pollen evolution and biostratigraphy of the basal Cretaceous formations of Maryland, Delaware, and New Jersey. Geol. Soc. Amer., Abstracts 7:51. (This abstract clarified the zones of the Upper Cretaceous.)

1969. Smith, H., and D. Smith. 1969. Box huckleberry—A much neglected native. Amer. Hort. Mag. 48:70-75. (A colony near Bethel, Delaware was described; plants were transplanted to Longwood Gardens, Kennett Square, Pennsylvania.)

1969. Wass, M. L., and T. D. Wright. 1969. Coastal wetlands of Virginia: Interim report of the Governor and General Assembly. Virginia Inst. Marine Sci. Spec. Rep. Appl. Marine Sci. Ocean Engineer. No. 10. (The floristic notes and report of rare or unusual plants listed *Carex kobomugi* Ohwi, a sedge introduced from the Orient, on Cedar Island, Accomack Co., Virginia.)

1969. Wildflower Committee, Delaware Nature Education Center. 1969. Wildflowers of Brandywine Creek State Park, Delaware Nature Ed. Center, Greenville, DE. (This updated and expanded the report of 1967 to 18 pages under the direction of Charles Mohr.)

1970. **Baker, R. L., and J. F. Kundt.** 1970. Leaf key to common trees in Maryland. Maryland Coop. Extens. Serv. Extens. Bull. 238. (Line drawings were presented of 127 species of native and introduced tree species in Maryland.)

1970. **Harvill, A. M.** 1970. Spring flora of Virginia. A. M. Harvill, Farmville, VA. (This flora included very few references to the Eastern Shore of Virginia beyond "coastal plain.")

c. 1970. **Moul, E. T.** c. 1970. Flora of Cape Henlopen and environs, Sussex Co., Del. E. T. Moul. (This privately distributed flora listed 65 families and 224 species.)

1970. **Phillips, C. E.** 1970. Weeds of the Northeast: Aids to their identification by basal-leaf characteristics. Univ. Delaware Agric. Exp. Sta. Field Man. 1. (While written as a general guide, this was written from experience in Delaware. It included 340 weeds as update of the author's guide to 100 weeds published in 1954.)

1970. **Reifsnyder, C. H.** 1970. The serpentine barrens of Pennsylvania and Maryland: Their preservation through knowledge and planning. M. Reg. Plan. Univ. Pennsylvania. (Brief mention was made of the serpentine barrens in Cecil Co., Maryland and New Castle Co., Delaware, but the primary emphasis was on Delaware and Chester Cos., Pennsylvania and Harford and Baltimore Cos., Maryland.)

1970. **Smith, H., and D. Smith.** 1970. *Gaylussacia brachycera.* Horticulture 48(11):26-27. (This summarized the publication by Smith and Smith in 1969.)

Acknowledgments

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Annotated Checklist of the Vascular Plants of Sagamore Hill National Historic Site, New York

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Sagamore Hill National Historic site is located in Oyster Bay, Nassau County, New York (40°45′ N Latitude, 73°30′ W Longitude). The property, comprising 34 hectares, was part of a larger property of 63 hectares purchased by Theodore Roosevelt in 1883 for the sum of $30,000. Sagamore Hill, Theodore Roosevelt's home, was constructed during 1884 and 1885 and remained his permanent home until his death at the age of 60 in 1919 (Bellavia and Currey 1995). His wife Edith Roosevelt resided there until 1948 when she passed away at the age of 87. In 1950, Sagamore Hill was purchased by the Theodore Roosevelt Association; in 1963, the association presented Sagamore Hill to the American people as a gift. The National Park Service acquired the property on July 15, 1963 and opened Sagamore Hill to the public in 1966.

The original 63 hectares included woodland, farmland, orchards, fields, and gardens. The woodland at the time of purchase over 100 years ago contained oaks (*Quercus* spp.), chestnut (*Castanea dentata*), hickory (*Carya* spp.), beech (*Fagus grandifolia*), tuliptree (*Liriodendron tulipifera*), American basswood (*Tilia americana*), and black locust *(Robinia pseudoacacia*) (Bellavia and Currey 1995). The present woodland is 20.2 hectares. The remaining communities include a salt marsh and brackish marsh of 1.8 ha, a poorly developed dune community of 1.3 ha, a mowed field of 1.4 ha adjacent to the visitor center parking lot, and disturbed communities around buildings, lawns, old fields, a dump site and gardens (9.3 ha). A small pond, the "hogspen" pond, and a small kettle pond (less than 0.1 ha) are additional sites as well as the saltwater bay that borders a portion of the property.

Climatological data for Sagamore Hill National Historic Site are similar to those at nearby Roslyn, New York. The climate is broadly representative of the humid continental type (Anonymous 1974), though winters are modified by Long Island Sound. Mean January temperature at Roslyn is 0.9° C; July is the warmest month with a mean temperature of 22.6° C (Anonymous 1941). Average annual rainfall is 1,155 mm, and is evenly distributed. August is the wettest month with 126 mm of rain. October is the driest month averaging 86 mm. The growing season at Roslyn averages 189 days. The last killing frost occurs about April 22; the first frost in autumn occurs about October 28.

Glaciation played an important role in shaping the topography of the area. Soils on the north shore of Long Island are classified as Montauk silt-loam, 3-8% slope. "The soils are very deep, gently sloping, well drained," and acidic in reaction (Wulfhorst 1987).

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Table 1. Summary of the vascular flora of Sagamore Hill National Historic Site, New York.

	Ferns	Conifers	Dicots	Monocots	Total
Familes	4	3	59	9	75
Genera	4	3	138	36	181
Species	6	3	182	41	232
Introduced species	0	2	76	15	93
Native species	6	1	106	26	139

Methods

The objective of the present study was to collect and identify vascular plants at Sagamore Hill National Historic Site. The vegetation at was sampled in October, 1995, and monthly from April 1996 to October 1996. Herbarium voucher specimens of each taxon were prepared and are deposited at Sagamore Hill National Historic Site. Nomenclature follows Gleason and Cronquist (1991); exotic trees were identified according to Bailey (1949). In the checklist plants are arranged first by division, then alphabetically by family and genus and species. Each entry contains the scientific name, plant community, and relative abundance within the Sagamore Hill site. The term *rare* means 4 or fewer occurrences or stands known for a specific community, *infrequent* means 5-15 occurrences or stands known, and *frequent* means more than 15 occurrences or stands known. Introduced plants as defined by Gleason and Cronquist (1991) are designated by an asterisk (*).

Results and Discussion

The vascular flora of Sagamore Hill National Historic Site as recorded by this survey consists of 232 species in 181 genera and 75 families. The Asteraceae, with 33 species and 25 genera, and the Poaceae, with 23 species and 20 genera, are the largest families in the flora; together they comprise 24% of the flora. Other well represented families are the Rosaceae (16 species) and the Chenopodiaceae (9 species). The most well represented genus is *Quercus* (6 species); no other genera are represented by more than 4 species. Ninety-three species, 40% of the flora are non-native (Table 1). Forty-two percent of the dicots and 37% of the monocots are non-native species. All the Caryophyllaceae (4 species) and Fabaceae (7 species) are non-native.

The herbaceous flora noted by Roosevelt in the late 1800s is somewhat different from the herbaceous flora of today. Bellavia and Currey (1995) provide some insight on the flowering plants observed by Roosevelt at Sagamore Hill.

"Early in April there is one hillside near us which glows like a tender flame with the white of the bloodroot. About the same time we find the shy mayflower, the trailing arbutus. Then there are shadblow and delicate anemones, about the time of the cherry blossoms;... and then the thronging dogwoods fill the forest with their radiance; and so flowers follow flowers until the springtime splendor closes with the laurels and the evanescent, honeysweet locust bloom. The late summer flowers follow, the flaunting lilies, and cardinal flowers, and marshmallows, and pale beach rosemary; and the goldenrod and the asters when the afternoons shorten and we again begin to think of fires in the wide fireplaces." —Theodore Roosevelt

The greatest diversity of species occurs in the various disturbed habitats such as roadsides, lawns, gardens and fields; these habitats contain the greatest number of introduced species. The salt marsh and dune communities contain the fewest species overall and the smallest number of non-native species.

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Flora

POLYPODIOPHYTA

Aspleniaceae

Polystichum acrostichoides (Michx.) Schott. woods; rare

Thelypteris palustris Schott. moist depressions; infrequent

Dennstaedtiaceae

Pteridium aquilinum (L.) Kuhn. dry woods; infrequent

Onocleaceae

Onoclea sensibilis L. moist woods; infrequent

Osmundaceae

Osmunda cinnamomea L. moist woods; infrequent

Osmunda regalis L. var. *spectabilis* (Willd.) A. Gray. moist woods; rare

PINOPHYTA

Cupressaceae

Juniperus virginiana L. old fields; infrequent

Pinaceae

* *Pinus strobus* L. reproducing from planted trees; rare

Taxaceae

* *Taxus cuspidata* Sieb. and Zucc. woods; infrequent

MAGNOLIOPHYTA--MAGNOLIOPSIDA

Aceraceae

Acer rubrum L. moist woods; frequent

* *Acer campestre* L. escaped and spontaneously reproducing in woods; infrequent

*Introduced

* *Acer saccharinum* L. reproducing from planted trees; infrequent
* *Acer saccharum* Marshall. reproducing from planted trees planted as a hedge row; rare

Amaranthaceae

* *Amaranthus hybridus* L. roadsides, gardens, and disturbed sites; infrequent
* *Amaranthus viridis* L. disturbed sites; rare

Anacardiaceae

Rhus copallina L. old fields; infrequent
Rhus typhina L. fields; infrequent
Toxicodendron radicans (L.) Kuntze [*Rhus radicans* L.]. woods and old fields; frequent

Apiaceae

Sanicula canadensis L. forest; infrequent
* *Daucus carota* L. old fields; frequent

Apocynaceae

* *Vinca major* L. escaped from cultivation along roads; infrequent

Aquifoliaceae

Ilex opaca Aiton. open woods, one individual; rare

Araliaceae

Aralia nudicaulis L. woods; frequent
Aralia elata (Miq.) Seem. forest; infrequent
* *Hedera helix* L. escape from cultivation; infrequent

Asclepiadaceae

Asclepias syriaca L. disturbed sites; rare
Asclepias tuberosa L. fields; rare

Asteraceae

* *Achillea millefolium* L. roadsides and old fields; infrequent
Ambrosia artemisiifolia L. disturbed sites; frequent
Antennaria plantaginifolia (L.) Richardson. lawns and fields; infrequent
* *Arctium minus* Schk. "dump"; rare
* *Artemisia stellariana* Besser. dunes; infrequent
* *Artemisia vulgaris* L. disturbed sites; frequent
Aster divaricatus L. woods; frequent
Baccharis halimifolia L. upper border of tidal marsh and disturbed sites; frequent
Bidens bipinnata L. disturbed sites; infrequent
* *Chrysanthemum leucanthemum* L. fields; frequent
* *Cichorium intybus* L. fields; rare
Conyza canadensis L. disturbed sites; frequent
Erechtites hieracifolia (L.) Raf. disturbed sites; frequent
Erigeron philadelphicus (L.) disturbed sites; rare
Erigeron strigosus Muhl. fields and disturbed sites; frequent
Euthamia graminifolia (L.) Nutt [*Solidago graminifolia* (L.) Salisbury]. fields; rare
* *Galinsoga quadriradiata* Ruiz and Pavon [*Galinsoga ciliata* (Raf.) Blake]. gardens and disturbed sites; infrequent
Helianthus annuus L. fields; rare
* *Hieracium caespitosum* Dumort [*Hieracium pratense* Tausch]. lawns and fields; frequent
* *Hieracium floribundum* Wimmer and Grab. lawns and fields; frequent
* *Hieracium lachnenalii* C. Gmelin. [*Hieracium vulgatus* Fries]. lawns; infrequent
* *Hypochoeris radicata* L. lawns and fields; frequent
Iva frutescens L. upper borders of salt marsh; frequent
Lactuca canadensis L. disturbed sites and borders of roadsides; frequent
* *Lapsana communis* L. disturbed sites and border of roadsides; frequent
Rudbeckia hirta L. old fields; infrequent
* *Senecio vulgaris* L. gardens and disturbed sites; frequent
Solidago caesia L. woods; frequent
Solidago canadensis L. old fields; infrequent
Solidago juncea Aiton. fields; infrequent
Solidago rugosa Miller. fields and woods borders; frequent
Solidago sempervirens L. salt marsh; frequent
* *Taraxacum officinale* Weber. lawns; frequent

*Introduced

Balsaminaceae

Impatiens capensis Meerb. [*Impatiens biflora* Walter]. moist woods; frequent

Berberidaceae

* *Berberis thunbergii* DC. woods; infrequent

Bignoniaceae

* *Catalpa speciosa* Ward. old fields; infrequent

Betulaceae

Betula lenta L. woods; infrequent

Betula populifolia Marshall. old fields; infrequent

Brassicaceae

* *Alliaria petiolata* (Bieb.) Cavara and Grande. moist woods; frequent

* *Arabidopsis thaliana* (L.) Heynh. disturbed sites and gardens; infrequent

Arabis lyrata L. disturbed sites and gardens; infrequent

Cakile edentula (Bigelow) Hook. dunes; frequent

* *Capsella bursa-pastoris* (L.) Medikus. disturbed sites; rare

Lepidium virginicum L. roadsides and disturbed sites; frequent

* *Lunaria annua* L. woods; rare

Buxaceae

* *Pachysandra procumbens* Michx. woods; rare

Campanulaceae

Triodanus perfoliata (L.) Nieuwl. garden at maintenance shop; rare

Caprifoliaceae

* *Lonicera japonica* Thunb. woods and disturbed sites; infrequent

* *Lonicera tatarica* L. woods; infrequent

Sambucus canadensis L. woods; rare

Viburnum acerifolium L. woods; frequent

Viburnum opulus L. var. *americanum* Ait. woods; infrequent

Caryophyllaceae

* *Dianthus armeria* L. fields and gardens; infrequent

* *Silene latifolia* Poiret [*Lychnis alba* Mill.]. fields and disturbed sites; frequent

* *Stellaria graminea* L. lawns; infrequent

* *Stellaria media* (L.) Villars. lawns and gardens; frequent

Celastraceae

* *Celastrus orbiculatus* Thunb. woods and old fields; frequent

* *Euonymus alatus* (Thunb.) Siebold. woods; infrequent

Chenopodiaceae

Atriplex arenaria Nutt. [*Atriplex pentandra* (Jacq.) Standl.]. dunes; infrequent

Atriplex hastata L. [*Atriplex patula* L. var. *hastata* (L.) A. Gray]. dunes and upper borders of salt marsh; infrequent

* *Bassia hirusta* (L.) Aschers. salt marsh; infrequent

* *Chenopodium album* L. disturbed sites and gardens; frequent

Salicornia bigelovii Torr. salt marsh; infrequent

Salicornia europea L. salt marsh; infrequent

Salicornia virginica L. salt marsh; infrequent

* *Salsola kali* L. dunes; frequent

Suaeda lineraris (Elliott) Moq. salt marsh; infrequent

Cistaceae

Hudsonia tomentosa Nutt. dunes; infrequent

Lechea maritima Leggett. dunes; infrequent

Cornaceae

Cornus florida L. woods; frequent

Ericaceae

Kalmia latifolia L. woods; frequent

Euphorbiaceae

Acalypha rhomboidea Raf. disturbed sites; rare

* *Euphorbia cyparissias* L. old field; rare

Euphorbia maculata L. [*E. supina* Raf.; *Chamaesyce maculata* (L.) Small.]. disturbed sites; frequent

Euphorbia polygonifolia L. [*Chamaesyce polygonifolia* (L.) Small.]. dunes; frequent

Fabaceae

* *Medicago lupulina* L. fields and lawns; frequent

* *Robinia pseudoacacia* L. woods; infrequent

* *Trifolium hybridum* L. fields; frequent

* *Trifolium arvense* L. fields; frequent

* *Trifolium repens* L. lawns; frequent

* *Vicia sativa* L. old fields; infrequent

* *Wisteria sinensis* (Sims) Sweet. woods; rare

*Introduced

Fagaceae
Castanea dentata (Marshall) Borkh. woods; rare
Fagus grandifolia Ehrh. woods; infrequent
Quercus alba L.woods; infrequent
Quercus bicolor Willd. woods; rare
Quercus coccinea Muenchh. dry woods; infrequent
Quercus prinus L. dry woods bordering salt marsh; infrequent
Quercus rubra L. woods; frequent
Quercus velutina Lam. woods; frequent

Geraniaceae
Geranium maculatum L. rich woods; infrequent

Juglandaceae
Carya glabra (Mill.) Sweet. woods; rare
Carya tomentosa (Poiret) Nutt. woods; infrequent
Juglans nigra L. woods; infrequent

Hammamelidaceae
Liquidambar styraciflua L. woods; rare

Lamiaceae
Agastache scrophulariaefolia (Willd) Kuntze. disturbed sites; rare
* *Lamium amplexicaule* L. lawns and disturbed sites; frequent
* *Lamium purpureum* L. disturbed sites; infrequent
Mentha arvensis L. disturbed soil near maintenance garden; rare
Teucrium canadense L. fringe of salt marsh; infrequent

Lauraceae
Lindera benzoin (L.) Blume. moist woods; frequent
Sassafras albidum (Nutt.) Nees. forest edge; infrequent

Lythraceae
* *Lythrum salicaria* L. moist disturbed sites; infrequent

Magnoliaceae
Liriodendron tulipifera L. woods; infrequent
* *Magnolia macrophylla* Michx. woods; rare

Molluginaceae
* *Mollugo verticillata* L. gardens and disturbed sites; infrequent

Monotropaceae
Monotropa uniflora L. path in woods near

Moraceae
* *Morus alba* L. woods; infrequent

Myricaceae
Myrica pensylvanica Mirbel. old fields and old dunes; frequent

Oleaceae
* *Ligustrum vulgare* L. escape from cultivation, old fields; infrequent

Onagraceae
Epilobium coloratum Biehler. disturbed sites; infrequent
Oenothera biennis L. disturbed sites and old dunes; infrequent

Oxalidaceae
Oxalis stricta L. disturbed sites; frequent

Phytolacceae
Phytolacca americana L. roadsides, old fields, and disturbed sites; frequent

Plantaginaceae
* *Plantago lanceolata* L. roadsides, lawns, and disturbed sites; frequent
Plantago rugelii Decne. roadsides, lawns, and disturbed sites; frequent

Plumbaginaceae
Limonium carolinianum (Walter) Britton [L. *nashii* Small]. salt marsh; frequent

Polygonaceae
Polygonella articulata (L.) Meissner. dunes; infrequent
Polygonum aviculare L. disturbed sites and paths; infrequent
* *Rumex acetosella* L. fields, lawns, and disturbed sites; frequent
* *Rumex crispus* L. roadsides and waste places; infrequent
Polygonum virginianum L. [*Tovara virginiana* (L.) Raf.]. woods; infrequent

Portulacaceae
* *Portulaca oleracea* L. disturbed sites and gardens; frequent

Pyrolaceae
Chimaphila maculata (L.) Pursh. woods; frequent
Pyrola rotundifolia L. woods; infrequent

Ranunculaceae
Ranunculus scleratus L. fields; frequent

Rosaceae
Amelanchier canadensis (L.) Medic. woods and woods borders; rare

*Introduced

Crataegus uniflora Muenchh. disturbed sites; infrequent
* *Duchesnea indica* (Andrews) Focke. gardens and lawns; infrequent
Fragaria virginiana Duchesne. fields; infrequent
Geum canadense Jacq. woods; rare
* *Potentilla argentea* L. disturbed sites; infrequent
Potentilla canadensis L. disturbed sites, gardens, and lawns; frequent
* *Potentilla recta* L. fields; infrequent
* *Prunus avium* L. woods; infrequent
Prunus serotina Ehrh. successional fields and woods borders; frequent
* *Pyrus communis* L. escape from cultivation; rare
* *Rosa multiflora* Thunb. escape from cultivation; infrequent
Rubus allegheniensis T.C. Porter. old fields and woods borders; frequent
Rubus flagellaris Willd. fields and woods borders; infrequent
Rubus occidentalis L. old fields and woods borders; infrequent
* *Rubus phoenicolasius* Maxim. woods; infrequent

Rubiaceae

Galium aparine L. woods; infrequent
* *Galium mollugo* L. parking lot border; rare

Salicaceae

Salix discolor Muhl. kettle pond; rare

Scrophulariaceae

Linaria canadensis (L.) Dum. Cours. disturbed sites; frequent
* *Linaria vulgaris* Mill. fields; infrequent
* *Verbascum blattaria* L. disturbed sites; infrequent
* *Verbascum thapsus* L. roadsides and disturbed sites; infrequent
* *Veronica arvensis* L. lawns and fields; frequent
* *Veronica persica* Poir. lawns; frequent

Simaroubaceae

* *Ailanthus altissima* (Miller) Swingle. disturbed sites; infrequent

Solanaceae

Solanum carolinense L. fields and gardens; infrequent
Solanum nigrum L. var. *virginicum* L. [S. *americanum* Miller.]. margins of woods; rare
* *Solanum dulcamara* L. disturbed sites; infrequent

Tiliaceae

Tilia americana L. woods; one tree; rare

Ulmaceae

Celtis occidentalis L. gardens and woods; rare

Urticaceae

Pilea pumila (L.) A. Gray. kettle pond; rare

Verbenaceae

Phryma leptostachya L. woods; frequent
Verbena sp. old fields; infrequent

Violaceae

Viola sororia Willd. lawns, old fields, and woods; frequent

Vitaceae

* *Ampelopsis brevipedunculata* (Maxim.) Trautv. woods edges; infrequent
Parthenocissus quinquefolia (L.) Planchon. dunes, fields, and woods; frequent
Vitis aestivalis Michx. woods; infrequent

LILIOPSIDA

Cyperaceae

Carex pensylvanica Lam. dry woods; infrequent
Cyperus grayii Torr. dunes; rare
Cyperus strigosus L. gardens; rare
Scirpus pungens Vahl. [S. *americanus auct.. non* Pers.]. brackish marsh; infrequent
Scirpus robustus Pursh. one population at edge of salt marsh; rare

Iridaceae

Sisyrinchium atlanticum E. Bickn. lawn at east side maintenance houses; rare

Juncaceae

Juncus tenuis Willd. roadsides and paths; frequent

Lemnaceae

Lemna minor L. hogpen pond; frequent

Liliaceae

* *Allium vineale* L. lawns and fields; frequent
* *Asparagus officinalis* L. disturbed sites; rare
* *Convallaria majalis* L. escape from cultivation in woods; infrequent

*Introduced

* *Hemerocallis fulva* (L.) L. roadsides and woods; infrequent
Maianthemum canadense Desf. woods; frequent

Polygonatum biflorum (Walter) Elliott. woods; frequent
Smilacina racemosa (L.) Desf. woods; frequent

Poaceae

Ammophila breviligulata Fern. dunes; frequent
* *Anthoxanthum odoratum* L. fields; infrequent
* *Chloris petraea* Swartz. [*Eustachys petraea* (Sw.) Desv.] gardens and disturbed sites; infrequent
* *Cynodon dactylon* (L.) Pers. roadsides and disturbed sites; frequent
* *Dactylis glomerata* L. roadsides; infrequent
* *Digitaria sanguinalis* (L.) Scop. roadsides, lawns, and disturbed sites; frequent
Distichlis spicata (L.) Greene. salt marsh; frequent
* *Eleucine indica* (L.) Gaertn. gardens and roadsides: infrequent
Elymus virginicus L. var. *halophilus* (Bickn.) Wieg. borders of salt marsh; frequent
Festuca rubra L. fields; infrequent
* *Lolium perenne* L. fields and gardens; infrequent
* *Microstegium vimineum* (Trin.) A. Camus [*Eulalia viminea* (Trin.) Kuntze]. moist woods; rare
Panicum amarum Elliott. dunes; frequent
* *Panicum miliaceum* L. disturbed sites; rare
Panicum virgatum L. disturbed soil near salt marsh
Phragmites australis (Cav.) Trin. [*Phragmites communis* Trin.]. fresh and brackish marsh; infrequent
* *Poa annua* L. lawns; frequent
Schizachyrium scoparium (Michx.) Nash. [*Andropogon scoparius* Michx.]. fields; rare
* *Setaria glauca* (L.) P. Beauv. disturbed sites; frequent
Spartina alterniflora Loisel. salt marsh; frequent
Spartina patens (Aiton.) Muhl. salt marsh; frequent
Tridens flavus (L.) A. Hitchc. [*Triodia flava* (L.) Smyth]. roadsides and fields; frequent
Triplasis purpurea (Walter) Chapman. dunes; infrequent

Ruppiaceae

Ruppia maritima L. shallow bay; infrequent

Smilacaceae

Smilax rotundifolia L. woods; frequent

Zosteraceae

Zostera marina L. shallow bay; frequent

*Introduced

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Vascular Flora of Sandy Hook, New Jersey

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Sandy Hook is a 10-km-long peninsula located in northeastern Monmouth County, New Jersey (40°28′ N, 74°00′ W). The peninsula, which forms the northern terminus of New Jersey's Atlantic Ocean barrier islands, is a recurved spit varying in width from about 100 m at the south end to about 1,500 m near the north end; it formed from the northerly transport of sand from eroded beaches south of the spit (Nordstrom et al. 1975). Total land area of Sandy Hook is approximately 674 ha, of which 599 ha are part of Gateway National Recreation Area (New York and New Jersey) administered by the National Park Service of the U.S. Department of the Interior, and the remaining 75 ha are under the auspices of the U.S. Coast Guard.

One of the earliest floristic inventories of Sandy Hook was conducted by Nathaniel Lord Britton during the preparation of his *Preliminary Catalogue of the Flora of New Jersey* (Britton 1881); thirty of Britton's voucher specimens from The Hook remain at the Chrysler Herbarium (CHRB), Rutgers University. Chrysler (1930) conducted an ecological survey of Sandy Hook's vegetation during the 1920s and included a list of 143 species of vascular plants. Mekenian (1968) conducted a second ecological study of Sandy Hook and reported 167 vascular plant species. Stalter (1979) described 17 different plant associations at Sandy Hook and reported 314 vascular plant species, including his own collections from 1978 and 1979 as well as taxa reported by Britton (1881), Chrysler (1930) and Mekenian (1968). Stalter and Greller (1988) described the plant communities of the Gateway National Recreation Area and added several species to Stalter's 1979 list from Sandy Hook, but an updated checklist of species was never published. Venezia and Cook (1991) prepared an unpublished floristic inventory of Gateway National Recreation Area based upon earlier publications and unvouchered "sight records". Finally, Stalter et al. (1996) commented on the rare plants occurring at Sandy Hook and elsewhere at the Gateway National Recreation Area.

METHODS

Collecting trips were made to Sandy Hook approximately once a month during the growing seasons from March 1991 through October 1994, with additional trips from the spring of 1995 until November 1997. Objectives for each trip included the collection of

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voucher specimens and accumulation of information on abundance and apparent habitat preference of each species.

More than 1,000 specimens form the basis for this study. Taxonomically problematic specimens were sent to various experts for annotation; experts consulted include Steven Clemants (Amaranthaceae, Chenopodiaceae, Juncaceae), Robert Meyer (Poaceae), Richard Mitchell (Polygonaceae), Richard Rabeler (Caryophylaceae), and Gordon Tucker (Cyperaceae). A complete set of voucher specimens has been deposited at the Sandy Hook Herbarium, Gateway National Recreation Area, New Jersey, and partial duplicate sets have been deposited in the herbaria of Brooklyn Botanic Garden (BKL), University of Michigan (MICH), New York State Museum (NYS) and Academy of Natural Sciences of Philadelphia (PH). Accession numbers will be assigned by the National Park Service to the primary set of specimens at the Sandy Hook Herbarium.

The checklist contains an inventory of the vascular plants at Sandy Hook that reproduce spontaneously and persist for more than one year without cultivation, including native taxa, naturalized and adventive weeds, and escapes from cultivation. Plants are arranged in the checklist by division and then alphabetically by family, genus and species. Several species not collected by the authors but reported by Britton (1881), Chrysler (1930) and Mekenian (1968) are also noted in the checklist, accompanied by a literature citation. A few species recently reported by Patrick Cooney from field trips to the site with the Torrey Botanical Society and the Long Island Botanical Society are noted in the checklist with the annotation "unvouchered report by Cooney." Indication of species rarity across all of New Jersey is based upon the New Jersey Natural Heritage Program list of rare plant species (Snyder 1997).

Nomenclature follows Kartesz (1994), and when nomenclature differs from Gleason and Cronquist (1991) synonyms have been provided in brackets. Anachronistic names formerly used by Britton (1881) and Chrysler (1930) are also provided in brackets. Non-native plants as defined by Gleason and Cronquist (1991) are designated by an asterisk (*).

Results and Discussion

The vascular flora of Sandy Hook consists of 482 species within 275 genera and 93 families. Two hundred thirteen species, or 44% of the flora, are not native to the region (summary provided in Table 1).

Thirteen species are on the New Jersey list of rare and endangered plant species (Snyder 1997). The rarest plant observed was *Polygonum glaucum*, which occurred at two locations during the summer of 1994, but this annual species was not observed during 1996 and 1997. Other rare species documented by us include *Artemisia campestris* subsp. *caudata*, *Chenopodium leptophyllum*, *Eupatorium hyssopifolium* var. *laciniatum*, *Honckenya peploides* subsp. *robusta*, *Oenothera oaksiana*, *Panicum oligosanthes* and *Solidago elliottii*. *Aster ericoides*, *Galium palustre*, *Plantago maritima* var. *juncoides* and *Rhododendron canadense* were reported by Dr. Cooney from field trips to The Hook with the Torrey Botanical Society and the Long Island Botanical Society; attempts by us to relocate these rare species were unsuccessful. Chrysler (1930) reported *Trichostema setaceum* from The Hook, but no voucher for this report is at the Chrysler Herbarium at Rutgers University. *Cyperus difformis* (determination verified by Gordon Tucker [NYS]) is a state record for New Jersey.

The major families in the flora are the Asteraceae (77 species) and Poaceae (71 spp.); 31% of the species comprising the total flora are contained in these two families. Other large

Table 1. A summary of the vascular flora of Sandy Hook, New Jersey.

	Lycopods	Ferns	Conifers	Dicots	Monocots	Total
Families	1	4	2	73	13	93
Genera	1	4	2	209	59	275
Species	1	4	6	361	110	482
Native species	1	4	3	193	68	269
Introduced species	0	0	3	168	42	213

families are the Fabaceae (23 spp.), Rosaceae (23 spp.), Polygonaceae (18 spp.) and Chenopodiaceae (14 spp.). The largest genus is *Polygonum* (12 spp.), followed by *Aster* (10 spp.) and *Solidago* (8 spp.).

Non-native species are numerous in the flora (see Table 1) and occur principally at ruderal sites, in lawns and along the edges of trails and roads. The occurrence of 33 species of non-native grasses (comprising 15% of the total number of non-native species) is especially noteworthy in the flora. The introduction of exotic species probably will continue as humans introduce seeds of non-native plants to Sandy Hook and create new open habitats of disturbance.

For the sake of simplicity, the vegetation of Sandy Hook can be categorized into four naturally occurring plant communities: 1) Maritime beach and dune community, dominated by *Ammophila breviligulata*, *Solidago sempervirens*, *Cakile edentula*, *Xanthium strumarium* var. *canadense*, *Euphorbia polygonifolia*, *Lathyrus japonicus* var. *maritimus* and *Salsola kali*. *Carex kobomugi* is well established on a foredune at the U.S. Coast Guard property and also occurs on the crest and leeward side of the secondary dune system at two other locations. 2) Maritime shrub community, dominated by *Prunus serotina*, *P. maritima*, *Ilex opaca*, *Juniperus virginiana*, *Amelanchier canadensis*, *Toxicodendron radicans*, *Myrica pensylvanica*, *Baccharis halimifolia*, *Smilax* spp., *Vitis* spp. and *Parthenocissus quinquefolia*. This community is extremely variable in composition. 3) Maritime holly forest community, dominated by *Ilex opaca*, especially at the Bayside Holly Forest located just west of the Sandy Hook visitor's center. All stages of the life history of *I. opaca* (seedlings to mature 100+ year old trees) are well represented at this site (see Stalter 1979). Associated species in the forest include *Prunus serotina*, *Amelanchier canadensis* and *Celtis occidentalis*. 4) Salt marsh community, dominated by *Spartina alterniflora*, *S. patens*, *Distichlis spicata*, *Juncus gerardii*, *Salicornia* spp., *Suaeda linearis*, *Limonium carolinianum* and *Iva frutescens* subsp. *oraria*. Ephemeral freshwater wetlands, successional fields, roadsides and ruderal sites support less extensive, though different and ever-changing plant communities.

This floristic study has been based upon more than 20 years of observations and collections. During those decades human disturbances and natural forces have modified the environment resulting in a concomitant change in the flora. We have observed that the plant life of Sandy Hook is dynamic; populations come and go and they increase and decrease in size from year to year. Natural forces such as hurricanes and northeasters, droughts and flooding, and insect infestations have significantly altered the physical structure of some plant communities resulting in opportunities for plants to colonize new sites, and conversely, resulting in the loss of habitat for other species. For example, the rare *Polygonum glaucum* was first observed at The Hook during the summer of 1994, two seasons following the devastating northeaster of December 1992 which brought a record high tide and storm surge to Sandy Hook. Conversely, during the past twenty years large open

natural areas have succeeded into shrubland resulting in the loss of several herbaceous species.

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[Flora follows]

FLORA

EQUISETOPHYTA

Equisetaceae

Equisetum arvense L.

POLYPODIOPHYTA

Aspleniaceae

Asplenium platyneuron (L.) BSP.

Dryopteridaceae

Onoclea sensibilis L.

Osmundaceae

Osmunda cinnamomea L.

Thelypteridaceae

Thelypteris palustris Schott

PINOPHYTA

Cupressaceae

Juniperus virginiana L.

Pinaceae

* *Pinus nigra* Arnott

Pinus rigida Miller

* *Pinus sylvestris* L.

* *Pinus thunbergiana* Franco

Pinus virginiana Miller

MAGNOLIOPHYTA–MAGNOLIOPSIDA

Aceraceae

* *Acer pseudo-platanus* L.

* *Acer platanoides* L.

Acer rubrum L.

* *Acer saccharinum* L.

Amaranthaceae

* *Amaranthus retroflexus* L. Collected by N. L. Britton in 1885; not recently observed.

* *Froelichia gracilis* (Hook.) Moq. Unvouchered report by Cooney.

Anacardiaceae

Rhus aromatica Ait.

Rhus copallinum L.

Rhus glabra L.

Rhus hirta (L.) Sudworth [= *Rhus typhina* L.]

Toxicodendron radicans (L.) Kuntze

Apiaceae

* *Aegopodium podagraria* L.

* *Anethum graveolins* L.

* *Daucus carota* L.

* *Pastinaca sativa* L.

Ptilimnium capillaceum (Michx.) Raf. Reported by Chrysler (1930); not recently observed.

Apocynaceae

Apocynum cannabinum L.

* *Vinca major* L.

Aquifoliaceae

Ilex glabra (L.) A. Gray

Ilex opaca Aiton

Ilex verticillata (L.) A. Gray. Reported by Chrysler (1930); not recently observed.

Araliaceae

Aralia nudicaulis L.

Asclepiadaceae

Asclepias incarnata L. var. *pulchra* (Ehrh.) Pers.

Asclepias syriaca L.

Asclepias tuberosa L.

Asteraceae

* *Achillea millefolium* L. ssp. *lanulosa* (Nutt.) Piper

Ageratina altissima (L.) King & H. E. Robins. [= *Eupatorium rugosum* Houtt.]

Ambrosia artemisiifolia L.

Antennaria sp. Unvouchered report by Cooney.

* *Anthemis arvensis* L.

* *Anthemis cotula* L.

* *Anthemis tinctoria* L.

* *Artemisia biennis* Willd.

Artemisia campestris ssp. *caudata* (Michx.) Hall & Clements. Listed as rare in New Jersey (Snyder 1997).

* *Artemisia stellariana* Bess.

* *Artemisia vulgaris* L.

Aster divaricatus (Nutt.) T. & G.

Aster dumosus L.

Aster ericoides L. Unvouchered report by Cooney; listed as rare in New Jersey (Snyder 1997).

Aster laevis L.

Aster lanceolatus Willd. var. *simplex* (Willd.) A. G. Jones

*Introduced

Aster pilosus Willd.
Aster puniceus L.
Aster racemosus Elliott
Aster tenuifolius L.
Aster undulatus L.
Baccharis halimifolia L.
Bidens bipinnata L.
Bidens laevis (L.) BSP. Reported by Chrysler (1930); not recently observed.
* *Bidens polylepis* Blake. Unvouchered report by Cooney.
* *Centaurea biebersteinii* DC. [= *Centaurea maculosa* Lam.]
* *Centaurea cyanus* L.
* *Chrysanthemum leucanthemum* L.
* *Cichorium intybus* L.
* *Cirsium arvense* Scop.
Cirsium discolor (Muhl. ex. Willd.) Spreng. Unvouchered report by Cooney.
Cirsium horridulum Michx.
* *Cirsium vulgare* (Savi) Tenore
Conyza canadensis (L.) Cronq. var. *canadensis*
Conyza canadensis (L.) Cronq. var. *pusilla* (Nutt.) Cronq.
Coreopsis lanceolata L.
Erechtites hieraciifolia (L.) Raf.
Erigeron annuus (L.) Pers.
Erigeron philadelphicus L.
Erigeron strigosus Muhl.
Eupatorium album L.
Eupatorium dubium Willd. ex Poir.
Eupatorium hyssopifolium L. var. *hyssopifolium*
Eupatorium hyssopifolium L. var. *laciniatum* A. Gray. Listed as rare in New Jersey (Snyder 1997).
Eupatorium perfoliatum L.
Eupatorium serotinum Michx.
Euthamia graminifolia (L.) Nutt.
Euthamia tenuifolia (Pursh) Nutt.
* *Galinsoga parviflora* Cav.
* *Galinsoga quadriradiata* Ruiz & Pavon
Gnaphalium obtusifolium L.
* *Helianthus petiolaris* Nutt.
* *Heterotheca subaxillaris* (Lam.) Britton & Rusby
* *Hieracium caespitosum* Dumort
* *Hieracium floribundum* Wimmer & Grab.
* *Hypochaeris radicata* L.
Iva frutescens L. ssp. *oraria* (Bartlett) R.C. Jackson
Lactuca biennis (Moench) Fern.
Lactuca canadensis L.
* *Lactuca serriola* L.
* *Matricaria discoidea* DC. [= *M. matricarioides* (Less.) Porter]
Mikania scandens (L.) Willd.
Pluchea odorata (L.) Cass. var. *succulenta* (Fern.) Cronq.
* *Rudbeckia hirta* L. var. *pulcherrima* Farw.
* *Senecio vulgaris* L.
Solidago canadensis L. var. *scabra* T. & G.
Solidago gigantea Ait. Unvouchered report by Cooney.
Solidago juncea Ait.
Solidago latissimifolia Miller [= *S. elliottii* T. & G.]. Listed as rare in New Jersey (Snyder 1997).
Solidago nemoralis Ait.
Solidago rugosa Miller
Solidago sempervirens L. var. *mexicana* (L.) Fern.
Solidago sempervirens L. var. *sempervirens*
Solidago ulmifolia Aiton
* *Sonchus oleraceus* L.
* *Taraxacum laevigatum* (Willd.) DC.
* *Taraxacum officinale* Weber
* *Tragopogon dubius* Scop. [= *T. major* Jacq.]
* *Tragopogon pratensis* L.
Xanthium strumarium L. var. *canadense* (Miller) T. & G.
Xanthium strumarium L. var. *glabratum* (DC.) Cronq. Unvouchered report by Cooney.

Berberidaceae

* *Berberis thunbergii* DC.
* *Berberis vulgaris* L.

Betulaceae

Alnus glutinosa (L.) Gaertn.
Betula populifolia Marsh.

Bignoniaceae

Campsis radicans (L.) Seemann
* *Catalpa bignonioides* Walt.

Boraginaceae

* *Buglossoides arvensis* (L.) I. M. Johnson [= *Lithospermum arvense* L.]
* *Echium vulgare* L.
* *Myosotis stricta* Link ex Roemer & J.A.

*Introduced

Schultes [= *M. micrantha* Pallas ex Lehm.]

Brassicaceae

* *Alliaria petiolata* (Bieb.) Cavara & Grande

* *Arabidopsis thaliana* (L.) Heynh.

Arabis lyrata L. Reported by Chrysler (1930); not recently observed.

* *Barbarea verna* (Miller) Aschers.

Cakile edentula (Bigelow) Hook.

* *Capsella bursa-pastoris* (L.) Medikus

* *Cardamine hirsuta* L.

* *Draba verna* L.

Lepidium virginicum L.

* *Lunaria annua* L.

* *Raphanus raphanistrum* L.

Buddlejaceae

* *Buddleja davidii* Franch.

Cactaceae

Opuntia humifusa (Raf.) Raf.

Caesalpiniaceae

Chamaecrista fasciculata (Michx.) Greene

Chamaecrista nictitans (L.) Moench

* *Gleditsia triacanthos* L.

Campanulaceae

Triodanis perfoliata (L.) Nieuwl.

Caprifoliaceae

* *Lonicera japonica* Thunb.

* *Lonicera tatarica* L.

Sambucus canadensis L.

Viburnum dentatum L. var. *lucidum* Ait. [= *V. recognitum* Fern.]

Viburnum dentatum L. var. *venosum* (Britt.) Gleason

* *Viburnum opulus* L. Unvouchered report by Cooney.

Caryophyllaceae

* *Agrostemma githago* L.

* *Arenaria serpyllifolia* L.

* *Dianthus armeria* L.

* *Holosteum umbellatum* L.

Honckenya peploides (L.) Ehrh. ssp. *robusta* (Fern.) Hulten. Listed as rare in New Jersey (Snyder 1997).

Sagina decumbens (Elliott) T. & G.

* *Saponaria officinalis* L.

* *Scleranthus annuus* L.

Silene antirrhina L. Reported by Chrysler (1930); not recently observed.

* *Silene latifolia* Poiret

* *Silene vulgaris* (Moench) Garcke

* *Spergula arvense* L.

* *Spergularia marina* (L.) Griseb.

* *Spergularia rubra* (L.) J. & K. Presl

* *Stellaria media* (L.) Vill.

Celastraceae

* *Celastrus orbiculatus* Thunb.

Celastrus scandens L.

Euonymus atropurpureus Jacq. Unvouchered report by Cooney.

* *Euonymus europaeus* L.

Chenopodiaceae

Atriplex arenaria Nutt. [= *A. pentanda* (Jacq.) Standl. ssp. *arenaria* (Nutt.) Hall & Clem.]

* *Atriplex patula* L.

* *Bassia hirsuta* (L.) Aschers.

* *Bassia hyssopifolia* (Pallas) Volk.

* *Chenopodium album* L.

* *Chenopodium ambrosioides* L.

Chenopodium leptophyllum Nutt. Listed as rare in New Jersey (Snyder 1997).

* *Cycloloma atriplicifolium* (Spreng.) Coult.

* *Kochia scoparia* (L.) Schrad.

Salicornia europaea L. [= *S. maritima* Wolff & Jeffries]

Salicornia virginica L.

Salsola kali L. ssp. *kali*

Salsola kali L. ssp. *tragus* (L.) Aellen [= *S. kali* L. ssp. *tenuifolia* Tausch]. Reported by Chrysler (1930); not recently observed.

* *Suaeda calceoliformis* (Hook.) Moq.

Suaeda linearis (Elliott) Moq.

Cistaceae

Hudsonia tomentosa Nutt.

Lechea maritima Leggett ex BSP.

Clusiaceae

Hypericum mutilum L.

* *Hypericum perforatum* L.

Triadenum virginicum (L.) Raf.

Convolvulaceae

Calystegia sepium (L.) R. Br.

* *Convolvulus arvensis* L.

Cornaceae

Cornus florida L.

Nyssa sylvatica Marshall

Crassulaceae

* *Sedum acre* L.

*Introduced

Cuscutaceae
Cuscuta sp.
Elaeagnaceae
* *Elaeagnus angustifolia* L.
* *Elaeagnus umbellata* Thunb.
Ericaceae
Gaylussacia baccata (Wangenh.) K. Koch
Rhododendron canadense (L.) Torr. Unvouchered report by Cooney; listed as rare in New Jersey (Snyder 1997).
Vaccinium corymbosum L.
Vaccinium pallidum Aiton
Euphorbiaceae
* *Euphorbia cyparissias* L.
Euphorbia maculata L.
Euphorbia polygonifolia L.
Fabaceae
Amorpha fruticosa L.
Apios americana Medikus
* *Cytisus scoparius* (L.) Link.
Lathyrus japonicus Willd. var. *maritimus* (L.) Kartesz & Gandhi [= *L. maritimus* Bigelow var. *glaber* (Set.) Eames]
* *Lathyrus latifolius* L.
Lespedeza capitata Michx.
* *Lespedeza cuneata* (Dum.-Cours.) G. Don
* *Lotus corniculatus* L.
* *Medicago lupulina* L.
* *Medicago sativa* L.
* *Melilotus alba* Medik.
* *Melilotus officinalis* (L.) Lam.
* *Robinia pseudoacacia* L.
Strophostyles helvola (L.) Elliott
* *Trifolium arvense* L.
* *Trifolium campestre* Schreber
* *Trifolium dubium* Sibth.
* *Trifolium pratense* L.
* *Trifolium repens* L.
* *Vicia cracca* L.
* *Vicia grandiflora* Scop.
* *Vicia villosa* Roth ssp. *varia* (Host) Corb. [= *V. dasycarpa* Ten.]
* *Wisteria floribunda* (Willd.) DC.
Fagaceae
Quercus coccinea Muenchh. Unvouchered report by Cooney.
Quercus palustris Muenchh.
Quercus rubra L.
Quercus velutina Lam.
Gentianaceae
Bartonia virginica (L.) BSP.
Geraniaceae
Erodium cicutarium (L.) L'Her ex Ait.
Geranium carolinianum L. var. *confertiflorum* Fern.
* *Geranium robertianum* L.
Hamamelidaceae
Liquidambar styraciflua L.
Lamiaceae
* *Glechoma hederacea* L.
* *Lamium amplexicaule* L.
* *Lamium purpureum* L.
* *Leonurus cardiaca* L.
Lycopus americanus Muhl. ex W. Bart.
* *Lycopus europaeus* L.
Lycopus virginicus L.
* *Nepeta cataria* L.
* *Origanum vulgare* L.
* *Prunella vulgaris* L.
Teucrium canadense L.
* *Thymus praecox* Opiz ssp. *arcticus* (Dur.) Jalas [= *T. serpyllum* L.]
Trichostema dichotomum L.
Trichostema setaceum Houtt. Reported by Chrysler (1930), not recently observed; listed as rare in New Jersey (Snyder 1997).
Lauraceae
Sassafras albidum (Nutt.) Nees.
Lentibulariaceae
Utricularia sp.
Lythraceae
* *Lythrum salicaria* L.
Magnoliaceae
Liriodendron tulipifera L. Reported by Mekenian (1968); not recently observed.
Malvaceae
* *Abutilon theophrasti* Medik.
Hibiscus moscheutos L.
Menispermaceae
Menispermum canadense L.
Mimosaceae
* *Albizia julibrissin* Durazz.
Molluginaceae
* *Mollugo verticillata* L.
Moraceae
* *Morus alba* L.
Morus rubra L.

*Introduced

Myricaceae
Comptonia peregrina (L.) Coult.
Myrica pensylvanica Loisel.
Nyctaginaceae
* *Mirabilis hirsuta* (Pursh) MacM. Unvouchered report by Cooney.
* *Mirabilis nyctaginea* (Michx.) MacM.
Oleaceae
Fraxinus americana L.
* *Ligustrum amurense* Carr.
* *Ligustrum ovalifolium* Hassk.
* *Ligustrum vulgare* L.
* *Syringa vulgaris* L.
Onagraceae
Circaea lutetiana L. ssp. *canadensis* (L.) Aschers. & Magnus
Epilobium coloratum Biehler
Oenothera biennis L.
Oenothera laciniata Hill.
Oenothera oakesiana (A. Gray) J.W. Robbins ex S. Wats. & Coult. [= *O. parviflora* L. var. *oakesiana* (A. Gray) Fern.]. Listed as rare in New Jersey (Snyder 1997).
Orobanchaceae
Orobanche uniflora L.
Oxalidaceae
* *Oxalis corniculata* L.
Oxalis stricta L.
Pedaliaceae
* *Proboscidea louisiana* (Miller) Thellung. Reported by Chrysler (1930); not recently observed.
Phytolaccaceae
Phytolacca americana L.
Platanaceae
* *Platanus* × *hybrida* Brot.
Plantaginaceae
* *Plantago aristata* Michx.
* *Plantago lanceolata* L.
* *Plantago major* L.
Plantago maritima L. var. *juncoides* (Lam.) A. Gray. Unvouchered report by Cooney; listed as rare in New Jersey (Snyder 1997).
* *Plantago psyllium* L.
Plantago rugelii Decne.
Plumbaginaceae
Limonium carolinianum (Walt.) Britt.

Polygonaceae
Polygonella articulata (L.) Meisn.
* *Polygonum arenastrum* Jord. ex Bereau
Polygonum aviculare L.
* *Polygonum cuspidatum* Sieb. & Zucc.
Polygonum glaucum Nutt. Listed as rare in New Jersey (Snyder 1997).
Polygonum hydropiperoides Michx.
Polygonum lapathifolium L.
Polygonum pensylvanicum L.
Polygonum punctatum Elliott
Polygonum ramosissimum Michx. var. *prolificum* Small [= *P. prolificum* (Small) B. L. Robins.]
Polygonum ramosissimum Michx. var. *ramosissimum*
Polygonum sagittatum L.
Polygonum scandens L.
Polygonum virginianum L.
* *Rumex acetosella* L.
* *Rumex crispus* L.
* *Rumex obtusifolius* L.
Rumex orbiculatus A. Gray
Rumex verticillatus L.
Portulacaceae
* *Portulaca grandiflora* Hook.
* *Portulaca oleracea* L.
Primulaceae
* *Lysimachia punctata* L.
Lysimachia quadrifolia L.
Pyrolaceae
Chimaphila maculata (L.) Pursh
Ranunculaceae
* *Clematis terniflora* DC.
* *Consolida ajacis* (L.) Schur [= *Delphinium ajacis* L.]
Ranunculus abortivus L.
* *Ranunculus bulbosus* L.
Rosaceae
Amelanchier canadensis (L.) Medik.
Aronia arbutifolia (L.) Pers.
Aronia × *prunifolia* (Marsh.) Rehd. Unvouchered report by Cooney.
Fragaria virginiana Duchesne
* *Potentilla argentea* L.
* *Potentilla recta* L.
Prunus maritima Marsh.
* *Prunus persica* (L.) Batsch
Prunus serotina Ehrh.

*Introduced

Prunus virginiana L. Unvouchered report by Cooney.
* *Pyracantha coccinea* M. Roemer
* *Pyrus communis* L. Unvouchered report by Cooney.
* *Pyrus sylvestris* Miller [= *P. malus* L.] Reported by Mekenian (1968); not recently observed.
* *Rosa eglanteria* L. [= *R. rubiginosa* L.] Reported by Chrysler (1930); not recently observed.
* *Rosa multiflora* Thunb. ex Murr.
Rosa carolina L.
* *Rosa rugosa* Thunb.
Rosa virginiana Miller
Rubus allegheniensis Porter
Rubus flagellaris Willd.
Rubus idaeus L. ssp. *strigosus* (Michx.) Focke
Rubus occidentalis L.
* *Rubus phoenicolasius* Maxim.

Rubiaceae
Cephalanthus occidentalis L.
Diodia teres Walt.
Galium aparine L.
Galium circaezans Michx.
Galium palustre L. Unvouchered report by Cooney; listed as rare in New Jersey (Snyder 1997).
Galium pilosum Aiton
Galium tinctorium L.
Mitchella repens L.

Salicaceae
* *Populus alba* L.
Populus deltoides Bartr. ex Marsh.
Populus grandidentata Michx. Reported by Chrysler (1930); not recently observed.
* *Populus nigra* L. Unvouchered report by Cooney.
Populus tremuloides Michx.
* *Salix alba* L.
Salix discolor Muhl.

Santalaceae
Comandra umbellata (L.) Nutt.

Scrophulariaceae
Agalinis purpurea (L.) Pennell
Linaria canadensis (L.) Dum.-Cours.
* *Linaria vulgaris* Miller
* *Verbascum blattaria* L.
* *Verbascum thapsus* L.
* *Veronica arvensis* L.
* *Veronica officinalis* L.
Veronica peregrina L.

Simaroubaceae
* *Ailanthus altissima* (Miller) Swingle

Solanaceae
* *Datura stramonium* L.
Solanum carolinense L.
* *Solanum dulcamara* L.
Solanum nigrum L. var. *virginicum* L.

Ulmaceae
Celtis occidentalis L.
Ulmus americana L.

Verbenaceae
Verbena hastata L.

Violaceae
Viola sororia Willd. [incl. *V. priceana* Pollard]

Vitaceae
* *Ampelopsis brevipedunculata* (Maxim.) Trautv.
* *Parthenocissus cuspidata* (Sieb. & Zucc.) Planch. Unvouchered report by Cooney.
Parthenocissus quinquefolia (L.) Planch.
* *Parthenocissus tricuspidata* (Sieb. & Zucc.) Planch.
Vitis aestivalis Michx.
Vitis riparia Michx. Unvouchered report by Cooney.
Vitis vulpina L. [= *V. cordifolia* Michx.] Reported by Chrysler (1930); not recently observed.

MAGNOLIOPHYTA–LILIOPSIDA

Agavaceae
Yucca filamentosa L.

Commelinaceae
* *Commelina communis* L.
Tradescantia virginiana L.

Cyperaceae
Bulbostylis capillaris (L.) Kunth ex C.B. Clarke
* *Carex kobomugi* Ohwi.
Carex pensylvanica Lam.
* *Cyperus amuricus* Maxim. [= *C. microiria* Steud.]

*Introduced

Cyperus diandrus Torr. Reported by Chrysler (1930); not recently observed.
Cyperus difformis L. State record for New Jersey.
Cyperus esculentus L.
Cyperus polystachyos Roth. var. *filicinus* (Vahl) C. B. Clarke [= *C. filicinus* Vahl].
Cyperus grayi Torr.
Cyperus lupulinus (Spreng.) Marcks ssp. *macilentus* (Fern.) Marcks
Cyprus retrorsus Chapman. Unvouchered report by Cooney.
Cyperus strigosus L.
Eleocharis obtusa (Willd.) Schultes
Scirpus cyperinus (L.) Kunth
Scirpus pungens Vahl
Scirpus validus Vahl

Juncaceae

Juncus dichotomus Elliott. Reported by Chrysler (1930); not recently observed.
Juncus effusus L.
Juncus gerardii Loisel.
Juncus tenuis Willd.

Lemnaceae

Lemna minor L.

Liliaceae

* *Allium vineale* L.
* *Asparagus officinalis* L.
* *Hemerocalis fulva* (L.) L.
* *Hosta ventricosa* (Salisb.) Stearn. Unvouchered report by Cooney.
Maianthemum canadense Desf.
Maianthemum racemosum (L.) Link [= *Smilacina racemosa* (L.) Desf.]
Maianthemum stellatum (L.) Link [= *Smilacina stellata* (L.) Desf.]
* *Ornithogalum umbellatum* L.
Polygonatum biflorum (Walt.) Elliott

Orchidaceae

* *Epipactis helleborine* (L.) Crantz

Poaceae

* *Agrostis capillaris* L.
* *Agrostis gigantea* Roth [= *A. alba* L.]
Agrostis hyemalis (Walt.) BSP.
Agrostis perennans (Walt.) Tuckerman
* *Agrostis stolonifera* L.
* *Aira caryophyllea* L.
Ammophila breviligulata Fern.
Andropogon gerardi Vitman. Unvouchered report by Cooney.
Andropogon virginicus L.
* *Anthoxanthum odoratum* L.
Aristida dichotoma Chapm.
Aristida oligantha Michx.
Aristida tuberculosa Nutt.
Aristida purpurascens Poir. var. *virgata* (Trin.) Allred [= *A. virgata* Trin.]
* *Avena sativa* L.
* *Bromus inermis* Leyss.
* *Bromus japonicus* Thunb. ex Murr.
* *Bromus tectorum* L.
Cenchrus carolinianus Walt. [= *C. pauciflorus* Benth.]
Cenchrus longispinus (Hack.) Fern. Unvouchered report by Cooney.
Cenchrus tribuloides L.
* *Chlorus verticillata* Nutt.
* *Cynodon dactylon* (L.) Pers.
* *Dactylus glomerata* L.
Dichanthelium clandestinum (L.) Gould [= *Panicum clandestinum* L.]
Dichanthelium meridionale (Ashe) Freckmann [= *Panicum meridionale* Ashe]
Dichanthelium oligosanthes (Schultes) Gould [= *Panicum oligosanthes* Schultes]. Listed as rare in New Jersey (Snyder 1997).
Dichanthelium sphaerocarpon (Elliott) Gould [= *Panicum sphaerocarpon* Elliott]
Digitaria cognatum (Schultes) Pilger [= *Leptoloma cognatum* (Schultes) Chase]
* *Digitaria ischaemum* (Schreber) Muhl.
* *Digitaria sanguinalis* (L.) Scop.
Distichlis spicata (L.) Greene
* *Echinochloa crusgalli* (L.) Beauv.
* *Eleusine indica* (L.) Gaertn.
Elymus riparius Wieg.
Elymus virginicus L.
* *Elytrigia repens* (L.) Nevski [= *Agropyron repens* (L.) Beauv.]
Eragrostis cilianensis (All.) Janchen
* *Eragrostis curvula* (Schrader) Nees
Eragrostis pectinacea (Michx.) Nees ex Steud.

*Introduced

* *Eragrostis pilosa* (L.) Beauv. Reported by Chrysler (1930); not recently observed.
Eragrostis spectabilis (Pursh) Steud.
* *Festuca elatior* L.
* *Festuca ovina* L.
Leersia virginica Willd.
* *Lolium perenne* L.
* *Microstegium vimineum* (Trin.) A. Camus
Muhlenbergia frondosa (Poir.) Fern.
Muhlenbergia schreberi Gmel.
Panicum amarulum A. S. Hitchc. & Chase. Unvouchered report by Cooney.
Panicum amarum Elliott
Panicum virgatum L.
* *Phleum pratense* L.
Phragmites australis (Cav.) Trin.
* *Poa annua* L.
* *Poa bulbosa* L.
* *Poa compressa* L. Reported by Chrysler (1930); not recently observed.
* *Poa pratensis* L.
* *Puccinellia maritima* (Huds.) Parl.
Schizachyrium scoparium (Michx.) Nash ssp. *scoparium*
Schizachyrium scoparium (Michx.) Nash. ssp. *littorale* (Nash) Gandhi & Smeins
* *Setaria faberi* Herrm.
* *Setaria glauca* (L.) Beauv. [= *S. lutescens* (Weigel) Hubbard]
* *Setaria viridis* (L.) Beauv.
Spartina alterniflora Loisel.
Spartina patens (Aiton) Muhl.
Spartina pectinata Link. Unvouchered report by Cooney.
Tridens flavus (L.) A. Hitchc.
Triplasis purpurea (Walt.) Chapm.
* *Vulpia myuros* (L.) Gmel.

Potamogetonaceae
Potamogeton sp.

Ruppiaceae
Ruppia maritima L.

Smilacaceae
Smilax glauca Walt.
Smilax rotundifolia L.

Typhaceae
Typha angustifolia L.
Typha latifolia L. Reported by Chrysler (1930); not recently observed.

Zosteraceae
Zostera marina L.

*Introduced

Bartonia No. 60: 117–120, 2000

Additions to the Flora of Potter County, Pennsylvania

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This account includes 80 species, 53 genera, and 4 families (Ceratophyllaceae, Elaeagnaceae, Lemnaceae, and Valerianaceae) as new to the flora of Potter County, Pennsylvania. Information on species previously collected in Potter County was obtained from a recent floristic atlas (Rhoads & Klein 1993) and an associated database (Pennsylvania Flora Database 1998). Voucher specimens, collected by Naczi and Thieret in 1996, are deposited in the herbarium of the Academy of Natural Sciences of Philadelphia (PH); some duplicates are at Northern Kentucky University (KNK) and the University of Michigan (MICH). Nomenclature largely follows that used in Rhoads & Klein (1993); if we depart from that source, the name used there is given in parentheses. The following list is alphabetical by family, genus, and species.

APIACEAE. *Aegopodium podagraria* (non-variegated form)—Ca. 6 mi W of Coudersport, lightly shaded roadside at edge of woods, *5731*, 22 Jun 1996, introduced. *Angelica atropurpurea*—Galeton, wet roadside ditch, *5741*, 22 Jun 1996. *Zizia aurea*—Ca. 5 mi S of Keating Summit, roadside, *5659*, 21 Jun 1996.

APOCYNACEAE. *Vinca minor*—Coudersport, deciduous forest behind Eulalia Cemetery, *5758*, 22 Jun 1996, introduced.

AQUIFOLIACEAE. *Ilex verticillata*—Andrews Settlement, sphagnous low area, *5775*, 23 Jun 1996.

ASTERACEAE. *Artemisia vulgaris*—Coudersport, roadside, *5761*, 22 Jun 1996, introduced.

BRASSICACEAE. *Alliaria petiolata*—Ca. 1 mi SE of Costello, floodplain forest, *5849*, 25 Jun 1996, introduced. *Barbarea verna* —Ca. 3 mi SW of West Pike, roadside, *5813*, 24 Jun 1996, introduced. *Brassica nigra*—Ca. 3 miles SE of Austin, *5846*, 25 Jun 1996, introduced. *Coincya monensis* ssp. *recurvata* (*Hutera cheiranthos*)—Ca. 10 mi E of Coudersport, rocky roadbank, *5740*, 22 Jun 1996, introduced. *Lepidium densiflorum*—Galeton, railroad yard, *5742*, 22 Jun 1996, introduced. *Raphanus raphanistrum*—Ca. 0.8 mi E of Andrews Settlement, roadside, *5783* (yellow-petalled form), *5784* (white-petalled form), 23 Jun 1996, introduced.

BERBERIDACEAE. *Berberis thunbergii*—Ca. 5 mi S of Keating Summit, *Tsuga-Fagus* forest, *5679*, 21 Jun 1996, introduced.

BETULACEAE. *Betula populifolia*—Ca. 5 mi SE of Wharton, deciduous forest, *5858*, 25 Jun 1996.

CAMPANULACEAE. *Campanula rapunculoides*—Ca. 5 mi SE of Wharton, roadside in deciduous forest, *5857*, 25 Jun 1996, introduced.

CAPRIFOLIACEAE. *Lonicera tatarica*—Ca. 5 mi S of Keating Summit, roadside, *5662*, 21 Jun 1996, introduced.

CARYOPHYLLACEAE. *Arenaria serpyllifolia*—Keating Summit, along railroad, *5709*, 21 Jun 1996, introduced. *Silene antirrhina*—Galeton, railroad yard, *5743*, 22 Jun 1996, introduced. *Silene vulgaris*—Ca. 6 mi W of Coudersport, lightly shaded roadside, *5730*, 22 Jun 1996, introduced.

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CERATOPHYLLACEAE. *Ceratophyllum demersum*—Andrews Settlement, shallow water, *5766*, 23 Jun 1996.

CORNACEAE. *Cornus canadensis*—Andrews Settlement, *Tsuga* woods, *5777*, 23 Jun 1996.

CYPERACEAE. *Carex albicans* var. *albicans*—Galeton, wooded slope, *5748*, 22 Jun 1996. *Carex annectens*—Andrews Settlement, old field, *5774*, 23 Jun 1996. *Carex argyrantha*—Galeton, wooded slope, *5751*, 22 Jun 1996. *Carex brunnescens*—Andrews Settlement, forest, *5772*, 23 Jun 1996. *Carex canescens*—Andrews Settlement, wet sphagnum, *5771*, 23 Jun 1996. *Carex cephaloidea*—Galeton, edge of mesic forest, *5753*, 22 Jun 1996. *Carex cephalophora*—Galeton, wooded slope, *5749*, 22 Jun 1996. *Carex deweyana*—Ca. 5 mi S of Keating Summit, *Tsuga-Fagus* forest, *5682*, 21 Jun 1996. *Carex foenea*—Ca. 2 mi ESE of West Pike, recently cleared slope, *5824*, 24 Jun 1996. *Carex gracilescens*—Ca. 6 mi W of Coudersport, riverbank, *5728*, 22 Jun 1996. *Carex hirsutella*—Ca. 4 mi SSW of Keating Summit, old field, *5691*, 21 Jun 1996. *Carex laxiculmis* var. *laxiculmis*—Ca. 6 mi W of Ulysses, deciduous forest, *5778*, 23 Jun 1996. *Carex leptalea*—Ca. 3 mi SW of West Pike, sphagnous depression, *5811*, 24 Jun 1996. *Carex lucorum* —Ca. 1.5 mi SSW of Sunderlinville, dry wooded slope, *5797*, 23 Jun 1996. *Carex molesta*—Galeton, railroad yard, *5744*, 22 Jun 1996. *Carex novae-angliae*—Ca. 1.5 mi W of Coudersport, *Tsuga-Fagus* forest, *5737*, 22 Jun 1996. *Carex pallescens*—Ca. 4 mi SSW of Keating Summit, old field, *5689*, 21 Jun 1996. *Carex pedunculata*—Ca. 5 mi S of Keating Summit, *Tsuga-Fagus* forest, *5683*, 21 Jun 1996. *Carex platyphylla*—Ca. 1 mi SE of Costello, deciduous forest, *5856*, 25 Jun 1996. *Carex prasina*—Ca. 5 mi S of Keating Summit, streambank, *5664*, 21 Jun 1996. *Carex sparganioides*—Coudersport, deciduous forest, *5756*, 22 Jun 1996. *Carex tonsa* var. *rugosperma*—Ca. 2 mi ESE of West Pike, disturbed slope, *5825*, 24 Jun 1996. *Carex trichocarpa*—Ca. 6 mi W of Coudersport, roadside on floodplain, *5721*, 22 Jun 1996. *Carex woodii*—Ca. 5 mi NE of Coudersport, deciduous forest, *5837*, 24 Jun 1996. *Scirpus expansus*—Ca. 5 mi S of Keating Summit, wet shaded soil along stream, *5666*, 21 Jun 1996.

ERICACEAE. *Chamaedaphne calyculata*—Ca. 1.5 mi SSW of Sunderlinville, wetland, *5806*, 23 Jun 1996.

ELAEAGNACEAE. *Elaeagnus umbellata*—Ca. 1.5 mi SW of Sunderlinville, sunny disturbed area at parking lot, *5807*, 23 Jun 1996, introduced.

FABACEAE. *Coronilla varia*—Ca. 4 mi SSW of Keating Summit, roadside, *5699*, 21 Jun 1996, introduced. *Robinia hispida*—Ca. 5 mi NE of Coudersport, roadside bank, *5761a*, 23 Jun 1996, introduced. *Vicia villosa* ssp. *varia*—Ca. 2 mi SE of Keating Summit, roadside, *5705*, 21 Jun 1996, introduced. *Vicia tetrasperma*—Andrews Settlement, old field, *5773*, 23 Jun 1996, introduced.

GERANIACEAE. *Geranium carolinianum*—Ca. 2 mi ESE of West Pike, roadside, *5816*, 24 Jun 1996. *Geranium robertianum*—Ca. 1 mi NW of Loucks Mills, forest edge, *5788*, 23 Jun 1996, introduced.

IRIDACEAE. *Iris pseudacorus*—Ca. 2 mi NW of Loucks Mills, roadside ditch, *5787*, 23 Jun 1996, introduced.

JUNCACEAE. *Luzula multiflora*—Andrews Settlement, *Tsuga* woods, *5776*, 23 Jun 1996.

LEMNACEAE. *Lemna minor*—Ca. 6 mi W of Coudersport, shallow pond, *5734*, 22 Jun 1996.

LYCOPODIACEAE. *Lycopodium hickeyi*—Ca. 1.5 mi SSW of Sunderlinville, dry edge of wetland, *5801*, 23 Jun 1996.

ONAGRACEAE. *Ludwigia palustris*—Ca. 6 mi W of Coudersport, in shallow water at edge of pond, *5734a*, 22 Jun 1996.

POACEAE. *Agrostis hyemalis*—Ca. 2 mi ESE of West Pike, disturbed slope, *5821*, 24 Jun 1996. *Arrhenatherum elatius*—Ca. 5 mi S of Keating Summit, roadside, *5660*, 21 Jun 1996, introduced. *Bromus commutatus*—Ca. 2 mi W of Coudersport, roadside, *5713*, 22 Jun 1996, introduced. *Bromus inermis* —Ca. 5 mi S of Keating Summit, roadside, *5658*, 21 Jun 1996, introduced. *Festuca rubra*—Ca. 6 mi W of Coudersport, roadside, *5718*, 22 Jun 1996, introduced. *Lolium perenne*—Ca. 1 mi SE of Costello, disturbed clearing, *5852*, 25 Jun 1996, introduced. *Panicum linearifolium*—Ca. 2 mi ESE of West Pike, disturbed slope, *5823*, 24 Jun 1996. *Phalaris arundinacea*—Ca. 6 mi SW of Coudersport, edge of field, *5711*, 21 Jun 1996. *Poa trivialis*—Ca. 5 mi S of Keating Summit, roadside, *5657*, 21 Jun 1996, introduced. *Puccinellia distans*—Ca. 6 mi W of Coudersport, roadside, *5719*, introduced. *Sphenopholis*

obtusata var. *major*—Galeton, railroad yard, *5746*, 22 Jun 1996. *Triticum aestivum*—Reynoldstown, roadside, *5786*, 23 Jun 1996, introduced.

POLYGONACEAE. *Polygonum cuspidatum*—Coudersport, edge of woods, *5844*, 25 Jun 1996, introduced.

RHAMNACEAE. *Rhamnus cathartica*—Coudersport, edge of woods, *5712*, 22 Jun 1996, introduced.

ROSACEAE. *Rosa multiflora*—Ca. 5 mi S of Keating Summit, roadside, *5654*, 21 Jun 1996, introduced. *Sanguisorba minor*—Keating Summit, along railroad, *5707*, 21 Jun 1996, introduced. *Spiraea tomentosa*—Ca. 4 mi SSW of Keating Summit, old field, *5695*, 21 Jun 1996.

SCROPHULARIACEAE. *Chaenorrhinum minus*—Keating Summit, along railroad, *5708*, 21 Jun 1996, introduced. *Melampyrum lineare*—Ca. 1.5 mi SSW of Sunderlinville, dry wooded slope, *5798*, 23 Jun 1996. *Veronica chamaedrys*—Ca. 6 mi W of Coudersport, riverbank, *5729*, 22 Jun 1996, introduced.

VALERIANACEAE. *Valeriana officinalis*—Ca. 2 mi W of Coudersport, roadside, *5715*, 22 Jun 1996, introduced.

DISCUSSION

Of the 80 species we report as new to Potter County, 43 (54%) are native to Pennsylvania and 37 (46%) are introduced to the state. The total number of species and infraspecific taxa previously recorded from Potter County is 702, of which 560 (80%) are native and 142 (20%) are introduced (Pennsylvania Flora Database 1998). Including our discoveries, 782 total taxa are now recorded for the county, with 603 (77%) natives and 179 (23%) exotics. These results are similar to those we reported for Bradford County (Naczi & Thieret 1996a), a county whose size and latitude are almost identical to those of Potter. In that study, also conducted in June, we recorded 80 species as new to the county, with 59% native and 41% introduced. Those additions gave that county 79% native and 21% introduced taxa for its total known flora (899 taxa).

The high proportion of introduced species among our county records indicates at least two things. First, introduced plants probably have been neglected in previous botanical exploration of the county. Second, such species probably have increased in importance in the flora in recent time. Among these introduced species, *Alliaria petiolata, Coincya monensis (Hutera cheiranthos), Elaeagnus umbellata, Polygonum cuspidatum, Puccinellia distans,* and *Rosa multiflora* appear to be recent invaders of Potter County. Rhoads and Klein (1993) included these exotics in a list of species that likely are spreading within Pennsylvania. In addition, Naczi and Thieret (1996b) documented the recent spread of *Coincya monensis* in Pennsylvania and elsewhere in the eastern United States. A large proportion of the natives (24 of 43, 56%) are members of the genus *Carex*. *Carex* is the most species-rich and taxonomically complex genus of vascular plants in Pennsylvania. Many field botanists avoid collecting *Carex* plants because they believe them to be too difficult to identify. Thus, neglect of these plants in past collecting in Potter County probably accounts, at least somewhat, for the large number of *Carex* species among our records.

Many of our county records, both natives and exotics, are quite expected. Such species as *Berberis thunbergii, Bromus commutatus, B. inermis, Carex annectens, C. cephalophora, C. hirsutella, C. laxiculmis var. laxiculmis, C. prasina, Cornus canadensis, Ilex verticillata, Lemna minor, Luzula multiflora, Melampyrum lineare, Panicum linearifolium, Phalaris arundinacea, Silene vulgaris, Vinca minor*, and *Zizia aurea* are recorded from adjacent counties, often commonly (Rhoads & Klein 1993). These records especially indicate that Potter County has received relatively little botanical exploration.

Some of our other records are rather surprising. *Carex foenea*, *C. molesta*, and *C. woodii* are native species somewhat disjunct from their other Pennsylvania occurrences. *Carex foenea* is a wide-ranging, boreal species with Pennsylvania as a portion of its southern range limit (Gleason & Cronquist 1991). Previous to our work, *C. foenea* was known from only two or three counties in Pennsylvania (Rhoads & Klein 1993). Its most recent previous collection in the state was in 1931. As a result, *C. foenea* was presumed extirpated in the state and it is listed for protection under the Pennsylvania Wild Plant Conservation Act (Rhoads & Klein 1993). *Carex molesta* and *C. woodii* are near the northern limits of their geographic ranges, at which their populations are quite scattered (Naczi, pers. observation). The introduced *Barbarea verna*, *Rhamnus cathartica*, and *Vicia tetrasperma* are a bit surprising, too. All appear to represent range extensions within Pennsylvania, northward (*B. verna* and *R. cathartica*) and westward (*V. tetrasperma*).

Our work illustrates the value of brief, intensive collecting in a relatively small region. We gathered a wealth of county records during only four full days' effort in a brief period of earliest summer. Certainly, floristic knowledge of Potter County has been incomplete. The flora of Potter County is better known now, though further botanical exploration will doubtless yield more records.

Acknowledgments

We thank Dr. Ann Fowler Rhoads (Morris Arboretum) for suggesting this study and for providing a list of the plant taxa previously recorded from Potter County and various statistics describing them, all generated from the Pennsylvania Flora Database. Dr. Anton A. Reznicek identified some of our sedge specimens and shared his knowledge of sedge distribution and ecology. Curt Weinhold, David W. Hauber, Malcom D. Waskiewicz, and Stan Hess told us of interesting habitats in Potter County. Northern Kentucky University contributed financially to the field work.

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Bartonia No. 60: 121–123, 2000

OBITUARIES

Hans Wilkens (12 January 1898–25 August 1993)

Born in Magdeburg, Germany, Hans Wilkens was the second of three children of Gustav Wilkens, master saddler/harness maker, and Luise Goldhagen Wilkens. His sister Elspeth or Elsie, with whom he lived until she died in 1974, was born in 1895. His younger brother, Arno, who was born around 1913 and died in the late 1980s, lived in Bridgeport, Connecticut, for much of his life.

Hans arrived in Reading in 1904 and learned English in a school run by St. John's Lutheran Church. He left high school to work at a number of different jobs, but still managed to complete his high school education at night. He graduated from Reading High Evening School in 1915. At the age of 19 he was working for the Textile Machine Works and was issued an alien work/residence permit stating that he "Continue to reside within/Be employed within an area of one-half of a mile radius from Textile Machine Co., Wyomissing, PA." He became a U.S. citizen in 1921. He retired from the Textile Machine Co., where he worked as a machinist, in 1963. In 1985 he left his home in Reading and moved to the Lutheran Home at Topton, Pennsylvania, where he resided until his death.

During his years of employment as a machinist and after his retirement, Hans not only developed a comprehensive knowledge of the flora of Berks County, but for much of North America as well. He also had in interest in philosophy and music. In 1975 he published a checklist of the flora of Berks County in Bartonia No. 43, which enhanced his reputation as the "dean" of Berks County botanists. He collected extensively and deposited thousands of botanical specimens at the Academy of Natural Sciences and the Reading Public Museum. His estate, worth about $300,000, came to the Academy after his death.

I met Hans soon after I came to the Academy of Natural Sciences in 1962 and did a considerable amount of field work with him. It was a cherished educational experience for me. My appreciation was partially expressed by naming a sedge that grows in southern Texas and northern Mexico as *Scirpus wilkensii* (*Not. Nat. Acad. Nat. Sci. Philadelphia* No. 423: 4, 1969).

Hans was always happy to share his botanical knowledge and there were many who benefited from his willingness to do so. He was active in the Philadelphia Botanical Club where he was a member from 1942 until his death. Hans succeeded John M. Fogg, Jr. as Curator of the Academy's Local Herbarium/Herbarium of the Philadelphia Botanical Club in 1983 and held the position until his death. There was no question that Hans loved botany, but what impressed me the most about him was how much he did while working 12-hour days (reduced to 8 on Friday, 4 on Saturday, 0 on Sunday) at the Textile Machine

Co. Despite working long hours as a machinist, Hans had a comprehensive knowledge of botany that included mosses, liverworts, and hornworts as well as vascular plants. This knowledge enriched the lives of many professional and amateur botanists.

ALFRED E. SCHUYLER

Grace Mary Tees (4 August 1906–9 November 1995)

Grace Tees, daughter of Rev. Francis and Grace I. Tees, lived most her life in the Germantown section of Philadelphia, and had bachelor's and master's degrees from the University of Pennsylvania. In 1933, she completed her master's thesis, "An Annotated Checklist of the Mosses of Philadelphia and Vicinity." Also in 1933, she gave a talk on "Interesting Mosses of the Philadelphia Region" at the November meeting of the Philadelphia Botanical Club, which also included talks by John M. Fogg, Jr., on algae, and Lewis E. Anderson on how to identify mosses. She joined the Philadelphia Botanical Club in 1934 and remained a member until her death. Her work in the Academy herbarium as a graduate student led, later in the 1930s, to a position as an assistant. Francis Pennell wrote (1943; *Bartonia* 22: 30) that she "put in order a large proportion of the [Academy's] Bryophytes that had long been awaiting attention, at the same time contributing many of her own collections, largely made within our Local Area." She also helped with various other herbarium chores. While working for Francis Pennell, she found manuscript materials of Lewis David von Schweinitz stored away in "some long-closed boxes in the Botanical Department" that came to the Academy in 1834 (1938; *Bartonia* 19: 49). These were Schweinitz's herbarium "Record Book" and his flora, *Synopsis Plantarum Americanarum*. These are extremely valuable source materials for early 19th century botany.

After leaving the Academy in 1938, Grace taught at the Abington Friends School. She retired from school teaching in 1966, and in 1971 was an Academy employee again. Her work focused on mounting, filing, and identifying collections in the Academy's Local Herbarium/Herbarium of the Philadelphia Botanical Club until her retirement from the Academy in 1988. She was the club's assistant curator of this collection from 1983 to 1990. Grace also was active in fostering field investigation of the local flora by encouraging club members to search for rare species in previously known localities. This effort is reflected in her paper: "Plants of Frazier's Bog, Montgomery County, Pennsylvania" (1979; *Bartonia* 46: 43-44).

Grace often entertained members of the Academy's Botany Department at her home and garden in Germantown during the spring. She was particularly fond of the irises in her garden. These pleasant outings ended about the time she left the Academy, and moved from her home in Germantown to Rydal Park, Pennsylvania, where she resided until her death.

Grace often told me how much she appreciated having the opportunity to work in the Academy's herbarium. Looking back, it seems to me it should have been the other way around: she's the one who deserved appreciation. Her devotion to both the Philadelphia Botanical Club and the Academy of Natural Sciences was demonstrated by the fact she left a large portion of her estate (about $50,000) to the botanical club to be used for the care and maintenance of the Academy's Local Herbarium/Herbarium of the Philadelphia Botanical Club.

ALFRED E. SCHUYLER

Bartonia No. 60: 124, 2000

Book Review

Chapel Hill and Elisha Mitchell the Botanist, by Rogers McVaugh, Michael R. McVaugh, and Mary Ayers. North Carolina Botanical Garden, Contribution No. 1, and Occasional Publications of the Chapel Hill Historical Society, No. 1. 1996. 122 pp. + fold-out map. $12.50. (Available from North Carolina Botanical Garden, University of North Carolina, CB #3375, Totten Center, Chapel Hill, NC 27599-3375; or Chapel Hill Historical Society, P.O. Box 9032, Chapel Hill, NC 27515-9032.)

Amateur and professional botanists should find great interest in the botanical work of Elisha Mitchell contained in the four short chapters and five appendices of this book. Elisha Mitchell (1793–1857), a graduate of Yale College, came to Chapel Hill in 1818 to teach mathematics at the University of North Carolina. The University, then in operation for 23 years, was still geographically isolated with much of its original flora in a wilderness separated from the small village. In 1824, Mitchell was named acting President. A year later he became Professor of Chemistry, Mineralogy, and Geology, a position he held during his entire life. That same year, 1825, he became head of the North Carolina Geological Survey, and not long thereafter, was made the bursar of the University with responsibility for most adminstrative decisions. He built the University library into one of the best in the sciences. Although his greatest contribution to science was in geology, he also had a great interest in botany.

Mitchell's fascination with the study of botany manifested itself only a few months after his arrival in Chapel Hill, where in 1819 he began exploring for plants in the local area. In the midst of his University teaching schedule, Mitchell devoted a part of every weekday afternoon to collecting plants in the forest and field. He was most active during the spring seasons from 1820 to 1822. Mitchell wrote his botanical notes in a ledger, and many of these notes are faithfully reproduced in this book's four chapters.

Mitchell's initial interest in botany appears to have been fostered by his contacts with the Rev. Lewis David von Schweinitz (1780–1835), the botanist and administrator of the Moravian church estates in North Carolina. Schweinitz lived in Salem until 1821 when he moved to Bethlehem, Pennsylvania. Mitchell sought help from Schweinitz in the identification of plants, and these efforts are described in the chapter "Mitchell and Schweinitz." Mitchell's own efforts as a floristic botanist are presented in the next chapter, as are his limited interactions and correspondence with two other North Carolina botanical friends, Moses Ashley Curtis (1808–1872) of Hillsborough and Hardy Bryan Croom (1797–1837) of New Bern.

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Bartonia No. 60: 125–126, 2000

NEWS AND NOTES

1994 THROUGH 1996 NORTHERN DELAWARE RARE PLANT SURVEY HIGHLIGHTS. The 1994 botanical field season in New Castle County and northern Kent County, funded by the Delaware Natural Heritage Program, involved a number of specific site surveys as well as more general exploration, but still yielded the by now usual number of new state records, relocations, and new sites for rare plants. Less exploration was done in the Piedmont area of Delaware than in years past, but that area of the state can still surprise the dedicated botanist. In the Brandywine drainage, new finds included several stations for *Carex conjuncta*, including relocations of sites discovered by Robert Naczi, indicating that this sedge may be on the move in northern New Castle County; a couple of additional sites for *Carex davisii*; two stations for the former SH species *Fraxinus nigra*; a site for *Mentha canadensis* (former SH); additional sites for *Solidago ulmifolia* and *Osmorhiza claytonii*, indicating that the latter had been overlooked in previous surveys; and finally, a small population of the new state record *Poa palustris* on the edge of a cornfield adjacent to a marsh. Unfortunately the farmer increased his tillage area in 1995 and may have eliminated that grass from the state's flora.

In the Red Clay drainage, a jaunt with Richard Lighty of the Mt. Cuba Center yielded new stations for *Pellaea atropurpurea* and *Woodsia obtusa* on an old barn wall, and the first modern station for *Fraxinus nigra* in Delaware. Other notable discoveries included a site for *Thaspium barbinode* (former SH), a third station for *Carex granularis*, two stations for *Poa sylvestris*, and sites for *Juncus subcaudatus*, *Mentha canadensis*, *Salix sericea*, and *Monarda fistulosa* (all former localities for *M. fistulosa* previously recorded in the state actually proved to be *M. clinopodia*). Other notable rarities found in the Piedmont included *Carex styloflexa* (former SH) in the Mill Creek drainage; *Cardamine angustata* (*Dentaria heterophylla*) along Pike Creek; a single plant of *Aplectrum hyemale* near Middle Run; and *Panicum yadkinense* and *Dryopteris celsa* in the Shellpot.

During a Coastal Zone survey project, a number of rarities were found in various small drainages of central Kent County. The St. Jones drainage yielded *Iris prismatica* and *Lysimachia hybrida*, and the Murderkill provided *Amianthium muscaetoxicum* in a less usual wetland habitat. At other central Kent County sites the following were found: *Spiraea latifolia*; *Andropogon gerardii*, along an active railroad; *Pyrrhopappus carolinianus* (former SH), and *Aureolaria pedicularia* near a former landfill; *Polygala cruciata*, *Liatris graminifolia*, and another *Pyrrhopappus* site along a major road; *Pycnanthemum incanum*; and a relocation of an early 90s site for *Cardamine parviflora* var. *arenicola*. During a project in southeast Kent County, despite difficulty in exploration caused by ice storm damage the previous year, the following rarities were observed: *Carex joorii*, *Smilax pseudo-china*, *Polygala cruciata*, and *Hypericum gymnanthum*. The Coastal Plain of New Castle County for the most part was merely passed through, but a canoe trip along Drawyers Creek yielded stations for *Drypoteris celsa* and *Fraxinus nigra*, among other rarities, including two stations of *Geum virginianum* (former SH) and *Quercus lyrata*.

The Choptank drainage in western Kent County provided much of the excitement in 1994. The first down-state station for *Arabis lyrata* was discovered in an old sandpit, and near this same series of sandpits numerous other rarities were found, adding to the list of

those found in 1993: *Pycnanthemum incanum*, *Agalinis tenuifolia* and *Andropogon gerardii* along a roadside; and *Rhynchosia tomentosa* (former SH). An active landfill provided an enormous population of *Leptoloma cognatum* (S2), along with another but smaller population of *Rhynchosia tomentosa*, *Polygonum scandens* var. *cristatum* (former SH) at a site first observed by Keith Clancy of the Heritage program, and the new state record *Botrychium oneidense*. An upland dry but rich wood pocket yielded *Eupatorium sessilifolium*, *Hedyotis purpurea*, *Solidago ulmifolia*, and *Triosteum angustifolium* (former SH). *Liparis lilifolia* and *Cyperus hystricinus*, among other species, were discovered by Bill McAvoy of the Heritage program. A rich wooded bank, first described by R. R. Tatnall, yielded a large population of *Aquilegia canadensis*, along with unusual downstate stations of *Dryopteris marginalis* (S4) and *Woodsia obtusa*. These finds along the Choptank were topped however by a find elsewhere: a large and healthy population of *Triphora trianthophora* (former SH) in full bloom, at a most unusual Coastal Plain station.

Unfortunately in 1995 and 1996 funding for the Delaware Heritage program was reduced, resulting in far fewer surveys being made for the state. However, partly due to independent survey requests, a number of rarities were found. In 1995, during a survey of Woodlawn Trustees' property along the Brandywine Creek, the following plants were found: *Arabis laevigata*, at only its second Delaware station; *Chamaelirium luteum*, at its third Delaware station; and the new state record grass *Danthonia compressa*. En route to surveys in Caroline County, Maryland, the botanists inadvertently discovered in the Choptank drainage a small population of *Matelea caroliniensis* and more importantly, a sterile population of the rare vine *Trachelospermum difforme* (former SH). In 1996, a survey in the Brandywine valley turned up two plants of *Cypripedium pubescens* (unfortunately, both were consumed by deer later in the year); a single plant of *Smilax hispida*; a second Delaware population of *Thaspium barbinode*; and late in the year, a small vine of *Smilax pseudo-china*.

JANET EBERT AND JACK HOLT

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Bartonia No. 60: 128–129, 2000

1995 FIELD TRIPS

20 May: Warren Grove, Burlington and Ocean Counties, NJ. One of the most unusual dwarf pine communities lies astride Beaver Dam Road just west of Warren Grove. Harshbarger (1916) named this pocket the Little Plains. On a portion of the site, the Federal Aviation Administration (FAA) erected three Volmet tower complexes in 1992. In exchange for this approval, the Pinelands Commission required the development of a management plant (prepared by the leader) providing for the protection, maintenance, and enhancement of the rare species present. We came here to observe, in part, the positive impacts of the management strategies employed: mowing, select cutting, and fencing. As determined from an examination of annual rings, the trees on site revealed no history of fire during the past 60 years. The sandy overburden is underlain by a pink silt-clay or loam which causes water to perch near the surface. These site conditions have provided suitable habitat for a greater number of rare species (7) than one normally would associate with pitch pine plains. All were impressed by the state's largest occurrence of *Corema conradii*, already well beyond bloom. We saw *Muhlenbergia torreyana*, *Calamovilfa brevipilis*, *Scleria pauciflora*, remnants of *Rhynchospora knieskernii* and *R. pallida*, and leaves of *Gentiana autumnalis*. Still in bud were *Lyonia mariana* and *Xerophyllum asphodelloides*. A large population of *Leiophyllum buxifolium* was in peak bloom, while *Pyxidanthera* was barely hanging on. Other plants in anthesis were *Hudsonia ericoides*, *Helianthemum canadense*, *Krigia virginica*, *Hypoxis hirsuta*, *Viola lanceolata*, *V. primulifolia*, *Aronia arbutifolia*, *Gaylussacia baccata*, *G. frondosa* (starting), *Vaccinium corymbosum*, *V. pallidum*, and *V. angustifolium*. The various huckleberries and blueberries were compared and contrasted in detail. Of note was the presence of *V. angustifolium* in the Plains. Stone (1911) listed this taxon as rare in the Pine Barrens, citing only one station there, Bamber. The species is not listed in the works of Lutz, Little, McCormick, Good, and others who did extensive research in the Plains. It appears that only Harshbarger (1916) cited it for this region. He also had it at Chatsworth and near Whiting. Today it occurs at scattered points in the Barrens. Our search for *Helonias* and *Arethusa* in the adjacent cedar swamp bordering the Oswego River was unsuccessful. We encountered fine carpets of a typical *Sphagnum* flora, *Juncus canadensis*, *J. caesariensis*, *Carex livida*, *C. barrattii*, *C. exilis*, and extensive patches of *C. striata*. At our final stop at Webbs Mills several miles to the north, we saw in anthesis *Arethusa*, *Trientalis borealis*, and *Orontium aquaticum*. (Thanks go to George Mancywoda for maintaining a species list.) Leader: Ted Gordon.

11-15 June: Bruce Peninsula, Ontario, Canada. The annual Joint Field Meeting of the Philadelphia Botanical Club, the Northeastern Section of the Botanical Society of America, and the Torrey Botanical Club was housed at Wildwood Lodge in Red Bay on Lake Huron. Localities visited included Kemble Forest, a maple woodland growing on the deeply fissured dolomite crest of the Niagara escarpment. *Phyllitis scolopendrium* and *Polystichum lonchitis* were found commonly here. At Dyer Bay we looked at alvars (dolomite pavements) in a rich scrub forest. *Cypripedium calceolus*, *Castilleja coccinea*, and *Hymenoxys herbacea* grew in profusion here. Also seen were *Corallorhiza striata* and the Great Lakes endemic *Iris lacustris*. Dorcas Bay fen and Oliphant fen are renowned for their orchids. *Pinguicula vulgaris* and *Sarracenia purpurea* were profuse here. We also visited Cave Point and Half-

way Dump on the eastern side of the peninsula. A day was spent on Flower Pot Island, so-called because of its tall dolomite formations carved into towers wide at the top and tapering downward. This island is in the national park system and is a haven for ferns and wildflowers including *Polygala pauciflora*, *Corallorhiza striata*, *Calypso bulbosa*, *Linnaea borealis*, *Orobanche uniflora*, *Cryptogramma stelleri*, *Asplenium viride*, *Listera cordata*, and *Goodyera oblongifolia*. Evening speakers were Professor John Morton, who gave an introductory lecture on the flora of Bruce Peninsula, and Dr. Stan Shetler, who gave a slide show on his trip through the Northwest Passage. Chairperson: Joan Norwicke. Leaders: John Morton and Jeff Kaiser. Report by Carol Levine.

26 August: Savanna near Oswego Lake, Burlington County, NJ. Southeast of Lake Oswego, we explored an extensive, relatively open savanna that periodically has been swept by wildfire. Such fires helped to maintain the pioneer conditions desired by the diverse flora we encountered. Some of the species we saw were *Scleria reticularis* var. *pubescens*, *Muhlenbergia torreyana*, *M. uniflora*, *Xyris fimbriata*, *Carex livida*, *C. barrattii*, *Rhynchospora pallida*, *R. gracilenta*, *R. alba*, *Narthecium americanum*, *Tofieldia racemosa*, *Juncus caesariensis*, and *Agrostis perennans* var. *elata*. A brief search for a known population of *Calamagrostis pickeringii*, an endangered grass, was unsuccessful. However, thanks to Bill Olson, we can include *Sphagnum cyclophyllum*, an S2 taxon, for this site. We drove to Stafford Forge Wildlife Management Area expressly to see the massive population of *Utricularia purpurea* in full bloom within an impoundment that once served as a cranberry bog. Our final stop brought us to an abandoned gravel hole just off Route 539 on the southern edge of the Lower Plains. In this small pool that behaves like an intermittent pond, we saw a fine population of *Rhynchospora knieskernii*. Leader: Ted Gordon.

23 September: Taylor's Preserve, Cinnaminson, NJ. One purpose of this trip was to add to the plant list of this 125 acre preserve. Seventy-three new species were found, bringing the total list to 287, of which 192 are native plants. Most of the additions were relatively widespread late-summer species of mesic situations, such as *Mirabilis nyctaginea*, *Tridens flavus*, *Eragrostis spectabilis*, *Aster pilosus*, *Mikania scandens*, *Bidens polylepis*, and *Rudbeckia laciniata*, with a sprinkling a somewhat less common species including *Lilium superbum*, *Croton glandulosus*, and *Laportea canadensis*. Exploration of the intertidal zone of the Delaware River, however, added *Acorus calamus*, *Scutellaria lateriflora*, *S. galericulata*, *Typha* × *glauca*, *Mimulus alatus*, and *Bidens bidentoides* to the list. The dry bottom of a small intermittent pond, just north of the preserve boundary, produced several robust clumps of the rare *Scirpus smithii*, as well as *Proserpinaca palustris* and *Cyperus erythrorhizos*. Many thanks to trip participants, particularly Ann Newbold, Mary Leck, and Ted Gordon, for their help with various identifications. Leader: Karl Anderson.

1 October: St. Peters to Warwick, Chester County, PA. Joined by members of the Valley Forge Audubon Society, we followed the Horseshoe Trail from the St. Peters village parking lot to Warwick. At Trythall Rd. in Warwick we explored a large bog owned by the Pennsylvania Game Commission. Here we saw *Aster cordifolius*, *A. divaricatus*, *A. lanceolatus*, *A. laevis*, *A. lateriflorus*, *A. novae-angliae*, *A. prenanthoides*, *A. patens*, *A. pilosus*, *A. puniceus*, *A. macrophyllus*, *A. schreberi*, *Gentiana andrewsii*, *Gentianopsis crinita*, *Rudbeckia fulgida*, *Cuphea petiolata*, *Lindernia dubia*, *Aristolochia serpenteria*, numerous *Solidago* species, and the rare *Pedicularis lanceolata*. Leaders: Ann Newbold and Heinrich Zoller.

Bartonia No. 60: 130–133, 2000

1996 FIELD TRIPS

10–12 May: Pocono Environmental Education Center, Pike and Monroe Counties, PA. In Tumbling Waters Ravine, we observed a good stand of *Trillium erectum*. In Hornbecks Ravine, we encountered a diverse display of spring flora and ate lunch in the roar of a waterfall. Among the species we observed were *Actaea alba*, *A. rubra*, *Aquilegia canadensis*, *Asarum canadense*, *Caramine bulbosa*, *Caulophyllum thalictroides*, *Chrysosplenium americanum*, *Dicentra cucullaria*, *Hepatica americana*, *Mitella diphylla*, *Sambucus racemosa*, *Senecio aureus*, *Streptopus roseus*, *Tiarella cordifollia*, *Uvularia sessilifolia*, *Viola conspersa*, *V. cucullata*, *V. pensylvanica*, *V. rostrata*, and *V. rotundifolia*. A short hike to Dingmans Falls allowed us to observe *Lycopodium porophilum* high up on the rock cliffs opposite the falls. Other species observed here included *Asplenium trichomanes*, *Acer spicatum*, and the stair-step moss, *Hylocomium splendens*. Saturday's trip finished up in the ravine of Conashaugh Creek with its typical spring flora. Here we searched unsuccessfully for *Viola selkirkii*, said to have been seen here in the recent past. Nearby we stopped to see a colony of *Campanula rotundifolia*. Many rosettes of an introduced *Digitalis*, either *D. lanata* or *D. lutea*, were seen near Route 209. On Sunday we visited Hogback Ridge near Bushkill which has a variety of acidic and alkaline geology. In both upland and wetlands communities we observed *Lobelia siphilitica*, *Geum rivale*, *Rubus pubescens*, *Asplenium rhizophyllum*, and *Equisetum fluviatile*. Leader: Bill Olson.

2 June: Atsion/Quaker Bridge area of the Mullica and Batsto Rivers, Burlington County, NJ. A joint expedition of the Torrey and Philadelphia Botanical Clubs visited a wet swale southeast of Atsion, not far from Route 206 and about a quarter mile from the west bank of the Mullica River. There had been severe summer fires here in 1983 and 1984. In bloom was *Iris prismatica* and soon to bloom was *Viburnum nudum* Dominating the bog iron swale were members of the sedge family: *Carex barrattii*, *C. striata*, *C. bullata*, *Dulichium arundinaceum*, *Eleocharis tenuis*, *Scirpus cyperinus*, and *S. longii*. The grasses included *Andropogon glomeratus*, *A. virginicus*, *Erianthus giganteus*, *Muhlenbergia torreyana*, *Panicum virgatum*, and *Amphicarpum purshii*. Flowering in the adjacent dry, dune-like areas of scattered *Pinus rigida*, *Quercus ilicifolia*, and Q. *marilandica* were *Minuartia caroliniana* (= *Arenaria* c.), *Hudsonia ericoides*, *Kalmia angustifolia*, *Leiophyllum buxifolium*, and *Lyonia mariana*. After eating lunch on a bluff overlooking the Batsto above Quaker Bridge, we walked south on Shamong Trail through dry, sandy pine/oak forest dominated by *Pinus rigida*, *P. echinata*, *Quercus ilicifolia*, *Q. prinoides*, *Q. prinus*, *Q. stellata*, and *Q. velutina*. Here, only *Lyonia mariana* was in bloom. In or along the Atlantic white-cedar swamp bordering the river, several *Carex* species were found: *C. stricta*, *C. crinita*, *C. atlantica*, *C. exilis*, *C. trisperma*, *C. livida*, *C. collinsii*, and *C. folliculata*. Associated species were *Magnolia virginiana*, *Nyssa sylvatica*, *Acer rubrum*, *Orontium aquaticum*, *Sabatia difformis*, *Sarracenia purpurea*, *Leucothoe racemosa*, and *Eriocaulon compressum*, the two latter in bloom. A little-known composite, *Sclerolepis uniflora*, was found along the edge of the stream corridor near the bridge. The leader read an 1818 letter from John Torrey which mentioned finding *Schizaea pusilla* at Quaker Bridge. Here within 250 feet of the spot where it was first discovered in 1805, we found the curly, sterile fronds of this diminutive fern. Also present were *Juncus caesariensis*, *Calopogon tuberosus*, *Pogonia ophioglossoides*, and about 30 flowering

stalks of *Arethusa bulbosa.* The final stop was an iron-ore savanna along the Batsto just above Lower Forge. This ancient oxbow comprises a quaking bog carpeted by sphagnum mosses. We had to proceed with caution to avoid sinking to the waist. Among several sphagnum species were *Sphagnum flavicomans*, *S. pulchrum*, *S. magellanicum*, and *S. pylaesii.* In bloom were *Eriocaulon compressum*, *Iris prismatica*, *Sarracenia purpurea*, *Carex exilis*, and *Danthonia sericia* var. *epilis.* Conspicuous members of the Cyperaceae included *Cladium mariscoides*, *Eriophorum virginicum*, and *Rhynchospora fusca*, and three sundew species, *Drosera filiformis*, *D. intermedia*, and *D. rotundifolia*, were present in abundance. Other species included *Aster nemoralis*, *Lophiola aurea*, *Narthecium americanum*, *Platanthera blephariglottis*, *Sabatia difformis*, *Utricularia fibrosa*, and *Xyris torta.* (My thanks go to Patrick Cooney for maintaining a species list and for assisting with this report.) Leader: Ted Gordon.

15 June: High Point State Park, Sussex County, NJ. This was a joint meeting with members of the Torrey Botanical Club. The group met near High Point Monument, highest elevation (1,803 feet/550 m) in the state. After viewing some of the characteristic species of the Kittatinny Ridge, including *Betula papyrifera*, *Sorbus americana*, *Acer pensylvanicum*, *Amelanchier laevis*, and the only New Jersey population of *Potentilla tridentata*, the group moved downhill for some botanizing of wood edges near a picnic area. Here were found *Epipactis helleborine*, *Paronychia canadensis*, *Hedyotis caerulea*, and various heath shrubs, including *Gaylussacia baccata* and four species of *Vaccinum*: *V. corymbosum*, *V. pallidum*, *V. angustifolium*, and *V. stramineum.* A few non-vascular species were examined, including the lichens *Hypogymnia physodes*, *Flavoparmelia caperata*, *Parmelia squarrosa*, and *Punctelia rudecta*, and three species of *Politrichum*: *P. ohioense*, *P. peliferum*, and *P. juniperinum*. Most of the afternoon was taken up by a 1.5-mile walk around the Dryden Kuser Natural Area, known locally as the "cedar swamp." Here, *Picea mariana* was seen growing with *Chamaecyparis thyoides*, *Tsuga canadensis*, and *Pinus rigida* in a wet forest. Among the plants seen were several northern species, including *Nemopanthus mucronatus*, *Calla palustris*, *Coptis trifolia*, *Clintonia borealis*, *Cornus canadensis*, and *Smilacina trifolia.* Sedges seen included *Carex folliculata*, *C. trisperma*, *C. lurida*, *C. gynandra*, and *C. intumescens.* Ferns included *Thelypteris simulata*, *T. noveboracensis*, *Pteridium aquilinum*, *Dennstaedtia punctilobula*, *Osmunda regalis*, and extensive stands of *O. cinnamomea* and *O. claytoniana.* A lsit is available from the trip leader, as is a complete list of the plants of the Kuser Natural Area. Leader: Karl Anderson.

23-27 June: Albany, NY. The annual joint field meeting of the Philadelphia Botanical Club, the Torrey Botanical Club, and the Northeastern Section of the Botanical Society of America was housed at the Albany campus of the State University of New York. There were three days of field trips, plus evening lectures. Localities visited included Hollyhock Hollow Sanctuary, a state Audubon preserve with a relatively young dry forest habitat; Joralemon County Park, a rich woods with some wetland and exposed limestone outcrops; the Ice Meadows along the Hudson River, a globally rare ecological community; the Albany Pine Bush, a 2,000-acre (800-ha) remnant of what was once a 100,000-acre (40,000-ha) pitch pine-oak barrens; and John Boyd Thacher State Park, a wooded area on the geologically interesting Helderberg Escarpment. Evening programs were presented by Dr. Yngvar Isachsen, New York State Geologist, who gave an introduction to the geology of the areas visited; Bob Zaremba, of The Nature Conservancy, who gave a slide presentation showing a variety of the state's ecological communities and the rare plants associated with them; Chris Hawver, Fire Ecologist at the Albany Pine Bush Preserve, who described their rather

complex fire management procedures; and Dr. Richard Mitchell, New York State Botanist, who described a computer program which uses a random access key to identify ferns of the Northeast and which could be a model for similar programs dealing with other taxonomic groups. Chairperson: Ed Miller. Leaders: Bob Zaremba, Greg Edinger, Robert Ingalls, Evelyn Greene, Chris Hawver, and other local botanists. Report by Karl Anderson.

14 July: Long Pond Preserve, Monroe County, PA. We met at The Nature Conservancy's Pocono Mountains office, in a historic schoolhouse near the edge of a large complex of barrens and wetlands on the southern Pocono Plateau, the Conservancy's highest priority area for biodiversity conservation in Pennsylvania. It harbors the state's highest concentration of globally rare terrestrial species. Our walk coincided with the publication of an account of the botanical history, floristics and ecology of the site, "The Pocono till barrens: shrub savanna persisting on soils favoring forest" (*Bull. Torrey Bot. Club* 123: 330-349). We walked through a landscape little changed from the one described in June 1779 by the first people to mention the barrens in writing, members of General John Sullivan's 1779 military expedition against the Iroquois. Most of the walk was through dense shrub "savannas" dominated by *Kalmia angustifolia*, *Quercus ilicifolia*, *Rhododendron canadensis* and *Pinus rigida*. The till barrens—so called because they occur on loamy soils formed from glacial till—include some of the largest stands of rhodora anywhere in the species' range. Across 5,000 acres of this habitat, plants normally found in wetlands grow intermixed with species usually seen in dry, sandy or rocky habitats. We saw many of the same species reported by the earliest botanists: Frederick Pursh (who visited Long Pond on 13 and 14 June 1807), Prince Maximilian of the German kingdom of Wied (25 and 26 August 1832), and Thomas C. Porter (22 to 25 August 1859). The unusual mix of species seen on our walk included *Abies balsamea*, *Amelanchier sanguinea*, *Amianthium muscaetoxicum*, *Aronia melanocarpa*, *Aster umbellatus*, *Brachyelytrum erectum*, *Calamagrostis cinnoides*, *Carex polymorpha*, *Carex vestita*, *Chamaedaphne calyculata*, *Comandra umbellata*, *Coptis trifolia*, *Gentiana linearis*, *Glyceria obtusa*, *Larix laricina*, *Lycopodium hickeyi*, *Lyonia ligustrina*, *Oryzopsis racemosa*, *Picea rubens*, *Prenanthes trifoliolata*, *Solidago puberula*, *Trillium undulatum*, *Vaccinium angustifolium*, *V. corymbosum*, *V. oxycoccos*, *V. pallidum*, *V. stamineum*, and *Viburnum cassinoides*. We examined a research area where prescribed burning eliminated the invading red maples and allowed barrens herbs and low shrubs to proliferate, including rare species such as *Carex polymorpha*. Leader: Roger Latham.

28 July: Inskips, Winslow Twp., Camden County, NJ. Our trip began on Winslow Rd., in the southern edge of the Winslow Wildlife Management Area. We walked a dirt access road into excavations that had provided fill for the Atlantic City Expressway. Here we encountered most of the shrubs and trees associated with upland and lowland communities of the Pine Barrens. We also saw numerous colonies of *Monotropa hypopithys*, *Hypericum stans*, and *H. hypericoides*. At an excavation that created a shallow pond, we observed *Rhychospora alba*, *R. capitellata*, *R. fusca*, *Eleocharis olivaceae*, *E. tuberosa*, and the rare *E. quadrangulata*. This pond also supported populations of *Utricularia purpurea*, *U. subulata*, *Brasenia schreberi*, and, on its western shore, *Xyris smalliana*. Nearby, at Winslow Rd. over the Great Egg Harbor River, we saw mistletoe, *Phoradendron serotinum*, in the tops of many large blackgum trees that line the river's shores. Dense vegetation concealed the majority of the plants, but a few were spotted with the aid of binoculars. From the shooting range of the management area, we walked into the site of the legendary "Blue Hole," popularized by Henry C. Beck in his classic, *More Forgotten Towns of Southern New Jersey*. Along the way we noted *Polygala lutea*, *Eleocharis microcarpa*, *Amphicarpum purshii*, *Carex pensylvanica*,

C. tonsa, *Solidago fistulosa*, and *Leiophyllum buxifolium*. The hole contained nothing botanically significant. We concluded it was not of meteor origin but an excavation that provided the fill necessary to build the causeway we had just walked. The blue color of the water is attributed to clay lenses in the soil. The riverine fill forms a road 1,000 feet (300 m) long through a huge wetland complex associated with the river's floodplain. This includes Atlantic white-cedar stands, lowland pine forests, and red maple swamps of large proportions. Leader: Joe Arsenault.

8 September: Lebanon State Forest and Route 563, Burlington County, NJ. Under the leadership of three expert mycologists, Club members explored the diverse fungal flora of the Pakim Pond vicinity during an annual foray of the New Jersey Mycological Association. In spite of relatively dry conditions, the mushroom count reached 52 species. Included in the collection were *Lactarius volemus*, *Russula variata*, *Clavulina cristata*, *Scleroderma citrinum*, *S. geaster*, *Suillus salmonicolor*, *Ganoderma lucidum*, *Amanita muscaria* var. *formosa*, and an undescribed *Amanita* found by and to be named by Dr. Tulloss. At noon, the botanists separated from the mycologists. On the border of Pakim Pond we observed *Eleocharis robbinsii* and a vigorous population of *Schizaea pusilla*. Nearby, on a shoulder of Shinn Road, we saw a scattering of *Gentiana autumnalis* associated with *Calamovilfa brevipilis*, *Pyxidanthera barbulata*, *Leiophyllum buxifolium*, *Xerophyllum asphodeloides*, and *Aster gracilis*. Because of the recent county implementation of a no-mowing policy along designated strips of Route 563 beginning at its junction with Route 72, we were able to witness an impressive floral display comprised of *Liatris graminifolia*, *Solidago erecta*, *Agalinis setacea*, *Chrysopsis mariana*, *Aster spectabilis*, *A. gracilis*, *A. patens*, *A. concolor*, and an apparent hybrid of the latter two. Here and there, the showier plants were highlighted against a backdrop of fruiting grasses of *Calmovilfa brevipilis*, *Sorghastrum nutans*, and *Tridens flavus*. We concluded our trip south of the Chatsworth cemetery, adding *Aster linariifolius*, *A. dumosus*, *Solidago nemoralis*, *S. puberula*, *S. stricta*, *S. canadensis* var. *scabra*, *S. rugosa*, *S. odora*, *Eupatorium album*, *E. hyssopifolium*, *Spiranthes cernua*, and *Toxicodendron vernix*. (Thanks go to Dr. Varney for assisting T. Gordon with this report.) Leaders: Rod Tulloss, Ray Fatto, Gene Varney, and Ted Gordon.

14 September: Canoe trip on the Oswego River, Pinelands of Burlington County, NJ. Water level was adequate as we paddled from Oswego Lake to Harrisville Lake. Stops were made at various savannas along the river. The species seen in these open communities included *Schizaea pusilla*, *Lycopodiella alopecuroides*, *L. appressa*, *Pseudolycopodiella caroliniana*, *Muhlenbergia uniflora*, *Rhynchospora oligantha*, *Scleria reticularis* var. *pubescens*, *Tofieldia racemosa*, *Narthecium americanum*, *Polygala lutea*, *P. cruciata*, *P. brevifolia*, *P. nuttallii*, *Utricularia juncea*, and *U. fibrosa*. Aquatic species observed included *Potomogeton confervoides*, *Eleocharis robbinsii*, *Scirpus subterminalis*, *Juncus militaris*, *Xyris smalliana*, and *Nymphoides odorata*. Leader: Bill Olson.

EDITOR'S NOTE

Field trip reports from 1997, 1998 and 1999 will appear in the next issue of *Bartonia*. Field trip leaders who have not already done so are encouraged to send reports of their trips during those years to the editor.

Bartonia No. 60: 134–135, 2000

PROGRAM OF MEETINGS
1995–1999

Date	*Subject*	*Speaker*
1995		
26 Jan	Smoky Mountains Wildflower Symphony/Concerto. (Spring wildflowers of the Smokies)	George H. Beatty
23 Feb	The Eastern Botanical Influence on Western Exploration	James L. Reveal
23 Mar	Blue-Eyed Grasses (*Sisyrinchium*: Iridaceae) of the Eastern United States with Special Emphasis on the Tri-State Area	Kathleen Hornberger
27 Apr	Rushes of North America	Steven E. Clemants
25 May	Rare Species in Disturbed Habitats	Alfred E. Schuyler
28 Sep	Slide-Illustrated Report of Summer Botanizing	Club Members
26 Oct	Lewis David von Schweinitz: Featuring His Outstanding Fungus Paintings, His Life and His Contributions to Mycology and Botany	Alfred E. Schuyler, Wilman Spawn and Eugene Varney
16 Nov	The Life and Work of Constantine Samuel Rafinesque	George H. Beatty
21 Dec	A Review of Plant Classification Systems from the Linnaean Sequence to DNA Sequence	Gerry Moore
1996		
25 Jan	Research in Conservation Biology at the Pocono Till Barrens—Pennsylvania's Little Newfoundland	Roger Latham
22 Feb	The Endemic Flora of the Canary Islands	William F. Olson
28 Mar	Noteworthy Plant Discoveries in Delaware	William McAvoy
25 Apr	Edible, Poisonous and Other Interesting Mushrooms with Emphasis on the Fungal Flora of the New Jersey Pine Barrens	Eugene Varney and Ray Fatto
23 May	Ecosystems of Long Island, New York	Eric E. Lamont
26 Sep	Slide-Illustrated Report of Summer Botanizing	Club Members
24 Oct	Benjamin Smith Barton and His Influence on American Botany	Alfred E. Schuyler
21 Nov	Does East Equal West?—A Comparison of the Ferns of the Eastern United States and Japan	John Mickel
19 Dec	Trilliums from Seed to Flower	John Gyer
1997		
23 Jan	Botanical Studies in the Bahamas	Timothy Block
27 Feb	Changes of Vegetation and Landscape Caused by 5,000 Years of Pasturing in the Central Swiss Alps	Heinrich Zoller
27 Mar	The Potomac Valley: A Botanical Overview and Some Questions on Distribution	Robert G. Johnsson
24 Apr	The Rio Grande Swamp of Cape May County, New Jersey	Keith Seager
22 May	A 90 Acre Seed Trap—the Duck Island Constructed Wetland	Mary Leck
25 Sep	Slide-Illustrated Report of Summer Botanizing	Club Members
23 Oct	The Botanical Contributions of Henry Muhlenberg	Alfred E. Schuyler
20 Nov	Relic Prairies and Prairie Plants of Pennsylvania	Ann Rhoads
18 Dec	Algae and the Origin of Land Plants	Richard McCourt

1998		
22 Jan	The Plant Collection of the Lewis and Clark Expedition	James L. Reveal
26 Feb	Some Generic Realignments in Sedges and How to Recognize Them	Alfred E. Schuyler
26 Mar	The Mushroom's Basement: The Ecological Role of Fungi	John Dighton
23 Apr	Ecology of the Conifer Peat Swamps of Northern New Jersey	Eric F. Karlin
28 May	Orchids of New Jersey	Ted Gordon
24 Sep	Slide-Illustrated Report of Summer Botanizing	Club Members
22 Oct	John Bartram and Philadelphia Botany	Alfred E. Schuyler
19 Nov	The Endemic Flora of Madagascar	Heinrich Zoller
17 Dec	Revisiting the Taxonomy and the Medicinal Benefits of Vaccinium (Cranberry/Blueberry)	Nicholi Vorsa
1999		
28 Jan	Local Herbs and Shrubs Used in Healing	Ara Der Marderosian
25 Feb	Understanding Succession in Serpentine Barrens to Conserve Grasslands and Rare Species	Roger Latham
25 Mar	The Vegetation Zones of Brazil	William Wayt Thomas
22 Apr	Turfcuts of the New Jersey Pine Barrens: A Haven for Special Plants	Patricia A. Gordon and Ted Gordon
20 May	John Bartram 300: A Gathering (symposium co-sponsored by the Philadelphia Botanical Club)	
23 Sep	Slide-Illustrated Report of Summer Botanizing	Club Members
28 Oct	Two Important Tropical Florida Plant Communities	Stevens Heckscher
18 Nov	Puerto Rico: Its Natural History	Bill Olson
16 Dec	The History of the Philadelphia Botanical Club's Herbarium	Alfred E. Schuyler

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Erratum

In *Bartonia* No. 59, under 1994 Field Trips, 13 August, p. 146, line 3, *Sphagnum angustifolium*, in New Jersey known only from Sussex and Warren counties, inadvertently was listed as occurring in the quaking bogs above Martha Furnace. The intended taxon was *S. carolinianum*.

T. Gordon

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